ALLUVIAL AQUIFERS: REVERSIBLE SURFACE WATER-GROUNDWATER INTERACTION

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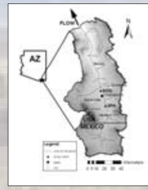
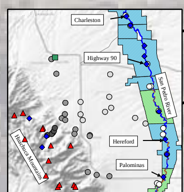
Introduction

Riparian ecosystems of the Southwest United States have received significant research attention in the last 30 years. Recent results indicate that floods play a critical role in sustaining water to this vital resource. Here we address-

1) How the role of flood waters has been quantified?
2) What is it's impact on river water quantity?
3) What is it's impact on river water quality?
4) What is the link to plants?



Water Sources and Vegetation Class



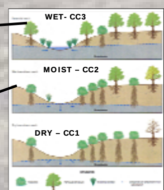


Figure 1 **Figure 2**

Our research results focus on the San Pedro river in southern Arizona. Here on the left is a map of the basin with sampling locations from a groundwater study conducted recently (Baillie et al, 2007). The Figure on the right shows the condition class framework of Lite and Stromberg (2005).

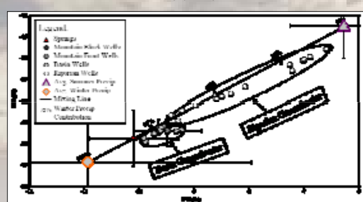


Figure 3 The water isotope results from the sample locations shown in Figure 1. Results indicate that basin groundwater is 75% winter rain and 25% summer rain. River water samples lie between this basin groundwater end-member and summer storm flow composition.

Figure 4 San Pedro at low flow near Palominas, Arizona, USA. Stream level can change radically between low flow and storm flow possibility facilitating bank storage and recharge.

Figure 5 Storm flow on the San Pedro near Palominas, Arizona, USA

Floods Importance

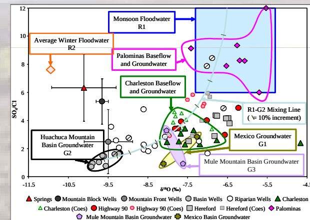


Figure 6 Investigation of potential water sources in the San Pedro river indicate that storm flows are a critical source of water especially in more ephemeral reaches.

Link to Vegetation

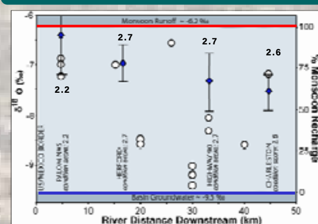


Figure 7 A comparison of water isotope data and the condition class framework of Lite and Stromberg indicates that lower condition classes also have greater water contributions from Monsoon runoff.

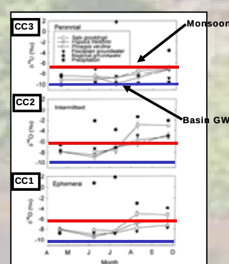


Figure 8 Seasonal investigations of plant water isotopes indicate that shift from basin groundwater to monsoon water seasonally and by condition class (Snyder and Williams, 2000)

Link to Water Quantity and Quality

A diverse number of studies have now been completed that demonstrate the links between surface and groundwater. On the water quantity side summer floods are most critical on ephemeral river reaches while perennial flow dominated reaches depend on basin GW. ON the water quality side summer floods are dominated by terrestrial nutrient sources but their influence appears to be short lived

Figure 9 To quantitatively assess the recharge mechanism the River has been modeled as a series of GW surface water mixing zones

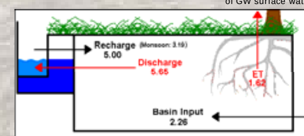


Figure 10 The model simulates a near stream zone that allows for mixing. Overall results show that on a river and time averaged basis recharge to the GW is almost equal to discharge to the river but that basin GW input is needed to support vegetation and perennial flow.

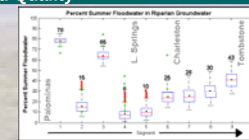


Figure 11 Model performs well in reproducing Baillie mixing model results for water origin.

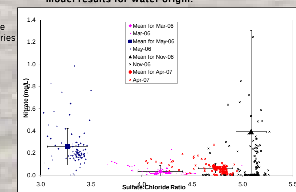


Figure 12 Decreasing sulfate/chloride ratio indicates decreased influence of monsoon flood water on water source nitrate concentrations are highest when this influence is lowest and highly variable when it is highest.

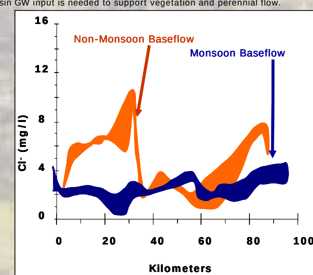


Figure 13 River chloride data indicates a disconnected evaporated river prior to monsoon and a continuous river after the start of the monsoon

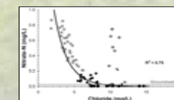


Figure 14 Black diamonds are pre-monsoon floodwaters. Light gray squares are during monsoon flows. Data indicates might higher nitrate in stream during monsoon

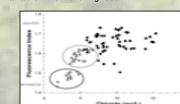


Figure 15 Fluoresence data taken simultaneously indicates that organic matter shifts form aquatic to terrestrial during monsoon. Figure 9, 10 and 11 from Brooks and Lemon 2007.

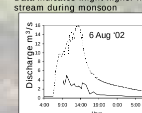


Figure 16 Storm event analysis on San Pedro indicates that out of total storm flow (dashed line) a significant fraction is "old"water.

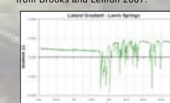
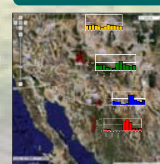
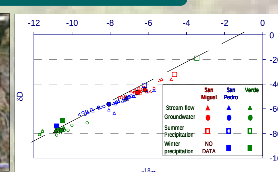


Figure 17 Hydrologic investigations of groundwater indicate little movement of water into the bank during storm events

Regional Linkage





Figures 18 and 19 We have begun to expand our range of understanding of water sources to SW rivers. By using a south to north transect of sites where winter precipitation contribution increases with latitude we are trying to investigate the seasonality of precipitation on stream water sources. Preliminary results along this transect indicate an important geologic control in systems like the Verde versus a more summer dominated groundwater source on the San Miguel in Sonora.

Questions/Directions

- Flood contributions confound Traditional assumption of basin groundwater dominance
- Monsoon flood recharge may not be "additional water"
  - "Old" water versus new water (Meixner et al. 2007)
- **Questions to be addressed**
  - What fraction of flood waters are basin groundwater?
  - How much of monsoon water presence in alluvial aquifer displaces existing groundwater versus adds new water to alluvial aquifer?
  - Are other places like San Pedro and Rio Grande (Plummer et al. 2004)?
  - How does this process operate spatial (predominantly lateral or longitudinal?)
- Semi-arid systems ideal to study alluvial aquifers- Isolation from hillslope processes

References

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