A global change scenario analysis for North Dakota: potential future trade-offs between agriculture, energy and grassland/wetland conservation

Michael Hill [†]; Rhonda Olson; Andrei Kirilenko
[†] University of North Dakota, USA
Leading author: hillmj@aero.und.edu

We have been developing a spatially explicit scenario analysis framework for assessing economic, environmental and climatic impacts of global change on land use and ecosystems in North Dakota (ND). The thematic analysis is carried out in a spatial multi-criteria analysis shell (MCAS-S). A spatial database of climate and spatial data layers has been compiled for ND at 300 m spatial resolution. . Climate scenarios the 2071-2100 prediction period are acquired from the WORLDCLIM database. Particular emphasis is placed on differences in seasonal temperatures in relation to the optimum for certain crops, and positive and negative changes in the water balance as represented by the difference between precipitation and evapotranspiration. In addition, climate data are aggregated into layers to capture changes in heating and cooling degree days (urban impacts), growing season length, and timing of freeze and thaw. A comprehensive database of spatial data has been collated to describe: roads, towns, transmission lines; rivers, streams, and lakes; land cover, crop types and proportions and distributions of grassland, wetland and cropland derived from these data; original vegetation and ecoregions; potential for energy generation from various sources; biodiversity data; and MODIS and Landsat Image data. The development of scenarios is based on merging the four SRES climate and economic scenarios from the IPCC - A1F1 (fossil fuel intensive), A2 (self-reliance), B1 (convergent world) and B2 (local solutions) - with the four environmental impact scenarios from the Millenium Ecosystem Assessment (MEA) - Global Orchestration (equity and public goods), Order from Strength (national security), Adapting Mosaic (regional focus) and Technogarden (ecosystem engineering). Additional factors such as oil scarcity and nationalization, major food shortages and geopolitical wars are also considered. These global scenarios are downscaled to North Dakota in a two stage process. First the global scenarios are selected, and then a small group of experts are asked to compile a consequential scenario set for the USA. The scenarios are then examined in relation to a set of drivers of change - these are ranked by pair-wise comparison. Finally, the national and global scenarios are filtered by properties of the North Dakota economy, and the social, political and economic attitudes that determine behavior and State government policy. A final set of drivers are then assessed for their potential impact of cropland expansion, agricultural reliability and productivity, grassland/wetland conservation and energy development trends. The land use change scenarios are visualized in the MCAS-S shell. In this paper, we examine the potential future trade-offs between agriculture, energy generation and grassland conservation for a number of alternative futures in North Dakota.