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THE WIND REGIME IN THE CRIȘUL NEGRU HYDROGRAPHIC BASIN

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Key words: wind regime, Crișul Negru hydrographic basin

Abstract. The paper presents the main features of the wind regime in the Crișul Negru hydrographic basin starting from meteorological data recorded at 10 stations distributed across the basin. The analysis was developed based on the classical methodology of processing the meteorological data presented with a climatological purpose in various specialty studies. The study developed reveals that the wind regime depends on a number of factors such as the air movement, topography and local conditions, actually known from previous studies, but this paper distinguishes itself as a novelty through its values that are statistically concrete and correct, all calculated for the main parameters.

Introduction

Just like precipitations, the wind is highly variable in time and space and is a consequence of the different heating of land and / or water that generates air masses with different thermal and baric characteristics.

In the hydrographic basin Crișul Negru, the wind regime is strongly influenced by the presence of the three steps of relief arranged in amphitheater, by the atmospheric circulation and by the local topography which greatly alters the wind speed and direction and fosters the development of local circulation.

1. History of research

Up to present no complex and complete climatic study has been conducted on the Crișul Negru hydrographic basin (Măhăra and co., 1999 Moza, 2009), so there is only information about the study of wider areas. Among these we mention the doctoral dissertations published by: Cristea (2004) which marks the climate risks from the Criș basin and which mentions certain climatic elements, including wind,

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all analyzed using data from several weather stations in the Crișul Negru hydrographic basin; Gaceu (2005) who analyzes a double period (40 years) and refers to climate and climate risks in Vlădeasa and Bihor Mountains, including the wind regime, a more detailed and highly parameterized analysis but which focuses less on our study area (with the weather stations from Stâna de Vale and Ștei); Șerban (2010) who, through a detailed analysis, refers to climate hazards from the Western Plain which is located north of Mureș and captures through the Salonta, Holod, Chișinău Criș, Ineu stations aspects concerning wind.

Climatic aspects concerning the wind regime from the Crișul Negru hydrographic basin were presented in other articles: Măhăra, Linc, 1993; Gaceu, 1997; Dragotă, Gaceu, 2002, 2004; Gaceu, 2004; Gaceu, 2009.. Some references to the Crișul Negru hydrographic basin climate appear in the following works: ***, 1960 *** 1961 *** 1962 *** 1966; *** 1966 b; *** 1972-1979 * ** 1983 *** 1987 *** 2005; Gaceu and co., 2002, 2003, Măhăra and co. 1999; Bogdan, Niculescu, 1999

2. Data and methodology

The Crișul Negru hydrographic basin covers all three levels of relief (plains, hills, mountains), an aspect considered when selecting the weather stations for a better measurement of air temperature characteristics. Thus, we chose 10 meteorological stations (Fig. 1) distributed as follows: Vlădeasa (1836 m), Stâna de Vale (1108 m), Zece Hotare (642 m), Moneasa (703 m) for the mountain area Dumbrăvița de Codru (586 m), Ștei (278 m) for the hilly area, Holod (163 m), Salonta (95 m), Chișineu Criș (96 m), Ineu (110 m). Unfortunately, the climate analysis was more difficult due to the lack of homogeneity of the data, the stations being set up in different stages, during the (1959 – Ștei, 1961 – Vlădeasa 1800, 1962 – Chișineu Criș, 1967 - Holod), the 1970's 1970 (1975 – Moneasa, 1979 – Stâna de Vale and Ineu), anii 1980 (1983 – Dumbrăvița de Codru and Salonta), the 2000's (Zece Hotare, Moneasa, Salonta, Ineu), which is why we used data from the 1978-2007 period, a continuum 30 years, thus respecting the climate research methodology.

Due to the process started in Romania in the 2000's to dispense with the weather stations (the question of the automation and computerization of the National Meteorological system arose) 4 of the 10 stations in the Crișul Negru basin (Zece Hotare, Moneasa, Salonta, Ineu) have 7 years short data, but the remaining 6 stations (Vlădeasa 1800, Stâna de Vale, Ștei, Dumbrăvița de Codru, Holod, Chișineu Criș) have continuous data for 30 years so they are representative according to the WMO norms and are uniformly distributed on the surface of the studied basin (Kostin, Pokrovskaia, 1964; Belozarov, Fărcaș, 1971; Arlery et. al., 1973; Marin, 1986; Fărcaș, 1988; Bogdan, Niculescu, 1999; Gaceu, 2002).

Thus, we tried to conduct a comparative analysis as objective as possible, which is why we used pure data, without interfering with statistical processing which can sometimes drift away from the factual reality, a goal accomplished due to the existence of six meteorological stations with data complete for 30 years.

3. Results and debates

3.1. Frequency of wind on cardinal directions

3.1.1. The annual average frequency of the wind on cardinal directions.

Compiling and analyzing the annual wind rose for each station has highlighted the main wind direction and the sectors in which it blows less often. As already known, the wind direction is not influenced at high altitudes, but with decreasing altitude, and the occurrence of friction it is changed. Thus, at Vlădeasa the wind blows generally according to the general atmospheric circulation in the western sector, with a frequency of 40.4%, but at lower altitudes topography shows its influence: Stâna de Vale, a station cramped in a small depression, recorded just 6.9% in west, Ştei just 1.7%, 1.7%, Dumbrăviţa de Codru 6.4%, Zece Hotare 2.1%, Moneasa 9.6%, Ineu 5.5%, Chişineu Criş 4.4%, Salonta 5.2% (Table 1, Fig. 2).

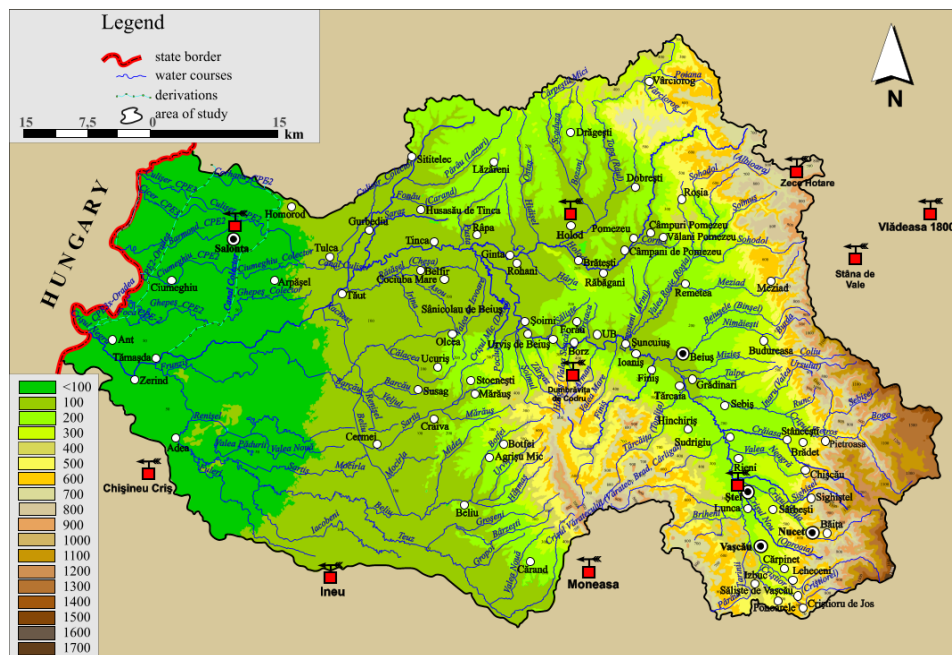


Fig. 1. The location of the meteorological stations in the Crişul Negru hydrographic basin.

We have to note that the value registered in a westerly direction at Stâna de Vale (6.9%) is still high, the highest frequency on cardinal directions taking into consideration the calm winds is the most frequent in this place (75.3%) (Table 1, Fig. 2).

In the case of the other stations located at lower altitudes, the wind recorded higher frequencies in the northern sector (14.1% at Salonta, 13.0% at Chișineu Criș, 9.2% at Ineu) and in the southern sector (33.0% at Ștei, 14.9% at Dumbrăvița de Codru, 20.8% at Zece Hotare, 5.7% at Moneasa) than in the western one, as it would be normal according to latitudinal movements, but these differences highlight once again the influence of topography (Table 1, Fig. 2).

Tab. .1 The annual average wind frequency (%) and speed (m / s) on cardinal directions in the Crișul Negru hydrographic basin

Station		Vlădeasa	Stâna de Vale	Moneasa	Zece Hotare	Dumbrăvița de Codru	Ștei	Holod	Ineu	Chișineu Criș	Salonta
Medium frequency (%)	N	3.2	1.1	4.1	4.1	3.3	4.6	13.2	9.2	13.0	14.1
	NE	3.8	1.3	1.5	9.1	4.4	1.0	13.2	2.6	4.1	10.4
	E	10.8	2.6	5.1	6.6	6.3	0.9	10.8	7.3	5.9	4.2
	SE	7.0	5.1	5.1	3.1	6.2	6.5	2.1	6.8	6.4	5.7
	S	4.0	2.1	5.7	20.8	14.9	33.0	2.6	8.7	11.8	11.3
	SV	14.5	1.8	9.8	12.1	17.6	5.1	10.7	8.9	9.6	7.0
	V	40.4	6.9	9.6	2.1	6.4	1.7	9.0	5.5	4.4	5.2
	NV	5.5	3.8	5.6	1.6	2.5	8.6	4.0	5.2	4.5	4.6
Calm		10.7	75.3	52.9	39.6	38.4	42.6	31.5	45.8	40.3	37.5
Medium speed (m/s)	N	2.6	2.3	2.9	3.3	2.4	3.0	3.0	2.9	3.5	2.9
	NE	2.7	2.6	2.5	3.0	2.2	3.1	2.4	2.1	3.1	2.7
	E	3.6	2.8	2.7	2.5	2.4	2.5	2.2	2.1	2.4	2.1
	SE	3.1	2.7	2.5	2.2	2.9	3.4	2.4	2.8	2.5	2.2
	S	2.5	2.7	2.1	3.6	3.5	3.3	3.3	3.3	4.0	3.5
	SV	4.2	2.6	1.9	4.1	3.3	3.3	3.5	3.0	3.9	3.4
	V	5.7	2.3	1.9	3.6	2.6	2.8	3.0	2.7	3.5	3.3
	NV	3.1	2.2	2.4	3.0	2.0	3.4	2.7	2.6	3.4	2.8

Source: Data from the A.N.M. Archives

Just like in the case of the annual values, the same directions of the wind are valid for the representative months of the year, which certifies once again that the local morphology is more important in setting the direction from which the wind blows than the general circulation of the atmosphere.

Thus, at Vlădeasa, at over 1800 m altitude, the wind blows predominantly from the west with a maximum in December (45.9%) and a minimum in May (33.2%) (Table 2, Fig. 3).

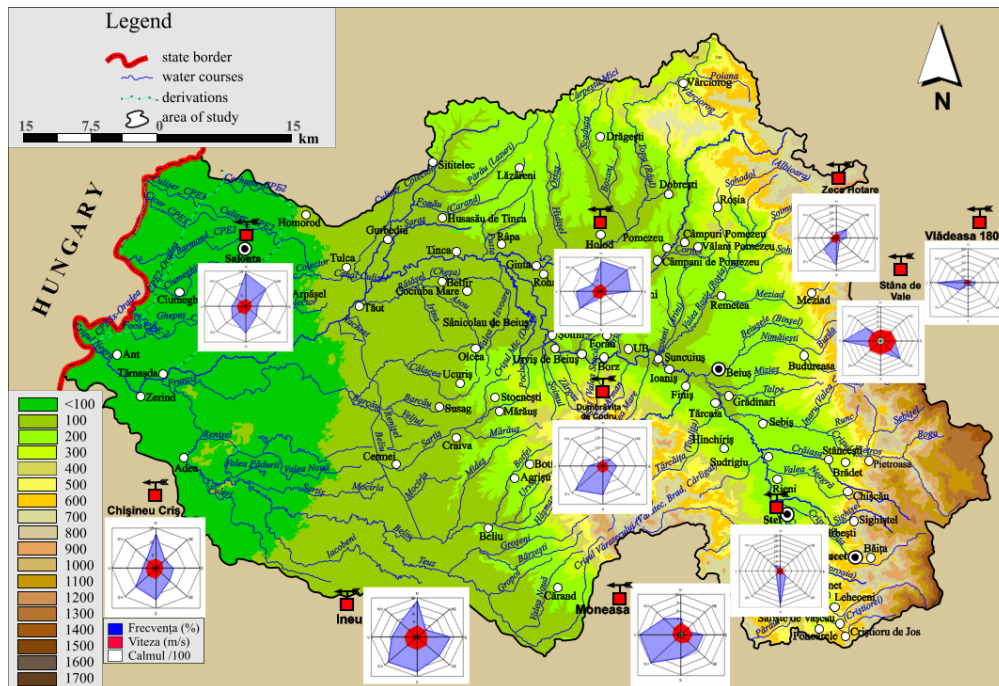


Fig. 2. The annual wind roses in the Crișul Negru hydrographic basin.

3.1.2. The monthly average frequency (%) of the wind on the cardinal directions. Moreover, the other stations keep the same characteristic: Stâna de Vale recorded the highest frequency of the wind in September in the western sector with 8.8% of the cases, at Ștei the wind blows from south more often in November, with a high frequency range between 36.1% in November and 25.8% in July, etc. (Table 2, Fig. 3).

The lowest monthly frequency of the wind direction in the the Crișul Negru hydrographic basin occurs in the winter months, with 1.9% in the southeastern sector at Vlădeasa in November, 0.5% at Stâna de Vale in December in the northern sector, 0. 4% at Ștei in December in the eastern and north-eastern sector etc. (Table 2, Fig. 3).

Tab. 2. *The monthly and annual average of calm winds and wind (%) at several stations from the Crişul Negru hydrographic basin*

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Station/direction	VLĂDEASA												
N	3.7	3.5	2.9	3.0	3.4	3.4	4.7	3.3	2.5	2.4	2.5	2.8	3.2
NE	3.9	4.2	2.9	4.6	4.8	4.8	5.4	4.8	2.4	3.4	1.9	2.9	3.8
E	9.9	7.7	9.8	14.0	16.3	12.4	13.1	13.3	10.2	8.9	6.2	7.9	10.8
SE	6.9	7.9	8.9	7.9	8.3	5.5	4.4	6.3	5.5	7.4	7.2	7.9	7.0
S	3.6	4.3	3.9	5.0	3.8	2.6	3.1	3.5	4.4	5.2	5.2	3.9	4.0
SV	14.0	14.2	15.9	16.4	14.0	11.0	10.0	12.0	15.7	16.4	19.5	15.0	14.5
V	44.1	43.3	41.1	35.8	33.2	39.3	41.2	35.2	42.5	39.0	43.8	45.9	40.4
NV	5.2	5.8	5.1	4.8	5.0	7.9	7.4	6.0	4.7	4.3	5.1	5.3	5.5
Calm	8.7	9.0	9.6	8.5	11.3	13.1	10.8	15.5	12.1	13.0	8.5	8.3	10.7
Station/direction	STĂNA DE VALE												
N	1.3	1.5	1.5	1.3	1.3	1.1	0.8	0.7	0.5	1.2	0.9	0.5	1.1
NE	1.6	1.8	2.2	1.6	1.9	1.2	1.3	0.7	0.8	0.8	1.2	0.8	1.3
E	2.3	3.6	3.1	4.2	3.8	1.7	1.2	1.3	1.7	2.5	3.1	2.9	2.6
SE	4.5	6.3	6.2	8.2	5.1	2.7	2.3	2.2	3.3	6.2	7.2	6.5	5.1
S	2.7	1.8	3.3	1.8	1.6	1.4	1.5	1.2	1.3	2.9	2.7	3.0	2.1
SV	1.5	2.1	2.0	2.1	1.5	1.6	1.7	1.2	2.0	1.5	3.1	1.6	1.8
V	5.7	5.9	7.5	6.6	6.6	8.2	7.2	8.1	8.6	7.7	6.5	4.4	6.9
NV	2.9	3.5	4.5	4.2	4.3	4.8	5.6	5.2	4.2	3.5	2.1	1.3	3.8
Calm	77.5	73.5	69.6	70.0	73.9	77.3	78.4	79.4	77.6	73.7	74.2	79.0	75.3
Station/direction	ŞTEI												
N	3.2	4.6	5.8	5.7	5.5	5.6	6.0	5.4	4.1	3.6	3.2	3.0	4.6
NE	0.9	1.3	1.4	1.0	1.1	1.3	1.5	1.1	0.8	0.5	0.5	0.4	1.0
E	0.6	1.1	0.9	1.4	1.3	1.1	1.2	1.0	0.8	0.6	0.7	0.4	0.9
SE	8.7	8.0	5.9	6.7	5.6	5.4	5.0	4.2	5.4	8.0	8.7	9.2	6.7
S	33.4	32.7	30.1	29.1	28.4	27.2	25.8	26.9	32.0	35.7	36.1	33.5	30.9
SV	1.6	2.1	3.7	3.7	3.7	3.5	3.1	3.2	3.3	3.2	3.2	1.9	3.0
V	1.3	1.0	1.6	1.9	2.6	2.4	2.1	2.0	1.7	1.3	1.2	0.9	1.7
NV	5.8	8.3	9.9	10.9	10.2	11.3	10.6	9.6	7.7	7.2	6.4	5.2	8.6
Calm	44.5	40.9	40.7	39.6	41.6	42.2	44.7	46.6	44.2	39.9	40.0	45.5	42.6

Source: Data from the A.N.M. Archives.

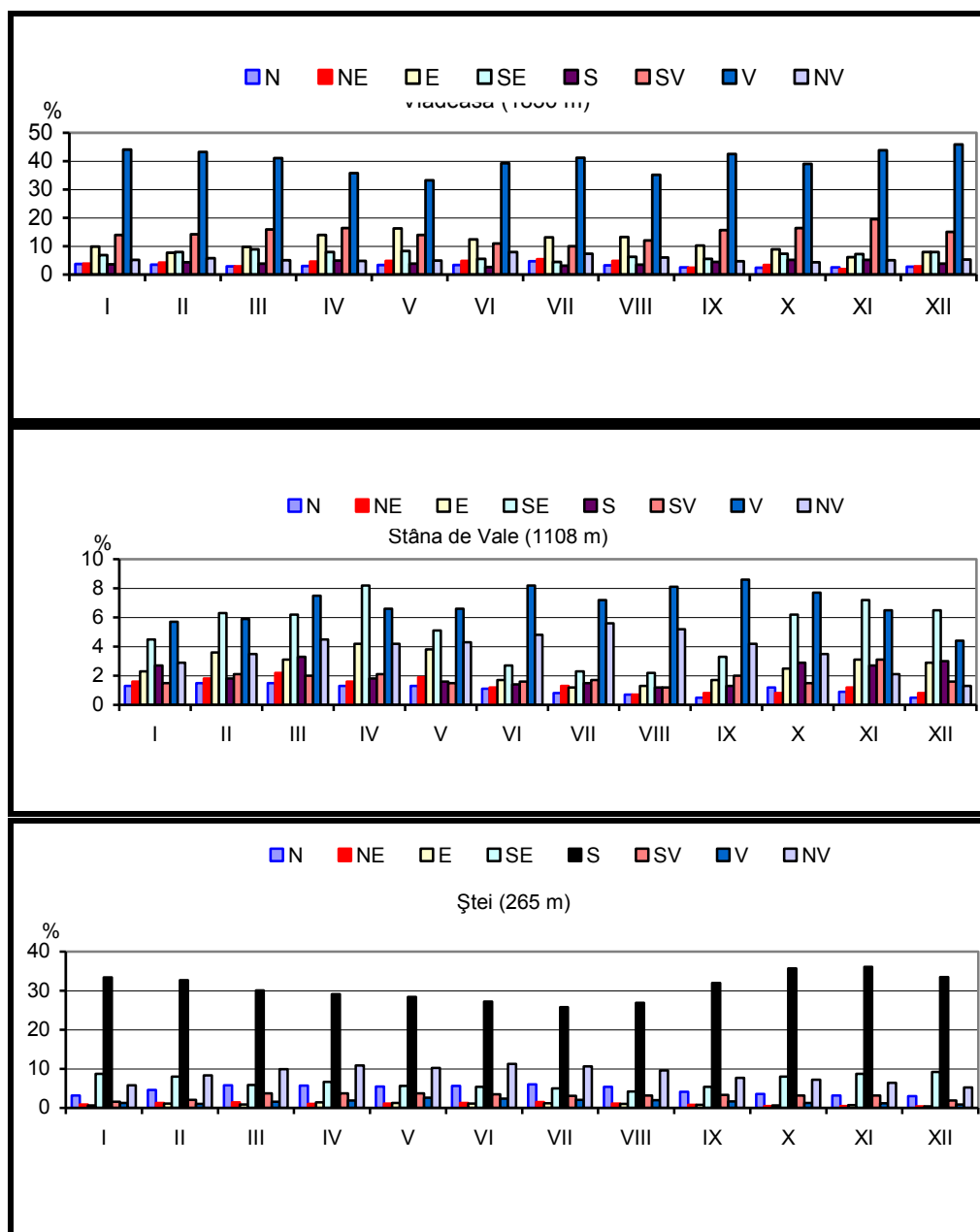


Fig. 3. The monthly frequency of the wind (%) on directions for several stations from the Crişul Negru hydrographic basin.

3.1.3. Calm winds. Looking at the annual frequency of the calm winds (Fig. 1, Table 1), we find that it has high values between 10,7% at Vlădeasa and 75,3% at Stâna de Vale. Generally, the calm winds have quite high values in the Crișul Negru hydrographic basin, especially at medium and low altitudes, due to the sheltered position of the representative meteorological stations, located in narrow depressions or due to higher friction in the case of the field area stations: 37.5% at Salonta, 40.3% at Chișineu Criș, 45.8% at Ineu. The lowest annual frequencies for calm winds occur on the heights of the Crișul Negru hydrographic basin represented by the meteorological station Vlădeasa (10.7%).

During the year *calm winds* usually recorded higher values in late summer and early autumn, when over our country lies the ridge of the Azoric anticyclone, which brings stable weather. Thus, at the greatest heights of Vlădeasa calm winds have a higher rate in August (15.5%), which also happens at Stâna de Vale (79.4% in August), Ștei (46.6% in August) and so on (Table 2, Fig. 3, Fig. 4).

The lowest monthly values of calm winds are recorded throughout the Crișul Negru hydrographic basin during spring when the atmospheric circulation changes and the thermal contrast between land and water and between different parts of the land is higher, which leads to the destabilization of the air, thus reducing the atmospheric calm values: 8.5% at Vlădeasa in April, 69.6% at Stâna de Vale in March, 39.6% at Ștei in April etc. (Table 2, Fig. 3, Fig. 4).

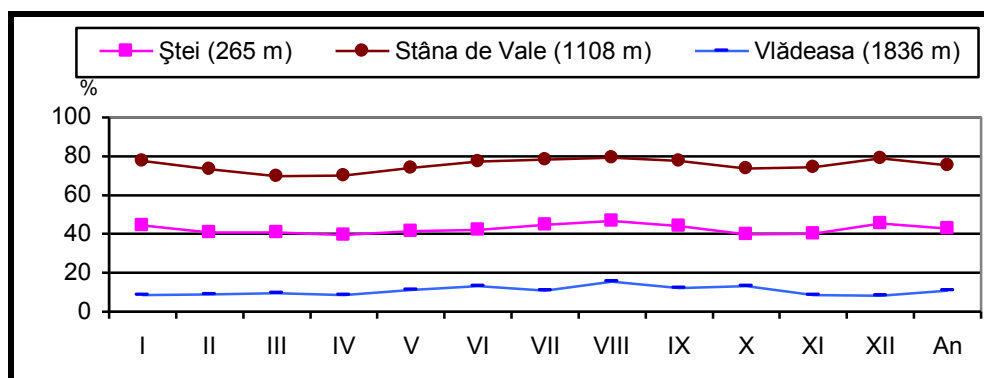


Fig. 4. The monthly frequency of calm winds (%) for several stations from the Crișul Negru hydrographic basin.

3.2. Wind speed on cardinal directions

3.2.1. The annual average wind speed on the cardinal directions. The highest annual average wind speeds in the the Crișul Negru hydrographic basin, are recorded in western mountain areas, at the highest altitudes: 5.7 m/s at Vlădeasa

and southern and in the southern field and hill areas: 3.5 m/s at Salonta, 4.0 m/s at Chişineu Criş, 3.3 m/s at Ineu and 3.5 m/s at Dumbrăviţa de Codru. Only the stations Ştei, Stâna de Vale and Moneasa, with special topography, record maximum speeds on the other direction, namely south-east: 2.8 m/s at Stâna de Vale, 2.5 m/s at Moneasa, 3.4 m/s at Ştei.

The *lowest annual average speeds on cardinal directions* in the Crişul Negru hydrographic basin occur on eastern direction in the fields area: 2.1 m/s at Salonta, 2.4 m/s at Chişineu Criş, 2.1 m/s at Ineu and 2.2 m/s at Holod, and on the southern direction at the highest points: 2.5 m/s at Vlădeasa. The meteorological stations located in special local conditions, respectively in the mountain depressions (Stâna de Vale), slopes (Dumbrăviţa de Codru, Zece Hotare), terrace in a depression (Ştei) recorded minimum values in other directions, depending on the specific topoclimatic conditions: north-east with 2,2 m/s at Stâna de Vale and 2,4 m/s at Ştei, northwest with 2,0 m/s la Dumbrăviţa de Codru, southeast with 2,2 m/s at Zece Hotare, west and south-west with 1.9 m/s at Moneasa (Table 3).

Tab. 3. Annual average wind speed (m / s) on cardinal directions in the Crişul Negru hydrographic basin

Station	N	NE	E	SE	S	SV	V	NV
Vlădeasa	2.6	2.7	3.6	3.1	2.5	4.2	5.7	3.1
Stâna de Vale	2.3	2.6	2.8	2.7	2.7	2.6	2.3	2.2
Moneasa	2.9	2.5	2.7	2.5	2.1	1.9	1.9	2.4
Zece Hotare	3.3	3.0	2.5	2.2	3.6	4.1	3.6	3.0
Dumbrăviţa de Codru	2.4	2.2	2.4	2.9	3.5	3.3	2.6	2.0
Ştei	3.0	3.1	2.5	3.4	3.3	3.3	2.8	3.4
Holod	3.0	2.1	2.2	2.4	3.3	3.5	3.0	2.7
Ineu	2.9	2.4	2.1	2.8	3.3	3.0	2.7	2.6
Chişineu Criş	3.5	3.1	2.4	2.5	4.0	3.9	3.5	3.4
Salonta	2.9	2.7	2.1	2.2	3.5	3.4	3.3	2.8

Source: Data from the A.N.M. Archives

3.2.2. The monthly average wind speed on the cardinal directions. It has similar values with the average annual speed, being respectively the highest and lowest on the same directions as in the case of the annual analysis.

Thus, at the highest altitudes from the Crişul Negru hydrographic basin represented by the Vlădeasa meteorological station, the monthly average speed occurs in the winter months of December and January when the wind is blowing with 71 m/s in a westerly direction and the lowest monthly average speed occurs in the summer months of July, August and September when the wind is blowing only with 1.9 m/s from south (Table 4).

In addition, the other stations keep the same feature: Stâna de Vale has the highest monthly average during winter in December, January and February when the wind blows with 3.1 m/s from northeast and east, and the lowest monthly average speed on directions occurs during summer in August, when the wind blows from the north-eastern sector with 1.5 m/s. At Ștei there is a maximum speed during winter in December when the speed is of 4.5 m/s in the north-eastern sector, while the lowest average speed occurs in January, 1.8 m/s in a westerly direction (Table 4).

Tab. 4. The monthly and annual average speed of the wind (m/s) on the cardinal in the Crișul Negru hydrographic basin

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Station/direction	VLĂDEASA												
N	3.0	3.3	2.7	2.5	2.2	2.3	2.8	2.1	3.1	2.4	2.7	2.3	2.6
NE	3.1	3.7	2.9	2.9	2.5	1.9	2.4	2.4	2.5	2.4	2.6	2.4	2.7
E	4.7	5.0	4.2	4.0	3.1	2.7	2.7	2.7	2.8	3.0	3.8	4.1	3.6
SE	4.2	3.3	3.5	3.7	3.2	2.7	2.4	2.4	2.4	3.1	3.4	3.7	3.1
S	2.0	3.6	2.0	3.0	2.3	2.2	1.9	1.9	1.9	2.2	3.2	3.2	2.5
SV	4.8	5.3	4.4	4.4	5.6	3.8	3.1	2.8	3.6	3.9	4.1	4.8	4.2
V	7.1	6.3	6.6	6.0	5.3	4.8	4.5	4.2	5.2	5.4	6.0	7.1	5.7
NV	3.9	3.8	2.9	3.2	2.9	3.0	2.6	2.4	3.0	2.8	2.9	3.4	3.1
Station/direc	STÂNA DE VALE												
N	2.3	2.3	2.2	2.1	2.5	2.3	2.2	2.0	2.1	2.2	2.4	2.5	2.3
NE	3.1	2.1	2.3	3.1	2.5	2.3	2.4	1.8	2.9	3.0	3.0	3.1	2.6
E	2.7	3.1	2.4	2.9	2.8	2.6	2.8	2.8	2.5	3.1	2.9	2.7	2.8
SE	2.8	2.9	2.9	2.7	2.6	2.6	2.5	2.5	2.6	2.6	3.1	3.0	2.7
S	2.8	3.1	2.8	2.2	2.5	2.5	3.0	2.5	2.9	2.7	2.7	2.7	2.7
SV	3.0	2.5	2.5	2.7	3.1	2.6	2.2	2.3	2.6	2.5	2.8	2.7	2.6
V	2.3	2.3	2.4	2.6	2.2	2.2	2.1	2.2	2.2	2.3	2.1	2.5	2.3
NV	2.1	2.3	2.1	2.2	2.3	2.3	2.1	2.0	2.1	2.4	2.2	2.1	2.2
Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	AN
Station/direc	ȘTEI												
N	3.1	2.8	2.9	3.4	3.0	3.0	3.2	2.7	2.9	3.0	2.8	3.0	3.0
NE	2.4	2.5	2.6	2.9	3.4	3.4	3.0	2.9	2.9	2.5	3.6	4.5	3.1
E	2.2	2.8	2.7	2.7	3.3	2.6	2.2	2.2	2.5	2.4	2.1	2.6	2.5
SE	3.7	3.6	3.7	3.5	3.3	3.1	3.0	2.9	3.1	3.4	4.3	3.9	3.4
S	3.7	3.6	3.5	3.4	3.1	2.9	2.9	2.9	3.0	3.3	3.7	3.7	3.3
SV	3.4	3.2	3.9	3.9	3.3	2.9	2.9	3.0	3.5	3.1	3.6	2.9	3.3
V	1.8	2.9	2.8	3.2	3.3	2.6	2.9	2.8	2.8	2.6	2.9	2.5	2.8
NV	3.4	3.6	3.5	3.6	3.6	3.4	3.3	3.4	3.3	3.2	3.3	3.3	3.4

Source: Data from the A.N.M. Archives.

3.2.3. *The average wind speed in any direction.* Except the high peaks, the average annual speed calculated regardless of direction is reduced in Crişul Negru hydrographic basin (Table 5).

Tab. 5. The monthly and annual average wind speed in any direction

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Vlădeasa	9.5	9.1	8.6	7.9	6.7	6.4	6.5	5.7	6.6	7.0	9.4	9.7	7.8
Stâna de Vale	0.6	0.7	0.8	0.8	0.6	0.5	0.5	0.5	0.5	0.7	0.7	0.6	0.6
Ştei	1.9	2.0	2.0	2.0	1.8	1.7	1.6	1.5	1.7	1.9	2.1	1.9	1.8
Holod	1.8	2.3	2.7	2.7	2.4	2.2	2.0	2.0	1.9	2.0	2.0	1.9	2.2
Chişineu Criş	2.1	2.3	2.4	2.7	2.5	2.1	1.9	1.6	1.7	1.8	1.9	2.2	2.1

Source: Data from the A.N.M. Archives.

Thus, the largest annual wind speeds (7.8 m/s) occur on the highest peaks of the Crişul Negru hydrographic basin, represented by the meteorological station Vlădeasa where the friction with the land area is smaller. Instead, at Stâna de Vale, all because of the morphology of the field (located in the homonymous depression which is 2 km long, more than 2 km wide and well closed by peaks higher than 200-500 m) it was recorded the lowest annual average wind speed of 0.6 m/s, a fact also highlighted by Gaceu (2005), *** (2008). At lower altitudes the wind speed is greater than at Stâna de Vale because these stations are not so well sheltered from the general circulation of the atmosphere; they recorded values of 1.8 m/s at Ştei, 2.2 m/s at Holod, 2.1 m/s at Chişineu Criş etc. (Table 5).

3.3. *Strong winds and wind storms*

3.3.1. *Frequency of days with strong wind and wind storms.* According to the specialty literature (***, 1986, 1995) the strong wind is moving air that meets or exceeds the speed of 16 m/s and the wind storm is defined as a wind that begins and ends suddenly, lasts only a few minutes while the wind often changes direction, turning into gusts of wind that exceed 100 km/h (28 m/s).

In our analysis, as well as for other wind parameters, we processed data from all 10 stations located in the Crişul Negru hydrographic basin, but the content of this paper and the included tables present de values recorded by three stations that have a longer string of observations (Ştei, Stâna de Vale, Vlădeasa). We proceeded in this manner because, just like in the case of precipitations, the wind has a high variability in time and space and the values of the other stations that are calculated on a shorter period would have altered the results.

In the area of the Crișul Negru hydrographic basin the strong winds and the wind storms are rare, the only exceptions being met at high altitudes. Thus, the annual average frequency of days with strong wind varies between 0 days in the well sheltered depressions such as the Stâna de Vale depression, it reaches 1.8 days at Ștei in the Beiuș Depression which is wide open for the western circulation and exceeds 110 days at the highest altitude (Table 6, Fig. 5).

The maximum number of days per year with strong winds ranged from 1 day to Stâna de Vale, 14 days at Ștei and 160 days at Vlădeasa (Table 6, Fig. 5), due to the greater friction with land in the field area, to the topoclimate of the intermountain depressions which are well protected by the surrounding peaks and the reduced friction of the air with the earth's surface at high altitudes, a fact noted by Bâzâc, 1984, Gaceu, 2005, *** The Romanian climate, 2008 etc.

During the year, most days with strong winds occur throughout Vlădeasa (13.9 days) in January, at Ștei (0.3 days) in November, i.e. during the winter months when the thermal contrast between land and water is higher and the wind blows harder. The fewest days with strong winds occur in the months of late summer and early autumn, i.e. August-September when the anticyclone regime given by the Azoric anticyclone extension to our country dominates (Bâzâc, 1984; Fărcaș, 1983; Gaceu, 2005; *** The climate in Romania, 2008 etc.) and the average is of 5.2 days at Vlădeasa, 0.0 days at Ștei and Stâna de Vale (Table 6, Fig. 6).

Tab. 6. The monthly and annual average and maximum days with strong wind

Station/Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Ștei	m	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.2	0.3	0.2	1.8
	M	2	1	2	2	1	1	1	1	1	4	4	3	14
Stâna de Vale	m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	M	0	0	0	1	0	0	0	0	0	0	0	0	1
Vlădeasa	m	13.9	11.2	11.5	9.3	7.3	6.2	6.6	5.2	7.9	8.0	11.7	12.9	110.0
	M	26	22	24	17	17	17	18	16	16	23	26	23	160

Source: Data from the A.N.M. Archives.

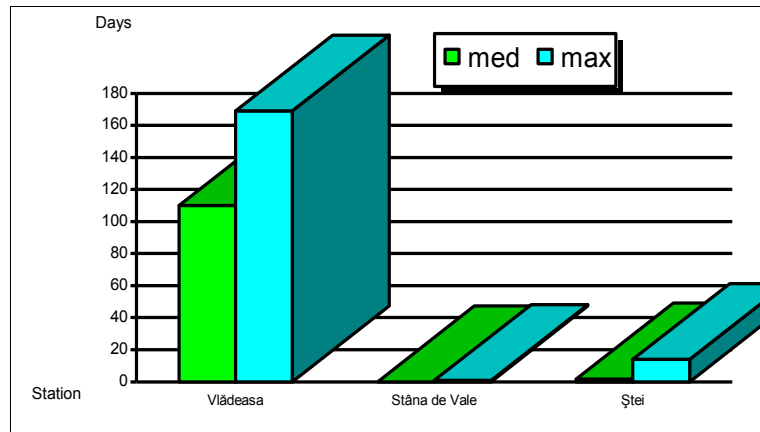


Fig. 5. The annual average and maximum days with strong wind (>16 m/s) in the Crişul Negru hydrographic basin.

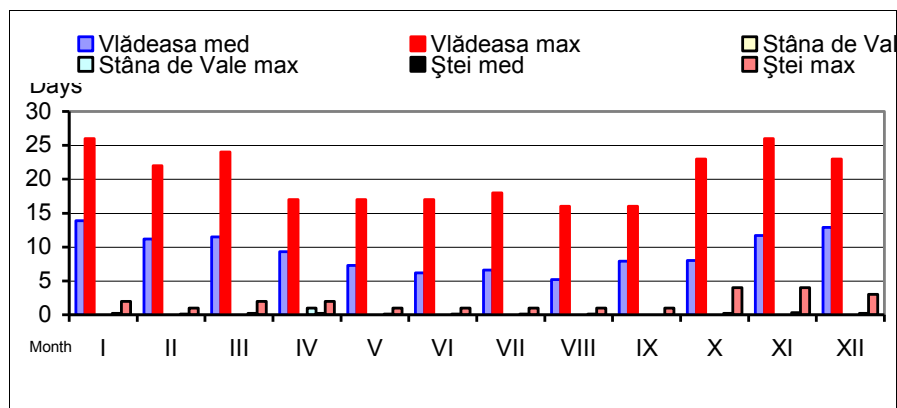


Fig. 6. The monthly average and maximum number of days with strong wind (>16 m/s) in the Crişul Negru hydrographic basin.

Analyzing the frequency of days with wind storms, we found that it is much more reduced than the frequency of the strong windy days. Therefore, the annual average of the days with wind storms reaches only 1.6 days at Vlădeasa, 0.4 days at Ştei and 0.3 days at Stâna de Vale, while the maximum annual number of days with wind storms totals 27 days at Vlădeasa, 4 days at Ştei, 3 days at Stâna de Vale (Table 7, Fig. 7).

Tab. 7. The annual and monthly average and maximum number of days with wind storms

Station/Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Ștei	m	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.4
	M	0	0	1	1	1	1	0	3	0	0	0	1	4
Stâna de Vale	m	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.3
	M	0	0	0	0	0	1	2	0	0	0	0	0	3
Vlădeasa	m	0.1	0.1	0.4	0.1	0.2	0.1	0.3	0.3	0.0	0.0	0.0	0.0	1.6
	M	5	3	8	3	2	2	4	4	0	0	1	1	27

Source: Data from the A.N.M. Archives.

During the year, in the Crișul Negru hydrographic basin area, the average number of days with wind storms is low: 0.4 and 8 days at Vlădeasa, 0.2 and 2 days at Stâna de Vale, 0.2 and 3 days at Ștei, the phenomenon of winds storms occurring mainly in the summer months as a result of the increased thermal and dynamic convection that generates clouds with vertical development like Cumulus congestus and cumulonimbus, and also in the spring months, when the basin area is crossed by a succession of cold fronts, characterized by significant thermo-baric contrasts (Fărcaș, 1983; Bâzâc, 1984; Cristea, 2004; Gaceu, 2005; Moza, 2009; Șerban, 2010; ***, 2008 etc.).

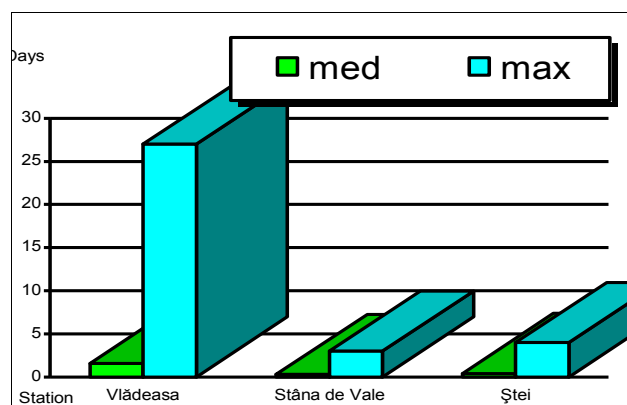


Fig.7. The annual and monthly average and maximum number of days with wind storms in the Crișul Negru hydrographic basin.

3.3.2. *The absolute maximum speed and wind direction.* The highest absolute wind speeds from the Crișul Negru hydrographic basin are recorded, as expected, on the highest peaks in January, in the western side: 62 m/s in 1976 at Vlădeasa. But with decreasing altitude and changes in topography, as in with the increasing

of the land surface and air friction process, the maximum absolute values of the wind speed is reduced to 20 m/s at Stâna de Vale (April 1983, in the south-eastern sector), 28 m/s at Ştei (June 1982, in the western sector), etc., the western direction found preponderantly at high altitudes changes (wind blows from the other cardinal points) and the maximum speed can be recorded during spring (due to the cold fronts) or during summer (due to the intensification of the thermodynamic convection)) (Fărcaş, 1983; Bâzâc, 1984; Cristea, 2004; Gaceu, 2005; ***, 2008 etc.) (Table 8, Fig. 8).

Tab. 8. The monthly absolute maximum speed (m/s), the direction from which the wind blows and the year of the recording at several meteorological stations from the Crişul Negru hydrographic basin

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Ştei	17, V, 76	16, V, 77	16, SSE, 92	14, NV, 82	14, SSV, 80	28 , V, 82	13, N, 78	12, S, 77	12, NV, 74	17, SSE, 75	12, SSE, 84	14, SSE, 81	28, V, 82
Stâna de Vale	12, SSE, 86	10, E, 88	14, S, 83	20 , SE, 83	10, SE, 84	9, VNV, 93	10, SE, 1996	8, ENE, 86	12, SE, 84	14, E, 81	14, V, 83	14, E, 81	20, SE, 83
Vlădeasa 1800	62 , V, 76	60, V, 77	43, V, 79	>40, V, 97	45, SV, 78	52, V, 82	>40, V, 80	42, V, 77	>40, V, 95	42, V, 83	43, V, 77	50, V, 76	62, V, 76

Source: Data from the A.N.M. Archives.

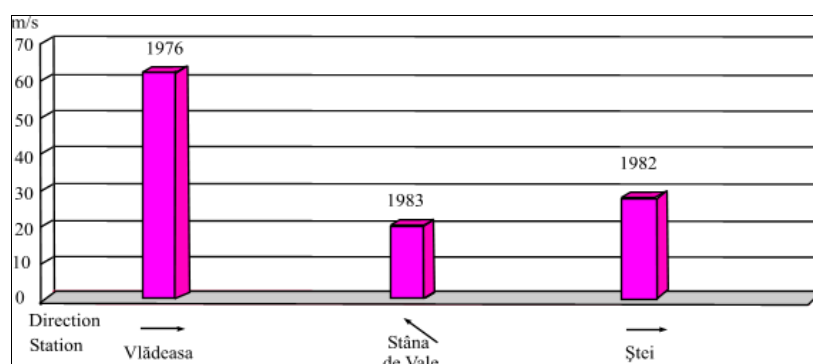


Fig. 8. The monthly absolute maximum speed (m/s), the direction from which the wind blows (arrows) and year of recording at several meteorological stations from the Crişul Negru hydrographic basin.

Conclusions

Analyzing the main parameters characterizing the wind from the Crișul Negru hydrographic basin we reached the following conclusions:

a) Topography influences the main features of the wind, in the sense that it may increase or decrease its speed and it may alter its direction etc. (Bâzac, 1984; Gaceu, 2005; *** The Romanian climate, 2008 etc.).

b) The highest frequency of the wind, both monthly and annually, is recorded in the western sector, 40% on the highest peaks of Vlădeasa where the friction with the land surface is reduced, 7-10% in the sheltered valleys of Stâna de Vale, Moneasa where the friction with the land surface is higher and at lower altitudes where the predominant frequency is found in the southern and south-western sides: 20% at Zece Hotare, 17% at Dumbrăvița de Codru, 33% at Ștei, 11% at Holod or in the lowest northern areas of Chișineu Criș (13%) and Salonta (14%).

c) The calm winds have a normal frequency for this area (10-11% at heights, 30-40% for small and medium altitudes), except for the depressions where most of the cases are characterized by the lack of wind: 53% at Moneasa 75% at Stâna de Vale, the latter having the second frequency for calm winds in Romania after the station Titești (Bogdan, Dragotă, 1997 Gaceu, 2005; Vlaicu Gaceu, 2009).

d) Wind speed is within normal limits for the location and the topography of the Crișul Negru hydrographic basin, the annual average being between 7.8 m/s at the highest peaks of Vlădeasa and below 2 m/s at the other stations located in depressions or at lower altitudes. During the year the highest speeds occur at low and medium altitudes during spring and at high altitudes during winter, basically during the periods of atmospheric instability, while the lowest speeds occur in late summer and early autumn, when the serene and peaceful anticyclone, brought by the extension of the Azoric Anticyclone, dominates (Măhăra and co., 1977; Gaceu, 2005; *** The Romanian climate, 2008; Vlaicu, Gaceu 2009 etc.).

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