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ENVIRONMENTAL RISK EVALUATION GENERATED BY EXTREME NATURAL PHENOMENA

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Abstract - Nowadays, in Romania extreme natural phenomena such as floods, droughts, tornadoes, storms, landslides take place due to climate changes. To minimize their effects or to reconstruct the affected areas, exact information about these phenomena are required. Therefore, in this paper, the authors use a simplified model of risk evaluation as well as a "source-way- receiver" analysis to determine the degree of risk regarding torrential rains and drought that were registered in Romania in the last period.
Keywords: floods, drought, climate changes, risk evaluation

1. INTRODUCTION

Humans live permanently in a media which is open to a great diversity of situations more or less dangerous that are generated by multiple factors. The extreme manifestations of natural phenomena like floods, droughts, tornadoes, storms, landslides can have a direct influence on the environment. Therefore, the exact information about these phenomena, named disasters and/or hazards, allow us to take adequate measures to diminish the effects and to reconstruct the affected areas. The attenuation of ecological disasters effects involve the interdisciplinary study of hazards, vulnerability and risk as well as humans education and information.

The probability of appearance of disequilibrium, or of a disorder that passes the tolerance limits of a natural system is translated with a risk existence for these systems. In these sense, the risk can be defined as a probability for passing the tolerance limits of some analyzed systems and the appearance of disequilibrium and disarrangement conditions.

Risk definition can be made through a dependence relation determination with appearance probability (P) and phenomena gravity (G) according to:

$$R = P \times G \quad (1)$$

In figure 1, the delimitation of 3 possible risk areas is presented:

• *Insignificant risk area* is a zone where the maintenance of an observation estate is necessary.

• *Inadmissible risk area*: represents a zone where is necessary the reduction of phenomena probability or gravity through active actions.

• *Risk reduction action area* represents a zone in which a set of measures and actions must be promoted to diminish gradually the risk amplification.

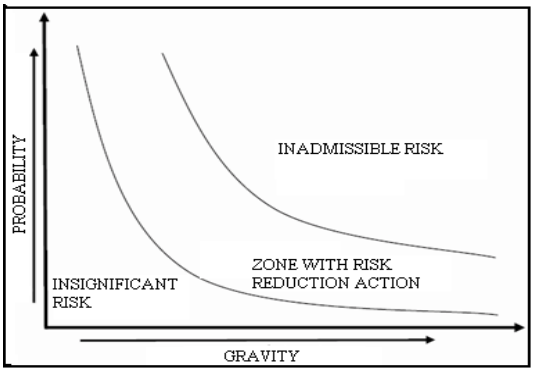

Fig. 1 – Risk delimitation

2. THE MONITORING OF CLIMATIC CONDITIONS IN ROMANIA

The climatologists from National Administration of Meteorology realized a study based on multiple dates in 14 meteorological stations that highlight an average warming of 0.3° C between 1901 – 2000 and 0.5° C between 1901 – 2007, with some seasonally differences, that is significant from statistical point of view in the extra-Carpathian region (fig.2).

The analysis, based on multiple information from meteorological stations (94) with continuous rows of observations starting with the year 1961, highlight an intensification of warming phenomenon in the last decades. Between 1961 and 2007 a major warming of 2° C during the summer period was registered, with increased values in Moldavia that passed 2° C in winter and 1° C in spring. During the autumn period a moderate cooling is observed all over the country, but it is not significant from statistical point of view.

From pluviometrical point of view (fig. 3), a general decreased tendency in annual precipitations is

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observed. After 1961, the deficit tendency is pronounced in South region.

At season level, a significant increased tendency in autumn precipitations can be seen. An important characteristic of the temporal variability of precipitations consists in an inter-decade component which makes difficult the separation of the climatic signal on long term.

Fig. 2 - The annual average of air temperature (^{0}C): 1901-2007

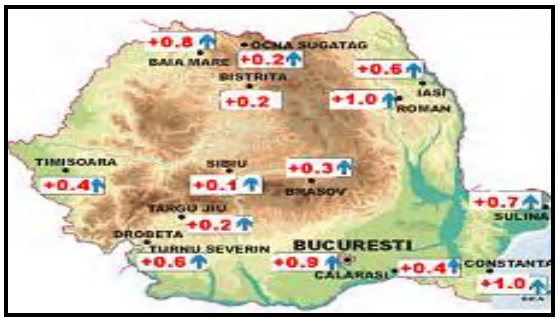
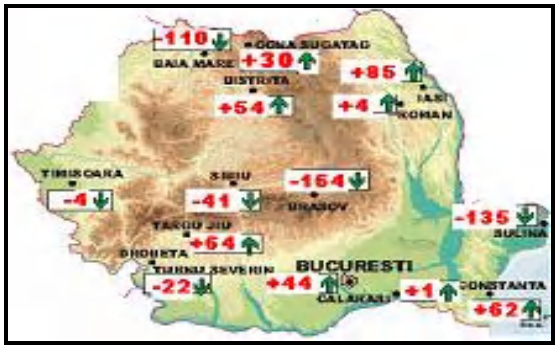


Fig. 3 - The annual quantity of precipitation (mm): 1891 - 2007



The characteristics of the year 2007 in Romania:

●The winter of 2007 was the warmest winter in the last 107 years; this characteristic was given in January.

- the temperature in January had increased by 6° unto the climatologically normal (1961 – 1990);
- during 2006-2007 winter period, the absolute records of maximum daily temperature were over passed at 24 meteorological stations in Romania;

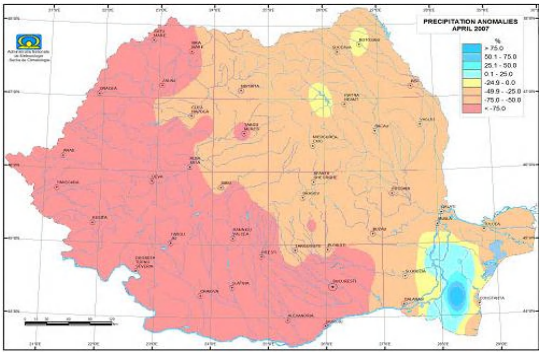
●The summer of 2007 was comparable with the summer of the year 1946, but it has registered a great constancy of warmer days.

- the maximum absolute temperature for July was over passed in Romania: 44.30C, 24 July, Calafat;
- the maximum absolute temperature in meteorological stations was over passed: June (53 stations), July (94 stations), August (17 stations);
- a record number of maximum daily temperatures > = 40oC (148 cases);
- July: record number of consecutive canicular days (maximum daily temperatures > = 35oC): 10 days at Calarasi, Buc-Filaret, Drobeta Tr. Severin.

From pluviometrical point of view, the 2007 year was easily abundant, with great monthly differences:

●April - July: a pronounced drought, comparable in intensity with the drought of 1946 was observed: the great deficit was registered in April (-71% average on country, reaching to -100% at Bechet, Caracal and Craiova - month without precipitations) (fig. 3).

Fig. 3 – Precipitations anomalies (%) in April unto the climatologically normal: 1961-1990



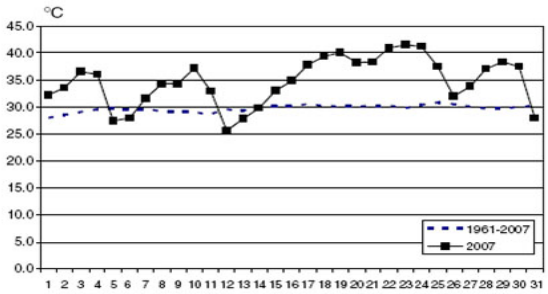
●August – November: abundant quantities of precipitations on large areas:

-the great average surplus was registered in October (123%), reaching to 362% at Caracal station- monthly quantity of precipitation over passed about 4 times the climatologically normal;

-the maximum quantity of precipitation in 24 hours was over passed: 6 stations in August, 9 stations in September and 8 stations in October.

The daily maximum temperatures considerably over passed the maximum temperatures of corresponsive days (fig.4).

Fig. 4 – The daily maximum temperatures divergence from daily average of maximum temperatures at Bucuresti-Filaret station (1961-2007)



These results confirm one of the 4-th IPCC Review conclusions, according to which, it was highlighted an increase in extreme phenomena frequency and intensity, due to climate changes intensification.

3. SUGGESTIONS FOR A SIMPLIFIED MODEL IN ENVIRONMENTAL RISK EVALUATION

The objectives of risk evaluation consist in detection of:

●pollution sources and the manifestation danger;

●mechanisms and processes for risk realization;
●transmission and transfer ways of risk;
●measures for risk manifestation prevention at acceptable levels;
●measures to minimize the effects after risk manifestation;

Integrated risk evaluation is based on the hypothesis that all the risks can be systematically identified, analyzed and evaluated in such a way that there can be made rational options on the risk rehabilitation way, the social and economic costs, the risk reduction benefits, associated costs, ensuring this way a base for an integrated and sure environmental inventory.

In qualitative risk evaluation will be taken into account the following:
●The risk/source represents the extreme natural phenomena that are identified and their particular effects.
●The action way represents the direct or indirect course through which the extreme phenomena reach at the maximum point where the harmfully effects are produced.
●The objective/receiver represents the objectives on which the harmfully effects of extreme phenomena have an impact.

The representation of a „source – way – receiver" analyses in a table form is useful to identify more clearly the action, the risks and the consequences. Then, function of the consequences importance, the necessity for reparation works must be identified.

Based on information presented in section 2, the authors will make an environmental risk and impact evaluation regarding the extreme phenomena in Romania.

The „Source – Way – Receiver" relation analyses

Table 1 – The „Source – Way – Receiver" relation analyses

Causes	Torrential rains
Risk	Flash floods, accidental floods, landslides, changes in river course and discharge, alluvial deposit, changes in the quality and quantity of water, fauna, flora and human safety are affected, , landscape degradation , increased turbidity , a great number of bacteria
Source	Climate changes
Way	Direct contact
Receiver	Surface and underground water, natural ecosystems, soil, crops
Reaching the source, way, objectives	Yes
The risk importance	High
The intervention necessity	Yes

Causes	Droughts
Risk	Increased evaporation, changes in thermal stratification, eutrophication, changes in the pH and alkalinity of water, changes in photosynthesis, water resources, economy and human health are affected,
Source	Climate changes
Way	Direct contact
Receiver	Surface and underground water, natural ecosystems, soil, crops
Reaching the source, way, objectives	Yes
The risk importance	High
The intervention necessity	Yes

Risk evaluation involves the identification of potential hazards and then the risk estimation that these have, through the examination of the probability and the consequences that can arise from these hazards. Risk quantification presented in table 2 can be based on a simple classification system in which the probability and gravity of any event are downward classified, a random draft being given for.

Table 2 – Risk quantification

Probability classification	Gravity classification
3 = high	3 = majore
2 = medium	2 = medium
1 = low	1 = easy

Then, the risk can be calculated through probability factor multiplication with gravity factor to obtain a comparative number, like 3 (high) x 2 (medium) = 6. This will allow some comparisons between different risks. Greater the result is, higher will be the priority which will be accorded for risk control.

Therefore, for torrential rains in Romania:
●the annual probability factor is medium, 2
●the gravity factor is medium, 2

For droughts in Romania:
●the annual probability factor is medium, 2
●the gravity factor is medium, 2

The risk calculation for torrential rains: 2 x 2 = 4
The risk calculation for droughts: 2 x 2 = 4
The risk levels are presented below:

R = 1 – insignificant risk
1 < R < = 2 – low risk

2 < R < = 4 – medium risk
4 < R < = 6 – high risk
6 < R < = 9 – very high risk

Because the torrential rains in Romania are more frequent in the last periods, the control and protection measures have to be taken against floods. The gravity factor is medium because these rains have local character and they are not registered on a large area.

In case of droughts, a seasonally warming can be observed in Romania, the risk probability being medium. It must be accorded a great importance for measures that can reduce the effects caused by high temperatures.

In conclusion, the methodology suggested in this paper highlights the importance of an accurate calculation of the intensity and probability of extreme phenomena (torrential rains and droughts). This way, a correct evaluation for risk in certain areas is obtained. Such phenomena are frequent associated with a large area of secondary processes, sometimes interrelated, which tend to complicate the risk situations.

In figure 5a and 5b the way in which the authorities and humans action before risk appearance – named hazard- is presented. The environmental, human and material loses will be of an incident or a disaster gravity, depending of these actions.

Fig. 5a - Actions that are taken to minimize the effects in case of a risk (source and transmission way)

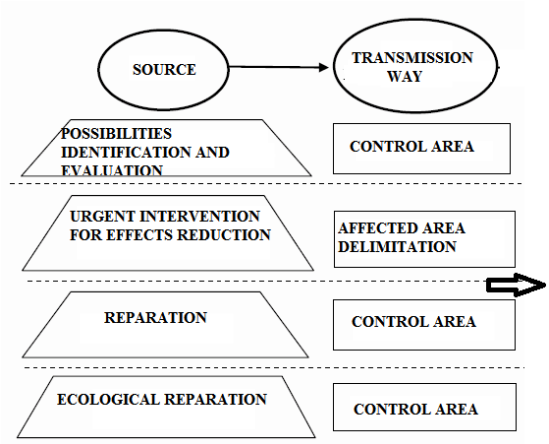
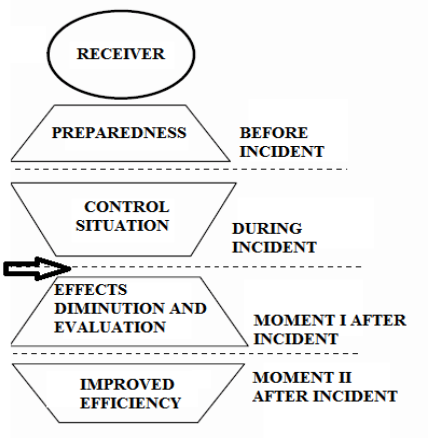


Fig. 5b - Actions that are taken to minimize the effects in case of a risk (receiver)



If during an incident or in different moments after its manifestation, the society is ready for efficient and quick actions, having the necessary materials and human resources, then, the consequences will be minimum and will show a great efficiency for risk management.

4. CONCLUSIONS

The effects of climate changes are materialized in different risks for human society and environment. The methodology that is suggested in this paper highlight the importance of a correct calculation for the intensity and probability of torrential rains and droughts. This way, an accurate evaluation of risk in certain areas is obtained and that helps society taking applicable measures to minimize the effects and to realize plans for protection.

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