CONSIDERATIONS ABOUT THE INFLUENCE OF CLIMATE CHANGES AT BAIA MARE URBAN SYSTEM LEVEL

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Abstract: *Global warming as a result of climate changes is a phenomenon widely accepted by the international scientific community, already highlighted by analyzing observational data over long periods of time. Simulations made with global climate models indicate that the main factors influencing this phenomenon are both natural and anthropogenic (changes in atmospheric composition due to human activities). But the cumulative effect of the two factors may explain the observed changes in average global temperature over the last 150 years.*

Changes in climate regime in Romania follows the global context, taking into account the regional conditions. Compared to the annual average temperature global increase during 1901-2013 with 0,6^{o}C in Romania the annual average temperature was increased only with 0,3^{o}C. Compared with other regions in the neighborhood, there were differences: a warming more pronounced in the south and east (reaching up to 0,8^{o}C) and non-significant in the intra-Carpathian regions, except the Baia Mare station, where the effect of local anthropogenic activity led to a heating with 0,7^{o}C.

For the present study were performed, using the MS Office Excel and G.S. Surfer program, statistical models to highlight the situation of Baia Mare Urban System, knowing that this region was until recently a hotspot area according to the atmospheric pollution.

Keywords: *climate changes, statistical modeling, vulnerability, Baia Mare*

1. INTRODUCTION

Global warming as a result of climate change is a phenomenon widely accepted by the international scientific community, as already pointed out by analyzing observational data over long periods of time. The simulations made using global climate models indicate that the main factors behind this phenomenon are both natural (variations in solar radiation and volcanic activity) and anthropogenic. The cumulative effect of these factors may explain the observed changes in global mean temperature over the past 150 years.

Increasing greenhouse gas concentrations in the atmosphere [7], especially carbon dioxide (CO_2), the main cause of the global warming, was pronounced in the last 50 years of this century. Global warming is also accepted by the european and romanian scientific community, and as a strategic result major decisions were established for the control and adaptation to the effects of global warming [9, 10].

2. SCENARIOS FOR THE CLIMATE CHANGES

Global average temperature has increased by about 0.74°C over the air in the last 100 years (1906-2005) than 0.6ºC during 1901-2000 [1]. Climate Europe experienced a warming of about 1oC in the last century, higher than the global average.

The hydrometeorological recorded data show that precipitation increased significantly in northern Europe, while droughts in southern became increasingly frequent (Fig. 1).

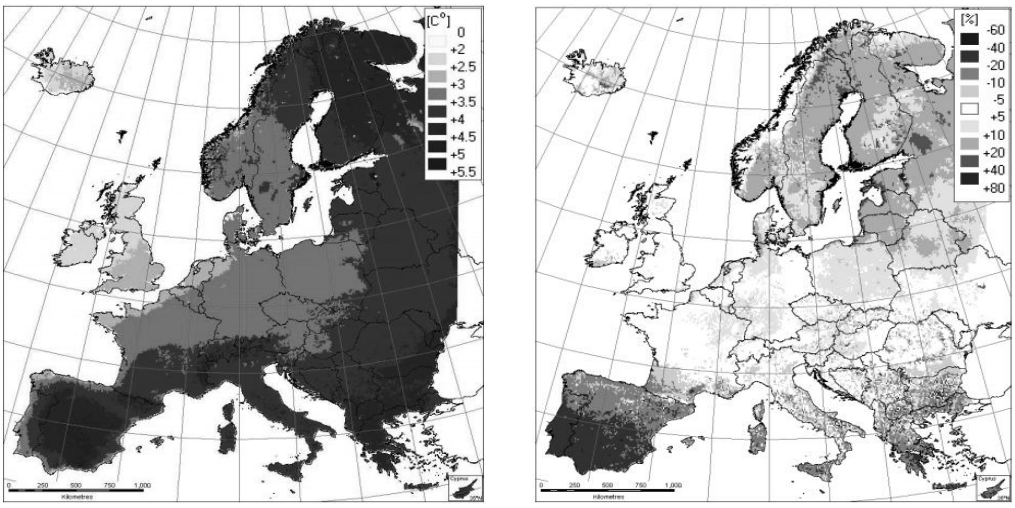

FIG. 1. The evolution trend of average annual temperature and rainfall in the Europe (1900-2050)

Extreme temperatures recorded recently, such as heat wave in the summer of 2003 and especially that of 2007 and 2009 were related to the observed increase in the frequency of extreme events in recent decades, as a consequence of climate change. While single weather events cannot be attributed to a single cause, statistical analyzes have shown that the risk of such events has increased considerably due to climate change. The most vulnerable areas in Europe in terms of the effects of climate change are [1]:

- Southern Europe and the entire Mediterranean Basin - where we meet a deficit due to rising water temperatures and reduced precipitation;
- mountain areas in particular the Alps problems in the water flow regime as a result of melting snow and glaciers volume mitigation;
- coastal areas due to rising sea levels and the risk of extreme weather events;
- densely populated floodplains due to the risk of extreme weather events (as in Fig. 2), rainfall and flash floods, causing major damage to built-up areas and infrastructure.

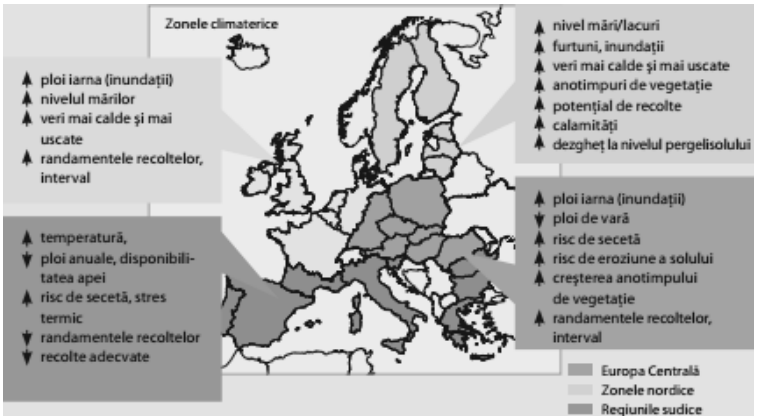

FIG. 2. The early effects of climate changes in different EU regions (2010-2050)

The configuration of these changes is similar to that observed during the 20th century. It is "very likely" that the trend of increase in extreme maximum temperatures and increased frequency of heat waves continue.

The Romania's climate is influenced by the position that it has on the world, as well as its geographical location on the continent. These features give a temperate climate in Romania continental. Compared to the annual global average temperature increase during 1901-2000 0,6°C in Romania the annual average increased by only 0,3°C.

During 1901-2006 the increase was 0,5°C to 0,74°C globally (1906-2005), but there were regional differences: a stronger warming in the south and east (0,8°C at stations Bucharest-Filaret and Constanta stations) and significant intra-Carpathian regions, except Baia Mare station, where the effect of anthropogenic activity local heating leading to a 0,7°C as presented in Fig. 3 and Fig. 4.

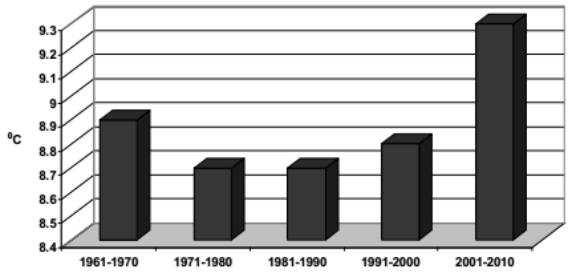

FIG. 3. The mean annual temperature in Romania between 1961-2010

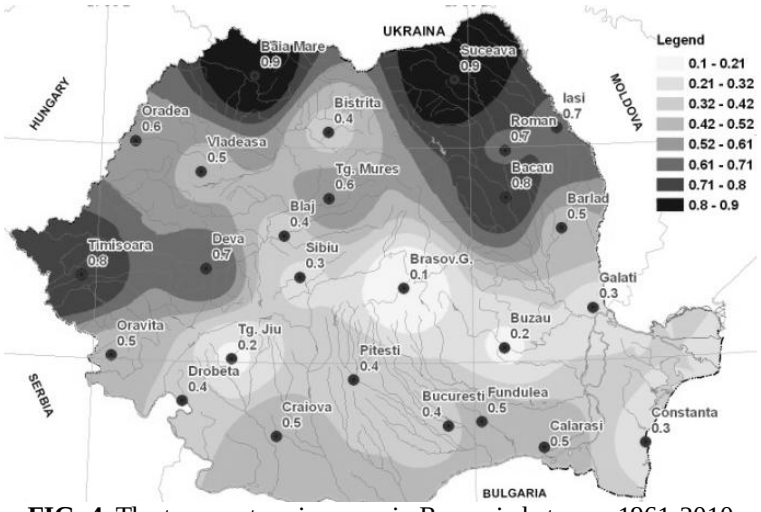

FIG. 4. The temperature increase in Romania between 1961-2010

In terms of rainfall during the period 1901-2010 showed a general trend of decreasing annual rainfall amounts (Fig. 5). Consistent with this result has been increasing the maximum duration of intervals without rainfall in the southwest (winter) and west (summer) [7].

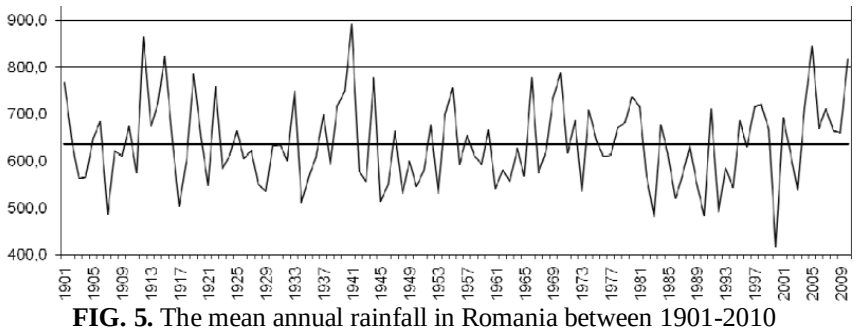

FIG. 5. The mean annual rainfall in Romania between 1901-2010

3. CASE STUDY-EFFECTS AND DISCUSSIONS

Baia Mare Depression climate is characterized by mediteranean influences, in addition morphographical particular conformation generated in contact with the mountain area exposed to the south, meeting the conditions of manifestation of climate shades shelter so that annual average temperatures reaches 9.4-9.6°C Baia Mare, dropping to -8°C in the hilly eastern and southern areas of the basin [4,5]. The average temperature of the summer months is 19.5°C, and the winter months - 2.8°C, with an average annual temperature variation of 20-22°C [2,6], in accordance with the microclimate observations recorded by the meteorological station Oregon Scientific WMR-type 100 (Fig. 6), which operates in the North University Center at Baia Mare, from April 2008.

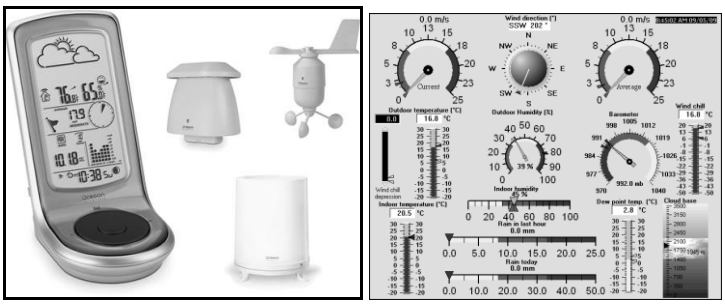

FIG. 6. The meteorological station Oregon Scientific WMR-type 100

Recorded weather variables, displayed on the main console, are: temperature indoor / outdoor, humidity indoor / outdoor, wind speed and direction, average monthly rainfall, daily, annual, atmospheric pressure, dew point temperature, the cooling produced by wind, temperature index and more. Information obtained from the meteorological station, even when measuring small variations - for which the calibration of sensors is automatically implemented by the station's console, is stored as log files containing more than 43,000 rows of data.

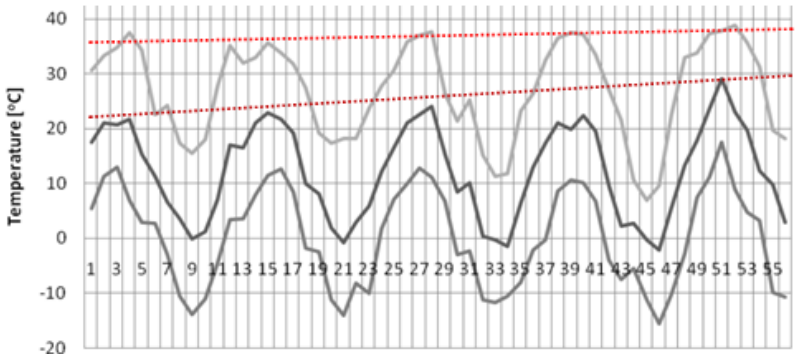

FIG. 7. The evolution of Baia Mare urban area temperature (May 2008-December 2012)

As as it can be observed, in Fig. 7, in terms of the evolution of the maximum temperature recorded in the period 2008-2012 there was an increase of approx. 1^{o}C compared with annual averages temperature's evolution for the same period where growth is more visible - from 22 to 29^{o}C [3].

Another characteristic is the reduced frequency of thermal inversions and a number of days with frost 100-120 days / year. Average relative humidity is at around 80%, favored by the mild climate and wooded areas of northern municipality and numerous green areas of the city administration Baia Mare [2].

According to the Fig. 8, we should mention that since 2009 there have been large fluctuations in terms of atmospheric humidity - with values between 20-80% for average annual humidity [3].

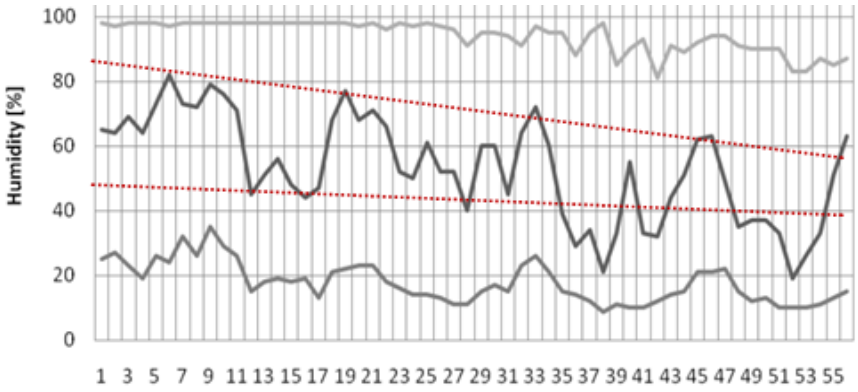

FIG. 8. The evolution of Baia Mare urban area air humidity (May 2008-December 2012)

In addition there has been a certain uniformity (stability) in terms of the evolution of minimum annual atmospheric humidity for which no values were recorded under 10% [2]. The area of Baia Mare depression is also characterized by an increased frequency of rainfall, while the average annual rainfall is increasing from the west (700mm / year) to the south and east (~ 1000mm / year), with an average of 922 mm / year in Baia Mare and the concentration of most of the precipitation in summer season. The number of days with snow increases from west (50 days / year) to the eastern basin (60 days / year) [3,5].

Due to the presence of the Săsar Valley, which crosses the city from east to west lake Firiza approach and developed industrial area of the city, located in the immediate vicinity of the city, misty air rate remains quite high even in the summer months, recorded on average from 13.1 to 16.6 days.

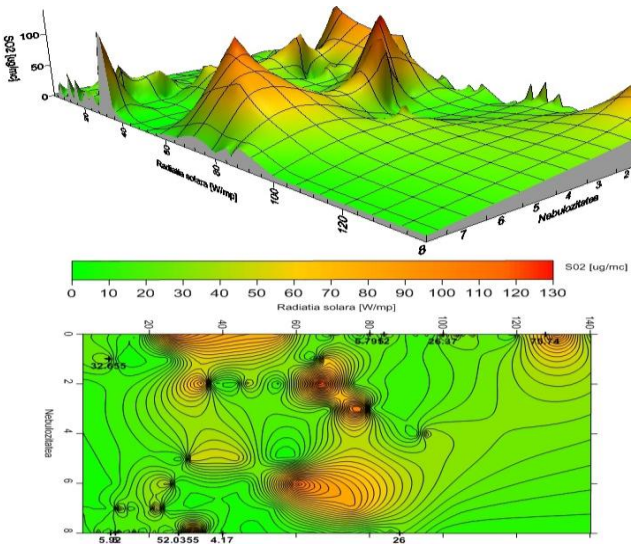

FIG. 9. The variation of CO and SO_2 in relation to nebulosity and solar radiation (Oct. 2010-Feb. 2011)

Changes to the microclimate (2008-2012) observed in the urban area Baia Mare although not seem significant at first, bring to the forefront the progressive growth in terms of temperature and fluctuating decreases in terms of atmospheric humidity, conditions that contribute decisively to the "urban heat islands" - with a significant presence in terms of SO_2 pollution [8].

The horizontal scale - given by the solar radiation (W/m^2) and nebulosity values, both recorded with the meteorological station Oregon Scientific WMR-type 100 - is connected, via the G.S. Surfer 9.0 software model (Fig. 9), to the vertical scale containing SO_2 values - registered, in the same period (oct. 2010 - feb. 2011), on the nearest air quality monitoring local station. According to the correlations made by the G.S. Surfer 9.0 software, there are a few SO_2 peaks highlighted for solar radiation values between 20-80 W/m^2, which are not increase in frequency during the study or as a result of urbanisation.

Moreover, these effects are felt near industrial or agricultural areas which are still not visibly affected by phenomena such as aridity, soil erosion or intense summer rains followed by devastating floods, but will definitely be affected in the next 10-15 years if microclimate changes continue in the same direction [2].

Another important aspect regarding the evolution of the climate in the Baia Mare area is the decrease in atmospheric inversions appearance, in this sense can lead to maintenance of air pollutants in the lower layers of the atmosphere, with the possibility of acid rain phenomenon, which may enhance the effects of global warming to urban and suburban area of Baia Mare.

CONCLUSIONS

Changes in climate regime in Romania follows the global context, taking into account the regional conditions; a warming more pronounced were identify in the south and east of Romania and in the Baia Mare area, where the effect of local anthropogenic activity led to a heating with 0,7-0,9^{o}C. Baia Mare depression climate is characterized by mediteranean influences, in addition morphographical particular conformation generated in contact with the mountain area exposed to the south, meeting the conditions of manifestation of climate shades shelter so that annual average temperatures reaches 9.4-9.6°C in Baia Mare, dropping to -8°C in the hilly eastern and southern areas of the basin.

Climate changes is expected to have significant negative consequences to human health. It is also possible to have an significant impact heat waves more frequent and intense, especially in "urban heat islands" of cities like Baia Mare along with other extreme weather phenomena with visible effects on sequence plants phenophases, agriculture, forestry and local economy.

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