



# The Implications of Climate Changes over Agriculture

Mioara CHIRITA\*, Daniela Ancuta SARPE\*\*

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## ABSTRACT

Climate change presents a great importance in all sectors of the economy, but the agricultural sector is directly influenced by them. These changes have different causes and effects, but the agriculture is known to be a strategic and dynamic sector, which is considered also difficult and a priority of the economy. The higher crop yields guarantee prosperity, economic and financial growth for many countries in the world. The paper aims to develop an overview on the implications of climate changes in agriculture over the last few years in Europe.

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## 1. Introduction

The implications of climate change have direct or indirect effect over the forests, the water resources, tourism, industry, health, and not least of agriculture. Climate change research starts from the need for monitoring the changes that occur more frequently and more obvious on different sectors of life, economy and natural resources. In the last years the socio-economic analysis of climate change has become a topic of intensive study for many researchers.

Therefore it was observed that in the last 80 years, the temperature rise in Europe by almost 1 °C, faster than the world average which was 0.7 °C, noticing a sharp increase in the last 50 years. Although it seems more a 1 °C increase, this trend has had a significant impact on many physical and biological systems, which over time have become increasingly fragile.

Due to extreme weather events that have increased greatly in recent years, the temperature has become more extreme and brings more economic losses. Was reported an important increase regarding to rain and snowfall in northern Europe causing more frequent floods compared to southern Europe, where rainfall decreased considerably and droughts are frequent. [1] [2]

These increases of the temperature, floods, droughts and storms have seriously affected the agricultural sector of many countries. This paper aims to highlight the implications of climate changes over agriculture.

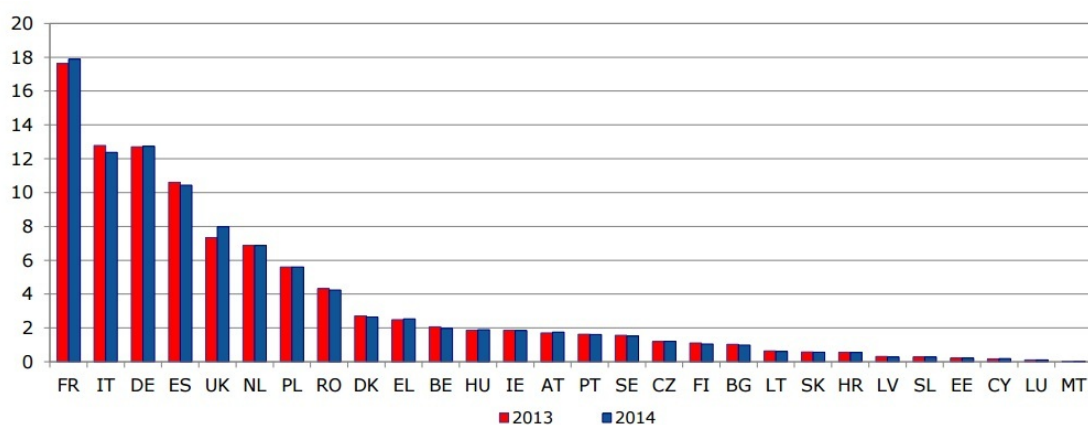
## 2. The importance of the agricultural indicators in Europe

Agriculture and the agro-food sector is the largest sector in Europe, providing 6% (46 million) of total employment, and climate change affects many sectors but the agriculture is one of the areas most exposed because of its dependence on weather conditions. They affect all the Europe first of all because the farms, farmland and forests occupy approximately 90% of the EU. Due the climate variability from year to year this became one of the major causes of crop yield variables and also one of the inherent risks of farming. Agriculture is therefore the forefront in the battle against climate change. Combating the climate change and preserving the biodiversity are the attention of majority of developed countries. [3]

Climate change affects agriculture globally and experts believe that even small increases in global warming will reduce crop yields and will lead to greater efficiency in low latitude regions. The negative effects on agricultural yields will be exacerbated by the frequent extreme weather events (such as floods, heat waves and drought). Family farmers and subsistence farmers will be particularly affected first of all because their adaptive capacity is less. It is expected growth the risk of famine, particularly in the warmer zones most of the year. [4]

The output of agricultural industry in EU-28 for 2013 and 2014 years is highlighted in the following figure:

\*, \*\*, Faculty of Economics and Business Administration, "Dunarea de Jos" University of Galati, Romania. E-mail addresses: mchirita@ugal.ro (M. Chirita), dsarpe@ugal.ro (D. A. Sarpe)



Source: [5]

**Figure 1. Output of agricultural industry in EU-28 (in %)**

The economic evaluation of the various effects of climate change is a difficult task because it requires the interdisciplinary knowledge in several fields. [6]

However, in the last years began to notice an increase in the involvement of researchers in the field of agricultural production forecasts as a result of climate change. This increased interest has as a starting point that climate change has become increasingly more pronounced and direct impact on agriculture, and thus the different sectors that have correlation with this, it has become increasingly evident. The researcher's economists appeared interest in the development of analysis, forecasts and highlighting of correspondence between climate change and the proportion and how they affect agricultural production. The Romania indicators are presented in Table 1:

Romania	2010	2011	2012	2013	2014
<b>Output of the agricultural industry (% of GDP)</b>	12,3	13,7	11,0	12,5	11,3
<b>Agricultural output prices (index, 2005=100)</b>	85,1	89,2	91,7	86,3	79,1
<b>Agricultural input prices (index, 2005=100)</b>	94,5	98,1	99,8	95,9	91,5
<b>Agricultural income (Indicator A) (index, 2005=100)</b>	97,1	122,2	157,5	123,0	134,0
<b>Agricultural employment (% of total employment)</b>	31,6	30,0	30,5	30,0	-

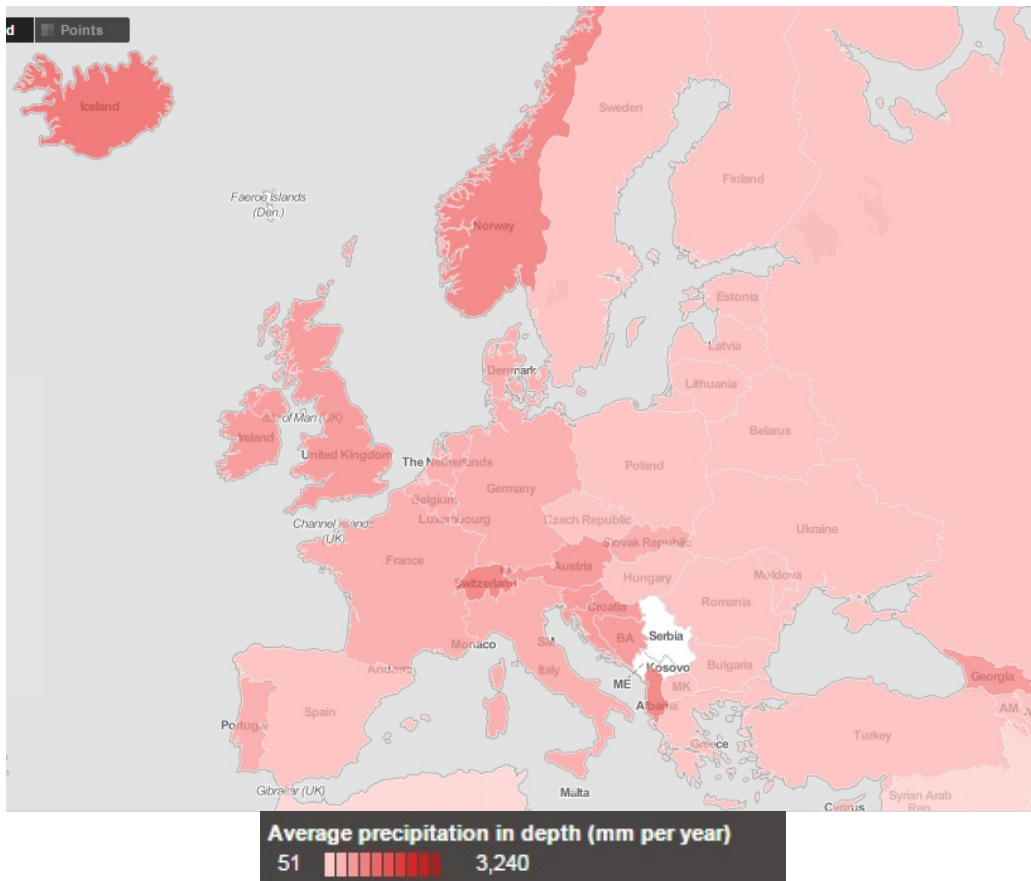
Source: [5][7]

**Table 1. Agricultural indicators for Romania (2010-2014)**

Several research carried out in the last ten years have highlighted the analysis of the distribution, intensity and frequency of rainfall, current dynamics analysis to forecasting trends of evolution by identifying areas in Romania where rainfall occurs more intense aggression, and thus proving the usefulness of both theoretical and practical. Meteorological data on rainfall widely used come from weather stations located in all the major agricultural perspective and relief of Romania for climatological periods. Rainfall are an important climatic variability characterized by spatial-temporal high largely responsible for triggering and further development of agricultural production. The energy that contain rainfall is divided into two, the kinetic energy of rainfall that is their striking force with direct role in the destruction of the surface soil aggregates and their potential energy, energy drain on the slopes and in whites. [8] [9]

According to recent researches the annual precipitation records averaged across Europe show no significant changes since 1950, but there is a general increase in annual precipitation in Northern Europe and a decrease in Southern Europe. [10]

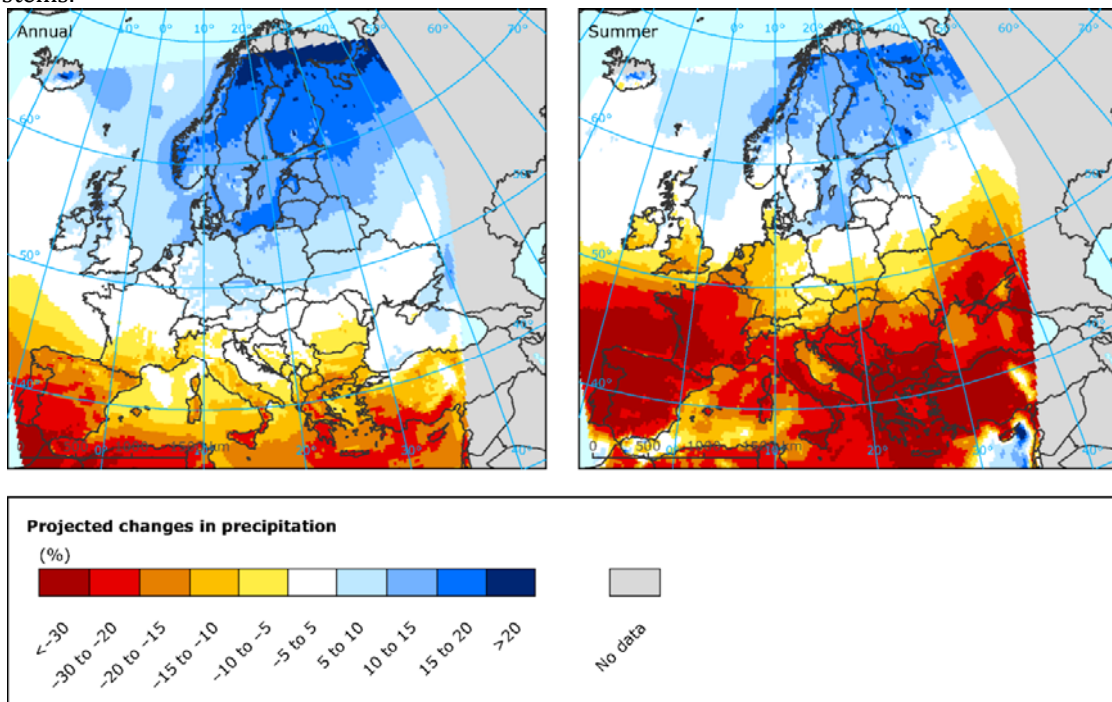
The annual average changes are between 10% and 20% in Northern Europe and between -5 to -20% in southern Europe and the Mediterranean, as it is presented in Figure 2. Forecasts for summer precipitation show a decrease in south, central and north-west, which can reach up to 60% in parts of southern Europe, and the rainfall will remain constant or will tend slight growth of northeast Europe as its highlighted in Figure 2 .



Source: [11]

**Figure 2. Average precipitation in depth in Europe (mm per year)**

In Figure 3 are evidenced the changes in annual and summer precipitation in Europe. The precipitations play a vital role in all sectors, including agriculture, water supply, energy production, tourism and natural ecosystems.



Source: [12]

**Figure 3. Changes in annual and summer precipitation in Europe**

Like other countries, Romania is not immune to climate change. In Romania, 2007 was the warmest year in the last two decades (with an average temperature of 11.5 °C), while the lowest average temperature (8.4 °C) was recorded in 1985. In 2005 Romania was affected by historic floods, which caused 76 deaths and significant damage to property, and 2007 brought the country's worst drought in 60 years. The effects of these extreme weather events have affected the country which suffered significant economic losses in agriculture, transport, energy supply and water management. For a 4 °C global warming, climate change impacts will certainly lead to the worsening situation in Romania. Therefore, adaptation to climate change and reducing emissions of greenhouse gases are important priorities for Romania. [13]

EU regions are increasingly feeling the adverse effects of climate change, but some areas will be more affected than others. Southern Europe and the Mediterranean basin will experience the combined effect of high temperature increases and reduced precipitation. Different research shows that there are also particularly vulnerable mountain areas densely populated alluvial plains will be threatened by the increased risk of storms, intense rainfall and sudden floods. [14] [15] [16] [17]

### **3. Models in order to predict the climate evolution**

The researcher community has been carried out some models in order to predict the climate evolution. One such model realized a scenario according to which in Romania will register an average increase in temperature of 1.5 °C over the period 2021-2050 to 1961-1990 and a 3.8% decrease in precipitation. The largest temperature increases occurring in the South, Southeast and Southwest, and generally in the months of autumn and winter. Rainfall in mostly will fall into these regions, especially in the summer months (in some counties touching a drop of nearly 30%). [18]

Several studies on this issue have shown that climate change - and its impact on how the population produce and consume - is increasingly closer to the center of sustainable development policy. They are therefore central to regional development, representing an unprecedented challenge, but also an opportunity for European regions in terms of their ability to innovate and create new jobs. [19]

Climate changes observed in recent decade's developments raise the question of assessing climate in decades and even century's probable future with mathematical models of climate. The complexity of the climate system, the different nature of its component parts and the interactions require the use of extremely complex numerical models, but which are based on systems of equations associated with the laws of physics. The influence of anthropogenic factor introduces uncertainty over the evolution of greenhouse gas emissions in the future. Various studies have helped refine the projection methodologies about temperature increases signals. They were used statistical modeling methods applied global climate model results and achievement of numerical experiments with regional climate models and analyze their results reported with observed data regarding the global climate signals.

Analyzing data recorded in recent years by the National Environmental Protection Agency, will certainly be significant impact on the world economy and Romania in the coming years in terms of climate change.

In Romania, the agricultural sector, which plays an important role in the national economy, is one of the sectors most affected, but is characterized by large territorial differences that cannot be negligible at decision-making levels.

The total area of agricultural land in Romania is 15.9 million hectares, of which about 13.3 million ha (about 56% of the total) are currently used. Around 1.5 million hectares of agricultural land use are covered by irrigation systems viable / marginal economically viable, although, at present, only 800,000 ha they are functional. Compared to other EU countries, the agriculture and rural development sector in Romania is an extensive, occupying 59.8% of the total and providing a home for 44.9% of the total population. A relatively large part of the national gross value added (32.4%) and employment (41.5%) is also generated in rural areas.

South Region has the largest area of agricultural land in the country, totaling 2,432,301 ha, of which 1,965,228 ha arable 288,019 ha pastures, meadows 108,419 ha, 28,817 ha of vineyards, orchards 41,818 ha. Arable land occupies the largest agricultural area - 80.79%, 11.84% followed by pastures, hayfields 4.46%, 1.18% live and orchards 1.72%. Given the considerable potential of the region, the opportunities to develop the agricultural sector consists mainly in efficient use of water resources in agriculture, irrigation system rehabilitation and adequacy farms. Investments in this sector would ensure sustainable and effective practice of agriculture in terms of productive and would support the rural population of the region, but in sight of the need for risk assessment regarding climate change and its consequences on agricultural production.

In terms of functional specialization of agriculture in the south area of the country identifies four counties that have a natural and economic potential of agriculturally developed. Giurgiu is predominantly based on agriculture, wheat, corn, sunflower, barley, soy and canola, processing vine. Teleorman has a grain-based agriculture (wheat, rye, barley, and corn), legumes (peas, beans), and sunflower, soybean, canola and forage plants. In Calarasi county agriculture is a basic sector of the economy, known as the large amounts of grain production (rye, wheat, and barley), sunflower, and forage plants. In Ialomita predominant crops are the wheat, rye, barley, maize and sunflower.

Although it is predicted increases in wheat crops in the southeast, researchers generally recognize extreme events as significant risk factors. Based on certain annual reports drought affected areas have expanded in recent decades in Romania, the most exposed territories being in the southeast. Thus, droughts and floods will lead to losses in agriculture. [20]

According to some studies most vulnerable to crop appears in field of Muntenia and Dobrogea, and lowest in the northern and central parts of the country. [21]

The data analysis from several meteorological stations highlighted an intensification of droughts in the south of the country after 1960. Consistent with this result has been increasing the maximum duration of the intervals without rainfall in the southwest (winter) and west (summer). Following a more pronounced warming in summer in the southeast, with a tendency to aggregate deficit more pronounced, there was an intensification of aridity phenomenon in this region. For some regions had an increase in the annual frequency of very rainy days (highest 12% daily quantities) and extremely rainy (the highest 4% daily quantities). [22]

The agriculture and rural development in Romania is put in danger by climate change. Due to the characteristics of agriculture as emitter of greenhouse gases and contribution to climate change mitigation the objectives for future of the Europe should be close related to develop the agriculture. On the other hand, agriculture and rural development sector is extremely vulnerable to impacts of climate change since the ability to provide an adequate supply of food to provide services to ecosystems, to support growth and to ensure a safe environment for rural communities living depends directly on favorable climatic conditions.

## Conclusion

Various studies and models based on meteorological data and information on agriculture have been developed with the idea to preventing problems related to rapidly changing and unpredictable climate.

Although it is difficult to predict both meteorological data and others immediate threats to the agriculture, various organizations and organisms around the world engage in these laborious research. In analyzing the implications of climate changes over agriculture there are numerous techniques of economic evaluation of the effects of climate change, which are based on estimating the effects due to the high degree of uncertainty in climate projections. Controlling global warming will require efforts from all nations, coordinated globally.

Agriculture and rural development sector in Romania is a diverse and complex sector with a high degree of variability in terms of socio-economic and human capacity. It is a sector with a seriously uncertainty and significant problems in relations with tackling climate change. Romania can reduce the effects of the climate changes over the agriculture by actions in accordance with the predictions based on models developed by researchers.

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