

CLIMATE CHANGE IMPACT ON WATER RESOURCES AND LIFE QUALITY

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ABSTRACT

The climate changes represent one of the major challenges in our century with major impact upon human being. This is the reason for which the study of the effects brought about by the climatic changes is one of the most current themes on international level.

According to the meteorological events of the last years, Romania will be one of the most affected countries by the climate changes effects. The purpose of this study is to assess the impact of climate changes on water resources and people's life quality as well as the elaboration of certain proposals regarding the improvement of the already existing problems in Romania.

Keywords: climate change, water resources, life quality, pollution

INTRODUCTION

Evidence that our world is warming has become stronger in recent years. Scientists have now confirmed that these changes are due to human activities (Halsnæs [1]). This century the average annual temperature in most of Europe has increased by about 0.8°C. Warming has been particularly great during the past two decades and in the middle to high latitudes. In the Alps, temperature increases have exceeded 1°C above the long term mean. Northern Europe has become wetter, but a region encompassing the Mediterranean and central Europe has become significantly drier (IPCC [2]).

Scientists of the Intergovernmental Panel on Climate Change forecast a 1°C-3.5°C increase in average global temperature by 2100. Although there is considerable uncertainty in forecasting regional and local changes in climate in Europe, it is likely that these observed trends will continue (IPCC [3], Christensen and Christensen [4]).

According to scientists, climate warming will lead to an increase in extreme climatic phenomena such as droughts and heat waves, but also violent rainstorms and flooding, thereby increasing pressure on water resources in already arid areas. The potential

impact of a global climate change on human health has been identified as a priority for research and action in the next century (Halsnæs [1]).

For Romania, the climate change effects are multiple and alarming concerning the: ecosystems, human settlements, agriculture, water management etc. The aim of this paper was to assess the impact of climate changes on water resources and people's life quality as well as the elaboration of certain proposals regarding the improvement of the already existing problems in Romania.

CLIMATIC CHANGES PRESENT IN ROMANIA

The observations and measurements done in Romania concerning the climate parameters and the climate effects on water resources show certain signals which sustain the hypothesis of climate change.

According to National Institute of Meteorology and Hydrology, the expert climatologists underlined an average warm in the country of 0.3°C, stressed in the Eastern part of the country (0.8°C to Bucharest-Filaret, Constanta and Roman stations), where this heat is significant from the static point of view. In the intra-Carpathian region the heat is not significant excepting that recorded at Baia Mare where a level of 0.7°C, indicates the influence of the antropogenous factors (the industrial activities in the area). From the pluviometric point of view, it has been underlined a tendency of reduction of the yearly amounts of precipitations, more stressed in the center of the country, with slight increases in the NE and some regions of the south.

It is an extraordinary privilege for Romania to have still four seasons (spring, summer, autumn, winter). But, because climate change, those four seasons long for two seasons (summer and winter). The winters in Romania will become less harsh, with higher temperatures and a reduced snow layer. The changes signal is more powerful in the extra-Carpathian regions. Although there are fluctuations from one winter to another and we note the tendency to have warmer winters, it does not mean that every winter will record higher and higher temperatures.

Romania is often confronting nowadays with floods, tornados and even with the desertification process. The climate changes caused by excessive pollution are already affecting the Romanian citizens' way of life. In what follows, there are illustrated some of the most important climate changes in our country.

Tornados

The first tornado officially mentioned in Romania was in 1886. In the next years some others were registered. In the last few years, Romania has been more and more often hit by strong winds with the force of a tornado (Lemon et al. [5]). The most powerful

tornado in our country was the one from Facaieni on the 12th of August 2002. This was described by the local people - that had never seen something similar before in the real life - to look like a “snake” or a “funnel”. The phenomenon, considered by the specialists to be a tornado, affected 1500 people, from who 3 lost their lives, destroyed 420 households and cut off the trees from the nearby forest. After this tornado, the occurrence frequency of such phenomena increased. While in 2002-2004 only 4 storms like these occurred, in 2005 there were 9 tornadoes in only 7 months! This should determine every citizen of this country to think about the consequences of the climate change.

Drought

The years of 1945-1946 were considered the most violent referring to the drought until 2000. Even though, recent studies have proved that the year of 2000 can be considered even more droughty (Tuinea et al. [6]).

Sahara moves to Dobrogea! According to the specialists, Dobrogea has big chances to become a desert like Sahara in the next 100 years. This phenomenon began almost two years ago. The affected area has about 20 km and extends even in Bulgaria. Here, the flora has drooped, the soil has become barren, and the fertile area was swept by the winds. If serious measures will not be taken, the phenomena could extend in the entire Dobrogea (Tuinea et al. [6]).

Floods

Other consequences of the climate changes in Romania are the floods, the number of which has increased amazingly in the last years. Chronicles weather recorded with regularly catastrophic floods: 10 in the XVI century; 19 in XVII century; 26 in XVIII century; 28 in the nineteenth century; 42 in the XX century. The floods affected almost all the regions of our country, especially those along the Danube course (Ciobanu et al. [7]). In 2000 Romania, Bulgaria, Ukraine and Moldavia agreed on “The Declaration for creating a green course of the Danube”, sustained by WWF (World Wide Fund). The project sustained the idea of working with the nature, not against it by enlarging the Danube’s riverbeds and draining the floodable plains for agriculture. Unfortunately, only 6% of this project was realized.

2005 was a disastrous year when six catastrophic floods were produced on the Romanian territory. The floods reached historical ranges on various rivers like: Ramnicu-Sarat, Putna, Trotus, and the biggest in April on Timis and Bega hydrographic basins. Moreover, 76 people died and 1734 settlements were affected. In 2006 the biggest flood on Danube occurred during April – May months, when the maximum flow was 15800 m³/s. The most barren region of our country, Dobrogea, was as well flooded many times.

The Black Sea - phenomena caused by the climate changes

The Black Sea has a very deep basin, with a maximum depth of 2200 m. The Black Sea's alimentation zone covers, partially or totally, 23 states from Europe and Asia Minor. There aren't any tides at the Black Sea, but the river flows, evaporation/precipitations and other drains through Bosphorus Strait vary each season and produce oscillations of the sea level with an increase of 10 cm.

Modern altimeters from space make possible the observation of the medium sea level over the whole surface of the basin (Korotaev et al. [8]). The global heating affected the sea level. The Black Sea level increased with 34 cm during period 1860-2004.

The medium monthly information shows that the Black Sea had suffered a significant heating process during the 90s (approximately 2 degrees Celsius between 1993 and 2001) (Figure 1.)

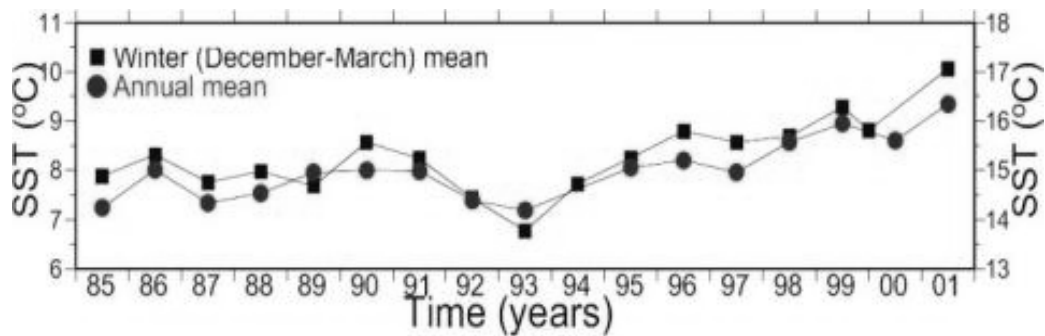


Figure 1. Black Sea' temperature evolution over the last decades (Oguz et al. [9])

Heat waves

Strong heat wave has hit Romania in the summer of 2007. The southern and western parts of the country were currently facing temperatures of over 38°C-40°C daily which lasted 14 days, is another likely sign of global warming. High heat combined with high UV radiation lead to health crisis and threat to life. As a consequence of high heat, more than 30 persons died and 19,000 people have been admitted to hospitals. Romanian Red Cross conducted several water distribution operations, in partnership with local city halls and prefect's offices. The heat and dry conditions sparked a rash of fires causing deaths too. In Romania two people died and 26 were injured.

These negative influences of the environment and the results of irrational human activities show an alarming dynamics, which has repercussion on the health and life of the human being.

THE EFFECTS OF THE CLIMATIC CHANGES UPON THE WATER HUSBANDRY

Although the IPCC projects that global warming of several degrees will lead to an increase in average global precipitation over the course of the 21st century, this amount does not necessarily relate to an increase in the amount of potable water available.

One reason is a decline in water quality from an increase in runoff and precipitation that carries with it higher levels of nutrients, pathogens and pollutants. These contaminants were originally stored in the groundwater reserves but the increase in precipitation flushes them out in the discharged water.

Similarly, when drought conditions persist, and easily recoverable groundwater reserves are depleted, the residual water that remains is often of inferior quality due in part to the leakage of saline or contaminated water from the land surface, confining layers, or adjacent waters that have highly concentrated quantities of the depleting element(s). This occurs because decreased precipitation and runoff results in a concentration of effluent in the water, which leads to an increased microbial load in waterways and drinking-water reservoirs.

One of the most significant sources of water degradation results from an increase in water temperature. The increase in water temperatures can lead to a bloom in microbial populations, which among other things can have a negative impact on human health (Confalonieri et al., [13]). Additionally, the rise in water temperature can adversely affect different inhabitants of the ecosystem due to a species' sensitivity to temperature. The health of a body of water, such as a river, is dependent upon its ability to effectively self purify through biodegradation, which is hindered when there is a reduced amount of dissolved oxygen. This occur when water warms and its ability to hold oxygen decreases.

From a national perspective, our understanding of the impact of climate variability and change on water resources, in terms of availability, vulnerability and sustainability of fresh water, remains limited.

The hydrologic consequences of the CO₂ concentration increase in atmosphere are significant. Their pattern establishment was carried out in Romania, by emphasizing the main hydrographical basins. Scientific evidence suggests that climate change will result in more frequent and severe extreme events (floods and droughts) and that it will have long term effects on the availability of water in different regions in Romania as well as on the quality of water and water related ecosystems. Water quality degradation can be a major cause of water scarcity. Consequently, when precipitation events do occur, the contaminants are flushed into waterways and drinking reservoirs which has significant health implications.

The tendency of diminishment of the snow layer, already noted in the N and NE of the country and that might amplify in the future, causes certain issues in the management of the water supply, also in jeopardize by the effects of the climatic changes.

Water management needs to take these effects into account, and long term strategies need to be designed with a view to the vulnerability and the options for adaptation.

Effects on Coastal Populations

For coastal populations, water quality is likely to be affected by salinization, or increased quantities of salt in water supplies. This will result from a rise in Black Sea level (projected between 14 cm and 44 cm by the end of this century), which will increase salt concentrations in groundwater and estuaries. Sea-level rise will not only extend areas of salinity, but will also decrease freshwater availability in coastal areas. Saline intrusion is also a result of increased demand due in part to growing coastal populations that leave groundwater reserves increasingly vulnerable to contamination and diminishing water reserves.

THE EFFECTS OF THE CLIMATIC CHANGES UPON THE QUALITY OF THE PEOPLE'S LIFE

In Romania, the impacts of climate change on agriculture, forestry, and human settlements are a growing concern.

Effects upon the agriculture

Over the last decade, drought- and flood-related periods have become more frequent with negative effects on crop yields, in particular on wheat and maize crop. Like in many others countries in the south-eastern Europe, in Romania climate variability including extreme events result in high variability in crop yield levels with negative consequences on food supply and economy.

Some research studies have shown that during history drought events have caused yield losses up to 40-60%, especially in the southern part of the Romanian Plain (Tuinea et al. [6]). Also, in the extremely dry years, such as 2000, the largest water shortage and rainfall variability associated with high maximum temperature during the critical phases of maize crop (silking-grain filling) resulted in significant yield reduction up to 90% (Marica et al. [10]). Recent studies show that changes in climate predicted by global climate model HadCM3, SRES scenario A2, may have significant negative effects on water balance elements and maize yield (Marica & Busuioc [11]). It is becoming more and more evident that food supply in our country will be affected by future climate change, particularly in regions with high present-day vulnerability and little potential for adaptation, such as the southern part of Romania (Marica et al.

[10]). Not all current and projected effects of climate change are adverse; in some areas the agricultural sector may benefit from a temperature rise.

Effects upon the forestry

Almost a quarter of the surface of Romania is covered by forests which provide shelter for a large number of species and ecosystems. The impact of the climatic changes upon the forests in Romania was analyzed by means of more global climatic patterns. In the low and hilly it is estimated a considerable decrease in the productivity of forests after 2040 due to the rise of the temperature and the decrease in the amount of precipitation (NSCC [12]).

Effects upon the human settlements

The industrial, commercial, residential, tertiary and of infrastructure fields (including the water and power supplies, transportation and residues depositing) are vulnerable to climatic changes in various ways.

These fields are directly affected by the change of temperature and precipitation, or indirectly through the general impact upon the environment, natural resources and agricultural production. The fields most vulnerable to the effects of the climatic changes are the buildings, transportations, oil and gas exploitations; the tourism and the industries located in the coast areas. Other possibly affected fields are the food industry, wood procession, the textile industry, the production of biomass and of regenerative energy.

The damages of the catastrophic floods produced on the Romanian territory in the last few years were hardly covered by the Romanian Government in spite of all the donations and the collaborations of the Romanian citizens: people were isolated; agriculture terrains, national roads, wells, bridges, houses, electrical poles, all were seriously damaged; many people died and even more were injured.

Effects upon the human health

Climate change is likely to affect the health status of many people, particularly those with low adaptive capacity. Climate change is experienced most intensively through the impacts of extremes, rather than gradual changes. Impacts include river floods, droughts, forest fires, and human health problems due to heat waves.

Extreme temperatures caused the loss of life: people with heart problems were vulnerable because their cardiovascular system must work harder to keep the body cool during hot weather. Moreover, several serious diseases appear only in warm areas. Finally, warm temperatures can increase air and water pollution, which in turn

harm human health. The heat and dry conditions sparked a rash of fires causing deaths too. Heat exhaustion and some respiratory problems increased.

Climatic changes altered spatial distribution of some infectious disease (Curseu et al. [14]). Concerning vector borne diseases there is an increased risk of tick borne encephalitis, Lyme disease, West Nile virus and Hanta virus infection. In the summer of 1996 Romania experienced a large outbreak of West Nile virus (WNV) meningoencephalitis with more than 500 clinical cases and high rates of death (up to 10%) (Han et al. [15]). It was the first epidemic recorded in Europe associated with a long heat wave that favored an increase in the distribution and abundance of mosquito vectors. Leishmaniasis is possible to appear as a new threat north of the 45° latitude. Higher temperatures in summer could considerably increase the incidence of food borne *Salmonella* infection. Climate change might increase levels of *Cryptosporidium* and *Campylobacter* in water.

Increased UV exposure – levels of UV radiation reaching the due to sunnier summers, a decline in cloud cover (as well as ozone depletion) - will increase the risk of skin cancer.

The global and national climate change strategies should put an emphasis on the elaboration of adaptation measures.

THE STRATEGY OF ROMANIA REGARDING THE CLIMATIC CHANGES

The adjustment strategies especially the short-term strategies are crucial. The change of the life manner, in order to adjust to the climatic change actually means a change of cultural approach. We have to overpass the idea that the human is the master of the nature and to re-learn how to integrate ourselves to the environment. The cultural mutation can come from apparently minor things: a better care in the use of the electric energy and the water resources, but also in the economic activities.

The strategy of Romania regarding the climatic changes defines the Romanian policies related to the compliance with the international obligations stipulated by the Convention of The United Nations upon The Climatic Changes, signed at Rio de Janeiro in 1992 and by the Protocol of Kyoto to the Frame-Convention signed in 1997 and, at the same time, gathers the obligations regarding the climatic changes assumed by the Romanian adhesion to the EU.

Romania ratified the United Nations Framework Convention on Climate Change (UNFCCC) by Law no. 24/1994 manifesting clearly its concern to mitigate this problem at global level, and signed the Kyoto Protocol in 1999 being the first UNFCCC Annex I Party that ratified it by Law no. 3/2001. The value of the greenhouse gas emissions reduction target adopted by Romania is of 8% compared to

the base year 1989, during the first employment period 2008-2012. The Kyoto Protocol entered into force at international level on the 16th of February 2005.

The first National Strategy on Climate Change was approved by the Governmental Decision no. 645/2005. The Strategy represents the general framework for implementing climate change policies and measures in the period 2005-2007 (NSCC [12]).

Currently, Romania faces a complex process, after the adhesion to the EU, a process of resuming the economic development in a high degree -dynamic international context. The approach of the environment protection issues is a priority within the strategic actions for development. The extensive character of the economic actions that induce climatic changes brings the necessity of the global approach at the economic level, implies the need of identification and correlation of the development activities and implementation measures, inter and intra-sectorial, related to the climatic changes. The strategy is based on the fact that on 01/01/2007 Romania has adhered to EU. The assurance of performing of all the engagements taken over by Romania by the Protocol of Kyoto represents the general objective implied by the adherence to EU.

CONCLUSIONS

The climatic changes will produce in Romania a series of changes:

- they will change the configuration of the agricultural crops, bringing about the necessity to use new sorts;
- there will increase the vulnerability of the humans towards the unknown viruses until now, brought by the shift to the North of some species of animals that act as vectors of the microorganisms;
- there will happen a frequency and intensity of certain extreme phenomena: draught, hot waves and flood will represent the main challenges to which we have to face by adjusting measures, rationally thought;
- the southern regions of the country are already exposed to an aridity phenomenon, which will continue for the future;
- a warming climate in Romania will have impacts on water quantity and quality across the country;
- it is expected that the Black Sea shore, which is already a vulnerable region, due to the human intervention caused by the management and building of harbor facilities and also by the changes on the Danube flow, would become a more exposed region;
- the climatic changes could affect the quality of life: they alter the settlements structure and the human activities; they have a strong impact upon the human health, safety and ownership.

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