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# Editorial: Rural Land Change and the Capacity for Ecosystem Conservation and Sustainable Production in North America

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## Editorial on the Research Topic

### Rural Land Change and the Capacity for Ecosystem Conservation and Sustainable Production in North America

Rural landscapes across the globe are vital to the production of food, timber, energy, and other resources for an increasing human population. They are also essential for sustaining ecosystem health for future generations. Accordingly, the challenge for humanity is to advance global production systems while also conserving and even enhancing ecosystem services (Rockström et al., 2017), and recognizing tradeoffs (Lark et al., 2020). The failure to meet this challenge is critical, pushing against planetary constraints of our biosphere, with cascading and potentially catastrophic repercussions to human well-being (Steffen et al., 2015). For societies to thrive, the capacity for ecosystem conservation must be enhanced, and rural landscapes are widely recognized as a key geography for this capacity.

Research on North American lands has examined trends in rural land cover (Sleeter et al., 2013), including urbanization (Brown et al., 2005; Sohl, 2016), woody encroachment (Bailey et al., 2010), 20th century cropping patterns (Sohl et al., 2016), and the periodic transitions of production forestry (Drummond et al., 2015). The dynamics of land change have been linked to multiple drivers associated with economics, policy, population, and climate (Napton et al., 2010; Drummond et al., 2012; Mcphee et al., 2021).

Emerging research increasingly emphasizes concepts that agriculture and nature can and should co-exist in ways that provide for people and healthy ecosystems (Kleinman et al., 2018; Spiegal et al., 2018; Mcphee et al., 2021). Developing a better understanding of human-environment dynamics in rural landscapes, including proximal and distant interactions (Liu et al., 2007), is critical.

The collection of papers in this research topic responded to this aim, identifying key aspects of rural landscapes in North America. The authors' approach ranged from broad examinations of national and regional trends, to more focused models addressing specific biophysical components of agroecosystems.

Contributions to this research topic included a pair of papers aimed at social and economic dimensions of agroecosystems. These include an improved framework for incorporating human well-being by Bentley Brymer et al., and advanced concepts of telecoupling (or "pericoupling") by Spiegal et al. to evaluate alternative strategies of beef production supply chains. Both papers

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challenge researchers to consider the perspectives and perceptions of producers. They also push us to think about relationships occurring outside of our immediate geographies by incorporating deeper meanings of "community", on the one hand, and the complex linkages among alternative strategies of production, on the other.

National agricultural policy was addressed by Spangler et al., who found that policies described in United States Farm Bills have broadened in purpose and influence over time, favoring the expansion of commodity crop production and limiting support for diversification. Examining the finer details, Medina et al. explored farmer perspectives on federal conservation programs in Iowa, noting that, while limited, conservation programs played a role in incentivizing the adoption of conservation practices, a finding which supports research by others (Piñeiro et al., 2020). In addition to these, policy needs in Canada with regards to reducing chemical inputs to agroecosystems were noted by Banger et al., and Malaj et al.

Drivers, trends, and patterns of rural land use in North America were examined at regional and national scales. Goslee explored these issues in-depth, modeling the importance of climate, soils, and irrigation as drivers of crop diversity and change for the conterminous United States. Irrigation emerged as a key explanatory variable in models of crop diversity, suggesting that increases in irrigation could result in increased agricultural diversity. However, while biophysical drivers of change in crop diversity were less clear, Spangler et al., suggest that national policy is a key driver of broad trends in crop diversity. Although calculated differently, crop diversity trends showed similar results at broad national scales for both papers, with the highest levels of diversity found in California, the Great Lakes area, the Northern Great Plains, and the Southeast. In contrast, the lowest levels of diversity were found in the central regions of the United States

Regional landscape and land use patterns were the subjects of three studies in this collection. Analysis of regional trends in land use, irrigation, and streamflow by Yasarer et al. showed that low flow conditions in rivers of the Mississippi River Alluvial Plain have been significantly altered over the last fifty years. Drastic increases of irrigated cropland were associated with lower flows, increasing days with no flow, and declining groundwater levels. In the adjacent Southeastern Plains, an examination by Coffin et al. showed that the balance of tradeoffs among ecosystem services varies across the region and at multiple scales. Conservation indicators were stronger in Florida than other areas, with supporting services provided by larger embedded natural systems and low intensity working lands there. Galpern and Gavin also conducted multi-scale analyses in the Canadian Prairie Croplands, examining the distribution and variability of uncultivated areas within agricultural fields. Their work emphasized the importance of scale and the underlying environmental gradients for both understanding patterns of non-crop areas within agricultural fields, and determining potential areas for management. The importance of the intentional planning, design, and evaluation of natural systems in working lands naturally arises out of these studies as an exciting new area of research. To this end, Kröbel et al. demonstrated and tested a tool for shelterbelt components for the *Holos* model, a whole-farm model for evaluating carbon and other greenhouse gas budgets of alternative farm designs. Their work upgrades the model from an age-determined to a circumference-determined calculation to estimate the above- and below-ground carbon for field shelterbelts.

Nutrient management and chemical use were addressed in four studies that also incorporated modeling approaches. Each of these studies considered the subject at vastly different scales of analysis. At the farm level, Banger et al., showed that the returns accruing from environmentally optimal nitrogen (N) rates are significant but require a tradeoff in net farm income, which they opine could be offset by policies that compensate farmers for their economic loss. At a broader, regional level, Mezbahuddin et al. used *Ecosys* process-based modeling to simulate alternative N fertilizer management scenarios. Their predictions that spring banding in Alberta would lower N-species emissions and runoff were validated with empirical estimates, and demonstrated the value of the agroecosystem modeling approach. Across the southeastern United States, Coffin et al., summarized modeled N runoff from previous work. They found that watersheds in Georgia had lower levels of N runoff than those in Florida, pointing to the significant buffering capacity of riparian forested areas. At the national scale, Malaj et al., found that agrochemical use in Canada has increased rapidly and systematically, but these increases vary by region and by agrochemical type. Fertilizer increases were associated with increasing oilseeds and soybeans and decreasing cereal crops in the Prairie and Central cropland regions. More alarming, however, were the substantial increases in fungicides and insecticides in these areas.

This collection of papers points to lessons that enhance our understanding of how changes in rural lands affect the dual capacity for conservation and production. However, the complexity of evaluating the tradeoffs among ecosystem services that result from interacting suites of conservation practices requires long-term, convergent approaches to scientific research. In North America, working lands constitute one of the greatest opportunities to enhance regional and global capacity for ecosystem conservation.

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AC, FA, MD and DH devised the concept for the editorial. AC drafted the manuscript. FA and MD provided editorial comments and revisions. AC finalized the manuscript and submitted.

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