APPLICATION OF INCREMENTAL SCENARIOS OF CLIMATE CHANGE ON WIND EROSION DATA

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Database of climatological factors (such as wind velocity, precipitation and air temperature) of the period of 1961–2010 was made from measured meteorological values of 15 meteorological stations of Southern Moravia, Czech Republic. The climatological data was then evaluated for the periods of 1961–2010, 1961–1990 and 1991–2000. Climatic-erosion factor, which explains potential erodibility of soil by wind, was determined through the analyses of factors influencing the wind erosion. Subsequently, climate change scenarios were created through the sensitivity analysis on the basis of available data. The assessment of changes in data sets and the comparative analysis of the outputs of the scenarios with measured data from the normal period of 1961–1990 were done. The climatic-erosion factor was also determined from the altered data of the scenarios. Afterwards, the influence of climate change on the wind erosion in the area of Southern Moravia was evaluated.

Introduction

Wind erosion is significantly influenced by climatic factors. Thus it is evident, that climate change will influence also wind erosion. Considering the fact, that the area of Southern Moravia is the most threatened territory of the Czech Republic, it is necessary to focus on this region when studying the mentioned phenomenon.

Material and methods

Data concerning the wind velocity, amount of precipitation, and air temperature – all for the period of 1961–2010 – were necessary for the evaluation of the influence of climate conditions on the intensity of wind erosion.

The influence of climate conditions on wind erosion is represented by the equation which Chepil *et al.* (1962) has called the erosion-climatic factor C (1). It depends on the wind velocity and effective soil surface humidity:

$$C = \frac{v^3}{(I_T + 60)^2} \times \frac{100}{1{,}9} \qquad (1)$$

where C = erosion-climatic factor, v = average annual wind velocity in the high of 10 m above the ground (mile per hour) and I_T = Thornthwaite's humidity index.

The changes of the erosion-climatic factor influenced by the variability of meteorological factors that come from were monitored on the data coming from 15 meteorological stations of Southern Moravia.

Scenarios of climate change were made on the basis of available meteorological data through sensitivity analysis. Analysis was made using incremental scenarios. When designing the incremental scenarios, the results of available studies occupying stated problems were used as a source for determination of limit values (e.g. Dufková 2004; IPCC 2007; Žalud 2009). Following limit values were chosen for the climate changes till the year of 2050 (Tab. 1):

- for air temperature – +2 °C, +2.5 °C and +3 °C,
- for precipitation – first option +10 % in cool half-year and –10 % in warm half-year; second option +15 % in cool half-year and –20 % in warm half-year (cool half-year means October to March, warm half-year April to September),
- wind velocity – 0, +10 % and –10 %.

Tab. 1 Values of designed scenarios of climate change till 2050

Scenario	Air temperature change (°C)	Precipitation change (%)		Wind velocity change (%)
		cool half-year	warm half-year	
S1	+2.0	+10	–10	0
S2	+2.0	+10	–10	+10
S3	+2.0	+10	–10	–10
S4	+2.0	+15	–20	0
S5	+2.0	+15	–20	+10
S6	+2.0	+15	–20	–10
S7	+2.5	+10	–10	0
S8	+2.5	+10	–10	+10
S9	+2.5	+10	–10	–10
S10	+2.5	+15	–20	0
S11	+2.5	+15	–20	+10
S12	+2.5	+15	–20	–10
S13	+3.5	+10	–10	0
S14	+3.0	+10	–10	+10
S15	+3.0	+10	–10	–10
S16	+3.0	+15	–20	0
S17	+3.0	+15	–20	+10
S18	+3.0	+15	–20	–10

Thus 18 possible scenarios of climate change were created by approximation and they are able to cover most of alternatives in several following decades.

Proposed climate change scenarios were applied on the data from 15 selected meteorological stations and the results were compared with month averages of the standard climatological period 1961–1990. Obtained results were analysed with respect to the differences between measured data and individual scenarios for the evaluated climatological factors of the measured period. Subsequently, the erosion-climatic factor was calculated as from the data of present climate, as from the data of changed one (through climate scenarios).

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Results and discussion

Maximum wind velocity of the most analysed areas is observed since February till April, when the arable soil is not protected by vegetation. However, the wind velocity linear trend is not evidential in the area of the Czech Republic, despite the fact that statistically significant trends could be found in the time series of wind velocity of almost all the stations during all the studied periods. From the total evaluation it is possible to expect that the wind velocity will not change and when the other factors influencing the wind erosion stay at the same level – which is improbable – the erodibility should not increase.

According to the climate change scenarios, the annual sum of precipitation will decrease a few or it will stay at the same level as at the present time. Observed or by the scenarios predicted changes in the annual course of precipitation are important. And just these changes could have the substantial negative impacts on the threat of soils by wind erosion in the spring time especially.

The air temperature is the only climatic factor from the three analysed that gives clear idea about its trend in the future. All the climatic scenarios give the increase in the average air temperature during all the months. The increase confirms also the increasing linear trend of the average month air temperature for the monitored period 1961–2010 at all the analysed climatological stations. The air temperature influences the evapotranspiration and hereby also the soil humidity. Generally, it can be stated that the lower the soil humidity is, the larger the threat by wind erosion exists. It is evident that impact of expected climate change will appear in the significant spreading of soils threatened by wind erosion.

The values of erosion-climatic factor grow up during the studied period of 1961–2010 what theoretically means the increasing of potential threat of soil by wind erosion. The increasing trend is the most evident at the stations of warm and dry areas. Also climate change scenarios predict the increase in values of erosion climatic factor (Tab. 2). Its values increased from 1.1 to 2.9 times in average in comparison with the period of 1961–1990, which means the increasing of potential threat of soil by wind erosion.

Tab. 2 Average values of erosion-climatic factor that were changed by climate scenarios till the year of 2050

Station	636	667	685	686	687	698	716	723	724	725	749	754	755	774	777
1961–1990	8.7	2.3	17.8	3.4	2.5	24.1	8.7	14.0	1.4	3.0	1.5	9.4	7.2	2.5	0.5
S1	11.8	3.6	24.2	4.3	2.9	32.3	11.0	20.2	1.9	4.3	2.0	12.4	9.6	4.0	0.6
S2	15.8	4.7	34.0	5.9	4.2	45.0	14.9	31.1	2.7	5.8	2.7	17.1	13.3	5.3	0.8
S3	8.0	2.3	16.8	3.0	2.2	20.9	7.9	14.1	1.5	3.1	1.4	9.0	6.7	2.6	0.4
S4	14.0	4.6	28.7	4.9	3.4	45.5	12.9	28.2	2.5	5.8	2.6	16.8	11.2	4.9	0.7
S5	18.8	6.2	40.6	6.8	4.9	64.7	17.5	44.2	3.7	7.9	3.6	23.3	15.6	6.6	0.9
S6	9.4	2.9	19.9	3.5	2.6	28.9	9.2	19.4	2.0	4.2	1.8	12.0	7.8	3.2	0.5
S7	12.6	3.8	25.6	4.5	3.1	35.7	11.5	22.3	2.0	4.7	2.1	13.5	10.3	4.3	0.7
S8	16.9	5.1	36.1	6.2	4.4	50.0	15.7	34.5	3.0	6.4	2.9	18.7	14.4	5.7	0.8
S9	8.5	2.4	17.8	3.2	2.3	23.0	8.3	15.5	1.6	3.4	1.5	9.7	7.2	2.7	0.5
S10	15.0	5.1	30.6	5.2	3.6	51.3	13.6	31.7	2.8	6.5	2.8	18.6	12.2	5.3	0.8
S11	20.2	6.7	43.3	7.2	5.2	73.6	18.6	50.0	4.2	8.8	3.9	25.8	17.0	7.2	0.9
S12	10.1	3.2	21.2	3.7	2.7	32.3	9.8	21.6	2.3	4.7	2.0	13.3	8.4	3.4	0.5
S13	13.4	4.2	27.2	4.8	3.3	39.8	12.2	24.7	2.2	5.2	2.3	14.8	11.2	4.6	0.7
S14	18.0	5.5	38.3	6.6	4.7	56.0	16.6	38.5	3.3	7.1	3.1	20.4	15.6	6.2	0.8
S15	9.1	2.6	18.9	3.4	2.5	25.4	8.7	17.1	1.8	3.8	1.6	10.6	7.8	2.9	0.5
S16	16.1	5.5	32.7	5.6	3.9	58.4	14.4	35.8	3.2	7.2	3.1	20.6	13.3	5.8	0.8
S17	21.7	7.3	46.3	7.7	5.6	84.4	19.7	57.0	4.7	9.9	4.3	28.7	18.6	7.8	1.0
S18	10.8	3.5	22.6	3.9	2.9	36.4	10.3	24.3	2.5	5.2	2.2	14.7	9.1	3.7	0.6

Conclusions

During evaluation of individual climate change scenarios it is not possible decidedly determine which change of climate factor has the most important impact on soil erosion susceptibility. The highest showing values were achieved always through individual combinations.

Climate conditions have substantial influence on the intensity and spreading of wind erosion especially in the dry areas of Southern Moravia. Thus, negative impacts of climate change will appear at first in these areas. Therefore at least from the beginning the humid areas with higher elevation will be spare from the negative impacts of warming. In the future it must be taken into account that threat of soil by wind erosion will extend into the areas up to now not threatened by wind erosion. The wind erosion is dependent also on the soil type. And if it is impossible to influence the climate process, then it should try to prevent the soil degradation and change of its structure state.

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