

Land-use Changes and Bioenergy

ORNL History of Exploring Changes in Land Use in the United States

For over thirty years ORNL ecologists, social scientists and geographers have documented and explored the processes responsible for land-use change and the implications of those changes. Building from their work with environmental impacts associated with biofuel production, ORNL is now exploring landscape planning approaches that optimize ecosystem health and productivity while integrating biofuels.

Building Understanding of Global Land-Use Change

ORNL has decades of field expertise investigating the complex forces driving land-use change around the world, including projects in Asia, Africa and Latin America on land use and sustainability. A scientific approach for allocation of land-use change impacts due to biofuels production is important to comply with biofuel eligibility requirements under the Energy Independence and Security Act. ORNL research suggests that current models also need improvement to reflect other key factors influencing emission calculations, such as fires and soil carbon sequestration.

Modeling Land-Use Change over Time and Space

- Land-use modeling for US croplands uses the POLYSYS (Policy Analysis System) model, developed and maintained at the Agricultural Policy Analysis Center (APAC) of the University of Tennessee. POLYSYS is an economic simulation model that incorporates yield and demand variability for major crops, livestock commodities, agricultural residues, and bioenergy crops. Drawing on ORNL and APAC county-level data on land management, agricultural inputs, and remote sensing products, POLYSYS estimates changes in agricultural land-use as a result of external incentives (for bioenergy crops, carbon sequestration, conservation practices, etc.) and energy and CO₂ emissions associated with all inputs to production, allowing full carbon accounting. On-going work is updating yields, sustainability limits, and cost functions for agricultural and forestry under new policy scenarios.
- ORNL has pioneered the spatial and spectral algorithm and protocol development for remote sensing based land use change detection models for the nation under the Coastal Change Analysis Program (CCAP) and extending this capability at global scale for population distribution modeling.
- ORNL has modeled and identified regions in the US where crop systems and land use are likely to change to meet bioenergy feedstock production targets. The modeling predicts potential supply of energy crops across a state and uses this information with current land-cover maps and road networks to spatially distribute potential energy crops and calculate transportation costs.
- Because bioenergy infrastructure is bound to biophysical conditions that vary over space, we are using geospatial competencies to better model implications of land-use change decisions and thus to optimize environmental and socio-economic sustainability of biomass production.
- ORNL's Dynamic Ecological Land Tenure Analysis (DELTA) model developed for an Amazon River Basin study has been used by ORNL researchers to understand how sustainable farming practices can affect carbon emissions and land tenure.

Testing understanding of Key Forces and Implications via Field Studies

The State of Tennessee Biofuels Initiative cellulosic ethanol facility in East Tennessee will be provided with switchgrass grown locally via three year contracts on up to 8000 acres of former pastures and land used for corn/soybean rotations. UT and ORNL scientists are collecting baseline soil samples to determine total soil carbon, soil structure and soil components, and anticipate determining soil changes over time on these fields, pending funding support.

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