CONDUIT FLOW MODELING OF KARST SYSTEMS IN GUILIN, CHINA

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Two typical karst flow systems, Yaji experimental watershed and Zhaidi observation watershed in Guilin, China have been established to study their flow, chemical, and biological characteristics. Yaji watershed is a closed conduit drainage system without any surface stream. Its recharge zone is composed of several isolated karst depressions. Runoff in the depression area drains to the sinkholes or vertical shafts that are connected to the conduits in the karst aquifer. Conduit flow combined with groundwater matrix flow discharges through spring(s). Because of the conduits, the response time to heavy rainstorms is about 3-4 hours. Zhaidi watershed is hydraulically even more complicated due to its dual drains, i.e. surface streams and underground rivers. Surface and subsurface flow interaction are very active during major rainstorm events. In the upper stream of the watershed, underground rivers discharge as springs to the surface streams, but when it gets close to the watershed outlet, surface stream drains to a 30-ft deep vertical shaft which connects the underground river. Open channel flow become free fall flow at the shaft and then pressurized flow in the underground river before it is discharged as a spring for the watershed.

In this research, a subsurface drain component has been developed into the USEPA SWMM to simulate flow exchanges between conduits and the karst aquifers. Test results from both watersheds show that the baseflow simulation can be well simulated with the drain option. This paper will also discuss the development of a modeling system that couples SWMM with the USGS conduit flow process model (MODFLOW-CFP). The coupled model compensates SWMM for subsurface flow modeling and MODFLOW-CFP for surface flow modeling and is more capable of simulating the dynamics of flow interactions in both systems. Two additional conduit flow modules have been developed to overcome the limitations of conduit flow modules in the original MODFLOW-CFP. The coupled model is very well suitable for the highly karstic conduit flow systems.