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Impact Of Rapid Land-Use Change In The Northern Great Plains: Integrated Modeling Of Land-Use Patterns, Biophysical Responses, Sustainability, And Economic And Environmental Consequences

We will evaluate the effects of an expanded agricultural base for biofuels and concurrent changes in climate on ecosystem sustainability across the Northern Great Plains. This research will test the hypothesis that land use patterns driven largely by economic considerations will result in deterioration of ecosystem services and be unsustainable. We will begin with a 2001 landscape classified using ETM+ and MODIS data, and will project alternative landscapes at annual time-steps through 2050, analyzing the results to estimate effects on ecosystem processes and services. Land-use history information derived from MSS, TM, and ETM+ data will inform projection of future change. Socioeconomic drivers, such as national policy and programs, commodity prices, and biofuel demand, will be incorporated to develop multiple scenarios that variously emphasize production of corn, soybeans, switchgrass, and mixed prairie species. We will also address management practices, such as tillage versus no-tillage, that we expect to have appreciable impacts on soil organic carbon, soil erosion, and, subsequently, water quality. Each scenario will be run for current climate conditions, low change conditions, and high change conditions, as defined in reports by the Intergovernmental Panel on Climate Change. We will use the model FOREcasting SCEnarios of Land Cover Change (FORE-SCE) to develop the annual maps of landscape change; the General Ensemble Biogeochemical Modeling System (GEMS) to model the biogeochemical response to land cover/use; the Better Assessment Science Integrating Point & Nonpoint Sources (BASINS) model to estimate associated levels of soil erosion and nutrient, pollutant (e.g., nitrate), and sediment loadings to major waterbodies; and economic and econometric models to determine agricultural profitability and energy costs and benefits. We will assess environmental quality and sustainability based on carbon accounting, agricultural productivity, greenhouse gas emissions, sediment and nutrient loadings to waterbodies, and availability of wildlife habitat. This research addresses the component on “projections” of NASA’s Land-Cover and Land-Use Change (LCLUC) program solicitation, relating to environmental, social, and economic consequences of current and potential LCLUC over the next 50 years. The work is relevant for six of nine societal needs identified by the Global Earth Observation System of Systems: ecosystems, climate, agriculture, energy, water, and biodiversity. Similarly, the research supports components of six goals of the Integrated Earth Observation System, as related to climate variability and change, sustainable agriculture and land degradation, effects of environmental factors on human well-being, ecological forecasting, water resources, and energy. Further, the research addresses Goal 4 of the U.S. Climate Change Science Program, to understand the sensitivity and adaptability of ecosystems and human systems to climate and related global changes.