WIND EROSION IN THE REGION OF ZÁHORIE ON AN EXAMPLE OF CADASTRAL DISTRICT DOJČ

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Abstract

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The paper is about soil erodability in the region of Záhorie shown on an example of the cadastral district of Dojč. The interest territory belongs to the most affected Slovak regions because conditions for wind erosion whether natural or anthropogenic have been met here. The paper takes these factors affecting intensity and course of winter erosion into account. Soil properties (soil kind), climatic factors – territory dustiness, soil surface humidity and anthropogenic factors – ploughed fields and vegetation cover.

Key words: wind erosion, soil kind erodibility

Introduction

In Slovakia large losses in agriculture and in deterioration of individual elements of the environment are caused by wind and water erosion. Of above shown wind erosion participates in these losses by 10–20% while on flat territories of the region of Záhorie this share is higher (Streďanský, 1993).

Wind erosion of soil is a function (STN 75 4501, 2000) both of natural soil properties such as: soil grain composition, soil structure, organic mass content in the soil, soil humidity, etc. and outer characteristics of the territory: climatic conditions, soil surface abrasiveness, soil vegetation cover, woody species representation, the length of unprotected territory in the direction of prevailing winds, etc.

According to Pasák (1970) it is reasoned, that protection against wind erosion in our climatic conditions is necessary in regions with frequent winds where the average annual aggregate of precipitation is below 550 mm together with forest coverage smaller than 20%, on sandy and sandy and loamy soils.

The highest wind erodability of soils happens on light soils (sandy and loamy), it is markedly lower on medium heavy soils (sandy loam and loamy) and the smallest is on soils medium heavy (clayey-loamy) and very heavy (clayey soils and clay). Wind erosion research in the region of Záhorie was made for instance by Streďanský, 1993; Dudek, 2004 and others. Indirect research, that is research of vegetation cover was made for instance by. Šomšák (1976), Halada et al. (1994), Šíbl (2004) and others.

Material and methods

Study sites

From the view of regional geomorphological classification the interest territory belongs to Borská nížina (lowland) and partially to Chvojnická pahorkatina (upland) which together form a regional soil-ecological region of Záhorská nížina. The territory in question lies along both banks of the Myjava river. It is a lowland with slope up to 1° (Fig.1).

To evaluate climatic situation of the cadastral district of Dojč data from the closest hydrometeorologic station at Kuchyňa–Nový Dvor, with the average over the years 1961–1990 (Špánik, 2000) are shown below.

Temperature situation

Average annual air temperature is 9.1 °C.
Average annual air temperature during vegetation period (IV.–IX.) is 15.5 °C.
Average annual air temperature in January is –1.9 °C.

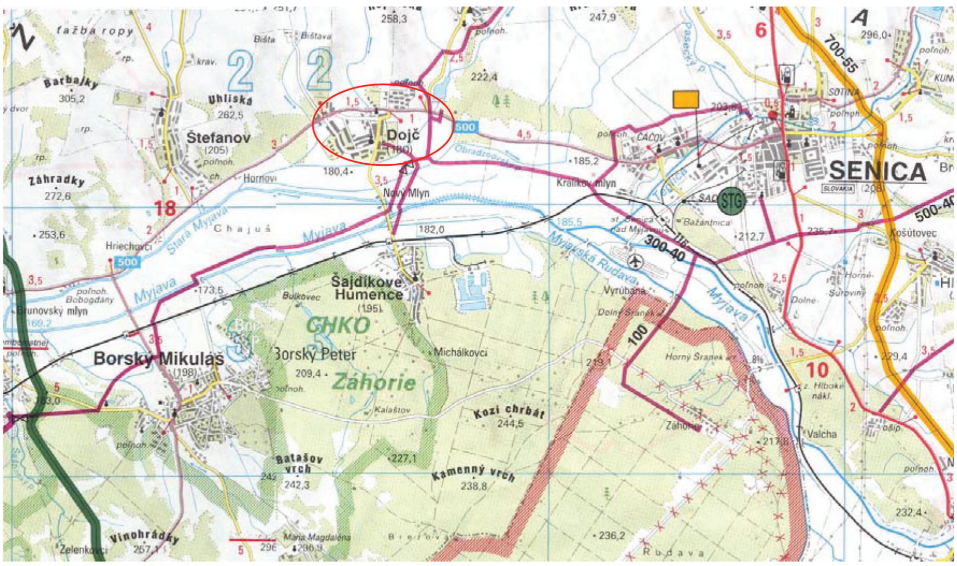

Fig. 1. Map of regions of Dojč.

Rainfall situation

Average annual rainfall aggregate is 651 mm.
Average annual rainfall aggregate during vegetation period (IV.–IX.) 387 mm.
The lowest annual rainfall aggregate is in January through March (I.–III.) 117 mm.

Wind situation

In the interest territory the prevailing direction of winds is southward. Relatively numerous are southwest and northwest winds. The lowest percent of occurrence has the west wind and highest mean velocity in $m.s^{-1}$ is reached by the southwest wind.

Soil situation

The characteristics of pedological properties of soils found in the cadastral district of Dojč was made on the basis of representation of classified (soil fertility) soil-ecological units (BPEJ) on the agricultural land. The data of BPEJ were obtained in a digital form from the administrator of the information system of soil fertility in Slovakia - Research Institute of Pedology and Plant Protection, Bratislava. Identification of percentage of soil kinds in the interest territory can be shown as follows:
Sandy and loamy soils – 23.7%
Sandy-loamy soils – 14.0%
Clayey soils – 48.8%
Clayey-loamy soils – 13.5%.
In the extravilan of the model territory the following representation of land kinds can be found in percentage of the acreage:
Arable land – 86.1%
Permanent grass stands – 0.8%
Gardens – 0.6%
Forest soils – 10.9%
The rest are water and other surfaces and built-up areas – 0.8%.
It is possible to divide methodically potential soil transport by wind into three parts:

- evaluation of the occurrence of winds according to their speed and duration
- single soil kinds erodibility determination
- calculation of soil transport on the basis of certain wind speed category data

and measured data of erodibility, drawing maps of erodibility.

Evaluation of the occurrence of winds according to their speed and duration

Wind conditions were evaluated at the Kuchyňa–Nový Dvor meteorological station, located in the centre of our region for 29 years. Anemographic records of this station were evaluated in one hour time intervals. We considered only those time intervals, when soil surface was dry " 0 " and this category is evaluated specifically in decades of individual months. Wind occurrence was classified to intervals by 5 $km.h^{-1}$. Wind evaluation method used for this case was described in detail by Streďanský (1991).

Determination of the erodibility of individual soil texture

The determination of soil erodibility of various soil textures with the earlier mentioned moisture surfaces of soil was made under laboratory conditions (in a wind tunnel). The damaged soil specimens, from which measuring was data taken, were modified in such a way that their surface was smooth and flat. Erodibility was determined on the following soil textures: sandy soil – P, loam sandy soil – HP, sandy loam soil – PH and loamy soil – H. On heavier soil textures no measurable denudation of soil was found. After ten measurements, the correlations were determined, and the following factors were taken into consideration as influencing the intensity and course of the wind erosion: soil texture, soil moisture and wind speed. More detailed measurements of soil erodibility were described by Streďanský (1993).

Soil transport calculation

The average potential soil transport was calculated on the basis of measured soil erodibility at catch soil texture situated in the observed region and the number of blowing winds according to single speed categories.

Erodibility map of the observed region was then drawn according to the calculated soil transport and soil texture occurrence.

Results and discussion

Results of wind evaluation according to speed and duration

An example of wind evaluation according to speed and duration measurements at the Kuchyňa–Nový Dvor meteorological station from 1961 to 1990 is shown in Fig. 2. Next regularities follow from the charts for the Kuchyňa–Nový Dvor region.

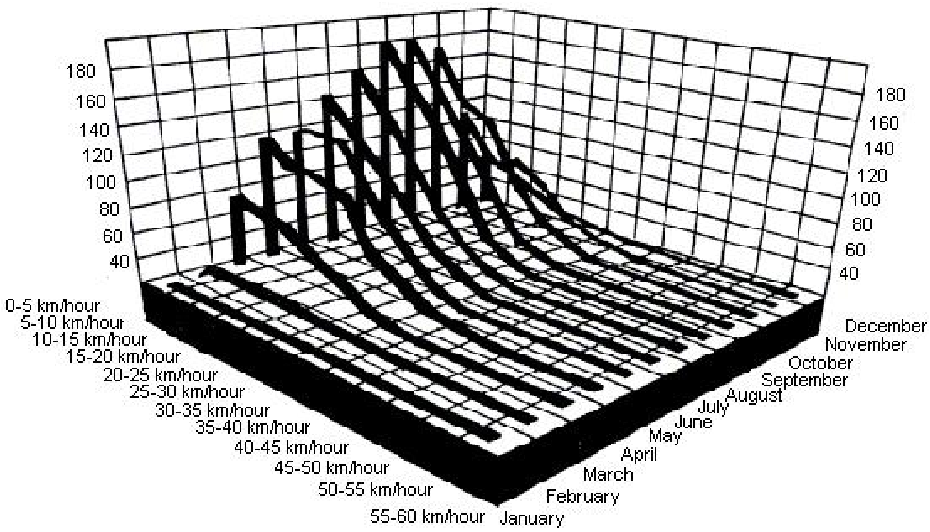

Fig. 2. Wind evaluation at the Kuchyňa–Nový Dvor meteorological station from 1980 to 2000 (Streďanský, 1993).

The number of wind occurrences at the soil surface moisture state " 0 " (dry soil) of all speed categories is the lowest in January, then relatively quickly rises and reaches the maximum in late spring and summer months. Successively, in autumn it starts to decrease and at the end of a year reaches low values again.

It follows from equations 1.–4. that dry soils " 0 " are the most predisposed to soil transport and the greatest potential danger according to erodibility in that year-periods, when wind appearance is the highest, with regard to the soil moisture (regardless vegetation suppressing effect).

Single soil textures susceptibility to erosion determination

Soil erodibility of single soil textures was determined in a wind tunnel for soil surface

- flat, loose and broken
- flat, compact.

The dependences between wind speed, soil surface moisture and soil transport were obtained by using linear correlation relationships. An example of relationships is expressed by these equations (for loose, broken soil surface):

sandy soil

$$\text{" 0 "} \quad y = -35.29 + 4.42\ x \tag{1}$$

loam sandy soil

$$\text{" 0 "} \quad y = -5.21 + 0.47\ x \tag{2}$$

sandy loam soil

$$\text{" 0 "} \quad y = -4.47 + 0.28\ x \tag{3}$$

loamy soil

$$\text{" 0 "} \quad y = -1.25 + 0.08\ x, \tag{4}$$

where y – transport of soil in $g.m^{-2}.h^{-1}$

x – speed of wind in $km.h^{-1}$ (measurement in the height of 8 m -calculation).

Wind soil transport calculation

Wind soil transport calculation for the Záhorská nížina lowland was done on the basis of certain wind speed categories, which were obtained by data evaluation obtained from the meteorological station – Kuchyňa–Nový Dvor and measured transport values from the wind tunnel for single soil types eq. (1) – (4).

This calculation was described in details by Streďanský (1991). Transport calculation according to wind erosion rate degree is shown in Table 1, where transport classification is done in accordance to Zacharcs classification (1984) (Table 2).

T a b l e 1. Establish stage of the wind ersosion intensity on agricultural soils in Dojč cadastral territory

Soil texture	Intensity rate degree	Intensity rate [%]	
		on arable land	on agricultural land
P + HP	3–4	10.1	9.8
PH	2–3	6.1	6.0
H	1–2	19.6	19.3

Legend: P – sandy soil, HP – loam sandy soil, PH – sandy loam soil, H – loamy soil, IH – clay loam soil, I – clayey

T a b l e 2. Area erosion and deflation classification according to intensity (Zachar, 1984)

Degree	Verbal evaluation	Erosive carry-away intensity		
		[m^3. ha^{-1}.y^{-1}]	[mm. y^{-1}]	[t. ha y^{-1}] *[1]
1	none	0–0.5	0–0.05	0–0.7
2	moderate	0.5–5	0.05–0.5	0.7–7
3	average	5–15	0.5–1.5	7–21
4	strong	15–50	1.5–5	21–70
5	very strong	50–200	5–20	70– 280
6	catastrophic	above 200	above 20	above 280

Legend: *[1] ρ_d= 1.4 t. m^{-3} (volume weight)

Conclusion

From the aspect of soil carry away by wind, the region of Záhorie and also lands in the cadastral district of Dojč, belong to the most affected regions of Slovakia. The main reason for the occurrence of wind erosion is representation of light soil kinds (sandy and loam) – 23.7%, high dustiness of the territory (speed and duration) and a lower aggregate of rainfalls compared to other regions of Slovakia.

As follows from Table 1 (Fig. 3), even 10.1% of arable lands in the interest territory can be affected by the 4 degree (strong erosion) and that is 9.8% of agricultural land. The 3 degree (medium erosion) endangers potentially 6.1% of arable lands (6.0% of agricultural soils) and by the 2 degree (slight erosion) 19.6% of arable (19.3% agricultural) lands. On the rest of arable lands that is on 64.2% (64.9% of agricultural soils) no wind erosion effect shave been determined, it is therefore the 1 intensity degree (no erosion).

Regarding the fact that cultivated crops in the interest territory reduce the intensity of wind erosion (Streďanský, 1993) to a great degree the effects of harmful, the so called accelerated erosion, are seen on about 10.1% of arable lands (9.8% agricultural soils) of the interest territory.

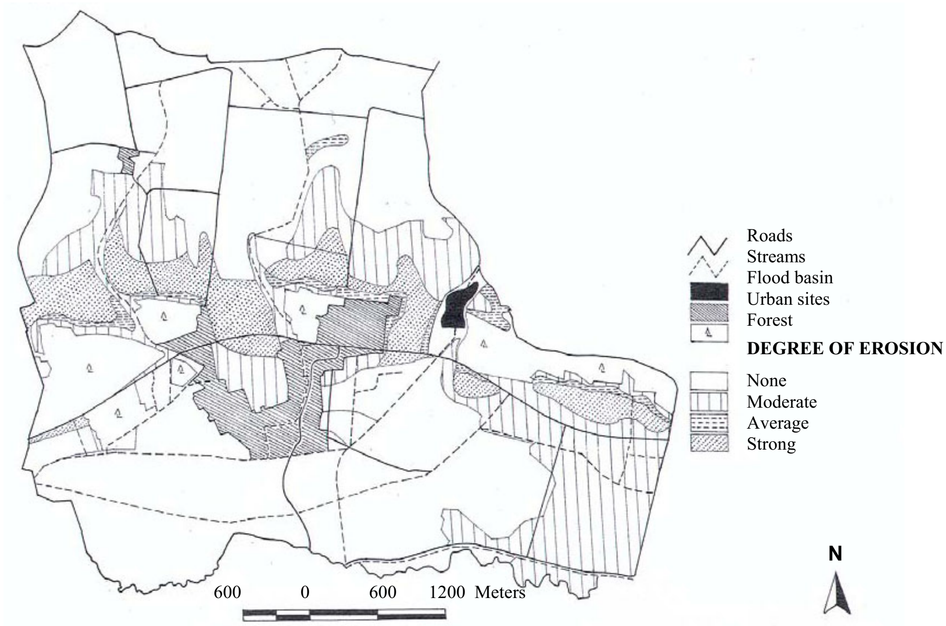

Fig. 3. Soil erodibility degrees by wind in Dojč cadastral territory.

By taking into account factors affinity affecting wind erosion intensity and its course, it is possible to apply the shown results with smaller deviations to the whole region of Záhorská nížina lowland – Záhorie lowland.

Translated by the author

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Streďanský J., Pariláková K., Streďanská A.: **Veterná erózia v regióne Záhoria na príklade katastrálneho územia Dojč.**

V práci sa zaoberáme určením erodovateľnosti pôdy v regióne Záhoria na príklade katastrálneho územia Dojč. Záujmové územie patrí k najpostihovanejším regiónom Slovenska, pretože sú tu splnené prírodné aj antropogénne predpoklady pre odnos pôdy vetrom. V príspevku sme zohľadneli tieto faktory ovplyvňujúce intenzitu a priebeh veternej erózie. Pôdne vlastnosti (pôdny druh), klimatické faktory – veternosť územia, vlhkosť povrchu pôdy a atnropogénne faktory – zornenie poľnohospodárskych pôd a vegetačný kryt.