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Spatiotemporal Variability of Drought Events and Their Effect on Winter Wheat Crops in the Republic of Armenia

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Abstract—The regularities of spatiotemporal distribution of drought events in the Republic of Armenia are revealed. The probability of damage of winter wheat crops caused by the severe and slight drought in different periods of their growth is assessed. The nomogram of chronoisopleths of atmospheric moisture coefficient and the map of distribution of the number of dry ten-day periods are constructed.

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The Republic of Armenia is located in the northern part of the arid Armenian Highlands. Despite the great absolute height (1700 m above the sea level on average) the highlands are the zone of risk farming. The aridity of the region is caused by its geographic location (35 –42 N). The vast zone of the South Asian thermal depression dominates on the whole territory of the region during the warm season, and dry winds blow from the south and southeast (from the Arabian Peninsula and Iran). In the most part of the Armenian Highlands, total annual precipitation varies within 250–450 mm, in the main farming zone the Selyaninov hydrothermal coefficient does not exceed 0.2–0.5 [2]. The degree of aridity of the region increases due to the fact that the most macroslopes of mountain ranges are south-facing; they are forestless and constantly azonally arid.

Droughts lead to different environmental anomalies: the hydrological regime of rivers, lakes, and ground waters is disturbed; the mass reproduction of some pests and the occurrence of diseases of agricultural crops and livestock are registered, the crop productivity is dramatically reduced; the serious economic damage is caused. Especially severe consequences are observed after the droughts which occur in 2–3 consecutive years and cover 30–40% of the territory of the republic. The frequency of such droughts in Armenia is 10–15% [2]. To prevent crop loss due to frequent droughts, reservoirs and main irrigation channels have been constructed in the republic in recent 50 years. However, the most of agricultural fields have not been irrigated yet. The winter wheat yield reaches 40–60 centner/ha on irrigated fields whereas it does not exceed 16–18 centner/ha on nonirrigated fields [3].

The drought events in Armenia were studied from different points of view, but it is the contribution of droughts to the development of desertification processes that was mostly assessed [5]. Unfortunately, the catalog of severe hydrometeorological events on the territory of the Republic of Armenia is still absent.

The author of the present paper tried to reveal regularities in the spatiotemporal variability of arid processes in Armenia and to determine their intensity in different periods of winter wheat development. For this purpose, the moisture coefficient was computed using the formula proposed by D.I. Shashko [6]:

$$Md \quad P/\ d$$

where P is the average long-term total monthly precipitation, mm; d is total monthly air humidity deficit, hPa.

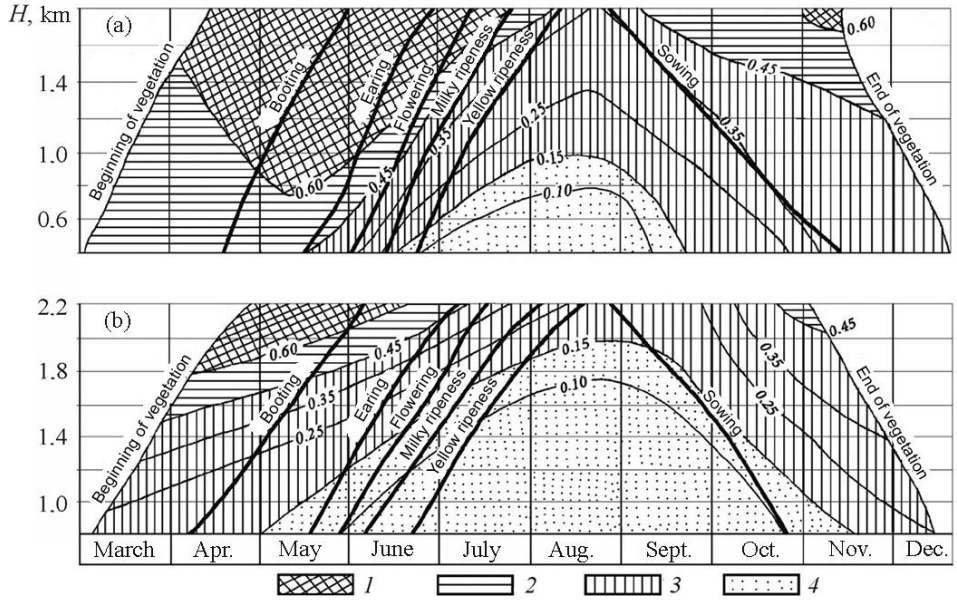

Fig. 1. Chronoisopleths and terms of phenological phases of winter wheat development in (a) less and (b) more arid regions of the Republic of Armenia. Conditions: (*1*) very moist (*Md* > 0.60); (*2*) moderately moist (*Md* = 0.45–0.60); (*3*) slight drought (*Md* = 0.15–0.45); (*4*) severe drought (*Md* < 0.15).

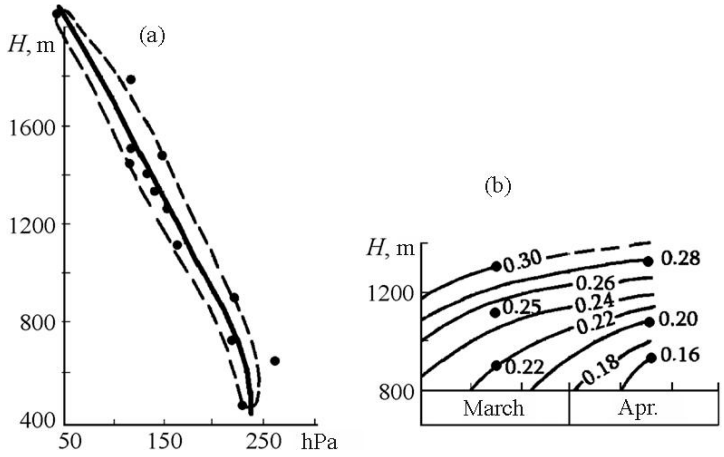

Fig. 2. The fragments of graphic data processing. (a) Dynamics of total air humidity deficit depending on altitude in June in the less dry regions of Armenia; (b) chronoisopleths of *Md* for the dry regions of Armenia.

Using the calculated values of atmospheric moisture coefficient *Md*, the graphs of chronoisopleths were plotted for the less arid regions of Lori and Tavush and for the more arid regions of the Ararat Plain, Shirak, and Sevan (Fig. 1). If *Md* < 0.15, the drought is considered severe, and if *Md* = 0.15–0.45, the drought is slight.

It was found [5] that one of the correct methods for the spatiotemporal analysis and assessment of meteorological processes under the mountain conditions of Armenia is the representation of data in the form of chronoisopleths. It allows the clear observation of temporal and altitudinal variations in events. Therefore, to reveal regularities in the distribution of dry events in the republic and to assess their effects on winter wheat yield, the chronoisopleth principle of analysis was applied. The fragments of data processing are presented in Fig. 2.

The correlation analysis revealed that the average long-term monthly values of precipitation and air humidity deficit significantly depend on the altitude above the sea level (according to the data of 60 weather