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# Evaluation of the Wind Erosion Risks in GIS

*Jana PODHRÁZSKÁ and Ivan NOVOTNÝ*

*Department for Land Use Planning, Research Institute for Soil and Water Conservation, Brno, Czech Republic*

**Abstract**: The paper refers to the possibilities of the evaluation of the wind erosion risks by using a model created in GIS. The model exploits the pedological information database for determining the potential risks of soils by wind erosion. The following data are the database of the agricultural land use, meteorological data and the topographic maps for determining the direction of wind and climatic conditions. Using the data transferred to the graphic form, it is possible to create the digital terrain model and to regionalise the meteorological data. Consequently, the wind barriers are localised in the landscape and it is possible to create the zone of efficiency around each barrier (protecting the land from the erosive effects of the wind) according to the characteristics of their height and density.

**Keywords**: wind erosion; wind barriers; geographic information system; digital terrain model; land use

Wind erosion is a serious problem in the Czech Republic, especially in southern parts (Southern Moravia) where the conditions are inclinable to its development: sandy soils, warm and dry weather in comparison with other parts of the country, windy areas, large areas of arable land.

Most of the problems emerged after World War II, when the properties of small farms were collectivised. Instead of short plots with rich diversification of vegetation, large areas of species plants were introduced. Almost all natural wind barriers were destructed (balks, field roads with trees and shrub lines, game refuges etc.) which enabled to increase the wind erosion risks and damage.

This serious problem was partially solved in 50ties by growing protective shelterbelts. However, since then no other care of them has been taken, so the situation in respect of their conditions, age, and efficiency is not very positive.

Although literature offers several methods for estimating the risks caused by wind erosion (Zhang *et al*. 1995), these techniques are hardly applied in designing works concerning the land use planning and land consolidation process.

Consequently to evaluate the wind erosion risks in certain areas, taking into account the efficiency of the wind shelterbelts and other vegetation wind barriers, a model was developed that can take into consideration the meteorological and soil conditions together with the combination of the conditions of the vegetation wind barriers (height, width, age, gaps, density of network). This model, developed in ARCINFO software, can be a useful tool for designers, landscape planners, and other experts. It enables to estimate the risks of wind erosion on each plot, to design new barriers on the endangered places as well as the renovation of the existing vegetation barriers.

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## MATERIALS AND METHODS

### Potential erosion risks from the wind erosion

For the analysis of the wind erosion risks, the following materials are necessary:
– pedological maps,
– orthophoto maps,
– digital maps of tracts of land,
– digital maps of vegetation wind barriers,
– data of the predominant wind direction and its velocity.

The first step is to evaluate the potential erosion risks from the wind erosion according to the pedological characteristics of the treated area. This process is based on the fact that the Czech Republic has the pedological information system in digital maps. This system has been created by complex information about the ecological and productive characteristics of agricultural soil, i.e. soil structure, texture, depth, slope, exposition, and climatic region. These characteristics are expressed by five-number numerical code, respective to each soil-ecological unit, and localised in the geographical information system.

The potential erosion risks are evaluated by combining the value of climatic region and that of soil factor, given by the soil type (Janeček *et al*. 2000).

The climatic region is given by the sum of daily temperatures higher than 10°C, probability of occurrence of dry vegetation periods, average consumptive water stability in the vegetation period, average annual temperatures and annual sum of precipitations.

The soil factor is destined by the soil texture, genetic soil type, hydromorphic level, matrix and skeletal conditions.

It is assumed that the areas in dry and warm weather are inclinable to wind erosion, also the sandy and light-textured soils incline to the wind erosion.

The combination of these two factors gives the coefficient of risk which is categorised into six levels of danger (Table 1).

Table 1. Categories of wind erosion risks

| Category | Level of risk |
|---|---|
| 1 | without risks |
| 2 | inclinable |
| 3 | slightly endangered |
| 4 | endangered |
| 5 | heavily endangered |
| 6 | most endangered |

As it is assumed that only the arable land is endangered, only the fields with arable land from the map of land trucks were chosen. The connection of the two levels – the level of endangered soils and the level of land trucks in GIS – led to the formation of the map of areas endangered by wind erosion.

### Evaluation of efficiency of vegetation wind barriers

This process consists of the three steps. Firstly, the map of the predominating directions of wind erosion effecting winds must be created. Wind velocity 3 m/s is considered as the erosion affecting wind in the Czech Republic. The map of regionalised directions of wind erosion effecting winds was obtained by using the digital model of the observed areas.

The second step is to assess the tolerable length of field according to the soil characteristics. Only the plots belonging to the categories of potential wind erosion risk 4–6 are considered (Table 2).

Table 2. Tolerable length of fields for categories 4–6

| Category of potential wind erosion risk | Tolerable length of field (m) |
|---|---|
| 4 | < 850 |
| 5 | < 600 |
| 6 | < 350 |

The model in GIS identifies all the plots with the exceeded tolerable length.

By the third step, protective zones were created around the vegetation wind barriers in the

Table 3. Spread of the protection zones around the different wind barriers

| Type of barrier | Leeward side (m) | Windward side (m) |
|---|---|---|
| Shelterbelts | 300 | 100 |
| Other line vegetation | 150 | 50 |

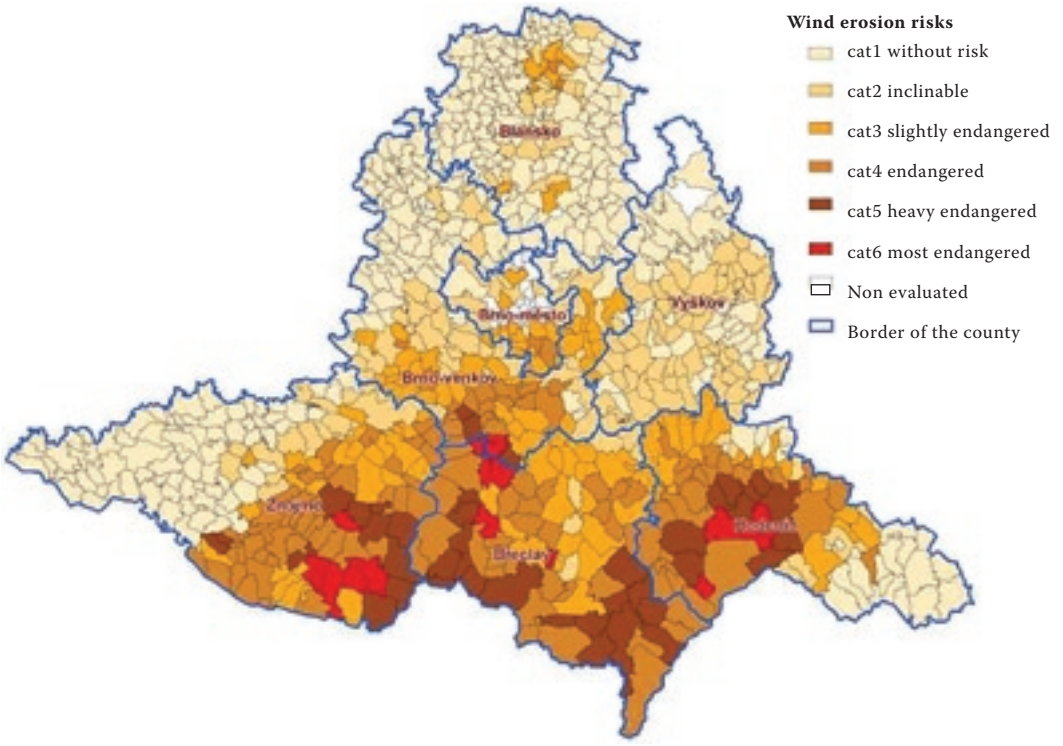


Figure 1. Potential risk of wind erosion according to the risks of arable land in South Moravia region (unit is cadastre)

predominant direction of wind. These protective zones represent the area protected from the wind by the wind barrier. The spread of the zones was defined according to the criteria (Table 3).

The model performs the evaluation of the efficiency of the wind barriers by defining the percentage representation of the protected area of arable land.

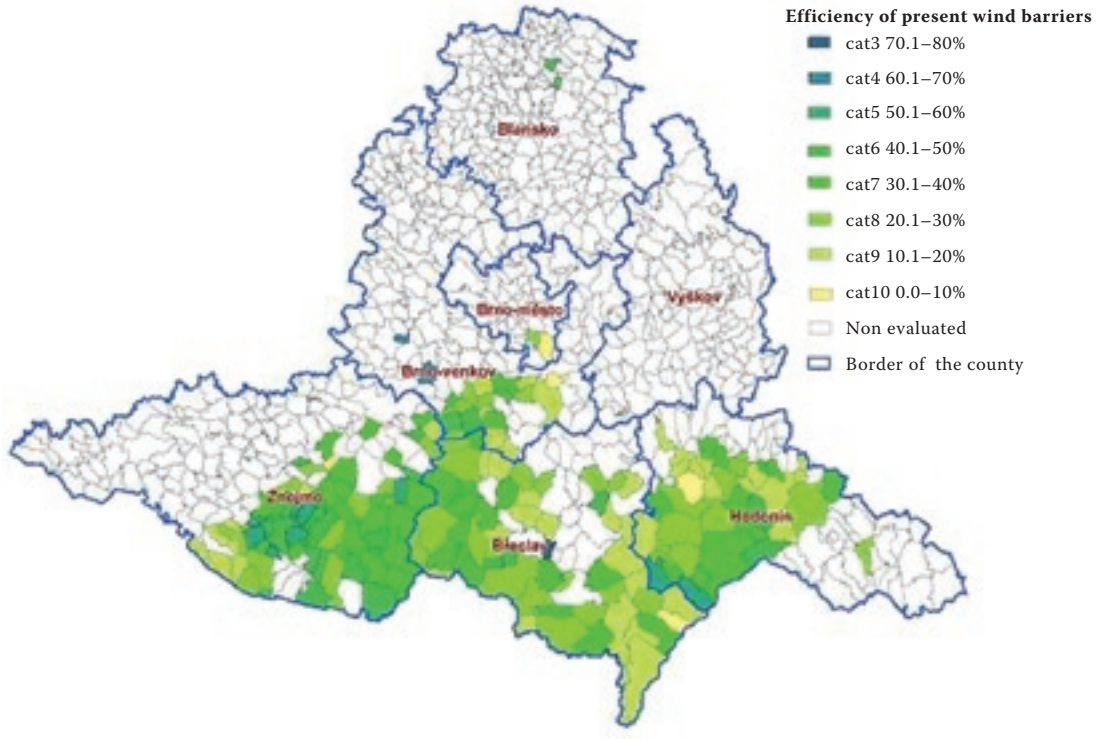


Figure 2. Efficiency of present wind barriers in South Moravia region (unit is cadastre)


Figure 3. Efficiency of wind barriers in certain cadastre (unit is land plot)

## RESULTS AND DISCUSSION

The model performed in this paper was used for the evaluation of the wind erosion risks in the region of South Moravia, a warm and dry part of the Czech Republic (Figure 1 and 2) (Agroprojekt, PSO, RISWC dep. Brno, 2005). By this method the areas were localised that are endangered by wind erosion. The results enable to focus on the problematical areas and to make the design the planting of new shelterbelts (Figure 3). The model can help with optimal placement of the barriers in certain fields, and with the evaluation of the new state in the area. The model can be used for analyses of large areas as well as in land adjustment projects in certain parts (cadastres).

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*Corresponding author:*

Ing. Jana Podhrázská, Ph.D., Výzkumný ústav meliorací a ochrany půdy, v.v.i., oddělení pozemkových úprav, Lidická 25/27, 602 00 Brno, Česká republika
tel.: + 420 541 126 278, fax: + 420 549 255 574, e-mail: podhrazska@vumopbrno.cz