Surface-Geophysical Surveys to Characterize Lithological Controls on Aquifer Recharge and Surface Water–Groundwater Exchange

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The U.S. Geological Survey (USGS) developed a groundwater-flow model of the Mississippi Embayment Regional Aquifer System (MERAS) that incorporated multiple aquifers including the Mississippi River Valley alluvial (MRVA) aquifer. In addition to groundwater withdrawal, two major fluxes in the model are recharge from precipitation and surface water-groundwater exchange. In order to determine appropriate values for recharge to the MERAS model, the USGS has utilized two published datasets- the geomorphology of Quaternary deposits and local soil surveys. At a regional scale, recharge in the MERAS model correlate well with large-scale geomorphological features. However, there is little spatial variability, so local-scale variations in recharge are not adequately represented. Higher resolution data such as soil coverages provide a more spatially-variable estimates of recharge, but, soil-survey data often characterize the shallow soil horizon and do not reflect the generalized geomorphological features in which the horizon lies. In addition, streambed sediments may differ greatly from the mapped geomorphologic areas and shallow soils due to alteration from stream mechanics. Thus, geomorphologic maps and soil information are both types of surficial information that may not accurately reflect the underlying hydrogeology that controls infiltration of recharge water or the composition of streambed sediments.

In 2016, the USGS conducted a surface-geophysical survey to characterize the near-surface (<15 m) lithology that controls recharge to the MRVA aquifer and surface water-groundwater exchange at selected locations in northwestern Mississippi. Two-dimensional vertical profiles of resistivity identified differences in geoelectrical properties of the streambed for reaches of the Tallahatchie (60 km), Quiver (50 km), and Sunflower (70 km) Rivers. Resistivity profiles of each stream were able to detect boundaries of individual geomorphic features. In addition, terrestrial-based resistivity surveys identified variations in geoelectrical properties from Money to Steiner, Mississippi, a distance of approximately 68 km. The terrestrial-resistivity survey showed distinct differences in surface soil resistivity based on lithology. Drilling logs of wells along the Sunflower River confirmed that lithologic descriptions correlated positively with the resistivity profiles.