Asymmetric quantification of stream-groundwater interaction based on Stream Aquifer Flow Exchange (SAFE) method

The interaction between stream and groundwater is an important component of the hydrologic cycle. The quantification of the flow exchange between streams and aquifers is critical for the conjunctive use of surface water and groundwater. Commonly, the quantification is achieved with the use of integrated surface-groundwater simulation models such as Modflow, IWFM etc. In these models the seepage (stream water loss to groundwater) is estimated as a function of the head difference between the stream and groundwater head and the “leakage coefficient” which is an empirical parameter estimated via calibration.

In this study we use the Stream Aquifer Flow Exchange (SAFE) method which replaces the calibrated “leakage coefficient” with a dimensionless conductance. So far, the SAFE method has been developed for structured-grid based numerical simulation codes i.e. finite difference models. In our work we demonstrate the applicability of the SAFE method for both structured and unstructured grids.

Traditional approaches cannot make a distinction between seepage occurring on the left and right side of the stream due to different pumping/recharge occurring on either side. Here, the SAFE method was modified to quantify independently the seepage occurring on the left and right side of the stream.

In this study, first we demonstrate the SAFE methodology on a hypothetical example and provide a sensitivity analysis of the method. Next the method is applied to a real-world example to quantify the seepage on the Central Valley basin, California which consists of a large, interconnected network of rivers, canals, sloughs etc.