The Assessment of the Agro-climatic Parameters and Coefficients Employed in the Drought Evaluation

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Abstract

The theme of the article is of theoretic and didactic nature, providing the systematization of agro-climatic parameters and coefficients, necessary for the explanation and evaluation of the drought phenomenon, within a precise geographic region. Through interactions and consequences on a social level, economical and political, the drought phenomenon represents an environmental problem, which implies analyses on a global scale, regional, national and local, with the purpose of establishing some specific measures of prevention and control. Therefore, the correct employment of climatic data (elements, parameters and coefficients) represents an effective way of approaching the organization, management, analysis and contrasting of elaborated studies which have as a subject the characterization and detection of the aridity and/or drought phenomenon. The article is based on professional literature, acting as an inventory of the main agro-climatic parameters and coefficients utilised in the assessment of the drought phenomenon, on a national and international scale.

Key words: *evaluation, agro-climatic coefficients, assessment, agro-climatic parameters, drought.*

JEL Classification: *Q 50, Q 54*

1. Introduction

The drought is a complex phenomenon, characterized by the insufficiency or total absence of precipitations, large values of the saturation deficit and extreme temperatures, with a time coverage of between a few days up to several weeks or even months. The drought is firstly manifested in the air, also known as an atmospheric drought, and if this event holds on

for a long time, reducing the water reserves in the soil, the edaphic drought occurs.

The atmospheric or meteorological drought is depicted through time periods without precipitations, high air temperatures and excessive values of evapotranspiration, usually developing after ten consecutive days without precipitations.

The edaphic drought arises when the pedological cover cannot supply the necessary amount of water for the plants and consequently they start fading.

The mixed drought represents the association of the two types of drought, delivering the agricultural drought, since it determines the partial or total compromise of the harvest.

Within the Romanian territory, the droughts, in the majority of cases, are owed to the anticyclones formed in the arctic regions, bringing air masses with relatively low temperatures and a scarce content of water vapours (cca 5 mg/m³). Advancing southward, the arctic air is rapidly heated, and consequently the relative humidity drops and the saturation deficit rises considerably. Aside from the dynamic atmosphere the characteristics of the active surface have to be taken into consideration, like the orographic barrier role of Carpathian Mountains, thus the drought phenomenon even though can occur all year round and all over the agricultural regions of the country, it cannot arise simultaneously throughout the country and with the same intensity.

The drought period, after the Hellman's definition, is the period of at least 10 days within the warm season (April – September) of the agricultural year, in which the precipitation quantity does not exceed $\geq 0,1$ mm/day.
Due to the complexity, the drought can be studied through various perspectives such as: meteorological, economical, hydrological, ecological, agro-climatologic and agricultural.

The article approaches the drought through an agro-climatologic perspective, in order to realize an inventory of the major agro-climatic parameters and coefficients, employed in the evaluation of the drought phenomenon.

The agro-climatology highlights the drought impact on agriculture, analyzing the climatic factors which condition the demand of an agricultural system or biotope for reaching the optimal biological productivity.

2. Materials and methods

In the process of preparing this material a series of professional literature was consulted. The drought event is studied through different

methods, of which we remind the spatial and temporal analysis of agro-climatic parameters, the agro-climatic coefficients implementation, and the graphic production of climatic-data.

3. Results and discussions

In the development of a study on aridity and/or drought events several criteria of identification and classification are employed, namely:

- the analysis of precipitation fluctuations in time intervals correlated with the primary phonologic phases of the harvest and the plats request in regards to water;
- the frequency of scarce pluviometric (arid) periods and dry intervals, after the Hellman criteria;
- droughty months and years – extreme and/or exceptional cases;
- the spatial and temporal repartition, intensity and duration of agro-climatic parameters;
- agro-climatic coefficients.

From the above principles we will focus on the last two, due to our wish of producing an inventory of primary parameters and coefficients agro-climatic used in the evaluation of drought events.

The agro-climatic parameters utilised in the drought assessment define conditions or atmospheric phenomena which characterise the weather within a time frame.

The agro-climatic parameters which define exemplify and identify the development of singular and/or complex agricultural drought events are:

- *air temperature* by means of diurnal, monthly, annual and multiannual averages; diurnal, monthly, annual and multiannual maxima and minima, and cumulative temperature;
- *soil temperature* through diurnal medium at surface and at depths of 05, 10, 20, 40, 60, 80 and 100 cm;
- *atmospheric precipitation* by means of monthly and multiannual average quantities; variability of monthly and annual quantities; frequency of different monthly and annual amounts; maximum quantities fallen in 24, 48 and 72 hours; number of rainy days and optimal and critical limits of precipitation amounts on characteristic intervals specific for crops;
- *parameters of thermal stress* which define the „broil" phenomena *as intensity of generation* by unities of „broil" ($\sum Tmax \geq 32\ ^{\circ}C$) > 15 ˚C for VI month; > 20 ˚C for the VII and VIII months; > 70 ˚C for the time VI – VIII frame;

- *parameters of thermal stress* which identify the „broil" events as *span of generation* by number of broil days month/ agricultural interval/season or agricultural year –medium and extreme values of production; number of consecutive broil days/3 as minim threshold and ≥ 5 days consecutive, enduring „broil";
- *parameters of atmospheric stress* by means of relative humidity of air < 30 – 40 % / month, V – VIII period;
- *parameters of hydro stress* by precipitations < 50 mm, IX – X; < 150 mm, XI – III and VI – VIII; < 450 mm, IX – VIII; soil water reserve (m^3 /ha), in values of < 50 in the soil layer 0 – 20 cm and < 100 in the soil layer 0 – 100 cm, close to the scorching coefficient, serving as extreme edaphic drought.

The identification, recognition and spatial and temporal examination of these agro-climatic parameters employed in the drought assessment, allow through correlation with the covering of growth and development processes of plants, the appointment of favourability degree from an agro-climatologic standpoint of farming surfaces for agricultural breeds and species with different degrees of resistance to the occurrence of drought events.

The agro-climatic coefficients engaged in the drought evaluation provide information on the risk degree, intensity, frequency, duration and probability of generating disruptive factors, and also for establishing the vulnerability extent of harvested terrains and the spatial – temporal repartition of hazard events.

The evaluation of climatic coefficients is attained with the aid of several simple mathematic formulas, the majority highlighting different rapports between two climatic elements, the most important being temperature and precipitations. In order to calculate the agro-climatic drought coefficients a correlation must be made with the requests in regards to vegetation conditions of plants on specific phases and inter-phases and the active season in its ensemble.

The primary agro-climatic coefficients used in the drought assessment both on a national and international scale are:

- *the soil humidity coefficient* G. T. Seleaninov [11]: k = 0.6 Sr1 + Sr2/St˚, where *Sr1* is the precipitation quantity outside of the vegetation period, *Sr2* is the precipitation amount during the vegetation period, while *St˚* is the sum of active temperatures ≥ 10 ˚C within the vegetation period;
- *the humidity coefficient* [2]: Iu = aq + Q/ETP, where *a* is the proportionality coefficient which differs throughout the year

from 0 to 0.6, *q* is the sum of precipitations from the XI – II months, *Q* is the sum of additional precipitations month by month, whilst *ETP* is the potential evapo-transpiration;

- *the rain factor Lang* [9] represents the rapport between the annual precipitations medium and the sum of monthly averages of positive temperatures (> 0 ˚C)/12, in order to obtain a positive and finite value of the rapport;
- *the aridity coefficient De Martonne* [2]: Ia = P/(T+10), where *P* is the average annual amount of precipitation (mm), while *T* is the medium annual temperature (˚C). It derives from modifying the rain factor Lang, so that at negative temperatures the coefficient will not take negative values [11]. It is calculated annual, monthly and during the vegetation season.
- *aridity coefficient Thornthwaite* [11]: ITh = P/ETP, where *P* is the precipitation amount, while *ETP* is the potential evapotranspiration. It is used as such, or as *a humectation coefficient* stated in percents after the 100P/ETP formula and dubbed *moisture coefficient „Thorn-thwaite"* or *humidity coefficient*;
- *the humidity coefficient* [10] *Rz*: Rz = z$\sqrt{}$RR, where *z* is the number of days with precipitations ≥ 0.1 mm within the considered time frame, while *RR* is the monthly amount of precipitations (mm). It is employed within the III – X monthly period;
- *hydrothermal coefficient* [9]: Iht = T· P/100 ·k1 ·k2 where *T* is the annual average temperature, *P* is the quantity of medium annual precipitations, while *k1* and *k2* are correction coefficients. For Romania the values are between 0.7 and 9;
- *Palmer coefficient* [10] is a function assigned by the differences accumulated between the precipitation provisions–assurance and evapotranspiration requirements for the purpose of forecasting the scarce and/or humid periods;
- *stress coefficient day/grad (SDD)* [10]: SDD = $\sum$ (Tc – Ta) where *Tc* is the temperature of vegetation layer, while *Ta* is the air temperature. It is an indicator of the water and drought strain;
- *pluviometric coefficient* [11]: IA = (N + 2P)/(N + 2S) where *N* is the number of normal months, *P* is the number of rainy months, and *S* is the number of arid months;
- *accessible humidity coefficient* (MAI) [10] is the rapport of certain precipitations and potential evapo-transpiration. A 50 %

probability is the optimal value for each advancement and development study of crop fields;

- *soil humidity coefficient* (SMI) [11] is the rapport of accessible water at the capacity of available water from the root zone directly reported to the potential evapo-transpiration during the period of high request of water by agricultural plants – critical period;
- *soil balance equation* [10]: $R - Q - U - E - \Delta W = 0$, where *R* is precipitation amount or irrigations, *Q* is discharge, *U* is the drainage depth beyond the root zone, *E* is potential evapotranspiration, whilst ΔW is the chage in the soil water reserve. The potential evapotranspiration is determined with the aid of Thornthwaite formula or through Pennman method. It can be calculated on a daily, decadal, monthly and annually basis.

The outcome of applying the comparative analysis on these agro-climatic coefficients of drought events assessment shows that actually they define the major environmental factors, appointing the degree of agro-climatologic favourability of agricultural years for each and every crop field.

Instead of conclusions

Agro-climatic parameters and indices are used in order to define the potential climate of the agricultural areas of interest, spatial-temporal areas of dryness or wetting, the depiction of years or season periods etc. The theme of the article is one of teaching nature and by its very nature of teaching approach must be comprehensive and systematic representing a significant requirement to achieve a quality process.

Knowledge, selection and correct use of agro-climatic parameters and indices is the first step in describing and assessing the drought phenomenon, with a precise geographical location, all the more so as in our country, of the approximately 14.7 million ha agricultural land, soils are affected by the drought over long periods and consecutive years over an area of about 7 million hectares of agricultural area (48% of the total) or excess moisture in rainy years (about 4 million ha).

The effects of droughts are immediate in the vegetation carpet, and affected vegetation reduces the protection scheme in terms of the erosion of [6], and as a result the proposed inventory provides the theoretical nature absolutely necessary in a future case study, whose subject is the detailed analysis of the drought phenomenon.

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