Learning about future applications of tritium-tracer in Japanese river waters from the Hokkaido headwater catchments

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Tritium-tracer in river water can provide useful information about surface water –groundwater dynamics in Japan as demonstrated at 12 headwater catchments of Hokkaido Island with altitudes between 22 and 831 m above sea level and catchment areas between 14 and 377 km^2. For these catchments, we collected 16 water samples at baseflows in June, July, and October 2014 and one river water sample on February 2016 near the south of Sapporo. These water samples were analysed for tritium as well as stable isotopes at the GNS Science low-level tritium laboratory in New Zealand. Measured tritium concentrations were between 4.07 (±0.07) TU and 5.29 (±0.09) TU in June, 5.06 (±0.09) TU in July, and between 3.75 (± 0.07) TU and 4.85 (±0.07) TU in October. In the south of Sapporo, the neighboring river catchments clustered in similar hydrogeological settings of Quaternary lava as well as Tertiary propylite formations had similar tritium values suggesting that they drain the same groundwater watershed system: 4.114 (± 0.062) TU (Takinosawa) and 4.184 (±0.063) TU (Otarunai), and 3.825 (±0.07) TU (Izariirisawa), 3.926 (± 0.061) TU (Honryujyoryu). On February 2016, the Otarunai river water sample collected at winter baseflow had 3.838 (±0.061) TU indicating similar tritium concentrations at subsurface water of the Izariirisawa and Honryujyoryu catchments. For these headwater catchments, we found unique mean transit times (MTTs) using the exponential(70%)-piston flow(30%) model (E70%PM) LPM and very low MTT aggregation errors with the long-term tritium record of Tokyo precipitation scaled for Hokkaido groundwater recharge using wine data. This result suggests that their low tritium concentrations are not ambiguous anymore for the MTT interpretation. However, nine river samples from six other catchments produced up to three possible MTT values with E70%PM due to the interference by the tritium from the atmospheric hydrogen bomb testing 5–6 decades ago. We show that tritium in Japanese groundwater will reach natural levels in a decade, when one tritium measurement will be sufficient to estimate a robust MTT, while using a series of tritium measurements over the next few years with 3 year intervals will enable us to determine the correct MTT without ambiguity in this period. Unique MTTs obtained from tritium-tracer allow us to improve numerical models and to estimate groundwater storage volumes for sustainable water resources management.

References:

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