Investigation of Ground-water/Surface-water Interactions in the San Pedro River near Charleston Using Distributed Fiber-optic Temperature Methods

Bruce Gungle

In mid-October of 2006 a distributed fiber-optic temperature system was deployed in the San Pedro River of southeastern Arizona, upstream of the United States Geological Survey's Charleston streamflow gaging station. The motivation for this deployment was to observe the ground-water interaction along the streambed in this river reach and to determine if and how the interactions change in response to the fluctuations in evapotranspiration (ET) concurrent with leaf drop in the cottonwood-willow forest along the river banks. The fiber-optic cable was deployed along 610 m of river-bank distance.

Streambed temperatures during the warmest part of an afternoon were compared to streambed temperature during the coldest part of the subsequent morning during the first week of data collection (fig. 1). Locations where the change in streambed temperature from coldest to warmest part of the day is small are interpreted to be gaining (groundwater entering the system has only a slight variation in temperature throughout the day), while large temperature differences during the day are interpreted to be static or possibly losing (groundwater does not moderate streambed temperature; any surface water leaving the system transports heat into the sediments) (Constantz and Stonestrom, 2003).

On the basis of this interpretation, the study reach can be subdivided into three sections (fig. 1): the first 180 meters upstream from Charleston is a region of broad, diffuse, low-velocity ground-water discharge into the San Pedro River. The difference in the average temperature is lower than it is further upstream, but there are no large fluctuations in diel temperature, either. This reach is coincident with a conglomerate that forms the streambed channel from about 160 meters upstream to over 300 meters downstream of Charleston. The second regime covers the next 230 meters upstream, and is characterized by gaining segments from about 10 to 30 meters in length separated by segments of static (poor or no ground-water/surface-water connection) or losing reaches of similar length. This is likely an expression of the silt and clay lenses (poor hydraulic connection) that are known to run through the alluvium in this area, or of fractures in the bedrock. The final 200 meters of stream investigated appears to be a static or losing reach with two exceptions: from about river bank meter 460 to 480, and over the final 30 meters upstream. Otherwise, the amplitude of the diel temperature signal over this reach is consistent and large.

References

Constantz, J. and Stonestrom, D., 2003, Heat as a tracer of water movement near streams, *in* Stonestrom, D.A. and Constantz, J., eds., Heat as a tool for studying the movement of ground water near streams: U.S. Geological Survey Circular 1260, p. 1-6.

Figure 1: San Pedro River at and upstream of Charleston Gaging Station