# THE IMPACT OF THE CLIMATIC CHANGES ON THE ENVIRONMENT – AGRICULTURAL DROUCHT

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**Abstract**

The drought in general and the agricultural drought in particular affect large territories on the entire planet. In Romania, there are important territories affected by the agricultural drought, the most well-known being located in Dobrogea and the south of Oltenia.
The case study of the agricultural drought phenomenon took place in Dobrogea, at Tulcea meteorological station, thus determining the quantitative and qualitative characteristics of the agricultural drought: the total amount of time of the agricultural drought, the maximum amount of time of the agricultural drought, the severity of the agricultural drought, the medium intensity of the agricultural drought, the agricultural yield obtained under the circumstances of the agricultural drought, the agricultural yield obtained when the irrigation with different watering norms.

**Key words**: runs, length, severity, agricultural, drought

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## MATERIAL AND METHOD

Consider $Y_t$ where t=1,2,......,n, a series of temporary observations, and the difference $Y_t - Y_0$ can be either negative or positive, such as the respective situation with excess or decificiency.

The temporary interval which has K deciciency data (or L excess data), precedeed or followed by an excess or deficiency sequency, represents the time d=K or d=L and, it represents the time of a „RUN" which is the sum of the deficiency values (or excedentary values) relative to the time d=k or d=L represents the excess or deficiency severity. The ration between severity and time is defined as being the medium intensity or medium deficiency: m = s/d

Consider a finit and constant Δt interval (day, week, decade etc), as the measure of the time variable. The precipitations infiltrating into the soil are noted $P_t$ and the potential evaporation is noted $ET_p$.

If $P_t - ET_p \geq 0$, then, humid intervals are recorded, when ETR occurs there is no deficiency and so $D_t = ET_p - E_t = 0$.

If $P_t - ET_p < 0$, there occur the droughty intervals and so, the entire vegetation suffers from hidryc deficiency $D_t = ET_p - E_t > 0$.

*Figure 1* graphically represents a short historical series of differences between precipitations and the potential daily evaporation (during the time interval 159 – 285 of the year 1961) in a certain area having the standard pasture cultivar; the potential evaporations were computed using the Blaney-Criddle method which was modified FAO (Doorenbos J., Pruitt W., 1984).

The hydric defficiency recorded during the droughty intervals is inferior to the pluviometric one $ET_p - P_t > 0$. the hydric content of the soil (A) at the moment (t) reduces Δt, changing from the value $A_{(t-1)}$ to the value $A_t$ ($A_{t-1} > A_t$) and having a variation of $\Delta At = A_t - A_{(t-1)} < 0$.

*Figure 1b* graphically represents the series of the soil hydric content $A_{(t)}$, where, the consecutive droughtier intervals are pointed out, the soil hydric content progressively being reduced.

*Figure 1c* highlights the fact that the droughty intervals are related to negative ΔAt and the humid intervals are related to positive ΔAt.

It is thus obvious that the agricultural drought determining can be done only by knowing the historical series of $A_{(t)}$ (and so, of ΔAt). The verification of a drought interval, respectively the value A(t), can be done using the expression (Nicolaescu I. 1995):

$$A_{(t)}/U = \exp\left[(Pt - ETp)/U + \ln A_{(t)} - 1/U\right] \quad (1)$$

and it is function of:

- the accumulation unit value as soon as it preceeds $A_{(t-1)}$;
- the potential water loss of the soil, which gets to a value equal to the cultivar necessity, meaning Lt = Pt - ETp;

- the active humidity interval U available for a cultivar (with reference to the surface unit of the area) and evaluated in mm such as:

U = 10 (CC-CA)H, where:
CC- field capacity (%)
CA- dropping coefficient (%)
H- active depth of the radicular system (m)

The verification of a humid interval, and so of the value $A_{(t)}$ can be done using the following expression:

$$A_{(t)} = A_{(t-1)} + (Pt - ETp) \qquad (2)$$

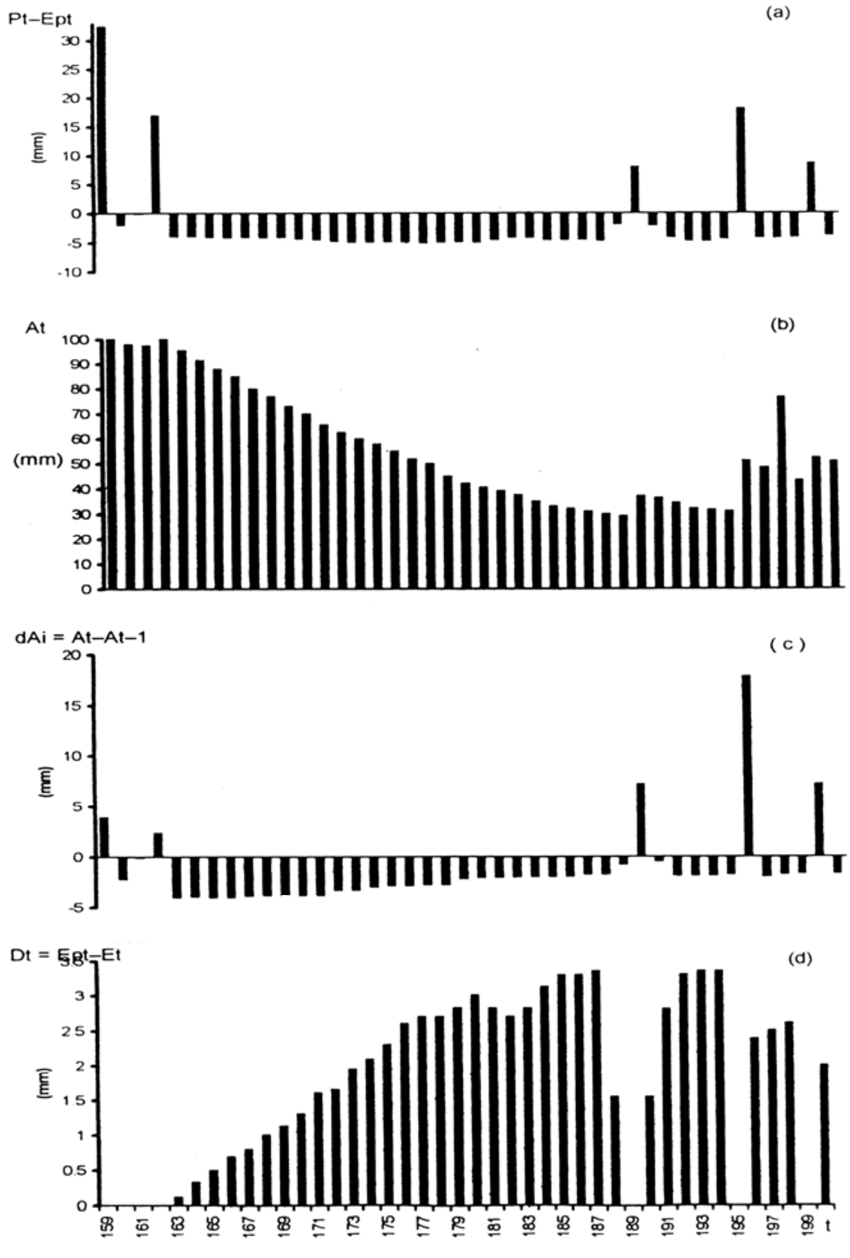


Figure 1 **Time series of: Pt – Etp (fig. 2a); At (fig. 2b); dAt=At-At-1 (fig. 2c); Dt=Etp-Et (fig. 2d); Tulcea Station, U=100mm, reference crop, year 2009**

## RESULTS AND DISCUSSIONS

The drought analysis starts from the hypothesis that at the initial moment there is an excess of water (Nicolaescu, I., 1998). It starts from the situation when it is assumed that there is no agricultural drought during the humid intervals, which are characterized by excess of precipitations proportional to the potential evaporation consume.

This is mathematically represented by the followings:

$Lt = Pt – Etp \geq 0$;

$Et = Etp$; $Dt = Etp – Et = 0$

During these intervals the function A(t) is increasing for Lt > 0 şi $A_t$<U or constant for Lt = 0 and $A_t \leq$ U and for Lt > 0 şi $A_t$ = U.

Mathematically speaking, there is a non-decreasing function in the following form:

$\frac{dA(t)}{dt} \geq 0$ knowing the fact that:

$$\frac{\Delta At}{\Delta t} = \frac{A_{(t)} - A_{(t-1)}}{\Delta t} \geq 0$$

*Figures 2c, 2b* graphically represent the functions A(t) and dA(t)dt, for a certain geographical area, with U=100 mm, Etp, computed with Blaney-Criddle modified, where the cultivar is that of pasture, and where A(t) is increasing and dA(t)/dt ≥0.

On the opposite, we can check the agricultural drought conditions during the drought periods, characterized by Lt , Pt – Etp < 0 and by a function A(t) decreasing and monotonous.

Mathematically speaking, this last condition can be expressed function on the condition dA(t)/dt<0 (see *figures 2b, 2c*).

On the other hand, the efffective drought conditions are considered, when the hydric content of the soil is below the minimum level when the plants are no longer able to provide the necessary income of water to continue their development. This threshold value $A_{(t)}$ is connected to the vegetation type and, it can be individualized in the critical point of the cultivar.

From mathematical point of view, it can be said that(Mannocchi F., Mecarelli P., 1990).

The conditions of the humid period existance are ecluded when:

Lt ≥ 0; Dt = 0; dA(t)/dt ≥0 (3)

there are droughty periods when:

Lt ≤ 0; Dt > 0; dA(t)/dt <0; A(t) > Ac (4)

and the conditions are verified:

Lt < 0; Dt > 0; dA(t)/dt < 0; A(t) ≤ Ac (5)

It can also be said that having the conditions Lt < 0, Dt > 0 and dA(t)/dt< 0,an agricultural drought can be simpler defined, based only on the function A(t) with its double connection:

$$A(t) \leq Ac; \ \frac{dA(t)}{dt} < 0 \qquad (6)$$

The conditions (6) are presented in figures 2b and 2c, where the horizontal threshold line was established (dropping point). Figures 2b and 2c highlight the relation A(t) ≤ Ac and the agricultural drought.

It is desired to know what is the value of the cumulated hydric deficiency (fig 2a). For this respect, the following relation is used:

$$Z(t) = \int_0^t D(t)dt \ \text{ unde } \ Zt = \sum_{t=0}^{t} Dt\Delta t$$

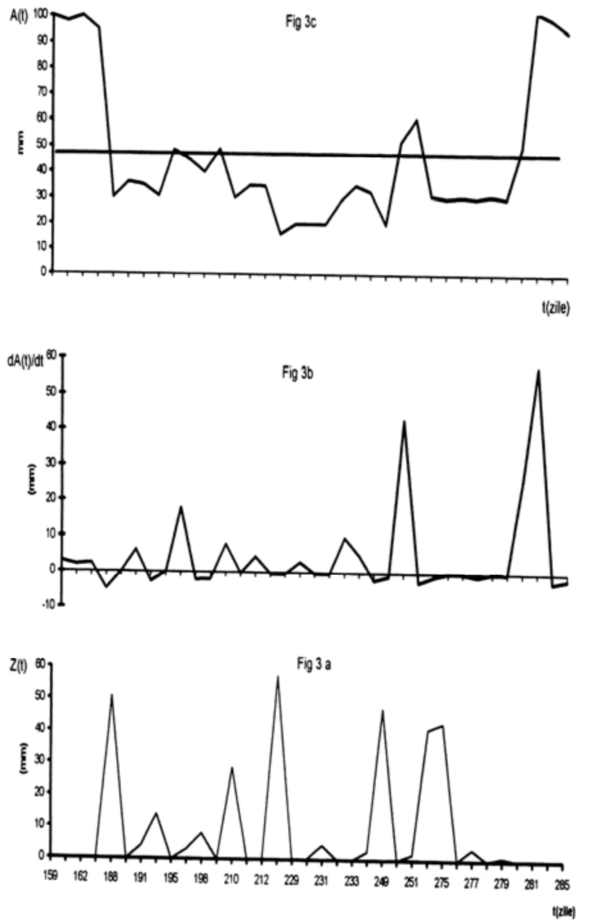


Figure 2 **Graph of the function: z(t) – fig. 2a; dA(t)dt fig. 2b; A(t) –fig. 2c - Tulcea Station, U=100mm, reference crop "grass", year 2009**

## CONCLUSIONS

Lately, some climatic transformations have occured and resulted in the increasing of the multiyearly medium temperature, on the entire planet. The global warming is due to the greenhouse effect particularly, correlated to the desertification and deforestation effect.

The drough generally, and the agricultural drought particularly, affect large territories on the entire planet. In Romania there are large territories affected by the agricultural drought.

The proposed methodology allows to know exactly the drought phenomenon, as well as the elements of the agricultural drought and, it also helps in establishing the daily watering norms even below the irrigation norms, so that the interval of the active humidity to be present above the minimum threshold.

The mathematical model allows to monitor the water content in te soil, to manage some watering norms gradually applied, below the nominal value, so that, the agricultural crops to provide quantities of 70-80%, the main purpose being that of protecting the vegetation and, implicitly, the agricultural field.

## BIBLIOGRAPHY

**Doorenbos, J., Pruitt, W., 1984** - *Crop water requirements*, FAO, Irrigation and dramage, Italia.

**Mannocchi, F., Mecarelli, P., 1990** - *Modelling of drougts by mitigated by irrigation,* ICID, Italia.

**Nicolaescu, I., 1995** - *Influence of climate change on Irrigation Sistem in Romania* – Proceedings of the International ICID workshop on Drought in the Carpathian's Region, Budapest.

**Nicolaescu, I., 1998 -** *Water demand minimum level for a profitable operation of an irrigation scheme*, Proceedings of the 1'st interregional conference on envinronment water: Issues in irigation and drainaje – Lisabona – Portugalia.

**Yevjevitch, V., 1967 -** *An objective approch to definitions and investigations of continental hydrologic papers,* Colorado State University.

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