An Aggregated Crop Yield Index to Explore Regional Potential Production Capacity
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Abstract
Explanatory crop models have been developed to estimate yield, growth, and development of individual plants. These models have been implemented extensively at the field-scale; however, there is interest in applying explanatory crop models to regional-scale studies to estimate properties of food systems such as potential production capacity (PPC). These models are well-suited to the study of climate change effects on regional food security and potential adaptation strategies. Corn and potato yields were simulated at a county level over the U.S. eastern seaboard region (Maine to Virginia) using a geospatial interface that interfaces with the crop models SPUDSIM and MAIZSIM over water-limited (WL) and non-limited (NL) conditions. A spatially-referenced yield index (YI) was developed to combine the results from both models, creating an estimate of baseline productivity over the region, and provide a simple numerical analogue for production potential. The sensitivity of this index was evaluated with respect to changes in climatic (temperature, precipitation, and atmospheric carbon dioxide). Future climate was simulated by adjusting monthly statistics used by the weather generator CLIGEN based on downscaled global climate model data. The results of this study could be used by regional planners for anticipating the potential risks of climate change (CC) and evaluating different adaptation strategies such as modifying crop management.

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Objectives
• Evaluate the potential production capacity (PPC) for the ESR
• Quantify the PPC using an aggregated yield index (YI)
• Compare the YI over different climate change (CC) scenarios

Geospatial Crop Model Interface
1) Input data layers (weather, soil, management, land use) are georeferenced and organized in ArcGIS for the region of interest.
2) Spatially homogeneous modeling units (MU) are created.
3) For each unique input combination, 30 independent growing seasons are simulated with SPUDSIM and MAIZSIM.
4) Output is spatially linked and aggregated to the county level. The top 3 MUs per county are used to reduce the number of simulations.

Potential Production Capacity

Potential Climate Change Scenarios
Baseline vs. Future Climate
• Baseline - 1970 to 2000 (NOAA)
• Future - 2050 to 2080 (HadCM3)
• A2 - Economic Development
• B2 - Ecological Sustainability

Why a Yield Index? • Aggregate multiple crops over space • Easily compare scenarios

Yield Index

Definitions and Equations

Total Production Yield index (YI) is the average production per unit area over multiple crops. 

Total Production = the amount of caloric yield that a given area can produce. 

Crop Yield (Mg/ha) = Dry Matter (g) / Density (g/m^3) / 1 / Moisture Content 

YI, (Mkcal/ha) = [1 / Moisture Content] * Harvest Index * [Yield (Mg/ha) * Harvest Area (ha)] 

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Output Variables

Potential Total Production Capacity is dependent on the Yield Index and Harvested Area. PPC increases or decreases if either (1) YI changes, which is weather, soil, management or (2) Harvested Area changes, which is dependent on land use and regional planning. Future work will refine the YI, simulate the effect due to climate change and evaluate adaptions.