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TRENDS OF SIGNIFICANT VARIABILITY OF CLIMATE CHANGE IN THE VILLAGE OF NEGREA IN THE LAST 120 YEARS

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Abstract

Climate change has a profound impact on the availability of resources and agricultural activities. Over the past decade, the country has experienced a number of extreme events, such as droughts and major floods, along with incremental effects caused by rising average temperatures and uneven rainfall throughout the year, which has had a negative impact on the country's economy. Welfare and health of the population. National and international investments in climate observation, research and modelling over the last decades have led to considerable progress in experimental and applied climate predictions and projections. The systematic application of existing climate knowledge in practical solutions requires a review of the way in which climate research is conducted. The main purpose of the investigations carried out in the village of Negrea, is to highlight the climatic oscillations that influence the soil production capacity. The pedological researches in order to assess the change in the characteristics of the arable layer of the researched soil were carried out from 2013 to 2021. Agrometeorological observations from the last 120 offered the possibility to systematize the influence of climate change on the study region. The string of researched data is of particular importance for highlighting and evaluating the real amplification of multiannual climate change. In this regard, improving methods of analysis and forecasting of agroclimatic processes and resources, meteorological parameters and crop yields, taking into account climate change, is currently an urgent scientific issue. In order to adapt agricultural production to climate change, it is necessary to comprehensively study the nature and trends of changes in meteorological parameters, their impact on the growing season and crop yields.

***Key words**: agroecosystem function, analyse agrometeorological parameters, inadequate anthropogenic activity, soil.*

INTRODUCTION

The territory of the Republic of Moldova falls within the area with insufficient humidity. The climate is mostly semi-arid, the aridity index being between 0.4-0.5. It is reported that, lately, the frequency of strong and very strong droughts has increased, the consequence of which is the substantial reduction or compromise of agricultural production (Senic et al., 2021).

Although little time has passed since the beginning of the 21st century, average temperatures have risen slightly during this period. The average temperature in Moldova has risen by about 0.6°C in the last 50 years, and by the middle of this century, it will increase by one degree. This will have two important consequences. First - winters will be shorter and probably less severe in all parts of the country, and summers will be very warm and longer. According to the records of the Meteorological Directorate of the Republic of Moldova, 2007 and 2020 was the warmest years in the country's history (with + 2.0-2.5°C above the norm), the temperature reaching on July 21, 2007 and on July 27, 2020 at +41.5-42.8°C in Camenca. The summer was also the warmest, with + 2.5-4.0°C above the norm. In 2007 and 2020 the country faced the worst droughts, when for five days the temperature exceeded +40°C (Agrometeorological Monitoring Direction).

Second - the characteristics of the weather will vary between north and south. The frequency of extremely rainy days has increased in the north and decreased in the south. A clear distinction of about 27% of rainfall between the northern and southern agro-economic zones, or between the northern and southern districts, has existed over the last 8 decades. As the north gets rainier, the south gets drier. Abnormal rainfall was recorded throughout the country and in the period 1940-2011. Although there has been an upward trend of up to 66 mm in the amount of rainfall since the end of the 19th century and until today, this increase has not been uniform. The number of days with heavy rainfall (> 20 mm of rainfall per day) increased by 23% in the north and decreased by 4.6% in the south. This reveals an intensification of irregular rainfall in the northern regions, with increased chances of flooding and a slow desertification of the southern regions. If we analyse the data on very heavy rainfall (> 50 mm of rainfall per day), the difference becomes more obvious: in the North there was an increase of 42% compared to a decrease of 9% in the South. In other words, the North-South division continues in the case of rainfall. From an economic point of view, economic losses due to drought situations were the worst phenomenon causing more than 65% of total losses caused by disasters (Agrometeorological Monitoring Direction).

The biggest contribution to the increase in the average annual air temperature was introduced by the winter season. According to the secular variation, the average air temperature for the winter season increased by 1.5°C compared to the end of the 19th century. By analogy with the global air temperature, in the Republic of Moldova the average air temperatures for pentad (2016-2020) and decade (2011-2020) were the highest in the entire period of observations. Since 1990, each decade has been warmer than the previous one. Also, the last 60 years of observations indicate an increase in the number of days with heavy rainfall and heavy rainfall. Compared to the mid-1970s, their number increased by 2 to 3 days. In the Republic of Moldova, 2020 was characterized by a high thermal regime and significant insufficient rainfall during the growing season. The average annual air temperature in the territory was +10.7 ... +13.1ºC, exceeding the norm by 2.6-3.7ºC and is reported for the first time in the entire period of observations. According to the Chisinau meteorological station (observation period 126 years) the average annual air temperature was +12.7ºC (3.2°C higher than the norm) and ranked 1st in the number of years with high average annual temperatures (www.meteo.md).

Strong and irregular meteorological phenomena, which will lead to intensified soil erosion, flooding and groundwater depletion (Andries et al., 2004; Constantinov et al., 2003).

A disproportionate reduction in agricultural land (which has fallen by 3% in the last 15 years) and the dependent population (which has fallen by 12% over the same period) is visible as a result of different national policies and geoclimatic factors. The level of stress due to water availability and use problems is expected to increase in the coming decades, especially in the central and southern districts of Moldova (Puthumai, 2017).

Assessment studies of the impacts of climate change on agriculture at farm to regional levels need to analyze complex interactions of climate, agro-ecosystem function, and human management. To this end, researchers typically link climate predictions to crop models and land management decision tools. For instance, Decision Support System for Agrotechnology Transfer (DSSAT), Erosion Product Impact Calculator (EPIC), Terrestrial Ecosystem Model (TEM), and the AEZ model have been used at the global scale (Oprea et al., 2014; Taranu, 2014).

The purpose of this paper is to highlight the most pressing issues for the village of Negrea, related to the ongoing climate change assessment, including inadequate anthropogenic activity, to determine the main directions of climate research in the researched territory needed to be used in preparing regional forecasts and economic and social development programs and proposals for improving soil in the event of climate change.

The analysis of data collected by the Hydrometeorological Service and other departments in the field of climate change study on the territory of the Republic of Moldova, made possible the practical use of climate information from Negrea village, Hincesti district to improve soil quality by properly applying agricultural works.

The way we use the land has a negative impact on the climate. In turn, climate change forces us to think differently about how we use it, making things worse. For example, a decrease in soil fertility forces us to create new fertilizers, new agricultural machinery, which squeezes all the juices from the soil and at the same time increases the volume of harmful emissions. Modern technologies force the soil to degrade a hundred times faster than it is able to regenerate. If humanity does not break this circle, a slip of the road to environmental disaster is inevitable. The price that humanity as a whole and individual countries pay is too high not to act or to take wrong or premature action because of climate change. Given this, we would like to hope that the concrete steps highlighted in the proposed materials will become a reality (Ungureanu et al., 2006).

MATERIALS AND METHODS

In the regions of the Republic of Moldova, agriculture is the most important economic development. The study object was chosen Negrea locality, located in the central physical-geographical province of the Republic of Moldova in the Codri area (Ursu, 2006). It is an ancient locality located in the Lăpușna river valley, a left tributary of the Prut. The main characteristics of climate change in the village of Negrea are presented in the results and discussion section.

The relevance of modern climate change studies is undoubtedly: an increase in the number of natural disasters is observed everywhere, the damage caused by floods, droughts and fires, which are a consequence of ongoing climate change, is increasing. The 2015 World Meteorological Organization (WMO) Statement on Global Climate Status notes that "one of the most effective tools for adapting to the effects of climate change is to strengthen early warning systems for disasters and climate services" (OMO, 2016). In this regard, the study of regional manifestations of climate change in mountainous areas is of particular importance, as it is able to detail the big picture.

To achieve this goal, agrometeorological data were taken and evaluated as a method of analyzing the dynamics of long-term meteorological parameters in the researched area.

The following methods were used: (1) Detailed documentary research of available documents on climate change (both trends and projections) related to Moldova and examination of reports on socio-economic vulnerabilities of the country; (2) Data analysis: included the examination of secondary data, primarily data from the National Bureau of Statistics, Agrometeorological Monitoring Direction and other directions to understand trends and situations of climate change.

The research is based on the materials of long-term meteorological observations for the period 1901-2020 (total precipitation, monthly, annual precipitation, average air temperature, maximum air temperature, minimum soil temperature, average relative humidity, air humidity deficit) according to data from 6 meteorological stations in Central and Southern Moldova. The following research methods were used: statistics, standardized range, deviations from the climate norm and moving averages with a period of N = 120 for the analysis of the dynamics of meteorological parameters.

The information system is the main mechanism by which climate information - past, present or future - is archived, analysed, modelled, shared and processed. It produces and provides authorized climate information products through operational mechanisms, technical standards, communication and authentication. Its responsibilities include analysis and monitoring, evaluation and allocation, climate predictions (monthly, seasonal, decade) and climate projections (centennial scale). Mathematical software was used - MS Excel, Statistics, Matlab and ArcGIS software.

It was found that, in the winter months, the cooling of the air at the surface of the soil in the researched area, is associated with the predominance of anticyclones, the leakage of cold air from the slopes and its stagnation. In the warm period, with the restoration of the western transfer of air masses, a barrier effect appears, and on the slopes under the action of the wind, the clouds are scattered, so little precipitation falls, just like in winter. In the valleys, the air is warming, the clouds are also scattered, and the number of solar hours is increasing (Cojocaru, 2020).

The radiation regime is characterized by significant fluctuations in the duration of insolation and the amount of solar energy that falls on the soil surface. Also, a change in the transit of solar radiation affects the change in air temperature, melting snow, vegetation, soil, seasons of natural phenomena. For each season 1901-2020, the statistics of the surveyed area were estimated on a sample of <90 days (taking into account the gaps that are different for different variables) for each of the 4 variables: T_{med}, T_{min}, T_{max} - average daily temperature, minimum and maximum, ΣP - daily amount of precipitation. The dynamics of climate change have been studied on the basis of long-term meteorological information (120 years: 1901-2020).

For a correct analysis of the temporal distribution of the main meteorological indicators on the territory of Negrea locality, monthly observation data from the operational observation unit of the State Hydrometeorological Service were used, official data from the archive.

The methods of conducting pedological research in the field and analysis used to determine the chemical characteristics of soils are those standardized nationally. The pedological researches in the field were carried out according to the unique system of classification and reclamation of soils, adopted by the Government of the Republic of Moldova by Decision no. 24 of January 11, 1995 as a normative document for the elaboration of the land cadastre and perfected in 1997.

The necessary analyzes for the diagnosis of soil taxonomic units were performed in soil samples collected from all profiles located in the field during the research period: to determine the texture, structure; humus content; carbonate content; pH values; hygroscopicity, density, bulk density, porosity, etc.

The agricultural lands in the Negrea river basin occupy over 600 hectares, of which 90% are located on a slope. As a result of the field monitoring of the leaks following the torrential rains, it was established that the rainwater that did not infiltrate drains on the surface of the sloping agricultural lands and causes soil erosion. As a result of this negative process, on the water concentration lines in micro-depressions, soil washes were formed by streams, directed from the hill to the valley to the foot of the slope. The losses amounted to tens of tons of fertile soil. Deep erosion has led to the formation on the ground of a network of ditches (elongated micro-depressions) with different lengths, from 200-300 m to 600-700 m. The direction of water flow depended on the direction of agricultural works. This fact greatly influenced the intensity of soil erosion on the lands of the Negrea hydrographic basin.

RESULTS AND DISCUSSIONS

The article presents the results of climate monitoring in the village of Negrea, Hincesti district for the period 1901-2020, carried out regularly. The village of Negrea is located in Central Moldova in the middle of the Lăpuşniţa river basin. The approximate distance from the village of Negrea to the main cities is as follows: Hancesti - 23 km, Chisinau - 60 km. The researched fields are located on the territory of two parallel elongated peaks, located northwest of the village. Between the peaks is a valley sloping towards the meadow of the river Lăpuşna, passing towards the river through the southern part of the village. The calculations of the annual air temperature in the calendar frame of the researched area, made it possible to establish a significant positive linear trend (Cojocaru, 2016). Thus, according to the monitoring of the data from the meteorological stations in the Center of Moldova, the increase of the average annual air temperature over a period of 120 years (1901-2020), based on linear trends, was 3°C (Figure 1) at a long-term medium.

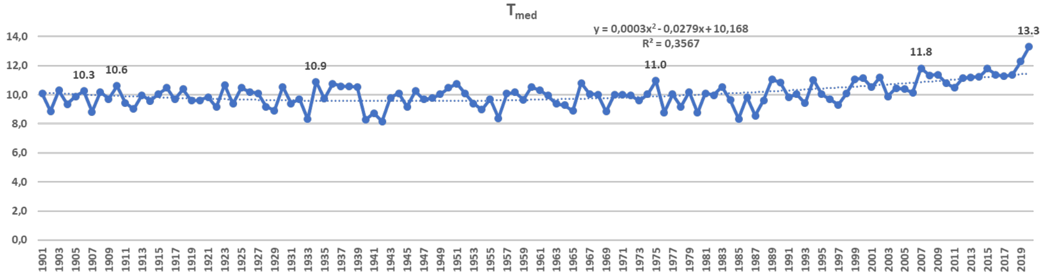

Figure 1. The values of the average annual air temperature (^{0}C) for the years 1901-2020

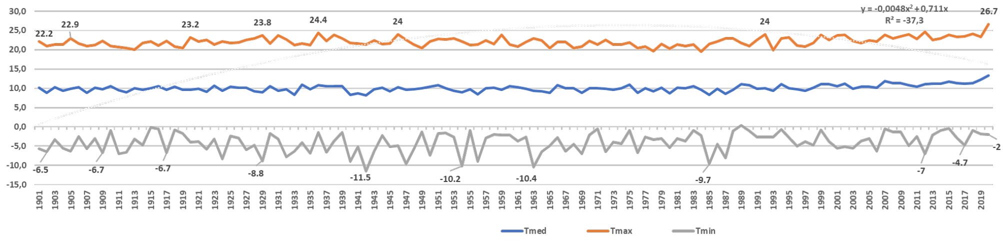

Figure 2. The values of the variation of the average, maximum and minimum air temperatures (^{0}C) during the years 1901-2020

We note that for 120 years the air temperature in the summer season often exceeds 23°C. In winter the snow cover is very thin and usually lasts only two months, the temperature drops below minus 12°C. Substantial temperature deviations occur in both summer and winter, which leads to various natural disasters such as drought and frost, but also to mass illness among the population. Summers are long and hot with average temperatures above 20°C, often tropical air masses bring temperatures of +30 ... + 35°C. Winters are poor in rainfall and in January the average temperature is around - 5° C. Absolute minimum: -11.5°C, absolute maximum: 26.7°C (Figure 2).

Since 1938 there has been a "warm-up break". This period is characterized by a relatively stable average temperature, which is occasionally accompanied by sharp explosions of heating. However, deviations from the temperature in the annual average indicators do not reflect the full dynamics of the thermal regime during the annual cycle.

As can be seen from Figure 1, the tendency to change the average annual air temperature before the 90^s of the twentieth century was quite small (0.05°C per decade or ~ 0.5°C per century). Since the 90's of the twentieth century this index has a sudden evolution towards growth (approximately 0.63°C per decade or ~ 6.3°C per century).

The average air temperature during the winter is in the territory of Negrea village between 0.9ºC and -3.4ºC. The coldest month of winter is January, the average monthly temperature is 0.1 ... -5.5ºC. The coldest was the winter of 1942 and 1954, when the average air temperature was -7 ... -9.5ºC, being 6-7ºC below the norm. The warmest was the winter of 2019-2020, when the average air temperature was +1.2 … +2.7ºC, exceeding the norm by 4.5-5.5ºC. During the entire period of instrumental observations, the lowest air temperature in the winter season was reported in January 1942 was -11.5ºC (Negrea village), and the highest - in February 1990 was + 23.3ºC. The instability of the thermal regime in the winter season is one of the most specific features of the climate of the Republic of Moldova.

Rainfall is rare, most of it falling during storms accompanied by hail and lightning.

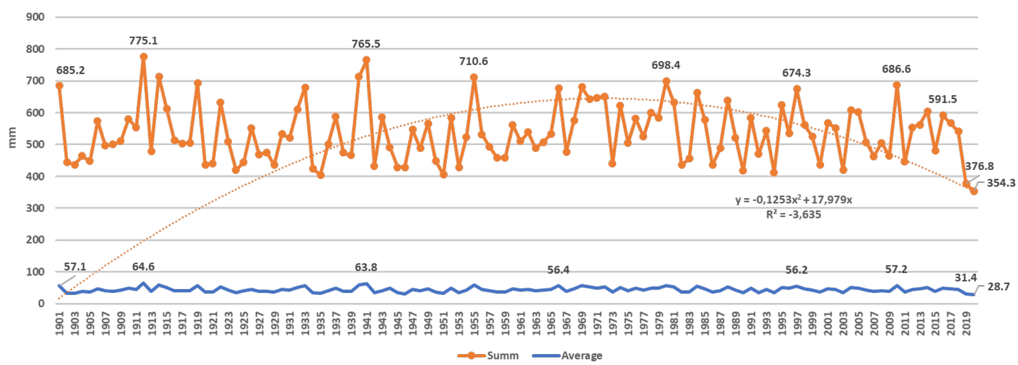

Figure 3. The values of the sum of the amount of annual atmospheric precipitation (mm) for the period 1901-2020

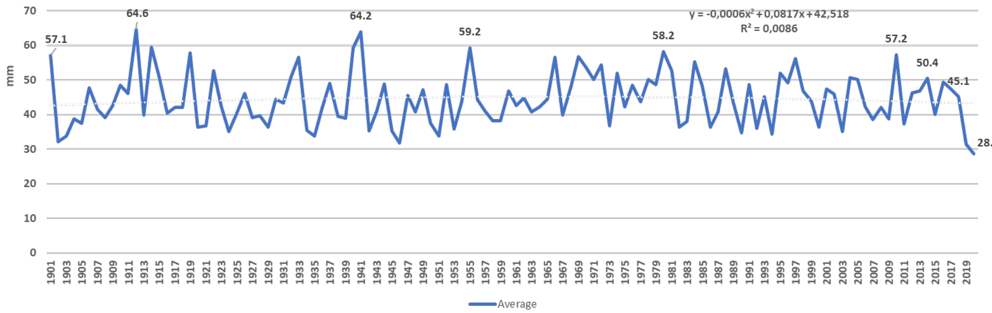

Figure 4. Values of the amount of average monthly atmospheric precipitation (mm) for the period 1901-2020

Droughts are very common. The first part of autumn is similar to summer, in the second part of autumn the temperatures start to decrease and the rains become more frequent.
The area of the village of Negrea is located in the region of interference of the Atlantic, continental air masses from Eastern Europe and the tropical ones from the south. Solar radiation, air mass dynamics and relief form a climate with relatively mild winters and little snow, with long, hot summers and low humidity. In summer, the heat causes the water from the wells to dry up in the high-altitude areas, and in August, torrential rains fall, causing the rivers and streams to overflow. The amount of rainfall varies drastically, droughts are frequent, but the average annual rainfall is around 500 mm. About 2/3 of the rainfall falls between April and September. During the winter season, the precipitation falls mainly in the mixed phase - in the form of rain and snow. The annual amount of their atmospheric precipitation is 350-770 mm or 16-20% of the average annual amount (Figures 3 and 4). At the same time, the variation of the precipitation quantities is observed, which in the last years start to decrease and are rarer having a monthly maximum that reached values of 142 mm (in 1901); 158 mm (in 1948); 185 mm (in 1985); 131 mm (in 2011); 108 mm (in 2018); 63 mm (in 2019) and 37 mm (in 2020).
As a result of the climate change that is generated by the increasing impact of the human activities of the locals, which causes more and more frequent and destructive natural dangers throughout the territory, other disasters can be caused. The full impact of climate change in the village of Negrea is unpredictable, with many long-term variations and fluctuations, including extreme weather in the form of droughts, heavy rainfall, heat waves and rising temperatures.
In this context, it was observed that droughts are becoming more frequent in the village of Negrea. Droughts were recorded in 2007, 2012 and 2020, which caused damage to agriculture, leading to impoverishment. Such a risk was also in the summer of 2013, 2015 and, but which did not have a great destructive impact on agricultural crops. Droughts lead to soil degradation, which poses a major threat to the sustainability of land resources and can reduce the ability of Negrea village agriculture to successfully adapt to climate change.
Floods are also a risk factor for the population of Negrea village. The frequency of heavy rainfall has increased in recent years and floods are a common danger in the locality, leading to soil erosion (essential area research conducted since 2012) and loss of crops in rainy seasons.
The negative aspect of the climate is drought, the frequency of which is 2-3 times in ten years and the torrential nature of precipitation. During the summer, heavy rains of low intensity fall, which moisten the soil well and do not cause appreciable erosion, but predominate torrential rains of high intensity ("erosion"). The latter are usually accompanied by hail storms. Over the course of 24 hours, it can fall over 50-100 mm. These precipitations are particularly dangerous from an erosion point of view. Torrential rains cause considerable water runoff from the slopes, causing surface and deep soil erosion. In order to minimize the erosive effect of runoff, it is necessary, first of all, to strictly observe the whole complex of soil erosion protection measures.

The materials of the periodic pedological researches of the lands with agricultural destination of the republic form the database for the elaboration of the spatial erosion monitoring. Soils are rightly considered the most valuable natural resources, which have always ensured the existence and well-being of our nation. The irrational use of agrotechnical and chemical methods of agricultural land processing in recent times has resulted in massive degradation of these resources. Erosion processes have increased (Cojocaru, 2016), which has considerably reduced the natural fertility of the researched soils. Productivity of eroded soils decreases as follows: poorly eroded - by 20 percent; moderately eroded - by 40 percent; heavily eroded - by 50 percent; very heavily eroded - by 70 percent; completely eroded - by 90 percent. The presence of large areas with poorly eroded soils testifies to the high potential for intensifying the erosion process on agricultural land. The damage done to the national economy by soil erosion is colossal. The weighted average annual crop losses on eroded land are: on arable land - 27 percent; on lands with fruit plantations - 30 percent; on pastures - 37 percent. Ordinary chernozems occupy an area of 548.4 thousand ha of the total area of the Republic of Moldova. This subtype of soil is widespread in most districts of the republic, predominates in the center (high river terraces) and southern Moldova (Southern Moldavian Plain). It is characterized by a lower humus content, often with the presence of carbonates in the arable layer. Slightly alkaline soil reaction. Stability to erosion processes due to the coarser particle size composition (loamy and loamy-sandy soils occupy up to 40% of the surface, and loamy-clayey - almost 60%) is lower than for other chernozem subtypes.

Landslides on the slopes are a source of water pollution in the village. Reducing soil erosion is possible by using the alternative strip farming method for slope-based agrosystems. The massive use of anti-ecological agrotechniques, especially the application of mineral fertilizers and pesticides during the Soviet period, has had a destructive and harmful long-lasting impact on the soils of the village of Negrea. The socio-economic crisis, which marked the last decade of the last century and which still persists today, has spread far and wide over the ecological management of agricultural land. Although the use of chemical fertilizers and pesticides on heavy agricultural machinery has been substantially reduced, the overall impact on agricultural land and soils is very high. Dehumidification processes, cultivation of the same crops for many years in a row, burning of agricultural waste, unsatisfactory sanitary indices have led to soil degradation. The reduction of humus content and the mechanical processing of arable land have contributed to the deterioration of the soil texture, the compaction of the arable land and the reduction of agricultural productivity.

Excessive migration of the able-bodied population, the aging of the commune's population has generated the phenomenon of enlarging the watering areas. The causes of the intensification of soil degradation processes are: fragmentation of agricultural land in the process of peasant ownership, which excluded from the beginning the possibility of sustainable agriculture, based on modern technologies of tillage and conservation, allocation of arable land, perpendicular to level, insufficient information of the beneficiaries about the agrotechnical and hydrotechnical methods of erosion prevention, the massive negligence of the local population; the lack of an economic motivation necessary to prevent and reduce the destructive impact on the soils, the existing contradictions between the provisions of the different normative-legislative acts in the field.

We state that agriculture is the main form of activity in the locality. Here, the agricultural sector has developed unevenly due to several causes: unfavorable weather conditions (drought, frost), agricultural land degraded due to lack of financial resources of the owners or their inability to be processed, difficulties in achieving increased agricultural production.

Most agricultural land is privately owned with an equivalent share of land. The indicators show that most people work the land without being specialists in the field, using various chemicals that do not meet the requirements of tillage. Economic agents in possession of the given lands also work the land, hiring people who do not work conscientiously, do not work the land according to the rules, like real landlords.

In the researched area, agriculture is facing extreme weather events, which have resulted in a high variability of agricultural crops. Both extreme local weather events and climate variability are increasing as a result of global warming. Cereal crops and other crops may decline due to more frequent droughts. Even if the losses could be partially offset by the beneficial effects of carbon dioxide, crops would still continue to be threatened by the need for water, the presence of pests and diseases, and the loss of agricultural land through desertification.

The main anthropogenic factors of soil degradation, in addition to climate change, are the maximum entrainment of the plowed territory, the cutting of forest strips, agricultural work along the slope, incorrect location of the road network, insufficient protection of soils with vegetation, the exaggerated share of weeding crops in crops, compaction of soils with heavy mechanisms, non-compliance with anti-erosion agrotechnics. The agricultural activity, without taking into account the particularities of the soils, the relief, leads to the continuous decrease of the fertility of the lands and their degradation. The intensity of agricultural activities in different periods, for different uses differs in terms of quality and quantity and is very varied (Cojocaru, 2018).

To date, the technology of growing crops on slopes with different inclinations is slightly different from that used on horizontal land with uneroded soils. For example, the cultivation of land along the slope causes the loss, with surface runoff, of 20-30 percent of torrential rainfall. In case of 30 mm of precipitation falling from the slope soils, 90-150 m^3 of water per hectare are lost. The damage to the wheat crop is 1.5-2 q/ha.

The concentrated nature of the leaks also damages the sowing. Stream erosion covers 40-50 percent of the area of the demonstration fields. Leaks formed by heavy rainfall destroy the soil, exposing the root system of plants. The annual loss of fertile soil is tens of tons per hectare. As a result, the annual losses of nitrogen, phosphorus and potassium, caused by erosion, often exceed the amount of fertilizers incorporated. The soil removed from the slopes is deposited at their foot, in valleys, ponds and rivers (Cojocaru, 2018).

The complexity of the structure of the soil cover, the diversity of the destructive influence of the natural factors, the intensity of the anthropic activity determines the wide development of the processes of degradation and destruction of the lands of the fields. The main factors of agricultural land degradation are climate change and soil erosion by surface water and depth.

The eroded soils in the researched area differ from the not eroded ones, by decreasing the thickness of the humus profile and the humus content. According to the data obtained from previous research, soils of varying degrees of erosion on the territory of Negrea village are characterized by the following parameters of the thickness of the humus profile with humus content greater than one percent: not eroded - > 90 cm; poorly eroded - 70-90 cm; moderately eroded - 50-70 cm, strongly eroded - 30-50 cm. The humus content in the soils of different degree of erosion in the researched soils is the following: not eroded - about 3.0-3.3%; poorly eroded - 2.5-3.0% for clay-loam and mainly 2.0-2.5% for clay; moderately eroded - 2.0-2.5 for clay-loam; strongly eroded - 1.3-1.7% (Cojocaru, 2016).

Recommendations. At the level of agricultural holdings, some elements of adaptation to the effects are extremely important climate change: the use of multifunctional agricultural technologies; diversification of agricultural crops resistant to climate change; the correct anti-erosion and hydrological organization of the agricultural territory taking into account the suitability of the lands for different use; crop adaptation through the use of existing genetic diversity and new opportunities offered by bio-technology; better soil management by increasing water retention in order to maintain soil moisture; creation of rainwater catchment basins; the introduction of crop rotation, the reduction of the share of weeding crops; planting herbaceous plant species that prevent soil erosion; afforestation of lands at risk of erosion.

CONCLUSIONS

The unpredictability of meteorological phenomena: the time and place where the phenomena will take place is difficult to predict, because there are many anthropological and ecological factors that determine the extreme meteorological phenomena.

The village of Negrea is characterized by moderately warm conditions and a semi-temperate climate. Average annual temperature 9.0ºC; the sum of temperatures higher than 10º - 150 days; the average temperature of July - + 21.5ºC, of January - minus 6ºC; the average amount of annual precipitation is 472 mm, of which 362 mm fall during the warm period, the hydrothermal coefficient 0.58; duration of vegetation period 176 days.

Changes due to high temperatures could lead to early-onset disasters - such as hailstorms, heavy and uneven rainfall, and landslides on the slopes.

In the agricultural sector in the village of Negrea it is proposed to introduce new varieties of crops, some older ones could adapt to climate change or could disappear altogether. At the same time, the emergence of more agricultural land, due to the food security conditions of the population and the possible water deficit, as well as the temperatures that will continue to remain sometimes lower, sometimes higher on the upper plains of the river basin, could condition a certain level of migration of microorganisms outside the investigated area. Thus, it is possible to reduce the fertility and quality of agricultural land, by obtaining much lower agricultural production.

As a result of the observations for the period of 120 years, it was observed that in the village of Negrea droughts are becoming more frequent. Droughts were recorded in 1902, 1924, 1935, 1946, 1951, 1973, 1994, 2003, 2007, 2012 and 2020 (Figure 4), which caused damage to agriculture, which leads to impoverishment of the population. Such a risk was also in the summer of 2013, 2015 and, but which did not have a great destructive impact on agricultural crops.

The average air temperature during the winter is in the territory of Negrea village between 0.9ºC and -3.4ºC. The coldest month of winter is January, the average monthly temperature is 0.1 ... -5.5ºC. The coldest was the winter of 1942 and 1954, when the average air temperature was -7 ... -9.5ºC, being 6-7ºC below the norm. The warmest was the winter of 2019-2020, when the average air temperature was +1.2 ... +2.7 ºC, exceeding the norm by 4.5-5.5ºC. During the entire period of instrumental observations, the lowest air temperature in the winter season was reported in January 1942 was -11.5ºC, and the highest - in February 1990 was +23.3ºC (Figures 1-2).

For this reason, in order to cope with climate change, we need to use crop varieties that are better adapted and more resistant to high temperatures and drought. To the same end, it is important for farmers to be able to continue their work, by providing services in rural areas and providing assistance so that they can adapt their production methods. Changes in land use are expected, as well as changes in ecosystems and reduced biodiversity, which will affect the balance of the agricultural sector. In addition, climate uncertainty will affect the financial security of farmers and reduce confidence in agricultural activities. Small farmers are the most vulnerable to climate change because they find it more difficult to cope with economic and social difficulties. Moreover, problematic environmental conditions increase their vulnerability and reduce their ability to adapt to the effects of climate change.

It is unlikely that humanity will be able to completely prevent climate change. However, the international community is able to contain the rise in temperature to avoid irreversible consequences. Climate change is one of the main challenges today.

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