RAINFALL IN THE SUHARD MOUNTAINS FROM BUCOVINA

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Abstract
In the study of the rainfall from Suhard Mountain, we used data from meteorological stations and rainfall stations situated in the immediate vicinity, which ensured a relatively satisfactory interpretation of this parameter. The altitude difference registered in Suhard, 1262m (between the 670m, at the confluence of Maria River with Someşul Mare and 1932m of Omu Peak), generates a remarkable spatial variation of rainfall. As a true reflection of the local geographical conditions, the rainfall quantities graphs don't describe anymore a proportional linear increase with the altitude, but mildly resembling a parable.

Key words: rainfall, variation, climatic hazards, humidity excess, deviation, frequency.

INTRODUCTION

Suhard's role of climatic barrier complicates rainfall regime and distribution. The orientation of the main peak, almost perpendicular to the direction of movement of air masses, the increase in altitude in North-West determines the reactivation of cloud systems and larger quantities of rainfall in this direction, which is totally opposite of Bistriţa's lane, situated in the "underwind" area, or Dornelor's depression, where the phenomenon of foehn takes place, which destroys the descending cloud systems from the Eastern peaks of Bârgău's Mountain.

A study on rainfall differences from between the Eastern and Western parts of Eastern Carpathians, realized by Barbu and Apăvăloaiei (1975), highlights the part of orographic obstacle played by this Carpathian branch, in the Western region of it being recorded larger quantities, with a difference of 200-300mm from the Eastern part.

MATERIALS AD METHODS

Because the weather and rainfall stations are missing from the inside of the mountainous area we study, monthly and daily data about rainfall from the higher or lower areas around this one were used. Based on the use of GIS and the corrections to real data recorded around Suhard Mountain, annual and semiannual maps were developed, De Martonne dryness index and mountains exhibition maps, both with important roles in the local differentiations of rainfall.

The reality on the field is proved by data registered in the neighboring rainfall and weather stations: Ciocăneşti, (840m) with

606.3mm, Poiana Stampei (915m) with 651mm, Vatra Dornei (800m) with 657mm, Cîrlibaba (930m) with 699mm, Iezer (1735m) with 1247mm, Rarău (1632m) with 907mm. We mention that we didn't take into account the data from Reţitis weather station (2020m) which, given the location and relatively short string of observations, registers only an annual average rainfall quantity of 524.6mm (1991-2009).

RESULTS AND DISCUSSIONS

Average annual rainfall amounts from areas in close proximity are located between 651mm in Poiana Stampei and 1267mm in Iezer. The inferior limit of the mountain, at contact with the depression, registers a smaller quantity than areas from lower altitudes, but positioned in the West, as a proof being the 650mm from Poiana Stampei in comparison with the 684mm from Bistriţa's station. Nevertheless, the 700mm value can be found in almost the entire area of Suhard Mountain (figure 1). In altitude, the increase is slower until 1600m, where values can reach up to 1000mm or even more above this height. An increase of values in North-West is added up, reaching 1250-1300mm in Omu Peak. Even though some sources present higher values, with approximately 100 mm (Monografia R.P.R., 1960), the situation can be explained by the fact that the analysis involves another interval of time, possibly more humid.

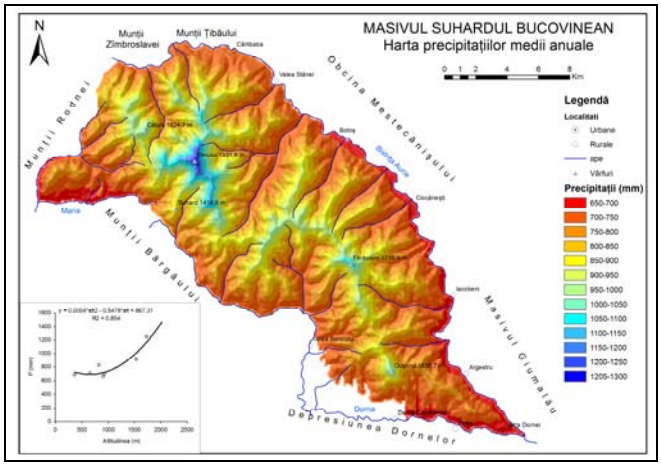

Fig. 1. Map of annual average rainfall of Suhard Mountain from Bucovina.

It is highlighted the patchy nature of rainfall, with quite large variations from year to year. For example, in Iezer, they were from 951mm, which is 75% from the annual average, and 1935mm, 152% from annual average.

The semiannually situation indicates that in the entire area, 60% of the total quantities of rainfall take place in the warm semester (between April and September). For lower areas, we can notice higher weights to 70%, with a slight decrease towards South-North. In altitude, the degree of continental is perfectly illustrated: at Iezer just 60% (weight approaching the

one of Bistrița), while in Rarău the weight of 72% exceeds even the one of Vatra Dornei, 70%.

In the cold semester, the average quantities vary from 197mm in Vatra Dornei, to 497mm in Iezer (table 1, fig. 2). Compared to the annual situation, the graph of rainfall distribution, in the cold semester, according to the altitude, describes a more pronounced parabola, showing the important part of local conditions in registering rainfall quantities. The entire area we study is delimited by the values of 200-250mm, and at higher altitudes, of 1600m, the increases are more noticeable, from 400mm to over 600 mm.

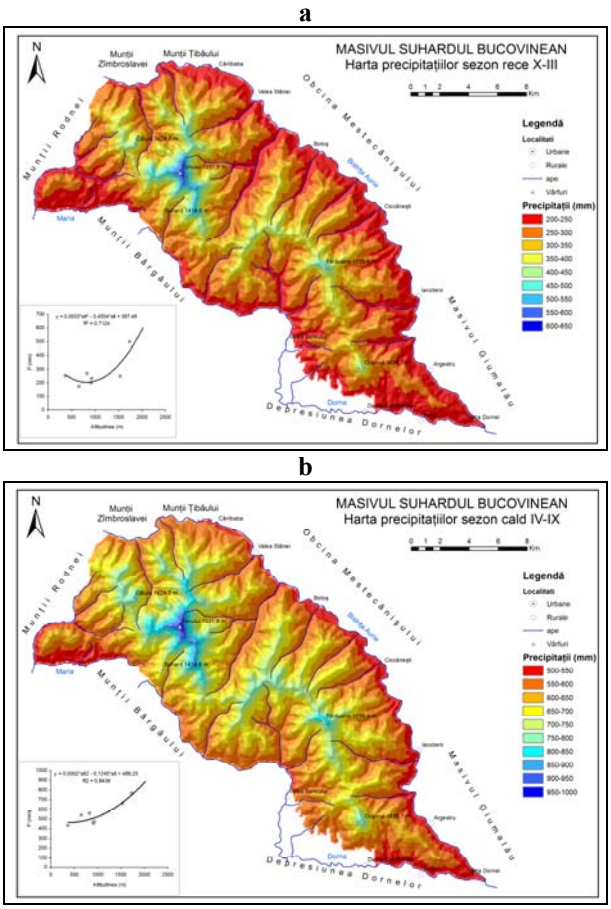

Fig. 2. The half-year repartition of average rainfall (cold season-a, warm season-b).

The continental degree was analyzed according to the Martonne dryness index (table 1, fig. 3), which expresses the deficit/excess of humidity, calculated by the formula $I_a=P/(T+10)$ (P is the average annual rainfall, T is the average annual temperature) and whose higher values emphasizes an humidity excess. For the studied area it is obvious the growth tendency with the altitude of the Martonne index.

The annual average quantities increase with the altitude, being at minimum in winter and maximum during summer. This way, from 24mm in Poiana Stampei, in February and 67mm at Iezer in January, in June it can be reached 104mm in Poiana Stampei and 160mm in Iezer. Analyzing the variation of annual average quantities of rainfall, it is noticeable the maximum from June, no matter the altitude, and the minimum from January-February.

Table 1

Annual average sums of rainfall, cold semester (CS), warm semester (WS) and De Martonne index.

Station	Year	CS	WS	de Martonne
Bistrița	684	251	433	37,17391
Campulung	709	172	537	42,71084
Vatra Dornei	657	197	460	54,76821
Poiana Stampei	651	198	453	45,13889
Rarău	907	247	660	73,14516
Iezer	1267	497	769	109,386

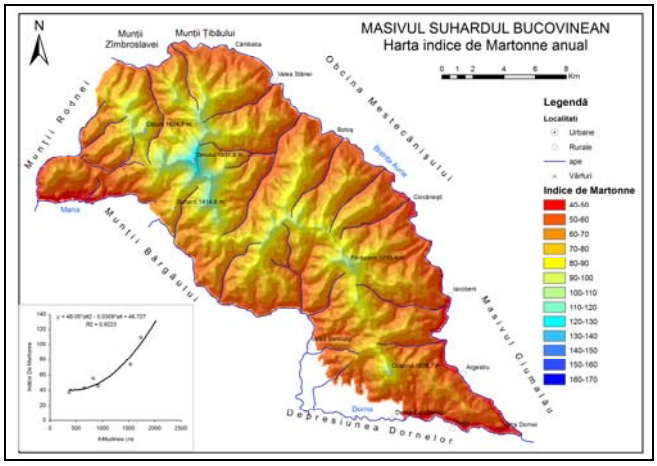

Fig. 3. The distribution of De Martonne index of aridity.

Quantitatively speaking, the increase is constant starting with winter months (with small differences among them and among stations) and continues until the beginning of summer. We can talk about the summer maximum (June-July), noticeable at all stations disregarding the altitude.

At the end of summer, the quantities constantly decrease until the winter interval. Besides the increase in quantities according to the altitude, the major difference between station at higher altitude and the lower ones consists in more constant values, proportionally with the altitude.

So, at Iezer, besides the winter minimum, the rest of the months register more than 800mm and monthly average of over 100mm 6 moths a year. In Rarău, station located with only 200 m lower, but towards East, the quantities not only represent 70% from those in Iezer but are there less than 50mm and average values over 100mm appear only in 4 months. (table 2, fig. 4).

At lower stations, the values are of 70mm, at Poiana Stampei half of the year has a minimum of 50mm and the maximum is of over 100mm.

24 hours maximum quantities are related to the continental influence and local particularities of cloud-burst rainfall and were registered valleys and depressions. Here are a series of values representing national records (table 3). It's the case of the 280.4mm registered in Cîrlibaba, on July 16, 1938, and reported in the newsletter edited by INMH, the fourth most large in the country, the third of the month of June and second in the mountain area.

Table 2

Mounthly average quantities of rainfall, registered at the weather stations around Suhard.

Station	Alt.(m)	J	F	M	A	M	J	J	A	S	O	N	D	Interval
Bistrița	365	42	33	33	57	75	93	78	68	52	46	46	52	1950-2000
Vatra Dornei	825	27	28	34	48	86	99	95	82	50	46	35	28	1988-1995
Poiana Stampei	915	29	24	30	50	78	104	98	72	51	41	35	38	1970-2009
Cîrlibaba	960	32	24	42	63	97	93	87	75	55	52	40	40	1969-1998
Rarău	1536	39	39	47	76	122	144	138	110	71	46	38	40	1961-2000
Iezer	1735	67	69	81	101	127	160	155	127	101	99	96	85	1958-2006

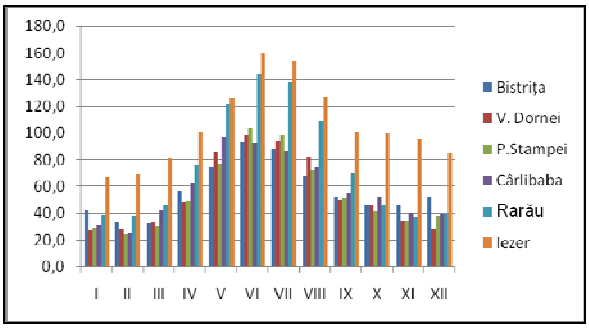

Fig. 4. Monthly average rainfall.

Recorded values appear in a series of works on the surrounding landscape units, which we haven't found published in professional newsletters. This way, in Vatra Dornei, on the 5th of September, 1912, the quantity of 260mm was recorded, considered to be the largest quantity produced in other period than summer, at country level. There are also values from the rainfall station of Gura Țibăului, 140.6mm at July 18, 1951 and Iacobeni, 63.1mm, on June 14, 1949.

Table 3

Monthly maximum rainfall registered in 24 hours, absolute maximum and the date of occurrence.

Station	J	F	M	A	M	J	J	A	S	O	N	D	Max.	Date
Poiana Stampei	23,4	19,6	26,3	23,5	59,4	48,8	**68,1**	44,6	43,0	37,1	32,3	25,6	68,1	9.07.1999
Iezerul Rodnei	34,4	37,1	38,4	45,3	66,1	61,0	**80,8**	60,5	62,1	70,6	50,5	48,1	80,8	29.07.1966
Vatra Dornei	20,0	27,9	23,2	44,5	62,1	51,0	**65,2**	49,7	26,0	34,2	34,3	19,2	65,2	5.09.1912
Ciocăneşti	19,0	24,7	17,8	20,2	42,7	37,8	**54,5**	35,8	43,5	24,0	23,2	24,0	54,5	22.07.1974
Cîrlibaba	20,0	20,1	21,5	32,5	50,0	**280,0**	36,6	70,0	61,5	28,2	29,0	31,7	280,0	16.06.1938
Rarău	30,9	34,9	33,4	88,7	56,0	**110,6**	91,0	71,5	60,2	38,5	27,6	29,7	110,6	29.06.1978

The average of the days with rainfall quantities 0.1 were analyzed based on the data from Poiana Stampei and Iezer stations, which are considered representative for the high area of Suhard Mountain (table 4).

For the number of days with rainfall bigger or equal with 0.1 mm, we can observe the increase in it according to the altitude, from 160 days at the boundary with depression, which is over 40% of the year, to 194 days at 1700m, representing more than half a year. Therefore, it is an increase with approximately 10% at a difference of 800 m in altitude, which leads us to the conclusion that at the Omu Peak, the number of rainfall days doesn't exceed with much the value of 200.

Table 4

Number of days with rainfall bigger or equal with 0.1mm.

Station	J	F	M	A	M	J	J	A	S	O	N	D	Total
Poiana Stampei	12,5	11,6	12,2	14,0	16,0	17,5	16,1	13,3	11,1	9,6	12,0	14,2	160,1
Iezer	15,9	16,0	17,7	17,9	18,4	18,8	17,8	14,2	13,1	12,3	15,4	17,0	194,5

Liquid rainfall, speaking in number of days, predominates in Poiana Stampei between April and October and in Iezer between May and October. Rain represents the most important type of liquid rainfall, which can appear in each month of the year, in the entire mountainous area (table 5, fig. 5).

Table 5

Number of days with liquid and solid rainfall.

Station	liquid	J	F	M	A	M	J	J	A	S	O	N	D	Total
Poiana Stampei		2,4	2,5	5,6	11,2	15,7	16,6	15,8	12,7	10,6	8,8	6,5	4,1	112,5
Iezer		0,3	0,8	1,7	6,2	14,6	17,7	17,9	13,6	11,6	8,7	4,6	1,9	97,1
	solid													
Poiana Stampei		11,7	10,5	9,5	5,6	0,6	0,0	0,0	0,0	0,2	2,3	7,5	12,1	60,0
Iezer		15,6	15,0	16,3	15,7	6,0	3,5	2,3	1,5	5,2	7,2	12,4	16,1	110,6

The number of days with solid rainfall at the contact with the depression reaches the maximum in December, while in altitude happen between March and April (fig. 5).

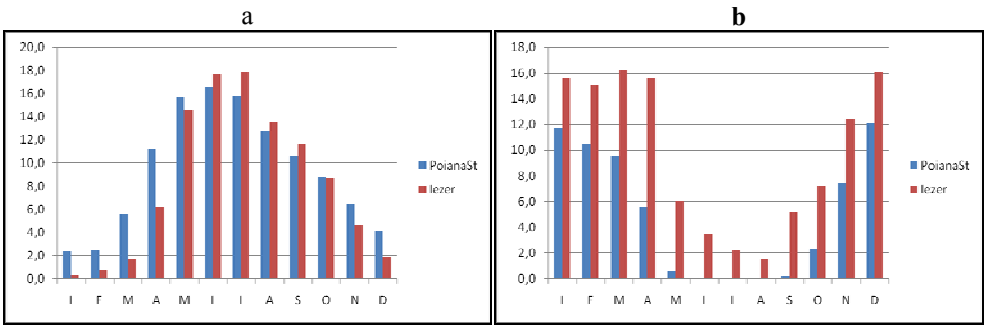

Fig. 5. Number of days with liquid (a) and solid (b) rainfall.

Number of days with snow

The type of precipitations which characterizes especially the cold season increases in days proportionally with the altitude. The consequence, besides a large amount of solid water, is also noticeable in the termic regime. From analyzing the data, for the Suhard Mountain, a weight of this phenomenon is found between 33% from marginal areas and 45% at over 1700m. These values may be further discussed both because of the particular situations of the stations which recorded them and the field configuration (table 6, fig. 6).

Table 6

Number of days with layer of snow.

Station	J	F	M	A	M	J	J	A	S	O	N	D	Total
Poiana Stampei	29,6	27,1	23,4	5,4	0,2					1,4	11,5	25,8	124,4
Iezer	30,7	28,2	30,6	22,1	8,0	0,6	0,1	0,1	1,0	5,0	16,8	25,6	167,2

Starting from the map of the mountains' orientation (fig. 7), in our analysis, we can see that more than one third of the peaks in Suhard go towards North, North – East, North-West, which helps maintain the snow for a long period of time.

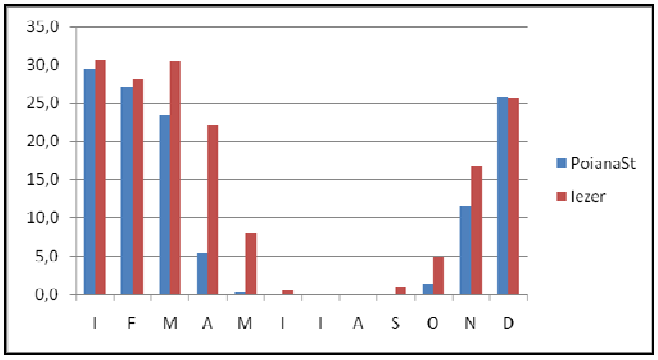

Fig. 6. Number of days per month with layer of snow.

Adding also the vast surfaces of forests, we can infer that the data from Iezer are valid for a much larger area than the altitude level they are registered at.

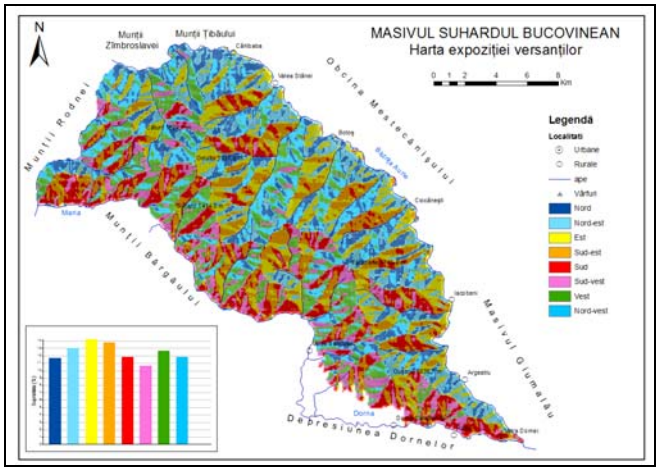

Fig. 7. Exposure of peaks from Suhard Mountain.

From our observations, yearly speaking, on the North-Eastern peak of Omu, the layer of snow exists even after the 15 of June and under Ouşoru Peak it can maintain itself until the beginning of the same month. These are the areas where the shattered snow in quantities big enough to produce avalanches. Meanwhile, on the sunny peaks, there are chances for the snow to be missing even in the middle of winter, fact depicted by the intensity of "gelifractie" process. Lower, at the forests level, the same orientation (South East, South and South West) determines shrinkage in the snowy interval of time during spring, but also a possible later installation of snow.

CONCLUSIONS

In the area of the Suhard's Mountain from Bucovina, the quantities of annual, semiannual, monthly and daily rainfall have a great variability, both in space and time. Thus, annual average sums are between 700 mm at lower altitudes and over 1250mm around Omu Peak (1932m). Variation of precipitations is between 0mm, in clear, without rainfall days and 280mm, the maximum quantity registered in Cîrlibaba, on June 16, 1938.

Most of the rainfall occurs in the warm semester, approximately 60%, when the maximum number of liquid rainfall days is also registered. The maximum number of days with solid rainfall occurs in the cold season.

REFERENCES

1. Apăvăloaie, M., N., Barbu, 1975, Contribuții asupra distribuției cantităților de precipitații în partea nordică a Carpaților Orientali, Lucr. Staț. Stejarul, Ser. Geol-Geogr., nr.6, Pângărați.
2. Apăvăloaie, M., L., Apostol, 1984, Caracteristicile inversiunilor termice în Depresiunea Dornelor, Lucr.Semin.Geogr. D.Cantemir, nr.4, Univ. Al.I.Cuza, Iaşi.
3. Apostol, L., M., Apăvăloaie, 1984, Contribuții la cunoaşterea precipitațiilor atmosferice din Țara Dornelor, Lucr.Semin.Geogr. D.Cantemir, nr.4, Univ. Al.I.Cuza, Iaşi.
4. Apostol, L., 1987, Considerații asupra raportului dintre cantitățile semestriale de precipitații din România, Lucr.Semin.Geogr. D.Cantemir, nr.7, Univ. Al.I.Cuza, Iaşi.
5. Alth, A., 1958, Ein Ausflug in die Marmaroscher Karpathen, Mitt. Geogr. Gess., Wien.
6. Barbu, N., 1976, Obcinele Bucovinei, Editura Ştiințifică şi Enciclop., Bucureşti.
7. Popescu-Argeşel, I., 1973, Masivul Suhard, ghid turistic, Colecția Munții noştri, Editura Sport-Turism, Bucureşti.
8. Rusu, C., 2002, Masivul Rarău-Studiu de geografie fizică, Editura Academiei Române, Bucureşti.
9. Rusu, E., 1999, Munții Bîrgăului-Studiu fizico-geografic, Editura Univ.Al.I.Cuza, Iaşi.
10. Sîrcu, I., 1979, Munții Rodnei, Editura Academiei, Bucureşti.
11. Straton, I., I., Mircia, 2010, Contribuții la îmbunătățirea pajiştilor permanente din partea de SE a Masivului Suhard, ce aparține etajului nemoral, Rezumatul tezei de doctorat, Iaşi.
12. ***, 1960, Monografia geografică a R.P.Române, Edit. Academiei R.P.R., Bucureşti.
13. ***, 1961-1972, Anuare meteorologice, I.M.H., Bucureşti.
14. ***, 1966, Atlasul climatologic al R.S.România, C.S.A., I.., Bucureşti.
15. ***, 1962, 1966, Clima R. P. Române, vol. I – II, C.S.A., Institutul Meteorologic, Bucureşti.
16. ***, 2008, Clima României, A.N.M., Editura Academiei Române, Bucureşti.