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THE INFLUENCE OF CLIMATIC FACTORS IN THE PROCESS OF SOIL EROSION

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Abstract

The main consequences of ecological imbalances generated by lands erosion were consisting in decreasing or bringing back, sometimes until cancellation, the soil's capability of production, the surface and groundwater drainage system's disruption, being strongly influenced by climatic elements specific to the area. Climate represents a very important factor for the multiannual environment regime of the weather's processes and phenomena's, characteristic to Rodnei Mountains National Park, determined by solar radiation, general circulation of the atmosphere, which varies in connection to the height, positioning and configuration of the landform. The elements and evolution of the climatic changes play a very important role in the context of soil erosion. The current paper illustrates the evolution of climatic factors from the last 9 years of the studied area – Rodnei Mountains National Park, Romania. For the studied area, it was taken into account the execution of an analysis of the following climatic factors: air humidity, temperature, precipitations, the direction and speed of the wind. Through the study and research of the climatic elements, delivered by National Institute of Meteorology and Hydrology – Cluj, we can say that the temperature, precipitations, humidity, the wind direction and speed, not only favours the erosion processes, but it also accelerates their apparition, when they aren't closely watched. The analysis of every climatic factor leads to a truthful appreciation of the probability that a certain territory may be exposed to erosional processes.

Key words*: soil erosion, climatic factors, Rodnei Mountains National Park.*

INTRODUCTION

Soil erosion is determined mostly by landform, climate (air temperature, atmosphere precipitations, air humidity, meteorological phenomena, wind and its direction), soil, solidification rock, vegetation and soil exploitation.

The elements and evolution of the climatic changes play a very important role in the context of soil degradation.

Air temperature has a big importance in the line of climatic factors that influence soil degradation, its evolution being connected to the solar radiation regime.

Given the temperature differences between the areas where pressure is higher and lower, the wind leads the air and causes multiple consequences over the terrains, especially in the areas where the wind continuously blows and in a dominant direction.

Wind erosion is intensified in the steppe and desert regions, especially where the soil's composition is of sandy conformation or composed of silt. When pursuing the wind, we have to take into account its direction, intensity and the air masses duration of movement. Due to landforms, season's succession and temperature modifications, the direction and speed of wind are visibly influenced.

Atmospherically precipitation being a hard to measure meteorological element, carries some inherent errors related mainly to the wind's action and evaporation.

It is obvious that, along with the increasing altitude and the implicit raise of solid precipitations share out of the total annual precipitations, the wind's action determines the raise of measurement errors through the reduction of the real quantity.

Air humidity is the amount of water vapours from the atmosphere and is caused by the air masses' peculiarities and by the local characteristics of the active surface.

Air humidity increases around water basis, vegetal massifs, forests, because these are

sources of evaporation and evapotranspiration. By condensing water vapours give birth to clouds, liquid and solid precipitations and fog is formed.

The area for which the analysis of climatic factors was drawn is the Rodnei Mountains National Park (Figure 1), the geographical space that overlaps over the area of geographic and morphological contact of Rodnei Mountains, being an integral part of the Oriental Carpathians, from the Nordic Group.

The park's area spans over two counties: Bistrița-Năsăud (BN) and Maramureș (MM).

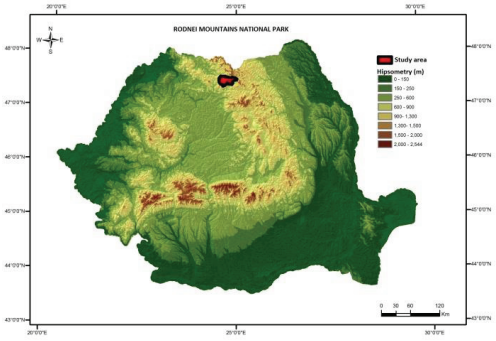

Figure 1. Study area

The surface area of Rodnei Mountains National Park is 47,177 ha (Management Plan, 2014).

MATERIALS AND METHODS

In order to get a characterization of the targeted area from a climatic point of view, we used the values recorded in the 2006-2015 span from the Iezer station (placed in the Rodnei Mountains National Park), delivered by the National Institute of Meteorology and Hydrology Cluj. These were processed in order to deliver data in connection to highlighting the climatic evolution in the studied area.

RESULTS AND DISCUSSIONS

Average annual rainfall

Rainfall represents one of the most dynamic factors that influence the erosion process.

Water drops that touch the surface of the soil detach and carry soil particles from the formation place to greater or smaller distances, depending on the kinetic energy they possess (Ceauşu et al., 1976).

Raindrops erosion appears in the moment when the rain drops, while falling, strike the soil's surface, dislodging particles, which however, get transported aerially on short distances, under 1.5 m (www.geography.ro).

Table 1. Average Monthly Precipitation 2006-2015 (l/m^2)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	**Precipitation (l/sq m)**											
2006	28.1	62.7	231.7	112.1	263.4	213.3	83.2	245.3	49.6	54.8	110.1	28.8
2007	197.5	126.6	96.8	58.7	184.7	102.0	225.1	99.5	199.3	58.3	150.3	53.6
2008	72.0	50.7	231.8	165.6	203.1	143.5	272.8	105.6	102.1	121.1	84.1	77.8
2009	53.2	72.1	123.5	38.9	124.6	155.9	54.5	166.7	43.5	210.6	114.7	117.6
2010	67.4	95.5	86.8	101.9	226.5	197.8	202.5	138.8	142.3	71.9	170.0	150.8
2011	49.4	48.6	41.0	94.0	71.7	200.0	226.8	57.0	90.6	36.8	1.2	149.0
2012	106.0	73.9	44.4	125.9	158.5	196.9	114.3	79.7	79.6	117.8	79.4	73.2
2013	83.6	48.9	115.6	77.4	123.6	156.0	20.9	131.7	112.7	19.7	100.7	37.3
2014	68.2	29.5	40.4	92.5	153.0	91.3	158.1	167.9	41.1	72.8	3.9	78.9
2015	98.3	43.5	65.0	112.4	148.5	78.4	73.9	37.1	81.4	26.1	178.7	30.8

Based on the monthly values for each year, the average annual rainfall was calculated.

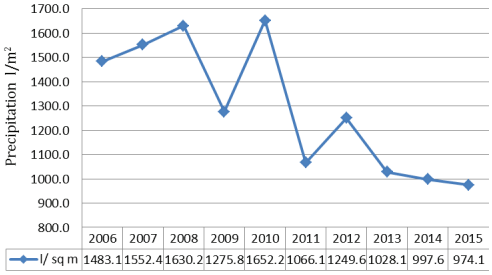

Figure 2. Average annual rainfall (l/m^2)

The maximum of average annual rainfall was registered in 2010, being 1652 l/m^2, and the minimum of rainfall is in the year of 2015, being of 974.1 l/m^2.

As a general average of the last nine years, pluviometri optimal is registered in the depressionary area (1400 m) and the beginning of the mountain stage (1900 m), being of 1000 l/m^2.

Average annual temperature

The air's temperature is the most important parameter that favours the erosion process's appearance through the snow's sudden melting. From 2006, the average annual temperature has increased slightly by 0.4°C until 2009, returning around the values of 2.3°C in 2010, expected to reach the maximum of the last 10 years of 3.9°C in the year of 2014. Still, we notice a slight warming in the last 5 years compared to the preceding years, according to Figure 3.

Table 2. Average Monthly Temperature (°C)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	Average Temperature (°C)											
2006	-7.0	-8.3	-5.3	1.3	4.5	8.3	11.8	10.0	7.2	4.5	-1.0	-2.3
2007	-4.8	-5.1	-1.6	-0.1	8.2	10.8	12.2	12.3	5.2	2.7	-3.6	-4.3
2008	-4.7	-5.2	-4.1	0.8	5.7	10.0	10.4	11.9	5.5	3.9	0.4	-3.7
2009	-5.5	-7.5	-5.3	3.7	6.1	9.8	12.1	11.1	8.1	2.6	0.8	-4.9
2010	-8.1	-5.5	-4.5	1.0	6.4	10.2	12.3	13.1	6.0	0.4	2.2	-6.1
2011	-6.8	-6.1	-2.9	0.6	6.6	9.7	11.3	12.1	9.2	1.8	-1.1	-4.1
2012	-8.9	-10.3	-5.0	2.2	7.2	11.1	14.9	12.2	10.4	5.1	1.6	-5.7
2013	-6.8	-4.8	-4.6	2.6	8.3	10.6	11.2	12.3	3.9	4.7	1.2	-2.7
2014	-2.2	-0.2	-0.5	2.4	5.9	8.6	11.6	11.2	8.0	5.0	1.3	-4.3
2015	-4.9	-5.3	-3.4	-1.3	6.8	9.9	12.8	13.6	9.7	3.5	0.9	-2.9

The lowest temperatures are registered in the winter months, January and February, ranging between -10 and -3° C, while the maximum ones are ranged between 10 and 13° C in the summer months, from May until the end of August.

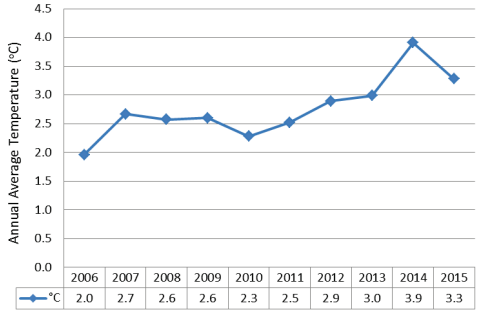

Figure 3. Average Annual Temperature (°C)

Humidity

Depending on the values of relative humidity (f), according to the World Meteorological Organization, the air is characterized from a hygrometrically point of view as: f > 100% - oversaturated; f = 100% - saturated; f = 81-90% - wet; f = 51-80% - normal; f = 31-50% - dry; f ≤ 30% - very dry.

Table 3. Humidity (%)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	Humidity (%)											
2006	70	86	88	83	76	83	75	83	81	71	82	68
2007	89	87	75	68	79	76	75	81	85	77	89	68
2008	72	76	87	79	76	75	80	75	82	77	76	79
2009	73	88	88	71	75	82	75	78	79	83	82	83
2010	83	88	82	77	81	89	85	82	85	74	75	85
2011	84	79	78	85	84	94	86	85	81	81	69	88
2012	89	85	82	81	82	81	71	76	77	78	73	77
2013	89	78	81	82	77	85	80	78	84	75	79	65
2014	80	67	74	81	81	77	83	80	72	74	75	84
2015	81	69	81	85	83	82	79	76	83	80	78	77

The registered humidity by the Iezer Meteorological Station is presented down below according to the diagram:

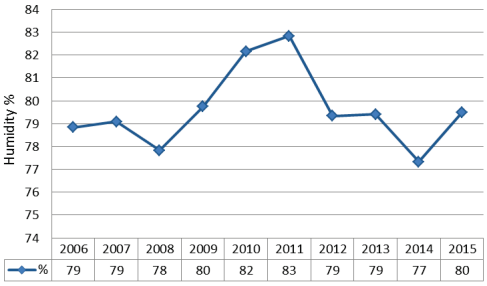

Figure 4. Average annual Humidity (%)

Following the diagram, we can say that humidity in the Rodnei Mountains National Park maintains itself at high levels, approximately around 80%, with differences dependent on altitude, vegetation, slope position, being a normal-wet humidity.

Wind speed

The winds have a higher frequency on heights, where they can reach values of over 90 km/h (25 m/s).

Table 4. Wind speed (m/s)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	Wind speed (m/s)											
2006	3.2	3.0	5.1	2.2	3.4	2.6	1.7	2.9	3.2	2.5	4.4	3.2
2007	7.1	3.2	4.9	2.4	3.6	2.8	3.2	2.2	3.1	2.4	4.1	2.6
2008	4.4	4.6	5.2	3.5	2.7	2.3	3.6	2.7	2.1	2.2	3.3	4.4
2009	3.7	2.2	3.5	2.1	3.0	3.6	2.6	2.0	2.2	3.5	4.6	2.5
2010	2.5	2.7	4.5	2.2	3.5	2.6	1.7	3.3	2.1	1.9	6.3	3.0
2011	2.1	3.3	2.5	2.7	2.4	2.3	2.9	1.4	2.7	1.8	1.1	3.5
2012	4.0	4.1	3.7	3.3	2.9	2.7	2.6	2.0	2.7	3.7	3.1	2.8
2013	3.7	3.1	2.7	3.1	1.8	1.2	2.0	1.2	2.8	2.4	3.2	3.2
2014	3.4	3.2	2.4	2.9	1.9	1.9	2.2	2.2	2.5	2.2	2.0	3.5
2015	4.7	1.9	2.5	3.9	2.6	1.2	2.6	2.2	3.6	2.3	4.3	3.7

In high areas, we have frequent wind speeds of over 50 - 60 km/h. Generally, the average wind speed over the whole surface of the park is of 3 m/s (10.8 km/h).

Studying wind speed and direction is particularly important in the context of wind erosion. In areas where logging was performed, the wind accelerates the erosion process through decreasing soil layer, changing the physic-chemical and biological properties.

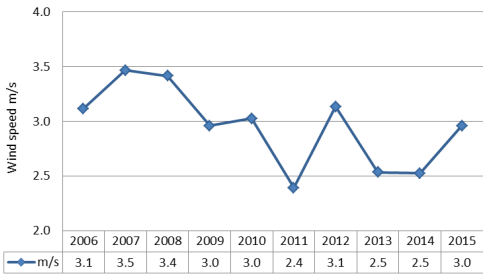

Figure 5. Wind speed (m/s)

Winds with high frequency are the SV, SE, S and then the NE, NNE şi V.

Table 5. Wind direction (%)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	Wind direction											
2006	SSV	SV, VSV	SE	S, SV, NE	SV, NE	SV, ENE	ESE	SV	SSV	NE	SV, SSV	S, SV, E
2007	S	S	SV, NE	S	SV, NE	SV, V, VSV, NE	SV	SV	VSV	N	SV, V, SE	SE
2008	S, SE	S	SV	V, SV	SV, NE	SV	SSV	SV	SSV	SSE, S, SV	SV	SV
2009	SV	SV	SV	SV	VSV, V	E, S	SV, SE	E, NE	S	E	V	VSV, SV
2010	VSV, SV	SV	V	VSV, SV	VSV, SV	SV	SV	VSV, SV, S	SV	SV, SSV	S	E
2011	SV, S, VSV, SE	SE	V	SSE, SE	ESE, E	SSE, SV	SV, S	SV	SE	VSV	S	S
2012	E	SV, VSV	S	S	E, SE	SE	V	SE	VSV	V	VSV	SV
2013	SV	SE, SV	SV	SV	V	SV	S	E	SE	S, SSV	SV	VSV, S
2014	SV	VSV	SE	NE, NNE, E, ENE, SV	NE, SV	NE, NNE	SSV	SV	SV, NE	SSV	S	SV
2015	V	S	SV	S	S, SV, V	SV, SE	NE	SV	VSV	V	SSV	S, SSV

CONCLUSIONS

In order to play as faithfully as possible the situation and in achieve an interpretation as correctly as possible, we have used the climatic values registered at the closest to the area of study meteorological station (Iezer Station).

For the works designed to fight soil erosion we analyse the climate elements with values registered for a longer period of time.

Climatic elements, especially rainfall, have a major role in determining water and soil spills on mountain sides and water flows. Likewise, it contributes to sizing and applying the most corresponding works of soil protection. Regarding the climatic element - temperature, in the studied range of 2006-2015, an average temperature of 3.08^{o}C has been registered. The wind's average speed, possessing a value of 3 m/s is classified as "weak wind" (1.8-3.3 m/s, according to the empirical scale for describing wind speeds - Beaufort scale of wind speed). The air currents that run on large areas, areas that don't have continuous vegetal coating, causes in time the erosion phenomena's apparition.

For the studied area, following the humidity analysis, an average value of over 80% has resulted, being strongly influenced by the hypsometric steps, vegetation and wind speed.

Thus, these four climatic factors offer essential information in the context of erosion.

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