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Evaluate recession characteristics from baseflow and separate baseflow via the knowledge guided machine learning

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Baseflow, referred to as the groundwater discharge, is essential to investigate the groundwater system. A common and classic approach to study baseflow is recession analysis method, but current methods confuse the concept of streamflow recessions and baseflow recessions. This confusion leads to a mixing effect of the fluxes from different storage components and theoretically inconsistent recession analysis results accordingly. Therefore, it motivates an improvement and enhanced scientific understanding of the empirically derived baseflow recession characteristics. In addition, quantifying baseflow from streamflow is defined as the baseflow separation problem. The state-of-the-art baseflow separation tools are in lack of physical rules and have either structural limitations or are inapplicable in regions with insufficient data, which confines the generalization performance. To overcome these issues, we applied a knowledge guided machine learning (KGML) approach to separate baseflow, which embeds physically derived baseflow recession characteristics in the traditional machine learning framework.

Recession parameter, which is derived from empirical recession analysis, has been observed to exceed its theoretical range on a recession event scale. Besides many potential environmental factors, we hypothesize that this well recognized inconsistency is because the quick flow from surficial water bodies has not been successfully excluded based on the recession selection criterion. We conduct recession analysis using both streamflow and baseflow over 1,000 gages across the continental United States. The baseflow was estimated from Eckhardt two-parameter digital filter and was calibrated against the in-stream field data. It was found that for gages whose calibration performance is satisfactory, the baseflow derived recession parameter agrees more consistently with the recession characteristics, which are indicated by the Boussinesq solutions.

Traditional baseflow separation tools partition streamflow into quick flow and base flow. Those tools have data scarcity issues and structural limitations without involving physical perspectives. To introduce physical rules into baseflow separation and overcome data scarcity issues, we apply a recession-based loss function to train the machine learning model such that the recession characteristics of separated baseflow agree with their theoretical behaviors. Guided by the recession knowledge of baseflow on a catchment scale, progress is being made to finalize this KGML implementation and to improve the baseflow separation approach.