Quantifying Mountain System Recharge Processes in Semi-Arid Catchments

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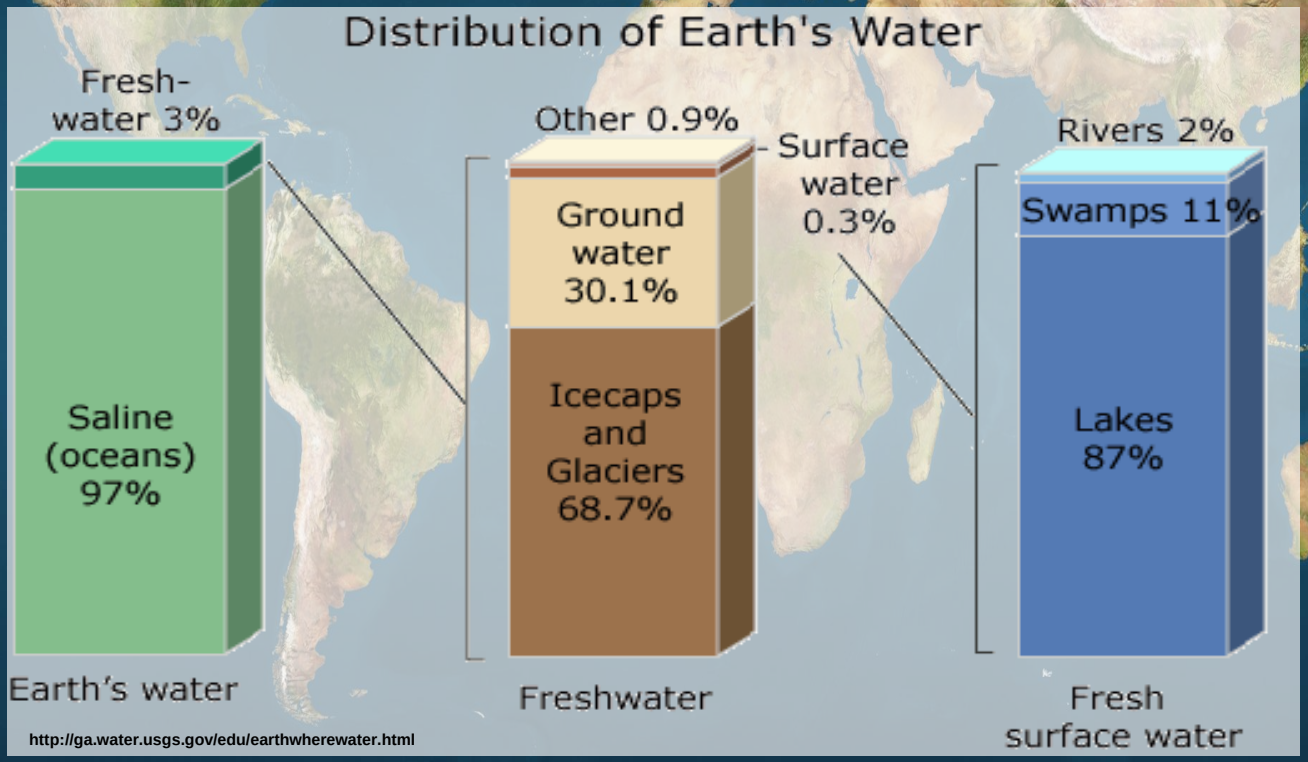
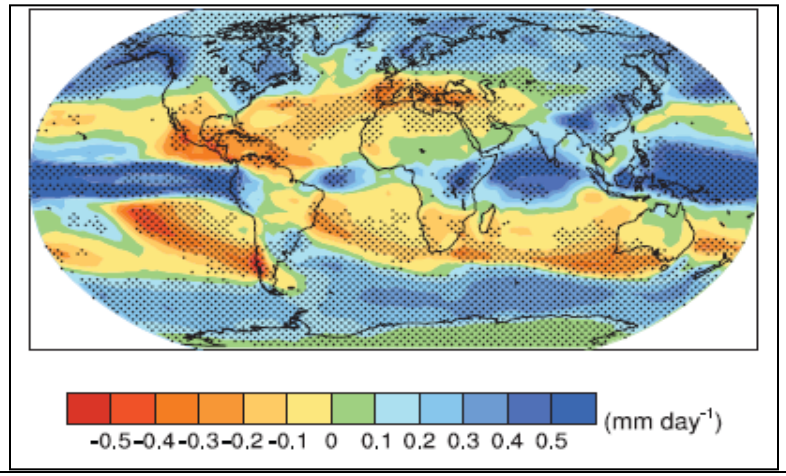
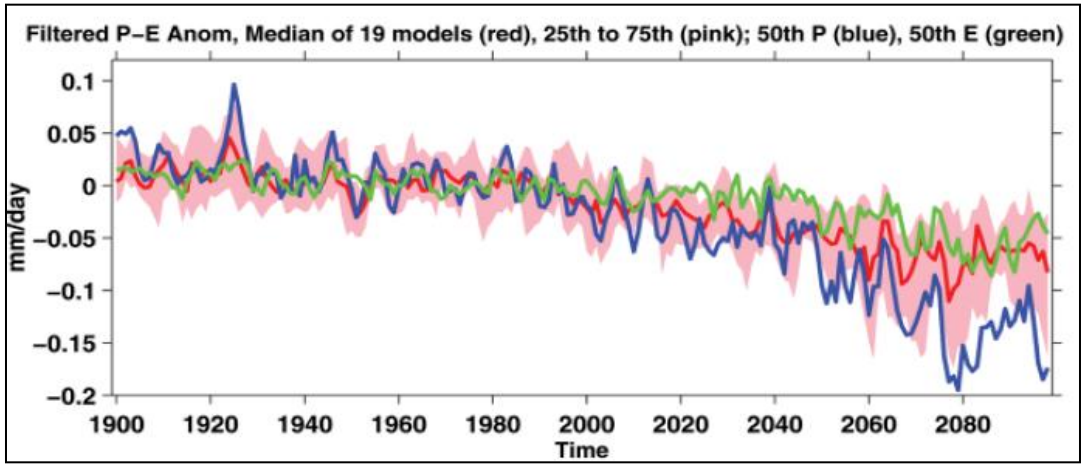
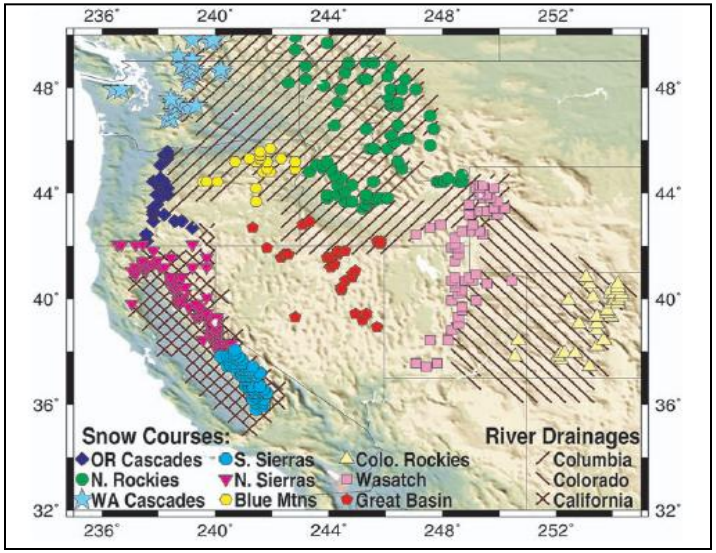

Distribution of Earth's Water
Fresh-
water 3%
Saline
(oceans)
97%
Earth's water
Other 0.9%
Ground
water
30.1%
Icecaps
and
Glaciers
68.7%
Freshwater
Surface
water
0.3%
Rivers 2%
Swamps 11%
Lakes
87%
Fresh
surface water
http://ga.water.usgs.gov/edu/earthwherewater.html

Climate Variability & Change





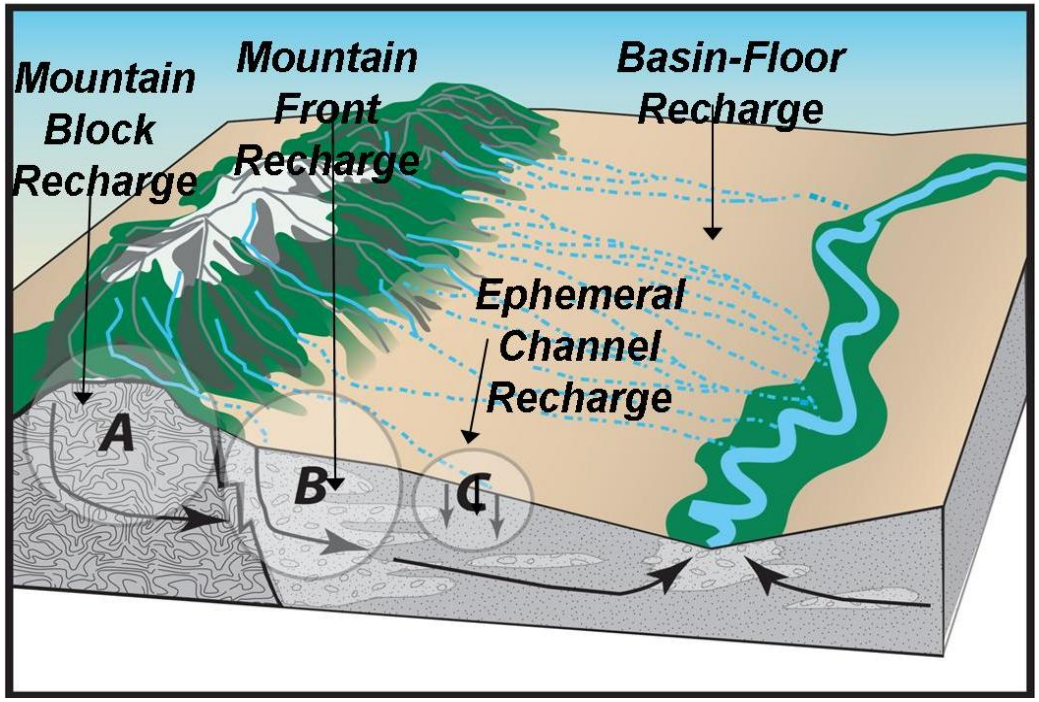
Groundwater Recharge is thus likely to be altered due to climate change and variability impacting groundwater resources.



In Mountainous Regions:

- Decrease in snow pack
- Higher January through March min daily temperature. *Science (Barnett et al., 2008)*

Recharge Pathways in Semi-Arid Basins



- **Mountain System Recharge**
- Alluvial Aquifer Recharge
- Ephemeral Channel Recharge
- Diffuse Recharge

Mountains are Source Region for 50% of Rivers on Globe

Significant Component of Recharge in Many Semi-Arid Basins

Mountain System Recharge (MSR)

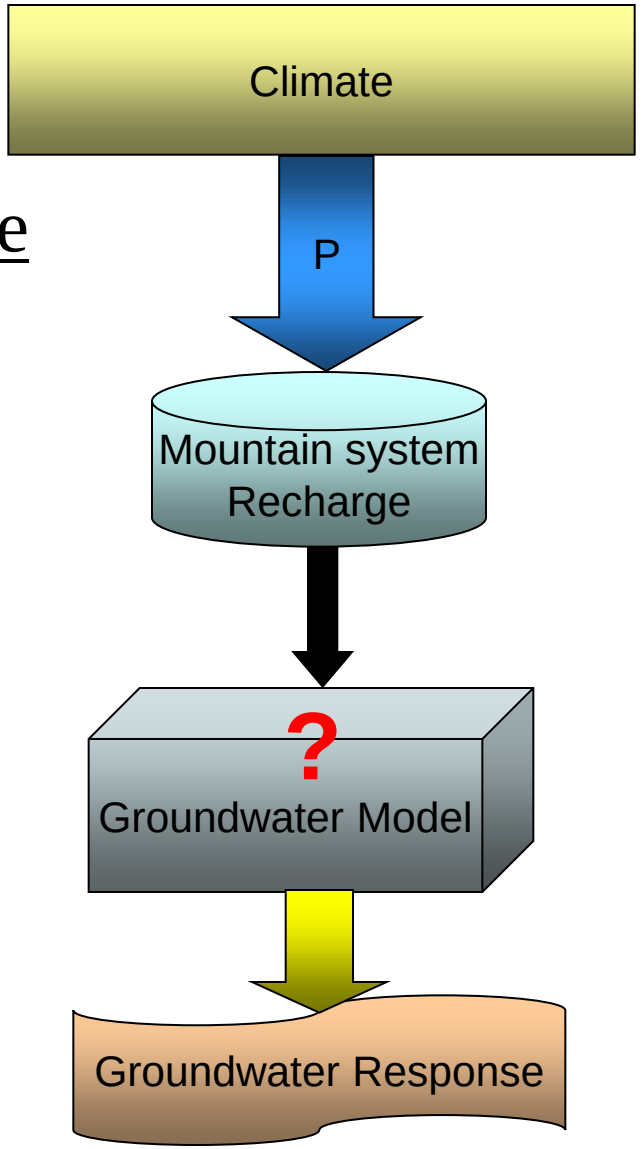
Mountain Block Recharge

Mountain Front Recharge

MSR Estimation

- Most groundwater models apply temporally and spatially static recharge rates across a groundwater basin.

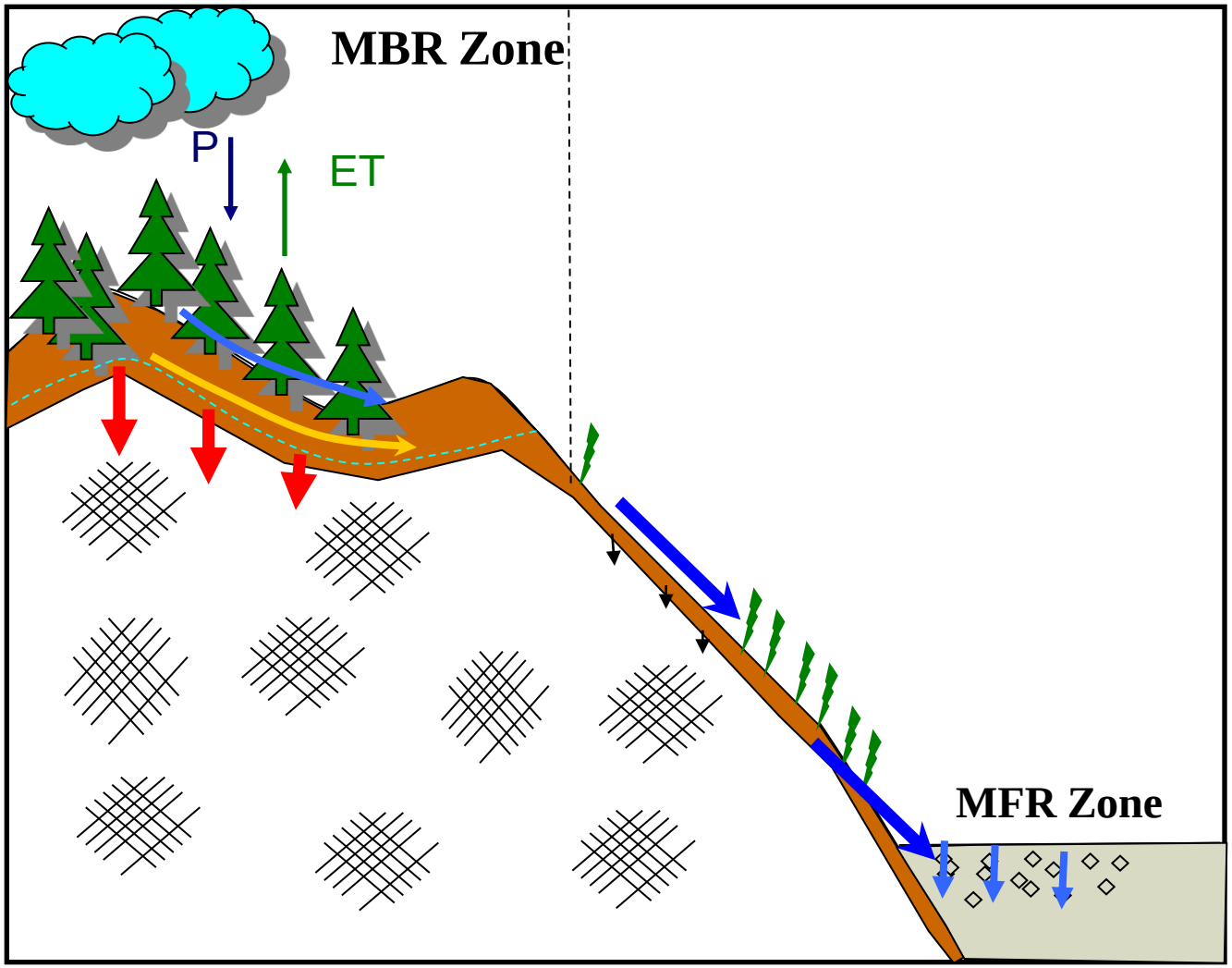
MSR Estimated → Empirical relationships Model calibration



Limitations:

- Complexity of recharge processes
- Lack of observational data

Mountain System Recharge Processes



MSR Estimation

1. Lack of observational data

How can ***annual empirical equations*** be modified to estimate seasonal MSR using basic hydrological data?

2. Meteorologic and hydrologic observations

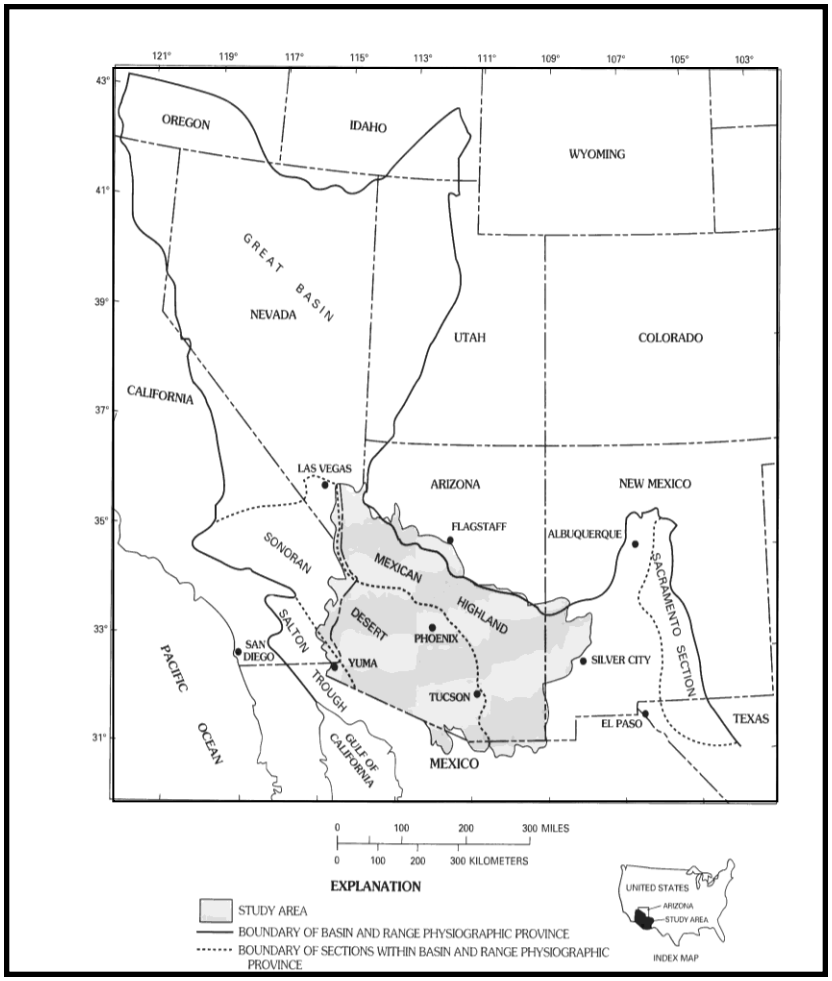
How to provide ***process-based*** understanding of **MBR** using stream flow recession analysis and isotopic data?

Empirical Equations

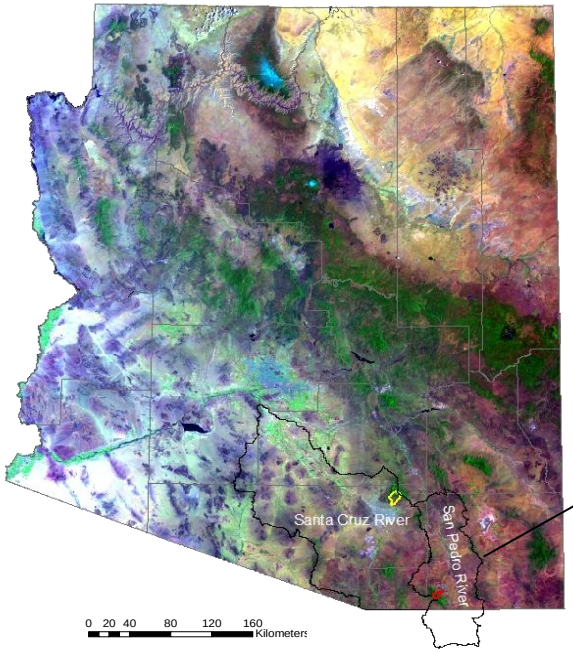
Anderson Equation (1992):

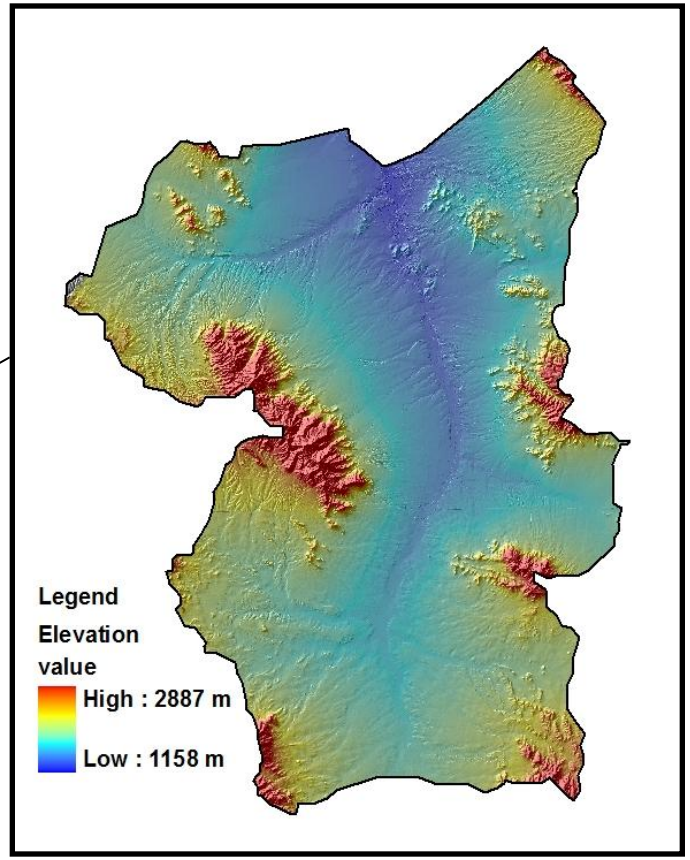
$$MSR_a = 0.042(P_a - 203)^{0.98}$$

Seasonalize MSR using existing models and data?



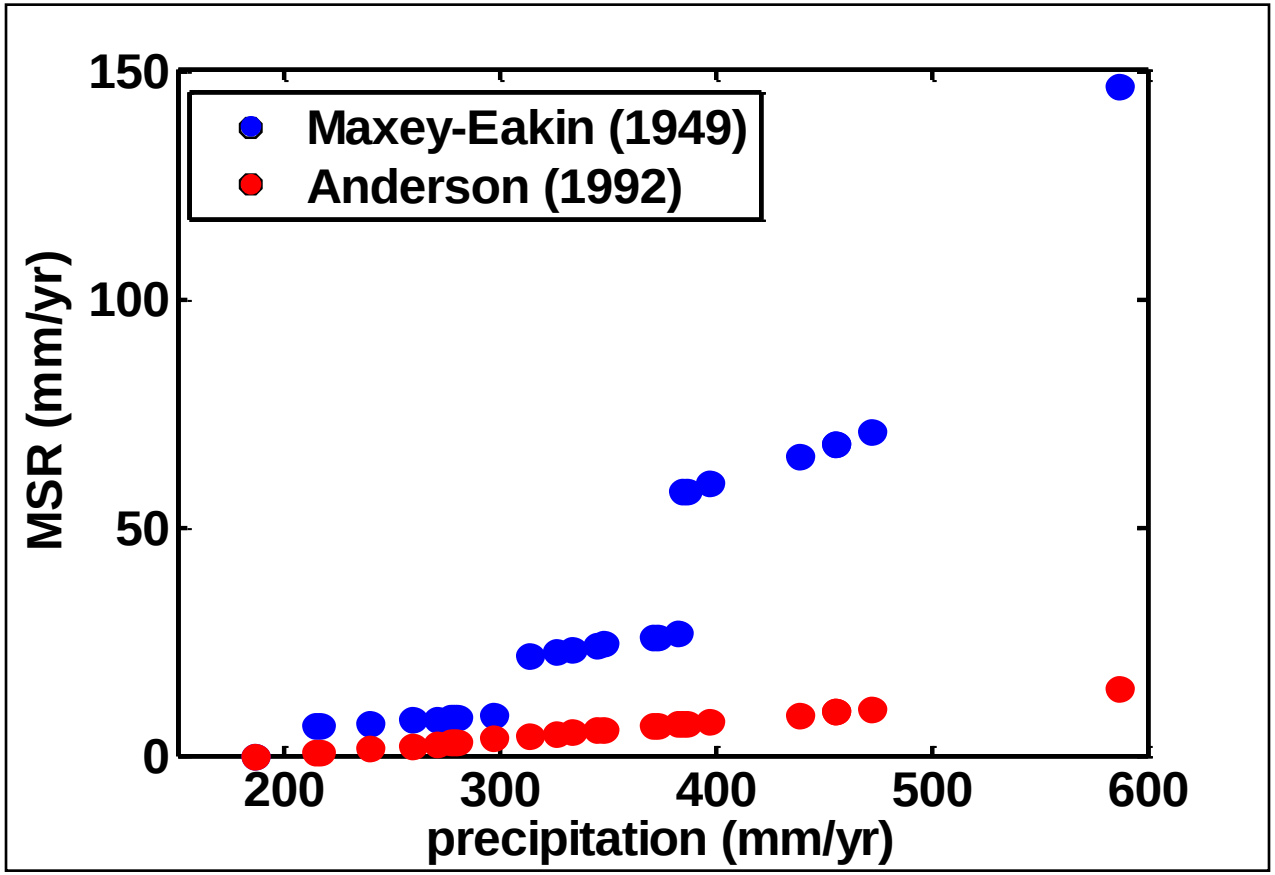
Study site: Upper San Pedro Basin, AZ





The Upper San Pedro basin is about 4500 km^2 with mean annual precipitation of 41 cm. Historically, July through September are the wettest months.

Empirical Models Shortcoming:



Although this approach provides a way to split recharge seasonally, but using ***different empirical equations provides different recharge estimates***.

MSR Estimation

1. Lack of observational data

How can ***annual empirical equations*** be modified to estimate seasonal MSR using basic hydrological data?

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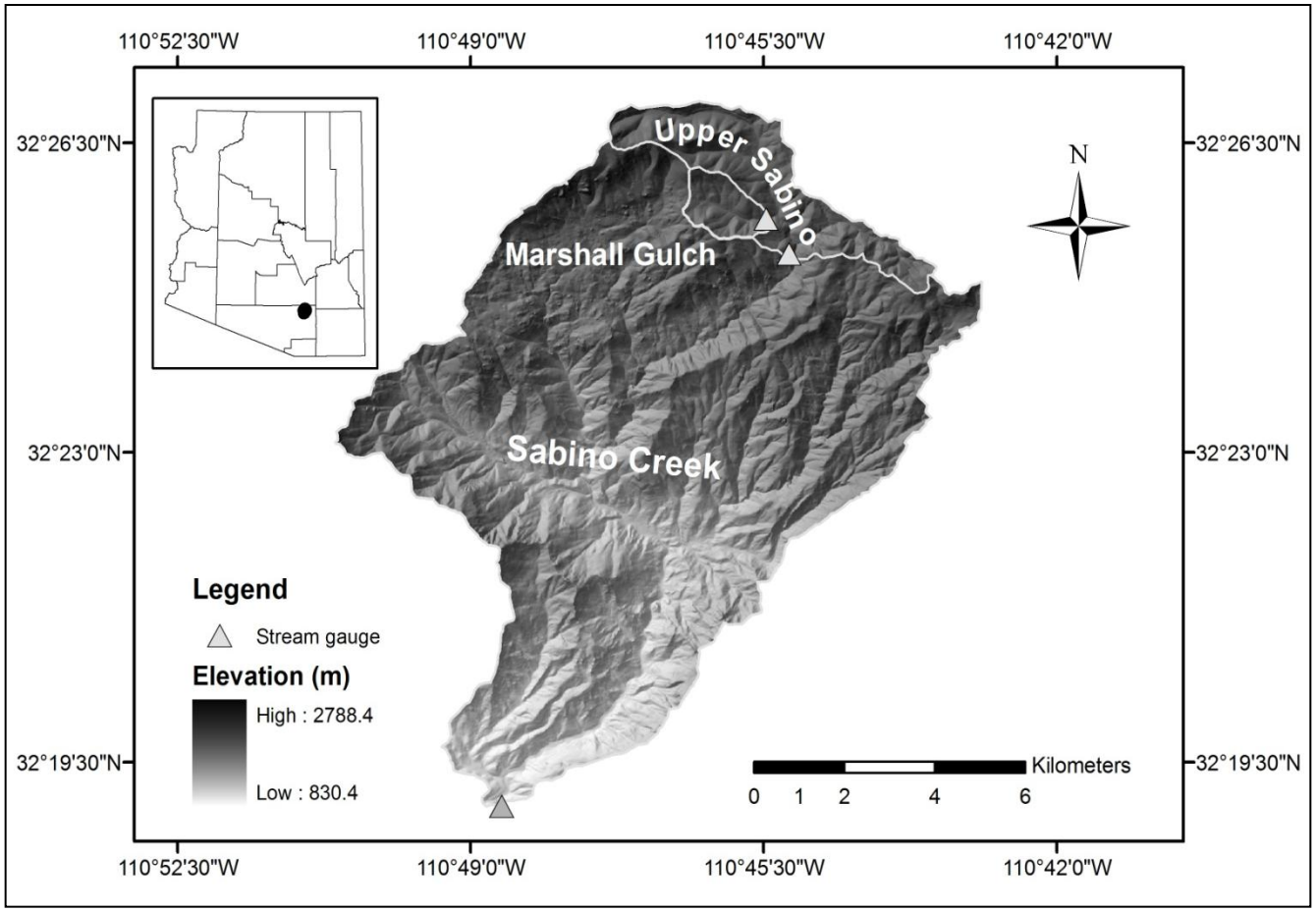
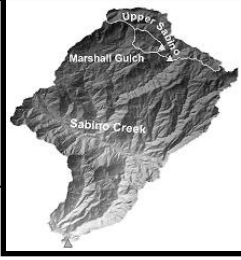
Study Site

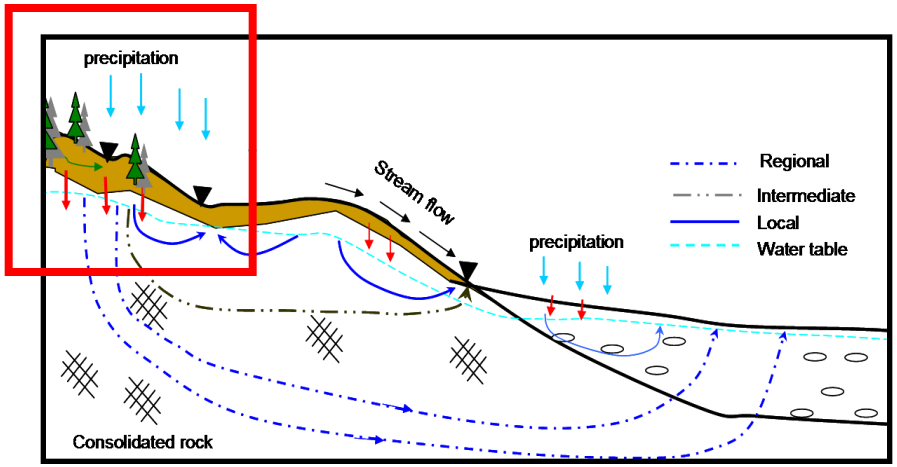


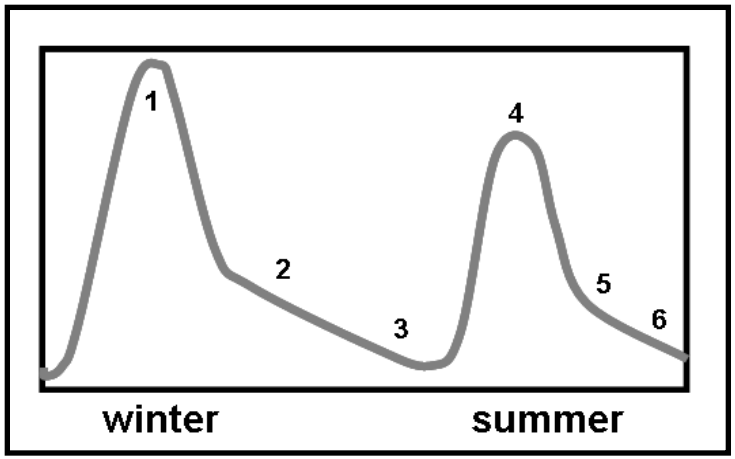
Precipitation: Winter frontal storms (November-March)

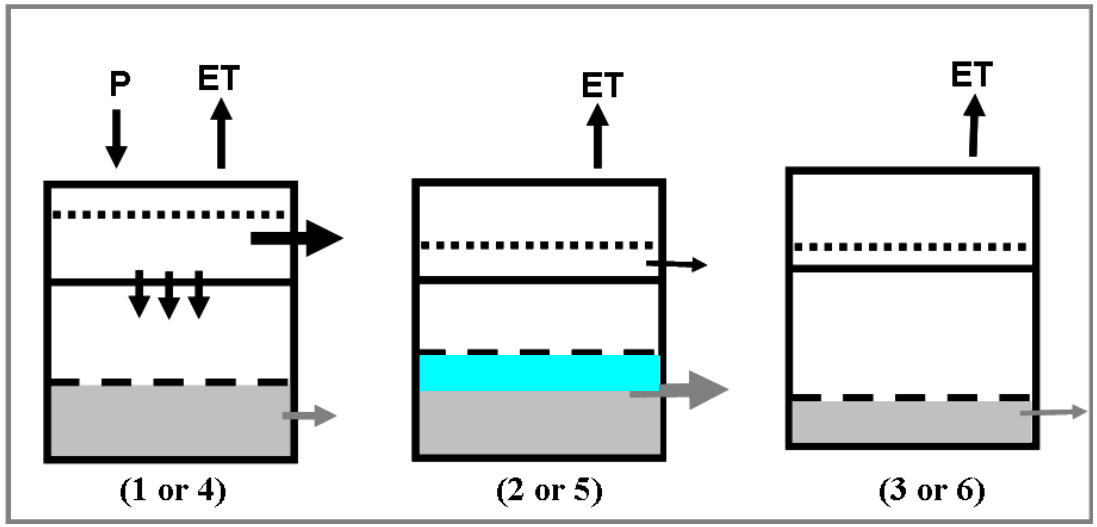
Summer monsoon (July-September)

Storage-Discharge Behavior









MBR

Ajami et al. (In Review)

Conclusion

- **Seasonal estimates of recharge** are required to evaluate the impact of climate variability on groundwater resources.

- Although large uncertainty exists for predicted recharge values, **higher temperatures in the winter season** compared to the historic period has important implications for water resource management in these semi-arid basins.

- A methodology was developed to quantify **mountain block recharge** processes by means of **storage-discharge relations**.