ASSESSMENT OF CLIMATE SUITABILITY FOR GRAPES QUALITY IN THE REPUBLIC OF MOLDOVA

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Introduction

Current climate change contributes to essential modification of crop development phases and quality [1]. At the same time, these conditions may weaken or conversely, increase the quality of the vine's grapes. Taking into account the trends of climate change in the August month - time when the quality of the grapes is determined, it is extremely important to quantify the climate suitability degree for grapes quality [2, 3].

We note that this requirement is determined by the fact that in recent years, throughout the country, during August, there is an increase in the intensity of thermal maximum beyond the limits, significant variability of relative air humidity and diurnal thermal amplitudes is recorded.

Initial material and research methods

In farming practice, during August, in conditions of relative humidity between 65-70%, a maximum temperature of 28 ... 30°C and the minimum temperature of not less than 14°C, favourable conditions in order to obtain quality grapes are established.

Therefore it was necessary to develop an index that takes into account the requirements of the vine grapes to climate regime during this period. The coefficient was developed (Nedealcov-Rapcea) to express the climate suitability for grapes' quality, the expression value of which is:

$$CNR_{(VIII)} = \frac{Ur}{T\max + Tmin}$$

where CNR- is the Nedealcov-Rapcea Climate Suitability Coefficient for grapes quality during August;

Ur- relative humidity, while *Tmax and Tmin* are respectively; monthly low and high absolute temperatures.

According to CNR quantification, if its values are within the limits 7-9, 9- unfavourable conditions for quality of the grapes are established.

Table 1: Quantification of Nedealcov-Rapcea of Climate Suitability Coefficient for grapes quality

Nr.	CNR Coefficient	CNR Quantification
1.	7-9,9	unfavourable
	10,0-12,9	favourable
	13,0-14,9	very favourable
	<15,0	extremely favourable

If CNR values ranging within the limits 10.0-12.9- the climate is favourable to obtain quality grapes, at the same time if 13,0-14,9- are favourable climatic conditions for the production of high quality grapes and CNR values that exceed the limit of 15.0 units - the climatic conditions are very favourable (Table 1).

As a background starting material for the research served CNR data calculated based on relative humidity, thermal extremes of the reference month, for 16 weather stations within the State Hydrometeorological Service.

Using the Statgraphics Centurion XV, statistical analysis was performed and spatial interpolation of the data - Surfer 8 program, the interpolation Radial Basic method has been used.

Analysis of the obtained results

Thus, CNR calculation allowed the CNR register elaboration, which indicates for example: that starting from 1982 in the central and southern part of the country were established only favourable conditions, highly favourable and extremely favourable for high quality grapes (tab. 2, 3), which in our opinion is conditioned by accelerated climate warming in recent decades.

Table 2: CNR Register concerning climate suitability for grapes quality in the south of the country

Yers	CNR	Climate suitability for quality grapes
1961	11,3	favourable
1962	9,9	unfavourable
1963	15,7	extremely favourable
1964	12,4	very favourable
1965	11,3	favourable
1966	7,2	unfavourable
1967	14,1	very favourable
1968	13,1	very favourable
1969	13,2	very favourable
1970	12,6	very favourable
1971	8,6	unfavourable
1972	14,5	very favourable
1973	11,2	favourable
1974	13,5	very favourable
1975	9,9	unfavourable
1976	11,7	favourable
1977	12,3	very favourable
1978	12,3	very favourable
1979	13	very favourable
1980	11	favourable
1981	8,9	unfavourable
1982	15,2	extremely favourable
1983	12,7	very favourable
1984	10,9	favourable
1985	13,1	very favourable
1986	11,9	favourable
1987	11,4	favourable
1988	12,7	very favourable

1989	13,3	very favourable
1990	13,1	very favourable
1991	13,5	very favourable
1992	16,8	extremely favourable
1993	11,2	favourable
1994	14,2	very favourable
1995	11,3	favorabil
1996	13	very favourable
1997	15,1	very favourable
1998	10,9	favourable
1999	14,1	very favourable
2000	12	favourable
2001	10,3	favourable
2002	15,7	extremely favourable
2003	14,8	very favourable
2004	10,4	favourable
2005	14,8	very favourable
2006	12,8	favourable
2007	14,0	very favourable
2008	14,2	very favourable
2009	14,6	very favourable
2010	14,3	very favourable
2011	13,5	very favourable
2012	12,8	favourable
2013	14,9	very favourable

According to the values of the Coefficient in 1966, 1971, 1981 both in the central and southern part of the Republic of Moldova climatic conditions were unfavourable to obtain quality grapes. Furthermore to the above mentioned, the years 1962, 1975 in the south and 1970 in the central part of the country are added.

Table 3: CNR Register concerning climate suitability for quality grapes in the central part of the country

Yers	CNR	Climate suitability for quality grapes
1961	10,5	favourable
1962	12,0	favourable
1963	14,6	very favourable
1964	12,2	favourable
1965	10,7	favourable
1966	7,5	unfavourable
1967	12,3	favourable
1968	11,8	favourable
1969	12,1	favourable
1970	9,9	unfavourable
1971	9,0	unfavourable
1972	14,0	very favourable
1973	9,5	favourable
1974	11,7	favourable
1975	10,7	favourable
1976	11,3	favourable
1977	11,5	favourable
1978	12,5	favourable
1979	14,0	very favourable
1980	10,1	favourable
1981	8,9	unfavourable
1982	15,5	extrem de favorabil
1983	13,1	very favourable
1984	11,3	favourable
1985	12,7	favourable
1986	11,8	favourable
1987	12,0	favourable
1988	12,7	favourable
1989	12,3	favourable
1990	12,7	favourable
1991	14,6	very favourable
1992	17,4	extrem de favorabil
1993	10,2	favourable
1994	14,1	very favourable
1995	11,3	favourable
1996	14,2	very favourable
1997	13,6	very favourable
1998	11,0	favourable
1999	14,9	very favourable
2000	12,7	favourable
2001	12,4	favourable
2002	16,1	extrem de favorabil
2003	15,3	extrem de favorabil
2004	13,5	very favourable
2005	14,1	very favourable
2006	13,4	very favourable
2007	15,3	extrem de favorabil
2008	11,6	favourable
2009	14,9	very favourable
2010	13,3	very favourable
2011	14,9	very favourable
2012	12,4	favourable
2013	14,4	very favourable

Thus the "warming" of August during the last decades beneficially influence on grapes quality. At the same time, we find that any crossing above the maximum temperature of 32^{0}C, on the contrary, negatively influence quality of the grapes.

The trend of Climate Suitability Coefficient change estimation for grapes quality (CNR) denotes its increase by 0.0656 / year - 0.0454 / year in the central and southern part accordingly (Figure 1).

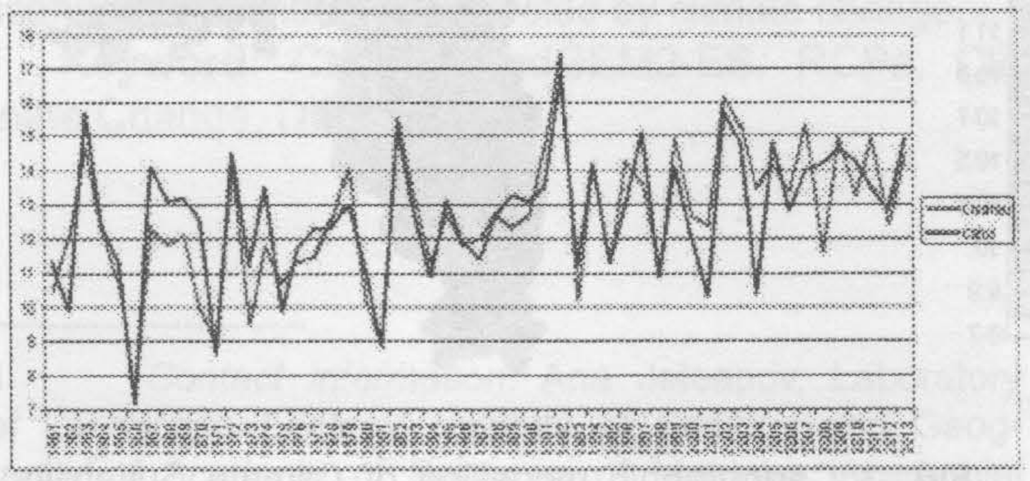

Fig. 1 The evolution of the climate suitability coefficient for grapes quality (CNR)

These changes, in one hand, will have an increase of absolute maximum and minimum temperatures with 0,0338^{0}C / year and 0,0419^{0}C / year corresponding and on the other hand the relative humidity of the air decrease by - 0.0091% per year. So the heat and aridity of the climate beneficially influence on the quality of the vine grapes.

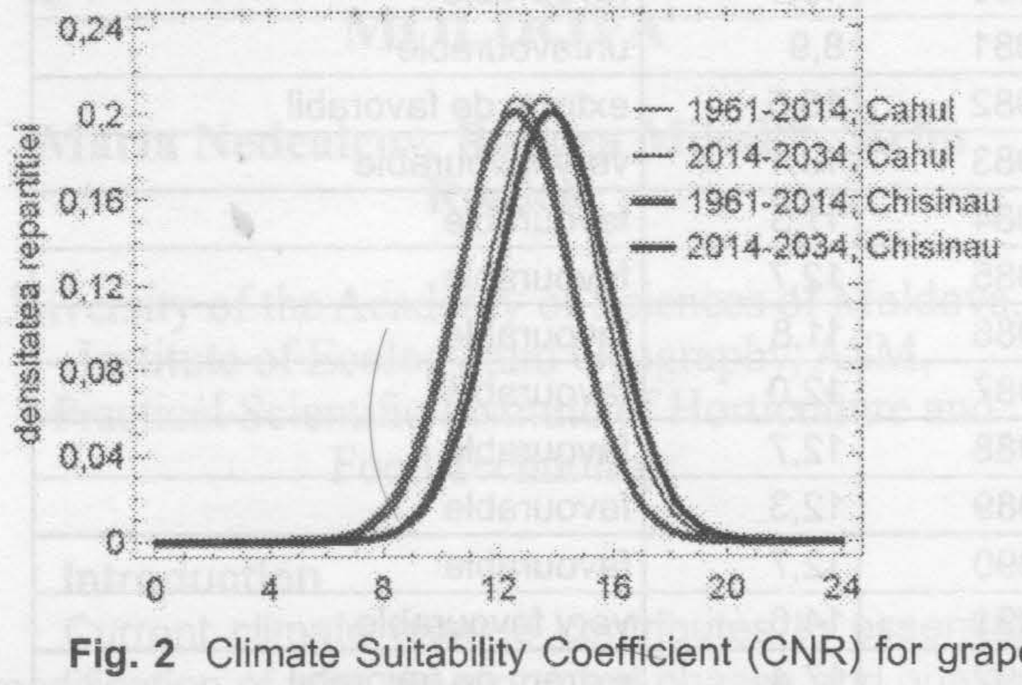

Fig. 2 Climate Suitability Coefficient (CNR) for grapes quality in the central and southern part of the country

If its current tempo of change is kept over the next 20 years (2034) it will increase by 1.3 to annual average; 12.6 and by 0.9 to annual average; 12.7 in the central part, qualifying climate suitability from favourable to very favourable in the central (13.9) and southern part (13.6) of the country (Figure 2).

Analysis of grape quality in recent years shows that in 2005, 2006, 2007, 2008, 2011, 2013 it was high. In this context, the favourable and unfavourable areas of the climate suitability for grapes quality it is necessary to highlight.

In spatial aspect in the north and northeast of the country there are established unfavourable conditions to ensure grapes quality. The rest of the territory

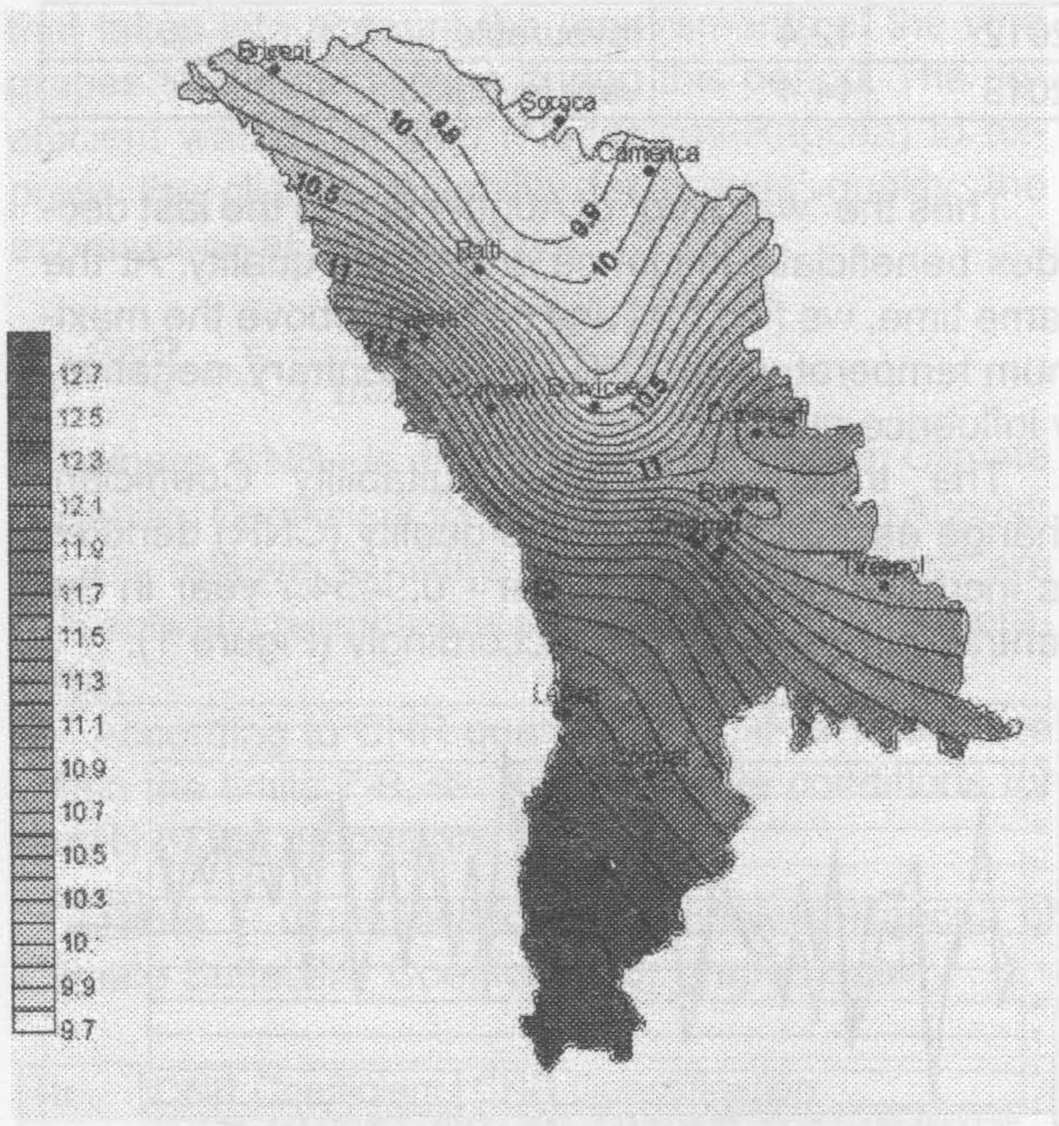

Fig. 3 Cartographic modelling of Climate Suitability Coefficient for grape quality (1960-2013)

suitable climatic conditions provide, and CNR values vary between 10.0 and 12.7 (Figure 3).

It is important to point out that in some years, when agro-meteorological conditions are unfavourable for growth and development of crops, for vines - in particular, quality of the harvest, these conditions can be favourable and very favourable. Thus, in August 2007 (Figure 4) in the north and northeast, according to CNR values (11.5 to 12.9) were established favourable conditions for ensuring the vines quality harvest.

The rest of the territory, the grape quality was provided with very favourable weather conditions (CNR values ranging within 13.0 to 14.9).

Since the CNR coefficient takes into account some background heat expressed by complex thermal extremes and relative humidity, in our opinion,

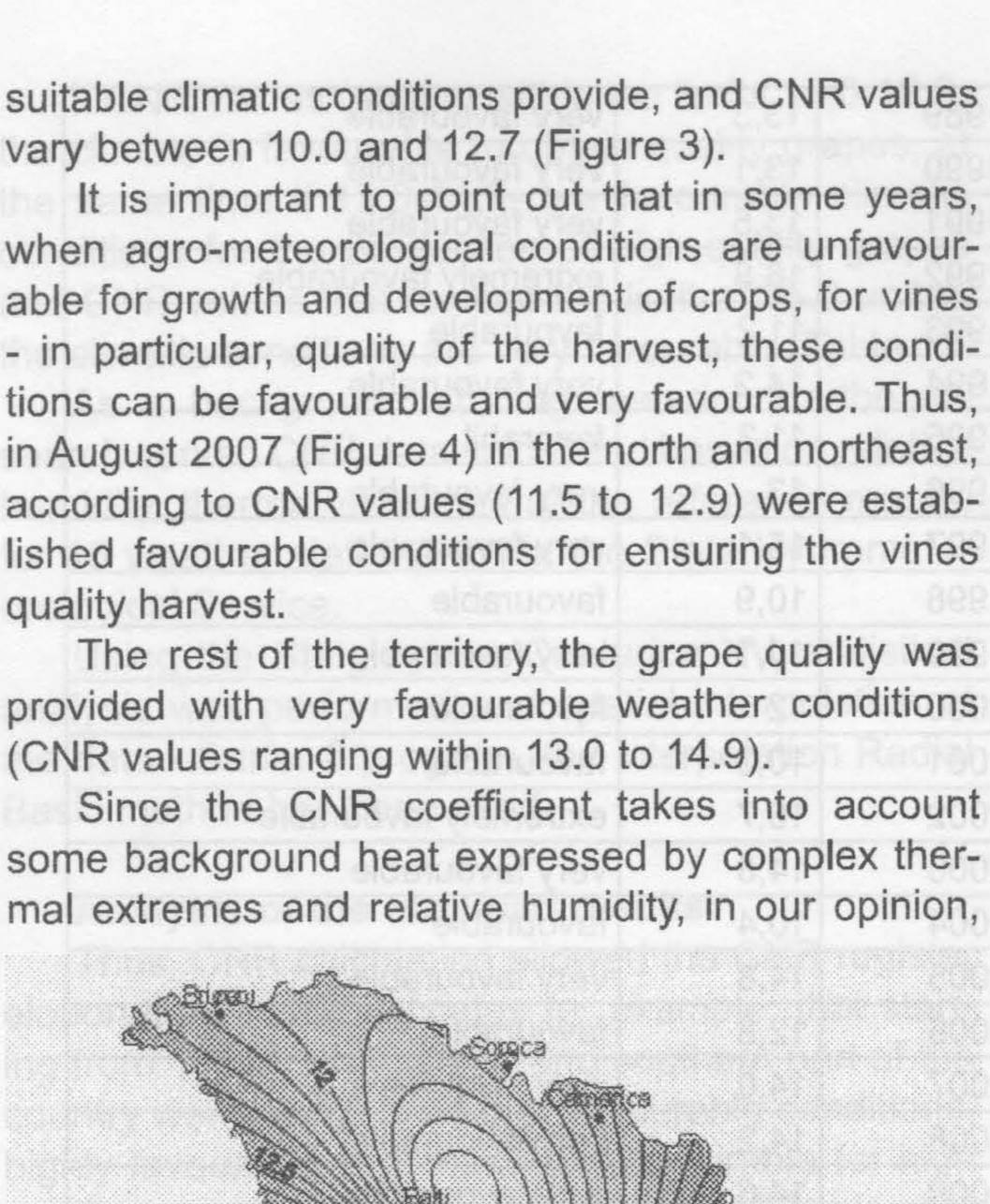

Fig. 4 Cartographic modelling of Climate Suitability Coefficient for grape quality. Case Study, 2007

its values adequately describe the suitability of the climate conditions, and high (or low) quality to confirm its utility for grapes quality estimation. As an example, agro-meteorological conditions from August 2013 can be set as a model (Figure 5), when in the north and northeast were established as favourable; in the rest of the territory - climatic conditions were very favourable, and even in the Southern extremity - extreme favourable conditions.

In conclusion we find that the development of Climate Suitability Coefficient for the grapes quality, at regional level contributes to appropriate estimation of current climate in order to ensure quality vine harvest.

As a research tool, Geographic Information Systems, allow quick access to the various programs of temporal and spatial interpretation of empirical data, which ultimately ensures the quality of the proposed research.

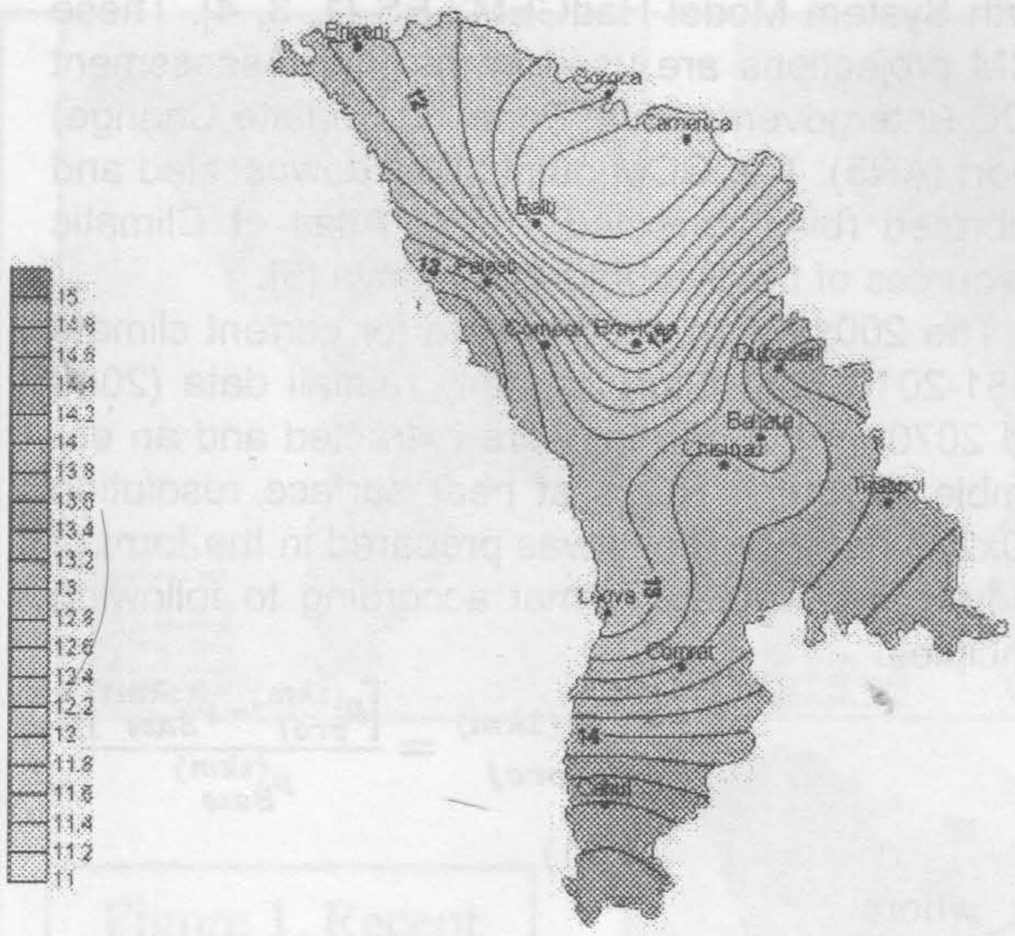

Fig. 5 Cartographic modelling of Climate Suitability Coefficient for grape quality. Case Study, 2013

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GEOGRAPHICAL INFORMATIONAL SYSTEMS AND CLIMATE PROJECTIONS IN THE REPUBLIC OF MOLDOVA

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Abstract. Presented article contains first attempt to evaluate modification of monthly sums of precipitation in the limits of Moldova under influence of future climate conditions. Initialy, climate projection database from global climate models (GCMs) for four representative concentration pathways (RCPs): 2.6, 4.5, 6.0 and 8.5 have been generated for the territory of the Republic of Moldova using the recent Coupled Model Intercomparison Project 5 (GMIP5), a coupled Earth System Model HadGEM2-ES. These climate projections are the GCM projections used in the Fifth Assessment IPCC report. The GCM was downscaled and calibrated using the maps for a monthly sum of precipitations generated using the database from climate stations and posts of the State Hydromeorological Service of Moldova for the period 1981-2010. Based on generated maps the monthly sums of precipitation were calculated for two main projected periods 2050 (average of 2040-2060) and 2070 (average of 2060-2080) for all administrative districts of the Republic of Moldova. Analysis of modeled data shows that modifications are characteristic for all months: substantial reduction being for July and August and relative increases being for October-May. The results of climate change projections can be utilized for generating bio-climatic variables and evaluation of future water resources essential to define agricultural scenarios in Moldova as affected by climate change.

Keyword: CMIP5, HadGEM2-ES, RCPs, Climate Change, DIVA-GIS

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