Evaluation of climate and land use changes on hydrologic processes in the Salt River Basin, Missouri, United States

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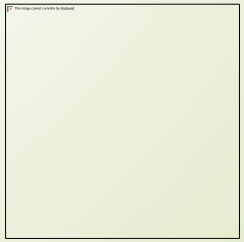
MISSOURI TRANSECT



USDA ARS

1. Introduction

- Around the world, many regions are struggling to effectively manage and allocate their freshwater.
- Competition and conflicts over water resource are rising among different sectors
- Essential for regions with limited water supplies as water resources becoming scarcer.

2. Objective

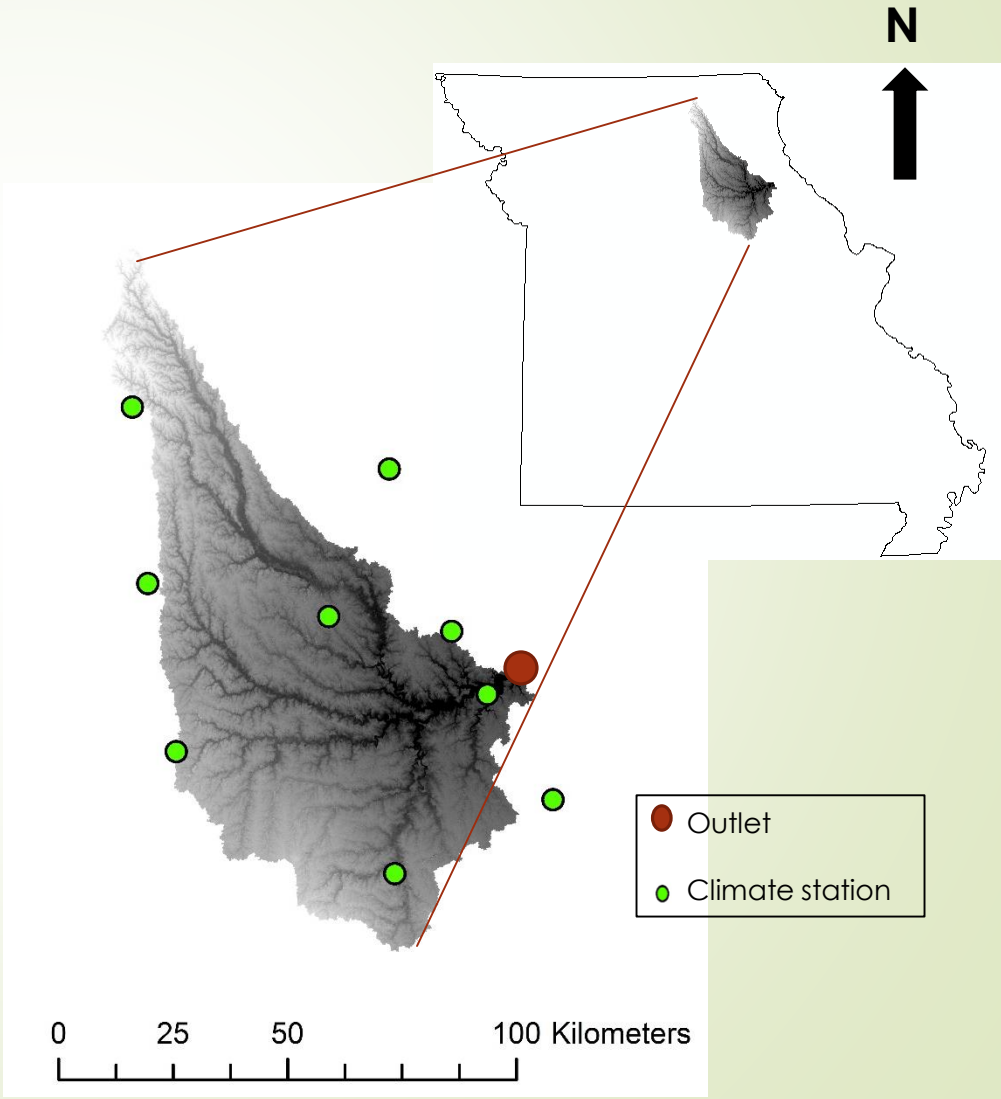
Assess impacts of climate and land use changes on hydrologic processes and estimate future water availability of the Salt River Basin

- *Projecting changes in land use and climate patterns*
- *Define scenarios*
- Estimate changes with help from SWAT

3. Site Description

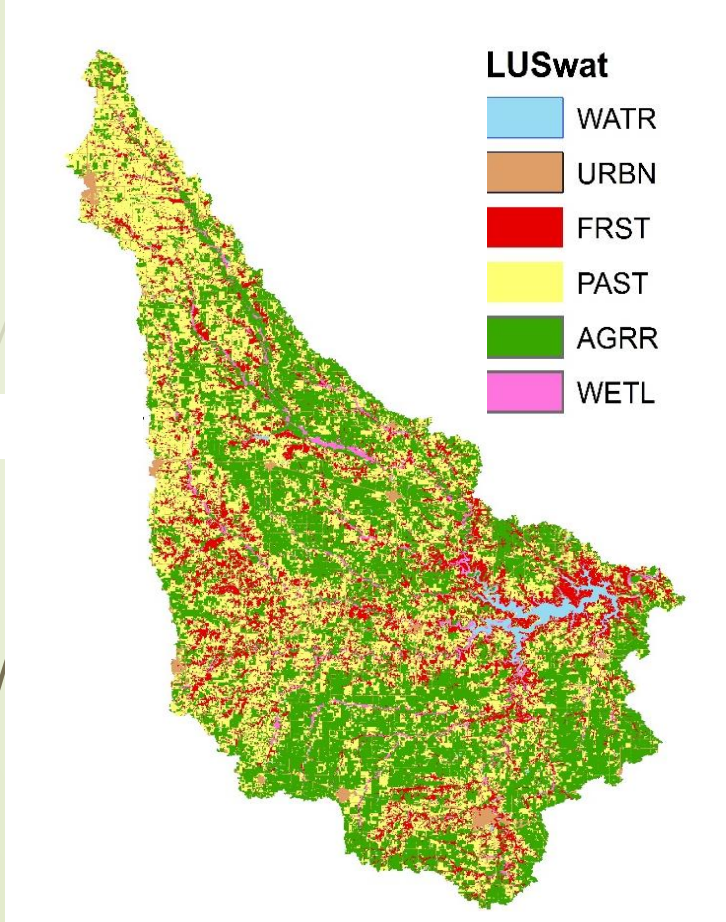
Salt River Basin:

- Located in Northeast Missouri
- Flows into the Mississippi River
- Total drainage area 6,417 km^2 at Mark Twain Lake outlet
- Predominant soil – high surface runoff and erosion potential
- Average annual precipitation of 1000 mm.



3. Site Description *(cont.)*

Original LU 2001



Land Use	Original %
Water	1.8
Urban	5.2
Forest	15.3
Pasture	35.2
Agriculture	39.7
Wetland	2.7
Total	**100**

3. Model Setup - Climate

Climate data

- Daily totals of precipitation,
- Daily means of maximum & minimum air temperature

- ***Historical data:***

Observed data (1965-2013) - Climate Data Online (CDO) system of NOAA's National Climatic Data Center (NCDC)

- ***Projected data:***

Future climate data (2014-2060) - daily bias-correction and constructed analogs (BCCA) from Downscaled CMIP5 Climate Projections. Resolution about 12 km x 12 km

Representative concentration pathway (RCP):

- RCP 8.5
- RCP 4.5

3. Model Setup – Climate *(cont.)*

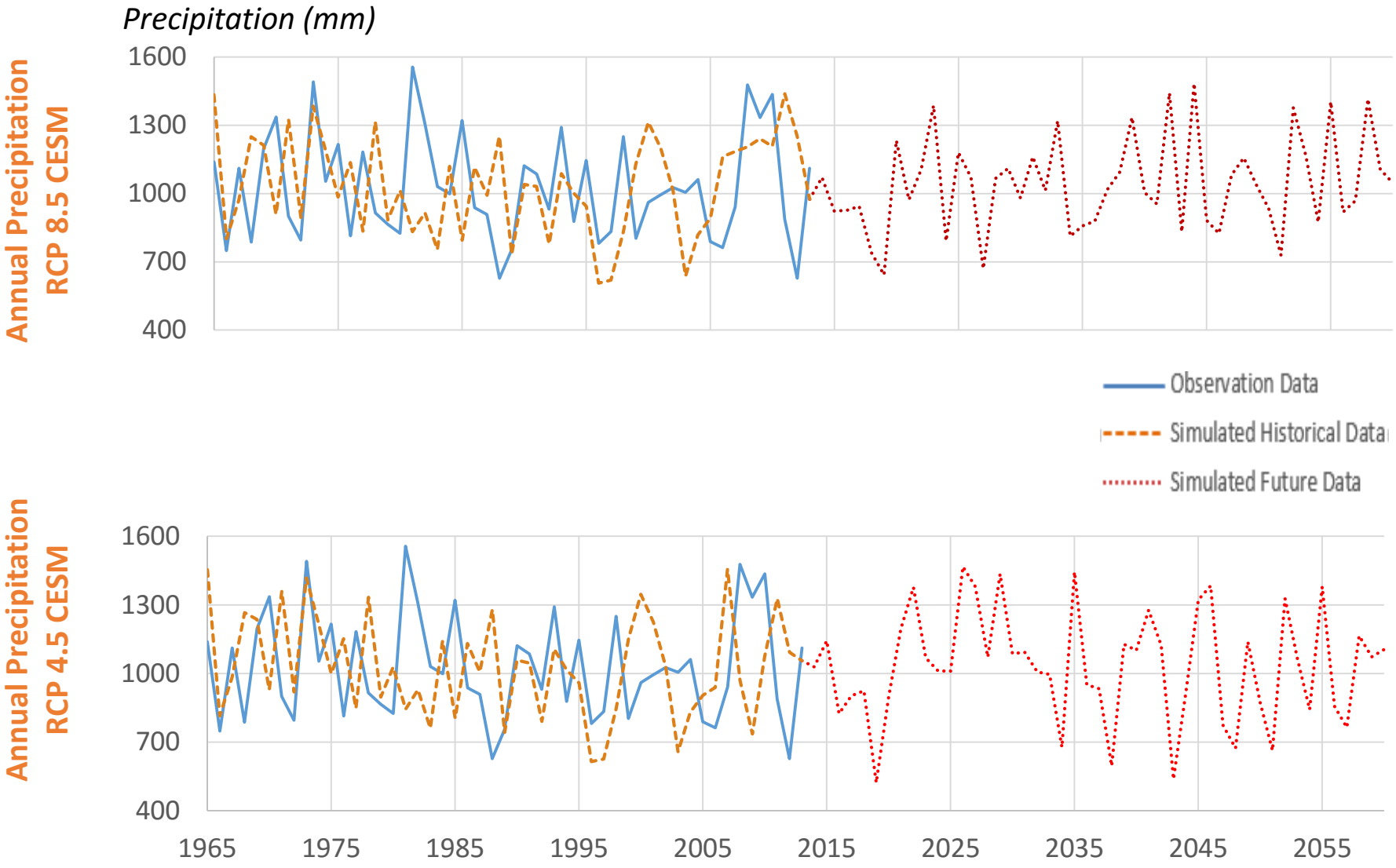
Climate Model

- Community Earth System Model (CESM) has been chosen

- *We will be adding additional models to create an ensemble dataset*

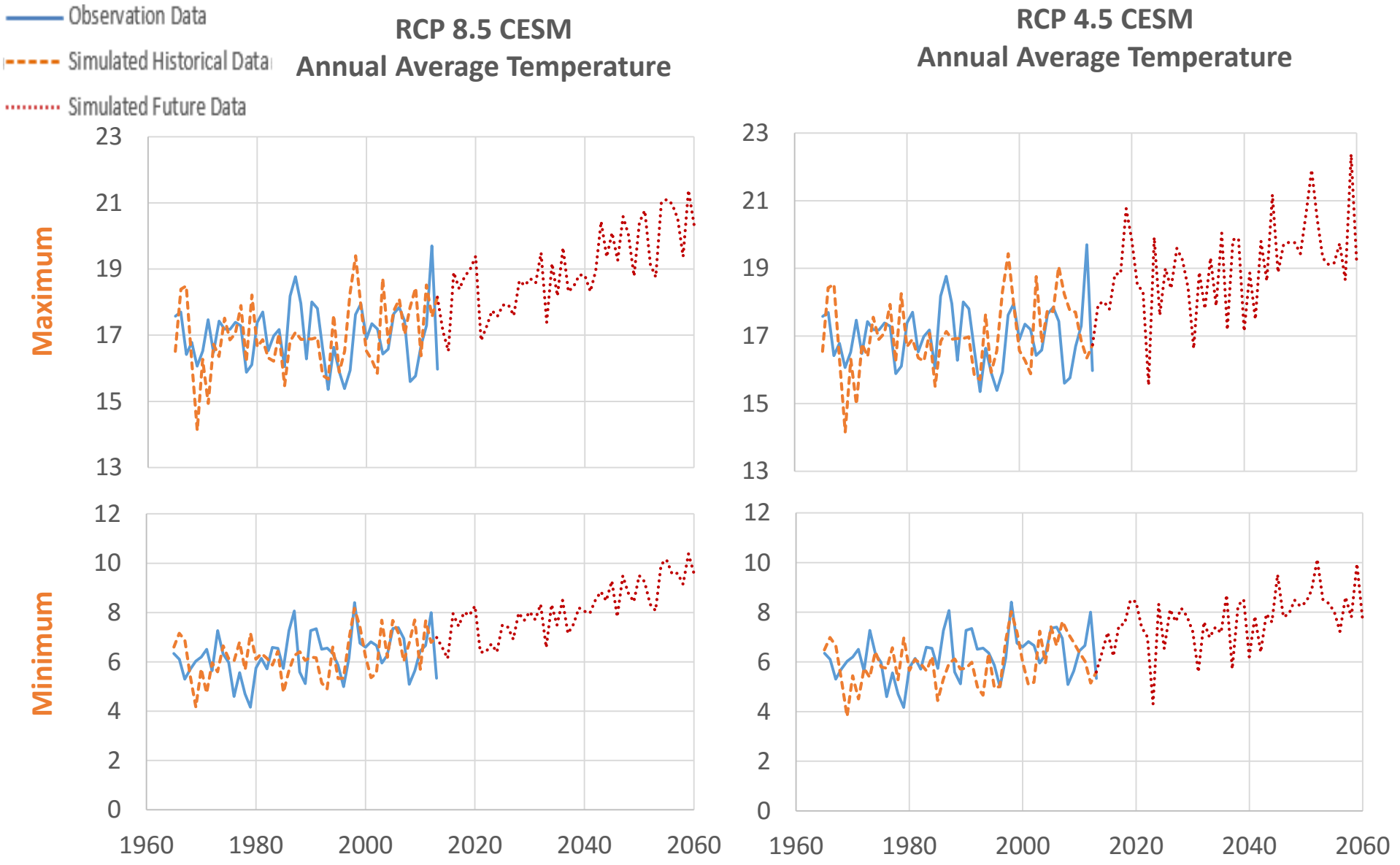
3. Model Setup – Climate *(Cont.)*

Quantile Mapping Result for Precipitation



3. Model Setup – Climate *(Cont.)*

Delta Method for Temperature



3. Model setup – Land Use

Landuse/Land Cover

Landuse map was obtained from Missouri Spatial Data Information Service for 2001 and 2011.

Project land use change

First Projection:

Forest land with less than 5% slope converted to agricultural land.

16% Increase in Agricultural Land

Second Projection:

Forest with less than 15% slope converted to agriculture land.

36% Increase in Agricultural Land

Third Projection:

Agriculture land with more than 5% slope will be converted back to forest

28% Decrease in Agricultural Land

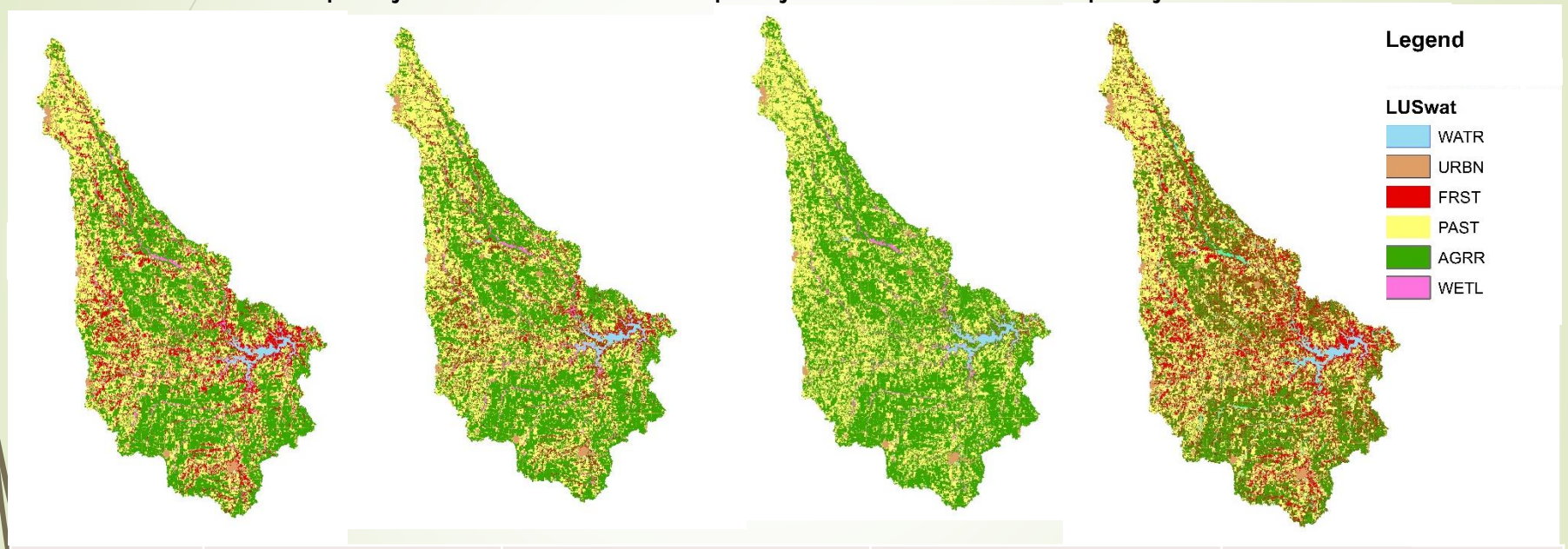
3. Model Setup – Land Use *(Cont.)*

Original LU 2001

16 % Increase in Agr Land -1st projection

36% Increase in Agr Land -2nd projection

28% Decrease in Agr Land -3rd projection



Land Use	Original	First Projection	Second Projection	Third Projection
Forest	15.2	8.8	0.9	26.7
Agriculture	39.7	46.2	54.1	28.4
Water	1.8			
Urban	5.2			
Pasture	35.2			
Wetland	2.9			

3. Model Setup – Other Parameters

Digital Elevation Model (DEM)

30 m (1 arc second) DEM - U.S. Geological Survey (USGS)

Soils

Soil Survey Geographic Database (SSURGO) - National Cooperative Soil Survey

Slope

5 slope classes

HRU Threshold

10% for land use

20% for soil

20% for slope

3. Model Setup - Scenarios

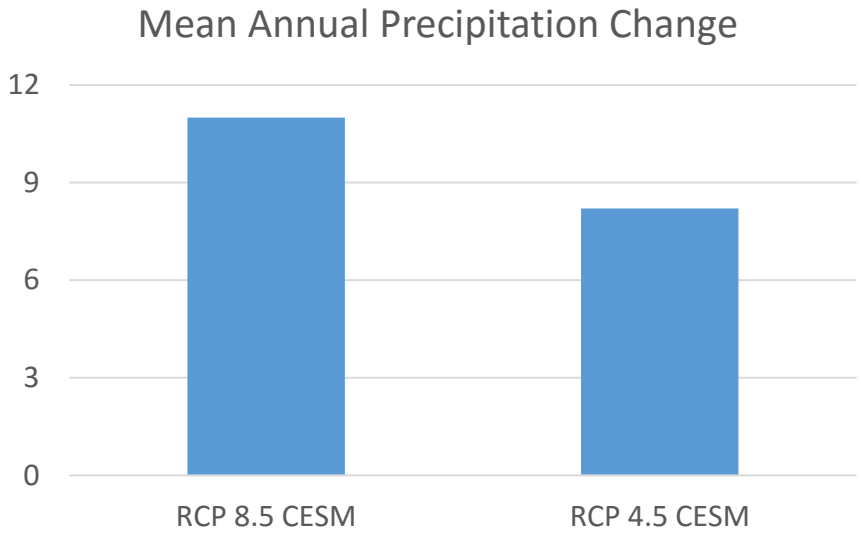
2014-2060

Scenario 1	RCP 8.5 CESM & No Land Use Change
Scenario 2	RCP 8.5 CESM & 16% Increase in Agriculture Land
Scenario 3	RCP 8.5 CESM & 36% Increase in Agriculture Land

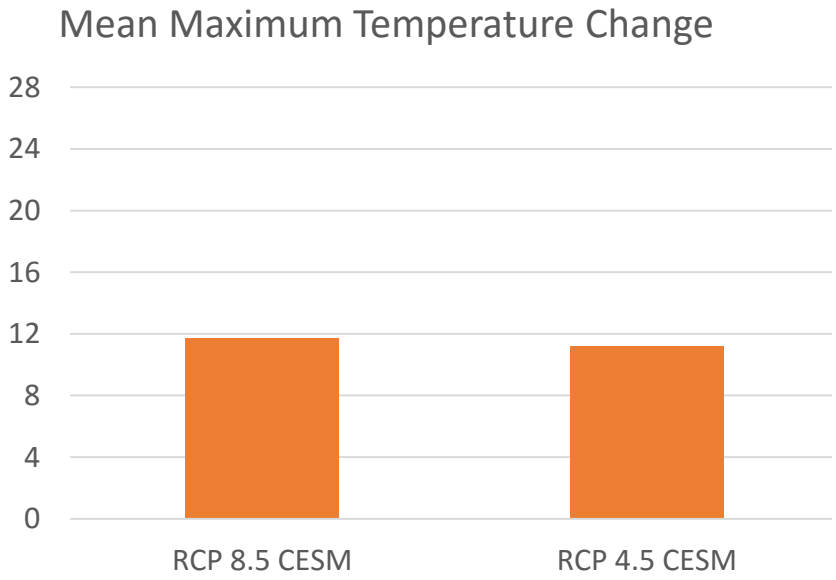
2014-2060

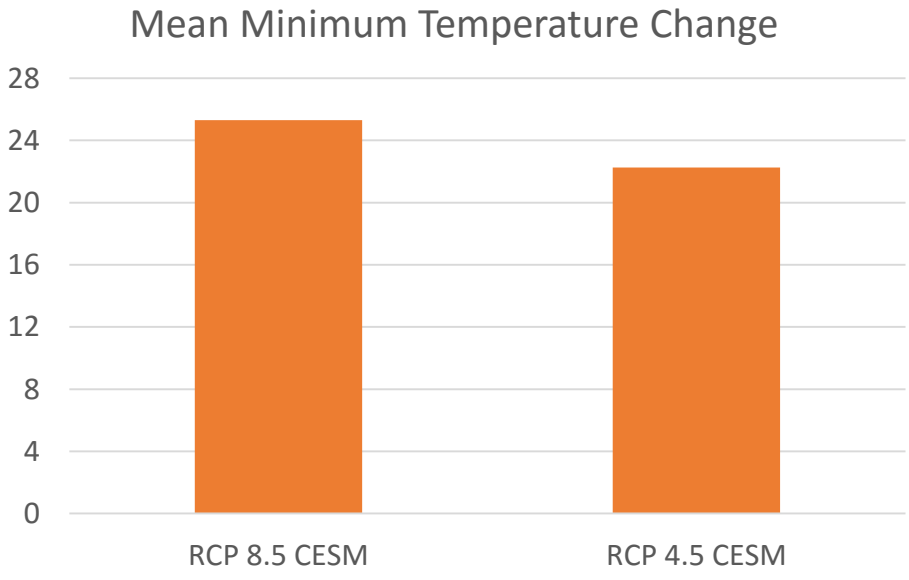
Scenario 4	RCP 4.5 CESM & No Land Use Change
Scenario 5	RCP 4.5 CESM & 16% Increase in Agriculture Land
Scenario 6	RCP 4.5 CESM & 28% Decrease in Agriculture Land

4. Results and Discussion



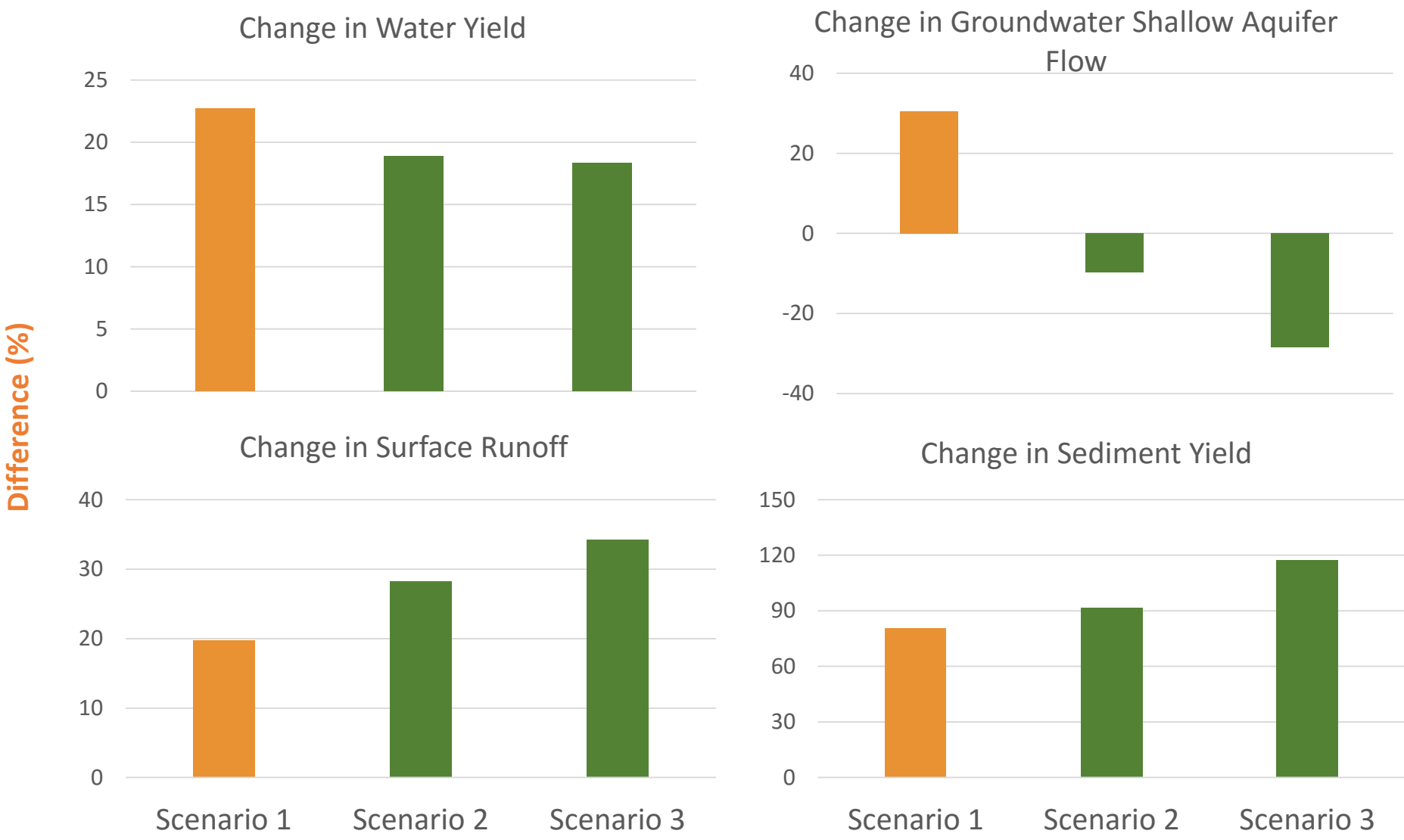
Difference (%)





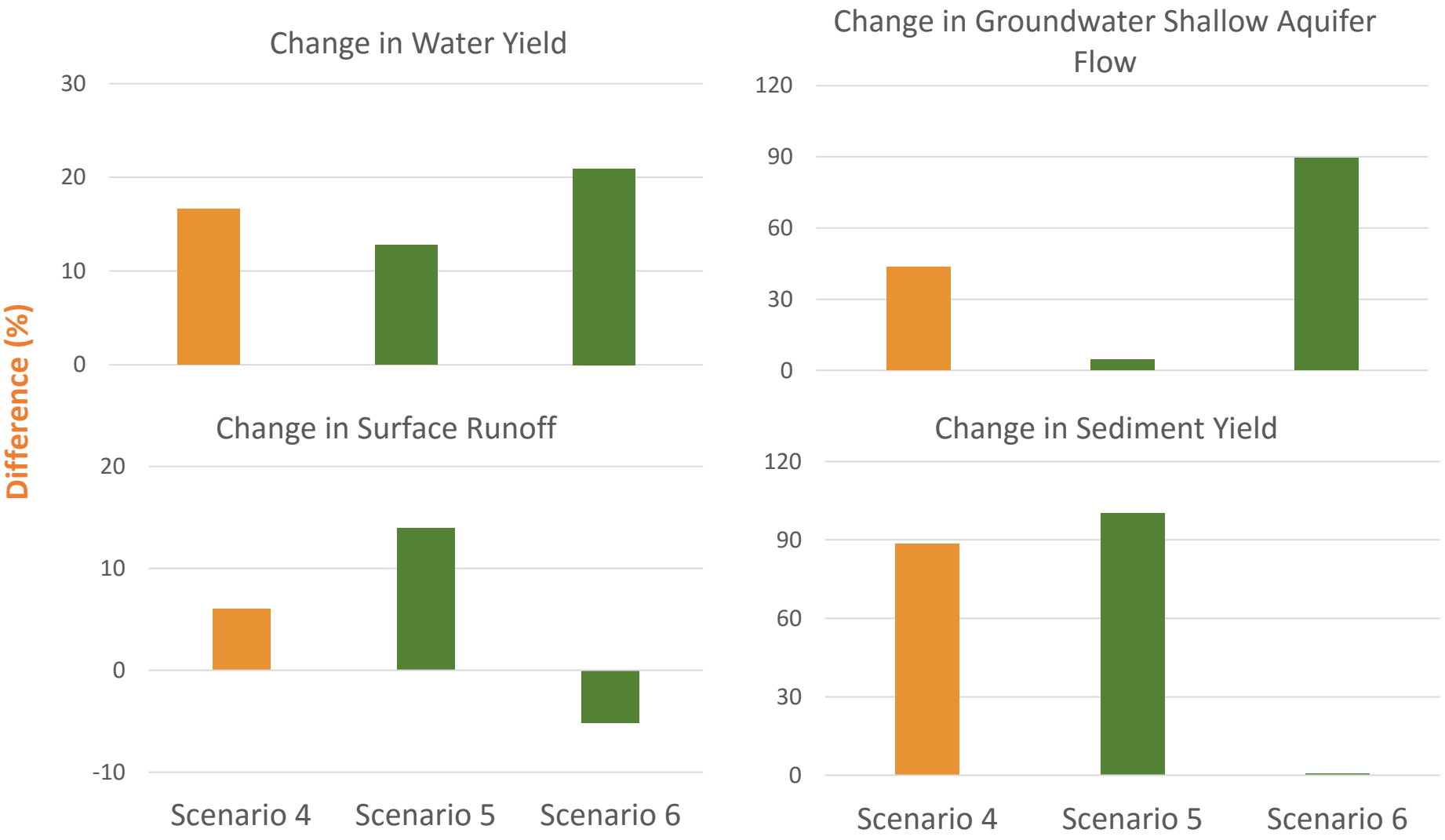
4. Results and Discussion (Cont.)

Scenario 1	RCP 8.5 CESM & No Land Use Change
Scenario 2	RCP 8.5 CESM & 16% Increase in Agriculture Land
Scenario 3	RCP 8.5 CESM & 36% Increase in Agriculture Land



4. Results and Discussion (Cont.)

Scenario 4	RCP 4.5 CESM & No Land Use Change
Scenario 5	RCP 4.5 CESM & 16% Increase in Agriculture Land
Scenario 6	RCP 4.5 CESM & 28% Decrease in Agriculture Land



5. Conclusion

With the projection of climate and land use change for RCP 8.5 and RCP 4.5 for the CESM model

- Changes in climate and increase agriculture land
  - Increase in precipitation ~10%
  - More runoff, less groundwater flow
  - Increase in sediment yield
- Reforestation could help mitigate some of the effect from climate change
  - Reduce surface runoff
  - Reduce sediment yield
- Future Work
  - Include additional CMIP5 datasets for each RCP and generate SWAT output.
  - Refine land use scenarios and link them to future population scenarios.
  - Estimating water availability, and water allocation for future