# THE PHENOMENON OF DROUGHT AND IT'S EFFECTS WITHIN ROMANIA

**Andreea Bianca LUPU, Florin Catalin IONESCU, Iacob BORZA**

***Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Agricultural Sciences, Calea Aradului no. 119, RO-300645, Romania***
*Corresponding author: andreea.lupu@uex-usamvbt.org*

***Abstract:*** *The changes in Earth's global climate show a trend of increasing average air temperature and causing drastic changes in hydrologic cycle as a result of the progressive greenhouse effect. As a result the vegetation period is expected to become shorter and even more irregular distribution of precipitation will occur, both from year to year and during the vegetation period. Essentially, the periods of semi-drought conditions are going to become more frequent. Whatever the reasons for drought appearance, the fact remains that it causes serious problems. Drought itself as a periodic phenomenon does not result in permanent or irreversible changes of the environment. Even in prolonged drought periods, flora and fauna gradually creep back (if left alone), when the conditions improve. It is in combination with other factors, especially human activities, that drought leads to permanent changes. Drought can affect all aspects of our lives and economies. It reduces not only the primary production of crops, good quality grass and fodder that is essential to maintain animal production, but also jeopardizes the constant supply of good quality water. Drought also leads to degradation of the environment - one of the most dangerous and harmful effects of drought is exerted on the natural resources (water, soil, air), habitats and ecosystems, besides it has impact on public health, on employment/unemployment, etc. All these losses have considerable financial consequences for the economies of all the countries affected. Its impacts on society result from the interplay between a natural event (less precipitation than expected resulting from natural climatic variability) and the demand people place on water supply. Drought should not be viewed as merely a physical phenomenon or a natural event and thus drought is the first stage in a process, if this process is left unattended, it may lead to an irreversible chain of reactions.*

***Key words:*** *climate change, drought, desertification, soil erosion*

## INTRODUCTION

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. It is a temporary aberration; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate.

Drought is an insidious hazard of nature. Although it has many definitions, it originates from a deficiency of precipitation over an extended period of time, usually a season or more.

Almost every climatic zone might experience drought although the characteristics can vary significantly between regions. Drought is, unlike aridity, a temporary phenomenon and can be characterised as a deviation from normal conditions, (HISDAL, H. & TALLAKSEN, L.M., 2000).

## MATERIAL AND METHODS

Drought can have a widespread impact on the environment and the economy, depending upon its severity, although it typically does not result in loss of life or damage to property, as do other natural disasters.

The purpose of this review paper is to succinctly review recent researchers about drought and understanding its impacts, both direct and indirect. Overall, the paper summarizes the current state of knowledge of the topic.

An overview of drought concept and several of it impacts of past droughts are presented in this paper.

Drought should be considered relative to some long-term average condition of balance between precipitation and evapotranspiration in a particular area, a condition often perceived as “normal”. It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of the rains.

Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with drought in many regions of the world and can significantly affect its severity.

Human beings often exacerbate the impact of drought. Recent droughts in both developing and developed countries, resulting economic and environmental impacts and personal hardships have highlighted the vulnerability of all societies to this natural hazard.

Three types of drought are commonly noted: meteorological drought, agricultural.

*Meteorological drought*

This type of drought is principally defined by the deficiency of precipitation from expected or "normal"amount over an extended period of time. This type of drought is focused on the physical characteristics of drought, the departure of precipitation from normal, rather than on the impacts associated with this departure.

*Hydrological Drought*

Hydrological drought can be defined in many different ways (STAHL K., 2001).

Hydrological drought is associated with the effects of substandard periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply. The frequency and severity of hydrological drought is often defined on a watershed or river basin scale.

Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system.

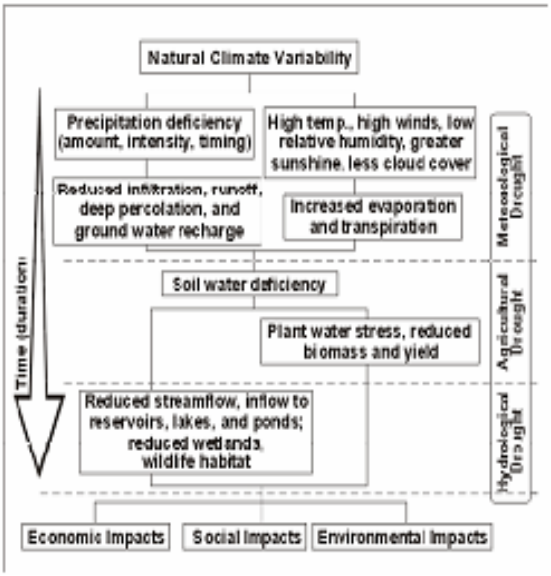
*Agricultural Drought*

The association between meteorological and hydrological drought leads to agricultural drought. Various characteristics of meteorological or hydrological drought are linked to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, and reduced ground water or reservoir levels (MONACELLI, G., 2005).

Crop water demand depends on prevailing weather conditions, biological characteristics of the specific crops, its stage of growth, and the physical and biological properties of the soil.

Deficiency in top soil moisture at planting may hinder germination, leading to low plant populations per hectare and a reduction of final yield. However, if topsoil moisture is sufficient for early growth requirements, deficiencies in subsoil moisture at this early stage may not affect final yield, providing subsoil moisture is replenished as the growing season progresses or if rainfall meets crop water needs.

As it can be seen, (Fig.1) drought is a complex phenomen and the interrelationship of the hydrological cycle can be described as below:




*Source: National Drought Mitigation Center, University of Nebraska, USA*

Figure 1. The concept of drought

**RESULTS AND DISCUSSIONS**

Romania is placed in South East part of Central Europe in the lower Danube catchment and in the Black Sea basin.

The climate is temperate-continental, with oceanic influences from the West, Mediterranean ones from South-West and continental-excessive ones from the North-East.

Multiannual average temperature is latitudinallydifferent, 8°C in the North and 11°C in the South, and altitudinally, with values of -2,5°C in the mountain areas (Omupeak-Bucegimassif) and 11,6°C in the plain (Zimnicea town-Teleormancounty).

Yearly precipitations decrease in intensity from west to east, from 600 mm to 500 mm in the Romanian Plain and under 400 mm in Dobrogea, and in the mountainous areas they reach about 1000-1400 mm.

It is well known that atmospheric circulation and climate are linked. But the regional climate is generated by the simultaneous action of the various processes at local, regional and global scales (ADLER, M.-J. ET. AL, 1999).

A characteristic of Romania's climate is the high frequency of droughts mainly in the low areas of South, South East. After 1980 year these drought characteristics increased the period 1982-1994 being the droughtiest period in the recorded climatic history of Romania. As shown in figure 2, four agroecological zones are distinguished:

I. *The Warm and Dry agroecological zone* comprises the steppe and partly the forest steppe regions from the south and eastern part of the country, a small area in the western side also being included. The climate is characterised by an average annual temperature between 10.5 and $11.5^0$C and an annual average precipitation between 325 and 600 mm.

In the major part of this zone (that included in the steppe zone with < 500 mm precipitation) the main constraint for agricultural use is the lack of precipitation during the growing period and the high frequency (up 63 years from 100) of severe drought.

*II. The Moderately Warm - Subhumid agroecological zone* corresponds roughly to the Oak Forest and forest-steppe vegetation zone of the outer Carpathians area and of the western part of the Transilvania Tableland. The climate is characterised by an annual average temperature between 8.0 and 10.5 $^0$C, an annual average precipitation of 500 - 700 mm.The main constraint for agricultural use is water erosion, often associated with terrain deformation (gullies and landslides).

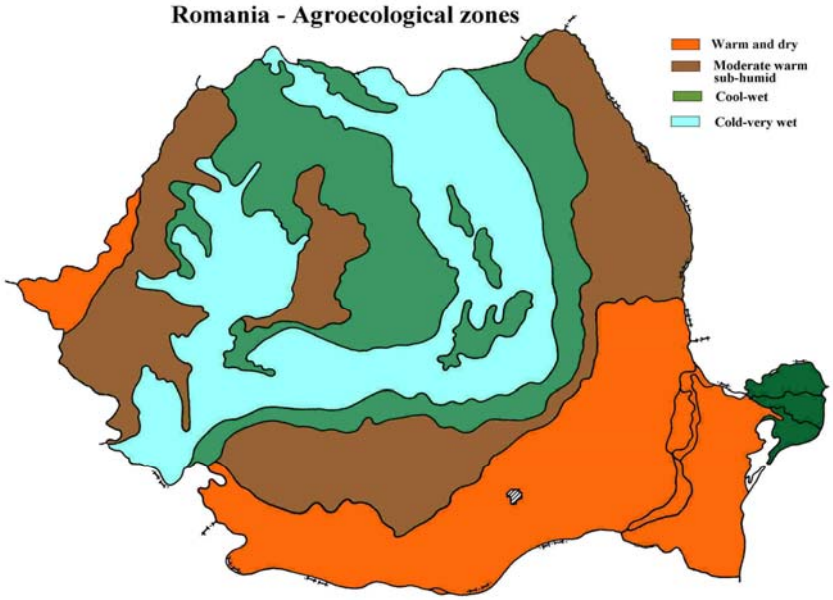



Figure 2. Agroecological zones in Romania

*III. The Cool-Humid agroecological zone* overlaps roughly the oak and oak-beech forest zones and stretches, corresponding to a hilly area of high gradient. The climate is a cool and relatively humid one: $5^0$ to $9^0$ C mean annual temperatures and 600 - 900 mm mean annual precipitation.

*IV. The Cold Wet agroecological zone* corresponds to the mountains region, with low temperature (< $5^0$C) and high amount of precipitation (> 900 mm/year). Dominant soils are Cambisols and Podzols. It is used mainly as forestland and grassland.

***Size and effects of drought in Romania***

According with the Convention to Combat Desertification (*** http://www.unccd.int/) about 2.2 million ha (about 10% af the country area) in South East Romania (East of Muntenia, Dobrogea and South Moldova) with arable land use mainly and in addition a great part of humid area of Danube Delta are included in "Arid, semi-arid and dry sub-humid land" having a ratio between rainfall and potential evapotranspiration less than 0.65.

According with the Aridity Index (AI = MAP/MAE) a world-wide index used today for defining the drought areas, the area of Romania with aridity index in the range of 0,50-0,65 covers 40 % of the agriculture land, mainly in the South, South East and East of Romania; the area with 0,65 – 1.00 is about 20 % of the agriculture land area, mainly in South and South east, but with areas in West and central part of the country, (Figure 3.).

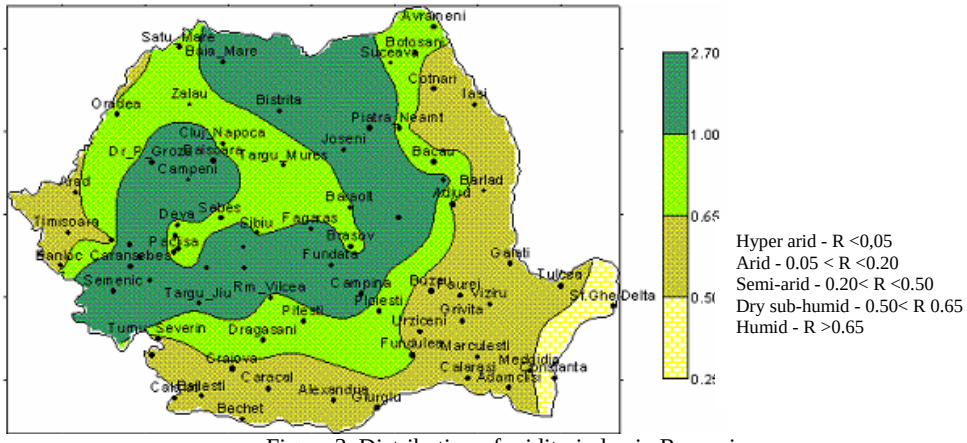



Figure 3. Distribution of aridity index in Romania

Agricultural land use and areas affected by drought in Romania, from a total surface of 237.500 km2, 62% are agricultural lands approximately 14.7 million ha –categorized according to usage in arable land, pastures, vineyards and orchards. Frequent and prolonged drought affects million ha, which represent 48% from the total agricultural land.

*Table 1.*

Agricultural land use and areas affected by drought

| | Agricultural area (thousand ha) | Structure %) |
|---|---|---|
| Total | 14717,4 | 100,0 |
| Arable land | 9414,3 | 64,0 |
| Pastures | 3355,0 | 22,8 |
| Hayfields | 1490 | 10,1 |
| Vineyards and orchards | 457,7 | 3,1 |
| Agricultural area irrigated | 569,1 | 3,9 |
| Affected by drought | 7100,0 | 48,0 |

Source: Romanian Statistical Yearbook, 2006

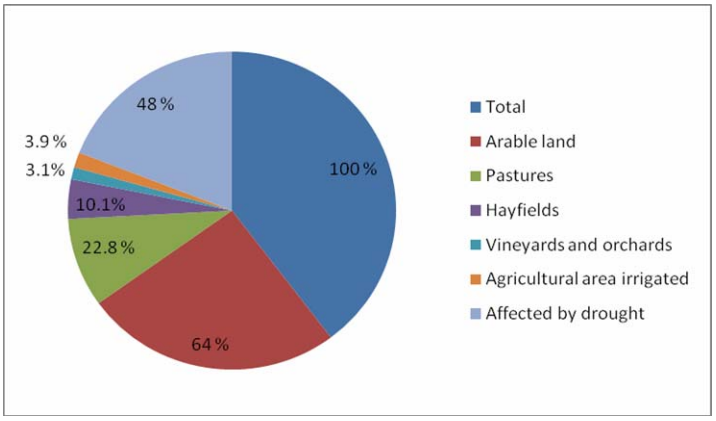



Figure 4. Agricultural land use and areas affected by drought

The intensity of the drought is dependent on soil, relief and groundwater depth land characteristics, too. Therefore, the well developed soils with medium texture, absence of skeleton, high water retention capacity and available water for cops are less vulnerable to drought than extreme sand, clay or skeleton soils with short soil profile depth, having salinisation problems and low soil water capacity. The slope relief increases the vulnerability of the land to drought induced processes due to water losses by runoff. This vulnerability of slope areas is reduced if the groundwater depth is in the range 1-3 m.

Considering these aspects in the drought affected area of Romania most of the soils have a small or moderate vulnerability to drought.

Land with high vulnerability to drought (mainly sandy soils with very low available water capacity placed in South Romania) is suitable only for irrigated agriculture.

These areas are less than 3 % of the drought-affected areas.

Droughts, without a very distinctive periodicity, are repeated for 12-15 years interval.In this interval are some extreme drought years and 1-3 years breaks with years with enough rainfall. In Romania extreme droughts were recorded in the following intervals:

Extremely droughty agricultural years in the XXth century:

- Decade 1901-1910: 1907-1908
- Decade 1911-1920: 1917-1918
- Decade 1921-1930: 1923-1924, 1927-1928
- Decade 1931-1940: 1934-1935
- Decade 1941-1950: 1945-1946, 1947-1948, 1949-1950
- Decade 1951-1960: 1952-1953
- Decade 1981-1990: 1982-1983,1985-1986, 1987-1988,1989-1990
- Decade 1991-2000: 1992-1993, 1999-2000

Extremely droughty agricultural years in the XXIth century:

- Decade 2001-2010: 2001, 2002, 2003, 2007, 2009

In this interval the drought affected area was higher than for the previous drought periods. From a hydrological point of view the drought periods with low river flows are more frequently and shorter than the meteorological drought. Therefore, such periods were recorded in 1894-1900 and 1961-1965 in Transilvania, and 1943-1952, 1958-1964 and 1982-1993 in Oltenia, Muntenia and Moldova regions.

Drought has a negative impact on forest areas changing the areal of various tree species, moving the limits of vegetation zones (moving North and West of the silvo-steppe) and penetrating in the South area of Romania of some Saharian species.

Very sensitive considering the existence, conservation and evolution of forest vegetation and landscape with negative influences on socio-economic human activities are the hill and plain areas where the synergic negative effect of severe climatic fluctuations (with extreme drought periods), fragility of the litology and small areas covered with forest is increased.

In this respect the most affected counties are placed in South and East Romania (Dolj, Olt, Galati, Braila, Ialomita). In this area the phenomenon of tree drying up is significant affecting the forest ecosystems: mainly with sessile trees in the plain area and willow and poplar trees in the inside- river meadows. The dramatic decreasing of the forest areas in the South and East Romania affects not only the socio-economic sector but induces the decreasing of a very important live-barrier in the way of penetrating to the Central part of Europe of Euro-Asiatic steppe.

When drought begins, the agricultural sector is usually the first to be affected because of its heavy dependence on stored soil water. Soil water can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, then people dependent on other

sources of water will begin to feel the effects of the shortage. Those who rely on surface water (reservoirs and lakes) and subsurface water (ground water), are usually the last to be affected.

A short-term drought that persists for 3 to 6 months may have little impact on these sectors, depending on the characteristics of the hydrologic system and water use intensity.

When precipitation returns to normal and meteorological drought conditions have abated, the sequence is repeated for the recovery of surface and subsurface water supplies. Soil water reserves are replenished first, followed by stream flow, reservoirs and lakes, and ground water.

Drought impacts may diminish rapidly in the agricultural sector because of its reliance on soil.

*Effects of Drought on Soil/Sediment*

The primary drought effect on soil and sediment is increased sheet erosion due to the loss of plant roots and wind. Brief thunderstorms remove soil from exposed ground surfaces, including channels. The increased deposition of sediment on deltas and into rivers increases turbidity that affects fish habitat.

The loss of farm soil causes long-term loss in farm production, even after the drought is over.

Wildfires remove vegetation, enhancing the potential for sheet erosion and soil removal. Soil is baked from wildfires, perhaps making them impermeable. Wildfire impacts create greater potential for debris floods and flows and for flash floods.

*Effects of Drought on Surface and Ground Water Levels*

Rivers and lakes drop to low levels during drought, while turbidity and salinity increase, affecting fish habitat. Mountain animals have less to drink and migrate to wetter areas or to places of water concentration.

Ground water levels drop and spring flows decrease. Deeper aquifers may not be affected until some years later, if at all. Wetlands can become dry until moisture returns. Soil moisture can decrease, killing even the deeper plant root systems.

Primary and secondary water systems lose pressure, creating potential for cross-connection contamination and potential illness. Low community water pressure makes firefighting difficult. More frequent wildfires may burn deeply, damaging root systems and future plant growth.

*Effects on the Air*

Air can become dry, warm, and dusty, further desiccating the soil and increasing evaporation from bodies of water. Respiratory ailments increase.

Winds enhance sheet erosion from dried soils. Fields, yards, flower beds, and gardens become dry and parched, enhancing the potential for field and yard fires. Dust storms decrease visibility.

More common wildfires will place smoke, ash, and dust into the air.

Lack of precipitation and humidity increases concentration of dust and pollutants in air.

*Effects on Wildlife and Plants*

Ecosystems depending on soil moisture or the presence of open water become damaged. Fish and game habitat is reduced. If soil is lost due to wind, then damage may be semi-permanent. Wetland and riparian animal and plant life are displaced or die.

Mountain burn areas damage game habitat and forage.

*Effects on Economical field*

Droughts cause hardship on many different sectors of an area's economy. Multi-generation farms may go under financially. In the community, agriculture-dependent businesses conduct less business and lose money.

Significant effects are not only felt in the agriculture-related sector. Tourists may be reluctant to visit drought-affected areas, reducing another source of community income.

Use of forests for recreational purposes may be discouraged because of fire hazards. Water based recreation may also decrease. Businesses relying on these activities will suffer.

Generally, in most sectors, people suffer economically, with some facing the potential for serious financial hardship.

Economic drought impacts are also influenced by many different sectors, including local households, businesses, and the community, as well as state and national policies and organizations. In addition, each of these entities and levels may influence the economic impact on the other sectors.

*Effect on Social life*

Mental and physical stress (e.g., anxiety, depression, loss of security, domestic violence).

Reductions in nutrition (high-cost, food limitations, stress-related dietary deficiencies). Loss of human life (e.g., from heat stress, suicides).

Reduced quality of life, changes in lifestyle, increased poverty in general, population migrations (rural to urban areas).

## CONCLUSIONS

Climate is the ensemble of meteorological processes and phenomena specific to a geographical region.

In Romania the negative consequences of natural hazards and of the climate changes have an increasing effect.

Soil degradation processes and drought affect large areas in the south of the country with very negative economic consequences.

Limiting the area of forests, ecological non-equilibrium and destructuration are the causes for the amplification in the last times of flooding, landslide and other land degradation processes (in the firstplace water and wind soil erosion).

The management and sustainable development decisions should aim to specialize the agricultural production by growing in each region the appropriate crops that have the largest benefit from the natural potential for agriculture, which is evaluated through analysis of pedo-climatic conditions.

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