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DROUGHT IN ROMANIA. EFFECTS AND ADAPTIVE STRATEGIES

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Abstract

Climate change is manifested by increased average temperature and reduced precipitation amounts, that determined in recent decades, a growth in drought affected surfaces in our country and worldwide with repercussions on economically, socially and environmentally development. This creates one of the largest challenges facing humanity due to its disastrous effects: increasing air and water temperature, increased risk of floods, drought, drinking water depletion, increased risk of fires that reduce vegetable and animal natural resources and leads to degradation of ecosystems.

Key words*: Climate change, temperature, precipitation, drought, effects, adaptive strategies.*

INTRODUCTION

Global climate change generates some of the greatest challenges facing humanity at present, due to the disastrous effects induced by increased air and oceans temperature, increased risk of floods, droughts, water shortages, increased risk of fire that reduce vegetal and animal resources, changes in ecosystems and natural resource degradation, increased risk of illness. In Europe, climate change affects all regions of the continent, and the effects of these changes are increasingly visible in our country, where in recent years there have been disastrous events of great magnitude, such as heat and drought, rainfall and catastrophic floods, extreme weather phenomena (tornado type), alteration of traditional seasons. All these disasters have made a strong impression on the socio-economic life of our country registering many casualties and considerable property damage among the population, and at community level, in terms of economic units and social infrastructure.

Climate warming is a phenomenon widely accepted by the international scientific community, as already pointed out by analyzing observational data over long periods of time.

Addressing the effects of climate change is a priority in the strategic development of the EU member countries and beyond.

MATERIALS AND METHODS

Modelling climate and projected changes in climate is a resource-intensive research activity, usually involving supercomputers and a multidisciplinary approach. These disciplines range from socio-economics (scenarios), to computing, physics, chemistry (climate models) and Earth and life sciences (impact models), as well as statistics and probability (analysis). To set up and run a climate "experiment", using a computer model to simulate 100 years of climate evolution on a global scale, can take weeks or months. Analysis of the results takes even longer.

THE WCRP CMIP3 MULTIMODEL DATASET

A New Era in Climate Change Research

The history of climate change modeling was first characterized in the 1980s by a number of distinct groups developing, running, and analyzing model output from their own models with little opportunity for anyone outside of those groups to have access to the model data.

The down-scaled climate model information will help to contribute to the proper depiction of meteorological forcing mechanisms responsible for extreme precipitation events. Understanding these contributing variables to extreme precipitation events and how they might change under future climate conditions is

important to assessing the potential risks of more frequent or more intense storms. Furthermore, identification of regions with increasing/decreasing potential for extreme rainfall events could serve as an important decision-making consideration for future planning.
In response to a proposed activity of the World Climate Research Programme's (WCRP's) Working Group on Coupled Modelling (WGCM), PCMDI (Program for Climate Model Diagnosis and Intercomparison) volunteered to collect model output contributed by leading modeling centers around the world.
Climate model output from simulations of the past, present and future climate was collected by PCMDI mostly during the years 2005 and 2006, and this archived data constitutes phase 3 of the Coupled Model Intercomparison Project (CMIP3). In part, the WGCM organized this activity to enable those outside the major modeling centers to perform research of relevance to climate scientists preparing the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC). The IPCC was established by the World Meteorological Organization and the United Nations Environmental Program to assess scientific information on climate change.

RESULTS AND DISCUSSIONS

Drought definition

In 1977 Passioura said about drought tolerance that: „is like an unknown factor that keeps increasing the more you look at it". Drought can be defined as an extreme condition, characterized in that a region suffers from lack of water, accompanied by heat.
Drought can be classified as:
Meteorological drought - occurs over a longer period of time and is manifested by complete or partial lack of rainfall.
Agricultural drought - existence of a sufficient amount of water needed for agriculture (derived from rainfall or groundwater).
Hydro-geological drought - substantial decrease in the level of water (groundwater reservoir), the rivers and backwaters.
As *forms* of drought we distinguish: soil and atmospheric drought.
Soil drought occurs frequently at the beginning and during the summer, as a consequence of insufficient rainfall.
Atmospheric drought (lack of water in the atmosphere (10-20%).

How does drought occurs

The cause: deficiency precipitation, soil degradation, increasing ocean water temperature, increasing the concentration of carbon dioxide in the atmosphere. In recent years there is more and more talking about global warming, ozone decrease, greenhouse effect, catastrophic drought and its effects on nature and human life. Climate changes caused by humans are becoming increasingly apparent, and researchers agree that the main cause of this phenomenon is the burning of fossil fuels. The specialists point out that droughts and phenomena generated by it are caused by changes in the general circulation of the atmosphere, by the greenhouse effect and also by manifestation of some anthropogenic causes, due to wasteful use of resources, deforestation and changes in landscape with negative effects on the water balance.
Climate changes are presently a great concern worldwide. According to the 4th Report of IPCC, climate scenarios made with different global climate models, predicted an increase in global average temperature by the end of XXI century (2090-2099), compared to the period 1980-1990, between 1.8ºC and 4.0°C, depending on the scenario considered for greenhouse gases emissions. At the same time major changes of rainfall regime are expected, as well as an increased frequency of extreme weather events.
These patterns of climate change conclude the following effects:

- temperature across Europe increased by nearly one degree Celsius, more than the overall rate of warming (0.74°C);
- currently, the concentration of greenhouse gases in the atmosphere exceeds the values recorded in the last 650,000 years and projections indicate an unprecedented increase;
- by 2100, global temperature will be higher with 6.3°C, and ocean levels will rise with approximately 58 cm;
- the frequency, occurrence and intensity of

extreme weather events (storms, tornadoes, hurricanes) has been increased;
- regional patterns of climate and rainfall (heat waves, droughts, floods) have changed, and trends indicate a gradual increase in the coming years;
- decreased thickness of Arctic glaciers and the area occupied by them (by 40% over the last 30 years), possibly their complete disappearance until 2100;
- development of mutations in biosystems: Early flowering plant species, species extinction of amphibians etc.

Ecoclimatic change impact in ROMANIA

Romania has already suffered important climate modifications in the last years.

The complexity of the climate system, the different nature of the components that compose it (atmosphere, ocean, cryosphere, biosphere, lithosphere) and the interactions between them, require the use of highly complex numerical models, which are based on systems of equations associated with the laws of physics. Influence of anthropogenic factor introduces uncertainty over the evolution of greenhouse gas emissions in the future.

Romanian researchers' studies have helped refine the region projection methodologies in order to predict global warming. Statistical modeling methods were used and applied to global climate model results (Figures 1, 2, and 3) and conducting numerical experiments with regional climate models and analyze their results together with observed data in order to highlight the mechanisms by which local factors modulate climate changes (Figure 4).

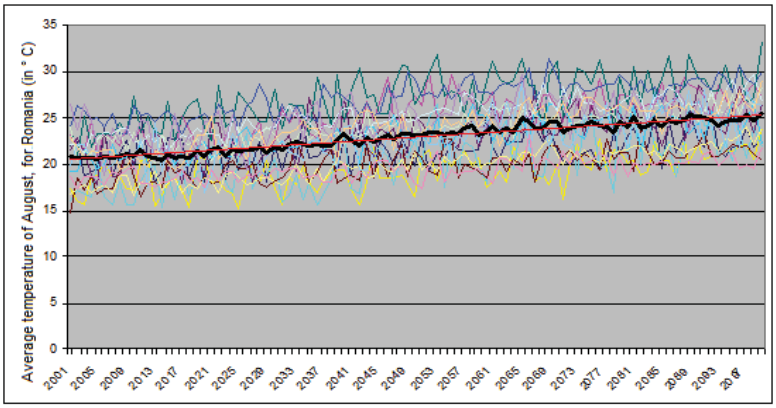

Figure 1. Progress regarding the average temperature of August, for Romania (in °C) for 16 climate models and ensemble average (black); tendency for multimodel average (red line). A1B scenario is used and it shows the averages of 17 climate models extracted from the CMIP3 database

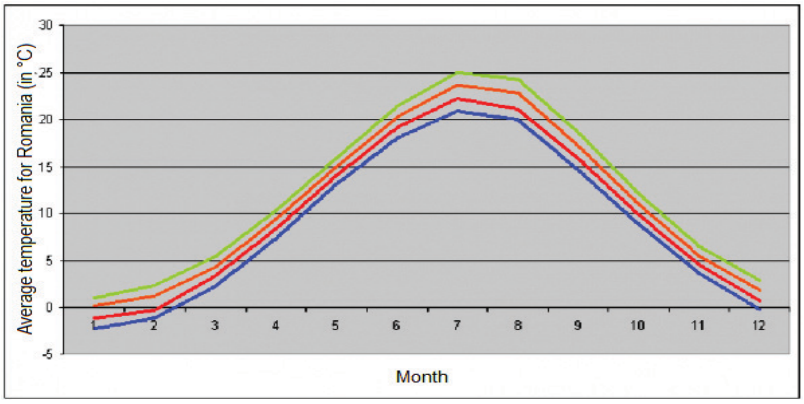

Figure 2. Seasonal cycle of temperature for the corresponding intervals between 1961 and 1990 (blue), 2001-2030 (red), 2031-2060 (orange) and 2061-2090 (green) average temperature for Romania (in °C). A1B scenario is used. The averages of 17 climate models were used and extracted from the CMIP3 database

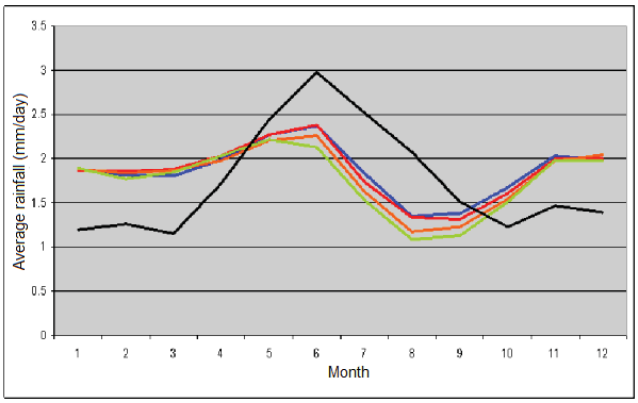

Figure 3. The seasonal cycle of rainfall for appropriate intervals 1961-1990 (blue), 2001-2030 (red), 2031-2060 (orange) and 2061-2090 (green) if the monthly average is analyzed for Romania (daily rate rainfall (in mm). A1B scenario is used. With black to represent the seasonal cycle of daily precipitation rate for Romania, calculated from the data of observation at meteorological stations. The averages of 17 climate models were used and extracted from the CMIP3 database

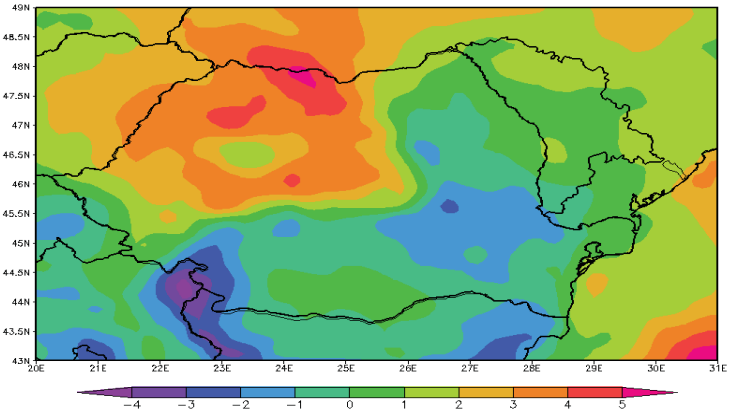

Figure 4. Change in annual rainfall amount estimated for 2001 to 2030 (in%) (reference period - 1961-1990) according to the A1B scenario. The results of a series of 11 experiments were used as stated by the regional climate models from FP6 ENSEMBLE project

Based on the research conducted by the National Agency of Meteorology, the future changes in regime of climate in Romania will fit into the global context, with specificity for the geographic region where our country is located. A warming similar to that projected for Europe, between 0.5°C and 1.5°C for the period 2020-2029 and between 2.0°C and 5.0°C for 2090-2099 is expected (Busuioc et al., 2010). In terms of rainfall, for the period 2090-2099, over 90% of forecast models, predicted drought during the summer in Romania, especially in the south and southeast, with negative deviations of more than 20% as compared with 1980-1990 (Christensen et al., 2007; Sandu et al., 2010).

Climate models simulate global climate system evolution under increased atmospheric concentration of greenhouse gases, based on the laws of physics using numerical methods. Climate scenarios are based on projections of rising global emissions of greenhouse gases and aerosols are subject to social and economic factors (population growth, economic development, technological change anticipated). A1B emissions scenario (IPCC, 2007) assumes a moderate increase in the concentration of greenhouse gases for the XXI century.

Romania will be basically divided into two distinct areas - northern half will be affected more by rainfall and low temperatures, while

the south will get high temperatures that will cause desertification in some areas.
Biodiversity, agriculture, water resources, forestry, infrastructure, energy, tourism and public health are just a few of the areas that will be heavily affected by these ecoclimatic changes.
Below we can see climatic weather scenarios for Romania. In the figure 5, the average of a set of numerical experiments was used with nine regional models, under A1B scenario (European FP6 ENSEMBLE project). In the figure 6 the average of a set of numerical experiments was used with nine regional models, under A1B scenario (European FP6 ENSEMBLE project).

EXTREME EVENTS AND WEATHER RELATED NATURAL DISASTERS following these climatic changes.
Drought and desertification affect sustainable development through interrelations with social problems and enhances them:
- heavy rains / floods, landslides, hail, lightning, ice, avalanches, storms, blizzards, droughts, heat waves, cold waves;
- reduction in water reserves, potential for food production and thus food security for the population;
- poverty, the most serious dysfunction in areas affected by these phenomena;
- deterioration of human health due to inadequate food consumption, generating anemia, malnutrition and malnutrition.

STRATEGIES FOR MITIGATION AND ADAPTATION TO CLIMATE CHANGE
Strategies that can be implemented to adapt to climate change are:
- developing integrated programs to reduce spoilage and anthropogenic influence on watershed geomorphology, preserving the natural flow and preserving biodiversity, conservation and restoration of natural areas in the sectors identified with risk floods;
- measures to increase the capacity of multiannual regularization of water flow;
- encouraging investment in hydrographic infrastructure; providing support to increase water use efficiency in agriculture and technological measures to adapt crops to become more resistant to drought and low amounts of water;
- promote land use management;
- promoting integrated information system for climate change adaptation;
- support measures in order to extend natural forest barriers (including forest plantations);

promotion of environmental friendly technologies in forestry activities.

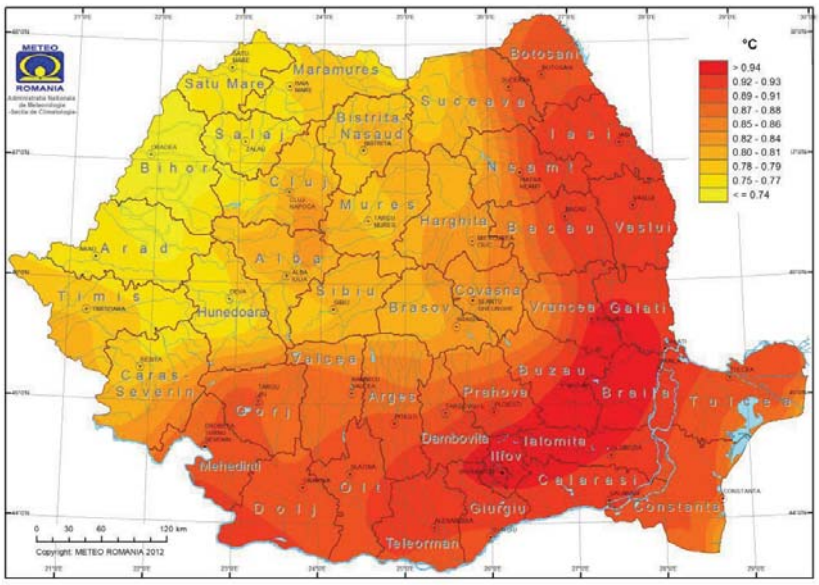

Figure 5. Average annual temperature increase (° C) between 2001-2030, compared to the reference period 1961-1990 (European FP6 ENSEMBLE project)

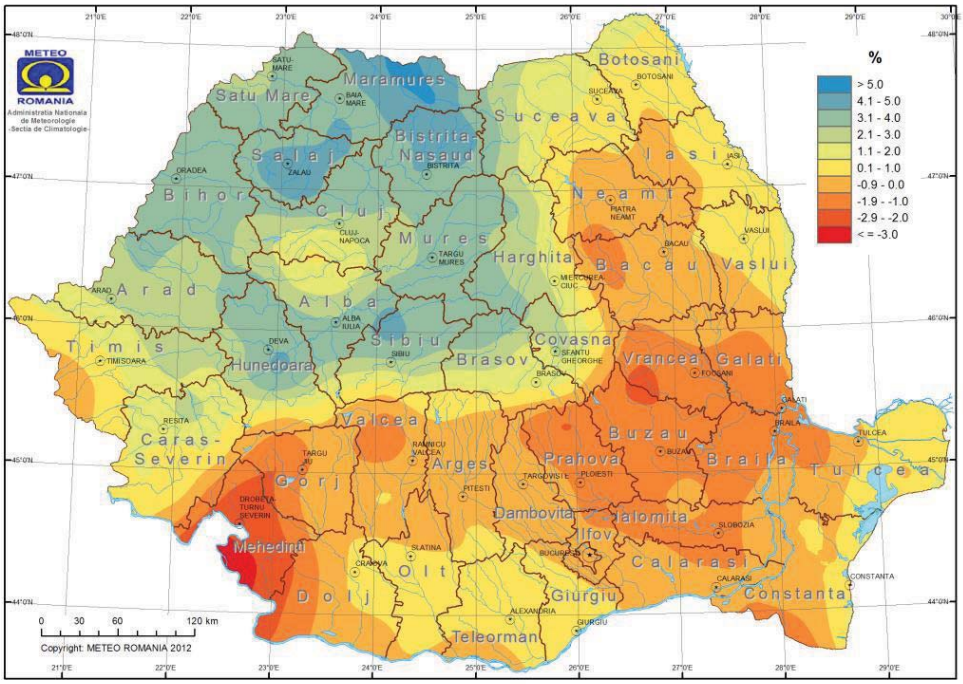

Figure 6. The difference in annual average precipitation amount (%) between the period 2001-2030 and standard climatological normal (for precipitation) (1961-1990) (European FP6 ENSEMBLE project)

CONCLUSIONS

Climate change affects the entire planet, with repercussions on the entire population, economically, socially and environmentally aspect. They provide one of the greatest challenges facing humanity at present, due to the disastrous effects induced by the increase of air and oceans temperature, increased risk of floods, droughts, diminishing drinking water supplies, increased risk of fire and reduction of plant and animal natural resources, changes and degradation of ecosystems and natural resource degradation, increased risk of ill health.

The effects of these changes are increasingly visible in our country. The Romanian climate has suffered and will suffer more radical changes that will impact many human settlements defining characteristics.

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