LEOPOLD CENTER
FOR SUSTAINABLE AGRICULTURE

'Cultivating' Conservation: Bringing Ecology, Economics, and Ethics Together

Abstract:

Most current modeling frameworks have a limited view when gauging the response of an agroecosystem to different stressors. They tend to focus individually on either productivity in terms of crop yield, or profit, in terms of net income. However, if the framework does not include a means to assess the overall health of the agroecosystem, it will provide only a short-range sense of food security. The current practices may initially provide a spike in yield or income, but they also may mask the slow but ongoing degradation of the soil.

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CROSS-CUTTING

The PIs developed an integrated ecological-economic modeling framework that examines the production of different ecosystem services including crop productivity, carbon storage, CO_2 fluxes, and net income for current practices using different metrics. One metric that proved to be most responsive to different climate and land management drivers was the Carbon Management Index (CMI). The CMI is a valuable addition to the list of metrics as it provides a good measure of how sustainable a practice can be. In this case, it appears that the least intensive tillage practice is best for sustaining productivity. This is due to the combination of the Carbon Pool Index (CPI), which captures the level of the management disturbance through the loss of SOC compared to a reference value, with the Lability Index (LI) which reflects the type of carbon being stored in the system.

What was done and why?

The central objective for this study is to develop a means of assessing how well current and potential future land stewardship decisions balance system productivity, farmer financial gains, and overall system health using an integrated ecological-economic modeling framework. The PIs suggest that most modeling frameworks take a limited view and fail to assess overall system health. The need to sustain in Iowa a healthy soil, or a soil that effectively functions to produce multiple ecosystem services, is critical because soil condition is the primary factor in the short- and long-term productivity of the agroecosystem.

In this project, Soil Organic Carbon (SOC) was used as a common thread to link the different functions of agroecosystems (e.g., food security, greenhouse gas regulation, climate regulation). Due to its close and well-established relationship to local soil biogeochemical controls and processes, SOC strongly influences soil quality, crop yields, net income, and other ecosystem services. It offers an appropriate measure for quantifying and assessing the effects of land management practices on overall system health in Iowa agroecosystems. The framework was used to develop a carbon budget for Iowa's Clear Creek Watershed located in Iowa and Johnson counties. The carbon budget was used to determine the other factors related to farmer financial gains and overall system health in an agroecosystem.

What did we learn?

The framework in the study transcends existing methods as it uses a bottom-up approach that integrates two established, process-based models, WEPP and CENTURY. The bottom-up approach better captures the overall effects of spatial heterogeneity in terms of flow, soil properties, land use/land cover, and hillslope curvature on erosion for different event, seasonal, and inter-annual periods.