Effects of Climate Change on Cropping Systems in the Palouse

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Motivation

• Uncertain how future climate change may affect dryland cropping systems in the Pacific Northwest
  • AEZs will likely shift
Motivation and Genesis

Projection for 2050 generated from the Canadian Centre for Climate Modeling and Analysis global climate model with the A2 emission scenario for CO$_2$ and climate surface interpolation (Hijmans et al. 2005)

Legend
- Research Sites
- Counties
- AEZ
  - Unclassified
  - Zone 1, Annual Crop: Wet-Cold
  - Zone 2, Annual Crop: Wet-Cool
  - Zone 3, Annual Crop: Fallow-Transition
  - Zone 4, Annual Crop: Dry
  - Zone 5, Grain-Fallow
  - Zone 6, Irrigation
  - New Zone: Warmer-Wetter

“Current”

2050
Objectives

• Discover how AEZs may shift as 21st century progresses
  • Simulate soil moisture response to future climate scenarios
    • Two climate scenarios
    • Six locations across all AEZs
    • Three cropping systems
Methods

• Spreadsheet hydrology model (Thornthwaite-Mather, 1955)
  • Compare spreadsheet output with observed eddy covariance data at the Cook Farm
  • Use the hydrology model to calculate likelihood of water shortage at each location
Thornthwaite-Mather Model

$\text{Precip} - \text{Et} - \text{Losses} = \text{change in Water Storage}$

- Precipitation (Precip)
- Evapotranspiration (Evapotranspiration)
- Maximum Available Water Content (cm)
- Water Storage (cm)
- Losses (Runoff or deep leaching)
Thornthwaite-Mather Model

• Inputs:
  • Daily Tmax, Tmin, and Precipitation
  • Maximum soil available water content
  • Crop rotation
    • Crop coefficients
    • Plant date
    • Length of growing season

• Output
  • Daily soil water storage
  • Daily ET
  • Daily Losses
  • Daily Snowmelt
Input Climate Data

- Daily precip, Tmax, Tmin from MACA dataset, CNRM-CM5 model, both RCP 8.5 and 4.5 scenarios
  - RCP:
    - Stands for Representative Concentration Pathway
    - Is a projection of greenhouse gas concentrations in the future.
7% precipitation increase over 50 years

Pullman RCP 8.5

Mean Annual Precip (cm)
Results
Observed Eddy Flux Measurement
Simulated
Frequency with which available water capacity is not reached

Prosser
Frequency with which available water capacity is not reached

Pullman
Transition to Annual Cropping

Frequency with which available water capacity is not reached

Lacrosse RCP 4.5
Transition to Annual Cropping

Frequency with which available water capacity is not reached

Lacrosse RCP 8.5
Summary

• Simulations suggest a general transition to more annual cropping in the REACCH region
• Increased overwinter precipitation in the REACCH region
• Earlier plant dates by ~3 weeks
• Average annual statistics are sometimes misleading
• Seasonal differences in climate predictions are important for hydrology
Recommendations

- Develop a grid-based GIS version of the model to visualize the transition in AEZs
- Give farmers access to this information with online tool
- Compare results to a more detailed cropping model (e.g. CropSyst)
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