

# Climate-driven rice expansion in Northeast China: A geospatial analysis

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The changing climate is reshaping our agriculture. Warming temperatures, changes in precipitation patterns and other climate variables are modifying the bioclimatic conditions or agricultural crop growth. This is shifting the suitable zones for growing specific crops. That shift is notably evident in the middle-latitude regions of the north hemisphere. The rapid expansion of rice production in northeast China (Heilongjiang, Jilin, and Liaoning provinces) illustrate a classic case. Changes in bioclimatic conditions have moved the suitable growing zones northwards and extend the growing season in some areas, while increasing exposure to heat waves and water resources in others. Because of these environmental changes, northeast China is rapidly becoming an important rice-growing region, dramatically re-mapping the distribution of rice production in China.



Preliminary reviews show that the rice cropping area in Northeast China has continuously expanded over the past three decades, and both the yield per unit area and the total output have increased simultaneously. The contribution from this region to the national rice production has increased from approximately 5-6% in 1991 to around 16-20% in the late 2010s. The period with the fastest growth occurred in the early to mid-2000s, with an increase of approximately 6-7 percentage points between 2003 and 2010. This is in sharp contrast to the stagnation or decline that has occurred in some traditional southern rice-growing areas. The northward shift aligns with a lengthening frost-free period and greater accumulated heat, which alleviate cold-damage constraints. However, exposure to heat extremes during reproductive-stage and increasing hydrological variability is raising risks to yield instability.

Understanding the relationship between the changing climate and the expansion and intensification of rice cultivation is crucial for food security planning and the design and implementation of climate-adaptive measures in agriculture. In this presentation we introduce a geospatial methodology for quantifying the rapid expansion of rice cultivation in Northeast China, outlining the driver-attribution framework and an approach for producing near-term projections of climate risk hotspots for rice cultivation. We will then discuss how the resulting maps and driver rankings can inform food-security planning and climate adaptation.

Provincial rice statistics (1991–2023) from the three northeastern provinces are being harmonized with long-term climate records and multi-temporal satellite imagery. High resolution gridded indicators: (temperature, precipitation, accumulated heat, and frost-free period) are being derived, and a long-term, internally consistent NDVI time series is being assembled. Econometric and geostatistical models relate rice dynamics to climate variability to estimate sensitivities and detect plausible thresholds. Key outputs include an annual rice map series and climate-risk zoning for northeast China.

By combining multi-decadal statistics, remote sensing, and GIS with rigorous spatiotemporal modelling, the study provides actionable evidence for agricultural planning and offers transferable insights for other mid- to high-latitude cropping systems experiencing climate-driven transitions.

**Keywords:** Climate drivers, Rice expansion, bioclimatic conditions, Remote sensing, Spatiotemporal modelling