

ASSESSMENT OF DROUGHT CONDITIONS ON THE TERRITORY OF BELARUS USING SATELLITE INFORMATION



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INTRODUCTION

The problem of monitoring and forecasting *drought events*, especially taking into account observed climate changes, is invariably relevant both in scientific research and in solving applied problems. *Drought* is one of the largest natural disasters in human life. According to the main indicators of negative impact, droughts are among the first indicators among other dangerous hydrometeorological phenomena. The problem of increasing aridity in different parts of the planet, especially in agricultural regions, has become especially acute under the influence of global climate change. In the long term, global temperatures are projected to continue to rise and the spatial and temporal variability of precipitation will increase, leading to a further increase in the risk of droughts in arid regions.

Despite the fact that the territory of Belarus is located in a zone of sufficient moisture, the temporal and spatial unevenness of the distribution of precipitation over its territory causes the formation of dry periods of varying duration. Drought in the republic can occur annually, at any time from April to September. At the end of the XX – beginning of the XXI century in Belarus the frequency of drought events increased significantly, especially in the southern regions of the country.

The rapid development of space technologies in recent decades has led to the emergence of numerous types of Earth remote sensing products from space, some of which can be successfully used to assess drought conditions – these are the *vegetation indices* characterizing the state of vegetation depending on its spectral reflectivity.

OBJECTIVE. MATERIALS AND METHODS

The aim of this study is to assess the vegetation conditions and the frequency of droughts on the territory of Belarus in the warm seasons (April-September) for the period 1994-2023 using the composite *Vegetation Health index (VHI)* (Kogan, 1990).

$$VHI = a * VCI + (1 - a) * TCI,$$

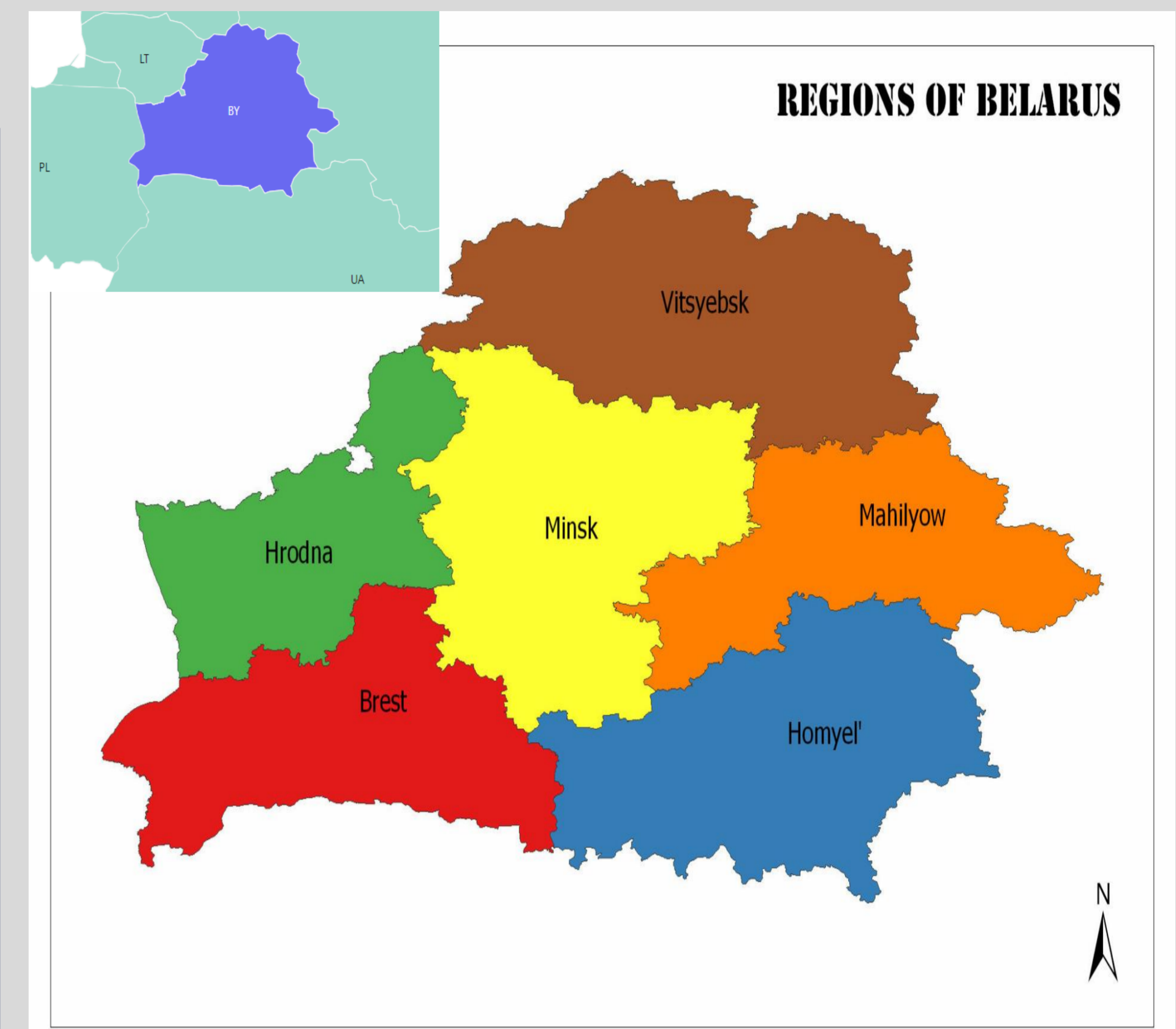
where *a* is a coefficient determining contribution of the two indices (*TCI* and *VCI*).

VHI is a proxy characterizing vegetation health or a combine estimation of moisture and thermal conditions.

The assessment of drought conditions on the territory of Belarus was estimated using weekly data on *VHI* values obtained from the *NOAA STAR database (Center for Satellite Applications and Research) - Global Vegetation Health Products* (<https://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/>), averaged across six regions of the country.

VHI describes the intensity of drought based on the state of vegetation and the effect of temperature on the state of vegetation.

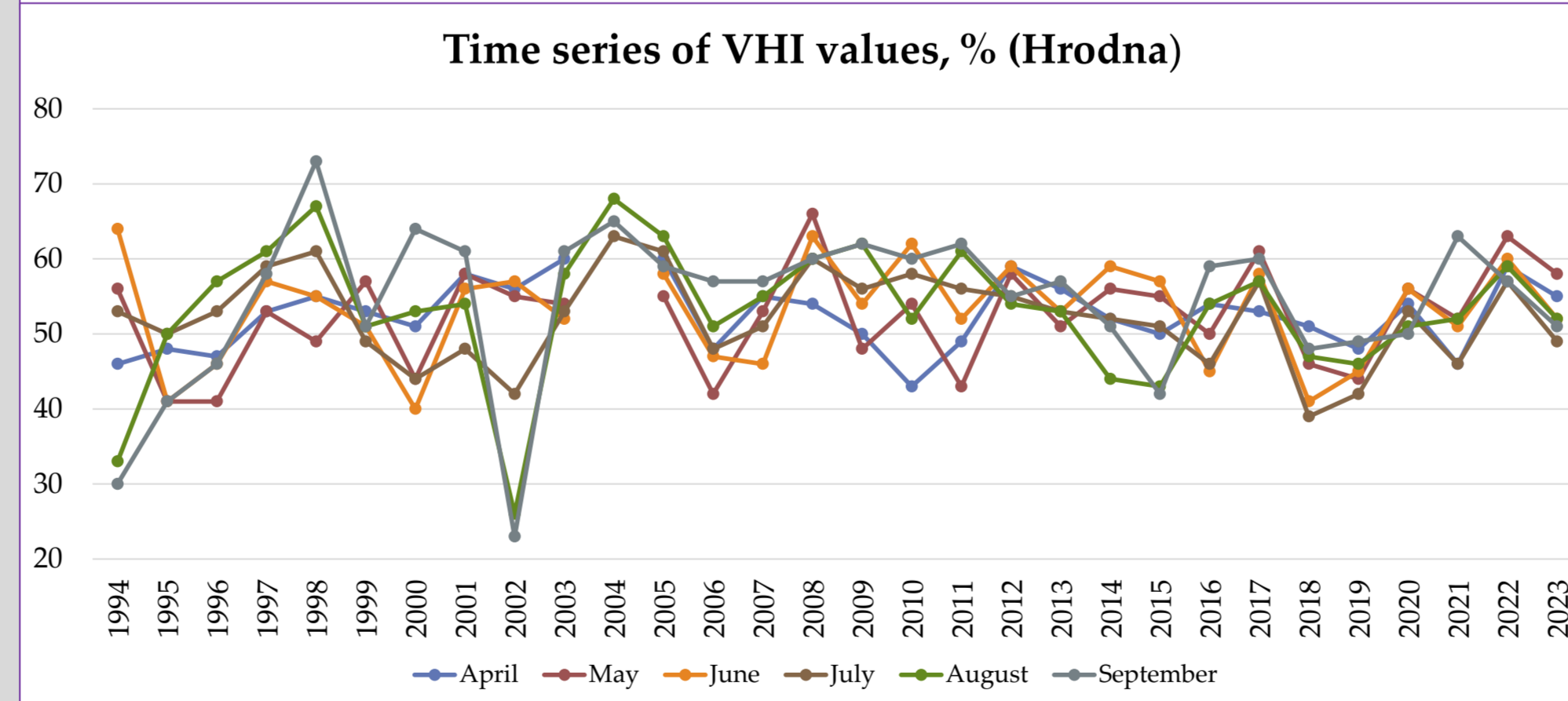
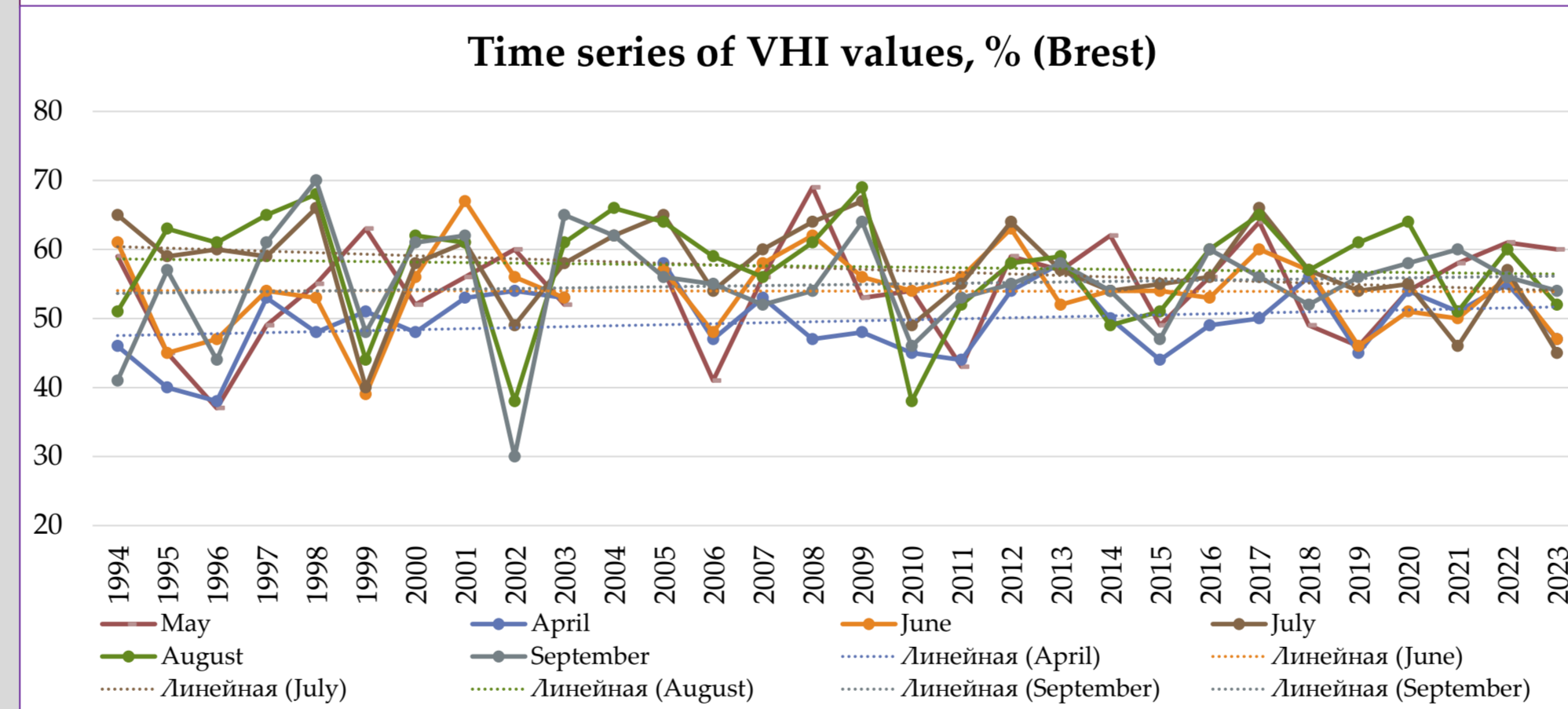
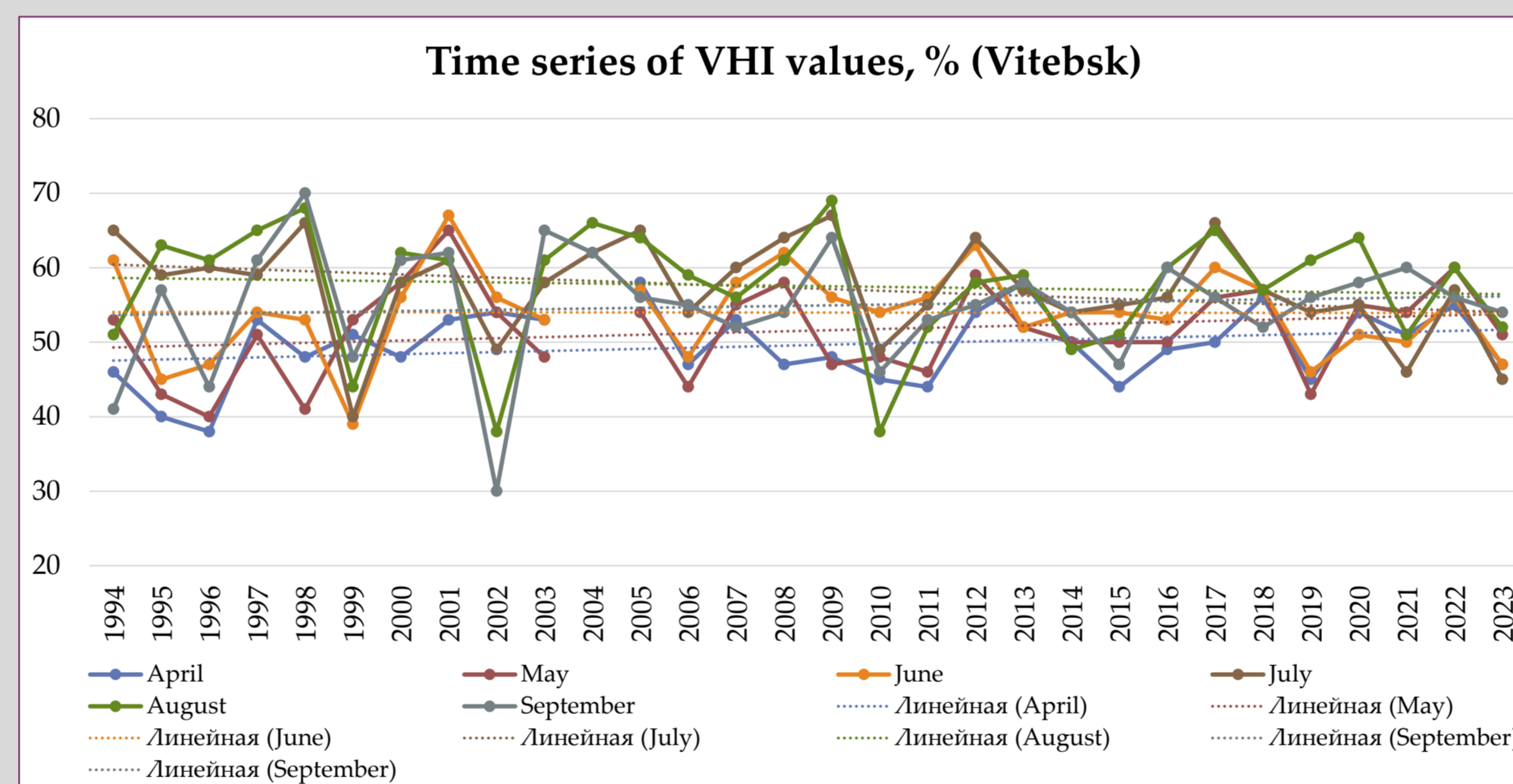
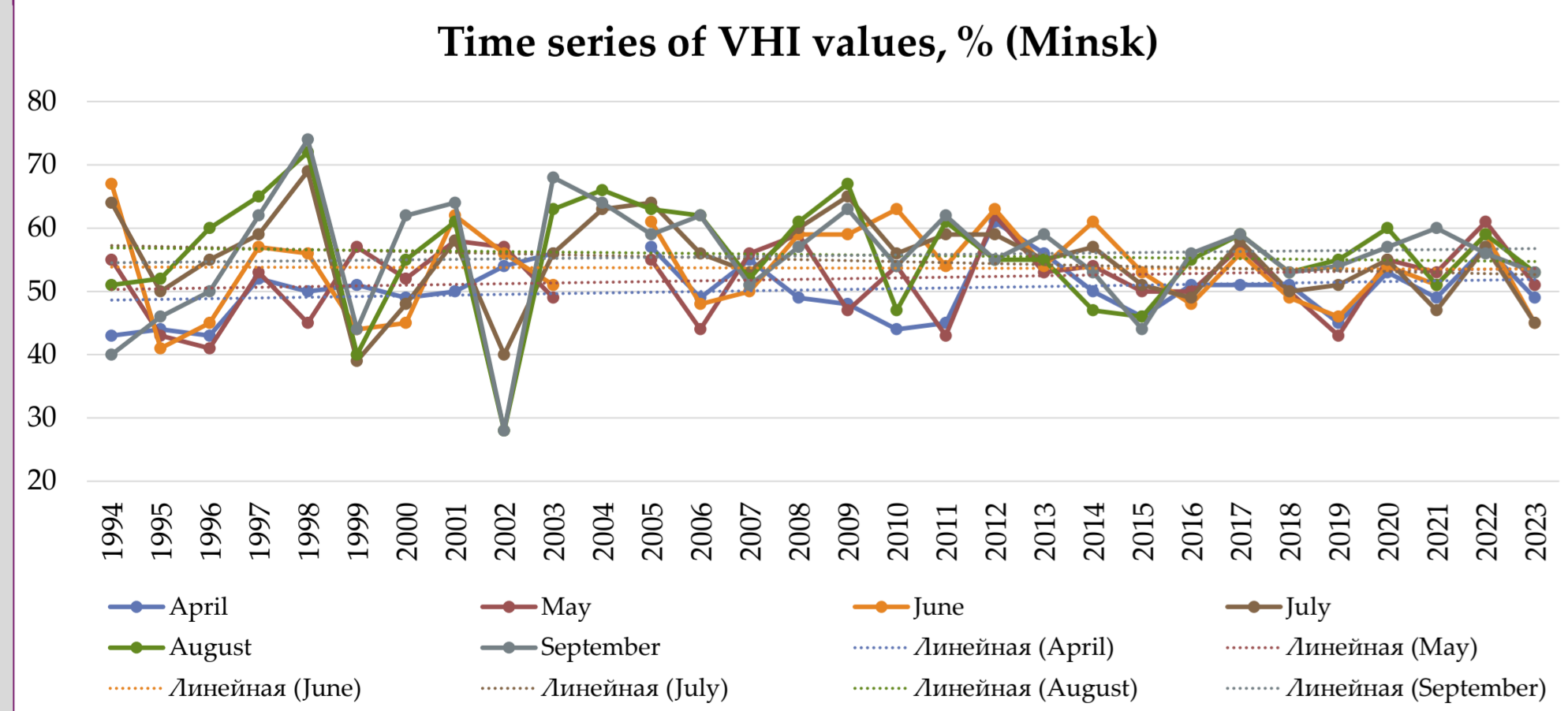
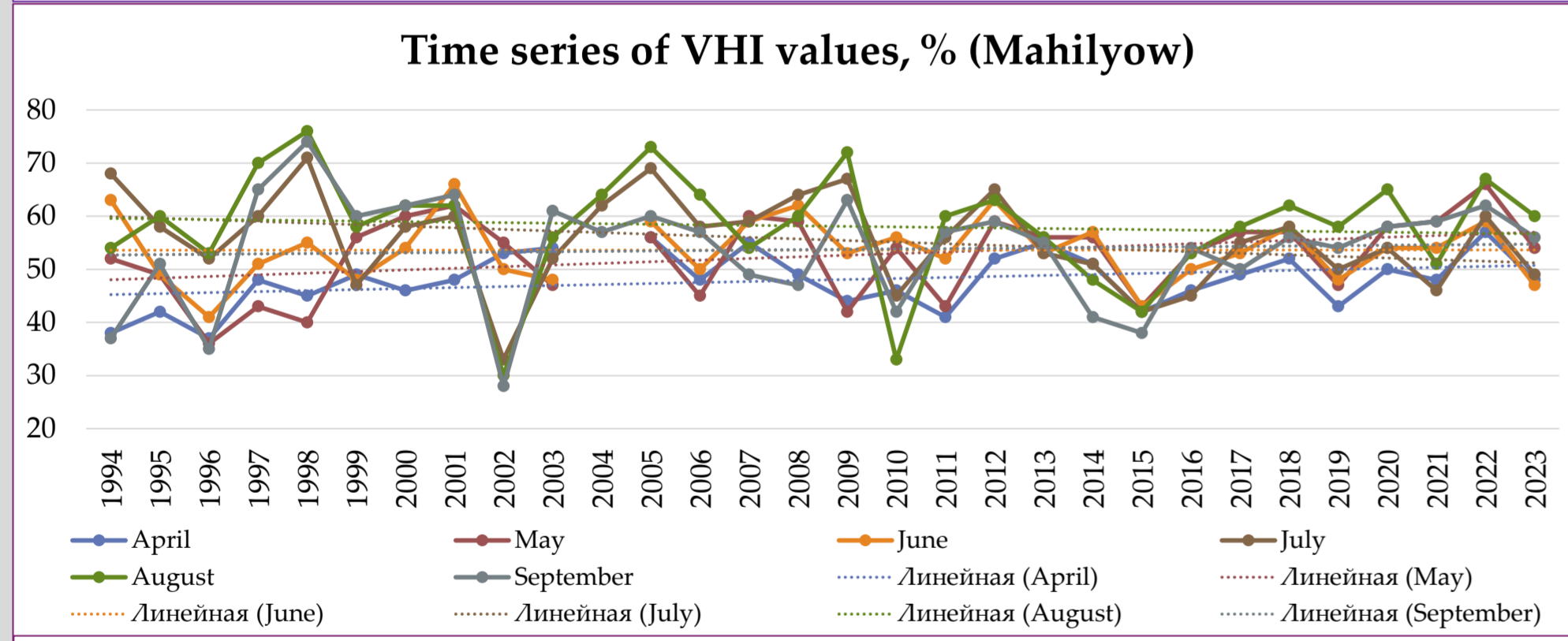
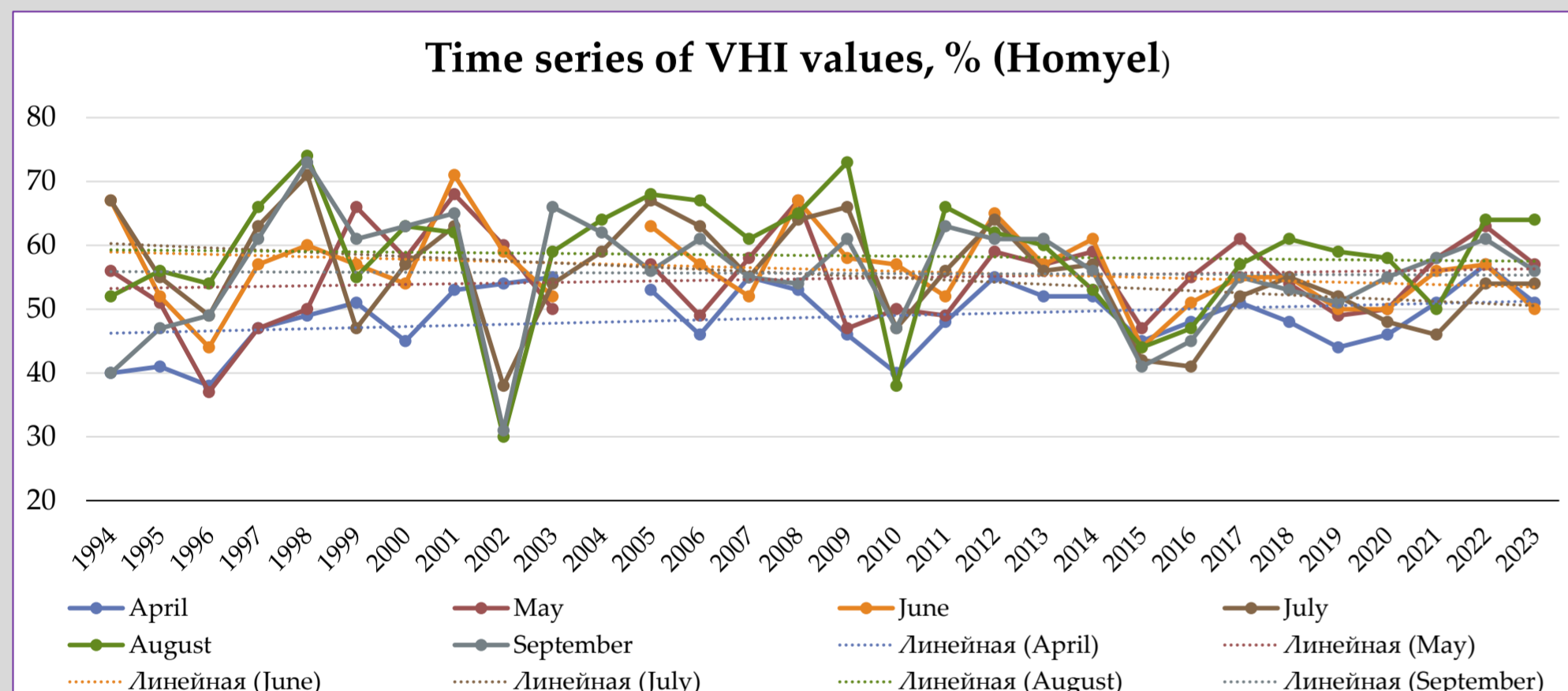
The $VHI \leq 40\%$ was used as a criterion for droughts in order to assess the frequency of droughts of the vegetation season.



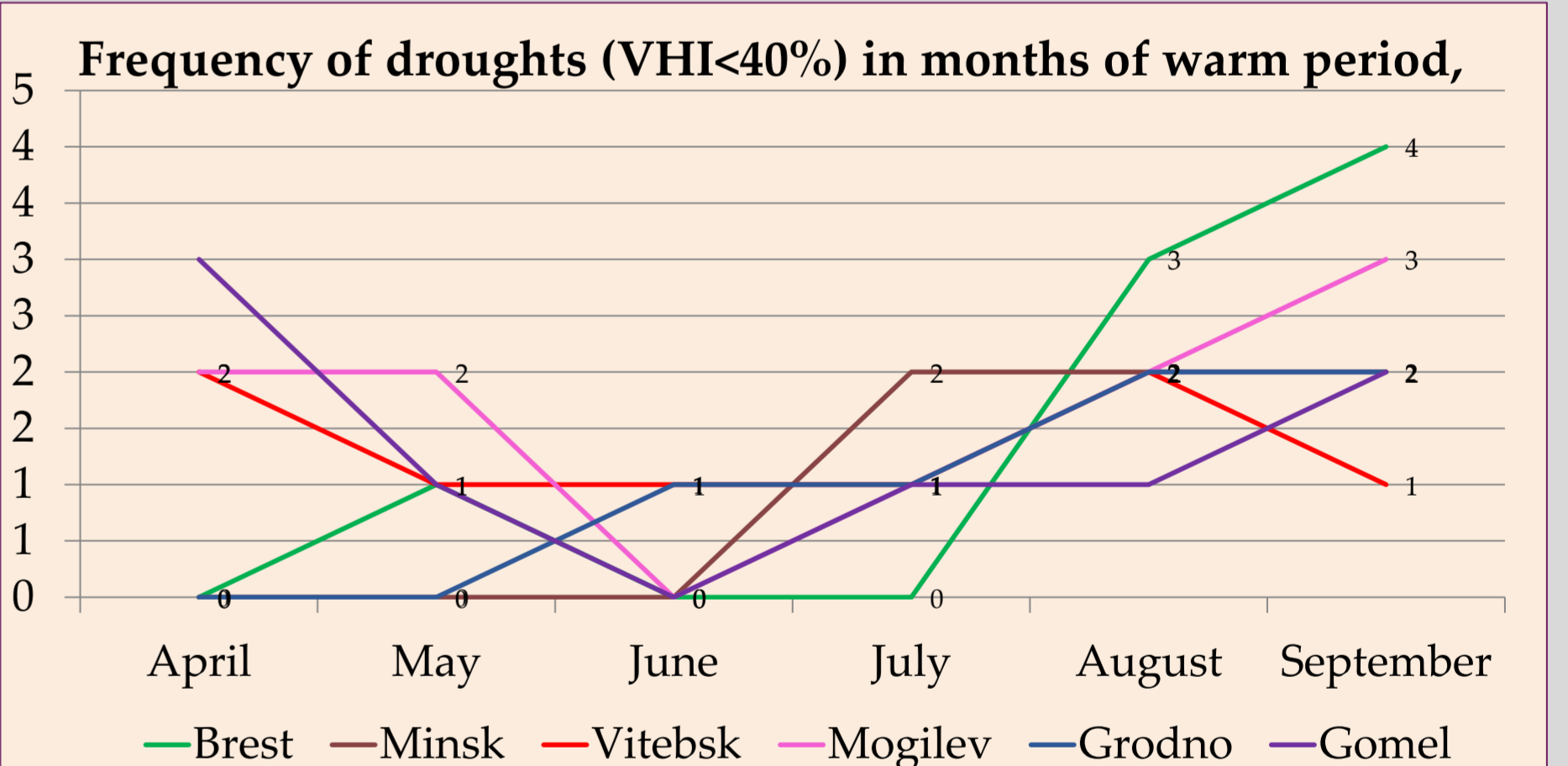
VHI varies from 0 (extreme stress) to 100 (most favorable conditions). As with *VCI*, *VHI* values of less than 40% correspond to the *stress state of vegetation*, and *VHI* values of more than 60% correspond to *favorable conditions for vegetation*. The following classes of droughts are distinguished by *VHI* values:

- $VHI > 40\%$ - no drought;
- $VHI = 30-40\%$ - mild drought;
- $VHI = 20-30\%$ - moderate drought;
- $VHI = 10-20\%$ - severe drought;
- $VHI < 10\%$ - extreme drought.

RESULTS



Dry conditions were most often observed in August and September 2-4 times in each region, in other months the frequency of droughts did not exceed 1-2 times, and in June drought was observed only in the Grodno and Vitebsk regions. The most intense droughts were observed in August and September 1994 in the west of the country, in August and September 2002 – throughout the country, and in Minsk and Mogilev regions – and in July 2002.



CONCLUSIONS

VHI is calculated based on satellite observation products in almost real time, on a regular basis and with spatial continuity, which makes its use practically indispensable for detecting and monitoring extreme events such as droughts and fire risks.

Thus, the assessment of the satellite-based *Vegetation Health Index* made it possible to identify the spatial and temporal variability of vegetation conditions depending on meteorological conditions on the territory of Belarus under the modern climate warming.

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It has been revealed that over the past 30 years, the vegetation season in the country has been characterized by alternating dry and wet years with different temperature regimes. An analysis of the time series of *VHI* values showed that in the spring months there was a tendency for the increasing of the index by 10-20%, i.e. at the end of the 20th century, weather conditions were less favorable than in the last decade. In summer, especially in July and August, there was a tendency for decreasing of the index by 5-10%, i.e. due to more uneven precipitation and increased temperature conditions due to the predominance of atmospheric instability in the summer, weather conditions during the warming period become less favorable for the vegetation. In early autumn, *VHI* values remained virtually unchanged during the study period due to the slight variability of precipitation and temperature during this season.

Both the minimum and maximum *VHI* values for the study period in six regions of the country were observed in August and September, reflecting interannual fluctuations in dry and wet years and different temperature conditions in these months. The average values of the index varied from 50% in April to 55-56% in August and September. The most unfavorable vegetative conditions during the study period were observed in the west of the country – in the Brest and Grodno regions, the best was revealed in the Gomel region.