Guidelines for adapting agricultural technologies to climate changes in the Region 7 Centre

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Institution: **NATIONAL METEOROLOGICAL ADMINISTRATION, BUCHAREST**

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Guidelines for adapting the agricultural technologies to climate changes in the Region 7 - Centre

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ABBREVIATIONS

MMAP	Ministry of the Environment, Waters and Forests
APM SB	Environmental Protection Agency, Sibiu
KS	The Norwegian Association of Local and Regional Authorities
ULBS	Lucian Blaga University, Sibiu
ANM	National Meteorological Administration

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CONTENT

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1. Introduction

The analysis of data observed over long periods of time showed that the global warming is an ongoing phenomenon accepted by the international scientific community, too. Simulations carried out using global climate models showed the main factors triggering this phenomenon, both the natural (changes in solar irradiance and volcanic activity), and the anthropogenic ones (changes in the composition of the atmosphere caused by human activities). The cumulative effect of the two categories of factors may explain the changes in the average global temperature over the last 150 years. The increase in greenhouse gas concentrations in the atmosphere, particularly the carbon dioxide, by 0.13 ° C over the last 50 years of the twentieth century was the main cause of warming, which is about 2 times the value in the last 100 years, as presented by IPCC in the AR4 and AR5 (http://www.ipcc.ch).

Between 1880 and 2012, according to the multiple independent sets of data, the average global air temperature has increased by about 0.85 ° C (with variations in growth between 0.65 and 1.06), an average of 0.06 ° C per decade. The total increase between the average value for the period 1850-1900 and the period 2003-2012 is 0.78 ° C (from 0.72 to 0.85 ° C), according to the only existing data set. Europe has registered a climate warming of about 1 ° C in the last century, higher than the global average.

Globally, all years of the 21st century (2001-2013) are among the top 15 warmest years since 1880, according to the 2013 report of the National Oceanic and Atmospheric Administration (NOAA).

2013 ranks fourth among the warmest in the last 133 years, being the 37th consecutive year with an average temperature above that of the twentieth century. The years 2010, 2005 and 1998 rank, in order, the top three warmest years since 1880.

Rainfalls have increased considerably in northern Europe, and droughts in south of the continent, have become more frequent. The extreme temperatures recently recorded, such as the heat wave in the summer of 2003 and especially the 2007, were connected 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 analysis has shown that the risk of such events has increased considerably due to climate changes.

IPCC identified in AR4 the most vulnerable areas in Europe, as follows:

- Southern Europe and the entire Mediterranean Basin – areas with water deficit caused by rising temperatures and reduced precipitations;
- Mountain areas, particularly the Alps – areas with water flow problems due to snow melting and the retreat of glaciers;
- Coastal regions – areas at risk of rising sea levels and extreme weather events;
- Densely populated floodplains – prone to extreme weather events, heavy rainfall and flash floods, causing major damage to built-up areas and infrastructure.

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Climate scenarios made with different global climate models have predicted an increase in average global temperatures ranging between 1.8 ° C and 4.0 ° C by the end of 21st century (2090 - 2099), compared to the period 1980-1990, depending on the scenario for greenhouse gas emissions considered. Due to the inertia of the climate system, global warming will continue to evolve despite the immediate implementation of measures to reduce emissions, but the temperature rise will be limited by the level of reduction applied. It is "very likely" (greater than 90% probability) that precipitations will increase at high latitudes, and "likely" (> 66% probability) to decrease in most subtropical regions. The configuration of these changes is similar to that observed during the twentieth century. It is "very likely" that the upward trend of hot extremes and heat wave frequency to continue.

Currently, global warming involves two major problems for humanity. On the one hand the need for drastic reduction of greenhouse gas emissions in order to stabilize the level of concentration of these gases in the atmosphere to prevent the human influence on the climate system and enable natural ecosystems to adapt naturally, and, on the other hand, the need to adapt to the effects of climate change, given that these effects are already visible and unavoidable due to the inertia of the climate system, regardless of the outcome of actions to reduce emissions.

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2. Climate changes in the Region 7 - Centre

Diagnostic analysis of the current situation

The agro-climatic potential of an area under cultivation provides information on assessing the vulnerability of natural vegetation and agricultural land to various forms of risk / stress which can cause significant annual deviations in terms of agricultural potential and economic development.

The analysis of thermal and water resources involves identifying parameters and critical thresholds on specific date ranges that correspond with completing the processes of growth and development of main crops (winter wheat and corn) during the growing season of plants, i.e. from seeding up to the maximum water consumption period (May to august).

Geographical location

The analysed area of agricultural interest includes large areas in central Transylvania, Figure 1, i.e. Alba, Sibiu, Brasov, Mures, Covasna and Harghita Counties, an area characterized as having optimal agro-climatic conditions, due to its temperature and water potential, while the risk factor with negative impact on the agricultural production of field crops being represented by the amount of water from rainfalls.

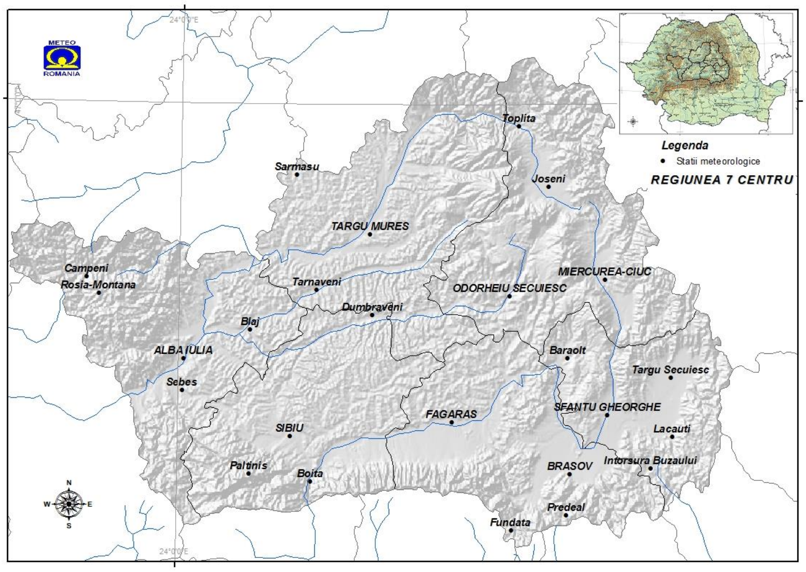

Figure 1.

The analysis included 28 weather stations, 6 of which are specialized in phenological observations and measurement of soil moisture reserve accessible to winter wheat and corn crops, as follows:

- *weather stations*: Alba Iulia, Bâlea Lac, Baraolt, Batoş, Blaj, Boiţa, Bucin, Câmpeni, Făgăraş, Fundata, Întorsura Buzăului, Joseni, Lăcăuţi, Miercurea Ciuc, Odorheiu Secuiesc, Păltiniş, Predeal, Roşia Montană, Gheorghe Munte, Târnăveni, Târgu Secuiesc and Topliţa;

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- *agro-meteorological stations*: Braşov, Dumbrăveni, Sărmaşu, Sebeş, Sibiu and Târgu Mureş.

The relief unit in the northern part of the region is the southern *Transylvania Plain*, with altitudes between 550 and 250 m, as well as heights above 600 m (Dâmbului hill, 651 m), representing the area of maximum immersion of the Carpathian crystal rock layer onto which considerably thick Paleogene and Miocene layers of sediments have deposited (> 5000 m thickness to the southwest of Targu Mures). The Transylvanian Plain's lower altitudes, the hilly and mountainous framework, and the wide valley chains customize the climate phenomena over the whole hilly Transylvanian Depression. This unit is warmer than other relief units. The same climate peculiarities impact the waters through unstable small river flows (Meles, Ludus, Valea Luțului) which imposed the arrangement of ponds, especially in the Fizeş and Ludus basins. Soils are characterized by the development of wet argillic and cambic chernozems. The Transylvanian Plain's climate is moderate, with differences between north and south because of the presence of the Apuseni Mountains, with warm foehnic influences of the Meseş Mountains to the north – west, as well as a number of topo-climates specific to broad valleys. The air temperatures slightly differ from the north to the south. The higher peaks to the north lower the temperature by almost 1˚C, compared to the south, where the annual average is about 8-9ºC. The Transylvanian Plain has a special situation related to the river system and deficient multi-annual rainfall. A feature of the Transylvanian Plain is that, although lower than the surrounding areas, neither the major river valleys, nor its large roads converge towards its center, but surround its boundaries.

Therefore it is an area with poor water resources, lacking the intense traffic, which explains in part its rural character and layout of cities towards the peripheries. The rainfalls, generally deficient in the Transylvanian Plain, usually record values of 500-600 mm / year, and the frequency of precipitations usually follows the NW-W direction. The winds have increased in intensity and meet the general trend of winds in this part of Romania, the prevailing ones being from NW to the West.

The Bistrița and Reghin Hills form a higher hilly region, with altitudes ranging between 600-700 m, located on the eastern side of the Transylvanian Plain. It is the only peak approaching the Sub-Carpathians specifics, the other depressions being piedmont formations. The altitude and humidity led to the development of brown Luvisolic soils (podzols) and river bed Luvisolic soils (argillic podzols).

Târnave Plateau is a predominant relief unit in the studied area, being a major southern sub-division of the Hilly Transylvanian Depression. Târnave Hills run south to Mureș Corridor, continue in the Niraj Valley, being in contact with the Carpathian branches through the Sub-Carpathian relief of the two contact depressions, Făgăraș and Sibiu, to the south, the Apold Corridor to the SW, and the Alba Iulia –Turda Corridor to the West. The highly segmented relief aligning parallel ridges or unitary "bridges" (Hartibaci, Secas) develops Pliocene deposits (sand, clay, marl) and Sarmatian deposits in the southeast, locally and Eastern part. However, the foundation is formed by less submerged and extensive blocks of crystal rocks, thus influencing the spatial arrangement and peculiarities of some relief subdivisions. A representative feature is the adaptation of the river system to the tectonic plates. There can be noticed the long parallel valleys of Mures, Târnavelor Hârtibaciului and Olt Rivers, oriented from east to west. The strongly inclined slopes are

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affected by frequent rains and gravitational processes. In relation to the bioclimatic factors, brown, brown Luvisolic soils, argillic and cambic Chernozems have developed.

The underground resources (natural gas, salt, mineral springs, sands, riverbed gravel) explain the common origin of the Transylvanian Depression. The average amounts of rainfall are smaller in the Secaşelor Plateau (<600 mm), and increase to the E and SE, exceeding 700 mm and even 750-800 mm in the high hills area.

2.1. Climate changes observed

2.1.1. Areas and sectors vulnerable to climate changes

The analysis of the climate regime in the Region 7 - Centre included the study of multiannual data sets of thermal parameters, water, energy and mechanical parameters by time periods included in the *climate change timetable* in order to outline the climate changes that have occurred.

Temperature is one of the most important meteorological factors in plant life. The biophysical and biochemical processes of plants, such as water, gas and mineral salt absorption, their processing, respiration, photosynthesis, etc. as well as the processes of growth and development depend on this factor. The pace of the various growing phases is influenced by the temperature, which causes the advance of or delay in the phenophases.

The **thermal** potential of a region means the natural conditions in terms of temperature values necessary for the growth and development of plant species. The scale of temperature values presentsreference limits, low and high, specific to each biological genotype (variety / hybrid); within these limits, the intensity of physiological processes is correlated with the values of this parameter. The positive / negative variations of these optimal limits reflect thus in the growing of crops, and hence the harvesting, depending on the intensity and duration of heat stress, the genetic characteristics of genotypes expressed by physiological requirements and resistance to extreme temperatures, the stage of growth and development, the agricultural technology, etc.

The intensity of heat stress between June and August distinguishes by the sum of maximum daily air temperatures Σtmax ≥32 ° C. The 32 ° C limit is the critical biological threshold for the optimal physiological growth and development of agricultural species, as forcing biological processes is in direct correlation with the intensity of the "heat-wave" and insufficient water in the soil (pedological drought).

In other words, the maximum air temperatures over the critical biological threshold of 32 ° C, associated with deficits of moisture in the air (atmospheric drought) and soil (pedological drought), increase the heat and hydrologic stress with severe effects on plants.

Rainfall is the main source of water for agricultural plant growth and development, and the most significant elements of this meteorological parameter are the quantitative variability, distribution and spatio-temporal distribution. *The total annual precipitation* is the variable quantitative indicator specific to each area of interest and shows the absence, presence or abundance. The *average annual precipitation* is a climate indicator of reference

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to agricultural areas, used to report the extreme years, considered cases of agroclimatic risk. This value expresses the potential of rainfall resources necessary to determine the suitability of an agricultural for certain species, varieties or hybrids.

The wind speed contributes to the erosion of the soil (wind erosion), which determines the presence of "dust storms" that have direct negative consequences not only on the land but also on other components of the space environment, affecting the vegetation, surface waters by depositing dust particles, and ultimately onto the life of humans and other animals.

The work methodology for achieving the climate analysis for the 3 municipalities (Brasov, Sibiu, Targu-Mures) included the processing of meteorological data on thermal and hydrologic indicators - monthly averages for the period 1981-2010 collected by 28 weather stations from the ANM database, and representative for the Region 7 - Centre: Brașov, Târgu-Mureș, Sibiu, Blaj, Dumbrăveni, Miercurea Ciuc, Târgu Secuiesc, Sebeș Alba, Făgăraș, Joseni, Toplița, Odorheiul Secuiesc, Sărmaș, Fundata, Baraolt, Boița, Câmpeni, Întorsura Buzăului, Lăcăuți, Păltiniș, Predeal, Alba Iulia, Batoș, Bâlea Lac, Bucin, Roșia Montană, Sf. Gheorghe Munte, Târnăveni.

For this purpose, we selected, extracted and processed the following meteorological parameters, calculated as multiannual average of average monthly air temperatures:

- Average air temperature (°C);
- Highest air temperature (°C);
- Lowest air temperature (°C);
- Absolute maximum temperature (°C)/ date;
- Absolute minimum temperature (°C)/ date;
- Total heat-wave temperatures (ΣTmax. ≥ 32°C) between June-August;
- Number of heat-wave days (Tmax. ≥ 32°C) between June-August;
- Total monthly precipitation (l/sq m);
- Maximum precipitation over 24 hours (l/ sq m)
- Relative air humidity at 1:00 pm (%);
- Sunshine duration (total hours);
- Average wind speed (m/s).

2.1.2. Air temperature

To assess the overwintering conditions for winter species, we analyzed the December - February specific heat index in the periods 1961-1990, 1961-2014 and 1981-2010, respectively the minimum total negative air temperatures (-15 ° C ΣTmin.≤ / air-freezing index) characterizing the harsh winter season. Thus, the analysis of minimum total negative air temperatures below the critical limits of resistance (Tmin.≤-10 ° C) of agricultural plants reveals the features of a normal winter (11-30 air-freezing units) in most of the region , with moderate freezing intensity, particularly in the period 1961-2014 compared to 1981-2010. One harsh (31-50 air-freezing units) and very severe winter (more than 50 air-freezing units) was reported in the central and western part of the territory. Isolated situations of mild winter (less than 10 air-freezing units) were recorded in the northwest region, Figure 2 (a, b, c).

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The period of transition from winter to spring comprises the months of February, March and early April, i.e. between February 1 and April 10, characterized by the spring

index. This period is characterized by strong temperature fluctuations from one year to another with implications for the resumption of vegetation and the pursuit of agricultural work in the field. Usually, the heating during February is favourable to winter cereals (wheat), giving an advance in growing, and intensive accumulation of dry matter in the grain.

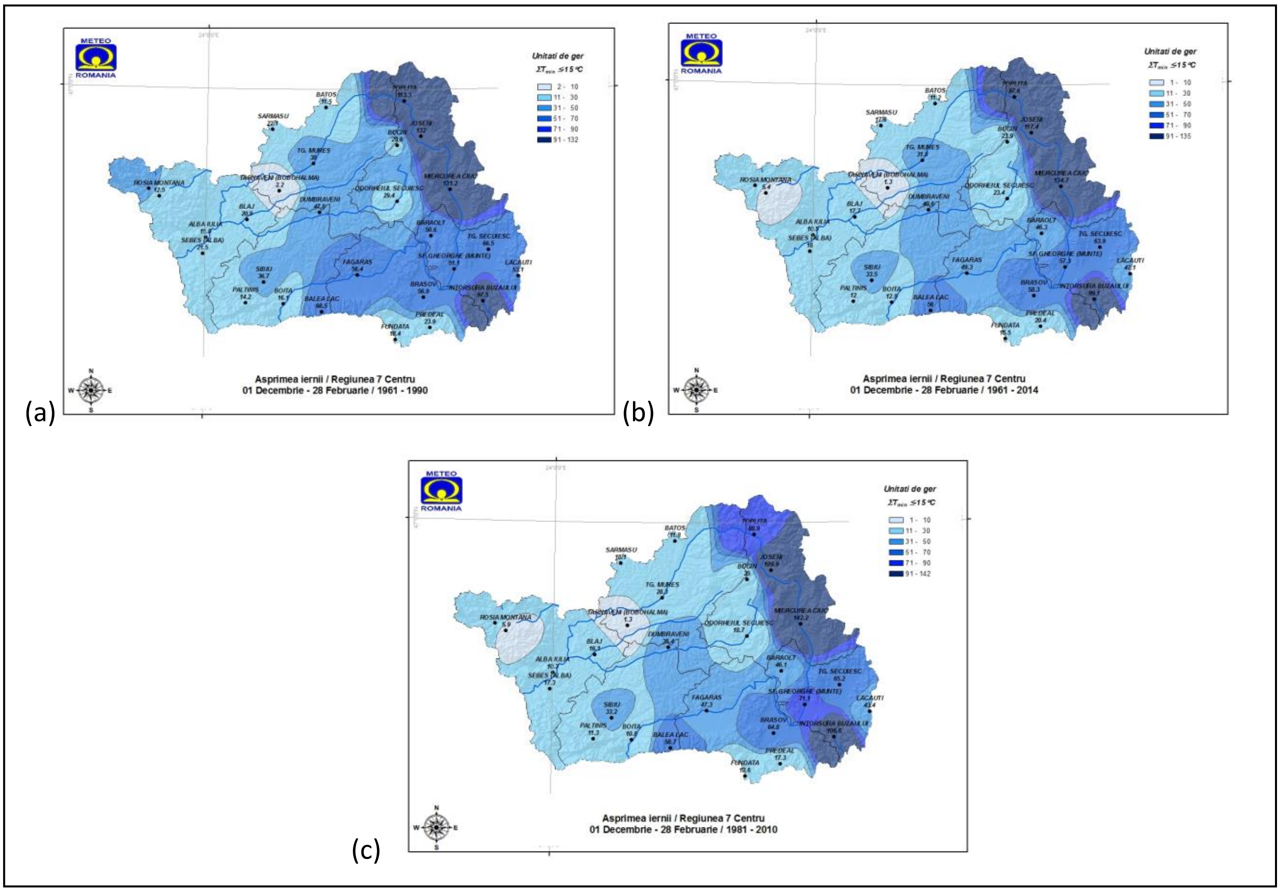

Figure 2.

The spring index (ΣTmed> 0 ° C), calculated over February 1 - April 10 for the periods 1961-1990 and 1961-2014, compared to the reference period 1981 to 2010,

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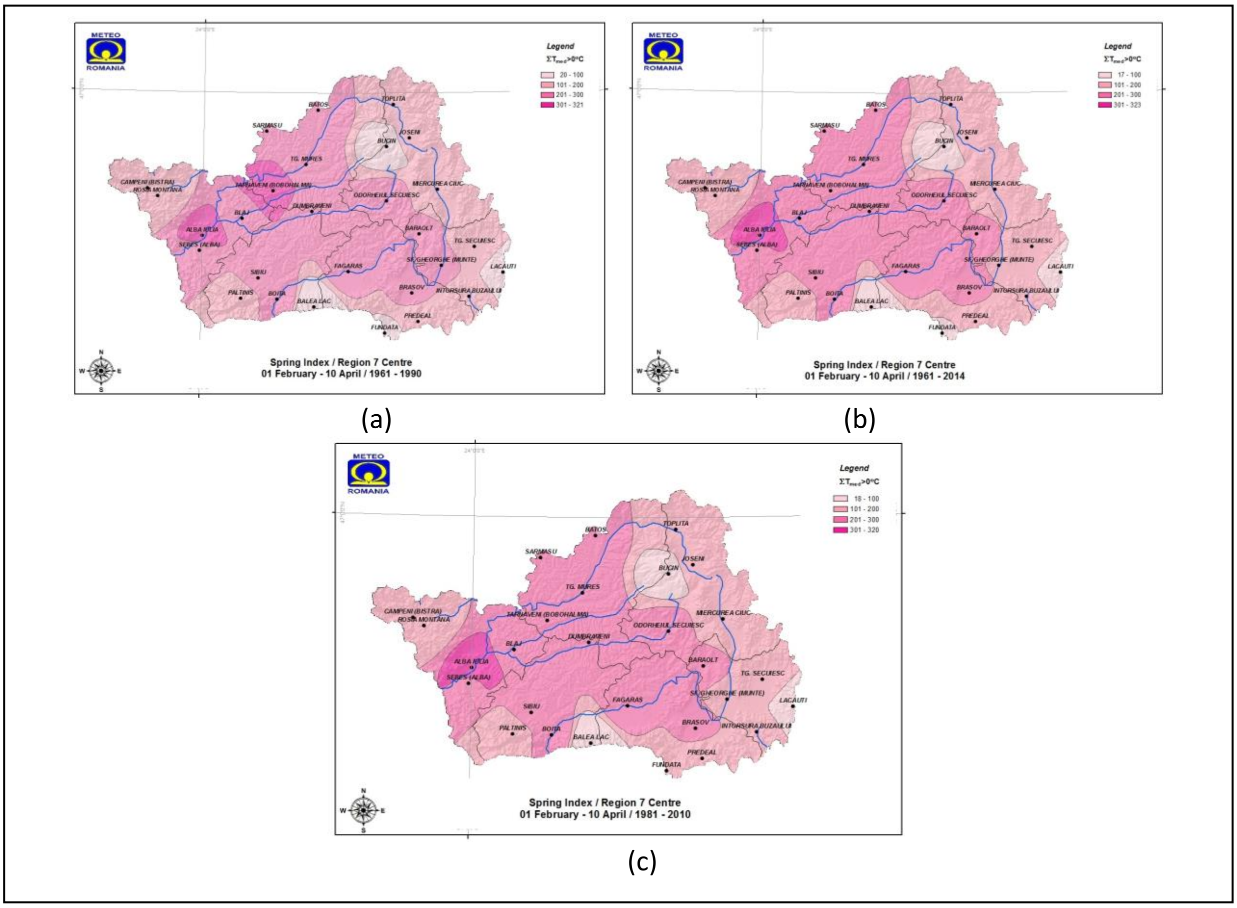
totalized 201-323 heat units, which means a moderate and normal spring in most agricultural areas, Figure 3 (a, b, c). The heat units <200 recorded in the east, south, and, locally, the west of the region, indicate a late spring.



(a) (b)

(c)

Figure 3.

2.1.3. Thermal resources at Braşov, Sibiu, Târgu Mureş and Târgu Secuiesc weather stations

Figure 4 shows the average annual temperatures recorded at the Brasov meteorological station, using the agro-meteorological software, over the periods 1961-1990, 1981-2010 and 1961-2014. It is noted that the maximum temperature of 18.5°C was recorded in the reference period 1981-2010, month of July, and the minimum -4.9°C in 1961-1990, month of January. In June, July, August of all three periods were recorded temperatures between 16.1°C and 18.5°C, while in December, January and February temperatures ranged between -4.9°C and - 2.1 °C. Between 1961-2014 and 1981-2010, the reference period, the deviation calculated was 1°C between the maximum of 0.5°C in

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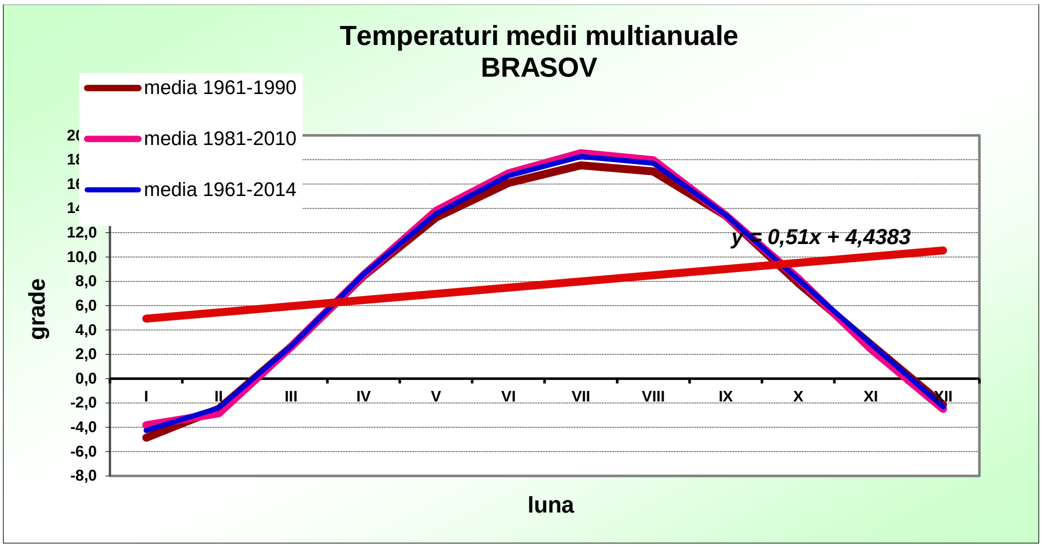
January and November and the lowest -0.5°C in February. In June, July and August there were negative deviations of -0.2°C / -0.3°C from the annual average, while in December, January, and February there were differences of approx. 0.2°C, -0.5°C, -0.4°C. The minimum average temperatures in all three periods were recorded in January, and the maximum in July. Figure 7 presents the three periods, as well as the increasing trend from >4°C to values exceeding 10°C, with a difference of about 6°C, between 1961 and 2014.



Period	Average monthly temperatures (°C) – BRASOV											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961 - 1990	-4.9	-2.5	2.6	8.4	13.3	16.1	17.6	17.1	13.4	7.9	2.8	-2.1
1981 - 2010	-3.8	-2.9	2.6	8.5	13.8	16.9	18.5	18.0	13.4	8.2	2.5	-2.5
1961 - 2014	-4.3	-2.4	2.7	8.6	13.6	16.7	18.3	17.7	13.5	8.2	2.9	-2.3
Deviation (°C)	+0.5	-0.5	+0.1	+0.1	-0.2	-0.2	-0.2	-0.3	+0.1	0	+0.4	+0.2

Figure 4.

Figure 5 shows the average annual temperatures recorded at the Sibiu meteorological station, using the agro-meteorological software, over the periods 1961-1990, 1981-2010 and 1961-2014. It is noted that the maximum temperature of 19.8°C was recorded in the reference period 1981-2010, month of July, and the minimum -3.9°C in 1961-1990, month of January. In June, July and August of all three periods, the recorded temperatures ranged between 17.1°C and 19.8°C, while in December, January, and February, they ranged between -3.9°C and -1°C. Between 1961-2014 and 1981-2010, the

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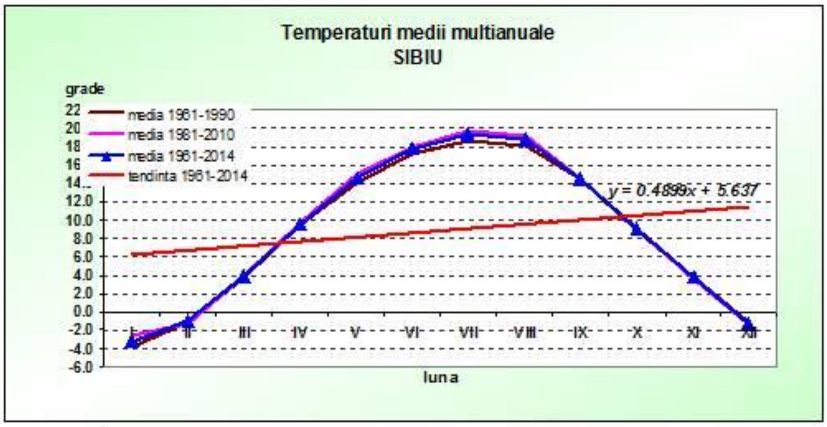
reference period, the deviation calculated was 1.2°C between the maximum of 0.5°C in January and the lowest -0.4°C in July. In June, July and August there were negative deviations, -0.3°C … -0.4°C, from the annual average, while in December, January, and February there were differences of approx. 0.5°C...-0.2°C. The minimum average temperatures in all three periods were recorded in January, and the maximum in July.

Figure 8 presents the three periods, as well as the increasing trend from 6°C to values up to 12°C, with a difference of 6°C, between 1961 and 2014.



Intervalul	Temperaturi medii lunare (°C) – SIBIU											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961 - 1990	-3.9	-1.1	3.8	9.4	14.2	17.1	18.7	18.1	14.4	8.9	3.7	-1.2
1981 - 2010	-2.7	-1.2	3.9	9.6	14.9	18.0	19.8	19.1	14.4	9.1	3.5	-1.2
1961 - 2014	-3.2	-1.0	3.9	9.6	14.6	17.7	19.4	18.8	14.4	9.1	3.8	-1.2
Abatere (°C)	+0.5	-0.2	0	0	-0.3	-0.3	-0.4	-0.3	0	0	0	0

Figure 5.

Figure 6 shows the average annual temperatures recorded at the Târgu Mureș meteorological station, using the agro-meteorological software, over the periods 1961-1990, 1981-2010 and 1961-2014. It is noted that the maximum temperature of 20.3°C was recorded in the reference period 1981-2010, month of July, and the minimum -4.4°C in 1961-1990, month of January. In June, July and August of all three periods, the recorded temperatures ranged between 17.9°C and 20.3°C, while in December, January, and February, they ranged between -4.4°C and -1.2°C. Between 1961-2014 and 1981-2010, the reference period, the deviation calculated was 0.8°C between the maximum of 0.6°C in January and the lowest -0.4°C in July. In June, July and August there were negative

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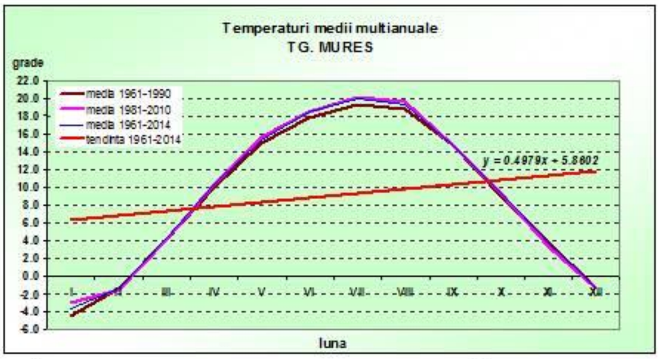
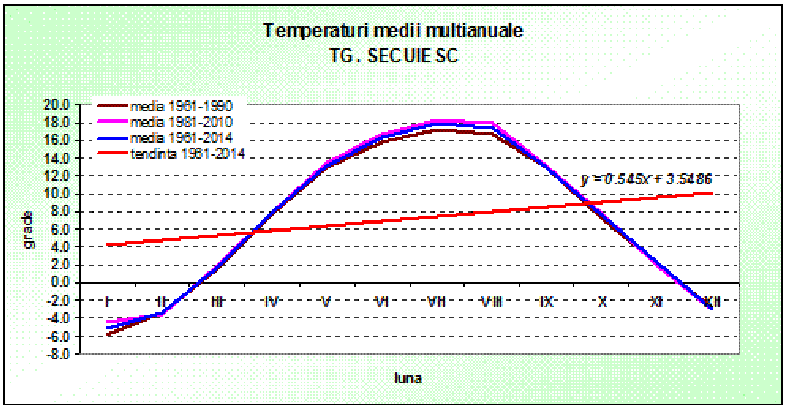
deviations, -0.4˚C … -0.1˚C, from the annual average, while in December, January, and February there were differences of approx. 0.1˚C, 0.6˚C, and 0.2˚C. The minimum average temperatures, -4.4˚C … -0.6˚C, in all three periods, were recorded in January, and the maximum, 19.3˚C and 20.3˚C, in July. Figure 6 presents the three periods, as well as the increasing trend from 6˚C to values up to 12˚C, with a difference of 6˚C, between 1961 and 2014.



Intervalul	Temperaturi medii lunare (°C) – TÂRGU MUREȘ											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961 - 1990	-4.4	-1.4	4.2	10.0	15.0	17.9	19.3	18.7	14.8	9.0	3.8	-1.2
1981 - 2010	-3.0	-1.5	4.2	10.3	15.7	18.5	20.3	19.7	14.8	9.3	3.4	-1.4
1961 - 2014	-3.6	-1.3	4.2	10.3	15.3	18.4	19.9	19.3	14.8	9.2	3.8	-1.3
Abatere (°C)	-0.6	-0.2	0	0	-0.4	-0.1	-0.4	-0.4	0	-0.1	+0.4	+0.1

Figure 6.

Figure 7 shows the average annual temperatures recorded at the Târgu Secuiesc meteorological station, using the agro-meteorological software, over the periods 1961-1990, 1981-2010 and 1961-2014. It is noted that the maximum temperature of 18.2˚C was recorded in the reference period 1981-2010, month of July, and the minimum -5.8˚C in 1961-1990, month of January. In June, July and August of all three periods, the recorded temperatures ranged between 15.7˚C and 18.2˚C, while in December, January, and February, they ranged between -5.8˚C and -3.1˚C. Between 1961-2014 and 1981-2010, the reference period, the deviation calculated was 1.2˚C between the maximum of 0.7˚C in January and the lowest -0.5˚C in August. In June, July and August there were negative deviations, -0.3...-0.5˚C, from the annual average, while in December, January, and February the differences ranged between 0˚C…-0.7˚C. The minimum average temperatures in all three periods and the deviation were recorded in January, from -5.8°C to -4.4°C, and the maximum, 17.1°C and 18.2°C, in July. Figure 10 presents the three periods, as well as the increasing trend from 4°C to values up to 10°C, with a difference of 6°C, between 1961 and 2014.



Intervalul	Temperaturi medii lunare (°C) – TÂRGU SECUIESC											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961 - 1990	-5.8	-3.5	1.4	7.6	12.8	15.7	17.1	16.6	12.9	7.3	2.1	-2.9
1981 - 2010	-4.4	-3.5	1.7	7.8	13.4	16.5	18.2	17.8	13.1	7.8	1.9	-3.1
1961 - 2014	-5.1	-3.4	1.5	7.8	13.1	16.3	17.8	17.4	13.0	7.6	2.2	-3.1
Abatere (°C)	-0.7	-0.1	-0.1	0	-0.3	-0.3	-0.4	-0.5	-0.1	-0.2	+0.3	0

Figure 7.

Figure 8 presents the average, maximum and minimum air temperatures (°C) recorded in Brașov County between 1981 and 2010. Thus, it is noted that the 4 weather stations, Brașov, Făgăraș, Fundata and Predeal, recorded average temperatures ranging between 4.7 and 8.2 °C, with a deviation of 3.5°C. the maximum average temperatures ranged between 8.9 and 14.8°C, with a deviation of 5.9°C, and the minimum ones ranged between 0.9 and 2.9°C. The lowest temperatures were recorded at Fundata weather station.

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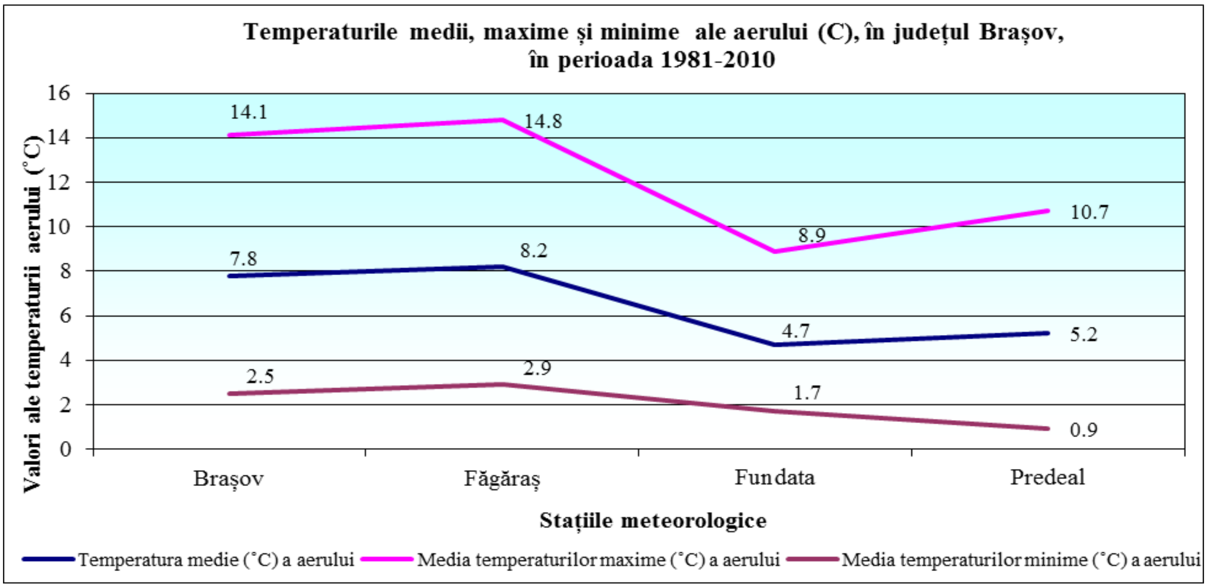

Figure 8.

Figure 9 presents the absolute maximum and minimum air temperatures (°C) recorded in Brașov County between 1981 and 2010. It is noted that the absolute maximum temperatures range between 29.5 and 37.5°C, with a deviation of 8.0°C, and the minimum ones between -32.3 and -23.2°C, with a deviation of 9.1°C. The highest value of absolute maximum temperature (37.5°C) was recorded at Făgăraș weather station, and the lowest one (-32.3°C) at Brașov.

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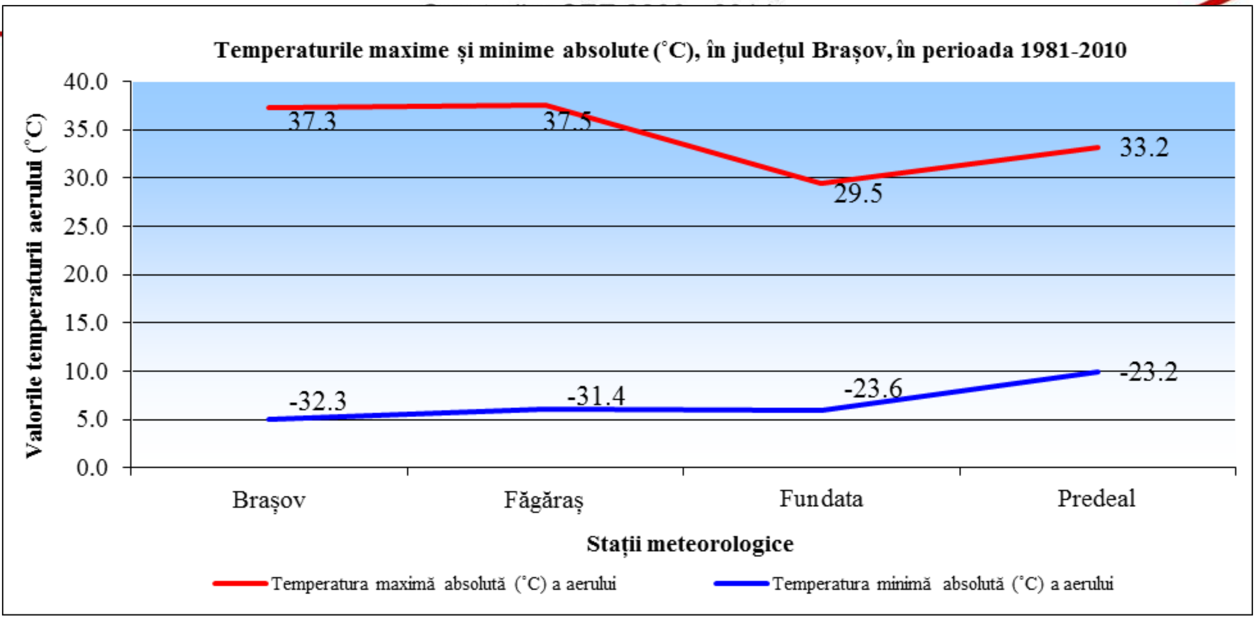

Figure 9.

2.1.4. Precipitation regime in the Region 7 – Centre

Compared to 1961-2014, the areas with more precipitation during the fall seeding, i.e. between September 1st and October 31st, were more extended between 1961 and 1990, with small amounts of 60-80 l/sq m (figure 8 a). The rainfall regime in the analysed time periods was optimal (81-120 l/sq m) in most part of the Region 7 – Centre, with isolated abundant showers (121-150 l/sq m) and extreme showers (151-193 l/sq m), as presented in figure 10 (a,b,c).

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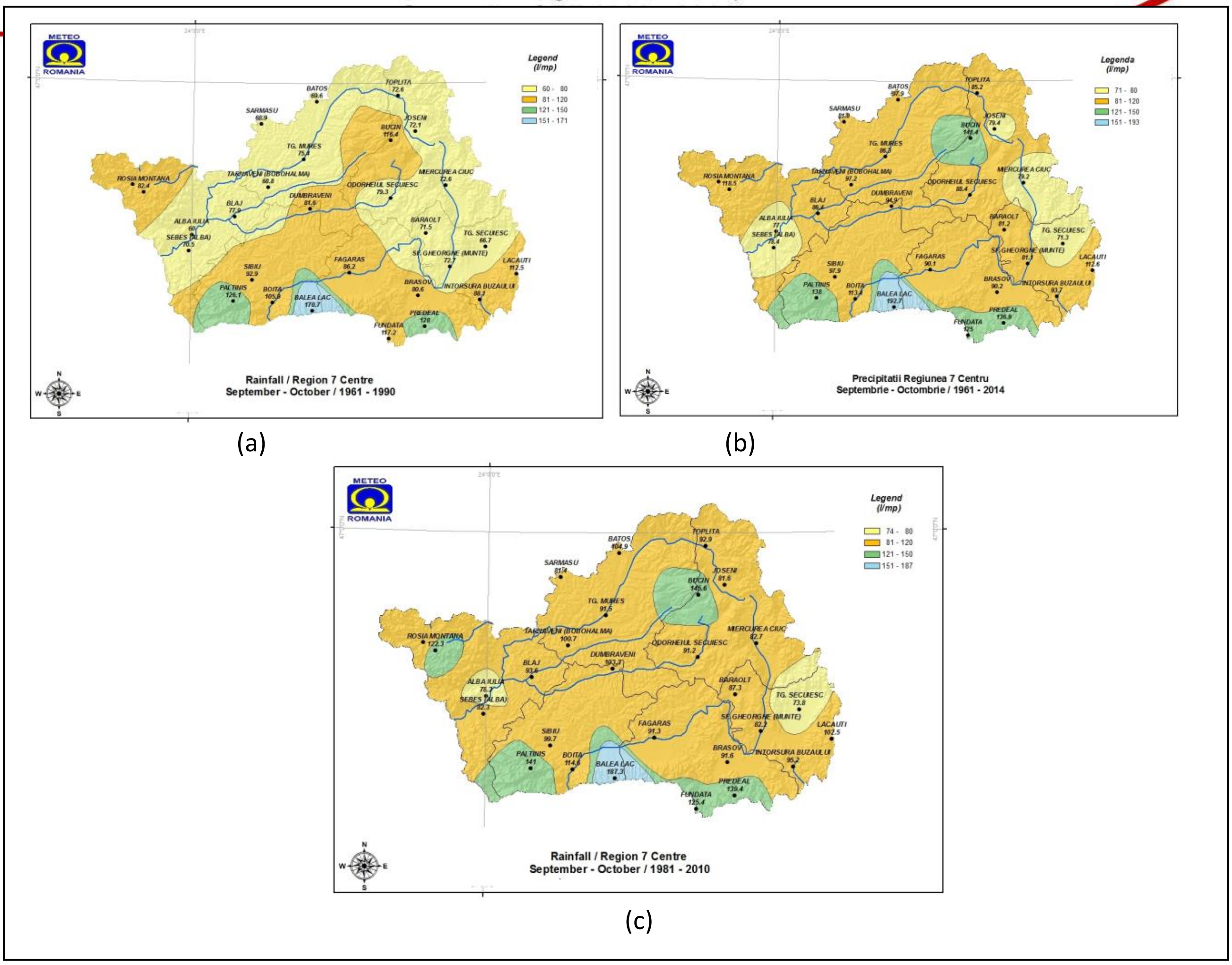

(a) (b)

(c)

Figure 10.

Between November 1 and March 31, the period of the water accumulation into the soil, the rainfall regime of both periods, 1961-1990 (figure 11a) and 1961-2014 (figure 11b), was moderate drought (151-200 l/sq m) and drought (96-150 l/sq m) in most part of the region, compared to the reference period 1981-2010 (figure 11c). Local agricultural lands in the south, north-east and west recorded optimal rainfall amounts (201-300 l/sq m). In the south (1961-1990) and northeast part of the region there were isolated abundant precipitation events (301-390 l/sq m).

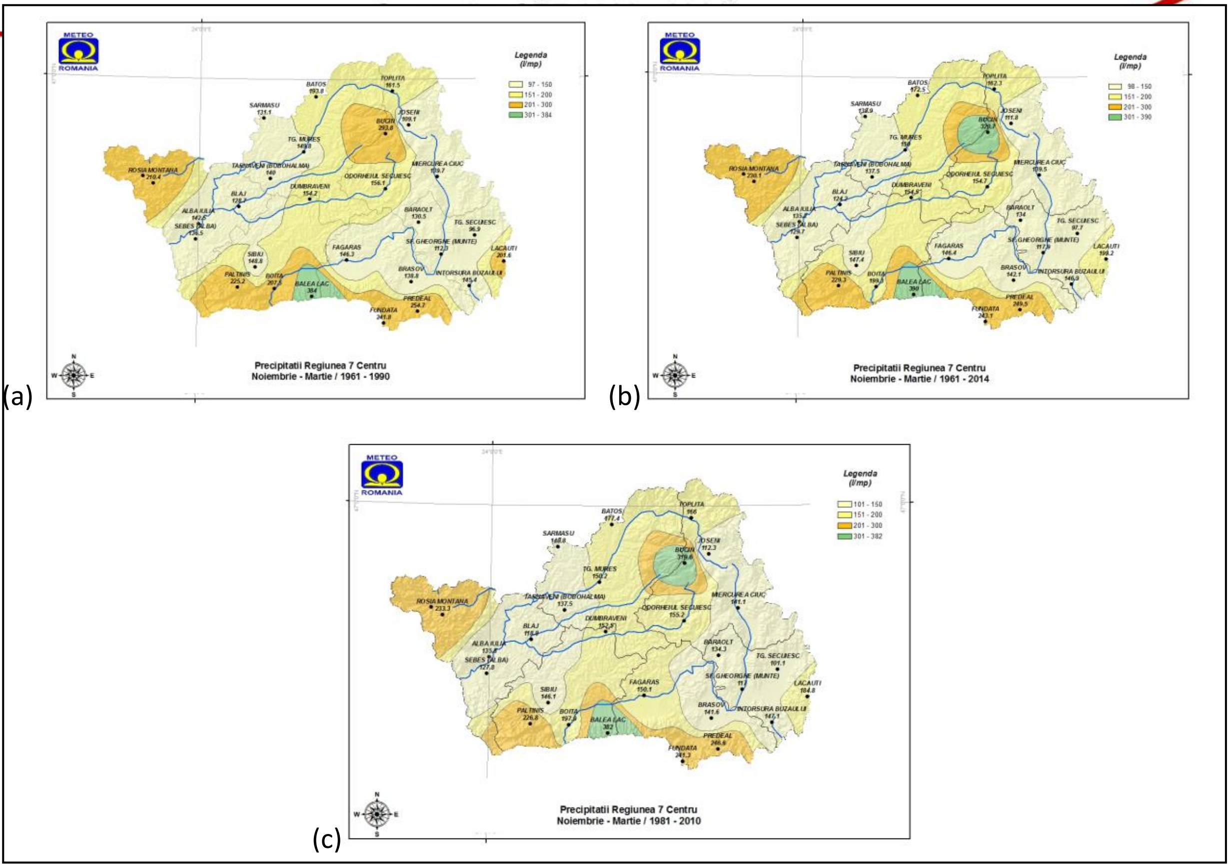

Figure 11.

Figure 12 presents the zoning of precipitation amounts during the critical period of corn plants (June to August). Between 1961 and 1990 (figure 12a), there were isolated reduced precipitation events (149-200 l/sq m) in the northwest and west part of the region. The rainfall regime over extended areas was optimal (201-300 l/sq m), with abundant rainfalls (301-400 l/sq m), and isolated excessive rainfalls (401-544 l/sq m).

Throughout the crop year, i.e. September 1 - August 31, during 1961-1990 and 1961-2014, the rainfall regime in the studied area was optimal (601-700 l/sq m), locally abundant in precipitation (701-800 l/sq m), and even extremely abundant (801-1300 l/sq m), figure 13 (a,b,c).

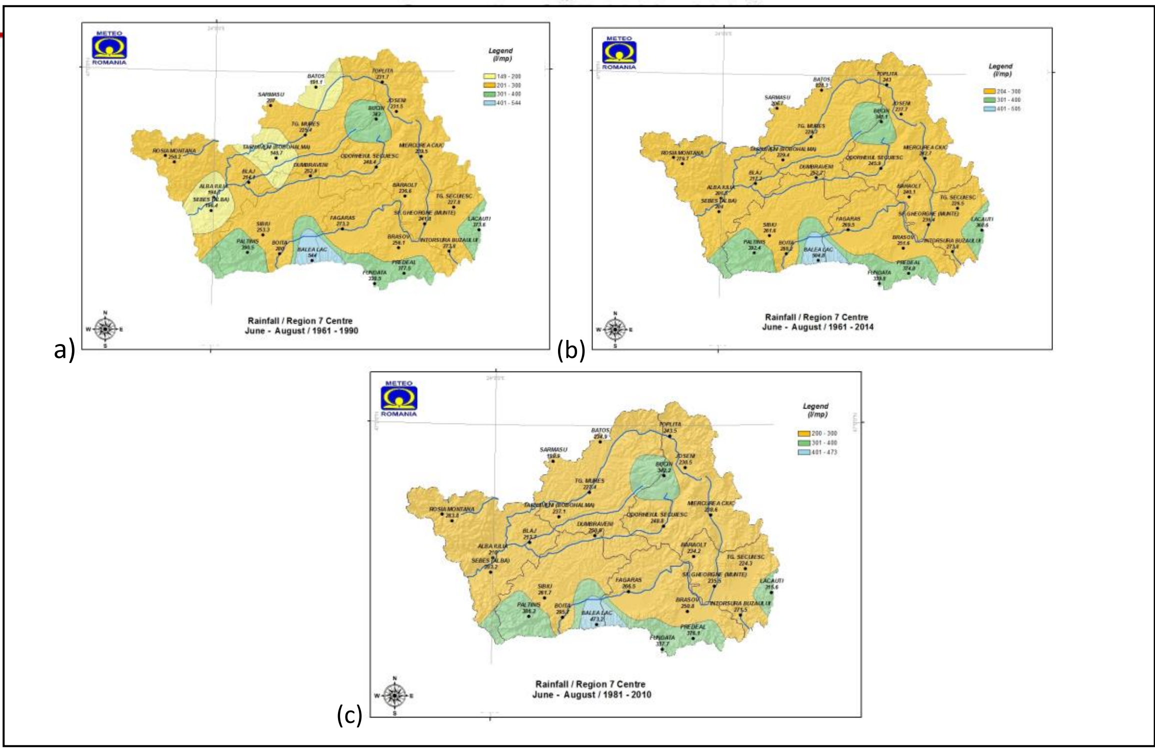

Figure 12.

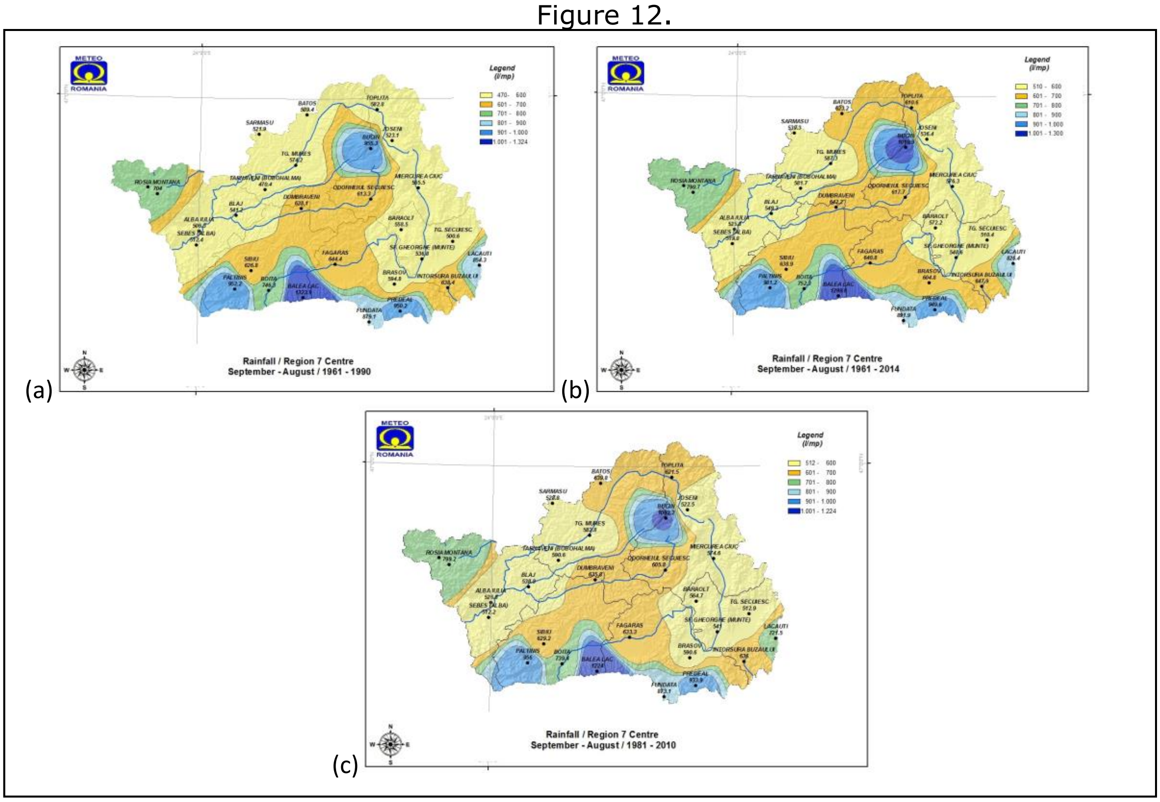

Figure 13.

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Parteneri:

METEO ROMÂNIA
ULBS Universitatea "Lucian Blaga" din Sibiu

Abundant rainfall amounts cause damage in agriculture, especially the excess moisture produced by ponding on the surface and in the soil depth. In these circumstances, the soil aeration and the activity of nitrifying bacteria in the crop plant root area, get worsen, preventing plants nutrition and development.

Excess moisture is harmful to plants, leading to their asphyxiation. The accumulation of 24 hours excessive water amounts within generates major distribution differences, in terms of both time and space, ending in a climate hazard with negative impact on agriculture. In mountain areas, it is also possible to record excess rainfall amounts within 24 hours, even in the cold weather.

Table 1 presents the maximum amounts (mm) of 24 hrs precipitations recorded in the Region 7 – Centre, between 1961 and 2014. The highest values of 24 hrs precipitations were recorded in June (195.6 mm/Bâlea Lac), July (115.4 mm/Lăcăuţi), August (94.6 mm/Păltiniş), September (92.1 mm/Predeal) and October (91.8 mm/Întorsura Buzăului). Lower values of 24 hrs precipitations were recorded in 1989 (46.9 mm/Fundata) and 1990 (47.8 mm/Predeal).

Table 1. Maximum 24 hrs rainfall amounts in the Region 7 – Centre, 1961-2014

Month	Weather station	Date	Max. amount (mm) of 24 hrs precipitation / 1961-2014
I	Lăcăuţi	17.01.1961	59,9
II	Păltiniş	10.02.1984	54,4
III	Târnăveni	28.03.1988	63,6
IV	Păltiniş	30.04.1982	68,4
V	Predeal	15.05.1984	84,2
VI	Bâlea Lac	13.06.1988	**195,6**
VII	Lăcăuţi	12.07.1969	**115,4**
VIII	Păltiniş	25.08.1977	94,6
IX	Predeal	06.09.1989	92,1
X	Întorsura Buzăului	05.10.2008	91,8
XI	Fundata	18.11.1989	46,9
XII	Predeal	12.12.1990	47,8

Figure 14 presents the average monthly precipitation in the 3 time periods, i.e. 1961-1990, 1981-2010, 1961-2014, as well as the difference between 1961-2014 and the reference period 1981-2010 recorded by the agrometeorological software at Brașov weather station. The maximum amounts in all 3 periods were recorded in July, with values ranging between 90.5 l/sq m and 92.9 l/sq m, the highest being 92.9 l/sq m between 1961 and 1990; the minimum amounts ranged between 24.2 l/sq m and 24.7 l/sq m in the months of

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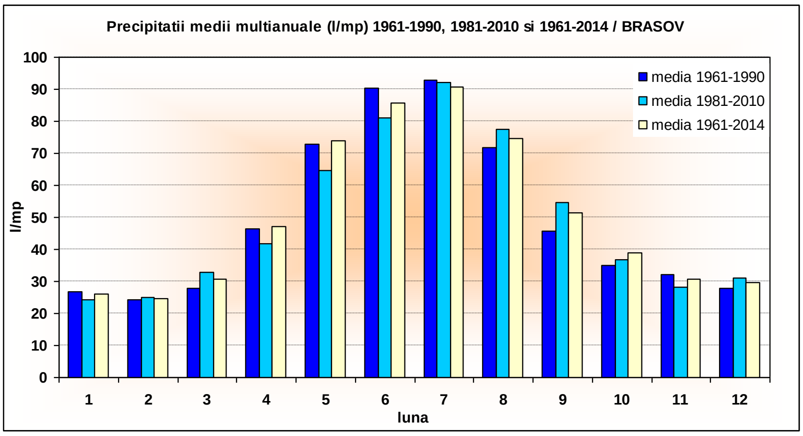
January and February. For 1961-2014 it was calculated a deviation of 3 l/sq m (negative values ranging between -3.4 l/sq m and -0.4 l/sq m recorded in February, March, July, August, September, and December) from the average annual precipitation in the reference period (1981-2010), and a deviation of 7.5 l/sq m with positive values ranging between 1.9 l/sq m and 9.3 l/sq m.



Period	Average monthly precipitation (l/ sq m) – BRAȘOV											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961-1990	26.9	24.2	27.7	46.4	73.0	90.5	92.9	71.7	45.8	35.1	32.1	27.9
1981-2010	24.3	25.1	32.8	41.9	64.6	81.2	92.2	77.4	54.8	36.8	28.3	31.2
1961-2014	26.2	24.7	30.8	47.0	73.9	85.9	90.5	74.7	51.4	38.9	30.9	29.6
Deviation (l/sq m)	+1.9	-0.4	-2.0	+5.1	+9.3	+4.7	-1.7	-2.7	-3.4	+2.1	+2.6	-1.6

Figure 14.

Figure 15 shows the average monthly precipitation recorded by the agrometeorological software at Sibiu weather station over the 3 periods, i.e. 1961-1990, 1981-2010, 1961-2014. Therefore, in all 3 periods, the maximum precipitation amounts were recorded in June, with values ranging between 92.9 l/sq m and 99.0 l/sq m, the highest being of 99.0 l/sq m in 1961-1990; the minimum precipitation amounts were recorded in January and February, with values ranging between 24.6 l/sq m and 25.8 l/sq m. The deviation from the average annual precipitation over the reference period (1981-2010), calculated for 1961-2014, recorded negative values in March, August, September, and December ranging between -5.4 l/sq m and -0.8 l/sq m, i.e. 4.6 l/sq m difference, and positive values ranging between 0.3 l/sq m and 8.8 l/sq m, i.e. 8.5 l/sq m difference, in January, February, April, May, June, July, October and November.

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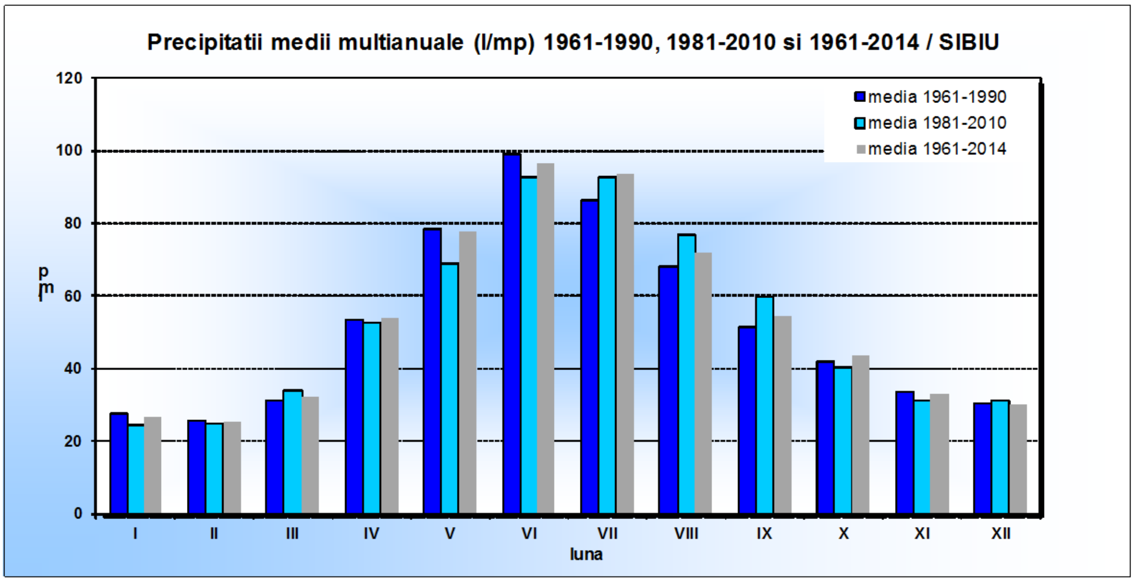

Period	Average monthly precipitation (l/sq m) – SIBIU											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961-1990	27.7	25.8	31.2	53.5	78.2	99.0	86.4	68.1	51.3	42.0	33.7	30.4
1981-2010	24.6	25.0	34.0	52.6	69.1	92.9	92.6	76.8	59.8	40.3	31.3	31.0
1961-2014	26.4	25.3	32.3	54.0	77.9	96.4	93.5	72.1	54.4	43.7	33.1	30.2
Deviation (l/sq m)	+1.8	+0.3	-1.7	+1.4	+8.8	+3.5	+0.9	-4.7	-5.4	+3.4	+1.8	-0.8

Figure 15.

Figure 16 presents the average monthly precipitation recorded by the agrometeorological software at Târgu Mureș weather station over the periods 1961-1990, 1981-2010, 1961-2014. Therefore, in all 3 periods, the maximum precipitation amounts were recorded in June (1981-2010 and 1961-2014) and July (1961-1990), with values ranging between 83.6 l/sq m and 84.8 l/sq m, the highest being of 84.8 l/sq m in 1981-2010; the minimum precipitation amounts were recorded in February, with values ranging between 23.6 l/sq m and 23.9 l/sq m. The deviation from the average annual precipitation over the reference period (1981-2010), calculated for 1961-2014, recorded negative values in February, March, June, August, September, October and December ranging between -3.8 l/sq m and -0.3 l/sq m, i.e. 3.5 l/sq m difference, and positive values ranging between 0.7

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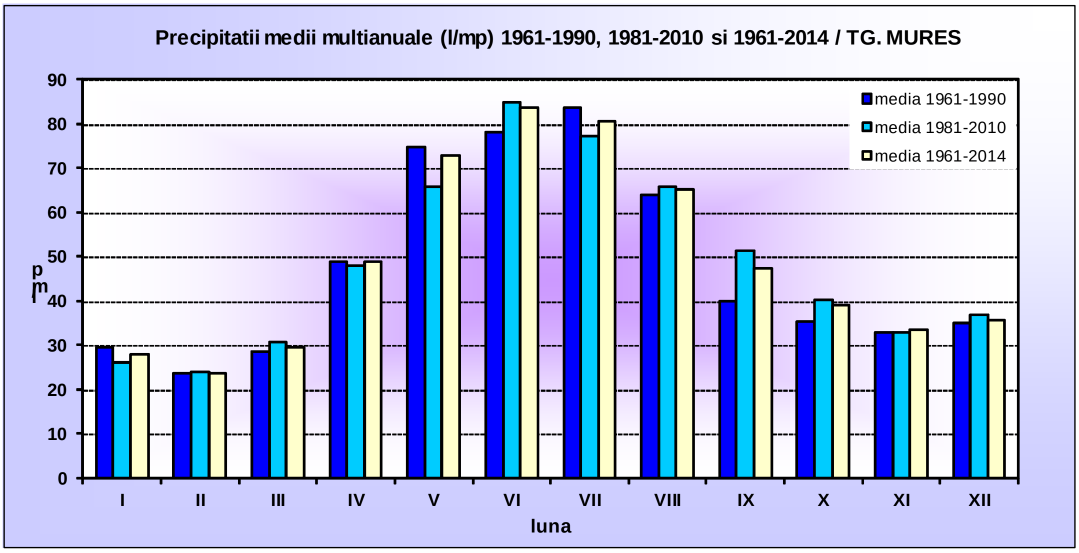
l/sq m and 7.2 l/sq m, i.e. 6.5 l/sq m difference, in January, April, May, July, and November.



Period	Average monthly precipitation (l/sq m) – TÂRGU MUREŞ											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961-1990	29.5	23.6	28.7	49.0	74.6	78.0	83.6	63.8	40.0	35.4	32.9	35.1
1981-2010	26.0	23.9	30.6	48.0	65.7	84.8	77.0	65.6	51.2	40.3	32.7	37.0
1961-2014	27.8	23.6	29.5	48.8	72.9	83.7	80.4	65.2	47.4	38.9	33.4	35.7
Deviation (l/sq m)	+1.8	-0.3	-1.1	+0.8	+7.2	-1.1	+3.4	-0.4	-3.8	-1.4	+0.7	-1.3

Figure 16.

Figure 17 shows the average monthly precipitation recorded by the agrometeorological software at Târgu Secuiesc weather station over the 3 periods, i.e. 1961-1990, 1981-2010, 1961-2014, as well as the deviation from the reference period (1981-2010), calculated for 1961-2014. Therefore, in all 3 periods, the maximum precipitation amounts were recorded in June, with values ranging between 79.8 l/sq m and 82.6 l/sq m, the highest being of 82.6 l/sq m in 1981-2010; the minimum precipitation amounts were recorded in December, January and February, with values ranging between 17.0 l/sq m and 17.5 l/sq m. The deviation from the average annual precipitation over the reference period (1981-2010), calculated for 1961-2014, recorded negative values in February, March, April, June, September, and October, ranging between -2.3 l/sq m and -

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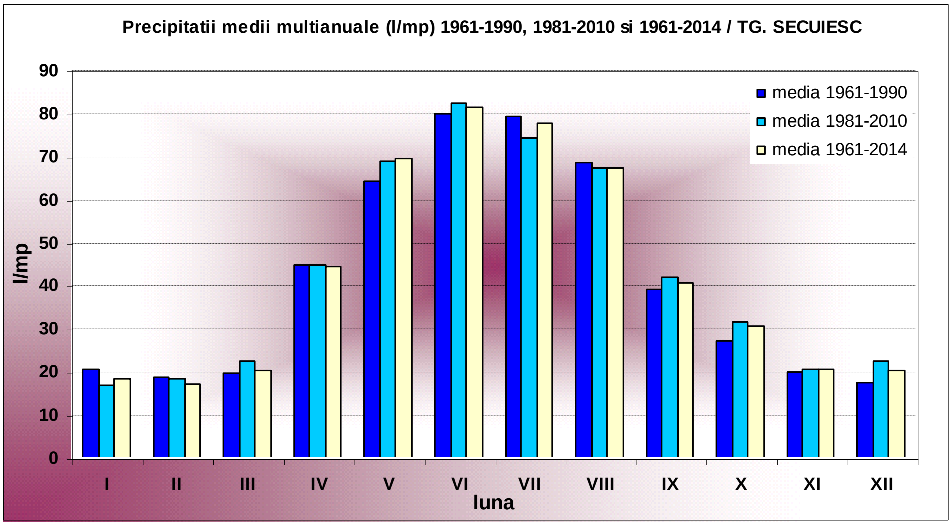
0.1 l/sq m, i.e. 2.2 l/sq m difference, and positive values ranging between 0 l/sq m and 3.4 l/sq m, in January, May, July, August and November.



Period	Average monthly precipitation (l/sq m) – TÂRGU SECUIESC											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961-1990	20.7	18.8	19.8	44.9	64.4	79.8	79.2	68.8	39.3	27.4	20.1	17.5
1981-2010	17.0	18.5	22.6	44.7	69.0	82.6	74.3	67.4	42.0	31.8	20.7	22.6
1961-2014	18.6	17.4	20.3	44.6	69.6	81.4	77.7	67.4	40.7	30.6	20.7	20.3
Deviation (l/sq m)	+1.6	-1.1	-2.3	-0.1	+0.6	-1.2	+3.4	0	-1.3	-1.2	0	-2.3

Figura 17.

Figure 18 presents the average and maximum precipitation (l/sq m) fallen in 24 hours, over the period 1981-2010 in Brașov County. Therefore, it is noted that the average precipitation amounts (l/sq m) ranged between 590.6 and 933.9 l/sq m, i.e. 343.3 l/sq m difference, and the maximum amount over 24 hours ranged between 62.2 and 122.1l/sq m, i.e. a deviation of 59.9 l/sq m. Both the highest average precipitation (933.9 l/sq m) and the maximum precipitation (122.1 l/sq m) / 24 hrs were recorded at Predeal weather station.

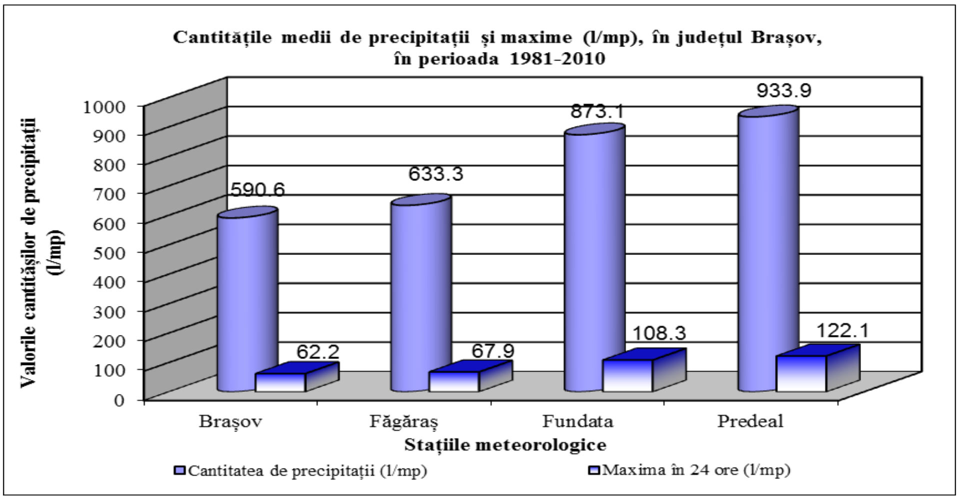


Figure 18.

2.1.5. Soil-moisture reserve for winter wheat crops in the Region 7 - Centre, between 1970-2014

Between 1970 and 2014, during the autumn seeding season, most agricultural areas recorded satisfactory values (300-400 m^3/ha) of the water level in the soil depth, 0-20 cm (field). Northern and, locally, western parts of the region faced a moderate pedological drought (200-300 mc/ha), figure 19 a).

During the reference period, i.e. 1981-2010, the soil-moisture reserve framed within satisfactory limits (300-450 mc/ha) in almost the entire region, except for some areas in the north and west, that recorded moderate soil-water deficits, figure 19 b).

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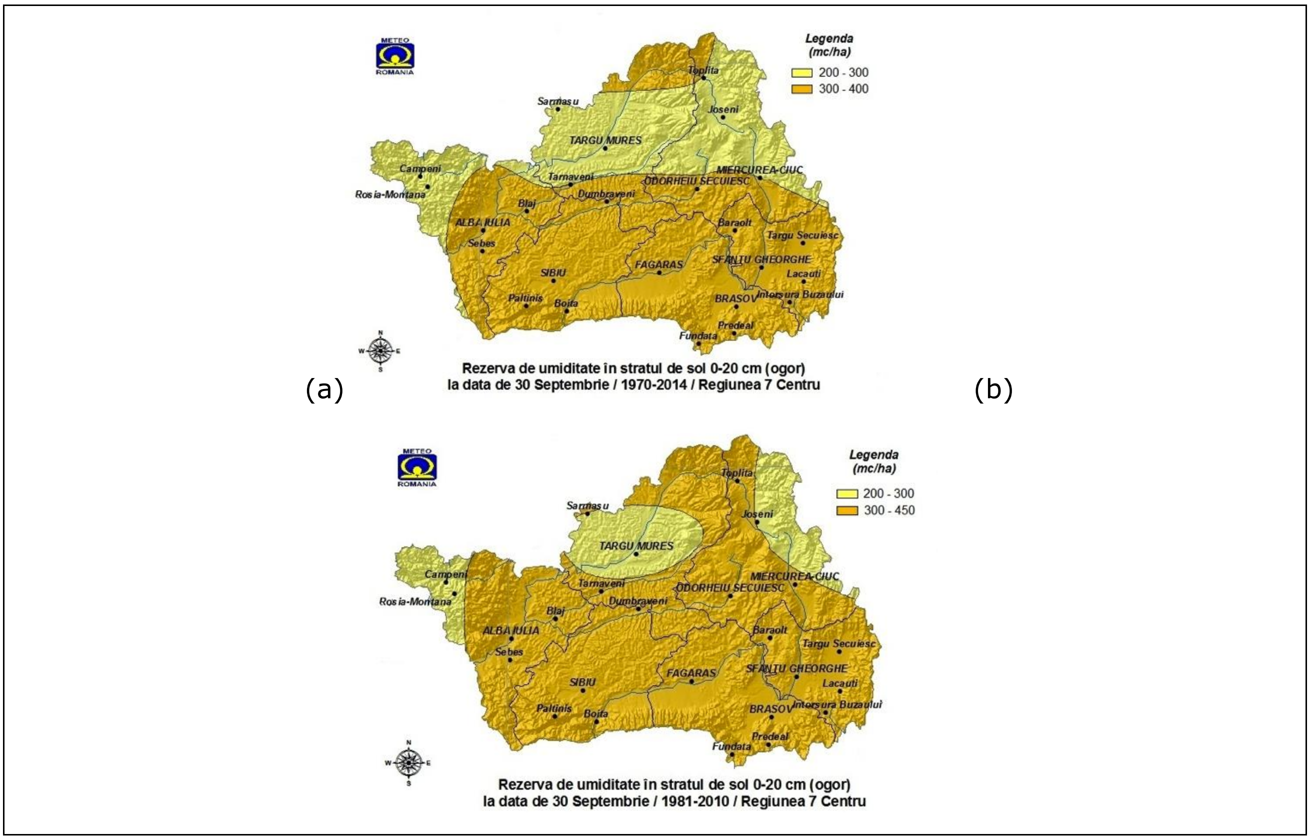


Figure 19.

At the end of May, in both periods 1970-2014 and 1981-2010, the moisture reserve / 0-100 cm soil depth available to winter wheat crops framed within satisfactory limits (700-1150 mc/ha), in the entire region, figure 20 (a,b).

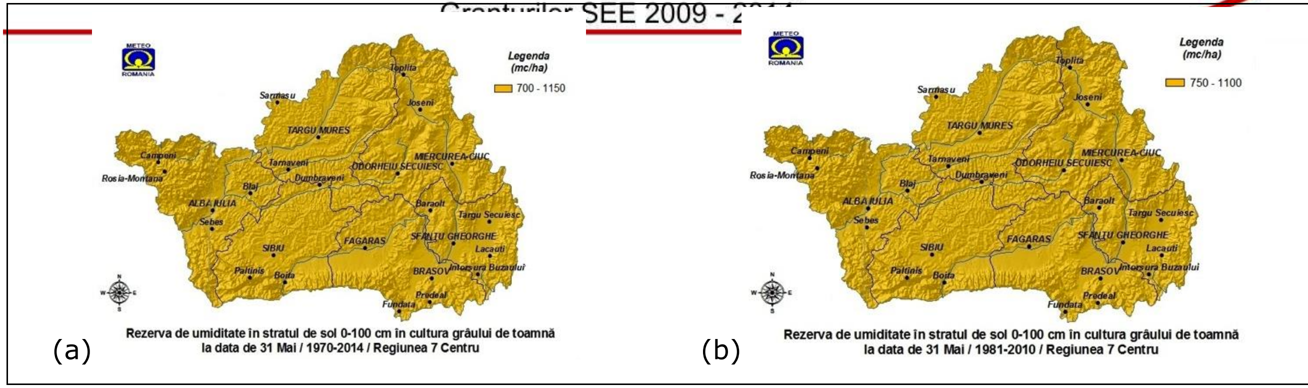


Figure 20.

In both periods, 1970-2014 and 1981-2010, the amount of water available to winter wheat crops / 0-100 cm soil depth was satisfactory (800-1000 mc/ha) in most part of the region. Locally, to the west and north end of the studied area, moderate pedological drought (750-850 mc/ha) was noted, figure 21 (a,b).

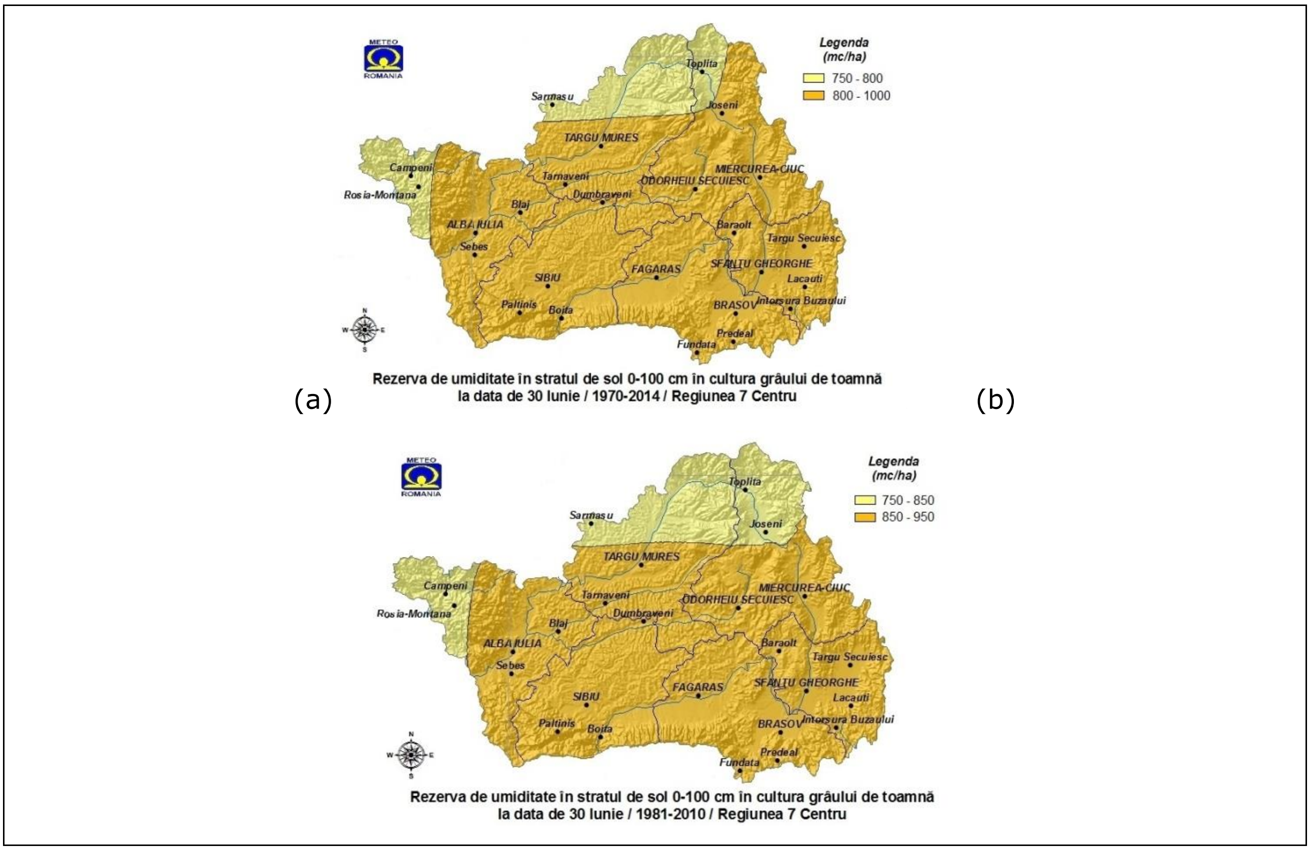
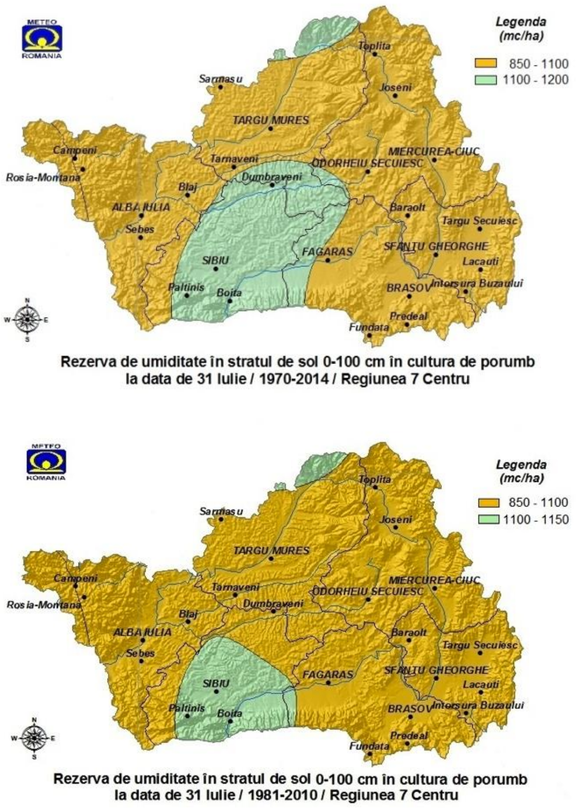


Figure 21.

2.1.6. Soil-moisture reserve for corn crops in the Region 7 - Centre, between 1970-2014

The moisture reserve / 0-100 cm depth on non-irrigated corn crop yields was satisfactory (850-1100 mc/ha), and, locally, almost optimal (1100-1200 mc/ha), in the entire region, figure 22 (a,b).



(a) (b)

Figure 22.

Between 1970 and 2014, the soil-moisture level / 0-100 cm depth was satisfactory (850-1050 mc/ha) on most crop fields. Between 1970 and 2014, at the end of August, the moisture level in some western areas recorded lower values (750-850 mc/ha) compared to the reference period 1981-2010, figure 23 (a,b).

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Rezerva de umiditate în stratul de sol 0-100 cm în cultura de porumb
la data de 31 August / 1970-2014 / Regiunea 7 Centru

(a) (b)

Rezerva de umiditate în stratul de sol 0-100 cm în cultura de porumb
la data de 31 August / 1981-2010 / Regiunea 7 Centru

Figure 23.

2.1.7. Air temperature and precipitation amounts between 1981 and 2010

Figure 24 shows the average maximum and minimum air temperatures (° C), in the county of Sibiu, between 1981 and 2010. It is noted that the 4 representative weather stations at Sibiu, Boiţa, Balea Lac and Dumbrăveni recorded average air temperatures between 0.5 and 9.1 ° C, with a deviation of 8.6 ° C. The average maximum temperatures ranged between 3.7 and 15.0 ° C, with a deviation of 11.3 ° C, and the lows between -2.2

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and 5.0 ° C. The lowest values were recorded at the weather station Balea Lac, located at 2,040 meters altitude.

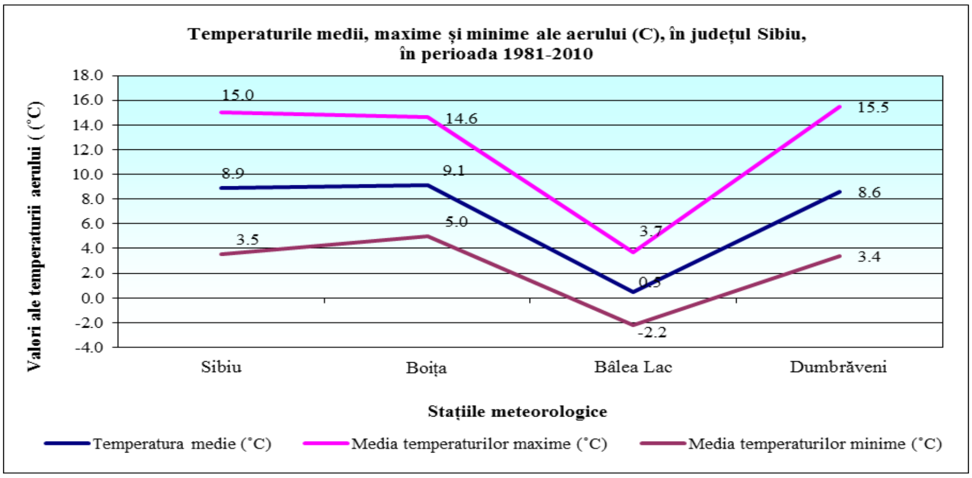

Figure 24.

Figure 25 presents the absolute maximum and minimum air temperatures (°C) in Sibiu County, between 1981 and 2010. Therefore, it is noted that the absolute maximum air temperatures range between 24.8 and 38.5 ° C with a deviation of 13.7 ° C, and the lowest between -31.7 and -26.5 ° C, with a deviation of 5.2 ° C. The highest value of absolute maximum temperature was recorded at the Dumbrăveni weather station / 38.4 ° C, and the lowest absolute value of the minimum temperature was recorded at Balea Lac / -31.7 ° C.

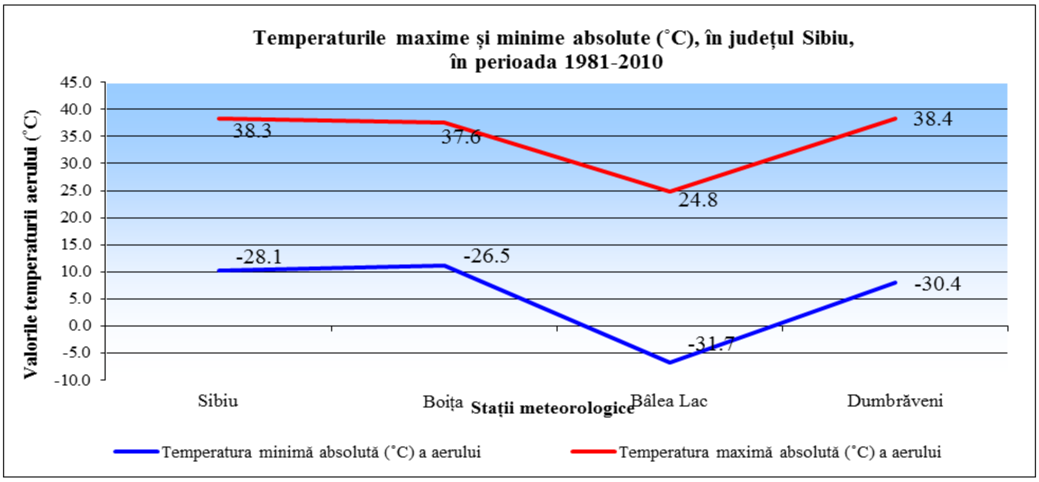

Figure 25.

Figure 26 presents the average and maximum 24 hrs precipitation amounts (l/sq m) in Sibiu county, between 1981 and 2010. Thus, it is noted that the average amounts of

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precipitation (l /sq m) ranged between 629.2 and 1224.0 l / sqm, with a difference of 594.8 l / sqm, and the maximum 24 hrs precipitation ranged between 59.0 and 195.6 l / m with a deviation 136.6 l / m. Both the highest average and maximum 24 hours precipitation amounts were recorded at the Balea Lac weather station, i.e. 1224.0 l / sqm and 195.6 l / sqm.

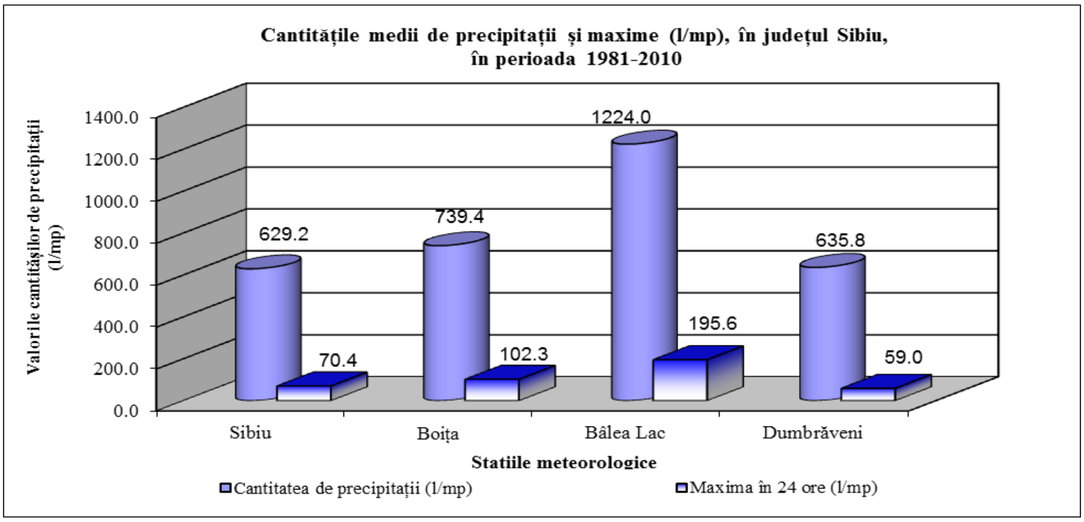

Figure 26.

Figure 27 presents the average maximum and minimum air temperatures (°C) in Târgu Mureș County, between 1981 and 2010. Therefore, it is noted that the 4 representative weather stations, Târgu Mureș, Batoș, Sârmaș and Târnăveni, recorded average maximum air temperatures ranging between 8.9 and 9.3°C, with a deviation of 1.3° C, and the minimum ones between 4.1 and 5.5° C, with a deviation of 5.2 °C. The differences between temperature values were insignificant, with small deviations compared to other counties.

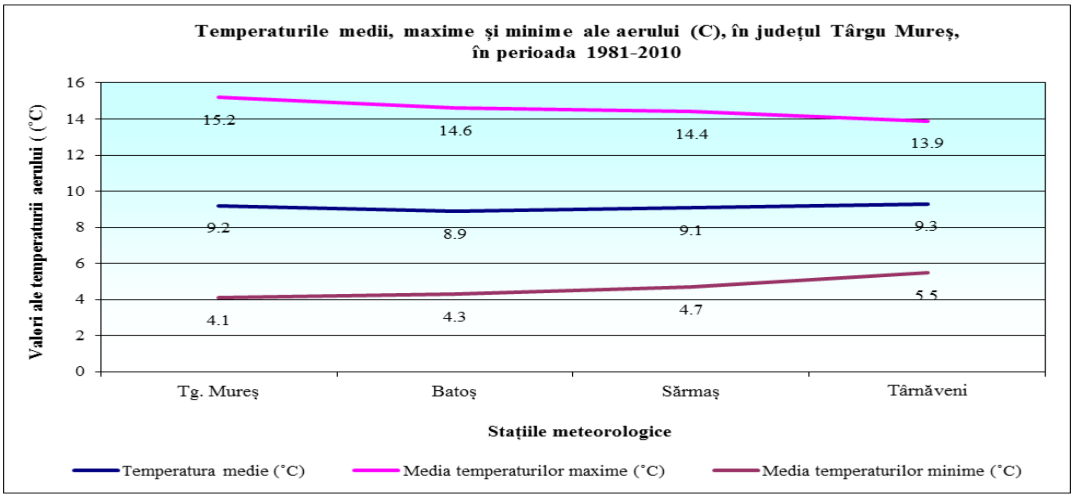

Figura 27.

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Figure 28 presents the absolute maximum and minimum air temperatures (°C) in Târgu Mureș County, between 1981 and 2010. Therefore, it is noted that the absolute maximum air temperatures range between 36.0 and 38.3 ° C with a deviation of 2.3° C, and the lowest between -30.5 and -20.2° C, with a deviation of 10.3 °C. The highest value of absolute maximum temperature was recorded at the Târnăveni weather station / 38.3 ° C, and the lowest absolute value of the minimum temperature was recorded at Târgu Mureș / -30.5° C

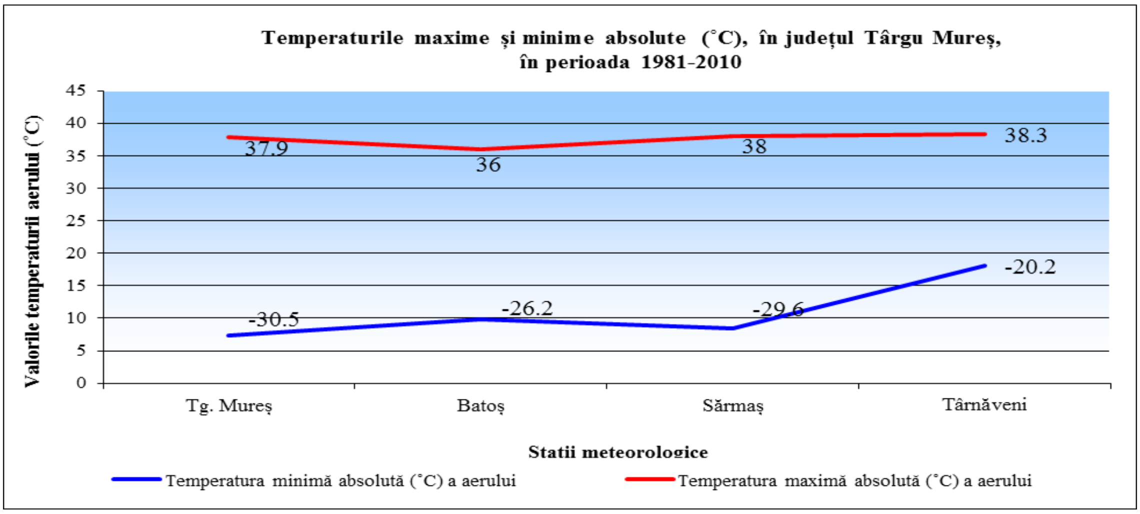

Figure 28.

Figure 29 presents the average and maximum 24 hrs precipitation amounts (l/sq m) in Târgu Mureș county, between 1981 and 2010. Thus, it is noted that the average amounts of precipitation (l /sq m) ranged between528.8 and 639.8 l / sqm, with a difference of 111 l / sqm, and the maximum 24 hrs precipitation ranged between 57.8 and 81.4 l / m with a deviation 23.6 l / m. The highest 24 hours precipitation amount was recorded at the Târnăveni weather station, i.e. 81.4 l / sq m.

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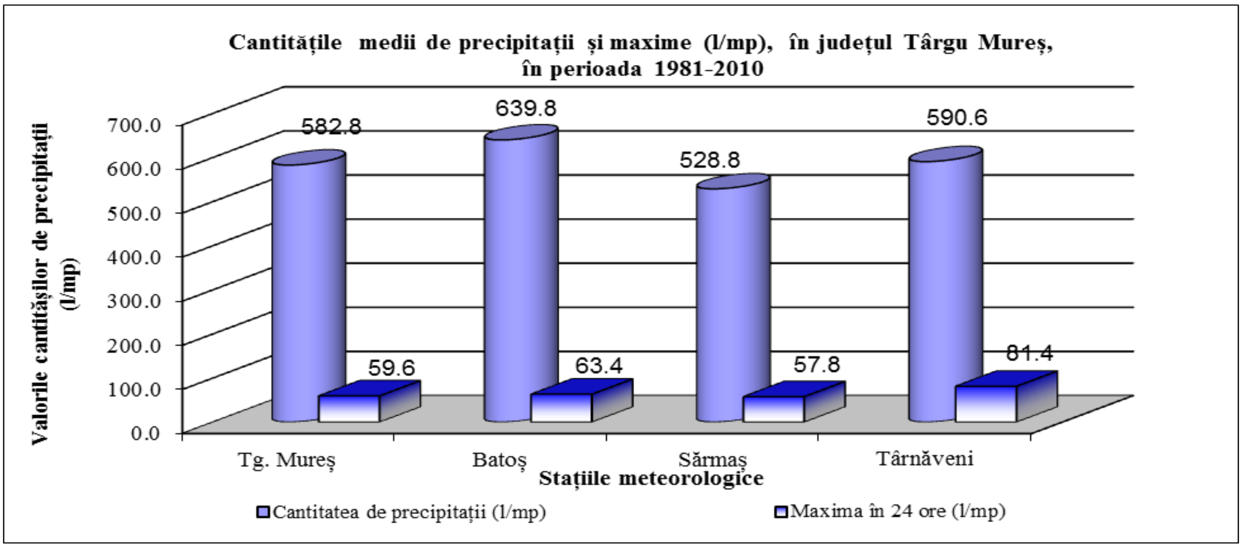

Figure 29.

Figure 30 presents the average maximum and minimum air temperatures (°C) in Harghita County, between 1981 and 2010. Therefore, it is noted that the 5 representative weather stations, Toplița, Joseni, Odorheiul Secuiesc, Miercurea Ciuc and Bucin, recorded average air temperatures ranging between 4.0 and 8.2°C, with a deviation of 4.2° C. The average maximum temperatures ranged between 8.5 and 14.8°C, with a deviation of 6.3° C, and the minimum ones between -0.5 and 3.6° C. The highest temperatures were recorded at Odorheiul Secuiesc weather station, and the lowest at Bucin weather station, except for the lowest air temperature recorded at Miercurea Ciuc weather station.

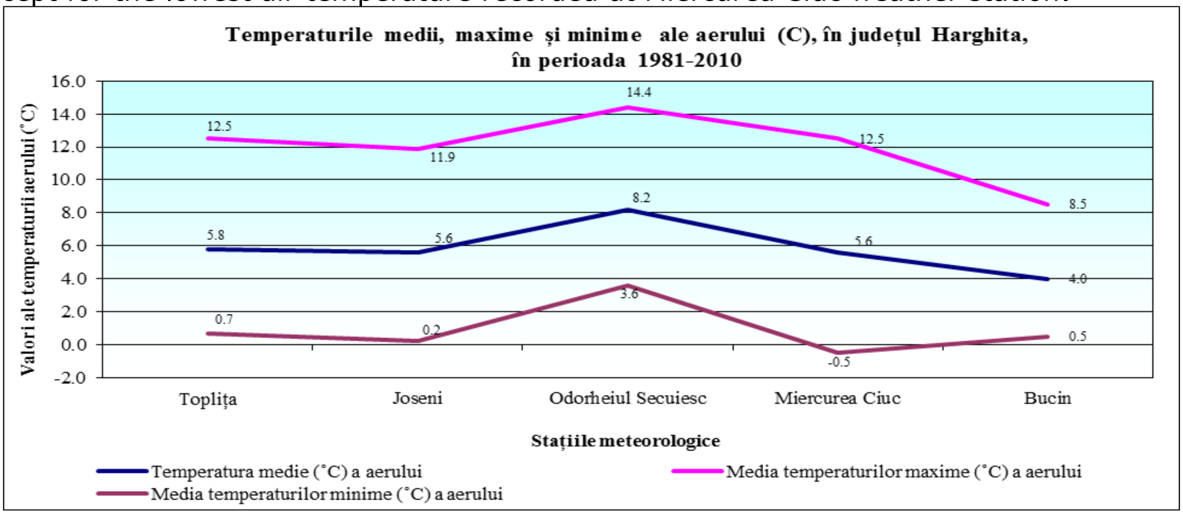

Figure 30.

Figure 31 presents the absolute maximum and minimum air temperatures (°C) in Harghita County, between 1981 and 2010. Thus, it is noted that the absolute maximum air temperatures range between 28.6 and 36.2° C with a deviation of 7.6° C, and the lowest between -38.4 and -25.7° C, with a deviation of 12.7°C. The highest value of absolute

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maximum temperature was recorded at the Odorheiul Secuiesc weather station / 36.2° C, and the lowest absolute value of the minimum temperature was recorded at Miercurea Ciuc / -38.4° C.

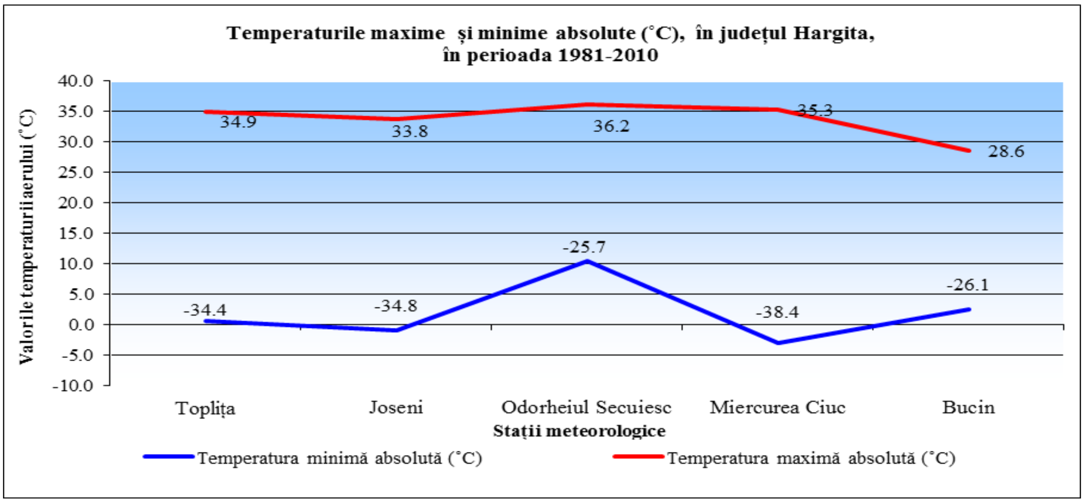

Figure 31.

Figure 32 presents the average and maximum 24 hrs precipitation amounts (l/sq m) in Harghita county, between 1981 and 2010. Thus, it is noted that the average amounts of precipitation (l /sq m) ranged between 522.5 and 1002.0 l / sqm, with a difference of 479.5 l / sqm, and the maximum 24 hrs precipitation ranged between 55.0 and 106.3 l / m with a deviation 51.3 l / m. Both the highest average and maximum 24 hours precipitation amounts were recorded at the Bucin weather station, i.e. 1002.0 l / sq m and 106.3 l/sqm.

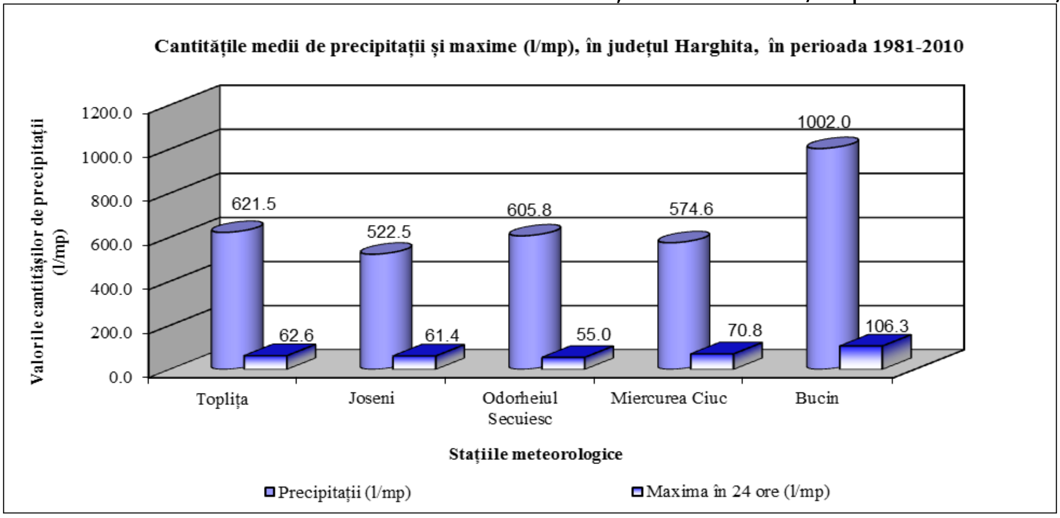

Figure 32.

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Figure 33 presents the average maximum and minimum air temperatures (°C) in Alba County, between 1981 and 2010. Therefore, it is noted that the 4 representative weather stations, Câmpeni, Sebeș-Alba, Alba-Iulia and Blaj, recorded average air temperatures ranging between 7.5 and 9.9°C, with a deviation of 5.4° C. The average maximum temperatures ranged between 14.5 and 15.9°C, with a deviation of 1.4° C, and the minimum ones between 2.6 and 5.0° C. The differences between temperature values were insignificant, with small deviations compared to other counties.

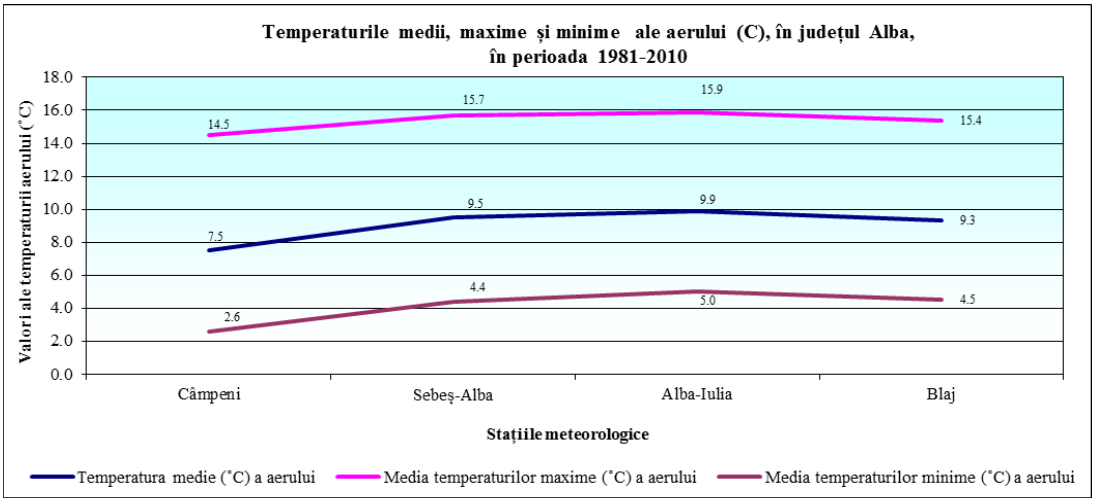

Figura 33.

Figure 34 presents the absolute maximum and minimum air temperatures (°C) in Alba County, between 1981 and 2010. Thus, it is noted that the absolute maximum air temperatures range between 36.0 and 39.7° C with a deviation of 3.6° C, and the lowest between -30.4 and -26.5° C, with a deviation of 3.9°C. The highest value of absolute maximum temperature was recorded at the Sebeș-Alba weather station / 39.7° C, and the lowest absolute value of the minimum temperature was recorded at Blaj / -30.4° C.

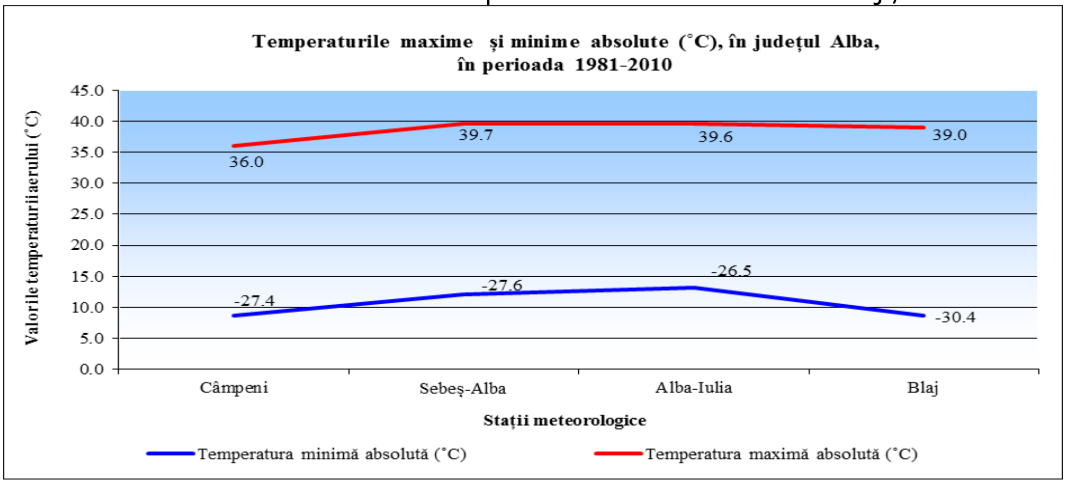

Figure 34.

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Figure 35 presents the average and maximum 24 hrs precipitation amounts (l/sq m) in Alba county, between 1981 and 2010. Thus, it is noted that the average amounts of precipitation (l /sq m) ranged between 512.2 and 769.4 l / sqm, with a difference of 257.2 l / sqm, and the maximum 24 hrs precipitation ranged between 60.0 and 84.4 l / m with a deviation 24.4 l / m. The highest 24 hours precipitation amount of 84.4 l/sqm was recorded at Blaj. Moreover, the weather station recorded a difference of 709.4 l / sq m between the average precipitation amount of 769.4 l/sqm and the max. 24 hrs precipitation of 60.0 l/sqm.

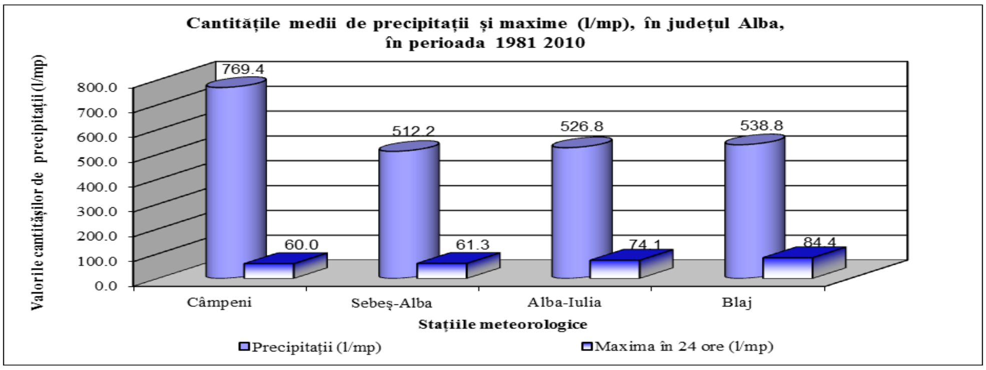

Figure 35.

Figure 36 presents the average maximum and minimum air temperatures (°C) in Covasna County, between 1981 and 2010. Therefore, it is noted that the 5 representative weather stations, Baraolt, Târgu-Secuiesc, Sf. Gheorghe, Lăcăuți and Întorsura Buzâului, recorded average air temperatures ranging between 1.5 and 7.8°C, with a deviation of 6.3° C. The average maximum temperatures ranged between 5.1 and 14.3°C, with a deviation of 9.2° C, and the minimum ones between -1.0 and 2.6° C. The lowest values were recorded at Lăcăuți weather station, with deviations >6.0°C.

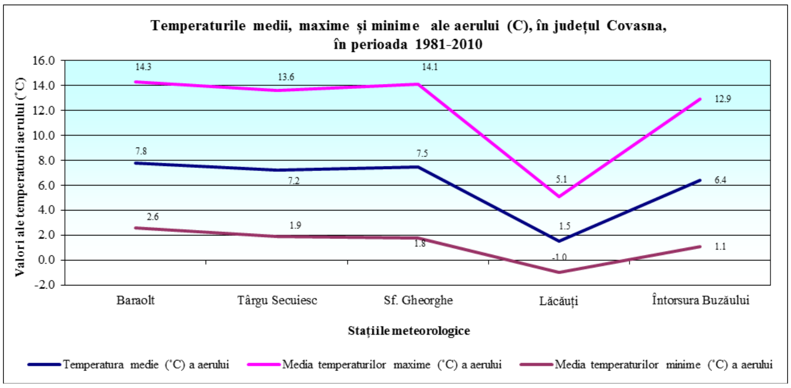

Figure 36.

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Figure 37 presents the absolute maximum and minimum air temperatures (°C) in Covasna County, between 1981 and 2010. Thus, it is noted that the absolute maximum air temperatures range between 27.2 and 37.0°C ° C with a deviation of 9.8° C, and the lowest between -35.8 and -27.2° C, with a deviation of 8.6°C. The highest value of absolute maximum temperature of 37.0°C was recorded at the Baraolt, Târgu Secuiesc and Sf. Gheorghe weather stations, and the lowest value of the absolute minimum temperature was recorded at Întorsura Buzăului / -35.8° C.

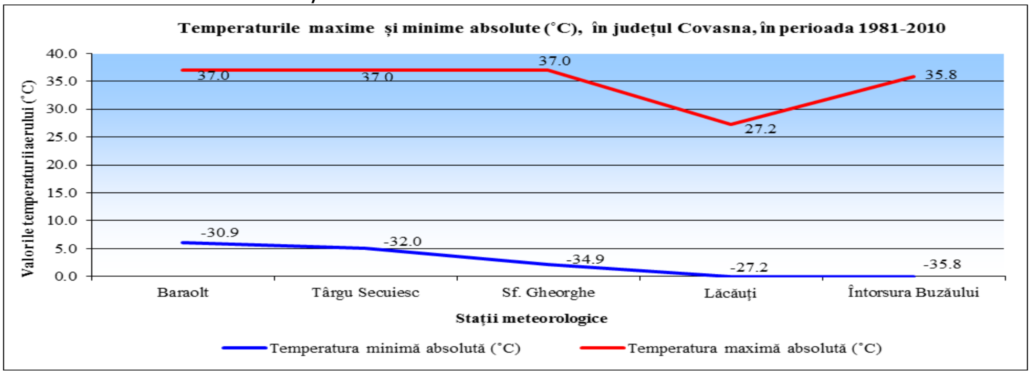

Figure 37.

Figure 38 presents the average and maximum 24 hrs precipitation amounts (l/sq m) in Covasna county, between 1981 and 2010. Thus, it is noted that the average amounts of precipitation (l /sq m) ranged between 512.9 and 721.5 l / sqm, with a difference of 199.6 l / sqm, and the maximum 24 hrs precipitation ranged between 60.0 and 91.8 l / m with a deviation 31.8 l / m. The highest 24 hours precipitation amount of 91.8 l/sqm was recorded at Întorsura Buzăului.

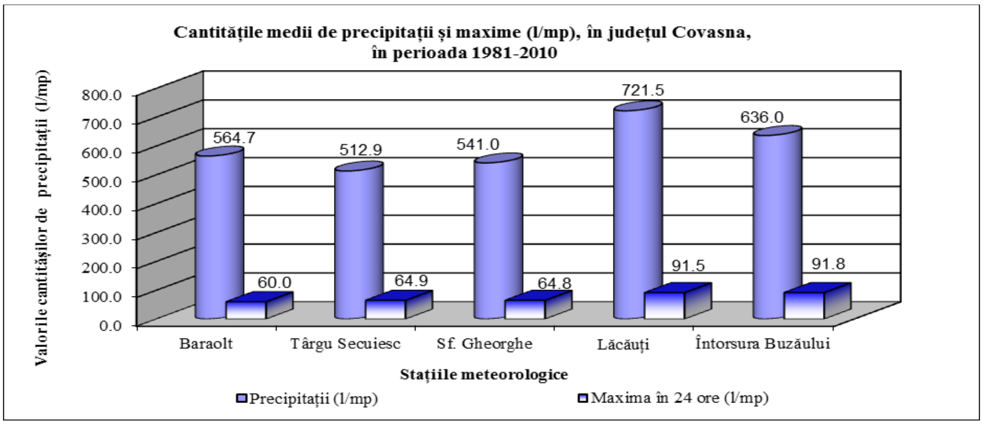

Figure 38.

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2.1.8. Relative humidity, average wind speed and sunshine duration between 1981 and 2010

Figure 39 shows the relative humidity (%), in Brașov county, between 1981 and 2010. It is noted that the relative humidity values (%) recorded by the 4 weather stations range between 62.4 and 71.2%, with a difference of 8.8%. The highest value of 71.2% was recorded at Fundata weather station, and the lowest, 62.4%, at Brașov weather station.

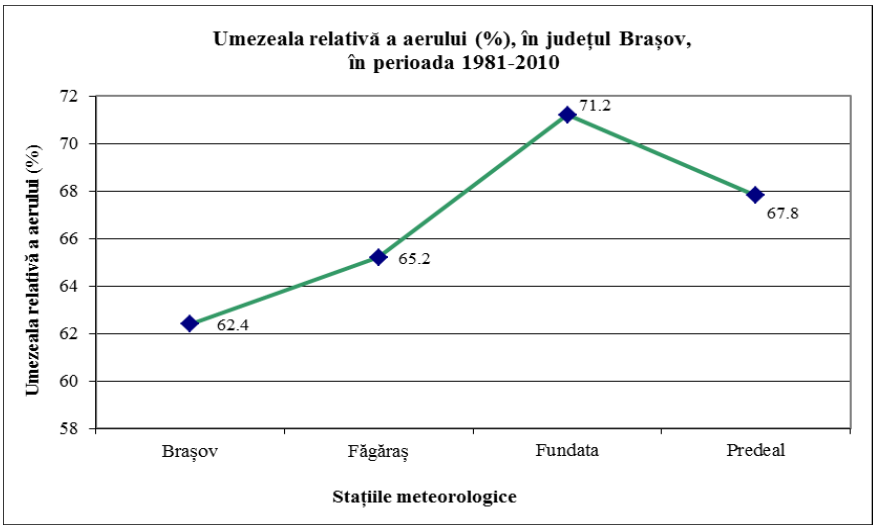

Figure 39.

Figure 40 shows the average wind speed (m/s) in Brașov county, between 1981 and 2010. It is noted that the average wind speed values (m/s) range between 1.4 and 3.4 m/s, with a difference of 2 m/s. The highest average wind speed (m/s) of 3.4 m/s was recorded at Fundata weather station, and the lowest, 1.4 m/s, at Făgăraș.

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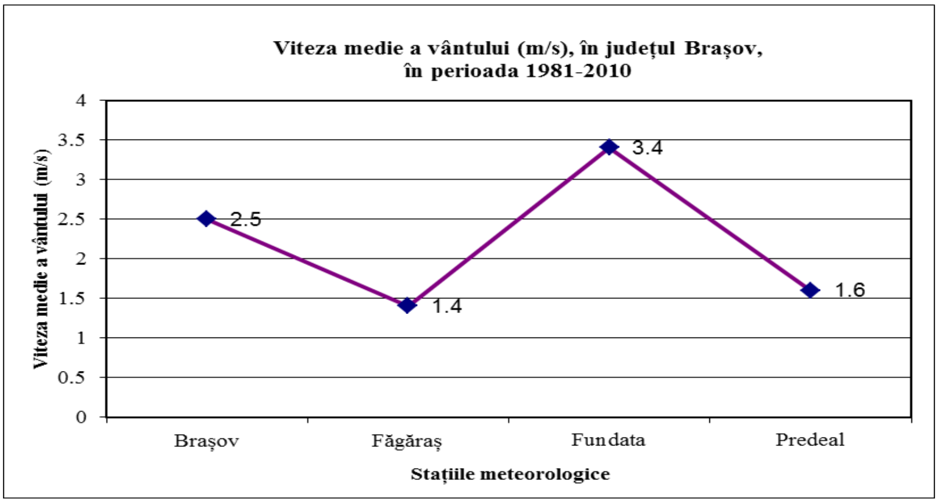

Figure 40.

Figure 41 presents the sunshine duration (hrs / year) in Brașov county, between 1981 and 2010. It is noted that the sunshine duration values (hrs / year) range between 1557.6 and 2089.9 hrs / year, with a difference of 532.3 hrs / year. The highest value of sunshine duration, i.e. 2089.9 hrs / year, was recorded at Fundata weather station, and the lowest, 1557.6 hrs / year, at Predeal weather station.

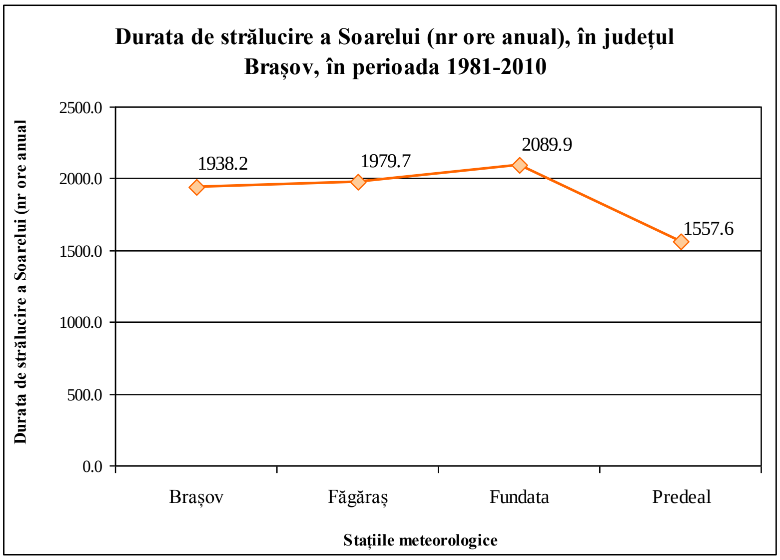

Figure 41.

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Figure 42 shows the relative humidity (%) in Sibiu county, between 1981 and 2010. It is noted that the relative humidity values (%) recorded by the 4 weather stations range between 61.1 and 64.7%, with a difference of 3.6%. The highest value of 64.7% was recorded at Dumbrăveni weather station, and the lowest, 61.1%, at Sibiu weather station.

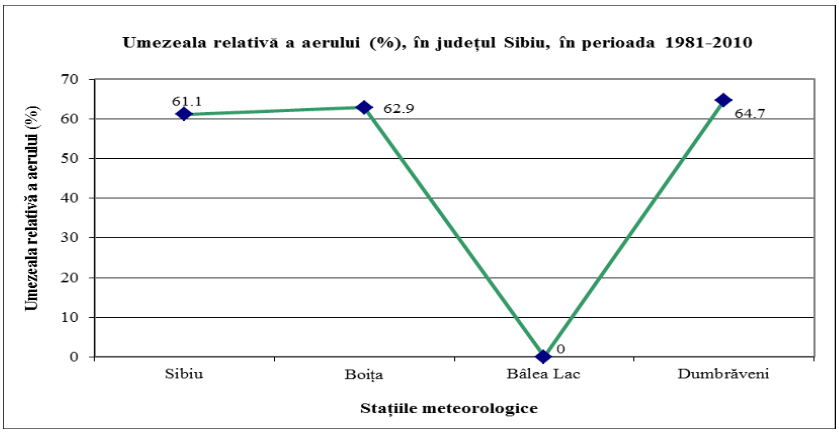

Figure 42.

Figure 43 presents the sunshine duration (hrs / year) in Sibiu county, between 1981 and 2010. It is noted that the sunshine duration values (hrs / year) range between 82.2 and 1990.7 hrs / year, with a difference of 1908.5 hrs / year. The highest value of sunshine duration, i.e. 1990.7 hrs / year, was recorded at Dumbrăveni weather station, and the lowest, 82.2 hrs / year, at Bâlea Lac weather station.

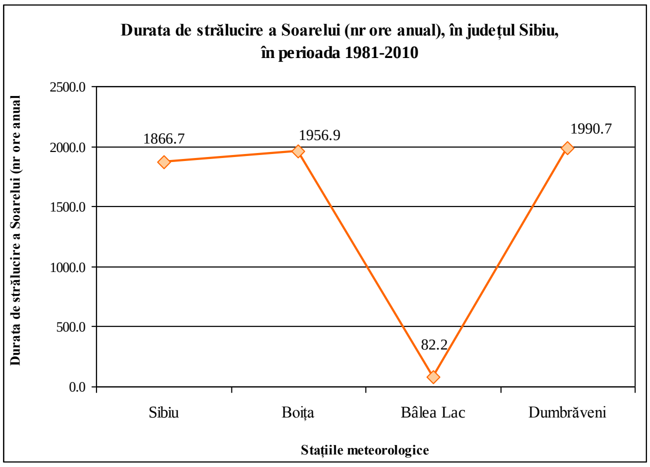

Figure 43.

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Figure 44 shows the average wind speed (m/s) in Sibiu county, between 1981 and 2010. It is noted that the average wind speed values (m/s) range between 1.2 and 3.6 m/s, with a difference of 2.4 m/s. The highest average wind speed (m/s) of 3.6 m/s was recorded at Boița weather station, and the lowest, 1.2 m/s, at Dumbrăveni.

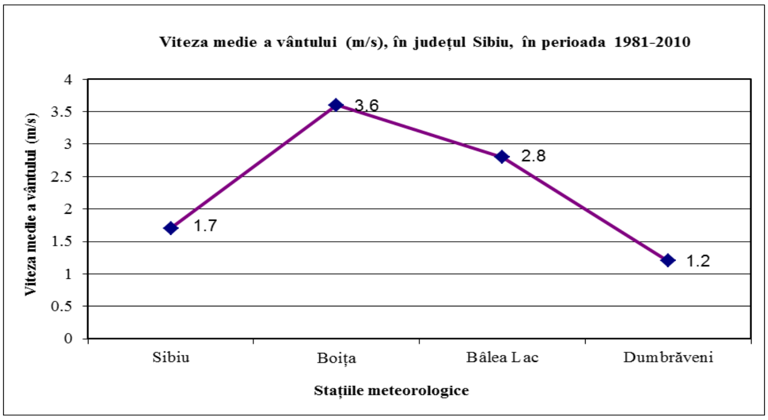

Figure 44.

Figure 45 shows the relative humidity (%), in Târgu Mureș county, between 1981 and 2010. It is noted that the relative humidity values (%) recorded by the 4 weather stations range between 58.6 and 64.9%, with a difference of 6.3%. The highest value of 64.9 % was recorded at Batoș weather station, and the lowest, 58.6%, at Târgu Mureș weather station.

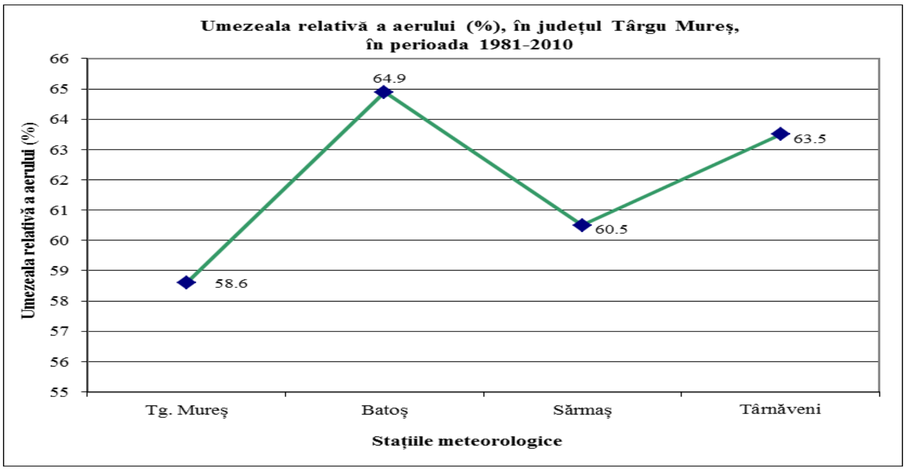

Figure 45.

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Figure 46 presents the sunshine duration (hrs / year) in Târgu Mureș county, between 1981 and 2010. It is noted that the sunshine duration values (hrs / year) range between 1954.0 and 2175.5 hrs / year, with a difference of 221.5 hrs / year. The highest value of sunshine duration of 2175.5 hrs / year was recorded at Târnăveni weather station, and the lowest, 1954.0 hrs / year, at Batoș weather station.

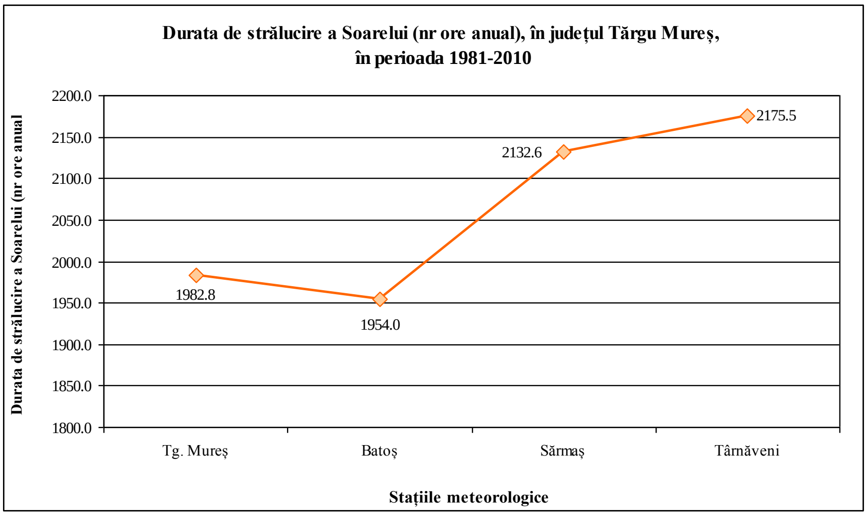

Figure 46.

Figure 47 shows the average wind speed (m/s) in Târgu Mureș county, between 1981 and 2010. It is noted that the average wind speed values (m/s) range between 1.2 and 3.1 m/s, with a difference of 1.9 m/s. The highest average wind speed (m/s) of 3.1 m/s was recorded at Târnăveni weather station, and the lowest, 1.2 m/s, at Batoș.

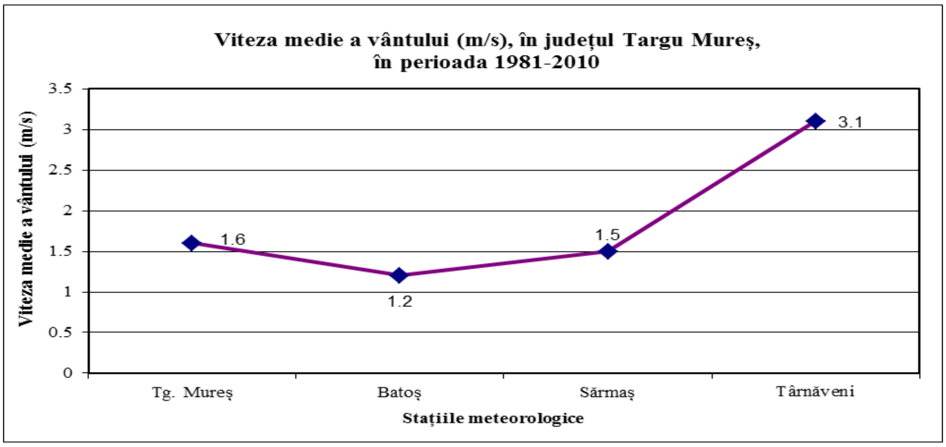

Figure 47.

Figure 48 shows the relative humidity (%), in Harghita county, between 1981 and 2010. It is noted that the relative humidity values (%) recorded by the 5 weather stations range between 61.3 and 71.6%, with a difference of 10.3%. The highest value of 71.6% was recorded at Bucin weather station, and the lowest, 57.0%, at Odorheiul Secuiesc weather station.

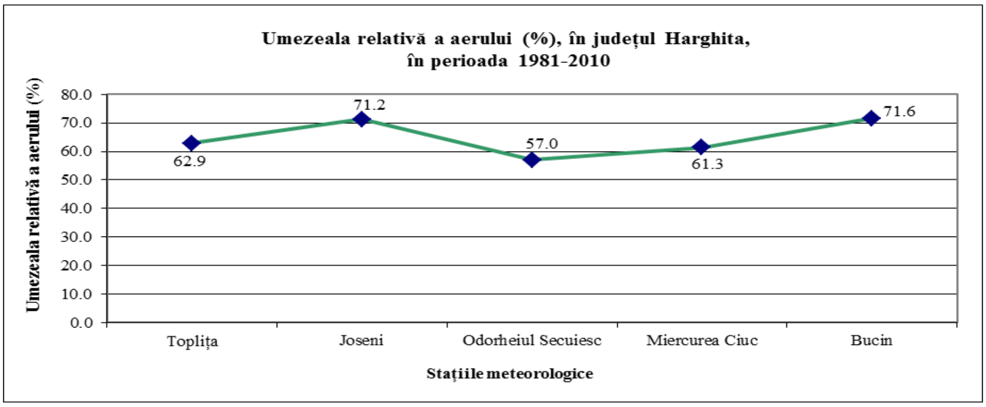

Figure 48.

Figure 49 presents the sunshine duration (hrs / year) in Harghita county, between 1981 and 2010. It is noted that the sunshine duration values (hrs / year) range between 1842.7 and 2112.9 hrs / year, with a difference of 270.2 hrs / year. The highest value of

sunshine duration, i.e. 2112.9 hrs / year, was recorded at Odorheiul Secuiesc weather station, and the lowest, 1842.7 hrs / year, at Batoș weather station.

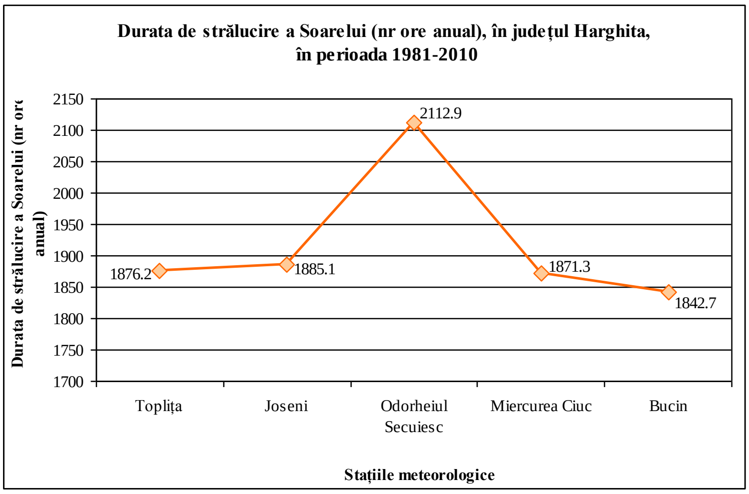

Figure 49.

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Figure 50 shows the average wind speed (m/s) in Harghita county, between 1981 and 2010. It is noted that the average wind speed values (m/s) range between 1.3 and 1.6 m/s, with a difference of 0.3 m/s. The highest average wind speed (m/s) of 1.6 m/s was recorded at Odorheiul Secuiesc weather station, and the lowest, 1.3 m/s, at Joseni.

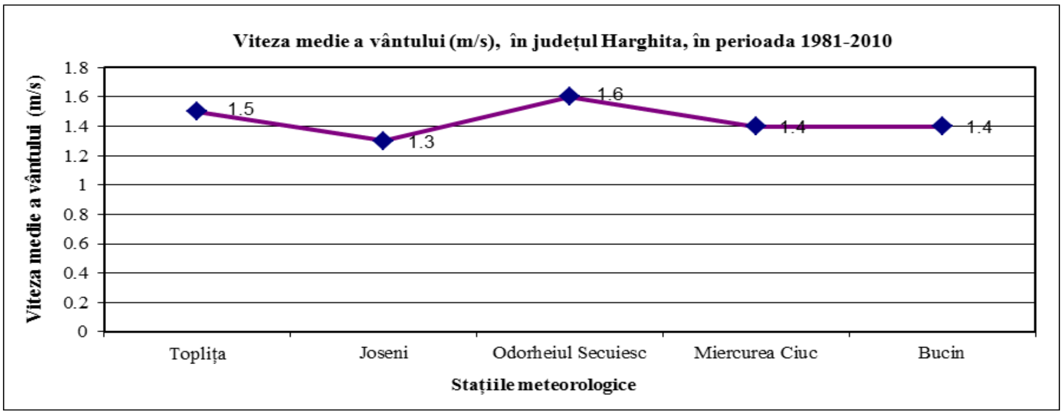

Figure 50.

Figure 51 shows the relative humidity (%), in Alba county, between 1981 and 2010. It is noted that the relative humidity values (%) recorded by the 4 weather stations range between 60.6 and 62.8%, with a difference of 2.2%. The highest value of 62.8% was recorded at Blaj weather station, and the lowest, 60.6%, at Sebeș-Alba weather station.

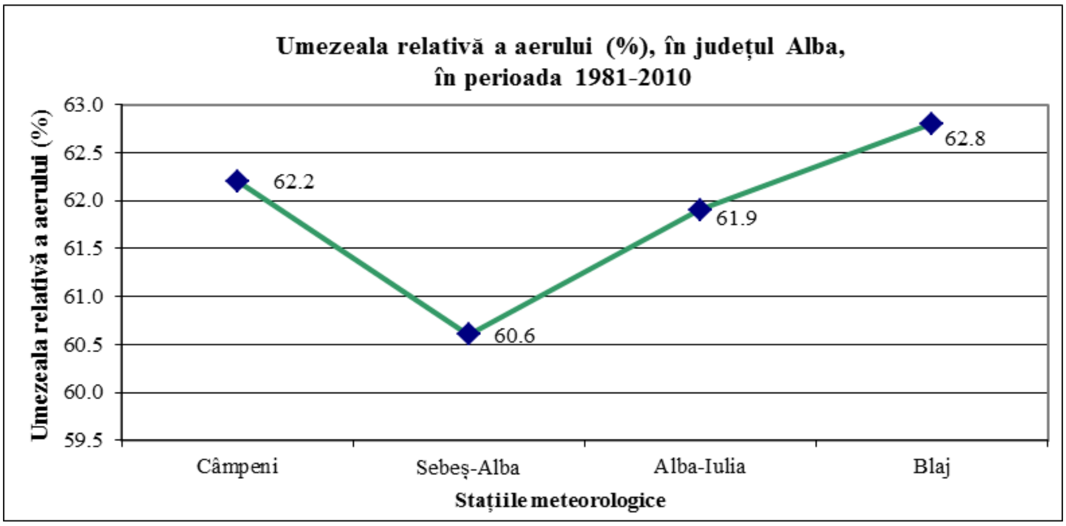

Figure 51.

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Figure 52 presents the sunshine duration (hrs / year) in Alba county, between 1981 and 2010. It is noted that the sunshine duration values (hrs / year) range between 1764.4 și 2086.0 hrs / year, with a difference of 321.6 hrs / year. The highest value of sunshine duration, i.e. 2086.0 hrs / year, was recorded at Sebeș-Alba weather station, and the lowest, 1764.4 hrs / year, at Câmpeni weather station.

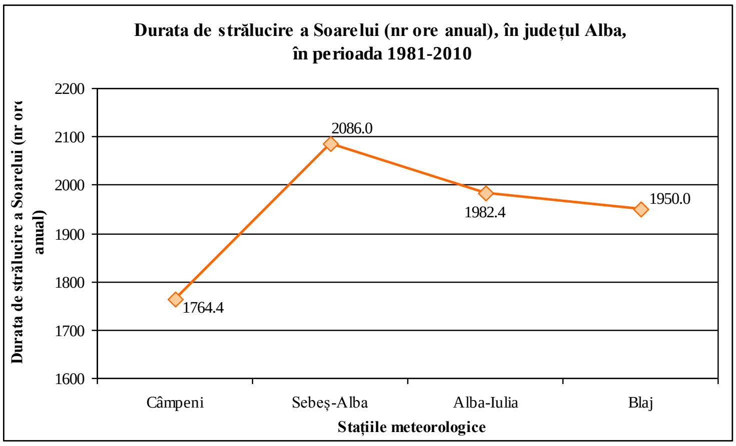

Figure 52.

Figure 53 shows the average wind speed (m/s) in Alba county, between 1981 and 2010. It is noted that the average wind speed values (m/s) range between 0.7 and 2.4 m/s, with a difference of 1.7 m/s. The highest average wind speed (m/s) of 2.4 m/s was recorded at Blaj weather station, and the lowest, 0.7 m/s, at Câmpeni.

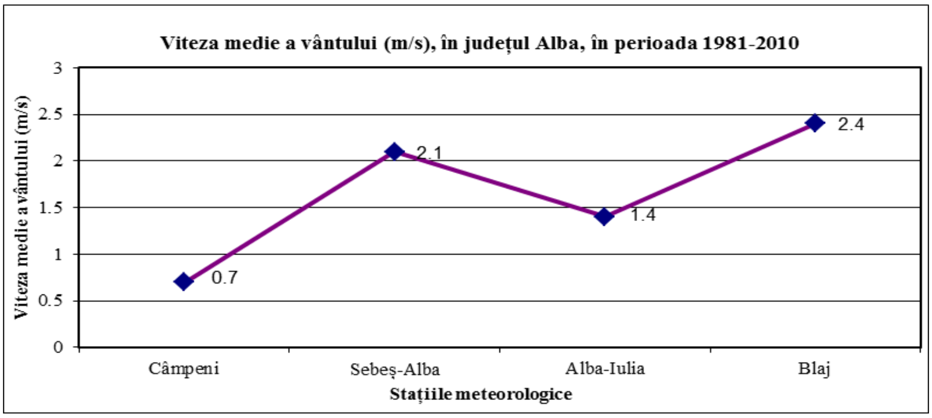

Figure 53.

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Figure 54 shows the relative humidity (%), in Covasna county, between 1981 and 2010. It is noted that the relative humidity values (%) recorded by the 5 weather stations range between 61.1 and 79.9%, with a difference of 18.8%. The highest value of 79.9% was recorded at Lăcăuți weather station, and the lowest, 61.1%, at Sf. Gheorghe weather station.

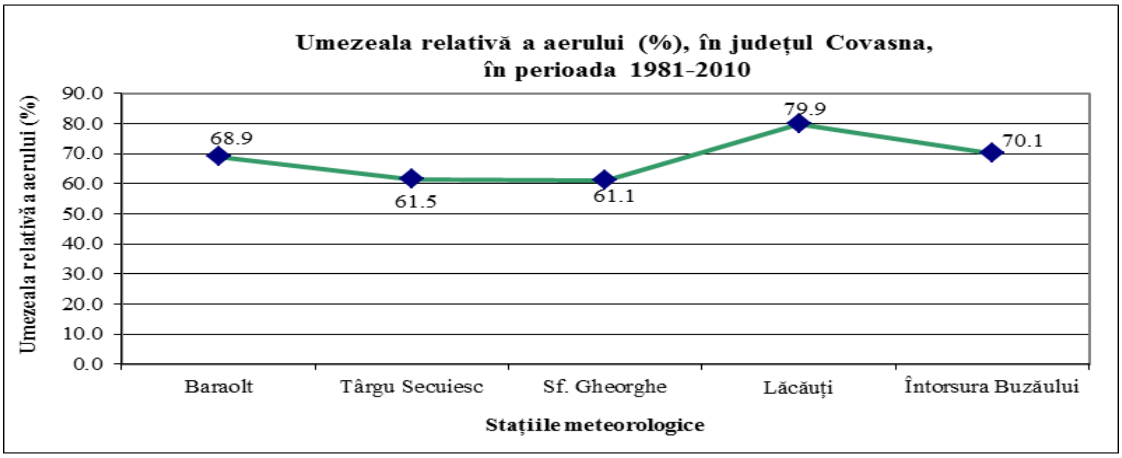

Figure 54.

Figure 55 presents the sunshine duration (hrs/year) in Covasna county, between 1981 and 2010. It is noted that the sunshine duration values (hrs/year) range between 1603.6 and 2055.9 hrs / year, with a difference of 452.3 hrs /year. The highest value of sunshine duration, i.e. 2055.9 hrs / year, was recorded at Târgu Secuiesc weather station, and the lowest, 1603.6 hrs / year, at Lăcăuți weather station.

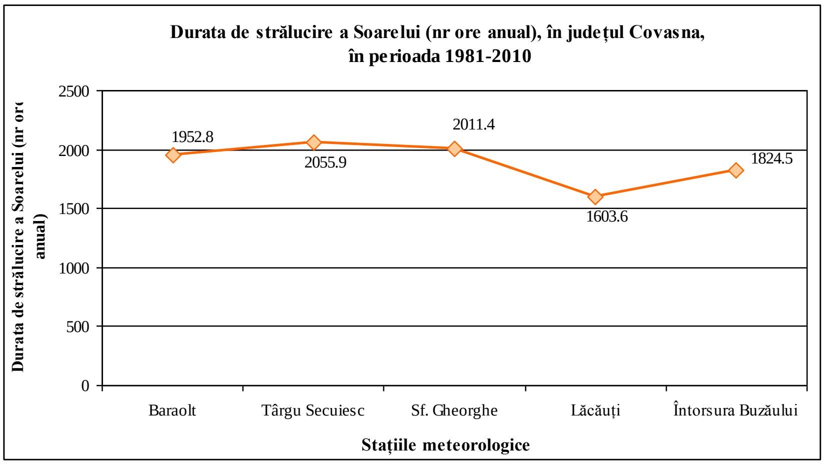

Figure 55.

Figure 56 shows the average wind speed (m/s) in Covasna county, between 1981 and 2010. It is noted that the average wind speed values (m/s) range between 1.1 and 6.8 m/s, with a difference of 5.7 m/s. The highest average wind speed (m/s) of 6.8 m/s was recorded at Lăcăuți weather station, and the lowest, 1.1 m/s, at Baraolt.

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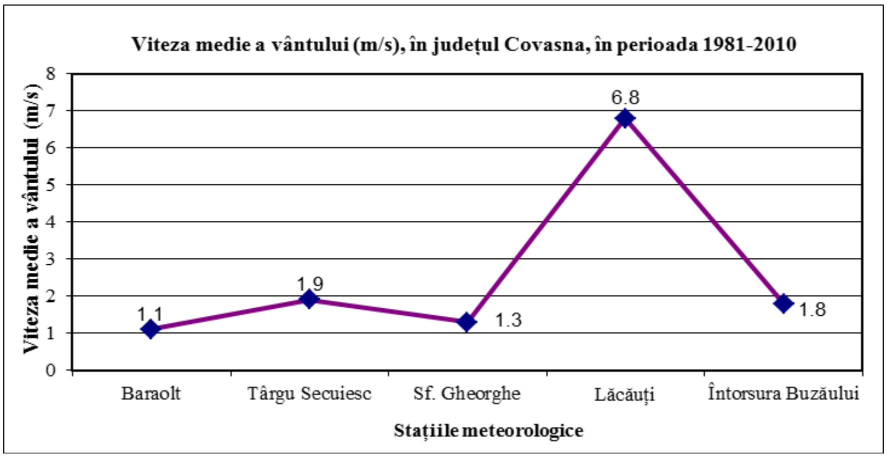

Figure 56.

2.2. Forecasts on future climate scenarios

Climate changes are impacting more and more the agriculture, water resources, energy, tourism, infrastructure, health, etc., the impact on the socio-economic activity being determined by both the changes to the average climate regime and the increase in intensity, frequency and duration of extreme weather events (heat waves, droughts, intense rainfall episodes, etc.). The simulation tools using climate data and "weather-crop" agro-climatic models are used to quantify the possible effects of climate change on agricultural production process.

This way we can identify the areas most exposed to climate variability, and thus the limiting conditions in terms of environmental variables (climate, water and soil) of the agricultural production process. Although in recent years there has been a significant reduction in GHG emissions from agriculture in Romania, this sector contributes with over 15% to GHG emissions, being one of the most vulnerable sectors to climate change, thus requiring urgent adaptation measures to be taken. Regarding the potential of adaptation measures, the water resources are also vulnerable to global warming taking into account the projections for rainfall variability in time and space, the alternation of droughts – short heavy rainfall that can generate flash floods in the region or floods (Source: Program on climate change and green economic growth with low carbon emissions, component B-Synthesis Report, Summary of rapid sector assessments and Recommendations for inclusion of climate change measures in 2014-2020 Sectoral Operational Programmes, Project co-financed by the ERDF 2007-2013 through OPTA, version 2015).

The climate forecasts based on the average values of the 5 regional climate models under the EURO-CORDEX program suggest an average air temperature increase in all months of the year, in all 3 municipalities - Sibiu, Brasov and Tg. Mures, according to the climate change scenarios analyzed for the 2021-2050 horizon compared to the current

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period (1971-2000), figures 57 and 58. The heat increase is higher especially in the summer months. In terms of precipitation, although there is no clear sign in their monthly amounts, the heavy rainfall episodes have a higher frequency. They may be interrupted by droughts, more frequent especially in the summer months and the first month of autumn (RCP 4.5 scenario, fig. 58), with major effects on the soil water level. In this context, adapting the agricultural field work timetable and growing season related technologies in the will be reached by taking into account the variability of temperature and precipitation, and the soil moisture reserves. Given that future climate scenarios for 2021-2050 horizon suggests an increase in the average air temperature in the Region 7 – Centre, and a higher frequency of heavy rainfall episodes of interrupted by periods of drought, there is a need for specific measures to reduce the impact of extreme weather events and adapt the agricultural technologies to their frequency and intensity increase.

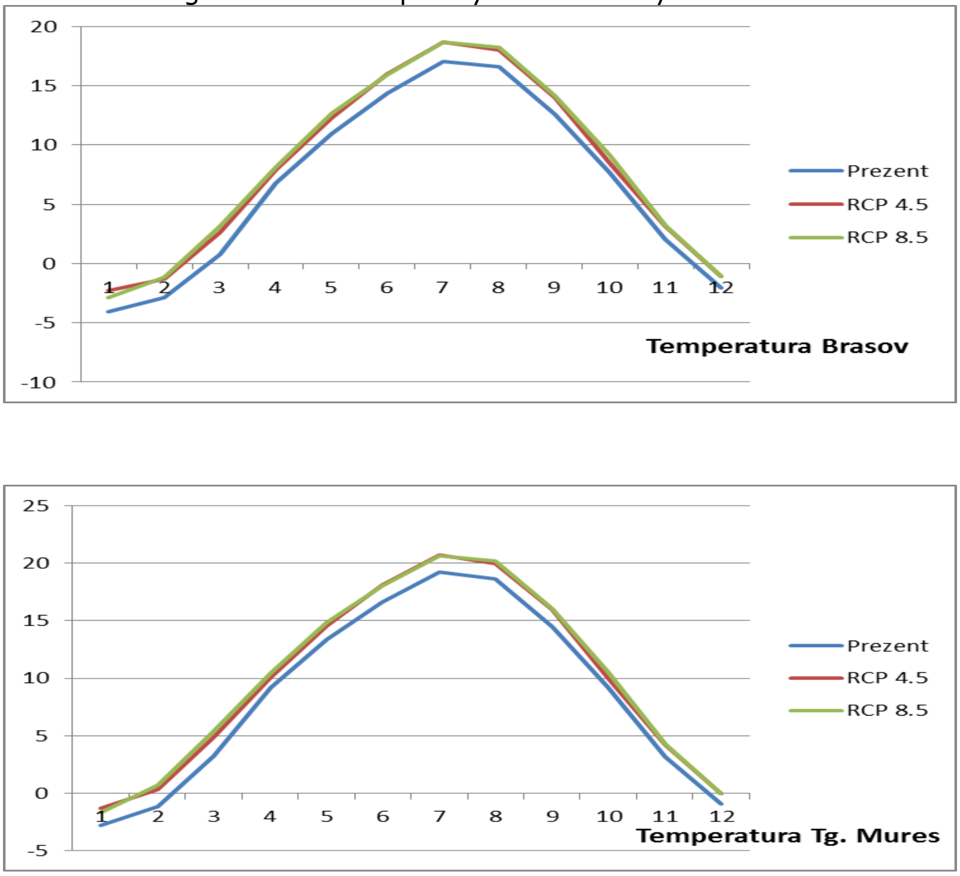

Fig. 57. Annual temperature cycles (in °C) for 1971-2000 (blue), 2021—2050 for RCP 4.5 (red) and 2021-2050 for RCP 8.5 (green).

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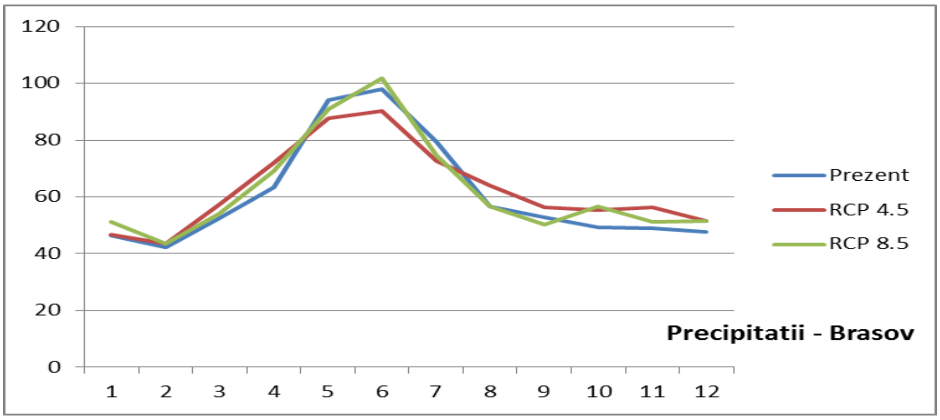

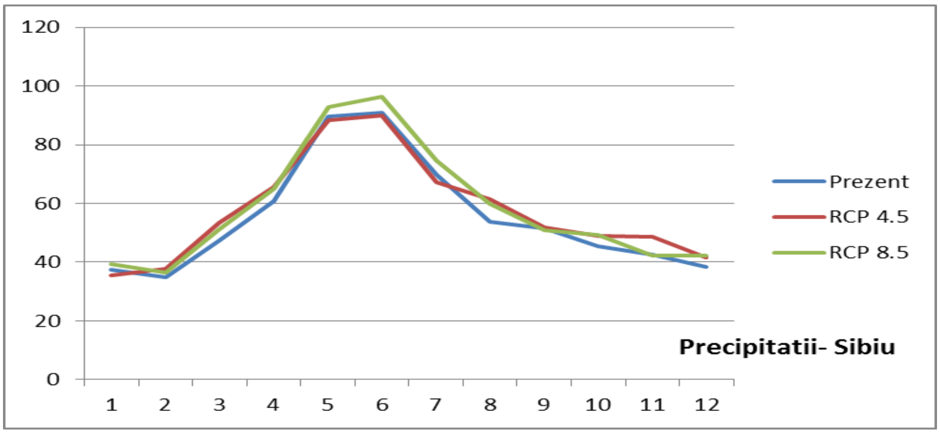

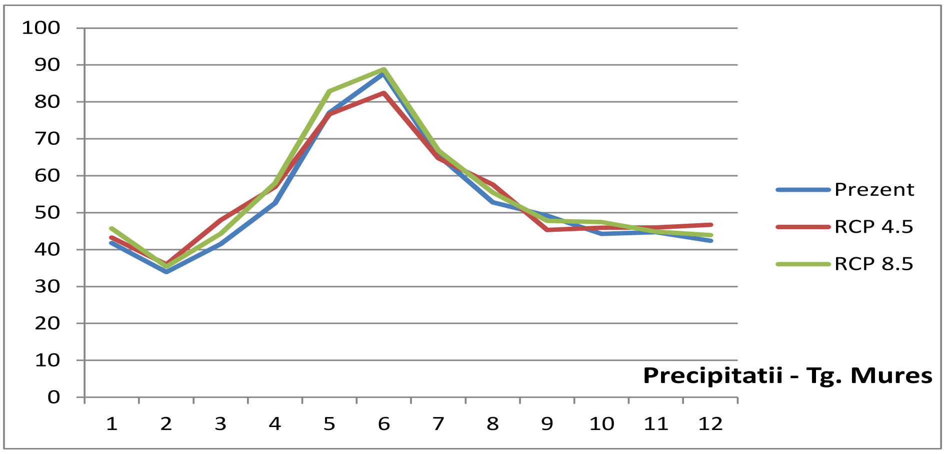

Fig. 58. Annual cycles of precipitation amounts (in mm) for 1971-2000 (blue), 2021—2050 for RCP 4.5 (red) and 2021-2050 for RCP 8.5 (green).

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The National Strategy on Climate Change in Romania for the period 2013-2020 (approved in July 2013 by GD 529/2013) is based on the knowledge of the priority sectors, vulnerabilities and key actions, as they were identified in the Adaptation Guide developed 2008. The strategy adds new information relevant to approaches and institutional cooperation needed to deal with the climate changes in Romania, in an integrative and multi-sectoral fashion. Nationally, the Strategy recommends the following actions: (1) regular updates to the climate change forecasts; (2) supporting climate research and building a national database on the trend of temperatures and precipitation resources and other relevant data for the analysis of climate change; (3) assessing the costs of climate change in priority sectors; (4) developing the National Agenda on Climate Change and its implementation under relevant policies; (5) monitoring and analyzing the adaptation to climate change; (6) increasing public awareness. Regarding the recommendations at the sectoral level, the basis for assessing the costs of climate change in different sectors, is to assess the current situation regarding the knowledge of adaptation to climate change in Romania.

Agenda 2030 goals on sustainable development requires action to improve food security, development of economy based on low carbon emissions and use of "green" energy leading to increased adaptability and sustainable management of natural ecosystems. In the National Strategy on Climate Change and growth based on low carbon – CRESC, and the 2016-2020 National Action Plan on Climate Change - NAPCC, the Romanian Ministry of Environment, Water and Forests also set concrete targets to reduce greenhouse gas emissions by 40% compared to 1990 levels, and a 27% increase in energy efficiency, these quantifiable targets being in compliance with the Agenda 2030.

In terms of adaptation to climate change, the aim is to support and promote the environmental protection, the people and economic activity against the effects of climate change, especially extreme weather events.

The major agriculture-specific measures are: a) promotion of technologies and farm management practices with direct impact on reduced emissions through energy efficiency optimization and better management of the carbon dioxide and nitrogen flows in the agricultural ecosystem; b) increased carbon sequestration (plus reduced loss of carbon into the soil) through afforestation of degraded and unproductive lands, and increased promotion of organic farming and no-till farming/ploughing conservation, and c)renewable energy production, including energy crops or investments in small and large-scale technologies available for the production of solar and wind energy.

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3. Agricultural technology adaptation measures in the Region 7 Centre

The need of all global efforts to reduce greenhouse gas emissions in the next period, given the increasing average global temperature, requires urgent measures to be taken for adaptation to climate change effects.

The adaptation to climate change relies on the ability of natural and anthropogenic systems to address those effects, including the climate variability and extreme weather events, to reduce potential damage, to take advantage of opportunities or deal with the consequences of climate change. There are several types of adaptation: anticipatory and reactive, private and public, autonomous and planned. The adaptation should be an important element of the national policy, because reducing greenhouse gas emissions in the near future does not reduce the global warming. Adapting to the climate change impacts is a complex process, taking into account the exposure-related variability of effects from region to region, the natural and human adaptation capacity, the public health services and hazard surveillance systems. The adaptation capacity includes all the tools, resources and institutional structures needed to implement effective adaptation measures. Increasing Romania's adaptability to current and potential effects of climate change, involves the following:

- ⇨ monitoring the impact of climate change, and its related socio-economic vulnerability;
- ⇨ integrating measures of adaptation to climate change into development strategies and sectoral policies and their intersectoral harmonization;
- ⇨ identifying the special measures on adapting the critical areas in terms of vulnerability to climate changes.

Considering the important role of local and central authorities in identifying and implementing adaptation measures at national and local levels, it is considered necessary to increase the awareness of authorities and the public, and to modify the behavior of economic operators and population accordingly.

In agriculture, the selection of crop varieties mainly includes the correlation of local environmental conditions with the genotypes' (varieties / hybrids) resilience to vegetation limiting conditions (drought, excess moisture, high temperatures, cold / frost etc.). Thus, in order to reduce the impacts of drought in the northern agricultural region, the following is required:

- ➢ effective management of water resources in agriculture, better use of soil-moisture reserves throughout the growing season, including the selection of seeding time depending on the water level into the soil, and a low consumption energy through irrigation systems;
- ➢ reduced production costs by choosing an alternative tillage and maintenance works specialized in weed, disease and pest combat;
- ➢ reduced risk of disease and efficient use of fungicides;
- ➢ reduced CO_2 emissions and increased production and vegetation;
- ➢ genotypes' adaptability to the potential of the area;

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- direct impact on physical (structure and structural stability), chemical (nutrient content), and biological (quantity of organic matter) properties of the soil;
- reduced risk of transmission of diseases and pests, or weed growth;
- soil protection against erosion, surface leaks and crust;
- reduced erosion and maintenance of constant crop production;
- agricultural land management by using a rotation system, keeping a balanced permanent crops - annual crop ratio;
- prevent water pollution by gully erosion and water percolation outside the areas crossed by the root system of plants from irrigated crops;
- selection of crop varieties by correlating the local environmental conditions with the genotypes resistance against limiting vegetation conditions (drought, excess moisture, high temperatures, cold / frost etc.);
- crop management and rational use of land are mandatory measures for maintaining the production potential, while preserving a low impact of farming practices on the environment and climate;
- cultivating a larger number of varieties / genotypes, respectively varieties / hybrids, with different vegetation period, each agricultural year, for a better capitalization of climate conditions, especially moisture regime and rescheduling agricultural works;
- selection of plant varieties with natural resistance to specific diseases caused by pathogens;
- the recommendation for farms is to rotate crops and establish a crop structure that includes at least three groups of plants, i.e. 33% straw cereals, 33% industrial plants, and 33% legumes. Crop production may use the rotation of agricultural, forage, special and mixed crops;
- polyculture for an efficient agricultural land use and increased biodiversity;
- organization of green manure rotation to improve the physical, chemical and biological properties of damaged soil;
- in terms of topography, the knowledge of groundwater and surface water depth ensures the prevention of pollution risks generated by the applied technologies;
- to perform tillage, especially plowing, the size of land slopes should be considered to prevent soil degradation due to water erosion;
- use of mixed crops, intercropping, permanent crops, double crops on the same parcel, for an increased biodiversity;
- own irrigation systems must be adapted to acreage and financial resources, conditioned by the presence of a lake or permanent river water in the proximity, and mainly of a permanent groundwater at 5-10 m depth that can be brought to the surface through a shaft and a small pumping station;
- knowledge of soil properties, namely the soil's capacity to retain water and depth that plant roots can reach;
- monitoring all organization aspects prior to, during, and after implementing irrigation systems, and the timing of implementation, water circuit verification by measuring the water flow performance and evenness of implementation;
- use of several monitoring mechanisms for irrigation planning, most of which include soil moisture measurements, observation of plant development status, and testing the drainage system after irrigation, in order to perform the necessary changes for the next watering;

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- carrying-out a complex study on prioritizing the rehabilitation and improvement of land and irrigation;
- rehabilitation of pumping stations from irrigation facilities of public utility, to reduce energy consumption and increase the hydraulic output;
- waterproofing of water transport, supply and distribution channels in irrigation facilities; hydraulic adjustment of the irrigation systems to new operating conditions and determining the areas that may be declared of public utility, for their optimal use;
- maintenance of irrigation subsidies to encourage the exploitation of irrigation facilities that provide great economic potential.

3.1. Agricultural genotyping

Crop varieties are adapted to different vegetation conditions through drought tolerance, shorter germination and vegetation, high carbon retention, etc., as well as agricultural practices specific to the annual work schedule. The selection of varieties suitable to local soil and climate conditions is essential to minimize specific agricultural practices with environmental impact and can increase the farms' efficient use of climate resources available.

In other words, the selection of crop varieties must take into account their adaptability to local climate conditions, i.e. plant resistance to stressors like insufficient water during certain periods or excess humidity, high / low temperatures, etc., and their natural potential for reaching a rich and high quality harvest. Regarding the relief, the knowledge of groundwater and surface water depth ensures the prevention of pollution risks triggered by the applied technologies.

Also, consideration should be given to the size slopes for tillage purposes, especially plowing, to prevent soil degradation due to water erosion.

The selection of varieties / hybrids can be a major challenge in the context of increasing extreme weather events of increasingly higher amplitude. This technology measure is related to how farmers establish and prioritize the criteria for selecting the crop varieties to be cultivated.

Variety is a population of plants created or identified which differ from populations already known by at least one important characteristic, accurate and less fluctuating, which can be clearly defined and described, or more characteristics whose combination is likely to give the quality of new (distinctiveness); it is uniform considering the set of characteristics considered by the regulations in force regarding the varieties uniformity, except for a very small number of atypical forms, considering the reproduction particularities (*uniformity*); *it is stable* considering its essential characteristics, meaning that following the successive reproduction or multiplication, or at the end of each reproduction cycles defined by the improvement unit, its essential characteristics remain as initially described (*stability*).

Hybrid is the seed obtained seed obtained from interbreeding between inbred varieties or hybrids in the first generation that ensures high yields due to the phenomenon of heterosis.

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Inbred biological material is the identical genotype, uniform and stable, resulting from self- directing, accompanied by selection over several successive generations.

Sowing or planting material. In agricultural practices, sowing material is called seed and planting material is referred as *seedlings*. The sowing seed is any reproductive material (seeds, fruits, vegetative organs, seedlings produced by any method of propagation) for multiplication or reproduction of agricultural plants.

Sowing seeds used are submitted to a compulsory check to check the quality indicators required by the rules in force, and for seed quality certification.

Certifying the seed and seeding material quality is a set of operations performed under the supervision of the National Inspection for Seed Quality, by the Central Laboratory for Seed and Seeding Material Quality (LCCSMS) and the Territory Inspectorates for Seed and Seeding Material Quality (ITCSMS). The purpose of this check is to protect the farmers against the risk of using improper seeds and seeding material.

The following outcomes are intended by the seed and seeding material certification:

- establishing the biological values of the seeds in the crop, considering their identity, authenticity, variety purity and phytosanitary condition;
- establishing the cultural value of the seeds, by performing lab quality tests, i.e.:
- physical tests: organoleptic test, physical purity (P), botanical compound (CB), mass of 1000 grains (MMB), hectolitre mass (MH), humidity (U);
- physiological tests: germination (G), cold-test (CT), viability (V), electric conductivity (PS);
- establishing the health condition: detecting infestation and infection.
- controlling health condition considering the absence of quarantine pests;
- checking the variety authenticity and purity in pre- and post- check.

The biological categories of the seeds designed for seeding are:
- "Breeder's reference" seed (S.A.);
- "Pre-basic" seed (P.B.), that can be a 1st Pre-basic seed (P.B.I) and a 2nd Pre-basic seed (P.B.II);
- "Basic" seed (B);
- "Certified" seed (C), which can be a 1st or 2nd generation certified seed, in the case of self-pollinated crops (C1 and C2).

The breeder's reference seed is the seed produced by or under the direct supervision of the improving or maintenance unit, using the conservative selection method or other specific scientific methods, designed to produce pre-basic seeds that satisfy the requirements of the regulations in force on the variety purity for pre-basic seeds.

The pre-basic seed is the seed obtained from all the biological varieties between the breeder's reference and the basic seed that was produced by or under the direct supervision of the maintenance unit, was produced from the improving unit's seeds or from the pre-basic seeds, and it is designed for the production of pre-basic or basic seeds and satisfies the requirements of the regulations in force on the pre-basic seeds.

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The basic seed is the seed that was produced by or under the direct supervision of the maintenance unit, obtained from the pre-basic seed, and designed for the production of certified seeds and satisfies the requirements of the regulations in force on the basic seeds.

The certified seed is, in case of hybrids, the seed produced in hybrid lots from the basic seed, and it is designed for the production of crosp for the human or animal consumption; in case of varieties, it is the seed produced directly from the basic seed for multiplication or for consumption crops and satisfies the requirements of the regulations in force on the certified seeds.

At the demand of the author or the maintenance unit, it can be obtained from a pre-basic seed. The law prohibits the selling of seeds and seeding material whose quality was not controlled and certified. The controlled and certified seeds (that weaver awarded the Biological and Cultural Value Certificate from the central laboratory or the county service) shall only be sold packed, accompanied by the following documents:

- for wholesale – "Quality Certificate" issued by the supplier, that contains information on the biological and cultural value of the seeds;
- for retail – the supplier’s label, representing the quality certificate.

In our country, the legislative framework on the production, processing, control, certification and selling seeds and planting stock, as well as the testing and registration of plant varieties, is ensured by the Law 266/2002, issued by the Ministry of Agriculture and Rural Development. The every year, the Ministry is also in charge with issuing Orders regarding the approval of the Official Catalogue of Crops Varieties in Romania. This Official Catalogue of Plant Varieties registers the varieties analyzed in the ISTIS network (the State Institute for Plant Variety Testing and Registration) and recorded in the Varieties Register.

3.2. Changing the seeding date and the duration of vegetation period of crops

Changing the seeding date is an important technological component to reduce the negative effects of climate change, mainly considering the adaptation of land preparation works and the start of seeding according to the water content of the soil.

The simulations performed for the 3 meteorological stations show that the climate change may bring changes of the optimal seeding date for the winter wheat and corn crops for the period 2021-2050, compared to the actual period (1971-2000). Therefore, compared to the actual period, a later period is estimated for the 2021-2050 horizon for the winter wheat, and for corn, an earlier date (tab 2).

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Tab. 2. Projections on the seeding date change for winter wheat and corn in the Region 7 Center, for the 2021-2050 horizon vs. 1971-2000

	Projections on the seeding date change for winter wheat and corn in the Region 7 Center, for the 2021-2050 horizon vs. 1971-2000	
	Winter wheat – later seeding	
	1971-2000	**2021-2050**
Sibiu	September 25 – October 5	October 10 - 25
Brasov	October 1- 20	October 15 - 30
Tg. Mures	October 1 - 20	October 15 - 30
	Winter corn – earlier seeding	
	1971-2000	**2021-2050**
Sibiu	April 15 - 20	March 25 – April 10
Brasov	April 20 - 30	April 1 - 15
Tg. Mures	April 20 - 30	April 1 - 15

Considering the fluctuation of thermal values that increase every year, it is recommended to set the crops in the optimal period and adjust the seeding works to the water reserve available in the soil. Last but not least, the selection of varieties with different precocity determines the optimization of the vegetation period of agricultural crops and the increase in their resistance to extreme climate values (periods with extreme temperatures or the alternating drought/rainfall periods). Therefore, the temperature raise associated with drought could force the vegetation process and impede the accumulation of reserve substances in the seed, fact that could result in low outputs, especially in the genotypes with lower resistance to thermal and hydric stress over the critical periods (mainly over the summer months). On the other hand, the temperature drop below the resistance limit of plants over the cold season could affect the subsequent vegetation process, by slowing it down, and the abundant precipitation could foster the attacks of phytopathogenic agents.

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4. Cross-sector analysis on the optimization of water resources in agriculture (WUE) in the context of the actual and predictable climate change

The water use efficiency (WUE), that represents the ratio between the production and evotranspiration, is the most relevant parameter in the impact analysis on the climate change and their effects on agricultural productivity.

Water resources used in agriculture

Atmospheric precipitation is any kind of water that falls from the atmosphere on the ground. Forms of precipitation: rain, snow, sleet, hail, frozen rain, frost and rainband. Precipitation is a basic component of the natural water cycle.

Irrigation is a set of works and operations designed to artificially bring and manage the water on a land covered in vegetation (usually), to support the growth of crops, to maintain landscaping objectives, to support the recovery of vegetation on the lands changed by construction works, to stabilize low cohesive soil in order to prevent wind erosion, to reduce the effects of late frost, or to create a moist microclimate during the drought and very hot periods. Irrigations are the major measure for fighting against the effects of drought on the crops. It is sometimes used in combination with drainage for the remediation of salty soils or to prevent the salinization of irrigated and/or drained soils.

Irrigation is performed through a system of economic, organization, technical and agrotechnical measures. The rational irrigations create the favourable conditions for the growth and development of plants, ensuring better and more stable crops, independent from the quantity of atmospheric precipitation. Irrigations can be performed periodically (at certain terms, within set norms) or once (by sub-irrigation, with the water resulted from the melted snow, and by flooding, when the water covers the irrigable surface only in the flooding period). The sources of water for irrigations are the rivers, lakes, groundwater and other natural sources of water. The water is supplied on the irrigable land through an irrigation system that has to be maintained, fact that involves financial efforts.

Irrigation management

The impact of water management on the climate change is less obvious than the multiple consequences of these changes on the need to adapt the irrigation techniques.

The decrease in the greenhouse gas emissions due to water management is mainly based on the decrease of the energy and water used, while the effects of the climate change on water management are more complex and impactful. The temperature increase will determine a superior level of evapotranspiration, and this could raise the need for water for agricultural purposes. This will result in an additional stress regarding the water resources.

The areas that presently have big water resources and are prone to climate change must learn the practices already used in the regions lacking in water. The crops will have to be supplied with water and irrigated in other ways, according to the way in which the precipitation regime changes; mean time, changes are expected with regard to the cultivated crops and varieties, as agriculture should adapt to the climate change. The

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irrigation practices and techniques should evolve, for example using the «dropping», which is more economic than spraying.
The overall temperature raise will probably reduce the snow and ice stored in the mountains and glaciers, that is supposed to get into the rivers during the spring and the summer. Moreover, the snow and ice melting can occur earlier in the spring, changing thus the seasonal regime of the rivers; we also know that the polluting spills affect more the warmer water flows.

The farmers use two methods: dry farming and irrigated agriculture:

The «dry farming» technology is profitable for the production of crops, with no irrigations, in areas that receive 500 mm precipitation or less per year. In the areas confronted with torrential rains, powerful wind, uneven precipitation distribution, the «dry farming» method is also recommended to the non-irrigated cultures, under the conditions of annual precipitation between 601 – 700 l/sq m. The basic issues of the «dry-farming» system are the accumulation in the soil of a small amount of annual precipitations, the preservation of soil humidity until it will be used by the plants, prevention of direct evapotranspiration of the soil humidity during the growing season, balancing the water quantity extracted by the plants from the soil, selecting the proper crops for the dry areas, applying the proper treatments for the crops and the use of products based on the superior composition of the plants that require smaller quantities of water.

The **irrigation based agriculture** relies on the artificial distribution of water in the agricultural land in order to establish the crops and to ensure the plants growing.

Selection of irrigation method according to the local soil and climate conditions

- **Type of soil:** sandy soils have a low water retention rate and a high filtering capacity. These require low but frequent irrigation norms, only in certain situations when the sandy layers are superficial. Under these conditions, the spray or drip irrigation systems are more adequate for the irrigations through the furrows. The clay soils may use all the irrigation types, mainly those through the furrows. The irrigation system through furrows is the most recommended for the clay soils with low infiltration rate. When the same irrigation scheme includes several types of soils, it is recommended the spray or drip irrigation, to ensure a better distribution of the water.

- **Land inclination**: The spray or drip irrigation are preferable to those in furrows, mainly for the very inclined slopes or on the uneven areas. The exception to this case is the land used as rice plantations on specially designed terraces.

- **Climate**: Strong winds may affect the spray irrigation. In such conditions, it is recommended to use the drip irrigation or the flooding. The areas that require additional water, the spray or drip irrigation are much more adequate due to their flexibility and adaptability to various needs of the farm.

- **Water sources**: The effectiveness of applying the irrigation norms is higher in the case of spray and drip irrigation than the furrow irrigation, as these methods are preferable due to the limited water reserves. We must also note that effectiveness is the major component of the irrigation method used.

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- **Water quality**: The furrow irrigation is preferred only when the irrigation water contains many sediments. The sediment deposits in the water may block the sprinklers in the case of spray or drip irrigation systems, fact that increases the maintenance costs. If the irrigation water contains salts, the drip irrigation may still be recommended as long as the water is used only for the superficial soil layer. The spray irrigation systems are more effective than the furrow irrigation on the lands rich in salts.

The irrigation system shall be selected according to:

- **The crop type**: The furrow irrigation may be used for all types of crops. The spray and drip irrigations are recommended for the vegetables, orchards and vineyards, due to the big investments per hectar. These are not used for crops with low economic value. The drip irrigation is adequate in the case of individual irrigation of plants, trees, vegetables and sugar cane. This method is not recommended for the crops cultivated in dense rows (ex. rice).
- **Technology type**: The technology type influences the irrigation method.
- In general, the spray and drip irrigations are the most complicated from a technical point of view. The purchase of equipment requires high level of investments per hectar. The maintenance of the equipment needs the adequate logistics and know-how. Moreover, an additional stock of fuel and spare parts is needed. The furrow irrigation systems require the simplest equipment, both for their construction and maintenance (small number of pumps). The equipment used is much easy to maintain.
- **Experience in using irrigation systems**: The selection of the irrigation system also depends on the irrigation systems that are mostly used in the region or the country.
- The introduction of new methods may lead to the occurrence of unexpected problems. It is not sure if the farmers will accept new methods. The technical assistance of the equipment may raise other difficulties, and the costs may be high compared to the benefits. In most of the cases it is easier to improve the present systems than to introduce absolutely new methods.
- **Human resources involved**: The furrow irrigation system usually needs the use of more human resources for the construction, operation and maintenance than in the case of the spray and drip irrigations. The furrow irrigation requires a good levelling of the soil, as well as the adequate training of the farmers in order to be capable of using and maintaining the system at high level. The spray and drip irrigations require less levelling of the land, and the use and maintenance of the system is much simpler.
- **Costs and benefits**: Before selecting the irrigation type used, we must forecast the costs and the benefits of each method. We have to consider both the construction and installation costs and the operational and maintenance costs (per ha). Then, we should compare these expenses with the benefit brought by the production increase.

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Minimizing the water waste

Water, air and soil are the most vulnerable environmental resources. The water resources are naturally formed from the hydrographic basin, defined as the territory where a river collects its water from. We shall use the basin concept as an integrating term, as it is applied to a wide spectrum of areas (from elementary basins to the basins of big rivers) and environments (urban or rural, agricultural or forestry basins, lake basins, groundwater or karst basins etc.).

In the presence of vegetation, part of the precipitation is retained by the vegetal layer, and the rest goes on the ground, through the leafs or falling on the trees logs. Therefore, to reduce the water loss, the land must be permanently covered with vegetation.

The following rules should be observed in farms:

- The soil works have to be performed at the optimal humidity times.
- Every 5 days, after harvesting the summer crops, the land should be coarse mulched using a disc harrow if the soil is very dry and by 15 -20 cm ploughing, if the soil has an optimum humidity.
- The fall ploughing throughout the entire area is compulsory, except for the lands with coarse texture (sandy, sand-clay, clay-sand).
- The tillage should be levelled and tilled right after the ploughing, starting even from the fall.
- The establishment of spring crops requires tools that enter as little as possible into the ground, allowing thus the aeration to be made only at the surface of the soil.
- The crops should always be cleared from the weeds.
- The hoeing machines should be well maintained in order to crash the crust and to avoid the water loss from the soil by the evapotranspiration process.

Agrotechnical methods for water conservation

The water conservation into the soil has a direct relation with all the water penetration, circulation, retention and loss actions.

The agrotechnical methods may directly or indirectly influence more or several components of the hydrological regime, in order to bring it as closer to the plants' needs for water and an optimal soil working conditions.

To **conserve the most quantity of ground water**, we should use different agronomic practices throughout the agricultural year, during a crop rotation that suits the area and in correlation with the technological inputs envisaged (irrigation, fertilization, weed control, density culture etc.).

Among the agrotechnical methods used to preserve the water into the soil, we mention:

- The use of blocking plans in each farm and setting a crop structure that includes three groups of plants, at least: straw cereals 33%, technical plants 33%, vegetables 33%.
- The soil works should be done during the optimal work time, when the soil is wet, spills behind the plough, the tillage has no soil clods or belts. In this stage, the soils may have 7-20% water contents, with an optimal working value of 16-20%, depending on their texture.

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- Using the best practices for working the soil during the optimal working time leads to the reconstruction of the internal drainage of the soil, the achievement of the optimal water infiltration speed of 2 mm/hour, the optimization of compaction (DA=1,3g/cm3), and increased water storage capacity, and the reduction of the unproductive water consumption.
- Practicing the coarse mulch right after the harvest of straw cereals, oilseed rape, vegetables, at 8-10cm depth, breaks the capillarity, reduces the evaporation of the water from the soil, and allows the rain water infiltration and the condensation of water vapours from beneath. The water quantity absorbed by the soil increases by 2-3 times, the evaporation decreases by approx. 8-10% and the vegetal waste behave similar cu the mulch strata.
- Avoiding the soil mobilization at depths that exceed the needed ones, both at the basic works and at during the preparation of the germination bed. Therefore, depths that exceed 30 cm when ploughing and 10 cm when preparing the germination bed are not justified.
- Practicing summer ploughing and the deep fall ploughing, that ensures the accumulation of water on the depth of the soil profile, creating thus the water reserve for the periods of droughts during the summer. For the summer ploughing, the plough works with the support of the harrow.
- On the inclined lands, the works shall not be done from the uphill down, in order to avoid the water drainage and the erosion of the soil. In hill areas, on lands with over 30% inclination, the works should be done according to the level curves. Performing the ploughing on this direction reduced the water loss to up to 75%. On inclinations that exceed 18-20%, where the tractors on wheels may roll-over, the ploughing may be performed using caterpillar tractors and reversible ploughs, and the furrow should be turned towards the top of the hill.
- The aerated soil layer resulted after the ploughing enables the storage of a bigger water volume, if it is cleared from weeds and no crust was formed.
- The preparation of the germination bed during the sowing time, only on the sowing depth, the use of active rotative pieces instead of soil turning. Processing the soil by using the combined and the rotating harrow is far more effective than the use of the disc harrow, as this turns all the processed soil and expose it to the environmental conditions and to water loss.
- Supplementing water quantity needed by the plants by irrigation. Even in the hill areas, irrigation ensures 13-15% of the optimal water level of the soil, fact that makes the expansion of irrigation systems in this area highly desirable.
- The soil mulching using various materials prevents the water evaporation and, moreover, influences the soil's thermal regime, depending on the mulch color.
- Extending the protection forest belts enables the climate improving, reduce the wind speed and therefore reduce the water evaporation from the soil.

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- In the case of heavy soils, with a Bt horizon profile (with high clay contents), it is recommended the soil permeabilization applying deep aeration works (40-80 cm), in order to improve the air and water circulation in the soil. The deep aeration shall be performed every 4-6 years, as it is effective only of the impermeable layer is completely pierced and it provides drainage options.
- The deep aeration should be performed together with other works that improve the soil drainage capacity. Thus, it is more effective when used in a crop rotation that includes technical plants and grain legumes and it is accompanied by the application of 60-80 t/ha of manure.

Optimizing the water use effectiveness

In order to extend the irrigation into the hill area of Region 7 Center, on various terrains, such as meadows, terraces, plateaus, the following measures are needed:

- The use irrigation aspersion method that allows a better control of the water (to avoid the soil erosion and mudslide).
- Automatic installations and the use of irrigation and water supply solutions that use the same water source and supply and distribution network.
- The distribution networks that supply the farms should work on demand all over the year. Therefore, they should be pressurized, with a secured water volume.
- To provide the water flow demanded by the network and an acceptable pressure in all the network sections and several altitude plans, balance tanks and irrigation terminals should be used.
- The use of equipment for the automated distribution of water to the land plots.
- Localized drip irrigation and perforated frames.

5. SWOT analysis

The present and future climate projections show that all the regions of the world could be affected by the global warming, with increasingly significant regional differences in the evolution of the climate parameters, such as thermal resources and precipitation, and with growing effects of the extreme meteorological phenomena. Therefore, the adaptation policies to the climate change impact will be based on the implementation of specific action plans in order to reduce the climate risks at national, regional and local level. An important element of the risk management strategies is the improvement of knowledge and the development of the capacity to better monitor and manage the dangerous phenomena, including the development of analysis regarding the historical climate data correlated to the risks and opportunities assessment.

For this project, we needed to develop a SWOT analysis to identify the gaps between the present situation and the forecasted or desired one, as a support for the strategy and the project. Therefore, we identified the weaknesses, for a better development of the study area's potential. The SWOT analysis conclusions allowed us to prioritize the challenges and potential of this area, considering the regional development.

Strengths:	Weaknesses:
- the existence of all relief forms, geological and mineralogical diversity, topoclimates, diversity of land use categories, complex pedological structure, diversity of hydrographic elements, wood potential are the major elements that represent the basis of an extremely diverse natural resources present in the Region 7 Center area. - being in a strict relation with the relief and climate levels, the soil quality represent a basic resource for the practice of an efficient agriculture. The most fertile soils are in the Transylvanian Plateau, especially in the lower areas. The widest spread soil types are the levigated chernozem rich in humus and high fertility (in Transylvania Plain), the argiloiluvial soils (with clay accumulations), brown soil and acid brown soil (cambisoil). In the mountain area, the soil quality is lower and requires restrictions to plant cultivation, as the spodosol predominate here (podzol and mountain acid brown). - weather conditions, terrain and soil influence in an important measure the agricultural development. Crops and potato crops and animal growing practices have favorable natural conditions in the region. In the mountain area livestock farming is based on using natural surfaces pastures and hay fields, raising sheep is traditional in parts of the Region, recalling in this regard Sibiu Surroundings (Jina, Poiana Sibiu) - a special role in the efficient use of the Region 7 Center resources is the extremely diversified land, according to the relief elevation: along the valleys, depressions, the Transylvanian Plain is mainly covered by arable lands planted with cereals, technical plants (sugar beet and in particular fodder plants), the hilly areas are occupied by vineyards and fruit trees, and the mountain area by pastures and natural hayfields. **-** the hydrographic network is rich, formed by the upper and middle flows of Mures and Olt rivers and their arms, and has a great energy potential, being exploited mainly on the flows of Sebes and Cibin rivers.	- the increased vulnerability of the Region to the incidence of extreme meteorological phenomena and the noticed climate change, mainly to the periods with frequent precipitation that may generate floods at regional level, extreme temperatures in the warm and cold seasons, long drought periods in extreme years that affect the agricultural production. - the vulnerability of rural communities to the climate change and their reduced capacity to adapt to the associated risks and uncertainties. - the characteristics of the agricultural production system based on the predominant local agricultural communities that focus a single type of exploitation or production, such as technical cultures or potatoes, causing them an increased vulnerability to the losses caused by extreme meteorological phenomena. - the differences regarding the polarization of the adapting potential emphasized by the size and investments made in the commercial farms that have a big scale potential, supported by investments and favourable technical resources compared to the small sized farms, where the agricultural technologies adaptation capacity is significantly reduced by the limited technical and financial resources.

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Opportunities:	**Threats:**
- monitoring the impact of the climate changes and the associated social and economic vulnerability. - the integration of adaptation measures to the effects of climate change into the sector development strategies and policies and their cross- sector harmonization. - the identification of special measures regarding the adaptation of critical sectors to the climate change. - to face the climate change, the agricultural producers may apply a set of measures, such as: crop rotation, for a better use of the water in the soil, changing the sowing dates according to the temperature and precipitation regime; the use of mixed crops, cover crops, catch crops as multiple crops in the same area/farm, in order to increase the biodiversity; the cultivation of a bigger number of varieties/genotypes or hybrids, in each agricultural year, with various vegetation periods, in order to improve the exploitation of climate conditions, especially the humidity regime and the scheduling of farm works. - planting of shrubbery to reduce the loss of water, acting like protection fences in order to reduce the growing evapotranspiration during the drought seasons. - the preservation of some extensive agricultural practices and avoiding the application of fertilizers and pesticides over the natural highly valued grass lands. These grass lands are important to the retention of CO_2 and for the preservation of functional ecosystems that provide important environmental benefits. - the use of alternative and renewable energy sources based on solar, wind, biomass and geothermal energy. - a better information of agricultural producers on the climate risks and the adaptation solutions. - the development of educational activities in order to raise the public awareness on the effects of climate change, mainly in the rural environments.	- in the Region 7 Center, the effects of the climate changes are obviously impacting the changes regarding the temperature and precipitation regime. - the climate change's impact on the growth and development of agricultural plants is significant, in the context of the lack of adaptation of agricultural technologies to the future climate evolution. - the low output of crops under the conditions of an increased intensity and frequency of extreme meteorological phenomena will have a significant impact on the financial stability of farmers, as the losses could exceed the profits in the years with drought, extreme temperatures, abundant rains, etc., as well in the absence of accessing the financial instruments to cover the climate risks.

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6. Conclusions and recommendations on agricultural adaptation measures and policies for the Region 7 Center:

In the context in which the future climate scenarios indicate for the Region 7 Center the decrease in the precipitation level, a set of measures a needed to reduce the impact of the pedological drought. Also, the cultivation of genotypes that are resistant or tolerant to the water deficit could contribute to the crop stability. Therefore, the improvement directions' target objectives regarding the creation of varieties with faster and deeper rooting, as well as varieties/hybrids with an osmotic regulation capacity that ensures the cells' firmness.

Also, the increased frequency and intensity of extreme meteorological phenomena in the context of global warming represents another research direction in the field of improving the cultivated genotypes. There are considered characteristics of the varieties such as their resistance to falling and breaking, shaking and germination on the stalk, low temperatures, etc.

The basic principles for the application of the adaptation measures rely on:

- ✓ the use of plant varieties/hybrids well adapted to the pedoclimatic conditions;
- ✓ the practice of blocking plans for big field cultures, in order to produce raw material for the food, textile, chemical industry, etc.;
- ✓ the polyculture, in order to effectively use the agricultural areas and to increase the biodiversity;
- ✓ the organization of blocking plans with green fertilizers, in order to improve the physical, chemical and biological properties of degraded soils.
- ✓ the selection of the cultivated varieties by correlating the local environmental conditions to the resistance level of the genotypes to limiting vegetation conditions (drought, humidity excess, high temperatures, cold/frost, etc.);
- ✓ the cultures management and the rational use of the land are compulsory measures to preserve the potential production, also keeping a low impact of agricultural practices on the environment and the climate;
- ✓ the cultivation of a big number of varieties/genotypes or hybrids, in every agricultural year, with various gestation periods, for a better use of the climate conditions, especially regarding the humidity levels and the planning of agricultural works;
- ✓ the selection of genotypes that resist to vegetation limiting conditions, with a high tolerance to "heat-waves", drought and excess humidity;
- ✓ the selection of plant varieties with natural resistance to diseases caused by pathogenic agents;
- at farms level, we recommend the practice of blocking plans and the selection of a culture that includes three groups of plants, at least, i.e. straw cereals 33%, hoeing – technical plants 33% and vegetables 33%. The following types of blocking plans can be used for the vegetal production: agricultural, fodder, special and mixed.

On the areas that are vulnerable to drought in the Region 7 Center, the most recommended *soil works* are the conservative works systems. The "conservative work" of soil is a general expression that refers to multiple work practices, from the direct sowing, to aerating and mobilizing the entire soil profile, excluding turning the furrows and burning the stubble, allowing thus the preservation of vegetal waste on the soil surface or close to it and/or the preservation of the aerated and granulated condition of the soil, in order to reduce the erosion and to improve the relation between soil and water. Therefore, the purpose of the conservative works is to save the water from the soil. An alternative soil working practice with ploughing is recommended for the years the follows a corn or sunflower crop, with disking or tillage in the years when the fall cereals are sowed. It is extremely important to avoid taking off the soil clods, is the soil is too dry and if the ploughing is too deep (over 20-22 cm). In the years with big humidity deficits, no fall ploughing shall be made.

An effective management of water resources in agriculture involves a better use of humidity reserves in the soil, accessible to the agricultural plants, as well as a reduced energy consumption by applying irrigations. The production costs can be reduced by selecting an alternative soil works system and the proper maintenance to fight against the diseases, weeds and pests.

Moreover, the raise of awareness, collecting and disseminating the information can be also improved by the technical and scientific events and fairs, with topics relevant to county, regional and national levels. These information should improve the knowledge base of the farmers and the authorities regarding the adaptation of agriculture to climate change. Regional training courses targeting farmers and representatives of farming associations would also help. Also, it is needed a better cooperation, supported by a constant transfer of technology, "know-how" and best practices. The experience exchanges should include a database of case studies that should provide examples for the agricultural adaptation measures, with a special emphasis on the extreme climate events.

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7. Glossary of terms

- **Adaptation:** action performed in order to change natural ecosystems and agricultural system in order to make them face the climatic change, by reducing the possible damages or taking advantage by the benefits.
- **Blocking plan:** the technique of dividing of a cultivable land into several land plots (according to the number of plants to be cultivated) and assigning each plant to a certain plot, by rotation.
- **Water catchment area:** a physical-geographic unit that includes the natural waters up to the drainage divide.
- **Climate:** it is the multi-year regime of meteorological processes that are specific to a given region or the average status of the atmosphere. In other words, the climate summarizes the average, field and variability of weather elements, such as the rain, wind, temperature, fog, lightning and sunshine, observed over a long period, in years (usually for a 30 year period) in a certain location or in an entire region. The climate of a region determines the type of plants that are cultivated and the spontaneous plants, as well as the specific fauna.
- **Application efficiency:** the ratio between the average depth of the infiltrated irrigation water and stored at the roots level and the average depth of the irrigated water.
- **Evapotranspiration** [ET] {mm/day, mm/week, mm/month}: a combination of the water plant transpiration and the water evaporated from the soil and plants surface.
- **Limiting factor:** any condition that limits the functions and/or the use of a soil.
- **Soil fertility:** the usual status of a soil type, considering its capacity of supporting the growth and development of plants. It is a complex feature or specification of the soil, by which plants are provided their nutrients, water and air they need to grow and develop, in the context of also satisfying the other vegetation factors; it is enhanced by the human labour, in order to harvest high crops.
- **Fertilization:** the application of fertilisers in order to increase the soil fertility or a culture substrate and increasing the vegetal production.
- **Manure:** the simple or complex mineral or organic substance that contributes directly or indirectly to the preservation and/or improvement of plant nutrition.
- **Mineral or chemical fertiliser**: a fertiliser that is either mineral or industrial – produced by physical and/or chemical processes.
- **Polyculture:** the association of multiple cultures.
- **Precipitation** [P] {mm}: the total amount of atmospheric water fallen on the land: rain, snow, hail, dew etc.
- **Effective precipitation** [Pe] {mm}: the part of the total precipitation that can be used for plant growing.
- **Soil productivity:** the capacity of a soil type to produce crops under regular conditions. The capacity of a land (the soil-plant-atmosphere system) to generate crops.
- **Water resources:** the surface waters from watercourses with their deltas, lakes, ponds, internal sea waters and territorial sea, as well as the ground waters, in total.
- **Crop rotation:** the method of cultivating a series of different culture types on the same land in successive seasons. The selection and succession of cultures depends on the type of soil, climate and precipitation, that determine all together the type of plants that can be cultivated. Also, there are other important aspects that have to be considered when selecting the cultures, such as marketing and economic factors. Here we have only some
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- predominant plants, mainly grains and technical plants, and the widest spread practices are monocultures (corn) and the 2 year rotations (corn and fall wheat), that involves big quantities of mineral fertilisers and pesticides.
- **Climate change:** the changes in the global atmosphere that are directly or indirectly attributed to human activities that are, together with the natural climate variations, observed over comparable timespans.
- **Drainage:** the term used for the water resulted from rains, snow melting and irrigations, that drains over the soil without being absorbed, and discharges into rivers or other surface waters or in basins.
- **Meteorological drought:** from a meteorological viewpoint, drought is defines as a period of time with a significant deficit (or even the absence) of precipitation. The meteorological drought is stated after 10 consecutive days without precipitation. The intensity of the meteorological drought is calculated depending on the number of days without precipitation and the number of days with precipitation below normal level or below the multi-annual average of the analyzed period.
- **Agricultural system:** the practice of the technological system of the agricultural production that is primarily characterized by the intensive or extensive type of the agriculture, by the use of the land and the combination of the production fields, using the methods applied to preserve and increase the soil fertility, by the use of labour and the production relations.
- **Irrigation system:** the equipment necessary to bring the water into the planned area.
- **Soil:** the upper part of the Earth and it consists of mineral particles, organic matter, water, air and organisms.
- **Climate variation**: in the most widely sense, the term of climate variation refers to the inherent characteristics of climate that occur during the climate changes in time. The variation degree may be described as the differences between the long term statistical data of the meteorological elements calculated for different periods. The term of climate variation is also used to express the climate deviations for a given period of time (such as a certain month, season or year) from the long term statistical values related to the corresponding calendar period. Therefore, the climate variations are measured by those deviations that are usually called anomalies.

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8. References

1) Bojariu R., Velea L., Cica R. D., Dobrinescu A.E., Bîrsan M. şi Dumitrescu A., A. (2012): Mechanisms of drought persistence in Romania in the climate change perspective, Annals of University of Craiova - Biology & Environmental Engineering, Issue XVII. (LIII), 2012/2, ISSN 1453-1275, 523-526;
2) Chiţu Emil, Giosanu Daniela, Mateescu Elena (2013) – *"Seasonal and Annual Extreme Temperature Variability and Trends of the last three decades in Romania".* Advances in Environmental Sciences - International Journal of the Bioflux Society, Online ISSN 2065-7647. Volume 5, Issue 2: 70-88; http://www.aes.bioflux.com.ro;
3) Dumitru, M., Simota, C., Dorneanu, Emilia, Geambasu, N., Stanciu, P., igans, Letiţia, Iliescu, H., Munteanu, I., Dumitru, Elisabeta, Mitroi, A., (2003) - Klein Tank, A.M.G., J.B. Wijngaard, G.P. Koennen (2002) - Daily dataset of 20th century surface air temperature and precipitation series for the European Climate Assessment. Int.J.Climatol., 22, 1441-1453;
4) Mateescu Elena, Tanislav N., Vatamanu V.V. (2004) – *„Impactul condiţiilor de secetă asupra culturilor de grâu şi porumb din Câmpia Caracalului",* Editura Sitech, Craiova, ISBN 973-657-535-7, 163 pag;
5) Mateescu Elena (2007) – *"EU-ACCRETe Project – Agriculture and Climate Change: how to reduce human effects and threats. Romania's contribution and future steps",* The Parliament Politics, Policy and People Magazine, Issue 258, 10 December 2007, pp 76-77;
6) Mateescu Elena (2007) – *"EU-ACCRETe Project – Agriculture and Climate Change: how to reduce human effects and threats. Presentation of the case studies presented at the project thematic goups", Publisher by Municipality of Chrissoupolis, Greece, pp, 11-14, 14-18, 20-22;*
7) Mateescu Elena**,** Turcu V. (2007) - *"EU-ACCRETe Project – Agriculture and Climate Change: how to reduce human effects and threats. Regional facts and challenges" Chapter 2 – Climate change in Europe and Chapter 3 – Regional climate change impacts on agriculture, Publisher by University of Rostock, Germany, pp 18-71;*
8) Mateescu Elena, Marica Adriana, Alexandru D. (2009) – *„Climate change impact on fruit growing production"*, Proceedings R.I.F.G.Pitesti, Vol. XXV, 2009, ISSN 1584-2231, Editura INVEL-MULTIMEDIA SRL, pp. 87-100.
9) Mateescu Elena, Alexandru D. (2010) – *"Management recommendations and options to improve the crop systems and yields on South-East Romania in the context of regional climate change scenarios over 2020-2050"*, Scientific Papers, Series A LIII - Agronomy, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Agriculture, ISSN 1222-5339, pp 328-334;
10) Mateescu Elena, Stancalie G. At all (2012)–*"Drought Monitoring in Romania",*Proceedings of theJoint Workshop JRC/DMCSEE/Biotechnical faculty/"Different approaches to drought monitoring – towards EuroGEOSS interoperability model", Ljubljana, *23rd – 25th November 2011,* "Towards EuroGEOSS interoperability model in drought monitoring în SEE region", ISBN 978-961-6275-43-9, 16-27 pp;
11) Mateescu Elena şi colab. (2013) – *Plan Regional de acţiuni pentru prevenirea deficitului de apă şi a secetei*", EU-INTERREG IV-C, Project on Waterscarcity and Drought-Water CoRe, ISBN 978-973-14611-0, 131 pag;

12) Mateescu Elena at all (2014) – *"Adaptation measures in Romanian Agriculture",* SEE
13) Project - OrientGate: A structured network for integration of climate knowledge into policy and territorial planning, *Thematic Centre 1*: Forestry and Agriculture, *Pilot Study 2:* Climate change adaptation measures in Romanian agriculture, ISBN 978-973-0-177760-2, 99 pp;
14) Mitrica B., Mateescu E., Dragota C. S., Busuioc A., Grigorescu I., Popovici E. A. (2013) – " *Climate change impacts on agricultural crops in the Oltenia Plain (Romania)",* 13th SGEM GeoConference on Energy And Clean Technologies, SGEM2013 Conference Proceedings, ISBN 978-619-7105-03-2/ISSN 1314-2704, June 16-22, 2013, 573 - 584 pp, DOI:10.5593/SGEM2013/BD4/S19.009, www.sgem.org;
15) Miura, T.; Huete, A.R.; Yoshioka, H. (2000) - Evaluation of sensor calibration uncertainties on vegetation indices for MODIS. IEEE Trans. Geosci. Remote Sens. 2000, 38, 1399-1409;
16) Nertan, A., Mateescu E., Stancalie G. and Flueraru C. (2008) - "Agro-ecosystems monitoring using spectral vegetation indices and agro-meteorological data in Romania". Symposium on Climate Change and Variability – Agro Meteorological Monitoring and Coping Strategies for Agriculture, Oscarsborg, Norway, June 3-6 2008, Bioforsk FOKUS, Vol 3 nr 8, p. 36, ISBN: 978-82-17-00374-8;
17) Paltineanu C., Chitu E., and Mateescu E. *(2011*) – "Changes in crop evapotranspiration and irrigation water requirements", International Agrophysics, Polish Academy of Sciences, *2011, 25, 369-373;*
18) Paltineanu C., Chitu E., and Mateescu E. *(2012*) – "*New trends for reference evapotranspiration and climatic water deficit***",** International Agrophysics.,Polish Academy of Sciences, *2012, 26, 159-165,* doi: 10.2478/v 10247-012-0023-9;
19) Prutsch A., Grothmann T., Schauser I., Otto S., McCallum S., (2010) – *Guiding principles for adaptation to climate change in Europe, EEA,* ETC/ACC Technical Paper 2010/6, http://acm.eionet.europa.eu/docs/ETCACC_TP_2010_6_guiding_principles_cc_adaptation.pdf;
20) Sandu I.**,** Mateescu Elena, Vatamanu V. V. (2010) – *"Schimbări climatice în România şi efectele asupra agriculturii"*, Editura SITECH Craiova, ISBN 978-606-11-0758-2, 392 pp;
21) Sandu I., Mateescu Elena (2014) – *Schimbări climatice actuale şi previzibile în România, V*olum "Schimbări climatice – provocare majoră pentru cercetarea agricolă, Lucrări prezentate la masa rotunda organizată de Secţia de Ştiinţe Agricole şi Silvice a Academiei Române, la data de 23 noiembrie 2012, Coordonator Acad. Nicolae N. Saulescu, Editura Academiei Române, ISBN 978-973-27-2421-7, pg 17-36;
22) Stancalie G., Mateescu Elena at all (2012) – "Guide to good practices for preventing drought and water scarcity in Mures River Basin", EU- DGE, Halting Desertification în Europe Programme, MIDMURES Project – Mitigation Drought in Vulnerable Area of the Mures Basin 07.0316/2010/582303/SUB/D1, 64 pp;
23) Sudhanshu, S.P.; Daniel, P.A.; Suranjan, P. Application of Vegetation indices for agricultural crop yield prediction using neural network techniques. 2010, Remote Sensing 2010, 2, 673-696; ISSN 2072-4292;
24) Todd, S.W.; Hoffer, R.M. Responses of spectral indices to variations in vegetation cover and soil background, Photogram. Eng. Remote Sens. 1998, 64, 915-921.

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25) Teodosiu M., Mateescu Elena (2008) – *"Romanian plant phenology – history, networks and data",* COST Action 725, The history and current status of plant phenology in Europe, ESF-COST Office 2008, ISBN 978-951-40-2091-9, pp. 140-144.

26) *Cod de Bune Practici în Fermă – CBPF (publicat în M.O. nr. 15 din 10.01.2007);*

27) Anexă la Ordinul Ministrului Mediului şi Schimbărilor Climatice nr. 1170 din 29.09.2008: *Ghid privind adaptarea la efectele schimbărilor climatice – GASC (publicat în M.O. nr. 711 din 20.10.2008);*

28) Cod de Bune Practici Agricole pentru Protecţia Apelor împotriva Poluării cu Nitraţi din Surse Agricole, draft-2012, www.icpa.ro;

29) IPCC WGII - AR5, Chapter 16, Final Draft (2014) - Chapter 16. Adaptation Opportunities, Constraints, and Limits, WG II- Impact, Adaptation and Vulnerability, IPCC'S FIFTH ASSESSMENT REPORT;

30) EEA Report No 3 (2013) - *Adaptation in Europe. Addressing risks and opportunities from climate change in the context of socio-economic developments*, EEA Copenhagen 2013, Denmark, ISBN 978-92-9213-385-6; ISSN 1725-9177, doi: 10.2800/50924, 132 pp;

31) *Programul Cercetare de excelenţă (CEEX***):** *"Ghiduri practice tehnico-economice destinate asigurării unui management de success la nivelul sistemelor de producţie vegetale şi animale" (Acronim: MAGIS),* Proiect nr. 732/3.10.2005. Responsabil: Ana Ursu, ICEADR Bucureşti; perioada derulării: 2005-2008;

32) Strategia Naţională a României privind Schimbările Climatice (2013-2020).

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The project develops between January 2015 and April 2017. The overall objective of this project is to reduce the vulnerability of humans and of the ecosystem to the climate change and envisages to create a best practices set on the adaptation to climate change.

The EEA Grants and Norway Grants represent the contribution of Iceland, Liechtenstein and Norway to reducing economic and social disparities and to strengthening bilateral relations with the beneficiary European countries. The three countries have a close cooperation with the EU by the European Economic Area (EEA) Agreement.

For the period 2009-2014, €1.79 billion has been set aside under the Grants. Norway contribution is approximately 97% of the total funds. The grants are available for NGOs, research and academic institutions and the public and private sector from 16 EU Member States, from Central and South Europe. There is a deep cooperation with the donor states entities and the activities can be implemented before 2016.

The key support fields are the environmental protection and climate change, research grants and scholarships, civil society, healthcare and children, gender equality, justice and cultural heritage.

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