LAND DEGRADATION: FROM DRYNESS TO DESERTIFICATION

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Abstract. *The main purpose of this paper is to illustrate the profound connection between dryness, drought and desertification. Causes and characteristics that lead to the occurrence of the three phenomena are discussed as well as the medium and long term effects. First of all, in the beginning of the draught a forerunner period of dryness can be observed that usually appears in the air; these two are considered distinct stages in which the intensity with which plants fell the need for water is differentiated. A more complex phenomenon is desertification, the result of a few extremely long drought periods. Desertification is also a phenomenon that involves biological productivity losses and land degradation in arid, semi-arid and dry-sub-humid areas, having as main causes human activity, climatic variation especially drought. The paper also discusses drought vulnerability of some soil categories as well as their traits that are of major importance in determining negative effects over land degradation. Climatic data from the last century reveal a progressive atmospheric warming a reduction of rainfall quantities and a strong land degradation became limitative factors for the growing, development and ecosystem`s productivity (agricultural, forestry, aquatic, etc) from certain geographic areas of the country and restrictive factors for assigning and using water reserves. The results reveal that firstly the lack in time and space of rainfall quantities generates such dryness processes and if they persist, drought will install itself. Using six of the most common used indexes a more efficient characterization of the drought was determined. The paper ends with a Discussion section where it is claimed without doubt that when elaborating the strategies for water resources management it is imperative for these extremely harmful phenomena to be taken into account. It is also necessary a clear establishment of the institutional responsibilities in drought conditions in an integrator and efficient manner.*

Keywords: *dryness, drought, desertification, degradation, land*

INTRODUCTION

The drought phenomenon is one of the dangerous natural phenomena with severe negative effects on humanity on the entire globe. Drought together with the two recurrent phenomena aridness and desertification is the second largest problem humanity confronts with, after pollution (ARMAS, A., MAN, T.E. 2014)

The discreet manner of institution of drought phenomena is the cause of a late response of authorities regarding the management of a crisis situation. In order to have knowledge, reducing the response time and negative effects produced by such phenomenon numerous definitions were developed worldwide.

One of the most widespread general definition of drought which does not have to be limited to a physical phenomenon is the fact that this is a normal and recurrent characteristic of any climate on the planet. These phenomena can appear anywhere on the globe and have extremely dispersed characteristics, according to the climate in which manifests itself and the

socio-economic effects it implies. Therefore, drought can be better defined on a limited, homogenous space not only climatic but also on the degree of socio-economic development.

Drought is mainly a meteorology issue which depends on the level of precipitations, on the size of mean daily temperatures, on the increase of the frequency of tropical days, hence the different types of drought: meteorological, atmospheric, soil, hydrological, etc (IENCIU, ANISOARA ET ALL. 2010).

Depending on the environment or the stages of the hydrological cycle in which its effects take place, duration and amplitude drought can be tackled from many perspectives: meteorological drought, agricultural drought and hydrological drought. As a direct consequence of the manifestation of all these drought types and their negative effects overlapped with a region`s social and economic activities, a new type of drought can be defined: the socio-economic drought.

The meteorological drought is the first phenomenon that manifests itself on drought conditions having as main cause the emergence of periods with high temperatures overlapped with rainfall deficit and wind intensification. The overlapping of these phenomena lead to the humidity shortage and atmospheric nebulosity in which case the evapo transpiration phenomenon is exacerbated which accentuates even more the dryness sensation. The meteorological aspect of drought is the main and direct cause of all the other aspects of the phenomenon (STANCIU, EUGENIA 2005).

In most of the cases defining the meteorological drought is made on the basis of atmospheric dryness degree compared with the values expected on a regular basis. Special attention needs to be given to the spatial development of the phenomenon taking into consideration the great variability of atmospheric conditions, therefore the criteria for defining a meteorological drought can be extended only on an area with a sufficient homogeneity from a climatic point of view or even micro-climatic.

The agricultural drought is recurrent to the meteorological drought and installs as a direct consequence for the lack of rainfall and evapo transpiration phenomena intensification which has a drastic water supply shortage as direct effect, with negative effects on vegetation development in general and crop development in particular. In the case of a significant prolonging of the agricultural drought phenomenon the biomass quantity produced by a ecosystem falls leading directly to an even more growth of evaporation component at soil level.

Practically, the agricultural drought can be defined as a time period in which the water reserves from the soil are insufficient for the normal growth of crops from a given place.

The general characteristics of drought phenomena are: apparition frequency, intensity, temporal delimitation, territorial manifestation space. Among these general characteristics, each aspect of drought phenomenon e.g. meteorological, hydrological, agricultural or socio-economic, a series of characteristics specific to the environment are attached.

MATERIAL AND METHODS

Of all the climatic phenomena the ones of dryness and drought can be considered the most complex, because for their outburst many factors participate: rainfall, soil water reserve accessible to plants, moisture and air temperature, evapo-transpiration, wind speed, etc., i.e. the main climatic parameters that define the status of dry or drought time.

Being complex meteorological phenomena, dryness and drought are characterized primarily through absence of rainfall and through a growth of potential evapo-transpiration. The dryness phenomena represents the “foreplay” for drought, they appear before the drought and persists sometimes even after it. During them the moisture deficit is somewhat more soften

(depending on the temperature), but will grow if the meteorological conditions persist, transforming into drought, which will manifest itself in the air as well as in the soil, therefore vegetation suffers a lot due to lack of moisture.

In producing the drought a forerunner dryness stage is always noticed which appears usually in the air. The dryness usually precedes drought, the two being distinct stages, in which the intensity with which plants resent the need for water is differentiated, although the transition is gradual.

Lack of rainfall quantities in time and space generate dryness phenomena, and if those persist, drought is installed. The breakout of droughts is linked to other factors such as the water reserve from soil, air temperature, evapo-transpiration, wind speed, active surface characteristics, plant physiological particularities and influence of anthropic factors on the environment (SOMOGYI, VERONICA 2009).

Regarding desertification, its four classes are: light (reduced deterioration or absence of vegetal and soil layer), moderate (significant growth of unwanted weeds and bushes; holes, small dunes or ravenes formed through wind and water accelerated erosions; soil salinity reduces irrigated crops productivity with 10-50%), severe (unwanted weeds and bushes dominate the flora; areal wind and water erosion have uncovered on large scale the land from vegetation or large dimension ravenes are presented; salinity reduced irrigated crops with over 50%), very severe (large unfertile dunes of sand are formed, numerous deep and large ravenes are formed; saline crusts have developed in irrigated soils almost impermeable).

On the Romanian territory drought owes to the predominant influence of baric formations, anticyclone, stationary with very high extension (anticyclone dorsal from the north Atlantic which stretches over central Europe) (BOGDAN, O. 1980) as well as the existence at altitude of a tropical current from south-west (CIULACHE, S., IONAC, M. 1995). Moving forward towards south the arctic air warms fast, recording because of this a accentuated decrease of relative moisture and a considerable growth of saturation deficit.

Direct causes can be natural (climatic conditions, risk phenomena, topographic aspect, covering the vegetation, soil conditions), and anthropic – over-grazing, inadequate land practices (over cultivating, inadequate use of water from irrigations and agrochemical products), deforestation, burning the grazing fields, industrial activities, urban expansion.

Indirect causes: way of using the field, poverty, growth of population, touristic activities, and governmental policies.

The climatic changes influences the frequency and intensity of droughts, may causing desertification, especially in dry areas (KELLY, M., HULME, M. 1993). Once with temperature growth a shortage of rainfall quantities takes place, as a consequence of continuous growth of atmospheric pressure which favors a growth of sun brightness duration associated with a decrease of anticyclones apparition conditions and implicitly of rainfall which they generate (VRANCEANU, V. et all. 2001).

Drought plays an important role on the road to desertification, in comparison to other possible links between desertification and climatic changes. Drought is not obligatory followed by desertification, there is an alternation, in cyclic form, of dry periods, with wet ones, usually every five years (BORTON, J., NICHOLDS, N. 1994).

Direct influence of drought over pedogenesis takes place, primarily, through modification, in a manner of aridness of humidity regime for unsupplied soils from the ground water in periods of climatic drought; a significant reduction of liquid phase share takes place and slowing or even stoping the majority of physical, biological, biochemical processes from the soil of which development is linked to water presence (MUNTEANU, I. 2000).

Vulnerability to drought of some categories of soil (sandy soils, extremely clayey, eroded soils, salty soils) can be a drought intensification factor and desertification (MUNTEANU, I. ET ALL. 2003).

Soil characteristics (texture, structure, chemical and biological properties), are of major importance, especially in the sub-humid areas, where the influence of climatic factors is less outstanding (EMAN, A.R. ET ALL. 2002) these play an essential role in accentuating the vulnerabilities to desertification especially when human activity intervenes (over grazing, deforestation, over cultivation, a poor water management, all leading to salinisation, as in the case of irrigated lands.).

Degraded soils have a high vulnerability to desertification, especially in drought conditions. The characteristics of degraded soil are (SOMOGYI, VERONICA 2009): destruction of soil aggregates, shortage of permeability, decrease of water reserves, loss of elasticity, redistribution of water, new stages for surface drainage initiation

RESULTS AND DISCUSSIONS

The multitude of definitions and evaluation methods of drought phenomena imposed the development of indexes that respond to the specific needs for the characterization method. Therefore, most of the evaluation methods use indexes of a smaller or greater complexity according to the conditions and necessities specific to following these phenomena. When structuring these indexes a series of hydroclimatic parameters are used: rainfall, sunstroking, evapotranspiration, degree and type of coverage with vegetation of soil, surface leaking, aquifers level.

The great variety of developed indexes by the specialists involved in this area is a reality derived from the impossibility of finding an universal method for evaluating droughts, in such a way that each index has its own optimal suitability area, whether we refer to hidrogeoclimatic conditions or to anthropic conditions of the area or availability period.

Depending on the parameters taken into consideration, the indexes used in evaluation and monitoring drought phenomena can be classified in: indexes based on climatic parameters; indexes based on hydroclimatic parameters; indexes based on biological parameters; indexes based on complex parameters. Next, the main utilized indexes are presented on worldwide scale in evaluation, monitoring and drought phenomena prediction.

The Standardized Precipitation Index relies only on the rainfall parameter, being invented by T.B. McKee and his team from the State University Colorado in 1993 and represents the probability of rainfall for various periods of time in a given area:

$$I_{SP} = \frac{(Ri - Rm)/Rm}{S\%} \cdot 100$$

Where: I_{SP} –Standardized Precipitation Index

Ri –rainfall occurred in the analyzed period (year, season, month, decade)

Rm –rainfall from the previous periods similar to the one analyzed

S% -variation coefficient of medium rainfall in the period of average calculation

The positive values of I_{SP} express periods with richer rainfall than the average (positive deviations) and the negative values show periods with rainfall under the average (negative deviations), like in table 1.

Table 1

Period evaluation using Standardized Precipitation Index (McKee, T.B. et all., 1993)

I_{SP} value	Period characterisation
>2,0	Extremely wet
1,5 - 1,99	Very wet
1,0 – 1,49	Moderately wet
-0,99 – 0,99	Almost normal
-1,0 – -1,49	Moderately dry
-1,5 - -1,99	Very dry
<-2,0	Extremely dry

The Effective Drought Index has rainfall at its core as well, but it evaluates their necessary to return to a normal climatic situation. This index was developed by Byun and Wilhite and uses the daily calculation of effective rain needed covering the humidity deficit accumulated from the beginning of drought phenomenon. Just like the former the Effective Drought Index is a standardized index, this way allowing its extension on considerable areas, ensuring comparison possibilities between different climatic regions. The daily values and drought periods characterization with the aid of this index are presented in Table 2.

Table 2

Intervals evaluation with the aid of Effective Drought Index

I_{ES} value	Period characterisation
-0,99 – 0,99	Normal period
-1,0 - -1,49	Moderated drought
-1,5 - -1,99	Very drought
< -2,0	Extremely drought

The Palmer Drought Severity Index was developed as a necessity of drought phenomena assessment, representing a mass balance of moisture quantities from various environments, valid for regions with a high homogeneity degree. The algorithm of this index relies on the concept of moisture intake-demand including evapotranspiration, water reserve regeneration capacity, moisture losses (drainage and evaporation from the water surface).

The main purpose of this index is to secure measurements regarding the moisture conditions, measurements that were standardized, in order for comparisons to be made between different regions or months.

Table 3

Evaluation of periods with the aid of Palmer Drought Severity Index

I_{PDS} value	Period characterisation
≥ 4,0	Extremely wet
3,0 – 3,99	Very wet
2,0 – 2,99	Moderately wet
1,0 – 1,99	Relatively wet
0,5 – 0,99	Inception of wet period
0,49 – - 0,49	Normal
-0,5 - - 0,49	Inception of drought
-1,0 – - 1,99	Light drought
-2,0 – - 2,99	Moderate drought
-3,0 – - 3,99	Severe drought
≤ -4,0	Extreme drought

The Palfai Aridness Index was developed by a team of Hungarian researchers and presented in 1995. It is a index that takes into account the climatic conditions through rainfall and temperature parameters, but also hydrogeological, using the ground water resources` contribution. Characteristic to this index is the two stages calculation manner, in the first stage a strict climatic index is identified through percentage reference of average temperatures from the April-August period to the rainfall in the October-August period.

The initial Palfai Aridness Index is easily comparable with the Palmer Drought Severity Index, the correction process to which the first one is examined allows an increase of its sensibility in evaluation and drought monitoring in general and agricultural drought in particular. The initial index`s correction is made through ascribing certain correction coefficients for the torrid days, those without significant rainfall and a correction based on the contribution of ground water (NAGY, M.C. 2008).

Table 4

Drought periods evaluation with the aid of Palfai Aridness Index

I_{PA} value	Drought characterisation
< 2	Very weak
2,00 – 3,99	Weak
4,00 – 5,99	Moderated
6,00 – 7,99	Strong
8,00 – 9,99	Very strong
≥ 10	Excessive

CONCLUSIONS

As to conclude with it can be said that in order to diminish the vulnerability degree of an economy to the socio-economic effects of drought phenomena, certain strategies for a controlled deduction of specific water demands can be implemented or identifying some possibilities of increasing the water availabilities of the respective society, through increasing the storage capabilities (artificial enriching the aquifers), and identifying new sources of water that can be transported to the respective area. Taking into consideration the exacerbated economic growth of the human society in the last two centuries, with the exponential increase of water demands, the only solution for maintaining an optimal and acceptable vulnerability degree to drought is for the social and economical development to be in balance with the environment`s potential of the given region, i.e. durable socio-economic development.

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