Implications of Wetter and Warmer Future Climates on the Soil Water Availability in the Palouse

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Introduction

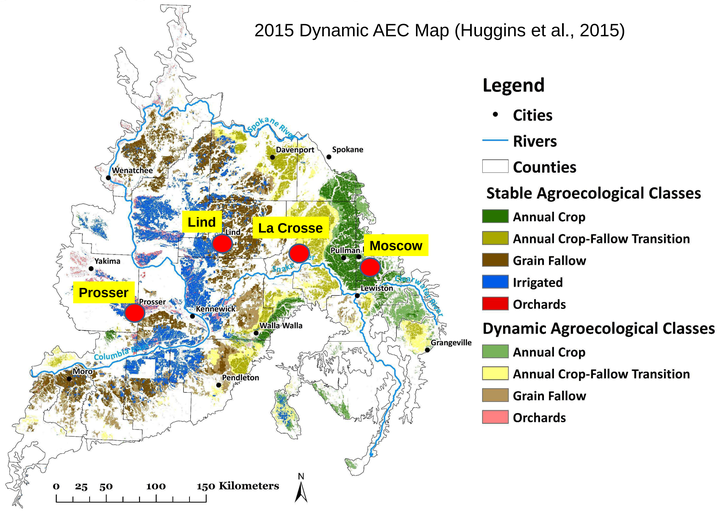
The Palouse region of the Inland Pacific Northwest is one of the most productive dryland cereal grain producing regions of the world. The Mediterranean climate regime is characterized by wet, cold winters and dry, hot summers. Mean annual precipitation generally increases with elevation with precipitation in western regions of less than 20 cm to precipitation in higher eastern regions above 75 cm. Producing grain in the dry, western regions is not feasible without irrigation due to the lack of available soil moisture. With increasing precipitation growers generally transition from irrigated systems to grain-fallow systems, where crops are grown every other year, to crop-fallow transition regions, where crops are grown 2 out of 3 years, to annual cropping systems in the wetter, eastern regions. Huggins and Rupp (2015) describes each of these cropping systems as "AgroEcological Classes (AECs)" and has mapped changes in these systems over the last 10 years (see Figure 1).

Generally the climate in the region over the next 80 years is expected to be wetter and warmer which will likely cause more shifting of these AECs. In this study we use a simple hydrologic, cropping model to quantify changes in available soil water for each of the three major cropping systems at specific points throughout the Palouse region using daily downscale climate data from 12 global climate models (Abatzaglou, 20**). These simulations not only provide insight into the effect of future climate future changes in AECs they also provide an indication of the potential environmental effects (e.g. leaching, runoff) that may be associated with future climates.

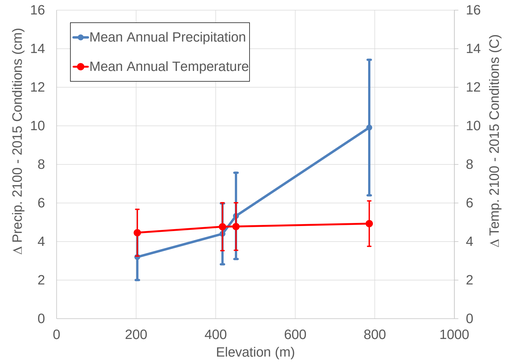
Objectives:

1. Quantify how climate change will affect plant water availability and the selection for fallow and annual cropping management strategies for arid cereal production in the REACCH region
2. Assess potential environmental and economic implications of the adaptations

Agroecological Classes (AECs)



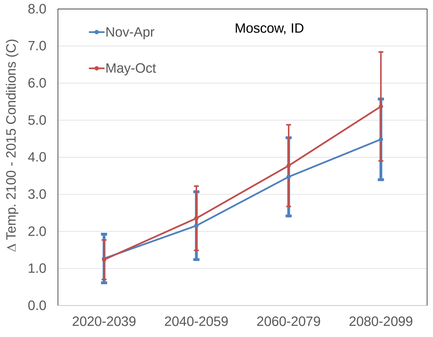
Downscale Climate Projections (RCP 8.5)

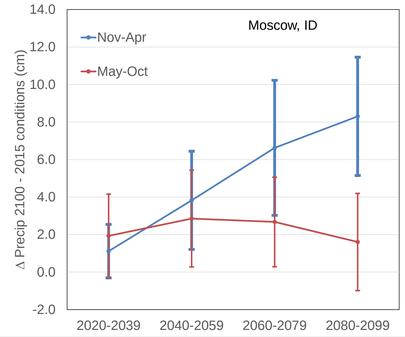


Mean annual temperature increases by 4.7 C uniformly across the region by 2100.

Mean annual precipitation will increase more in the wetter, high elevation regions (~10 cm) than increases in the drier lower elevation regions (~3 cm)

The majority of the increase in annual precipitation increase will occur in the winter (Nov.-Apr)

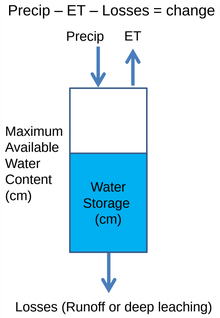


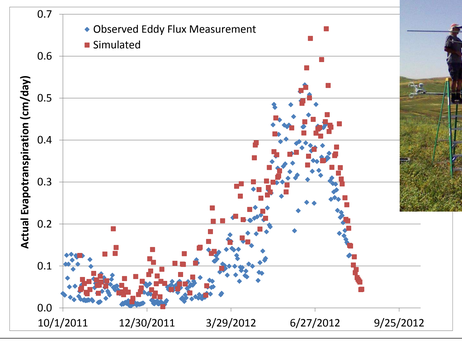


Thornthwaite Mather Model

- Simple, daily, 1-D Water balance model
- Potential ET using Hargreaves equation
- Actual ET based on crop coefficients and soil water stress
- Simulates snowmelt, canopy interception
- Requires a maximum available soil water

Precip – ET – Losses = change in Water Storage



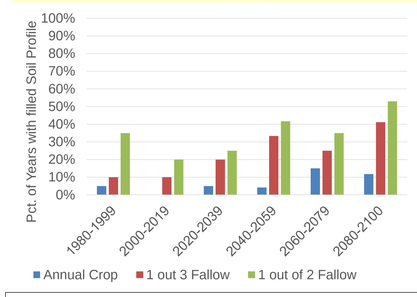


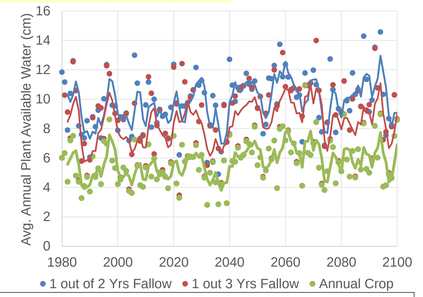
Three simulated cropping scenarios:
- Annual cropping, fallow 1 out of every 3 years, fallow 1 out of 2 years

Limitations/Assumptions
- Total soil available water supply ranges from 21 cm in wetter regions decreasing to 19 cm in drier regions to reflect changes in rooting depth.
- Assumes growth is not limited by disease or weed pressures or nutrient stress
- Does not simulate heat stress, crop yield, or increased CO_2 effects on yield
- Assumes all water exceeding soil field capacity either drains below the root zone or runs off

Grain-Fallow AEC Lind, WA (25 cm Annual Precipitation)

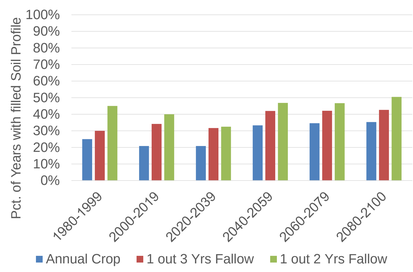
- **Slight increase spring soil moisture levels**
- **Potential for increased cropping with shallow, drought resistant crops in off years**

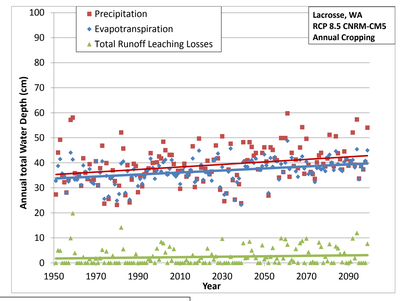




Grain-Fallow AEC: La Crosse, WA (35 cm Annual Precipitation)

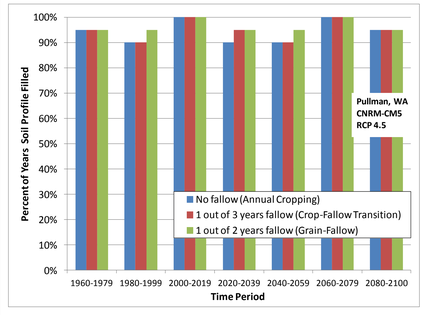
- **Increased spring soil moisture levels. By mid century the soil profile is filled 4 out of 10 years in the 1 out 3 year fallow scenario**
- **Potential for increase in cropping with decreasing the use of summer fallow to 1 out of 3 years**

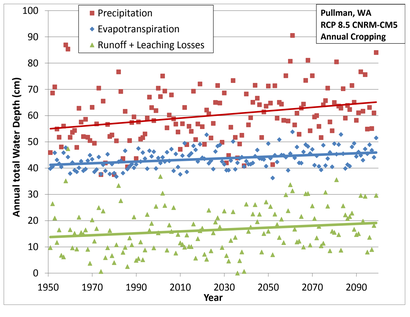




Annual Crop AEC: Moscow, ID

- **Soil profile is filled every spring; increased excess water by late century**
- **Suggests continued annual cropping with greater off season water/nutrient/sediment losses.**





Summary/Implications

- No change in irrigated regions
- Potential for increased cropping in Grain-Fallow regions
  - Increase in shallow rooting drought resistant crops during some normally fallow years
- Annual Crop AEC
  - Wetter conditions will like lead to increased runoff, nitrate losses, erosion
  - Likely see an increase in fall-seeded crops/cover crops
  - Delay in plant date due to wet spring conditions

Future work necessary to ensure other factors such as heat stress, weed/disease pressures are not limitations

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