DROUGHT AND FLOODS RISK ASSESSMENT IN SIBIU AREA

Simona, SPÂNU
"Lucian Blaga" University of Sibiu, Sibiu, Romania

ABSTRACT: Climate is an environmental resource and as such it can be measured and evaluated. The precipitations are one of the most important factors, with great impact in the environment. The physico-geographical reality presented in the analysis of rainfall excess and deficit in Sibiu and Păltiniş showed that the system operated according to certain mechanisms and processes, and in between certain coordinates, under the influence of different causal factors that vary in time and space. The analysis of the periods with pluviometric surplus or deficit can be done using the percent deviation of rainfall method. This approach allows the identification of a possible cyclicity of the episodes with flooding and of those with drought, for a good prognosis in the environmental management. Climate is an important part of a region's resource base, but its role in determining the suitability of a region and in the environmental protection is often assumed to be self evident and therefore to require no elaboration. Relatively little is known about the effects of climate on the environmental risk. And even less is known about the economic impact or significance of climate on sustainable development. The whole area involving climate related-criteria which people use to make decisions about environmental protection is largely unresearched, but highly relevant to a variety of applications. In this period of major climate changes, the problems concerning the environment are deeply connected to the precipitation risk. Climate is an environmental resource and as such it can be measured and evaluated. An index approach is required for this task because of the multifaceted nature of weather and the complex ways in which weather variables come together to give meaning to climate for environmental protection. The precipitations are one of the most important factors, with great impact in the environmental protection domain.
Keywords: risk, environmental protection, pluviometric surplus, pluviometric deficit, rainfall influence

1. INTRODUCTION

In its history, the planet has gone through climatic changes, highlighted by the relation between the solar variability and the glacial periods. These changes depended on the natural causes and had a cyclic manifestation. But there are also climatic changes caused by humans, with a strong negative impact on the greenhouse effect. The consequences of the greenhouse effect refer to the warming of the air with 1.5o C up to 4.5o C in the conditions in which the CO2 emissions are doubled in quantity, they then refer to the apparition of seasonal anomalies, through the diminishing of the winter thermic regime. The climatic changes will determine both the increase in the quantity of precipitations at the planet's level, and the rise of the ocean level, through the melting of the ice cap and of the glaciers and through the warming of the ocean's water.

The quantity of precipitations will grow, but rains will more often have a torrential character, being accompanied by phenomena related to storms and by wind intensifications. These precipitations will disrupt the hydrologic system through the decrease of the infiltration and the accentuation of the rapid surface flow, which will determine major increases in the debit and level of rivers, generating deluges and floodings. It is thus necessary to preserve the forests in the hydrographic basins. At the same time, torrential precipitations will determine rises in the solid debit of rivers, which will have negative effects regarding the rapid plugging of the retention basins with hydroenergetic and irrigations purpose, or the regular floodings.

Although the water will only suffer modifications regarding the quality, the spatial distribution and the means of obtaining and using it, respectively the problems related to the administration of waters, these will be felt in the availability of hydric resources, in the use and consumption. The problems related to the water economy are of utmost importance and that is why both the resources and the hydric sources must be carefully administered.

That is why knowing the way in which precipitations influence the components of the geographic environment allows the prevention or at least the limitation of the negative effects that they can cause in an area that is rather vulnerable to such risks.

The systemic tackling of the chosen subject is in the spirit of modern science, because it has been proved that the environment has the organization and the characteristics of an organism, in which each element contributes to the well functioning of the system as a whole.

The climate of a region represents the pluriannual regime of weather conditions, characterizing a certain region, being determined by the solar radiation, the character of the active surface and the general atmospheric circulation.

Therefore, the climate is characterized by certain stability and it is one of the components defining a geographical area. The Romanian landscape is defined by the concentric arrangement of the South-Eastern Carpathians which, due to their position, altitude and massiveness obviously influence all the components of the environment. The relief also determines the climatic conditions, reflected in the variation of all the other components of the natural environment and especially in the presence of the succession of the geographical landscape, from the steppe-like one, in the lower zones, to the Alpine floor.

Weather and climate constitute the natural resource-base. Climate can be treated as a risk asset for environment. The asset can be measured and the resource is capable of being assessed. But there are numerous problems. One major problem is selection of meteorological or climatologic criteria. For example, what exactly are the criteria for ideal, suitable, acceptable, or risk conditions? What are the weather hazards or climate extremes likely to be? Only after appropriate climatologic criteria have been clearly identified can key questions be answered.

2. MATERIALS AND METHODS

The analysis of the excess rainfall periods can be done using the percent deviation of rainfall method. The perception in case of periods with pluviometric surplus is that of a major hydrological risk, due to the violent or progressive way of manifestation, while the droughts are perceived as being less harmful phenomena. The percent deviation of rainfall index is also used to study the drought "in situ" or on a regional scale, because it gives the possibility to analyze the frequency, length and intensity of the phenomena.

In order to determine the type of pluviometric regime, it has been analyzed the rainfall quantity registered in Sibiu and Păltiniş, between the years 1961 and 2009. According to the percent deviation of rainfall method, there are:

- Extremely droughty periods (rainfall quantity variation >-50%) noted with D4;
- Very droughty periods (rainfall quantity variation from -31% to -50%) noted with D3;
- Droughty periods (rainfall quantity variation from -21% to -30%) noted with D2;
- Moderately droughty periods (rainfall quantity variation from -10% to -20%) noted with D1;

In order to determine the intensity of the periods with pluviometric surplus, the identification criteria are:

- Almost normal periods (rainfall quantity variation from 10% to -10%) noted with N;
- Moderately wet periods (rainfall quantity variation from 10% to 20%) noted R1;
- Wet periods (rainfall quantity variation from 21% to 30%) noted R2;
- Very wet periods (rainfall quantity variation from 31% to 50%) noted R3;
- Extremely wet periods (rainfall quantity variation >50%) noted R4.

3. RESULTS AND DISCUSSIONS

In the temporal and spatial analysis of the periods with pluviometric surplus, certain difficulties that have to do with determining the control variables and the threshold values used might occur, difficulties generated by the complexity of the phenomena of interest.

The periods with excess rainfall represent a risk that often has a local spread, unlike the periods with scarce rainfall, when the area spread is great, and the trigger action and evolution are slow. The perception in case of periods with pluviometric surplus is that of a major hydrological risk, due to the violent or progressive way of manifestation, while the droughts are perceived as being less harmful phenomena.

In this study we have used only the data that refer to the period 1961-2009, for Sibiu and Păltiniş. In the 49 years that have been analyzed in this study from a pluviometric point of view, there were numerous cases of excess or scarce rainfall, that have often had effects on the environment and the socio-economical life of Sibiu an Păltiniş. The analysis of the long range of data provides an overview regarding the succession of the periods with pluviometric surplus. This approach allows the identification of a possible cyclicity of the episodes with flooding and of those with droughts.

The rainfall quantity registered in Sibiu and Păltiniş has been organized into deviation classes (a normal class and four classes for each of the quantities that are above and below the normal) and into pluviometric domains (where the values of all classes with positive and negative deviations have been cumulated and have been compared with the normal).

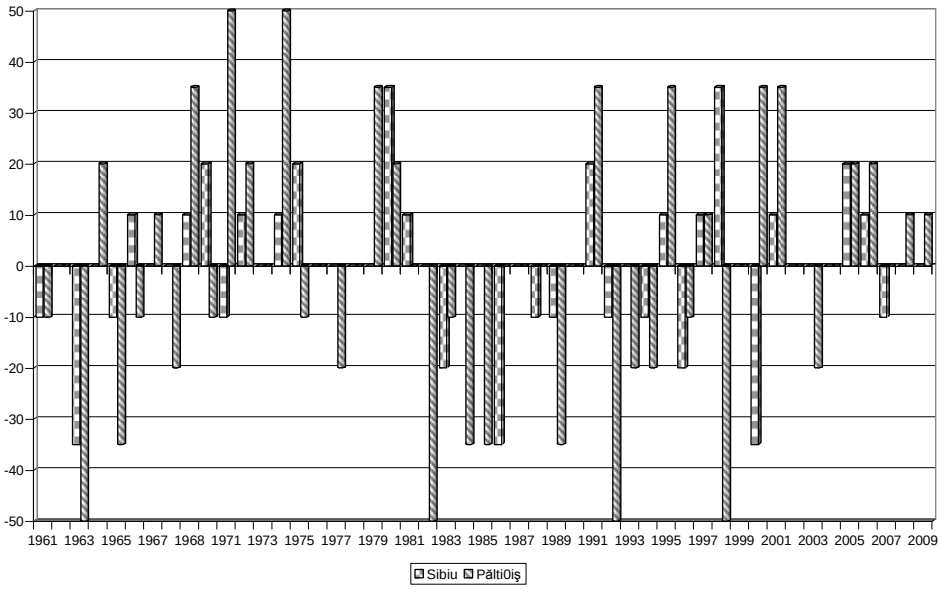

Figure 1. The pluviometric domains for Sibiu and Păltiniş in February (1961-2009)

There have also been established groups of pluviometric risk due to surplus or deficit, to which was then added the group that presents no pluviometric risk. The normal class and domain have been considered as varying between -10% and +10%. For the pluviometric risks there have been selected deviation thresholds that vary by 10% and are between 11%-20%, 21%-30%, 31-50% and over 50% for the risks that are due to pluviometric surplus. For the groups with pluviometric deficit there have been selected thresholds from -11% to -20%, -21% to -30%, -31% to -50% and lower than -50%.

These value thresholds have been analyzed for the annual values and for the rainiest month (June) and the driest one (February). These months have been chosen because of their extreme pluviometric characteristics.

It has been chosen to analyze the month with the highest precipitation quantities (June) and the one with the lowest

precipitation quantities (February) in order to emphasize the risk that is due to pluviometric excess and deficit. Out of the 49 years with meteorological observations, the frequency according to the classes of percent deviations shows that most years can be placed in the class that presents a risk due to surplus as well as deficit, the next one being the class that is pluviometric normal.

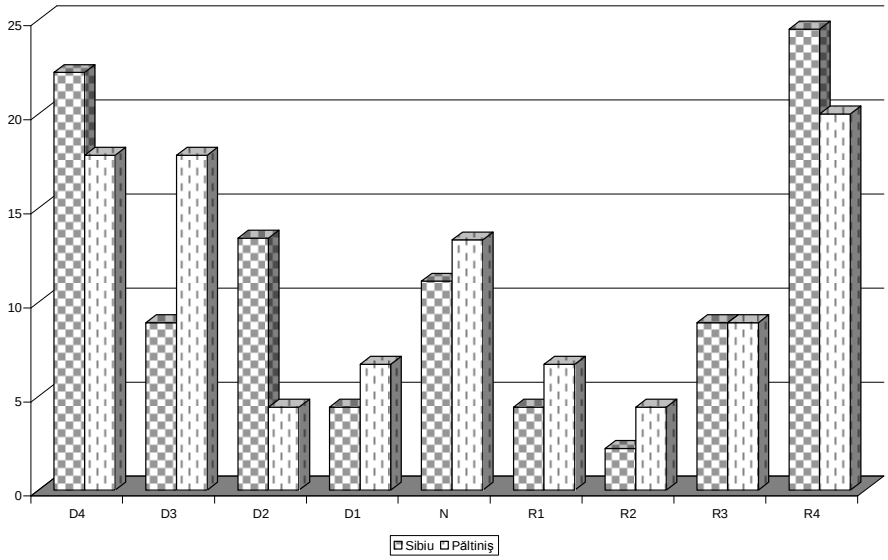

Figure 2. Frequency according to classes of percent deviations in February, for Sibiu and Păltiniş (1961-2009)

February is characterized by a great variety in the distribution of frequency in all of the nine classes of percent deviations. The situations with a rainy or droughty regime have a high frequency and represent 89.9% for Sibiu and 86,7% for Păltiniş. As for the risk due to surplus or deficit, it can be noticed that there is an almost equal repartition between groups of risk and groups that are pluviometric normal.

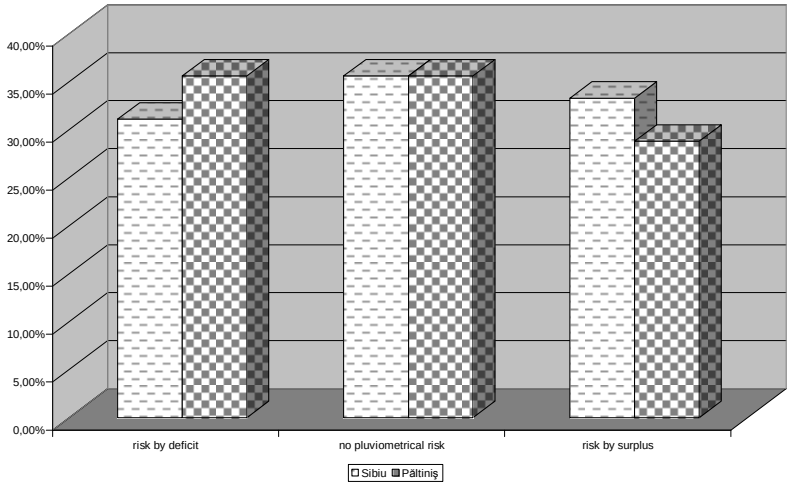

Figure 3. Frequency according to groups with and without pluviometric risk in February, for Sibiu and Păltiniş (1961-2009)

For Păltiniş, In February, the group of risk due to deficit is greater than the one that presents risk because of the surplus, while for Sibiu, the one with a risk caused by surplus is greater. The group with no pluviometric risk has the highest occurrence, but the difference between this one and the groups that present risk is rather small. It is worth mentioning that the reference was made according to the average rainfall registered in February during 1961 and 2009, so to a relatively small quantity. Thus the intensity of the risk by surplus or deficit is not as great as it may seem when simply comparing the values. June is characterized by a varied distribution of the frequency in all the nine classes of percent deviations. In June it can also be noticed the great frequency of the higher classes (D4 and R4) for Sibiu, while for Păltiniş the classes D3 and R3 have a greater frequency. The pluviometric normal class has the greatest frequency, of up to 26.7% for Sibiu and Păltiniş.

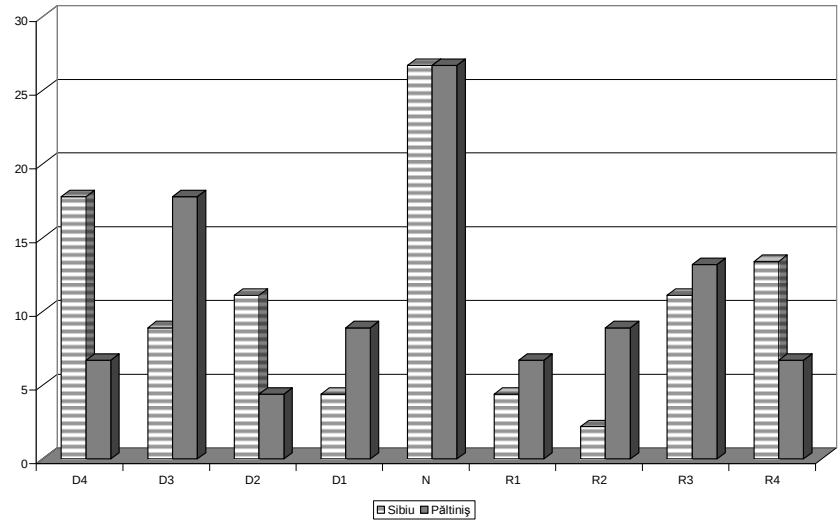

Figure 4. Frequency according to groups with and without pluviometric risk in June, for Sibiu and Păltiniş (1961-2009)

The analysis of frequency according to the pluviometric domains shows in all of the geographical units of Cibin hydrographical basin the supremacy of the droughty domain, with values of up to 42,2% for Sibiu; in the mountain areas these values drop to. The rainy domain has higher values in the mountains, of up to 35.6%, in comparison with the lower regions where the values are around 31.1%.

The group with no pluviometric risk represents 42,3% - 48,9% in the depression and plateau area, while for Păltiniş it represents over half (55,6%) of the total number of months of June that have been analyzed. In both the geographical areas the risk by deficit has higher values than the risk by surplus. If in the case of February the average precipitation quantity to which the monthly values were being compared was a rather low one, this time the deficit is so much more severe since the reference is being made to the rainiest month of the year.

4. CONCLUSIONS

The analysis of the periods with pluviometric surplus can be done using the percent deviation of rainfall method. This approach allows the identification of a possible cyclicity of the episodes with floodings and of those with droughts, for a good prognosis in the environmental management, gives the possibility to make an analysis of the rainfall quantity, for the time interval for which we have data. It has the advantage of offering information regarding the relation between the excess or scarce rainfall quantity and the normal one.

It is generally accepted that climate is an important part of a region's environment resource base, but its role in determining the suitability of a region is often assumed to be self evident and therefore to require no elaboration.

In the area of interest, relatively little is known about the effects of climate like an environmental risk. And even less is known about the economic impact or significance of climate on commercial prospects for tourism. The whole area involving climate related-criteria which people use to make decisions about environment is largely unresearched, but highly relevant to a variety of applications. Thus far, much of the research on climate has been superficial in that relationships between climate and environment are assumed rather than observed and seldom objectively tested. Moreover, the research is largely devoid of any clearly structured conceptual frameworks that embrace important theory, paradigms, processes and interactions. These frameworks are important because they provide a basis for data generation, hypothesis testing and further theory generation.

Without this, it is difficult to develop coherent research methods, and to develop models that constitute a bridge between the observational and theoretical levels that can assist in building a coherent knowledge base for understanding, explanation and prediction. In the temporal and spatial analysis of the periods with pluviometric surplus, certain difficulties that have to do with determining the control variables and the threshold values used might occur, difficulties generated by the complexity of the phenomena of interest.

REFERENCES

1. Balteanu, D., (1992), Impact analysis of climatic change in the Central European mountain ranges, Interrelated Bioclimatic and Land Use Changes, Holland
2. Bryant, E. A., (1991), Natural Hazards, Cambridge University Press, UK
3. Busuioc Aristiţa, (1992), Synthetic Description Method for Regional Climate Anomalies, Meteorology and Hydrology, INMH, vol. 22
4. Mawdsley J., Petts G., Walker S., (1994), Assessment of drought severity, British Hydrological Society Occasional Paper nr. 3 UK
5. Sneyers R., (1992), On the use of statistical analysis for objective determination of climate change, Meteorol. Zeitschrift, I, p. 247-256
6. http://climate.atmos.colostate.edu/standardizedprecipitatio.shtml
7. http://nadss.unl.edu