

ASSESSMENT REGARDING THE EVOLUTION IN TIME (1980-2014) OF DROUGHT ON THE BASIS OF SEVERAL COMPUTATION INDEXES. STUDY CASE TIMISOARA

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Abstract

Drought is a major issue that humanity confronts with and due to its vast ramifications it is also most difficult to solve. Being a natural phenomenon it has various manifestations which scholars have categorised into meteorological, agricultural, hydrological, environmental and others, in order to better define and understand this phenomenon. Several drought indices have been proposed by different scholars for measuring it which take rainfall, temperature, sun shining and other features into account. This of course, led to a variety of interpretations which makes the phenomenon even more difficult to size up and quantify its devastating effects on a long term scale. The seven indexes this paper makes use of, for calculating drought are: N. Topor index, De Martonne index, Domuta hydroheliothermal index, Selianinov hydrothermal index, Palfai drought index and Lang rain index. In this paper, the case study conducted for Timisoara in the 1980-2014 period reveals alternating wet and dry periods which do not pose any threat of aridisation or desertification in the near future. However, a constant monitoring is imposed in order for these phenomena not to occur, made by the authorized law enforcement together with specialists from various fields.

Key words: drought indices, rainfall, temperature, sun shining, climate changes

INTRODUCTION

The drought phenomenon and its two recurrent phenomena, aridity and desertification represent according to the United Nations Organization the second largest problem with global implications that humankind confronts with, after environmental pollution. Due to the negative effects that are induced by it, drought is part of the dangerous phenomena category.

Published literature made use of various terms (extreme phenomena, dangerous phenomena, hazard, risk, calamity, disaster, catastrophe, cataclysm, etc) to size up and quantify the amplitude of some natural or special anthropogenic events and material losses produced (Armas, 2016).

According to the environment or the hydrological cycle stages in which it exercises its effects and also according to the phenomenon's duration and magnitude, drought can be observed from multiple perspectives:

- meteorological drought;
- agricultural or pedological drought;
- hydrological drought.

As a direct consequence of drought types` manifestation, with its afferent negative effects overlaid with a region`s social and economic activities, a new type of drought can be defined, that is, the socio-economic drought.

The numerous definitions of the drought phenomenon can be split into two large classes, according to the phenomenon`s approach mode and their utility:

- conceptual definitions of the drought phenomenon;
- operational definitions of the drought phenomenon.

As a direct result of the increase in drought frequency, severity and duration, and the narrowing of the gap between water supply and demand, there has been a remarkable increase in the impacts associated with drought in both developing and developed countries (Wilhite, 2014).

The relation between the number of hydro-climatic parameters taken into consideration as relevant and the accuracy degree of phenomenon`s definition for a certain area more or less extensive is a highly sensible topic among specialists, perhaps this could be the reason of the existence of such a large number of operational definitions for the drought phenomenon.

The drought phenomenon manifests itself throughout the entire hydrological cycle, in essence, drought can be regarded as a consequence of temporary abnormal deterioration of the normal hydrologic cycle (Man, 2007).

Drought phenomena are specific to all climates, because of this there is an extremely high diversity concerning the characteristics of such phenomena, especially influenced by local conditions of the area on which the phenomenon manifests itself. For instance, absence of rainfall can occur in all the months of a year (Stanciu, 2005).

General conditions of the drought phenomena are:

- occurrence frequency;
- intensity;
- temporal delimitation;
- the area on which it manifests itself.

Among these general characteristics, to every drought phenomenon aspect, be it meteorological, pedological, hydrological or socio-economical, a series of features are attributed specific to the environment in which it manifests itself.

As stated previously in this paper, the drought phenomenon cannot be dealt just as a physical phenomenon, most of the times drought is increasingly seen through the negative effects that are produced on the ecosystems and humans` social-economic activities.

To better summarize the negative impact of drought phenomena, it shall be grouped on the predominantly and direct affected areas. It needs to

be mentioned that these negative effects are most of the times interdependent and with a direct impact in other fields.

The negative effect of drought phenomena on ecosystems refers mainly to unwanted effects on environmental factors in general and on biodiversity in particular. The plant kingdom is much more vulnerable to drought's negative effects in comparison to the animal kingdom especially because of its reduced mobility. "The lack of rainfall for a sufficiently long period of time, accompanied by high air temperatures cause high moisture deficit in the air, that is characteristic for atmospheric or climatic drought" (Sabau et al., 2015). The best way for analysing drought is through "meteorological data for which there is long-term information" (Smuleac, 2016).

Taking into consideration Romania's position on the globe, half the distance between the pole and the equator, being crossed by the 45° parallel, as well as its geographical position on the continent at approximately 2.000 km from the Atlantic ocean, 1.000 km from the Baltic sea, 400 km from the Adriatic sea and riparian with the Black sea, the air masses directed towards Romania in different synoptic contexts, evolve in a wide range heading towards the tropical ones. The instability relation between main baric centres lead to recordings of both important periods with an anticyclone regime specific to drought phenomenon, and rapid transitions from the anticyclone regime to cyclone circulation and the opposite with extreme phenomena like storms, hail or tornadoes.

From the point of view of aridity index, which is on average 0.20 Romania's territory fits on the semi-arid areas, dry-sub humid, and humid.

MATERIAL AND METHOD

Calculations on the climatic indexes: Hellman criterion, N. Topor index, De Martonne index, Domuta hydroheliothermal index, Selianinov hydrothermal index, Palfai drought index, Lang rain index.

From over 20 indexes for drought evaluation calculus known in the specialised technical literature, 7 were used for Timisoara for processing climatic data (rainfall and temperatures) on a period of 35 years (1980-2014).

The study case was conducted for Timisoara for the period 1980-2014. The entry data for the study is rainfall and monthly average temperatures from the period 1980-2014 presented in figures 1 and 2.

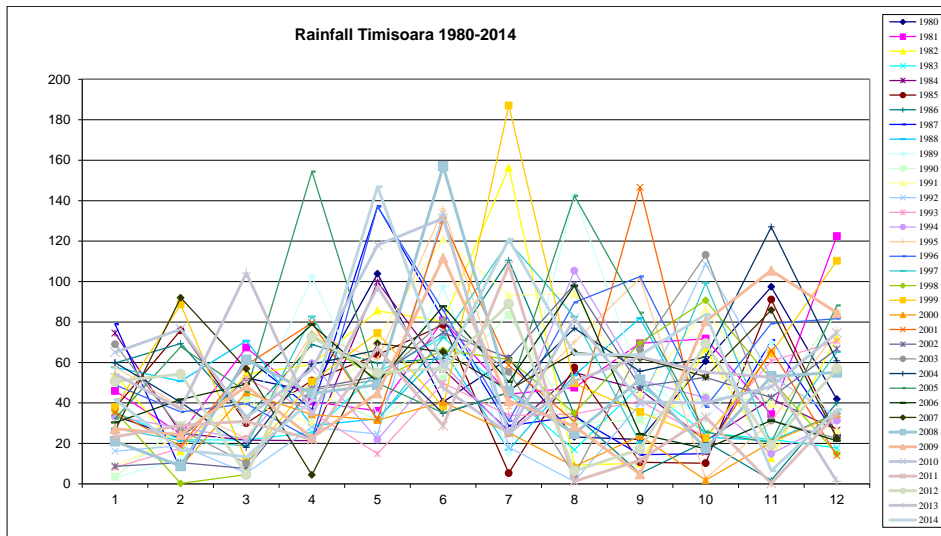


Fig. 1. Monthly average rainfall

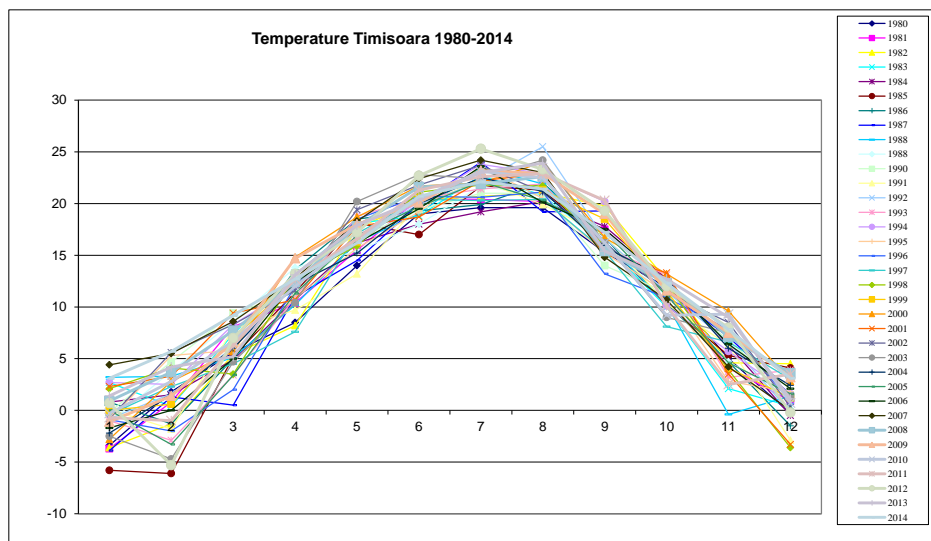


Fig. 2. Monthly average temperatures

RESULTS AND DISCUSSION

After processing, the data drought indexes according to the criteria presented in paragraph 2 were obtained. They are presented in figures 3 through 9.

The results gathered from the drought index calculus after the criteria presented in paragraph 2 are presented in figure 10.

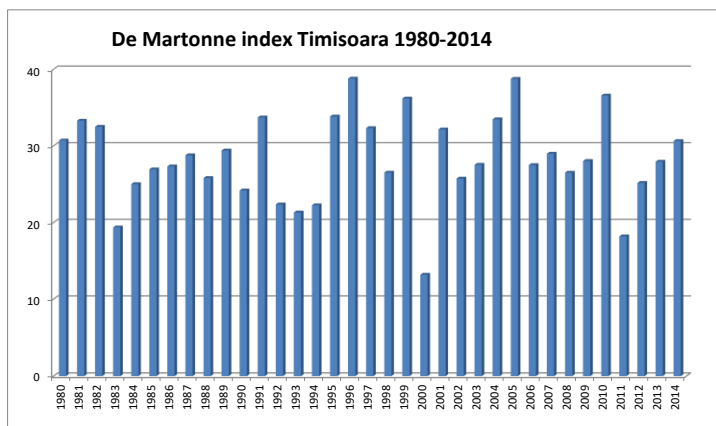


Fig. 3. De Martonne drought index

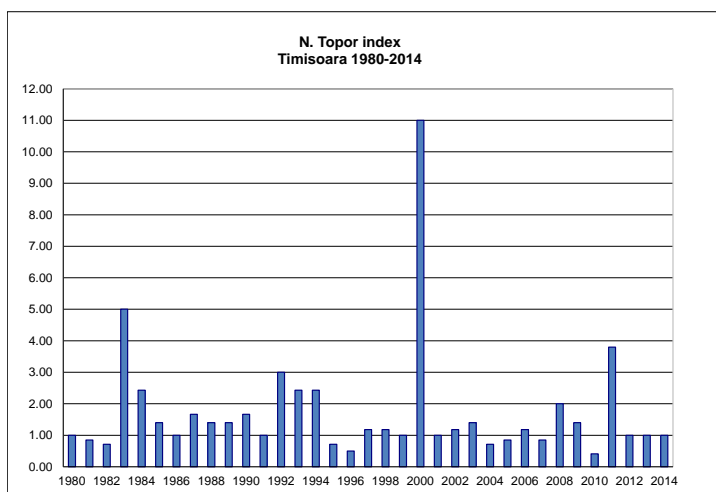


Fig. 4. Pluviometric N. Topor index

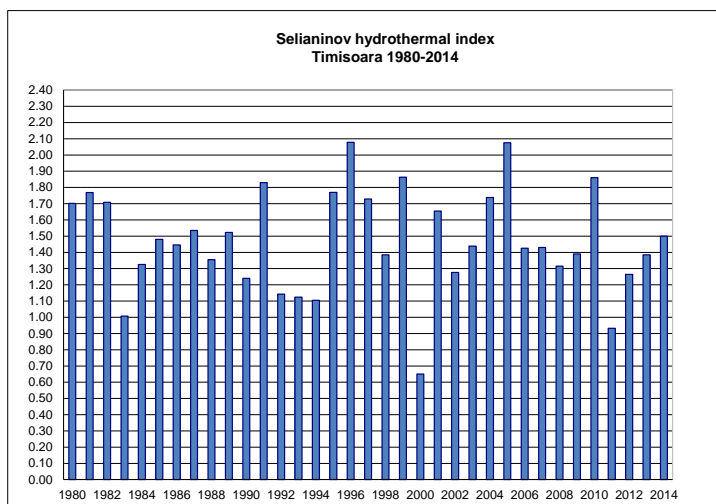


Fig. 5. Selianinov hydrothermal index

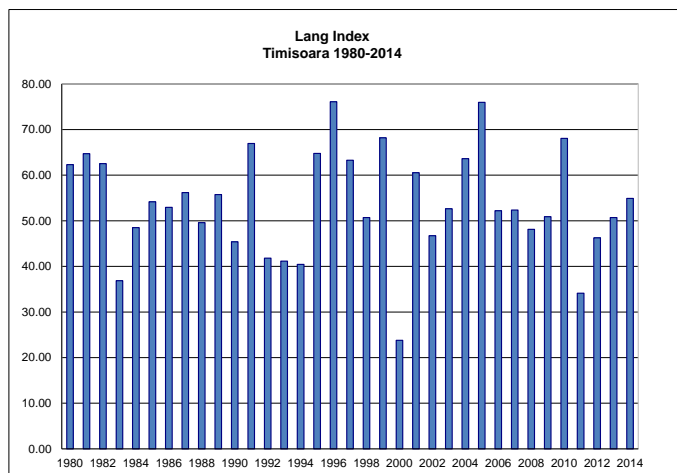


Fig. 6. Pluviometric Lang index

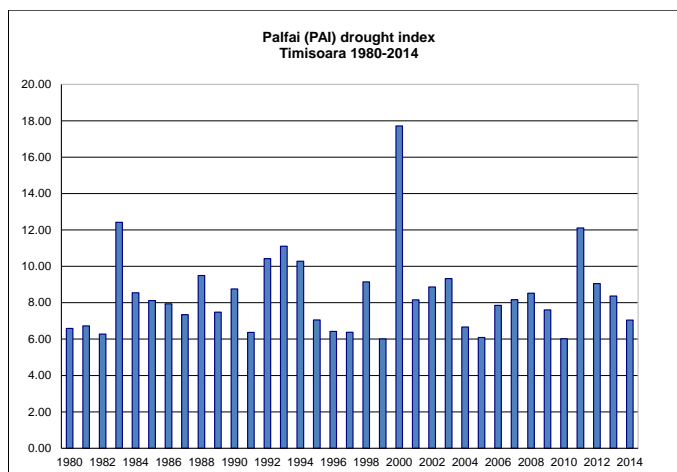


Fig. 7. Palfai drought index

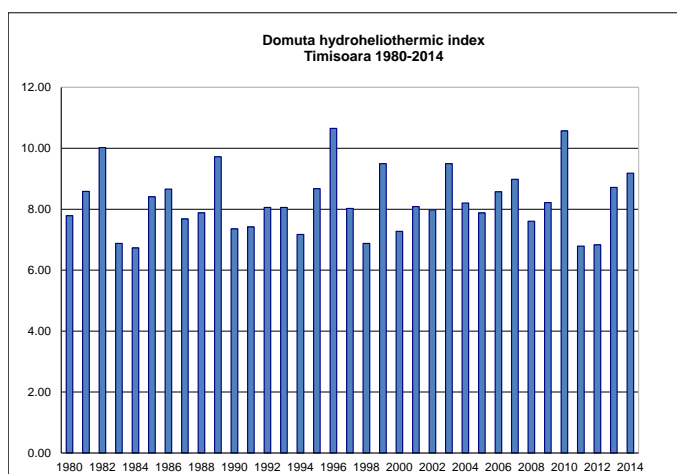


Fig. 8. Domuta hydroheliothermic index

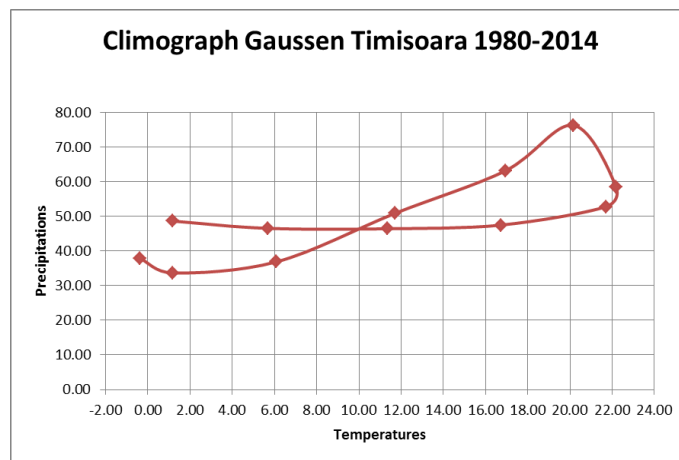


Fig. 9. Gausson climograph

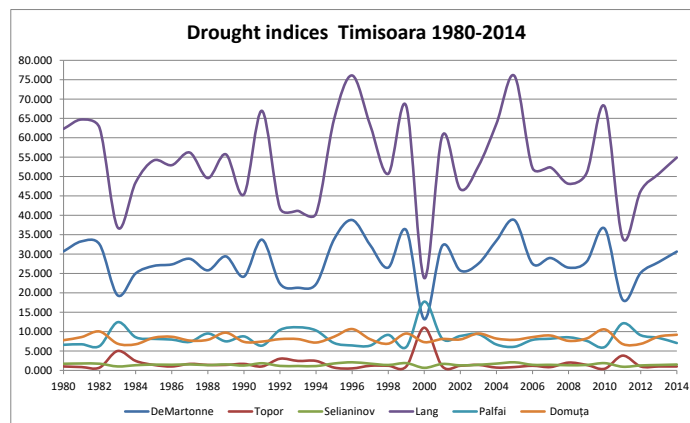


Fig. 10. Comparison between calculus methods for drought indexes

CONCLUSIONS

The ability to manage climate risk is fundamental to disaster prevention and preparedness (Hellmuth et al., 2011). The drought phenomenon represents, according to the United Nation Organization the second largest problem of global implications which mankind confronts with, after environmental pollution. Due to the negative effects it has, drought is part of the dangerous phenomenon.

Climatic data from the last century reveal progressive atmospheric warmth and a reduction of rainfall quantities as well as strong land degradation (Codreanu, 2002).

Through data processing by the presented methods drought maps for Timisoara can result. A wet period has been recorded in the studied years resulted from calculations with all the methods.

At the moment, in the analyzed area there is not a strong drought, but the phenomenon must be studied in order not to reach aridisation and respectively desertification in the near future.

The analysis of monthly average rainfall evolution chart on a period of 35 years (1980-2014) presented in figure 1, shows that the maximum value of annual average rainfall sum from this period was in the year 2005 at 791.3 mm, the minimum value in the year 2000 at 295.8 mm, and the average multiannual value for the whole period was 598.96 mm.

Analysis of monthly average temperature evolution chart on a 35 year period presented in figure 2 shows that the maximum value of annual average temperature sum from this period was in the year 2014 equal with 151.5 °C, the minimum value in the year 1980 is 116.6 °C and the average multiannual for the whole period was 134.52 °C.

Values of calculated indexes are presented in charts 3,4,5,6,7,8,9.

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