THE EVOLUTION OF THE CLIMATIC WATER BALANCE IN POLAND IN THE LIGHT OF PROGRESSING CLIMATE CHANGE

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L'évolution du bilan hydrique climatique en Pologne à la lumière de l'évolution du changement climatique

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Keywords: temperature, precipitation, climatic water balance, Poland

Introduction

Prior to the pronounced warming of the climate observed globally and in Poland since the 1980s (Jarraud, 2013), the water needs of crop plants were usually defined by the concept of optimal rainfall and the associated values of rainfall excesses and deficits. Currently, due to the marked increase in air temperature, resulting in an increase in evapotranspiration, the concept of climatic water balance (CWB) is commonly used. In contrast to the increase in air temperature, the level of precipitation in Poland has not shown significant changes since 1980 (Wibig, 2009). However, variation in precipitation in Poland is increasing; the value of the coefficient of variation increased from 10% to 16% in the period from 1861 to 1990, and to 19% in the years 2001–2018 (Kożuchowski, 1996, Ziernicka-Wojtaszek and Kopcińska, 2020). This causes an increase in the frequency of extreme precipitation phenomena – heavy rainfall as well as droughts.

The aim of the present study is to present the evolution of changes in the values and spatial differentiation of the climatic water balance (CWB) in Poland in the successive periods of 1951–1980, 1971–2000, 1981–2010 and 1991–2020.

Data and methods

The data used for the analysis were average monthly air temperature values and monthly precipitation totals for all periods compared in the study, obtained from the National Research Institute of Meteorology and Water Management. The data were from 21 weather stations evenly distributed around Poland. Mountain areas were not included due to the insufficient number of weather stations. The climatic water balance was calculated as the difference between the precipitation total and the total potential evapotranspiration, determined according to Thornthwaite (1948). Water resources were calculated for the time interval from June to August, i.e. for the part of the growing season with the most intensive plant growth, when water requirements for most crop plants are highest. Four climatic water balance regions were distinguished: wet > −60 mm, optimum water balance −60 to −90 mm, moderately dry −90 to −120 mm, and dry < −120 mm (Fig. 1).

Results

In general, wet areas and areas with optimal water balance decreased systematically over time in the successive 30-year periods, from 70% to 60% to 47% to 31% of the area of Poland, while moderately dry and dry areas increased during the 30-year periods, from 28% to 38% to 51% and finally to 67%, and thus two-thirds of the territory of Poland. Dry areas with a CWB value < −90 mm are always observed in the strip of central Poland running from west to east, which over time, i.e. as the air temperature increases, is gradually broadening northwards and southwards. The driest area, with CWB values < −120 mm, increased from a few percent of the total area of Poland in the previous periods to 22% in the final period of 1991–2020.

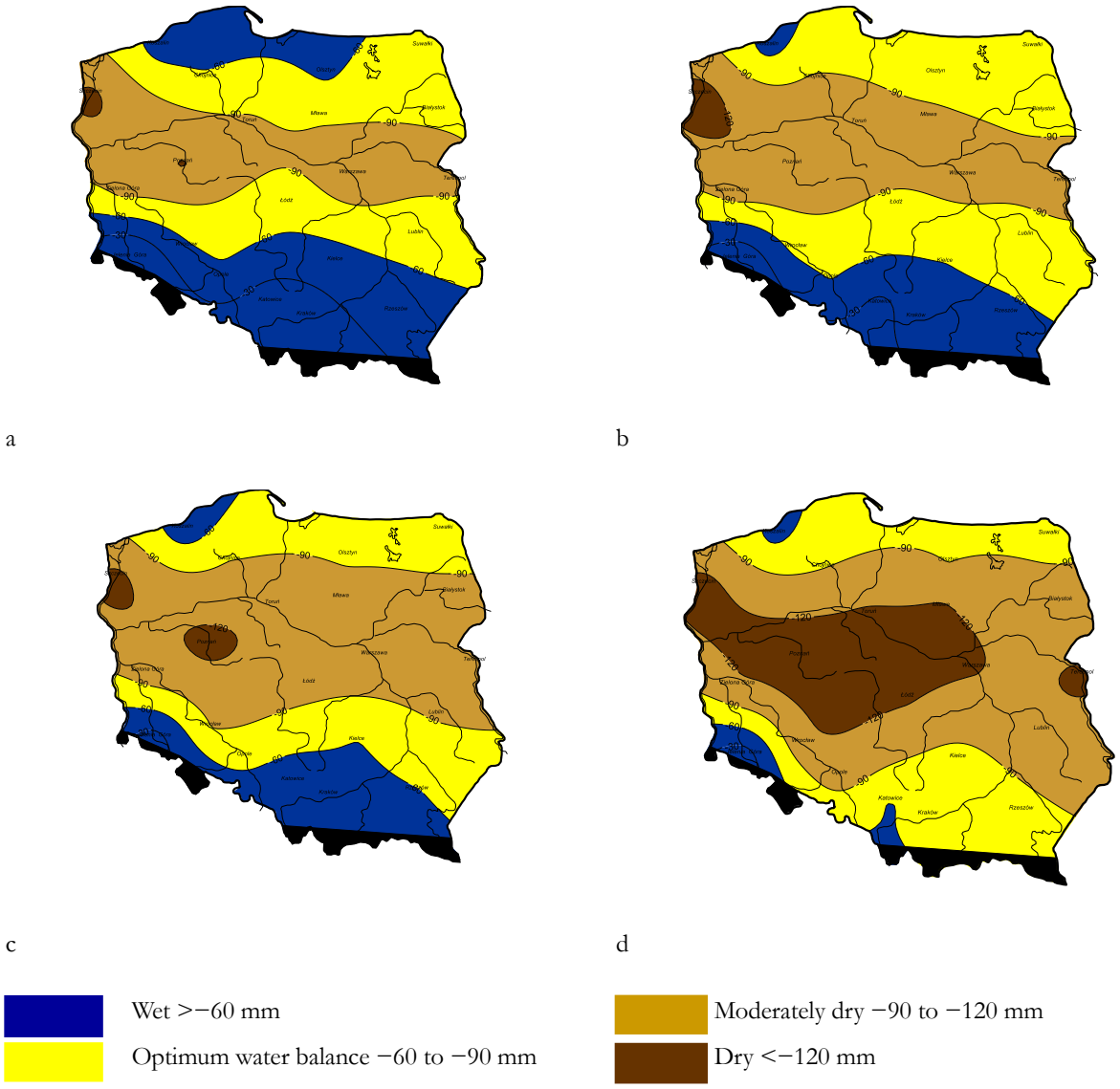

Figure 1. Climatic water balance regions in Poland during the years a) 1951–1980, b) 1971–2000, c) 1981–2010 and d) 1991–2020.

Conclusion

This study is a continuation of research on the effect of global warming on the decrease in water resources due to the increase in evapotranspiration, in the situation of progressive warming and the absence of clear tendencies in precipitation in Poland. These conditions cause the area of the water balance regions designated as dry to increase systematically in successive periods.

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