# Meteorological and Climatological Aspects of Wind Erosion in Bulgaria

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### *I. Background*

Wind erosion is one of the main factors reducing agricultural production in the country. Dust storms have been observed in over of 68 % [1] of the years during the period from 1910 until 1960. Severe dust storms occurred in 1975, 1976, and 1978, when 13.2 thousand ha of agricultural land in the North Bulgaria were covered by wind blowing dust. Eighty percent of dust storms were observed during the period January to May. Weather and climate conditions from June to December are very important for wind erosion processes.

### *II. Meteorological and climatological condition for dust storms*

The main goal of the paper is to identify meteorological and climatological conditions which have caused wind erosion in the country. As a result of analyzing of 42 dust storms, three groups of synoptic processes were identified [1]:

The first group involves cases of zonal circulation over the Balkan peninsula. The frontal zone passes the Balkan peninsula. Dust storms lasts 5-6 h; monthly sum of precipitation during the period from January to April is 30-70 % of normal; air temperature is higher than normal; air humidity drops to 30 % and maximum wind speed exceeds 20-30 m/s. The maximum of the air temperature is often moved to the hours before the dust storm. As a result, the horizontal visibility decreases to 300-400 m (Fig.1, case 1-Rousse).

The second synoptic process is connected with the North-East circulation when Siberian anticyclonal circulation prevail. The Arctic air mass which covers the Balkan peninsula is very dry. The dustiness lasts from 1-2 h to 8-9 h without interruption; monthly sum of precipitation is 50-70 % of normal; air temperature is higher than normal; humidity is 60-80 % of normal; maximum wind speed exceeds 20 m/s; the horizontal visibility does not exceed 700-800 m (Fig.1, case2-Orjahovo).

The third group is observed during the South-West circulation when dust storms last 3-4 h; precipitation is 60-80 % of normal; air temperature is higher than normal; humidity drops to 30 %; maximum wind speed is 30 m/s; horizontal visibility drops to 900 m (Fig.1, case3-Knezha).

### *III. Climatological forecasting of frequency occurrence of dust storms*

The yearly total wind erosion potential E (in t/acre/yr) depends on different factors, as defined by Chepil [2,3]:

$$E=f(I,K,C,L,V) \qquad (1)$$

where:

- I- soil wind erosion factor,
- K- roughness of the ground,
- C- local climate factor,
- L- mean field length,
- V- value of vegetation covering the land

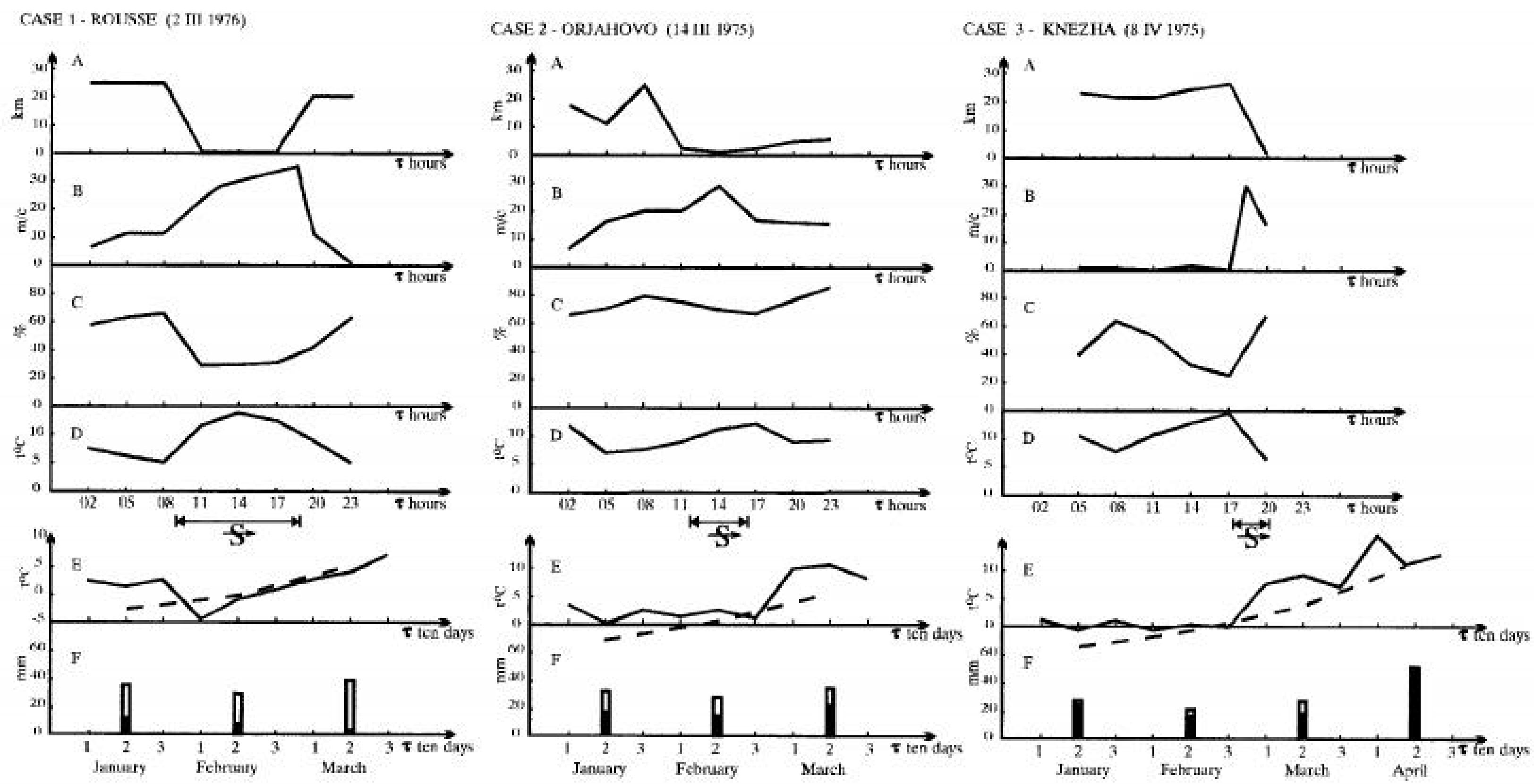


Fig. 1. Daily and seasonal course of meteorological elements:
A - visibility; B - wind speed; C - humidity; D - air temperature;
E - mean air temperature (—) and norm (- -); F - precipitation ( ▮ ) and norm ( ▯ );
|←→| - uninterruptedly continues of dust storm.

The local climate factor C influences soil potential for wind erosion by:

(2) $$C = 100\ \bar{V} / 2.9\ (P\text{-}E)$$

where: $\bar{V}$- early mean wind speed in m/s,
$(P\text{-}E) = 11[\sum(P_i / T_i - 10)$ - the sum of effective precipitation in inches
$P_i$ - monthly sum of precipitation
$T_i$ - monthly mean air temperature (F)

The investigation period was taken from the beginning of June to the end of May of the next year as 80 % of dust storms are observed from the beginning of January to the end of May.

Table 1 gives values of yearly and total climatic factor for representative stations.

Table 1. Value of climate factor $Cx10^{-5}$ for representative stations.

| Station/Year | 1964 | 1970 | 1971 | 1972 | 1975 | 1976 | 1977 | 1978 | 1980 | 1983 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rousse | 8.2 | 6.7 | | | 5.4 | 4.9 | | | 1.3 | | 26.5 |
| Oriahovo | | | 0.9 | 1.9 | 0.5 | 0.8 | | | | | 4.1 |
| Knega | | | | | 0.6 | | | | | | 0.6 |
| Shoumen | | | | | 5.7 | 3.4 | | | | 8.0 | 17.1 |
| Svistov | | | | | 0.1 | 0.1 | 0.2 | 0.1 | | | 0.5 |
| Dobritsch | | | | | | 2.2 | | | | 6.9 | 9.1 |
| Lovetsch | | | | | | 0.6 | | | | 2.1 | 2.7 |
| Gramada | | | | | | | 0.4 | | | | 0.4 |
| Karnobat | | | | | | 4.2 | | | | 3.9 | 8.1 |
| Elhovo | | | | | | | 4.1 | | | | 4.1 |
| Novo selo | | | | | 0.3 | | | | | | 0.3 |
| Silistra | | | | 6.3 | | | | | | | 6.3 |
| Lom | | | | 0.7 | 0.9 | | | | | | 1.6 |

As a result of calculations, a good relationship was found (correlation coefficient exceeds 0.50) between the number of days with dust storms and the total value of local climate factor C.

The next regression formulae have been developed as a base for calculations of the local climate factor (C) and the number of days (D) with dust storms (3 and 4):

(3) $$C = 0.0175 \times 10^{-3} D + 0.010 \times 10^{-3}$$

(4) $$D = 22141.9\ C + 1.6,$$

The F statistic equal to 6.99 was compared to the Snedecor-Fisher coefficient F=4.4 at a free level of 1 and 11 at 95 % of frequency occurrence, which is used to identify the significance of formulas (3) and (4). So the most frequent occurrence of dust storms (1-2 days yearly) could be expected in North-West Bulgaria (Table 2); Shuomen region - 2.1 days; Kubrat - 1.8 days; Rousse - 1.5 days; Dobritsch - 1.2 days; Silistra - 1.0 days, etc.

Table 2. Frequency occurrence (days/yr) of dust storms for representative stations.

| Station | Number of days | Station | Number of days |
|---|---|---|---|
| Novo selo | 0.2 | Silistra | 1.0 |
| Lom | 0.3 | General Toshevo | 1.4 |
| Knega | 1.0 | Dobritsch | 1.2 |
| Pleven | 0.2 | Shoumen | 2.1 |
| Svistov | 0.15 | Iambol | 1.1 |
| Rousse | 1.5 | Elhovo | 1.4 |
| Kubrat | 1.8 | | |

### *IV. Conclusions*

As a result of this investigation of meteorological and climatological conditions for wind erosion storms the conclusions could be summarized:

Atmosphere circulation patterns over the Balkan peninsula determine the meteorological conditions preceding dust storms. They provoked very dry conditions; high air temperature; high wind speed and low horizontal visibility.

The climate conditions during the months before dust storms are very important together with the vegetation covering the land and soil condition.

The local climate factor is a good indicator for the influence of previous climate conditions for wind erosion processes.

### Literature cited

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3. Soil Erosion. Edited by M.J.Kirkby and R.P.Morgan. A Wiley- Interscience Publication, 1984, P.415.