Natural Resources and Sustainable Development
Volume 8, Issue 2, 2018
DOI: 10.31924/nrsd.v8i2.013

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

Armaș Andrei*, Man Teodor Eugen*, Beilicci Robert*, Sabău Nicu-Cornel, Ienciu Anișoara***, Baștea Oana-Bianca*****

*Politehnica University of Timisoara, Civil Engineering Faculty, Department of Hydrotechnical Engineering, 1A Spiru Haret., 300022, Timisoara, Romania, e-mail: ing.armasandrei@gmail.com; eugen@zavoi.ro; beilicci@yahoo.com;
*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048, Oradea, Romania, e-mail: nicusabau@yahoo.com
**B.U.A.S.M.V. "King Michael I of Romania" from Timisoara, Romania, e-mail: ienciuani@yahoo.com; oana_bianca95@yahoo.com

Abstract

There is no doubt that drought is considered the second major issue humanity confronts with after of course, pollution. Due to the numerous forms it can occur and the various levels it can create damage scholars have categorized it mainly into agricultural, environmental, hydrological, meteorological and others. This designation was chosen in order to better understand and study the phenomenon`s manifestations. More than a couple of indexes have been proposed by specialists for preventing and measuring it relying mostly on: temperature, rainfall, sun shine and other features. This multitude of indexes made room for a large number of different interpretations which makes the phenomenon even more difficult to study and prevent. The seven indexes the hereby paper uses to calculate indexes are: Palfai drought index, DeMartonne index, N. Topor index, Selianinov hydrothermal index, Lang rain index and Domuta hydroheliothermal index. The case study is conducted for Lugoj for a period of 34 years (1980-2014) in this time impressive amount of data has been collected. The study revealed that the wet and dry periods of time alternate, therefore, there is no threat of aridisation or desertification in the near future.

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

INTRODUCTION

According to the United Nations Organization the second largest problem with global implications that humankind confronts with, after environmental pollution is drought, together with its two recurrent phenomena, aridity and desertification. Drought is part of the dangerous phenomena category because of the negative effects that are drawn from it.

Scholars have always been interested in quantifying and measuring the magnitude of natural events, therefore, terms like *catastrophe*, *risk*, *hazard*, *calamity*, *extreme phenomena*, *disaster*, *dangerous phenomena*, *cataclysm*, have been advanced for a better understanding of its devastating effects (Armaș et al., 2016; Pereș et al., 2017).

Drought can be observed from multiple perspectives: meteorological drought, agricultural or pedological drought and hydrological drought 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 (Sabău, Brejea, 2016).

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

In respect of the phenomenon`s approach mode the definitions have been split into two major categories (which also describe their utilization): conceptual definitions and operational definitions of the drought phenomenon.

The remarkable impact drought has in both developing and developed countries is a clear indicator of its universality. The major increase in its frequency, duration and severity, is better found in the narrowing gap between water demand and supply (Wilhite et al., 2014).

The main reason for the existence of so many operational definitions for the drought phenomenon could be linked to the relation between the number of hidro-climatic parameters taken into consideration as relevant and the accuracy degree of phenomenon`s definition for a certain area more or less extensive which is a highly sensible topic among specialists (Sabău, 2014).

In essence, the drought phenomenon manifests itself throughout the entire hydrological cycle, therefore drought can be regarded as a consequence of a temporary abnormal deterioration of the normal hydrological cycle (Man et al., 2007).

Of course, drought phenomena are specific to all climates, this leading to an extremely high diversity concerning the characteristics of such phenomena, clearly influenced by the local conditions of the area on which the phenomenon manifests itself. For instance, the absence of rainfall can occur in all the months of a year (Man et al., 2018).

The general conditions of the drought phenomena (Armaș et al., 2016) are the following: temporal delimitation, intensity, the area which it manifests itself and occurrence frequency.

According to the environment in which it manifests itself, a series of specific features are attributed to every drought phenomenon and among the general characteristics, meteorological, pedological, hydrological or socio-economical aspects can be found (Sabău, Iovan, 2017).

Most of the times drought is increasingly seen through the negative effects that are produced on the ecosystems and humanities` social-economic activities. Therefore, the drought phenomenon cannot be dealt just as a physical phenomenon.

It needs to be taken into consideration that these negative effects are most of the times interdependent and with a direct impact in other fields

(Sabău et al., 2002). Therefore to better summarize the negative impact of drought phenomena, it ought to be grouped on the predominantly and direct affected areas.

When discussing biodiversity it is important to mention that the harmful effects of the drought phenomena is more visible on a vegetal level than influencing the animal world. Because of plants` reduced mobility the vulnerability increases greatly in comparison to animals` migration possibilities. “High moisture deficit in the air is mainly the result of lack of rainfall for a sufficiently long period of time also accompanied by high air temperatures is a clear indication of atmospheric or climatic drought” (Sabau et al., 2015). “Long-term information from meteorological data” is the most efficient way for analyzing drought (Smuleac et al., 2016).

From a territorial point of view Romania can be framed as having a humid, dry-sub-humid and semi-arid areas by most aridity indexes which has a 0,20 average.

The instability relation between main baric centers 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 (Șerban, Bei, 2011).

In relation to the cyclonic regime, a discussion regarding air masses is also important to be taken into consideration at this point due to the different synoptic contexts that can be found in Romania. The hot and humid air masses are in a constant movement clashing into each other, changing the course of the climate constantly increasing the temperatures everywhere and their evolution is heading towards tropical influences.

MATERIAL AND METHOD

The following indexes have been used to make calculations from: Palfai drought index, N. Topor index, Selianinov hydrothermal index, Hellman criterion, Domuta hydroheliothermal index, Lang rain index and DeMartonne index.

These indexes have been chosen for their enhanced accuracy in describing, sizing up and quantifying drought effects on a long term scale. Here, a period of 35 years (between 1980 and 2014) has been chosen.

The focus of the study case is Lugoj, a study conducted in the above mentioned period. The monthly average rainfall and the monthly average temperatures were the first ones to be calculated in figures 1 and 2 due to their crucial importance in determining drought features.

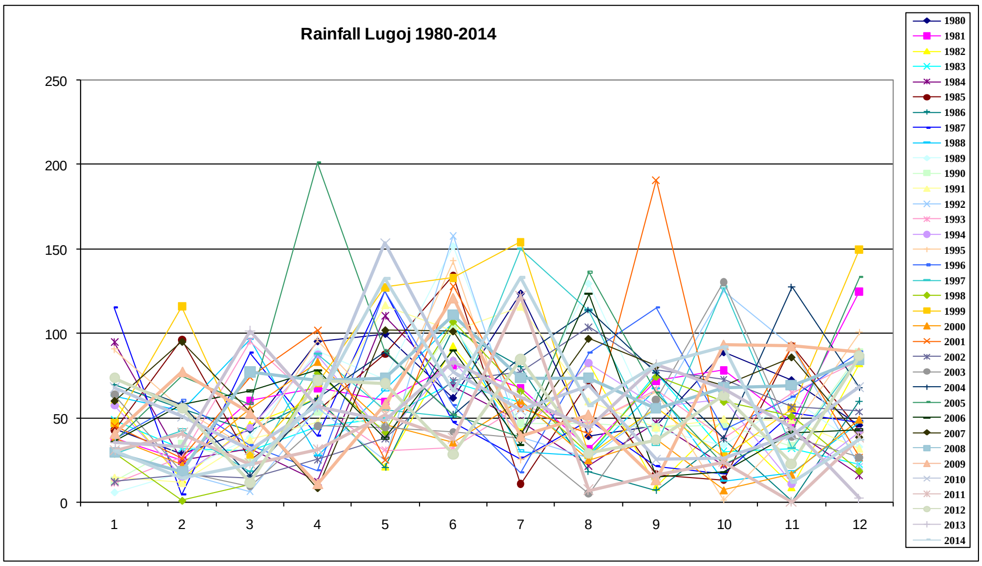

Fig. 1. Monthly average rainfall

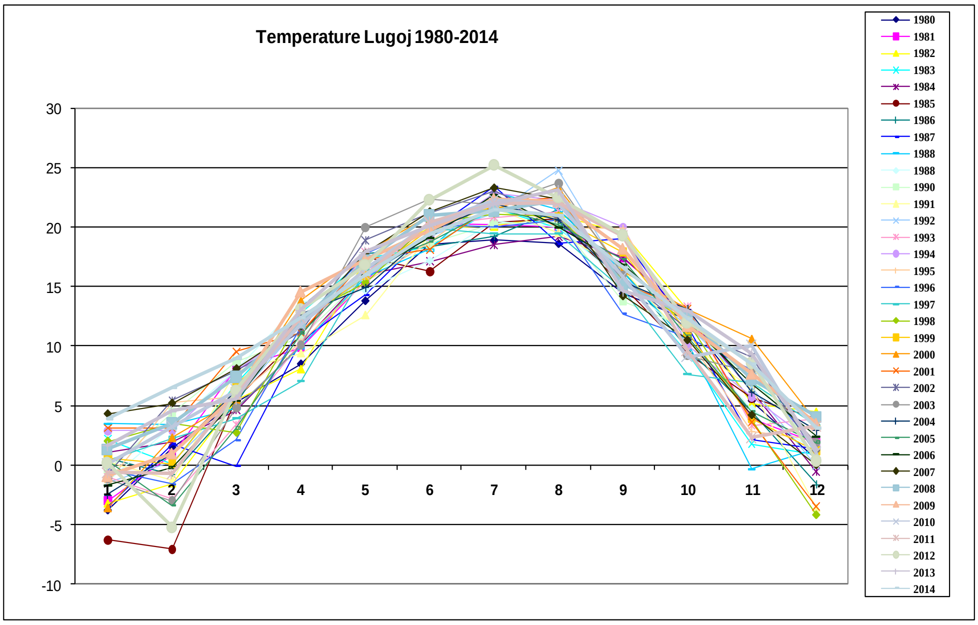

Fig. 2. Monthly average temperatures

RESULTS AND DISCUSSION

After processing the data using the seven indexes mentioned above, interesting figures have been obtained all being illustrated in figures 3 through 9.

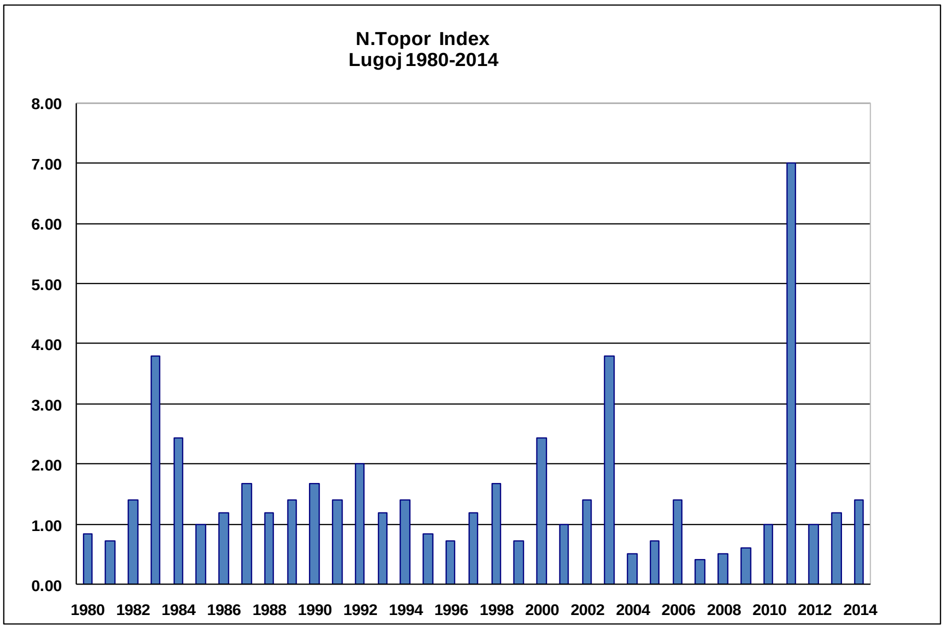

Fig. 3. Pluviometric N Topor index

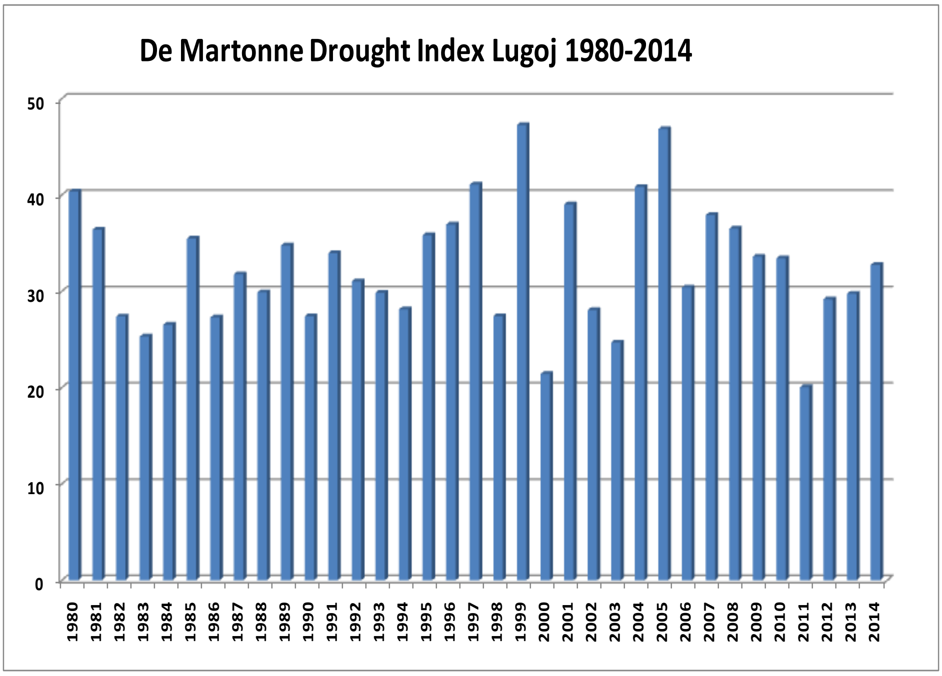

Fig. 4. De Martonne drought index

A more detailed calculus of the seven indexes used in this paper can be observed in figure 10 which follows on in the next section.

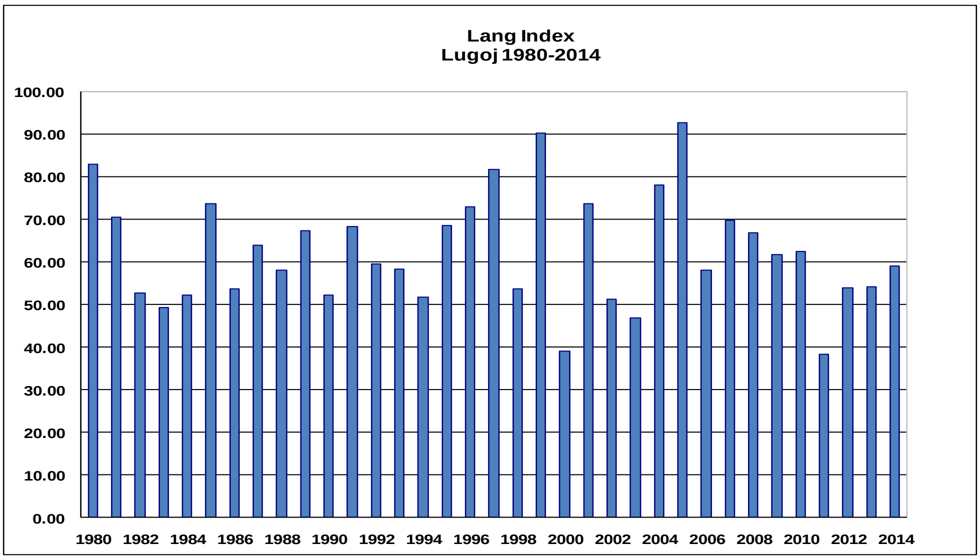

Fig. 5. Pluviometric Lang index

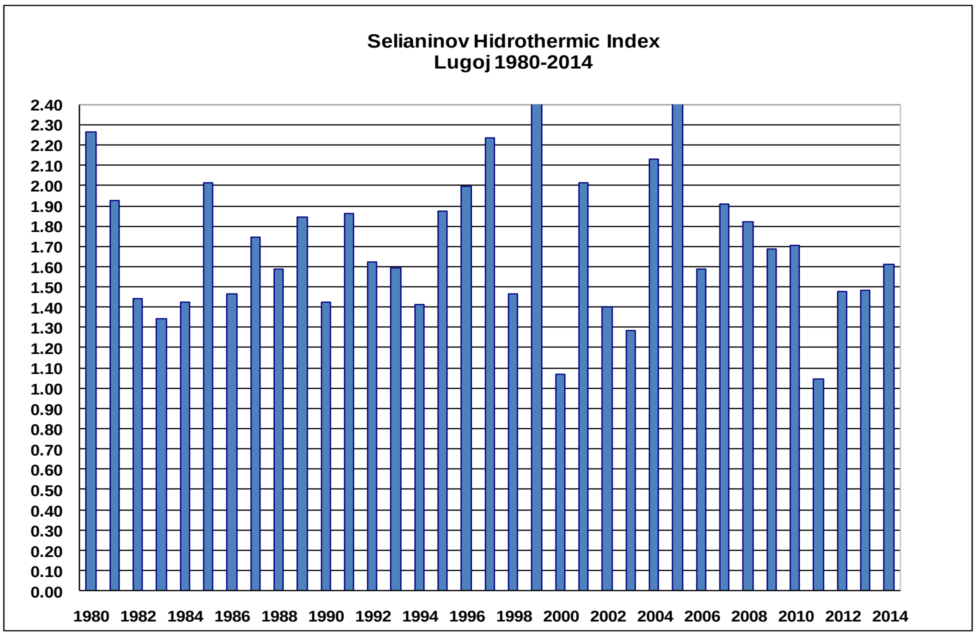

Fig. 6. Selianinov hidrothermic index

Strong land degradation is the result of reduced rainfall quantities, moreover, a progressive atmospheric warmth is revealed by climatic data from the last century (Codreanu, 2002).

In the Lugoj area the phenomenon must be studied in order not to reach aridisation and respectively desertification in the near future even though at the moment, in the analyzed area there is not a strong drought.

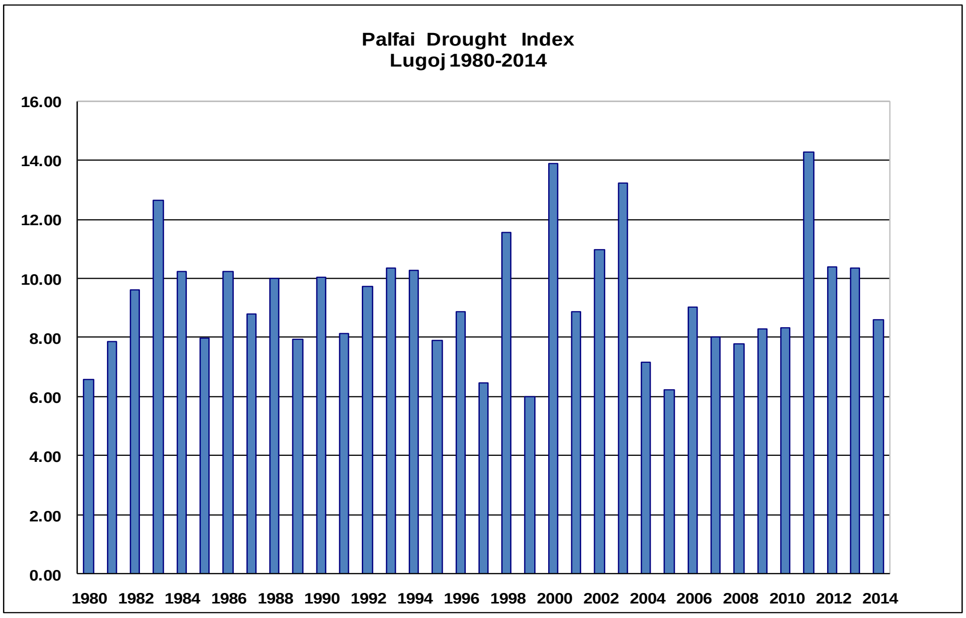

Fig. 7. Palfai (PAI) drought index

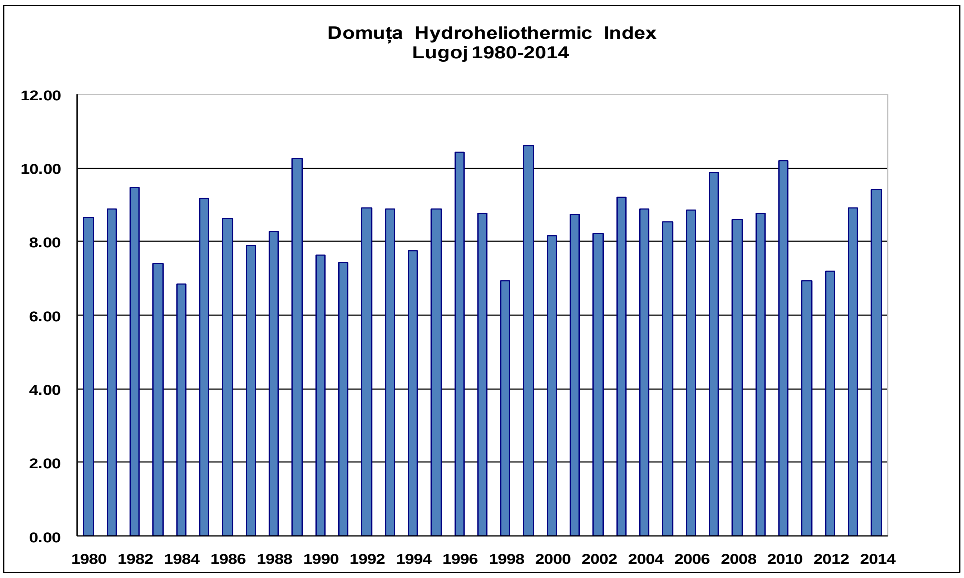

Fig. 8. Domuta hydroheliothermic index

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 from this period was in the year 2007 at 830,5 mm, the minimum value in the year 2011 at 421,4 mm, and the average multiannual value for the whole period was 680,42 mm.

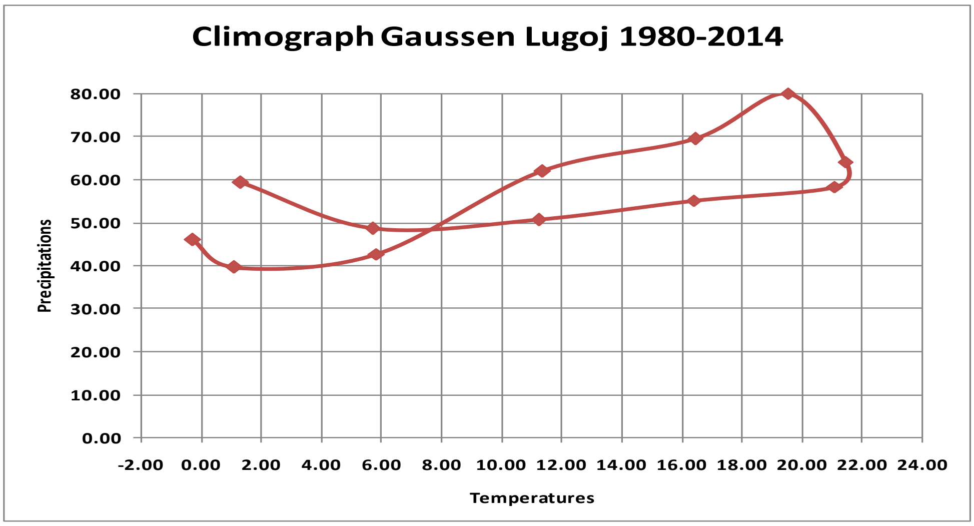

Fig. 9. Gaussen climograph

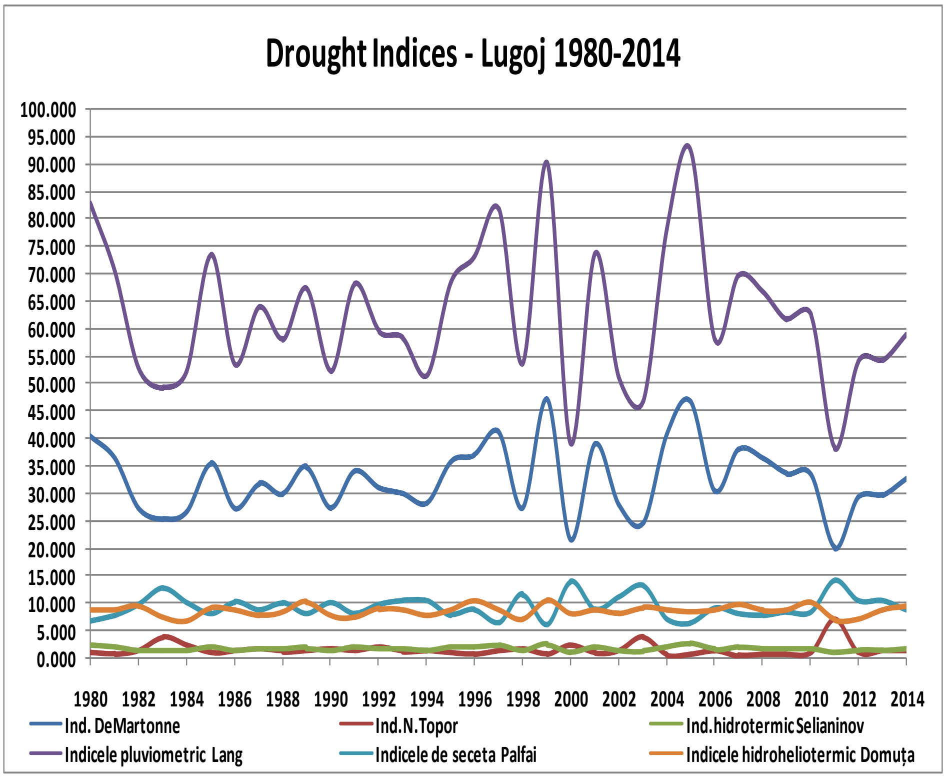

Fig. 10. Comparison between calculus methods for drought indexes

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 from this period was in the year 2014 equal with

12,6 °C, the minimum value in the year 1985 is 9,3°C and the average multiannual for the whole period was 10,95 °C.

Charts 3, 4, 5, 6, 7, 8, 9 present values of calculated indexes.

CONCLUSIONS

Dangerous hazards have always existed on our planet, but even in the early times the various species that inhabited earth managed to overcome such adversities.

The way mankind chooses to deal with this sort of hazards can be definitive to the well being of not only our crops and fresh water supplies but also to the preservation of different species of wild animals. Lack of prevention affects all the inhabitants of our planet making harm especially to the atmosphere.

Drought maps for Lugoj were made from calculations with all the methods which revealed a wet period, recorded in the studied years through data processing by the above methods.

REFERENCES

1. Armaș A., Man T.E., Ienciu A.A., Cuzic O.S., Beilicci R.F., 2016, Drought As Climate Risk in Timis County, Romania. 16th International Multidisciplinary Scientific GeoConference, www.sgem.org, SGEM 2016 Conference Proceedings, ISBN 978-619-7105-61-2 / ISSN 1314-2704, June 28 - July 6, 2016, Book 3 Vol. 1, DOI: 10.5593/SGEM2016/B31/ S12.033. pp.2
2. Armaş A., Man T.E., Sabău N.C., Beilicci R., 2016, Vulnerability assessment and mitigation measures in Republic of Moldova. Scientific Bulletin of Politehnica University of Timişoara, Transactions on HYDROTECHNICS, Vol. 61(75), Is 2
3. Codreanu M.M., 2002, Semicentenar ISPIF. Sesiune stiintifica internationala aniversara, Bucuresti, pp.109-120
4. Hellmuth M.E., Mason S.J., Vaughan C., van Aalst M.K., Choularton R., (eds) 2011, A Better Climate for Disaster Risk Management. International Research Institute for Climate and Society (IRI), Columbia University, New York, USA
5. Man T.E., Sabău N.C., Cîmpan G., Bodog M., 2007, Hidroamelioraţii, Vol II. Ed. Aprilia Print, Lugoj, (Red. 2008)
6. Man T.E., Armas A., Beilicci R., Beilicci E., 2018, Assessment Regarding the Evolution in Time (1980-2014) of Drought on the Basis of Several Computation Indexes, Study Case Timișoara. Natural Resources and Sustainable Development, Vol 8, I. 1, DOI: 10.31924/nrsd.v8i1.001, pp.1-8
7. Palfai I., Petrasovits I., Vermes L., 1995, Some methodological questions of the European drought sensivity map. Drought in the Carpathians region, Budapest-Alsogod
8. Pereş A.C., Domuţa Cr., Borza I., Costea M., Köteles N., 2017, Hazardous Weather Phenomena in the Warm Semester of the Year in the Area of Oradea, Bihor County. Natural Resources And Sustainable Development, Vol 7, pp.69-74
9. Sabău N.C., 2014, Evolution tendenccy in pluviometric indexes used to monitor global climate changes. Analele Univ. din Oradea, Fascicula Protecția Mediului, vol. XXII, pp.185-194

10. Sabău N.C., Domuţa C., Man T.E., Șandor M., Brejea R., 2002, Drought Analysis by thr Climate Indexes in Link with the Yield of the Main Crop from the Crișurilor Plain, Romania. International Conference on Drought Mitigation and Prevention of Land Desertification, Bled, Slovenia
11. Sabău N.C., Man T.E., Armaş A., Balaj C., Giru M., 2015, Characterization of agricultural droughts using standardized precipitation index (SPI) and Bhalme-Mooley Drought Index (BDMI). Enviromental Engineering and Management Journal. Vol.14, No. 6, pp.1441-1454
12. Sabău N.C., Brejea R., 2016, Aspects of Droughts Characterization the Crișurilor Plain with Standardized Precipitation Index (SPI) Calculated with the Help of Gamma and Log Normal Functions. Natural Resources And Sustainable Development, Vol 6, pp.168-179
13. Sabău N.C., Iovan C.I., 2017, Aspects of the Hydrological Drought Evaluation in the Galbena Valley with Streamflow Drought Index (SDI). Annals of the University of Oradea, Fascicle: Environmental Protection, Vol. XXIX, pp.239-250
14. Şerban E., Bei M.F., 2011, Thermic Characterization of the Years and Months of the Agricultural Period 1992-2009, at Oradea. Natural Resources And Sustainable Development, Vol 1, pp.273-278
15. Şmuleac L., Oncia S., Ienciu A., 2012, The study of potential evapotranspiration in the Banat plain in 1897-2011. Research Journal of Agricultural Science, Timisoara, ISSN 2066-1843, vol.44 (3), pp.288-292
16. Wilhite D., Sivakumar M., Pulwarty R., 2014, Managing drought risk in a changing climate: The role of national drought policy. Weather and Climate Extremes, Volume 3, June 2014, pp.4-13
17. ***, 2005, Ordinul nr. 503/2005 privind componența Comitetului Național pentru Combaterea Secetei, a Degradării Terenurilor și a Deșertificării

Received: November 01, 2018
Revised: November 21, 2018