Global Analysis of the Relationship between Vegetation and Transit Time of Water in the Subsurface using Literature Data on Stable Water isotopes

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Abstract

Climate conditions and the vegetation of a catchment have closer relation and the same time climatic conditions also affect the catchment storage and release of water to the catchment (transit times). Based on that, the study hypothesized that there is a link between vegetation and transit times. Therefore, to find the relationship between root zone storage capacity and the transit time of water, the current study investigated 67 catchment data from different countries with areas ranging from 0.39-8264 km^2. Root zone storage capacity was estimated using long-term water balance while the transit time was calculated from young water fraction (F_{yw}) as transit time matric. Root zone storage capacity for 20 years drought return (S_{R20yr}) and young water fraction linked to the hydro-climatic characteristic, vegetation type, and the dominant soil type of the catchment. Based on the hypothesis of the study, a direct relationship between transit time and vegetation was expected. However, the relationship between F_{yw} and S_{R20yr} is less clear in catchments across the USA while the European catchments show a slight link between F_{yw} and S_{R20yr}. The catchments across the USA have higher S_{R20yr} values with a range from 39 mm to 642 mm and show a broad range of F_{yw} (0.02-0.65). Dominate type of soil in the catchment plays an important role in both S_{R20yr} and F_{yw} values which might explain the broader range of F_{yw} in the USA catchments. In all the Europeans' catchments, S_{R20yr} is less than 200 mm while catchments with crops as the dominant land use have S_{R20yr} value below 100mm.

As a next step, this study suggests that a detailed investigation of each catchment controls like hydro-climatic properties and other factors is needed to better understand the relationship between transit time and vegetation. Implications of volume-weighting and flow weighting of isotope data in precipitation and stream flow to the future analysis and including catchments from other continents and climate regions are also recommended to better understand the relationship between transit time and vegetation on the global scale.

Study of relationship between transit time of water and the vegetation is an essential factor in understanding and prediction of how transit time of water changes with the changing land cover due to the natural and anthropogenic processes such as wildfires, clearance of forest. Therefore with a better understanding, the relationship between vegetation and the transit time of water might help to understand and prevent major environmental problems (e.g. desertification) and climate changes.