THE AEOLIAN REGIME WITHIN CRISUL REPEDE DRAINAGE AREA

Ana Cornelia MOZA, Nandor KÖTELES,

University of Oradea, Faculty of Environmental Protection,
26 Gen. Magheru St., 410048 Oradea; Romania,
Corresponding author: mozaani@yahoo.com

Abstract: *In order to highlight the wind characteristics in Crisul Repede drainage area we used the data collected between 1970 – 2008 from the 5 meteorological stations within Crisul Repede drainage area, namely: Oradea meteorological station (136m), Sacueni meteorological station (125m), Borod meteorological station (333m), Huedin meteorological station (560m), and Stana de Vale meteorological station (1108m). In order to carry-out this research study we employed both a series of traditional research models as well as a series of modern means and models. The main methods used in the current research are the following: analysis method, deduction method, induction method, comparative and statistics-mathematics methods and graphs, and cartographical method. The comparative method highlights, through comparing the parameters of aeolian regime, the weather fluctuation within Crisul Repede drainage area, the differences occurring function of the nature of active surface. The data collected from the database of National Meteorological Administration (ANM) were computed by means of statistics-mathematics. The outcome obtained through mathematics – statistics methods were subsequently translated into graphs in order to highlight clearly the wind unsteadiness (variations) in time. The aim of the current paper is to research the wind' direction and speed in the within Crisul Repede drainage area. On soil proximity, wind presents short-term direction and speed fluctuations soil proximate surfaces; these are strongly dependent on the value of baric horizontal gradient, the local conditions, especially the orography, etc. The relief influences the wind features by fragmentation level, through summits or corridors' orientation, by altitude, and mountain massifs expansion. The wind is channelled into Aeolian depression (hollows) channels thus leading to boosting wind speed and, at the same time, to changing its direction of displacement. The Crisul Repede Valley is East-West oriented, and thus it stimulates the wind air flows creation on this direction. In highlands, the dominant air flow directions are different as against the plains ones, and function of meteorological stations in the local relief, they can protected or in some sectors. In urban areas, the wind elements are influenced both by soil characteristics and urban constructions, by means of building heights, streets' direction and largeness. The Aeolian data have a practical importance, as they are used in several fields of activity: weather forecasts, setting industrial building locations, city planning, air and maritime traffic, energy sector, agriculture, constructions, etc.*

Key words**:** *wind, speed, direction, calm air*

INTRODUCTION

Wind conditions within Crisul Repede drainage area, as throughout the country, is marked by the development of the 4 major focal points of air action: Azores high (during summer), Eurasian high-pressure area and Island minimum (during winter) and Mediterranean low pressure area during cold season but also by local geographical factors.

The soil surface through its inhomogeneities, may enhance or diminish the local dynamic air turbulence, this leading to decreasing or enhancing the wind speed. Among the natural factor one may recall the herbal and cultivated vegetation in the city neighbouring areas, while as for the areas located at higher altitudes, the presence of large forests surfaces puts its mark on wind constituents' behaviour.

MATERIAL AND METHODS

In order to highlight the wind speed and conditions within Crisul Repede drainage area one used the instrumental and visions observations and monitoring collected from the meteorological observation station for a 39 year time span. Data was processed by means of mathematics and statistics methods and the results were subsequently translated into graphs in order to highlight clearly the wind unsteadiness and fluctuation in time.

RESULTS AND DISCUSSIONS

1. Wind direction

Wind direction is set according to the cardinal point from which it blows. For this, the wind rose with its cardinal and inter-cardinal points is used.

The annual conditions on wind frequency by directions

Out of the current wind rose analysis, elaborated for each meteorological station within analysed area, for 1970 – 2008 period of time, it results that for the stations placed at higher altitudes (depressions and mountain areas) the western winds are dominant, according to overall air direction but, due to the friction with soil surfaces, their rates are low, thus the highest rate being recorded at Huedin city with 12.8%, followed by Borod with a rate of 8.5%, and Stana de Vale with a 6.9% rate. At plains stations the dominant directions are from South and South-Eest sector with a 18.1%, a high rate is recorded also by the South-West wind, with 14.5% At Sacuieni station, the wind blows on a dominant direction from South, namely 10.1% and from North-east sector, namely of 10.0% of all cases (see Table 1).

Table 1

Annual average wind frequency (%) on cardinal directions within Crisul Repede drainage area, within 1970 – 2008 time span

Direction/frequency	N	NE	E	SE	S	SV	V	NV	Calm
SACUENI									
Frequency (%)	6.6	10.0	5.2	5.2	10.1	12.6	2.2	1.7	46.4
ORADEA									
Frequency (%)	9.3	5.2	7.7	11.1	18.1	14.5	6.1	5.3	22.7
BOROD									
Frequency (%)	3.6	3.2	5.8	5.9	3.2	8.1	8.5	5.6	56.1
HUEDIN									
Frequency (%)	3.2	3.7	4.4	1.6	10.8	5.7	12.8	3.1	54.7
STANA DE VALE									
Frequency (%)	1.0	1.3	2.6	5.1	2.1	1.8	6.9	3.8	75.3

Source: Data collected out of national Archive of National Meteorological Administration and processed

The low rates of wind frequency are recorded in different cardinal point, lacking a dominant direction; thus, at Stana de Vale the lowest rate among of multi-annual frequency within Crisul Repede drainage area is recorded, with a 1.0% frequency out of the total, recorded in the northern sector, followed by Huedin city with a 1.6% frequency rate, from the South-eastern sector, next by Sacuieni with a 1.7% frequency generated from the North-Western sector, and than by Borod from North-eastern and Southern sector with a multiannual average frequency of 3.3% of total while Oradea has the largest share amongst the wind speed low values, generated from North-Eastern sector with a 5.2% frequency out of total (Table 1).

Monthly regime of wind frequency on directions

Analysing the monthly wind speeds on cardinal directions, one notices that the dominant directions on plains areas are from South and South-western sector, the highest rates from South direction being recorded at Oradea city while the highest ones from South-western are recorded at Sacuieni. Thus, at Oradea city during cold season the highest rates from South sector occur, their level in December being of at the maximum frequency of 23.3% out of total, followed by January and November with 21.8% and 21.7%, respectively. The lowest rates in this sector, recorded at Oradea city, occur in summer season, namely in August and July, with the levels of 11.8% and 14.4%, respectively. The lowest rates in this sector occur also in summer season, as fro the South sector frequency, namely in August and July, with rates of 11.7% and 12.5%, respectively (see Table 2).

Table 2

Annual and monthly win frequency (%) on cardinal directions within Crisul Repede drainage area for the 1970 – 2008 period of time

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	AN
Station/Direction	SACUENI												
N	4.4	7.4	9.4	8.1	7.3	7.0	8.1	7.1	6.3	4.7	3.5	6.2	6.6
NE	8.7	10.1	10.9	11.9	11.8	10.1	9.8	10.0	9.5	9.6	8.7	9.0	10.0
E	4.7	4.4	4.9	5.0	5.7	5.7	5.0	6.6	7.1	5.3	4.8	3.4	5.2
SE	1.4	2.3	3.7	5.9	7.1	6.5	6.1	8.3	6.8	9.4	4.0	1.3	5.2
S	13.8	13.1	10.8	10.0	8.4	8.1	6.4	3.8	7.9	9.8	13.7	15.3	10.1
SV	13.5	13.4	13.9	14.0	12.9	12.0	10.6	9.8	12.6	11.5	13.7	13.5	12.6
V	1.2	1.3	2.6	2.4	2.9	4.3	4.1	3.0	1.7	0.9	1.3	0.3	2.2
NV	0.2	1.2	1.3	2.3	3.0	3.3	3.2	3.2	1.2	0.3	0.4	0.2	1.7
Station/Direction	ORADEA												
N	7.1	10.1	12.2	11.3	10.0	9.7	10.9	9.8	8.0	7.0	6.2	8.9	9.3
NE	3.9	5.3	6.1	7.1	7.0	5.3	5.0	5.2	4.7	4.8	3.9	4.2	5.2
E	7.2	6.9	7.4	7.5	8.2	8.2	7.5	9.1	9.6	7.8	7.3	5.9	7.7
SE	7.3	8.2	9.6	11.8	13.0	12.4	12.0	14.2	12.7	15.3	9.9	7.2	11.1
S	21.8	21.1	18.8	18.0	16.4	16.1	14.4	11.8	15.9	17.8	21.7	23.3	18.1
SV	15.4	15.3	15.8	15.9	14.8	13.9	12.5	11.7	14.5	13.4	15.6	15.4	14.5
V	5.1	5.2	6.5	6.3	6.8	8.5	8.0	6.9	5.6	4.8	5.2	3.9	6.1
NV	3.8	4.8	4.9	5.9	6.6	7.2	7.5	6.8	4.8	3.9	4.0	3.1	5.3
Station/Direction	BOROD												
N	1.1	2.2	3.8	5.7	5.2	5.2	5.4	5.6	3.3	2.7	2.0	1.3	3.6
NE	1.9	2.7	3.9	4.5	4.8	3.8	4.0	4.0	3.2	2.0	2.1	2.0	3.2
E	4.7	4.9	8.4	7.6	7.2	4.8	5.8	5.0	6.0	6.8	4.2	3.8	5.8
SE	5.8	6.4	6.3	7.0	5.2	4.3	4.5	5.4	6.6	6.9	7.1	5.0	5.9
S	4.9	4.3	4.7	3.9	2.5	1.9	1.8	1.1	2.4	2.9	4.4	3.9	3.2
SV	5.6	9.7	10.5	11.0	7.3	7.5	6.8	4.9	6.5	7.4	9.1	10.6	8.1
V	7.0	4.0	9.2	10.5	9.4	10.8	10.9	8.7	8.2	8.7	8.0	6.4	8.5
NV	3.9	4.0	5.2	5.6	6.5	8.2	7.9	6.3	5.7	5.4	4.2	4.5	5.6
Station/Direction	HUEDIN												
N	0.8	1.9	2.5	3.2	4.8	4.9	4.8	4.9	4.0	3.5	1.8	1.0	3.2
NE	1.4	2.4	3.5	3.9	4.7	5.6	4.9	5.2	5.1	4.8	2.2	1.1	3.7
E	1.9	3.8	6.0	7.3	6.9	4.0	4.2	4.6	3.7	4.7	3.5	2.3	4.4
SE	1.1	1.2	2.0	1.9	2.0	1.7	1.8	1.9	1.5	1.9	1.3	0.8	1.6
S	5.6	7.7	12.1	16.5	16.0	11.6	12.2	11.8	11.9	9.2	8.0	6.5	10.8
SV	5.5	5.8	6.8	6.3	7.3	7.1	6.8	5.1	5.1	4.6	3.6	4.8	5.7
V	13.0	13.1	13.6	15.1	12.5	15.5	15.8	10.4	11.6	9.5	11.3	12.6	12.8
NV	1.7	2.2	2.9	3.8	4.5	5.1	5.6	3.6	2.8	2.0	1.7	1.2	3.1
Station/Direction	STANA DE VALE												
N	1.3	1.5	1.5	1.3	1.3	1.0	0.8	0.7	0.6	1.2	0.8	0.5	1.0
NE	1.5	1.9	2.1	1.7	1.9	1.2	1.3	0.7	0.8	0.8	1.1	0.8	1.3
E	2.4	3.6	3.2	4.2	3.6	1.7	1.2	1.4	1.8	2.4	3.0	2.9	2.6
SE	4.5	6.3	6.1	8.2	5.1	2.8	2.3	2.2	3.3	6.2	7.1	6.6	5.1
S	2.6	1.8	3.4	1.8	1.5	1.4	1.5	1.2	1.3	3.0	2.8	3.0	2.1
SV	1.5	2.1	2.0	2.1	1.5	1.7	1.8	1.2	1.9	1.5	3.1	1.5	1.8
V	5.7	5.9	7.5	6.6	6.6	8.2	7.2	8.1	8.5	7.8	6.4	4.5	6.9
NV	3.0	3.5	4.5	4.1	4.3	4.8	5.6	5.1	4.3	3.5	2.1	1.3	3.8

Source: data collected out of National Meteorological Administration (ANM) and processed

At Sacueni, throughout the year, the highest frequency of wind speed is from South-western sector with the maximum levels recorded in spring, namely in April and March, of

14.0% and 13.9%, respectively. The minimum rates within this sector are recorded in summer season, namely in August and July, reaching the values of 9.8% and 10.6%, respectively. From South sector, the wind frequency for Sacuieni station has a similar evolution with the Oradea one, thus the maximum rates are recorded in cold months of the year, with maximum rate in December and January, of 15.3% and 13.8%, respectively, and the low rates occur in summer, namely 3.8% in August and 6.4% in July.

In depressions and mountain areas, the highest rates of monthly wind direction frequency are from West sector; thus, the highest values within this sector being recorded at Huedin city with the highest values during summer season of 15.8% in July and 15.5 in June respectively, and the lowest values in October of 9.5%, respectively. Within the same Huedin depression area, the South sector frequency is has close values with maximum rate in April (16.5%), and minimum rate in January (5.6%) (See Table 2).

At Borod, the dominant frequency if still from West sector with maximum rates in July and June, namely of 10.9% and 10.8%, and the minimum rate in February of 4.0%. A closer frequency rate is recorded in the case of South-western sector with a maximum rate in April of 11.0% and a minimum one in August of 4.9% (see Table 2).

Stana de Vale has the dominant wind direction still from West sector but with lower rates than in the depression areas; it shows a higher frequency rate in September of 8.5%, respectively, and the lowest value in December, of 4.5%, respectively.

Throughout the year, the lowest values if wind direction frequency within Crisul Repede drainage area are the North-West, North, North-East, South and South-East. Thus, from the North-West direction the lowest values are recorded at Sacuieni, namely of 0.2% in January and December. The North-East direction shows the lowest values at Oradea and Borod with a lower frequency at Borod, namely of 1.9% and in January of 3.9%, respectively, at Oradea these values being recorded in January and November. At Borod also the minim values of wind direction frequency occurs from South sector with, the lowest value of 1.1% being recorded in August. At Stana de Vale, the wind direction minimum frequency is recorded from North sector with the lowest rate of 0.5% in December, respectively. As for Huedin, the lowest rates of wind frequency occur from South-East sector with a ratio of 0.8% in December (see Table 2).

Air calm frequency

The air calm represents the weather lacking wind, and it is of practical and scientific importance. The calm is related to the presence and persistency of baric high pressure areas and the geographical local conditions, this weather parameter participate sat featuring the calm and serene weather (inside which the normal evolution of weather parameters take place), and favourable to the development of all human activities: spa and curative, touristic, sports, production, etc. (BOGDAN OCTAVIA, DRAGOTA CARMEN, 1997).

The air calm depending on certain local conditions where polluting source proliferate may become a weather risk factor for air quality, being assessed as the main weather element laying the basis for the polluters persistence, while the later causes air pollution.

While assessing the annual frequency of air calm one may notice that it shows a higher frequency than the wind periods of time, in depression and mountain areas these values being contained between 54.7% out of the total case at Huedin and 75.3% out of total at Stana de Vale. In plains areas their frequency is smaller than 50%; thus, at Sacuieni they are of 46.4% while at Oradea they are reaching the level of only 22.7% (the lowest frequency of air calm). The high rates in high areas are caused by the placement of meteorological stations protected against the impact of the surrounding higher relief. The relative low frequency of

wind at Huedin, a city although located in mountain depression, is due to the fact that it is placed at a location protected against winds, at the basis of Vladeasa Mountains.

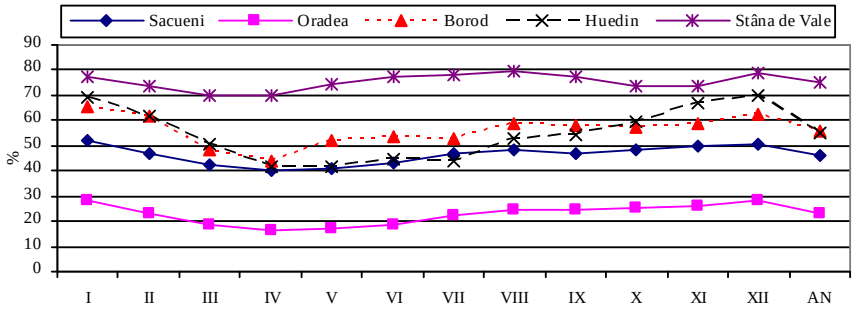

Figure 1: Monthly average frequency of air calm in Crisul Repede drainage area

Monitoring the monthly evolution of air calm one may notice that this show higher values in winter season, in plains and depression areas while for mountain areas the higher frequency occurs in August. Thus, at Stana de Vale, air calm has the highest rates with a maxim frequency of 79.4% in August, followed by Huedin with a 69.7% frequency rate recorded in December, by Borod with a 65.1% frequency rate in January, Sacuieni with 53.1% frequency rate also in January and Oradea city with the lowest frequency rate of 28.4% in the same month. (See Figure 1).

The highest values of air calm in cold season are duet o the occurrence, in this time of the year, of some baric high pressure areas with cold and stable air masses, thermal inversion occurrence through air cooling on thick layers in contact with cooled soil surface. In depression areas the highest value during winter are duet o cool air flow on mountain within this time and its stratification at ground level. The higher frequency in august in mountain area is duet o the dominance of high pressure weather. The lowest monthly frequency rates of air calm are recorded within Crisul Repede drainage area are in spring season, namely in March at Stana de Vale, in April at Sacuieni, Oradea, Borod and in May at Huedin. Thus, the lowest rate of air calm within assessed area is recorded at Oradea with a frequency rate of 16.2%, followed by Sacuieni with a frequency rate of 40.2% recorded in April, next by Huedin with 41.3% frequency rate recorded in May, Borod with 44.2% frequency rate recorded in April, and Stana de vale with 69.7% frequency rate out of total, recorded in March (see Figure 1).

The low rates of air calm in spring are due to the intensifying of air high pressure areas and anabatic processes.

2. Wind speed

It represents the distance covered by air in a time unit. It is expressed in seconds or kilometres per hours, i.e. 1 m/s = 3.6 km/hour, 1km/hour = 0.278 m/s.

The force exerted by wind depends upon the size of the horizontal gradient bar, and the impact of physical and geographical factors.

Annual conditions of wind speed

Multiannual average wind speed in Crisul Repede drainage area for the 1970 – 2008, period of time records the lowest values in high areas due to the fact that Stana de Vale meteorological station is surrounded by higher relief and it is also protected by some holydays

villas and chalets built in here during the last 10-15 years; thus in here a minimum speed of only 0.6 m/s occurs.

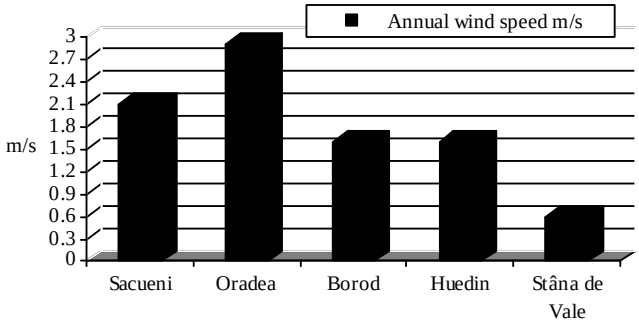

Figure 2: Annual average wind speed in Crisul Repede drainage area

Borod and Huedin depression areas, although located at lower altitudes, record sensitively higher rates duet o the fact that these areas are more open and exposed to air overall circulation . Thus, these areas show a multiannual wind average speed of 1.6 m/s. In plains areas the wind speed has values contained between 2.1 m/s at Sacuieni and 2.9 m/s at Oradea, in here the maximum speed within the drainage area being recorded (see Figure 2).

Monthly conditions of wind speed

Analysing the monthly evolution of wind speed one notices that the highest rates occurs during spring season, namely in March and April, mainly caused by the air active dynamics, with higher temperature and pressure fluctuations, highlighted by reduced values of air calm. Thus, the minimum rates are recorded at Oradea city, with 4.1 m/s, in April, followed by Sacuieni with 2.7 m/s in March and April, Huedin city with 2.2 m/s in April, Borod with 2.0 m/s in March and April while at Stana de Vale the maximum value is recorded is the lowest within Crisul Repede drainage area being only of 0.8 m/s in March.

The lowers wind speed rated are generated, usually, in summer season, with the lowest speeds in August, and with the exception of Huedin, where the minimum rate occurs in winter season, with the lowest speed being recorded in January. Thus, the lowest speed within Crisul Repede drainage area occurs at Stana de Vale, of 0.4m/s respectively, recorded in August, followed by Huedin and Borod depression stations with speeds of 1.1 m/s and 1.2 m/s, respectively, recorded for Huedin in January and for Borod in August, respectively. On plain areas the lowest wind speeds are of 1.4 m/s and 2.3 m/s at Sacuieni and Oradea, respectively, both recorded in August (see Figure 3).

The monthly evolution of wind speed is similar with the annual one, namely the lowest wind speeds occur at mountain areas while at plains area the lowest ones; Oradea city record the highest wind speeds rates while for the depression stations the rates show intermediary levels.

Wind speed on directions

While analysing the average annual rates of wind speed on the eight cardinal points one may notice that, in plains areas, the highest wind speed occurs from South and South-West direction with speeds varying from 4.2 m/s at Sacuieni and 4.1 m/s at Oradea, respectively. In depression areas, the maximum multiannual speeds are recorded for the South and South-West, namely at Borod the average wind speed is of 4.9 m/s from South-Western directions with

speeds varying from 4.2 m/s at Sacuieni and 4.1 m/s at Oradea, respectively. In depression areas, the multiannual maximum speeds belong to South-West and West directions, namely the wind blowing with of 4.9 m/s at Borod from South-Western while at Huedin it blows with an average speed of 4.1 m/s from Western. As for Stana de Vale, the wind blows with a constant speed of 2.0 m/s up to 2.5 m/s in all directions, one notice that the maximum values of 2.5 m/s are specific to several sectors: South, South-East, East, and Nord-East (see Table 3).

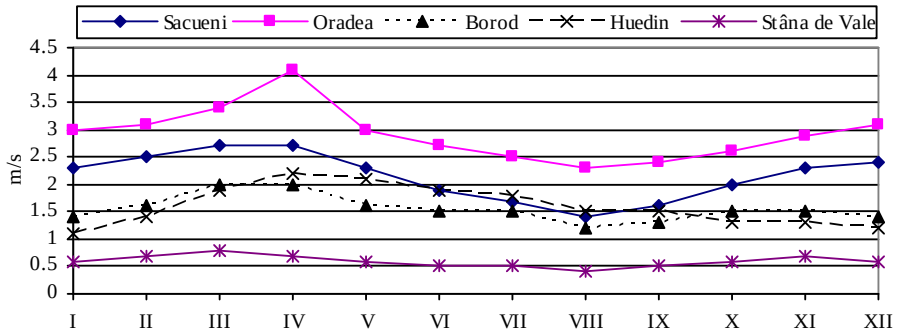

Figure 3: Monthly evolution of wind speed within Crisul Repede drainage area

The lowest annual average wind speeds on directions are from South-East and North-West directions. At Sacuieni and Stana de Vale the wind has the lowest average rate blowing from the North-Western sector with 2.7 m/s and 2.0 m/s, respectively. As for the remaining stations, the minimum wind speed is recorded while the wind blows from South-Eastern sector; thus, at Oradea the average speed is of 2.6 m/s, at Borod, it is of 2.5 m/s while at Huedin is of 2.2 m/s. Thus, the multiannual lowest average speed on directions is generated from the North-Western sector at Stana de Vale, with a speed of 2.0 m/s while the highest average speed is from South-Western sector, with 4.9 m/s recorded at Borod (see Table 3).

Table 3

Annual and monthly average wind speed on directions within Crisul Repede drainage area, within 1970 – 2008 time span

Direction/station	N	NE	E	SE	S	SV	V	NV
Sacueni	3.3	2.9	3.7	3.7	4.2	4.2	3.4	2.7
Oradea	4.0	3.8	2.9	2.6	4.1	4.1	3.4	3.2
Borod	3.1	3.1	2.9	2.5	3.6	4.9	3.5	3.1
Huedin	2.4	3.2	3.2	2.2	3.2	3.3	4.1	3.0
Stana de Vale	2.2	2.5	2.5	2.5	2.5	2.4	2.2	2.0

Source: Data collected out of National Archive of National Meteorological Administration and processed

CONCLUSIONS

The wind conditions show characterises imposed by the overall air masses circulation but also by the local geographical conditions. Thus, the wind is dominant from the West sector in depression and mountain areas and from South and South-West sector in plains areas. The multiannual average speed of wind records the lowest values at high altitudes areas, duet o the mountain peaks surrounding the stations: thus at Stana de Vale a minimum speed within the

entire drainage area is recorded – 0.6 m/s, while at plains areas the highest speed rates are recorded – 2.9 m/s maximum rate at the level of Oradea city.

The highest wind speeds on cardinal points within Crisul Repede drainage area occur from the South and South-Western sector in plains areas, namely with values between 4.2 m/s at Sacuieni and 4.1 m/s at Oradea. In depression areas, the multiannual maximum speeds characterise the South-West and West directions, namely at Borod the wind blows with a speed of 4.9 m/s from South-Western sector while at Huedin it blows with an average speed of 4.1 m/s from Western sector. At Stana de Vale the wind speed is more constant from all directions, varying from 2.0 m/s to 2.5 m/s. while maximum speeds of 2.5 m/s characterise several sectors, namely: South, South-East, East and North-East sectors.

BIBLIOGRAPHY

1. CIULACHE S., (2002), Meteorologie şi climatologie, Editura Universitară Bucureşti.
2. DUMITER AURELIA FLORINA, (2007), Clima şi topoclimatele oraşului Oradea, Editura Universităţii din Oradea.
3. GACEU O., (2002), Elemete de climatologie practică, Editura Universităţii din Oradea.
4. GACEU O., (2005), Clima şi riscurile climatice din Munţii Bihor şi Vlădeasa, Editura Universităţii din Oradea.
5. MĂHĂRA GH., (1970), Regimul vântului în zona oraşului Oradea, Institutul Pedagogic Oradea, Lucrări Ştiinţifice, Seria A.
6. MĂHĂRA GH., (2001), Meteorologie, Editura Universităţii din Oradea.
7. MOZA ANA CORNELIA, POPOVICI MARIANA, (2006), Aspects regarding wind regime in Oradea, Natural Resources and Sustainable Development: International Symposium: ed a 4-a 10-11oct. 2006, Oradea, University of Oradea, Faculty Environmental Protection, University of Debrecen, Faculty of Agriculture, pag. 293-297.
8. MOZA ANA CORNELIA, (2009) Clima şi poluarea aerului în bazinul hidrografic Crişul Repede, Editura Universităţii din Oradea, ISBN 978-973-759-775-5.