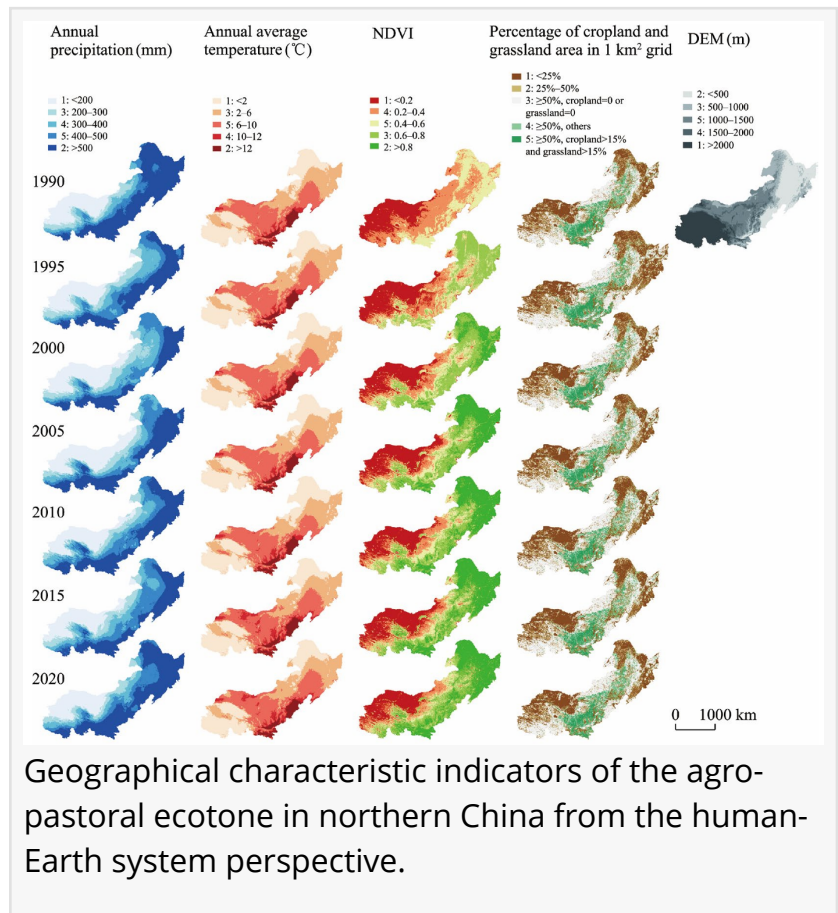


Where grasslands meet farmlands: tracing the pulse of a fragile ecotone

GA, UNITED STATES, September 22, 2025 /EINPresswire.com/ -- [Agro-pastoral ecotone](#) in Northern China (APENC) is a delicate boundary where farming meets herding—now under pressure from both environmental and human forces. In a new study, researchers applied a human-Earth system approach to track how this transitional zone evolved between 1990 and 2020. Their analysis, integrating climate, land, vegetation, and human activity, reveals a fluctuating and increasingly fragmented landscape. With its center of gravity shifting westward and its boundaries continuously redrawn, the APENC illustrates the deep interdependence of ecology and society—and underscores the urgency of sustainable regional planning.



Spanning vast swaths of northern China, the agro-pastoral ecotone (APENC) has long acted as a living frontier between croplands and grasslands. It plays a vital role in stabilizing ecosystems and supporting rural communities. Yet this region faces mounting challenges—climate shifts, land degradation, and uneven economic development threaten its ecological balance. Past research has often focused on single factors like rainfall or land use, offering limited insight into the system's full complexity. In light of these limitations, there is a growing need for an integrated approach that considers the mutual feedback between people and the environment. Against this backdrop, researchers initiated a study of the APENC as a coupled human-Earth system.

In a study published in the *Journal of Geographical Sciences* (April 2025), a team from Chang'an University and Henan University applied human-Earth system science to trace the evolution of

the APENC over three decades. Drawing from spatial raster data between 1990 and 2020, the researchers redefined the zone's shifting boundaries and identified hotspots of contraction and recovery. The findings reveal how environmental changes and land management policies intersect to reshape this crucial ecological interface—offering valuable insights for policymakers seeking to balance sustainability and development.

Using an entropy-weighted model, the team analyzed five interconnected indicators—precipitation, temperature, terrain, vegetation cover (NDVI), and land-use composition—to map the likelihood of a region belonging to the APENC. Their results show that the ecotone did not remain static: it shrank notably around 2005, fragmented in peripheral zones, and later rebounded in some areas due to successful ecological restoration efforts. A particularly telling sign of change was the westward migration of the ecotone's "center of gravity," moving closer to the Hu Huanyong Line, a key demographic divide in China. Beyond simple climate trends, the study highlights how land use and human adaptation determine whether regions contract or remain resilient. For instance, some zones lost ecological function despite improving rainfall, due to poor land-use management. Others remained stable despite harsher conditions, bolstered by effective policy interventions. The researchers argue that this shifting frontier is governed not by nature alone, but by a complex, coupled dance between ecological pressures and human decisions—challenging past approaches that treated people as external factors.

"Our findings reveal that the APENC is not just a climatic gradient—it's a living system shaped by land decisions, local adaptation, and policy," said Professor Liu Yansui, senior author of the study. "By embracing a human-Earth system lens, we move beyond simplistic boundaries and begin to understand how social and ecological forces co-evolve. This is essential for managing such dynamic and sensitive landscapes in a sustainable way."

This research lays the groundwork for smarter, more adaptive land-use strategies across northern China. By pinpointing regions that are ecologically vulnerable or mismanaged, local governments can tailor interventions such as rotational grazing, afforestation, and water-efficient farming. It also emphasizes the need for cross-provincial coordination to manage transboundary ecological systems. Looking forward, the human-Earth system approach could guide decision-making in other transitional zones worldwide, helping regions anticipate and adapt to socio-environmental change. For China's APENC, the study offers both a diagnostic tool and a policy compass for achieving long-term ecological and economic resilience.

References

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