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# Spatiotemporal Dynamics of the Northern Limit of Winter Wheat in China Using MODIS Time Series Images

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**Abstract:** Studying the spatiotemporal changes of the northern limit of winter wheat (NLWW) in China is important to ensure regional food security and deal with the effects of climate change. Previous studies mainly used climate indicators to analyze the variation of the potential NLWW in different historical periods, while little attention has been paid to the actual migrations and changes of the NLWW. The objectives of the present study were three-fold: (i) to map the spatial distribution of winter wheat in northern China in 2001, 2007, 2014 and 2019; (ii) to extract the actual NLWW; and (iii) to quantitatively explore the dynamics of the NLWW. First, we adopted the "combining variations before and after estimated heading dates" method to map the winter wheat in northern China based on time series MODIS EVI2 data. Second, we used the kernel density estimation algorithm to extract the actual NLWW in four historical periods. Finally, the fishnet method was utilized to quantitatively analyze the direction and distance of the spatiotemporal changes of the NLWW. The results demonstrated that the NLWW has exhibited a marked fluctuating trend of migration southward, with a 37-km shift in latitude over the past 20 years. The elevation limit of winter wheat planting was around 1600 m; however, the centroid of winter wheat planting has shifted slowly to lower elevations. There was a gap between the actual NLWW and the potential NLWW. The reason for this gap was that the actual NLWW moved southward under the interacting effects of human activities and climate change, while the potential NLWW moved northward due to climate change. The results of this study are of great scientific value in the formulation of winter wheat planting strategies in climate-sensitive areas to respond to climate change and ensure food security.

**Keywords:** northern limit of winter wheat; crop mapping; time series classification; MODIS EVI2; northern China