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Climatic water balance and agricultural productivity dynamics in Dobrogea, southeastern Romania, against the background of climate change over the past decades

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Interdisciplinary analyses of the relationship between climate system dynamics and agricultural system variation are an essential component for increasing the efficiency of water resource management, and for adapting crops at local level. This paper analyzes the dynamics of the climate water balance (CWB) in the past five decades in Romania's most arid region, Dobrogea, against the background of climate change, as well as the statistical relationship between the variation of CWB values and that of regional agricultural systems.
Thus, a first stage consisted in detailed climatic analyses of CWB value variation between 1961 and 2009, based on climatic data provided by 9 regional weather stations. The study mainly focused on CWB trends (mm) recorded annually and seasonally (winter, spring, summer and autumn), using statistical methods such as the Mann-Kendall test and the Sen's slope method, as well as GIS methods in order to visualize the results.
The second main stage was directed towards the analysis of the statistical relationship between the aforementioned climate indicator's dynamics and agricultural yields (t / ha / year) in the administrative-territorial units overlapping Dobrogea (generally the plateau region), while corn was considered for the case study as it is one of the region's main crops. In this instance, the agro-climatic data were analyzed / statistically correlated in the 1990-2003 period (depending on data availability for corn production output at administrative unit level), based on Thiessen-Voronoi polygons which were considered to be compact spatial units in which both data categories can be grouped in order to establish interannual relationships.
In terms of climate, the results indicated an annual increase of the climatic water deficit at the stations located in the northern region of the study area, with maximum rates of -3.2 mm / year. In contrast, CWB values decreased seasonally (the climatic water deficit increased) roughly throughout Dobrogea (winter, spring and summer, with maximum negative rates of -1.4 mm / year in the warmest season), except for autumn, characterized by general increasing rates, with maximum values in the southwest (2.3 mm / year). However, a general trend overview indicated an overall lack of statistical significance.
Considering the 1990-2003 time interval, the data analysis in the Thiessen polygons showed an overall similarity of agro-climatic oscillations, a first assessment of which indicated a general correlation between climate and agricultural data. However, upon analysis of the data series normality criterion, it was found that, during the 14 years, the CWB index variation influenced the dynamics of corn yields especially in the south-central region, in certain cases by up to 50%, causing losses of up to 11 kg / ha / year when the deficit increased by 1 mm. Therefore, while climatic results indicated CWB summer decreases (the most important season in corn productivity dynamics) in the northern region as well, the asymmetries found in agro-climatic data distributions in the northern region did not allow a statistical assessment of the dependence of agriculture on climatic conditions. Hence, for the northern region of the study area, the results indicate the role of additional factors in the dynamics of agricultural systems, which can be both natural (soil and groundwater characteristics) and anthropogenic (management conditions).