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Current and Future Water Scarcity

Thomas C. Brown

Rocky Mountain Research Station
Forest Service, USDA



WREEDON 4-29

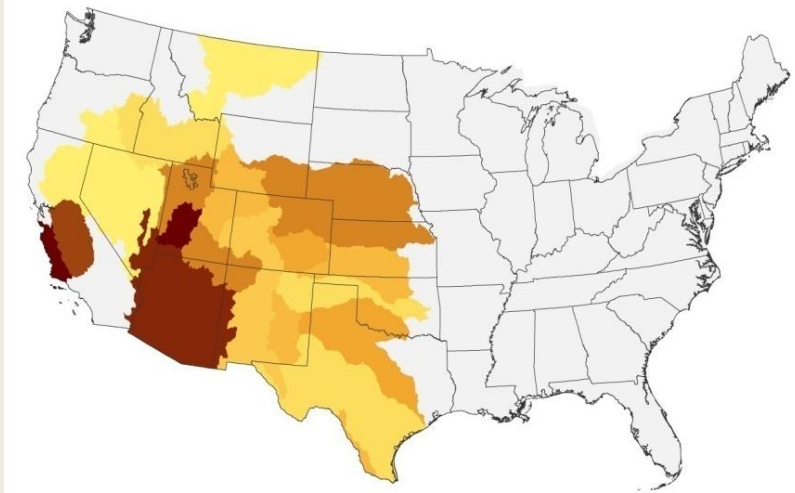
This talk will examine these topics at a broad spatial scale:

1. Past and future off-stream water use
 - a. in non-agricultural sectors
 - b. for irrigation.
2. Potential water shortages.
3. Uncertainty about these things.

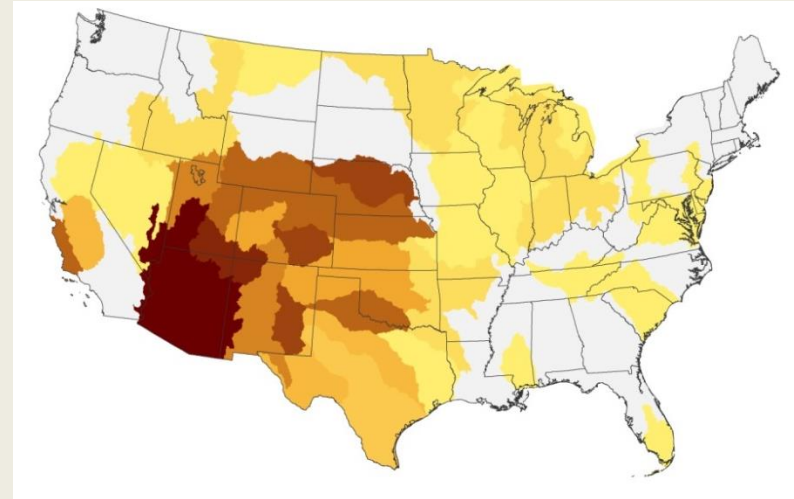
Vulnerability in 2060, A2 socio-economic/emissions scenario

Probability of water shortage with three global climate models

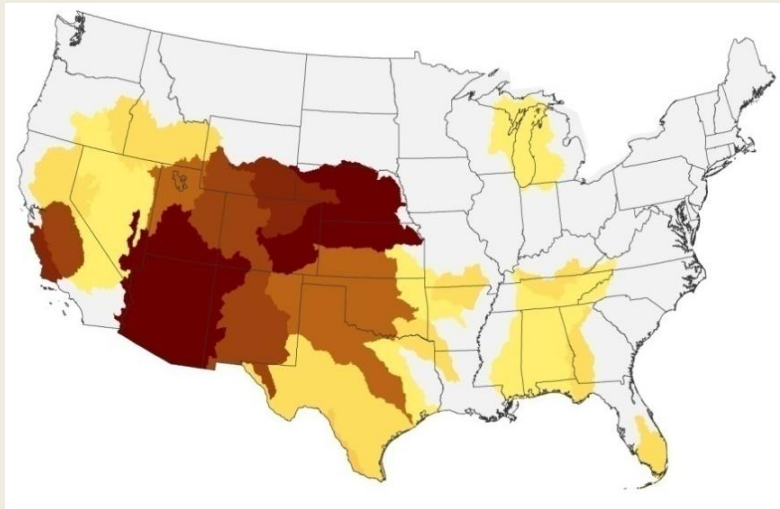
CGCM model



CSIRO model



MIROC model

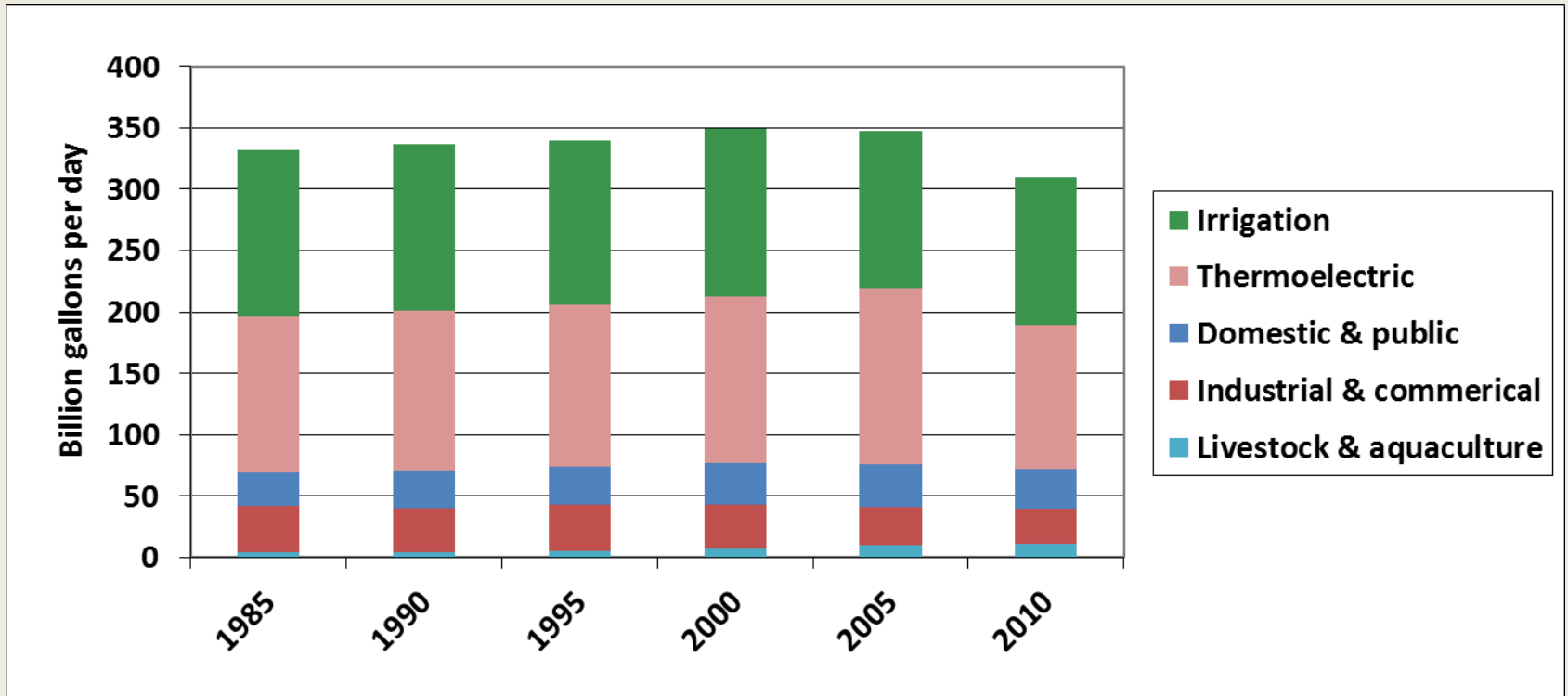


Upper end
of category

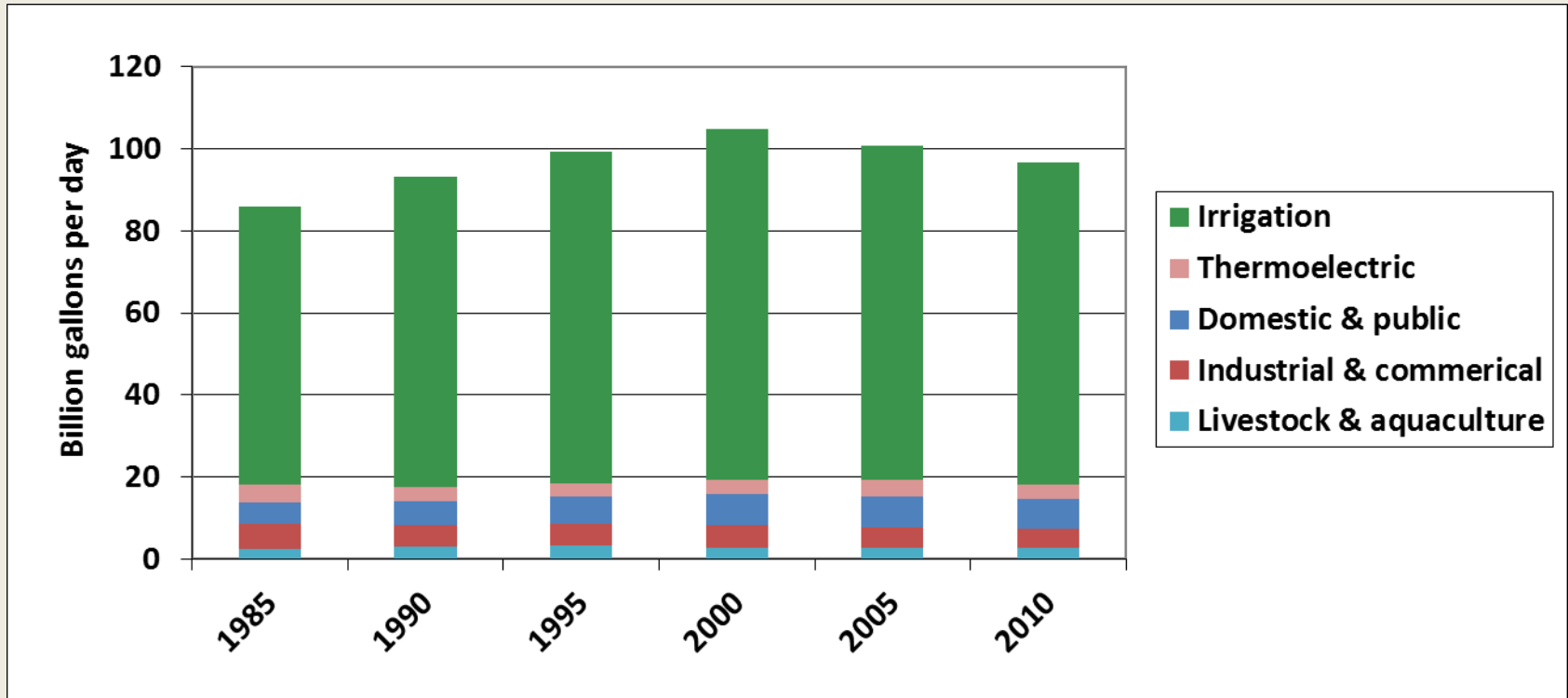


Source: 2010 RPA Water
Assessment, Forest Service

Total US annual water withdrawal by sector



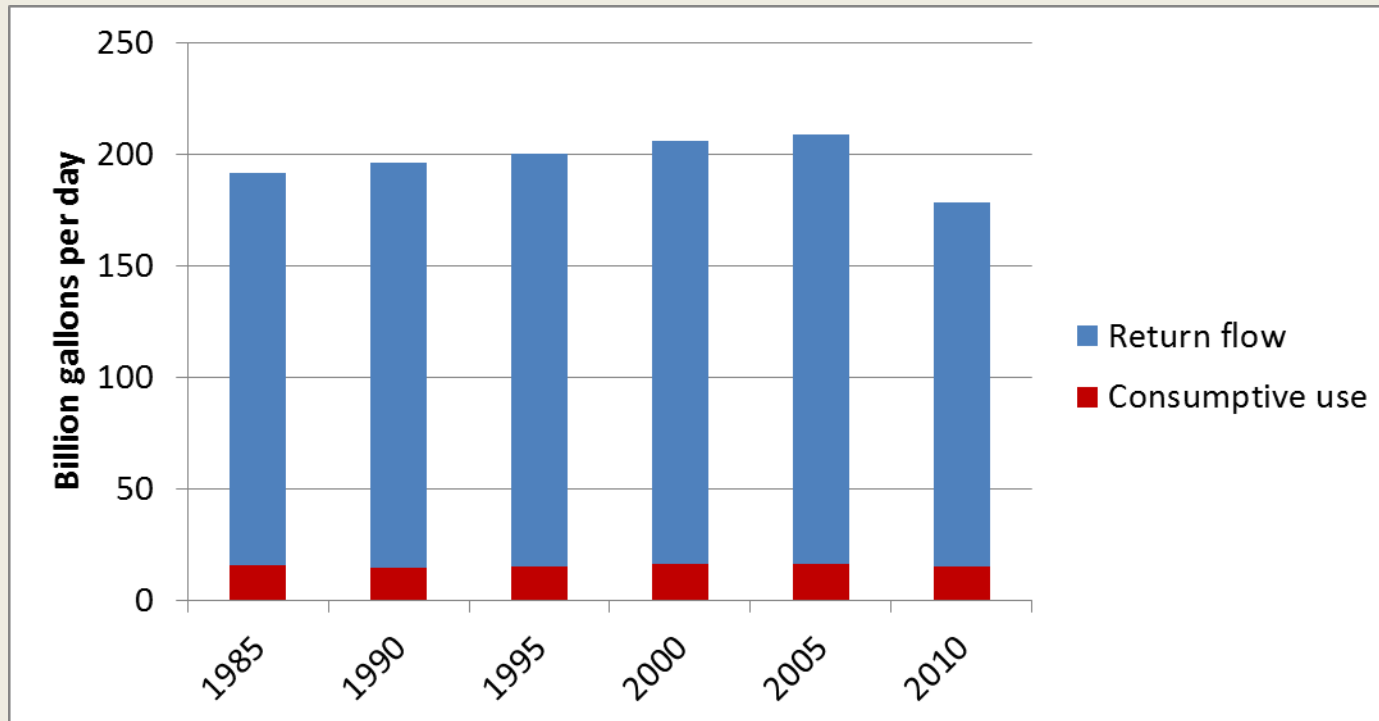
Total US annual water consumption by sector



Data source: USGS, FS (RPA Water Assessment)

Total US annual water use in non-irrigation sectors

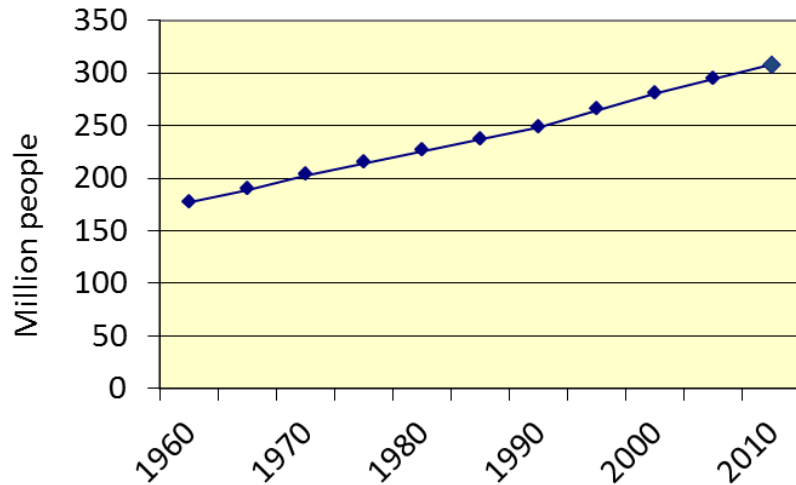
Total withdrawal (consumptive use + return flow) of the domestic & public, industrial & commercial, and thermoelectric sectors



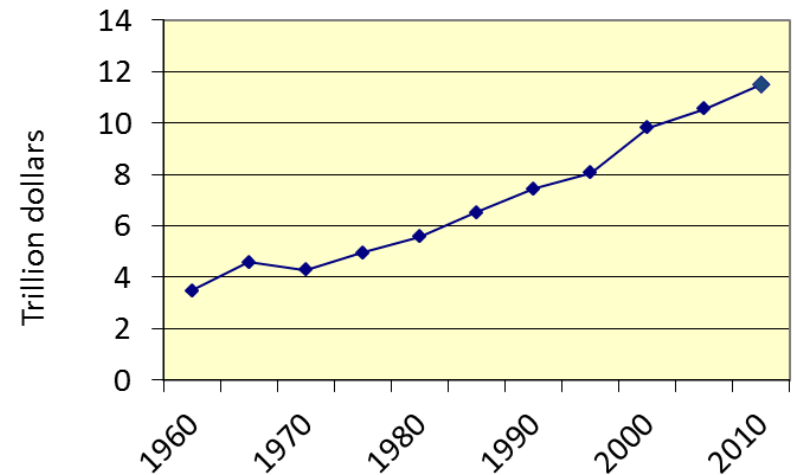
Data source: USGS, FS (RPA Water Assessment)

Trends in water use drivers of major non-irrigation sectors

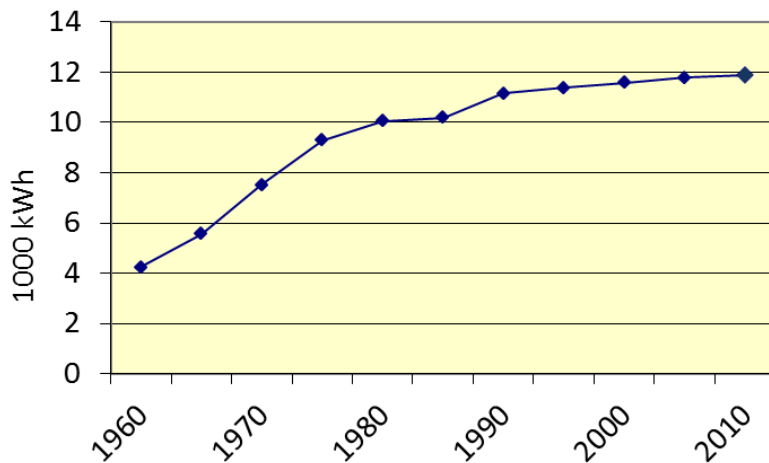
Population



Income per year (2006\$)



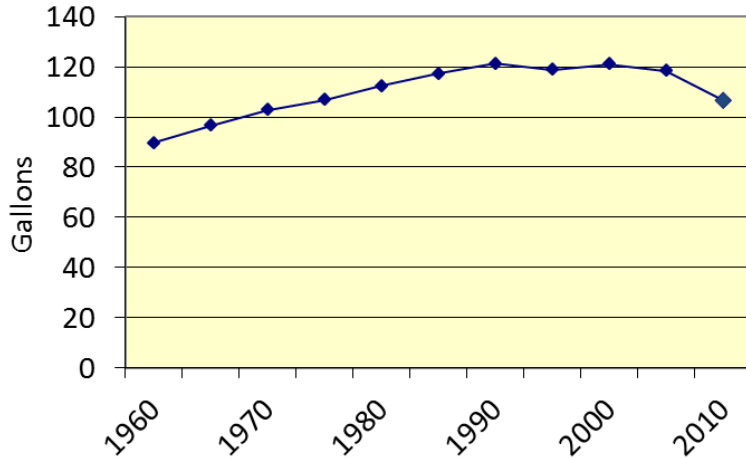
Total electricity use per capita



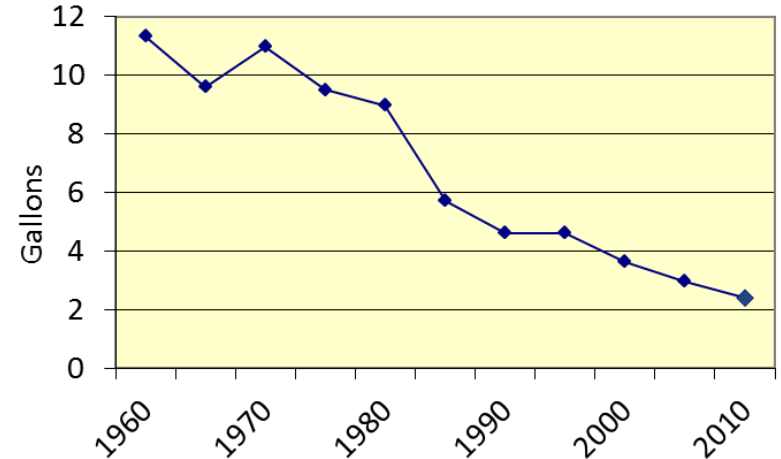
Data sources: BEA, EIA, Census Bureau

Trends in water withdrawal rates of major sectors

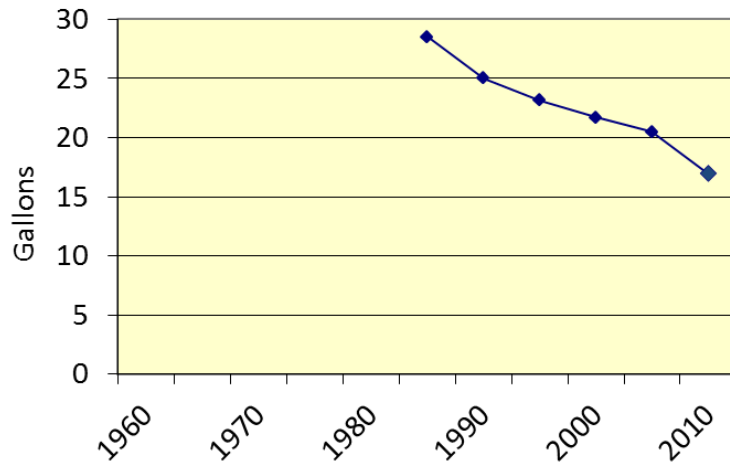
Domestic and public withdrawal per capita per day



Industrial and commercial withdrawal per \$1000 of income (2006\$)

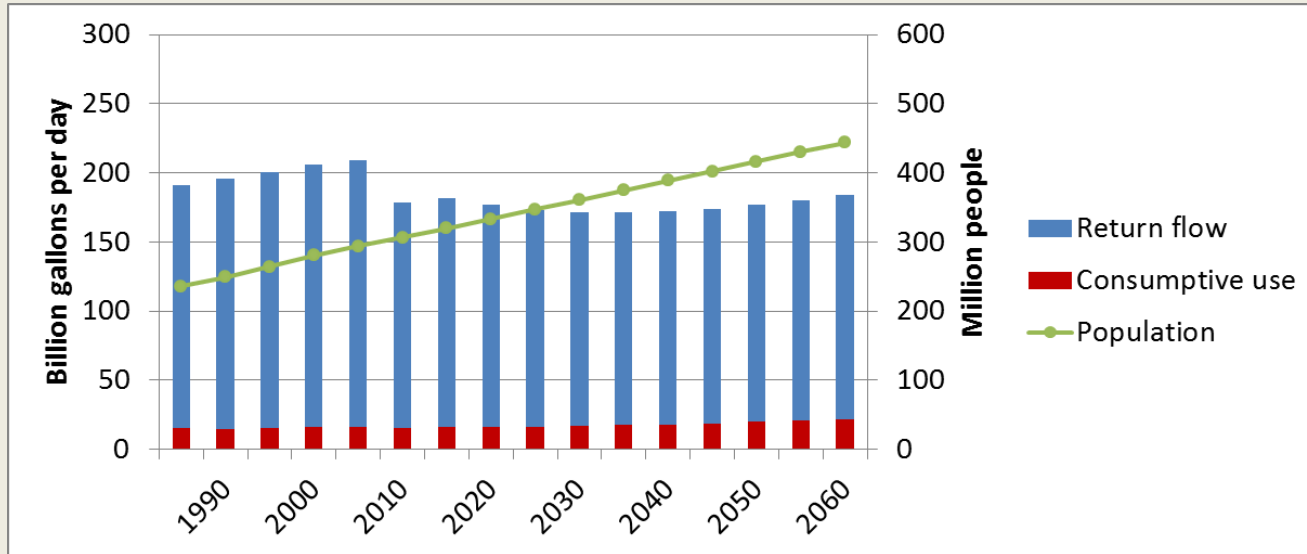


Thermoelectric withdrawal per kWh produced

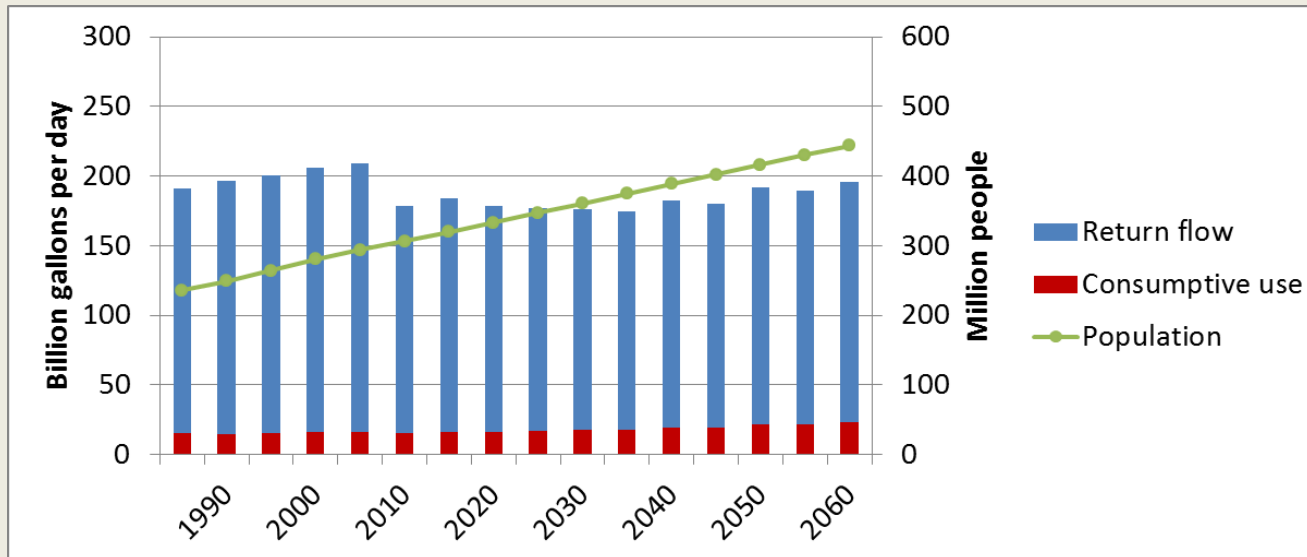


Data source: USGS, BEA, EIA, Census

Past and projected US water use in non-irrigation sectors



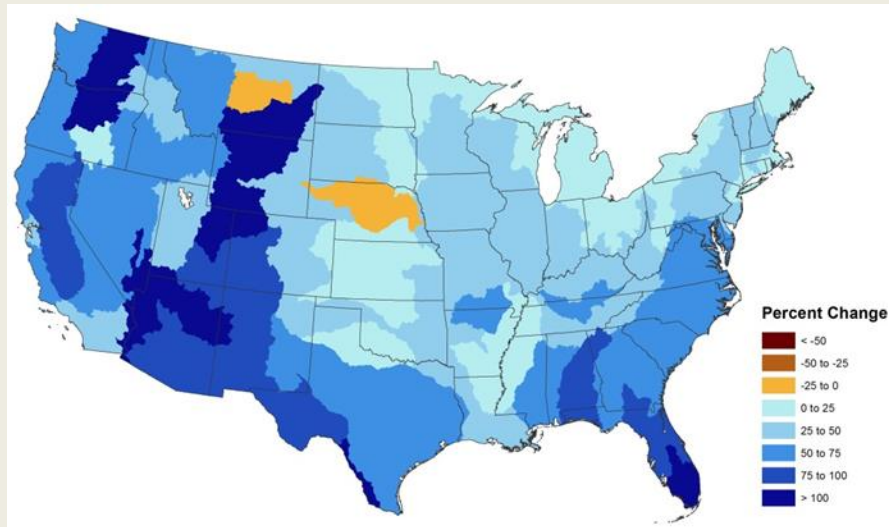
A1B population,
no climate
change



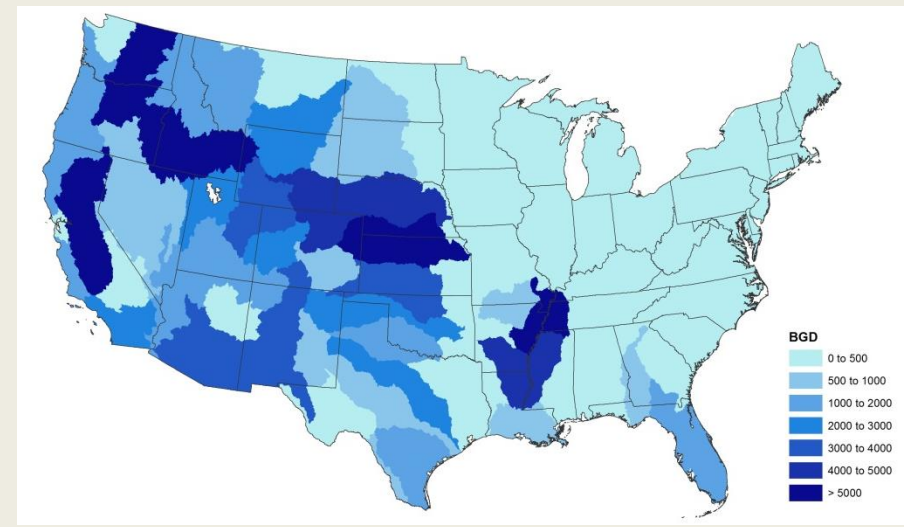
A1B population,
CGCM climate
model

Irrigation withdrawal vs growth in competing water demands

Projected change in competing water use



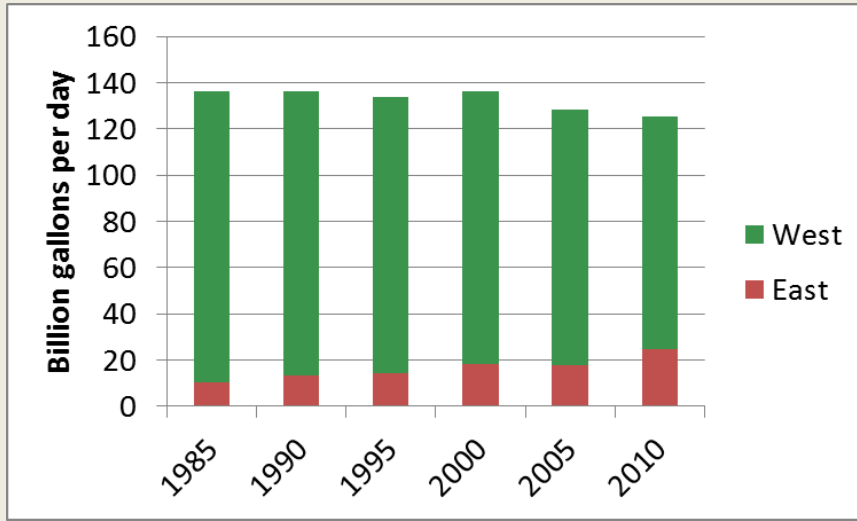
2010 Irrigation water withdrawals



The areas of greatest expected growth in water use in non-irrigation sectors (left map) are often the same as the areas of greatest current irrigation demand (right map).

Water use for agricultural irrigation

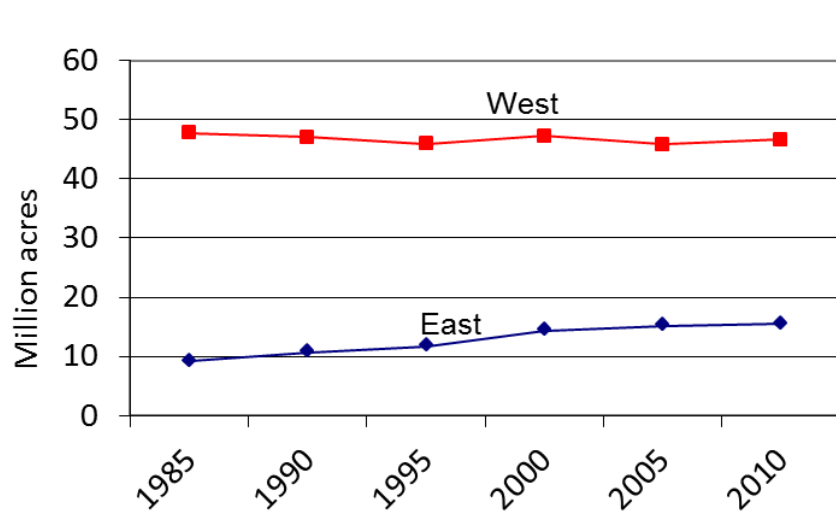
Withdrawal



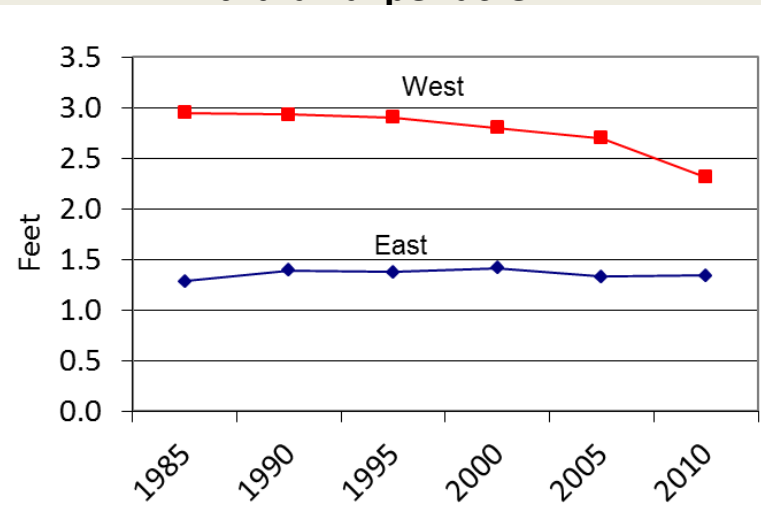
West / East divide



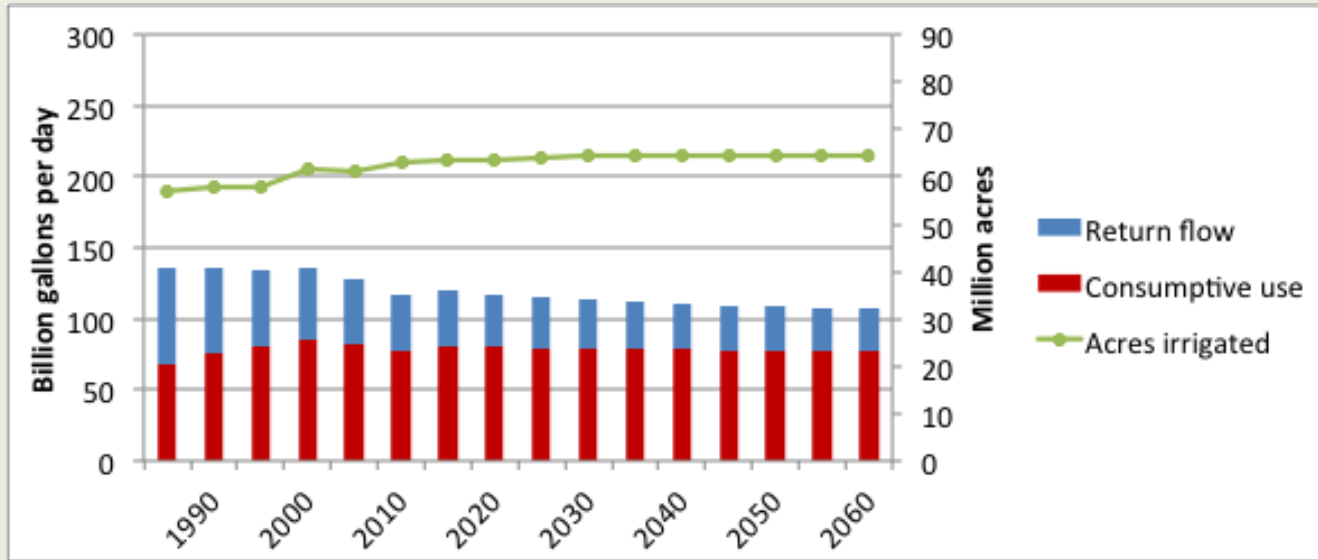
Area irrigated



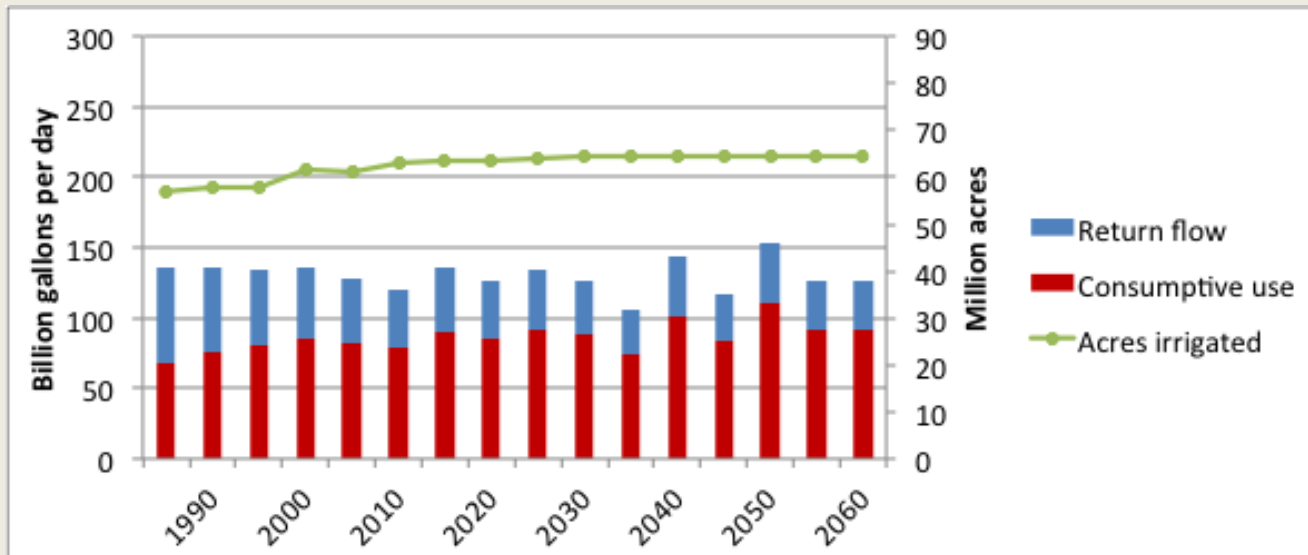
Withdrawal per acre



Past & projected US irrigation water use: effect of climate

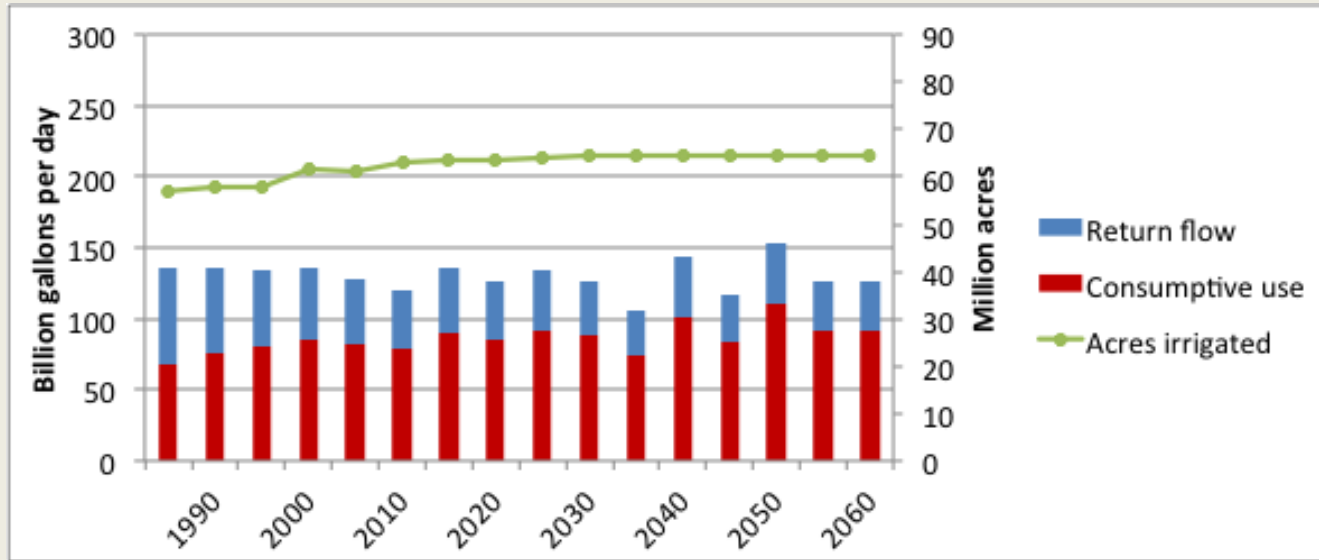


A1B population,
no climate
change

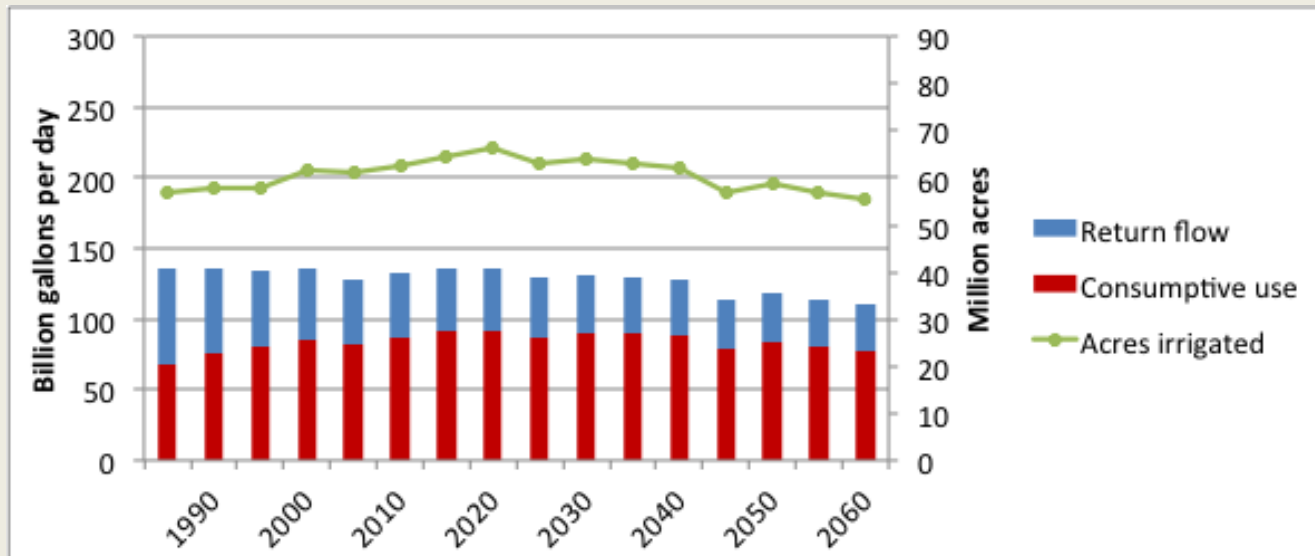


A1B-CGCM
climate

Past & projected US irrigation water use: effect of ag models

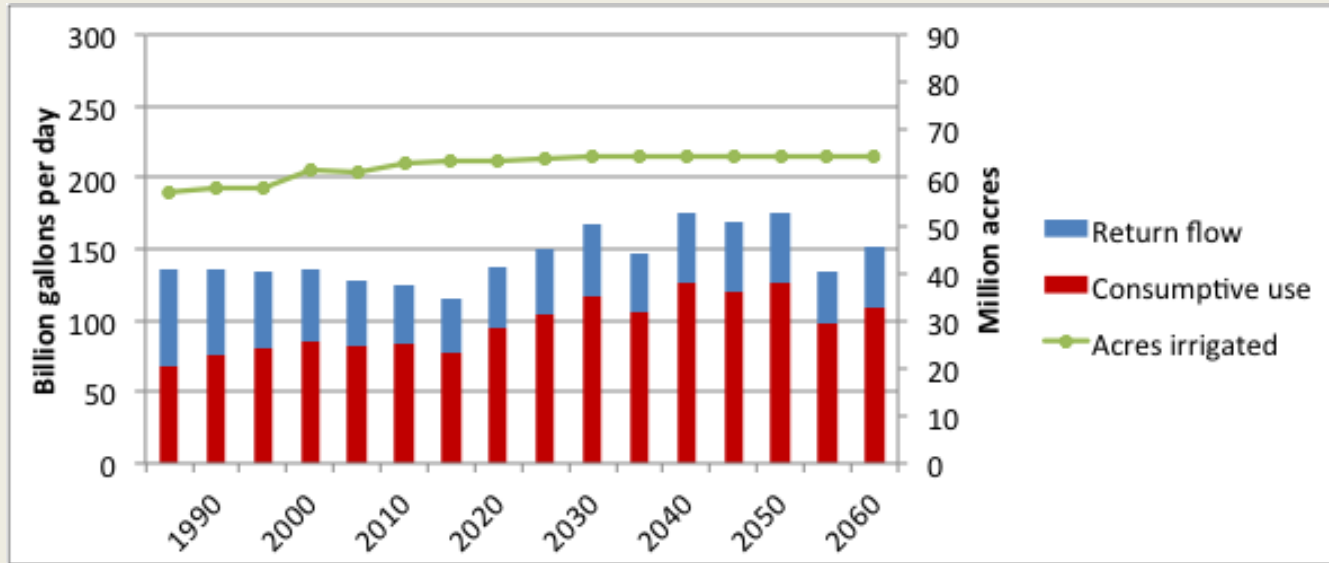


A1B-CGCM future,
RPA

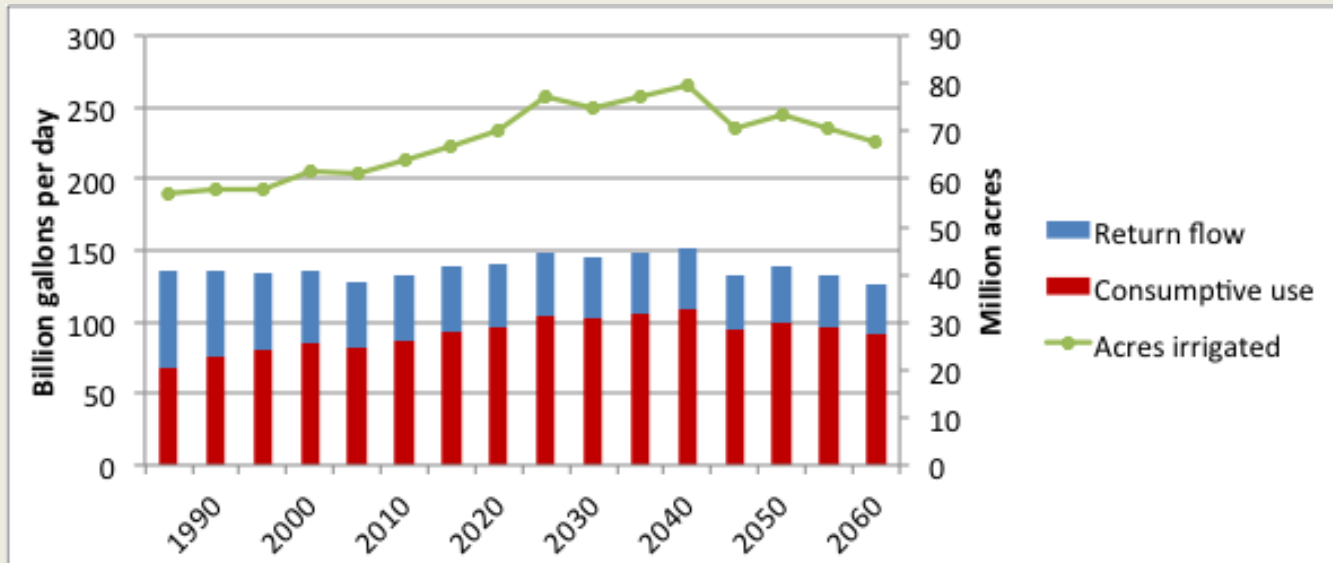


A1B-CGCM future,
ERS

Past & projected US irrigation water use: effect of ag models



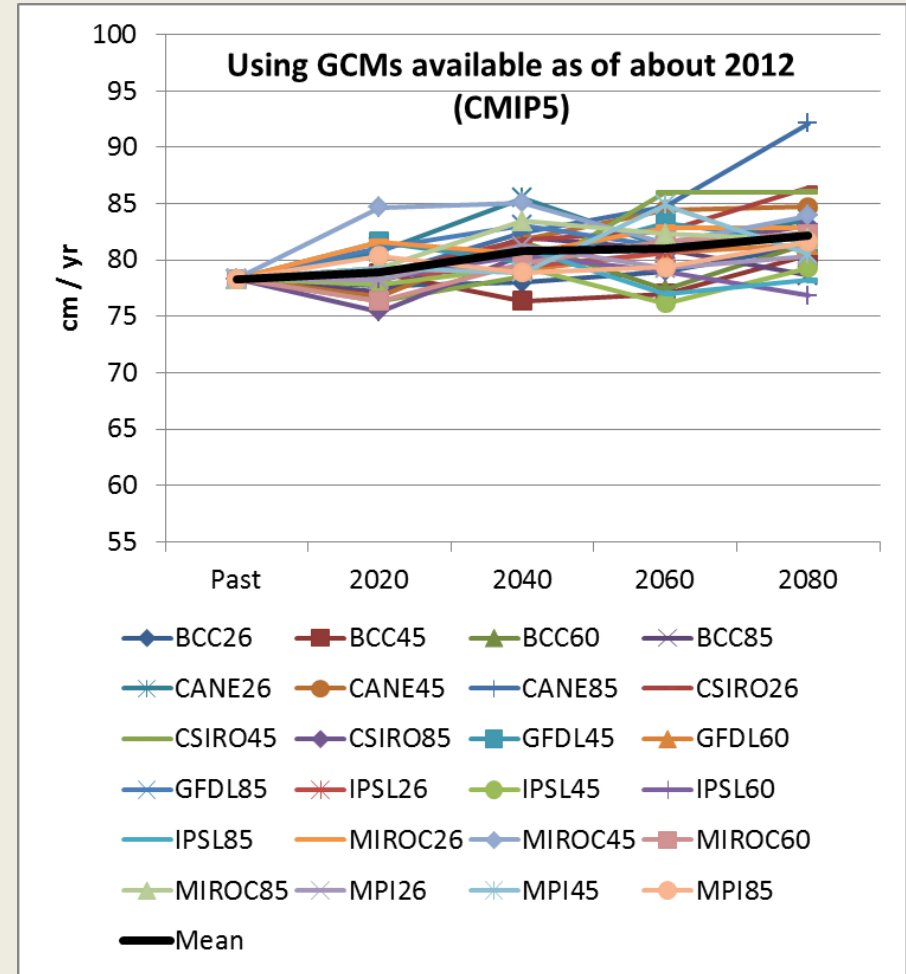
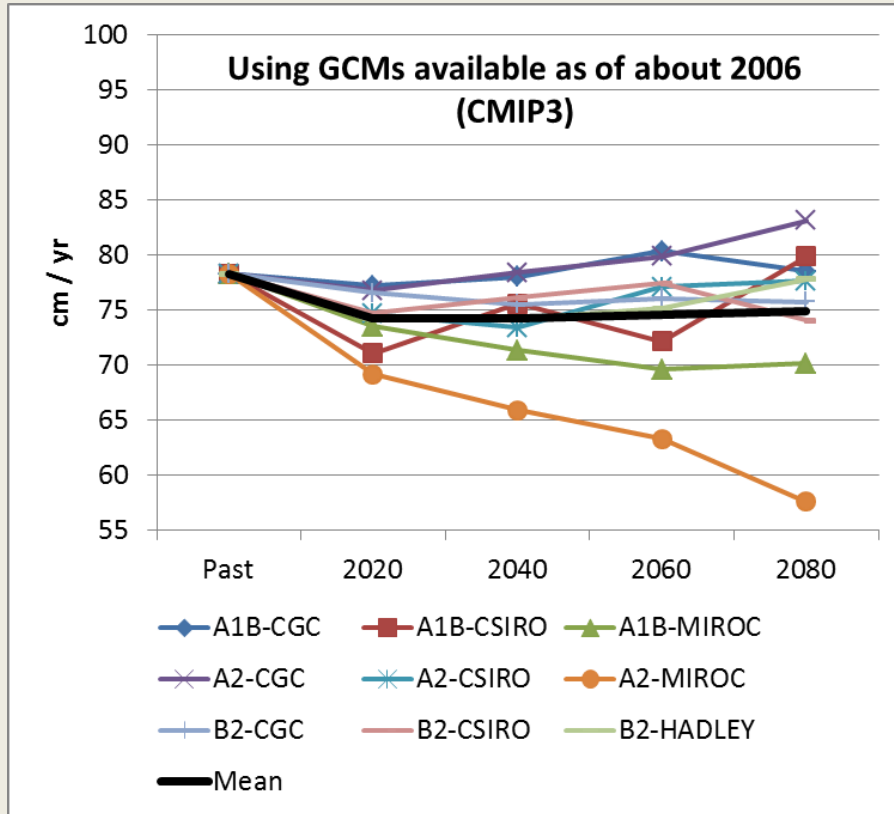
A2-CSIRO future,
RPA



A2-CSIRO future,
ERS

Projected US average annual precipitation

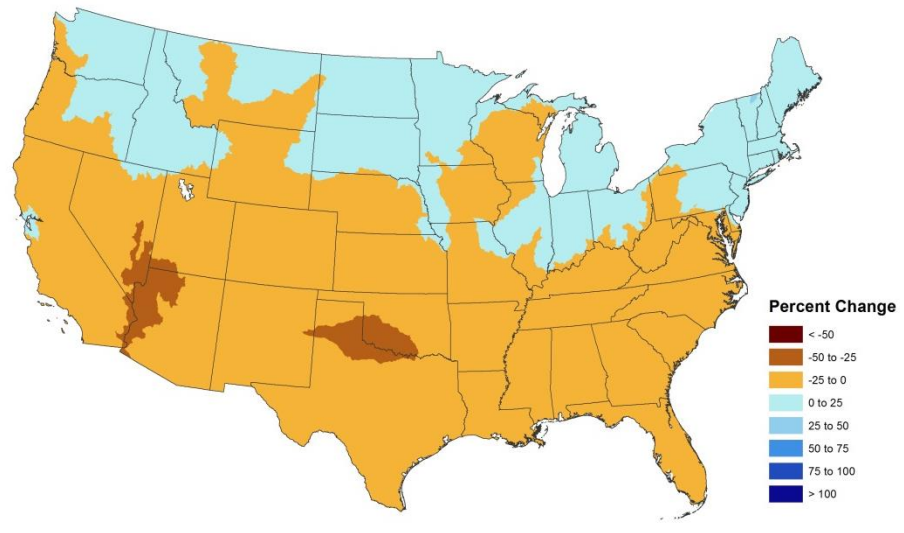
Using two generations of global climate models: CMIP3 and CMIP5



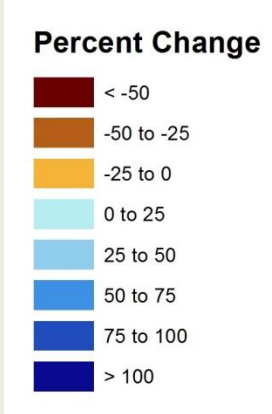
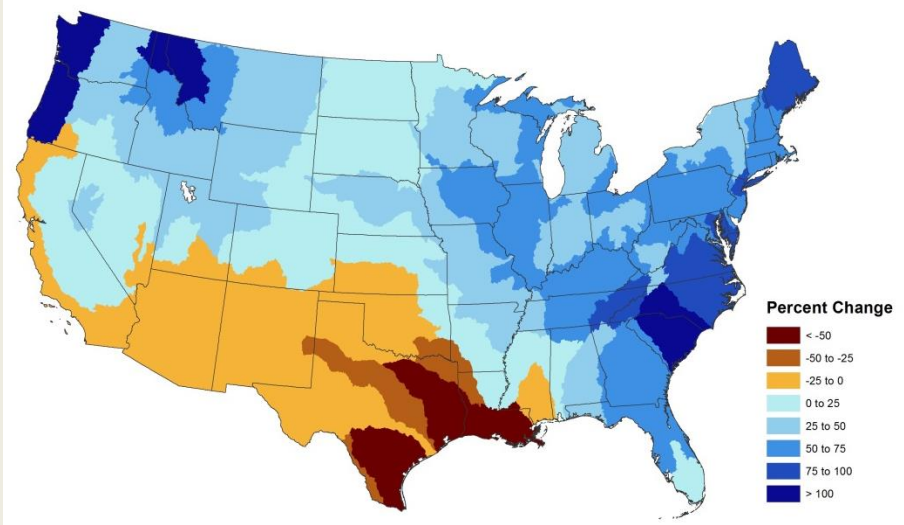
Projected change in precipitation from two sets of models

Percent change from past period to 2060

A2 scenario, CMIP3 multi-model average



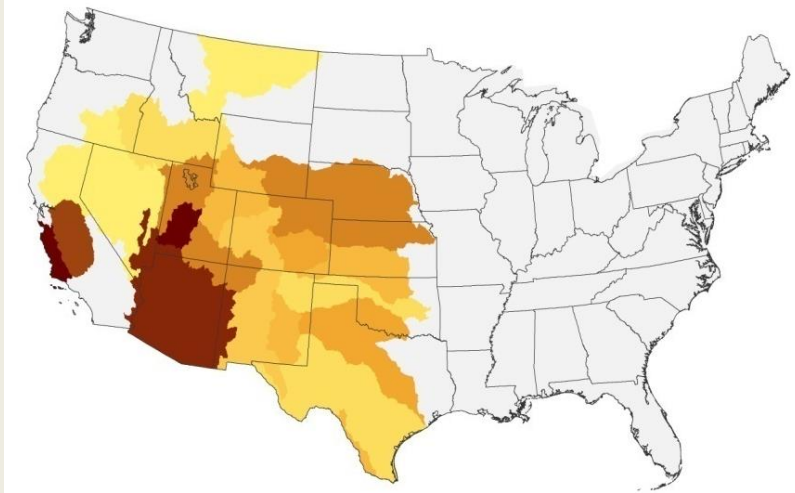
RCP 8.5 scenario, CMIP5 multi-model average



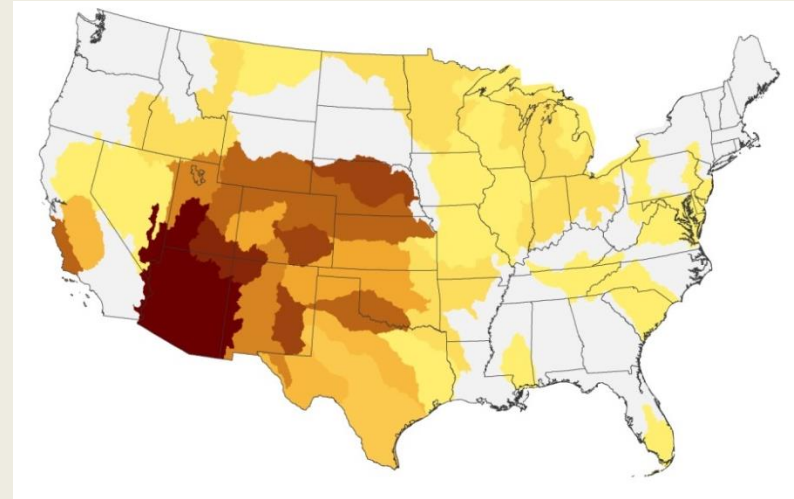
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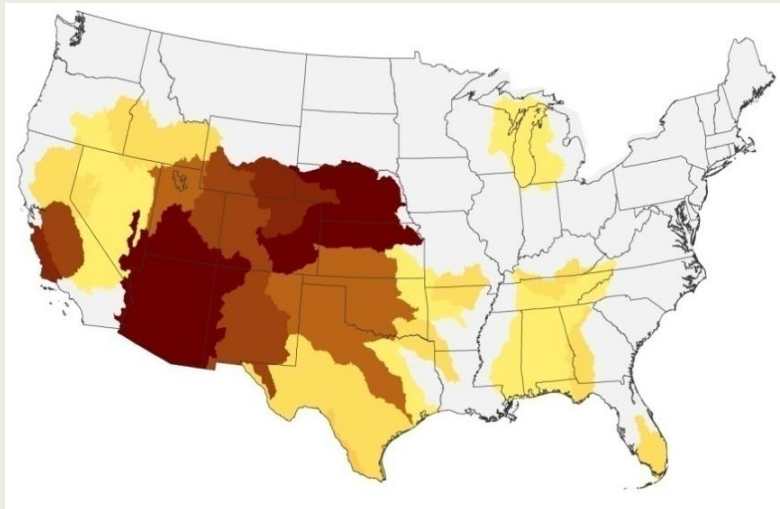
CGCM model



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Upper end
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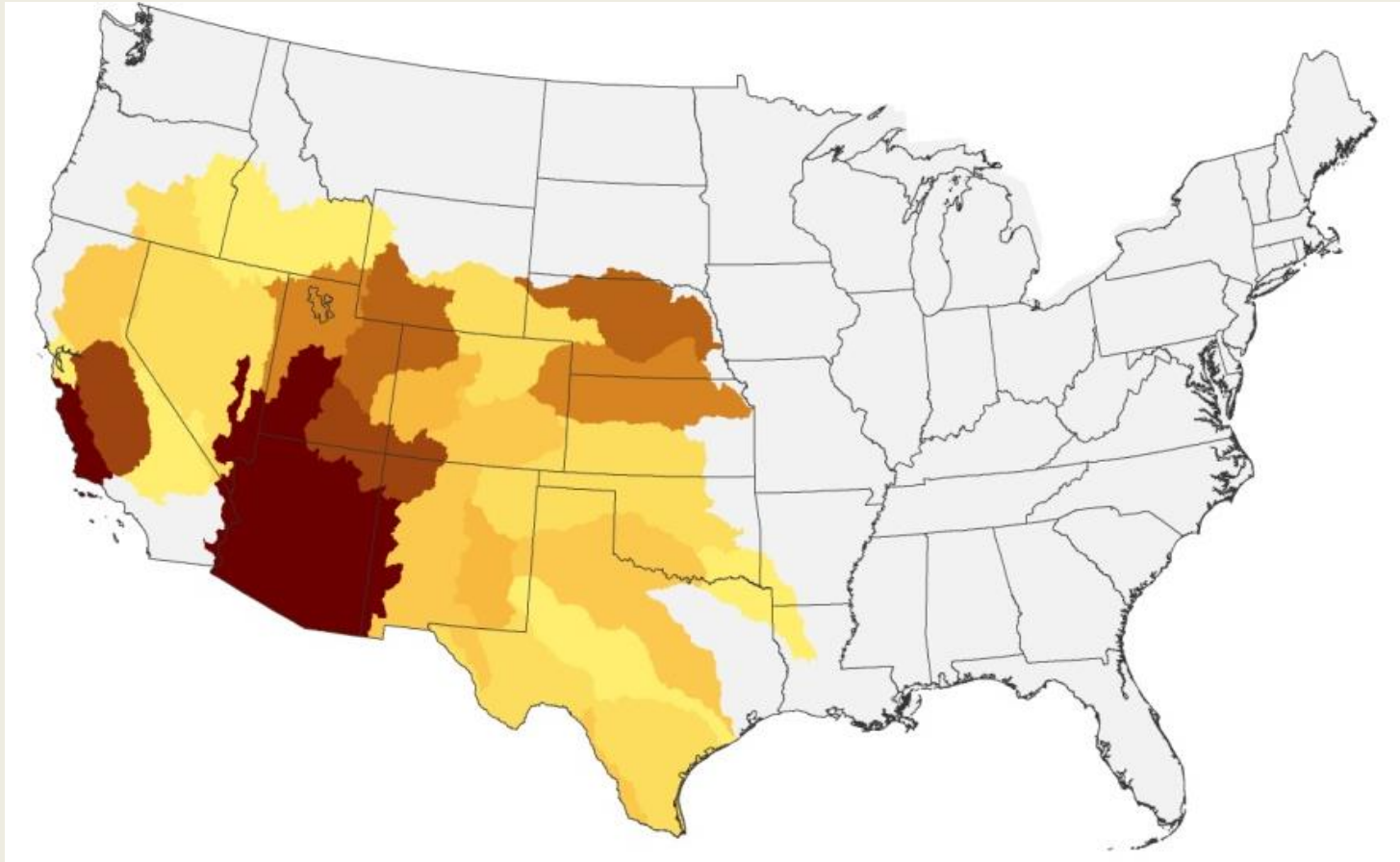


Source: 2010 RPA Water
Assessment, Forest Service

Wrap-up—key findings

- **Water consumption in non-ag sectors is likely to gradually increase in response to rising population, despite dropping withdrawal per capita.**
- **Climate change will further increase water use in non-ag sectors.**
- **Climate change could actually decrease irrigated area and water application in many areas.**
- **New climate models project generally increasing precipitation over much of the US, but serious decreases in the Southwest, southern Plains, and coastal California.**
- **Of course, rising temperatures will increase evapotranspiration, which will reduce water yield even in areas of moderate precipitation increase.**
- **Considerable uncertainty remains about the specific level of demand, supply, and vulnerability.**
- **In general, the larger Southwest, including parts of California, the Great Basin, and the central and southern Great Plains, are likely to experience increasing water supply vulnerability in the absence of new adaptation measures.**

This is not a picture of what will be.
It is a picture of the adaptation challenge we may face.



Thank you