WIND EROSION ON LIGHT SOILS IN VOIVODINA

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Abstract:

The wind erosion process, appearing as a consequence of the application of intensive technologies in agriculture and global climatic changes, has already encompassed a significant part of Europe. The region of Voivodina, as a part of the large Pannonian plain, is not exempted from this process. Destructive effects of wind erosion are most visible in agriculture. In natural and anthropogenic conditions on territory of Voivodina deflation processes represent important factor of soil degradation and have also a negative effect on the other elements of the environment: water and air.

Keywords:
wind erosion, aeolian deposit, soil degradation, soil loss

1. INTRODUCTION

Both natural and anthropogenic conditions on the territory of Voivodina (2.15 mil. ha, northern part of Serbia) favour the occurrence of wind erosion. The continental climate of the Pannonian Plain with frequent strong winds, attaining the rates of even 40 m/s; annual precipitation sometimes even below 400 mm; large temperature amplitudes; markedly plain relief; more than 70% of the area being plow fields which are at a time without any vegetation cover and which under conditions of intensified agricultural production may be very erodible; insufficient (only about 6.5 %) and inappropriately located forest areas, are only some of the factors clearly indicating that the danger of wind erosion in Voivodina is potentially very

high, and if the forecast climatic changes are to become true, the situation may be even worsened.

Destructive effects of wind erosion in Voivodina are most visible in agriculture. Because of wind erosion, the soil - one of fundamental natural resources, is degraded. The wind carries the finest humus particles, and also the nutritive and protective matter, and the just sown crop grains, pulls out and breaks young plants, denudes the roots of perennial plants, causes excessive evaporation and soil drying, and the blows of wind-borne particles damage green parts and fruit of the grown crops. Besides, wind sediments are filling in the drainage canals and water reservoirs. The loss of nutrients and moisture from the soil, repeated sowing, lower and non-uniform yields can also bring into question the profitability of the agricultural production on the areas endangered by wind erosion, and especially at the present when the intensive agricultural production is very expensive. On the other hand, the attenuation of wind erosion processes can directly lead to lowering of the production costs, and enabling, even under unfavourable climatic conditions, high yields to be more probable, and thus the production more effective.

2. MATERIAL AND METHODS

The process of wind erosion is essentially a very complex problem which requires that all its stages (initiation of movement, transportation, and deposition) should be encompassed by the study and quantification, i.e. all the relevant factors have to be included. Because of the multitude and stochastic character of essential parameters of the process, as well as because of high costs of such experiments, only fragmentary investigations have been carried out, so that is not possible to define some universal relationships. Still, on the basis of such investigations, a number of models, empirical formulae and indicators (coefficients, indexes, etc.) have been established for a quantitative description of wind erosion processes, i.e. for assessing their intensity. However, a direct, non-critical application of such models, defined for particular locations, irrespective of all their complexity and effective mimicking of natural processes, may under the given conditions represent a certain risk, especially if the application is not followed by appropriate field investigations.

First concrete assessments and direct measurements of the intensity of wind erosion in Voivodina were carried out on the two sandy areas, which are potentially most endangered in this part of the Pannonian Plain. In the beginning of seventies, on a location in the Deliblato Sands ("European Sahara") based on measurements using a special rotating catcher of wind-borne particles [1]. Afterwards, in 1980, in the Subotica-Horgos Sands a special centre was founded to monitor wind erosion on the soils of lighter composition [2]. The investigations encompassed instrumental measurements of the intensity of wind erosion by monitoring relevant

climatic parameters and the state of the soil – the object of the wind action. These investigations have been carried out simultaneously at two measurement stations, one under the conditions of intensive agricultural production with no wind protection, and the other in the forest protection belt.

Because of the justified assumption that the process of wind erosion is involved and very significant, not only on sandy soils but also well-structured soils of the type of chernozem and meadow black soil, starting from 1995 the investigations and measurements of wind erosion intensity have been carried out on a location near Novi Sad [5], [6].

In this paper to point out the research of wind erosion on the soils of light mechanical composition on the Subotica-Horgos Sands (*Fig. 1.*). The Subotica-Horgos Sands are situated in the North part of Voivodina plain between the Danube and Tisza rivers, average length 50 km and diameter 5-10 km, area cca 24,000 ha. It is well-known orchard-grape vine region, with more then 33% under vineyards and orchards, cca 20% forests and woodlands, and over 34% under grassland.

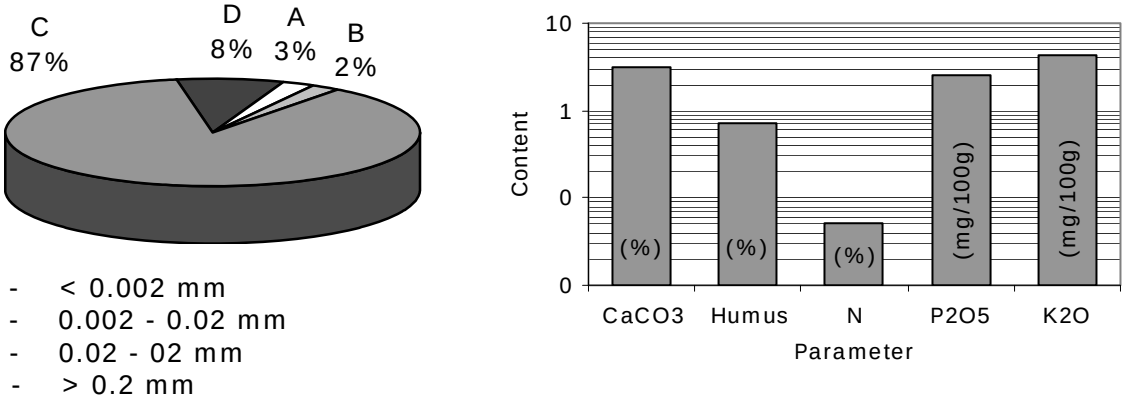

Fig. 1. *Mechanical composition and chemical characteristics of soil on the Subotica-Horgos Sands*

Experimental station record: quantity of aeolian deposition, wind frequency and velocity, air and soil temperatures, air and soil humidity etc. Field data are analysed in order to qualify and quantify the deflation processes, as well as to define the conditions of climate and residual soil in which they occur [3], [4].

3. RESULTS AND DISCUSSION

A comparative method of stationary observation by wind-gage stations has been applied on specially selected erosion plots, of which one, used for agriculture, has not been protected ("A"), while the other ("B") has been protected with forest plantings. The obtained results suggest the existence of

significant erosion processes outside the protective forest belt. On the basis of the measurements carried out during a number of years, an empirical relation has been derived for calculation of the wind erosion intensity on this and similar locations.

In the 1980-2000 period frequent variations in the wind erosion intensity and of some qualitative characteristics of the wind sediments were registered. The annual amounts of wind-borne sediments initiated in the Subotica-Horgos Sands are in the range from 0.63 to 35.87 kg/m on the unprotected area, and from 0.10 to 0.59 kg/m on protected areas (*Fig. 2.*).

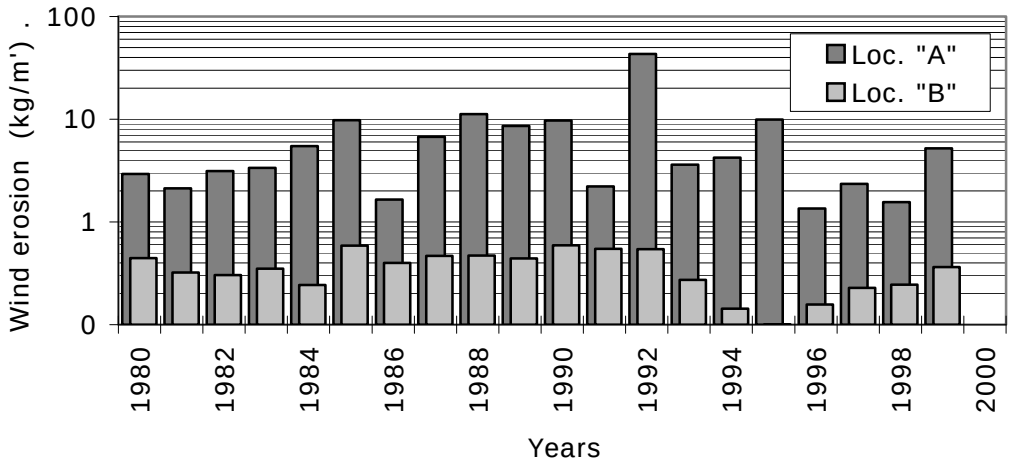

Fig. 2. *Annual wind erosion intensities in the Subotica-Horgos Sands:*
"A" – Plowed field with no wind protection;
"B" – area in the protective forest belt.

In addition to the quantification of deflation processes in the researched area, the analyses of quality have been made, i.e. physical and chemical properties of the aeolian deposition were defined and compared to the same characteristics of the residual, surrounding soil. This time to point out to the following nutrients which are removed from the soil complex of the Subotica-Horgos Sands: humus, total nitrogen, readily available phosphorus and potassium. [3]

Humus content in the aeolian deposition oscillated during the research period and ranged between 3.94-7.02 %, which is cca 5.7-18.1 (on the average 10.5) times higher content of organic matter then in the residual soil from which the particles were detached.

Total nitrogen content in the aeolian deposition ranges within the limits of 0.28-1.73 % which is 2.8-19.0 (on the average 11.1) times higher content than in the residual soil.

Readily available phosphorus content in the aeolian deposition ranges within the limits of 10.0-41.1 mg/100 g of soil, and that is cca 3.7-20.3 (on the average 9.3) times higher content of phosphorus than in the residual soil.

Readily available potassium content in the aeolian deposition oscillated within the limits of 15.7-40.0 mg/100 g of soil, and that is cca 5.8-14.3 (on the average 10.1) times higher content of potassium than in the residual soil.

The analysis of the relation of chemical characteristic of the aeolian deposition ("Ad") and the residual soil ("Rs") points to the very significant indication of soil fertilization loss affected by deflation processes. It is denoted by the "deflation coefficient" (η=Ad/Rs).

Also, by analysing the oscillations of the contents of humus and biogenic elements during the research period, it has been observed that the maximum and minimum of their concentration do not correspond to the maximal and minimal quantities of the aeolian deposition.

4. CONCLUSIONS

In natural and anthropogenic conditions on the territory of Voivodina deflation processes represent important factor of soil destruction and have also a negative effect on the other elements of the environment: water and air. Comparative researches on the protected and unprotected erosion fields and presented results pointing out the significant degree of the vegetative cover protective effect.

The processes of accelerated wind erosion are most frequently a consequence of anthropogenic factors, inappropriate use of the soil, vegetation destruction, etc. Modern measures of wind erosion control must be complex, all-inclusive, continuous, and systematic. At that, one should constantly bear in mind the fact that there is no absolute protection from wind erosion, that is, there is no possibility of complete elimination of wind erosion processes, one can only endeavour to reduce them to a rationally acceptable level.

It would be highly desirable to establish a network of measuring stations to monitor the wind erosion in Voivodina under the different natural conditions (microclimate, soil, etc.), as well as under different crops. In this way, among other things, it would be possible to check the correctness of the applied empirical methods and achieve a more reliable estimation of the erodibility of particular types of soils, protecting effect of the crop covering in particular stages of crop development, effects of different modes of soil cultivation, humidity state of the soil, and like. It should be especially pointed out the importance of establishing the amount, characteristics, and composition of the wind erosion sediments, as of the crucial factor of degradation of all the elements of the environment.

Chemical analyses of sediments indicate its increased load of nutritive matter compared to the residual soil from which the sediment was originated: humus up to 18 times, nitrogen up to 19 times, phosphorus up to 20 times, and potassium up to 14 times, and even more.

5. REFERENCES

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