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Resilience of Forest Evapotranspiration and its Response to Climate Change Estimated From a Long-Term Catchment Observation in Japan.

Although the resilience of terrestrial ecosystem supports the environment necessary for the human life, we are now facing a serious risk of crossing the threshold into ecosystem declination in response to the climate change. Evapotranspiration (ET) decreasing due to limited moisture supply has been already detected particularly in the Southern Hemisphere (Jung et al., 2009). It is important to examine such influences of climate on ET from a resilience and threshold perspective in a small catchment where a long-term hydrological observation with high accuracy has been conducted by forest hydrology.

A 69-year record (1937-2005) of the precipitation and runoff in a small catchment Japan was analyzed to evaluate effects both of the vegetation and climate changes on ET. Careful considerations were needed for the evaluation because the annual loss, the difference between precipitation and runoff, was not the same as the annual ET due to considerable influences by change in the catchment storage. The annual ET averaged for several years was estimated as the loss in the period when the baseflow runoff rates at the beginning and the end were almost identical. To detect a long-term trend of ET, we applied cumulative anomalies curve (Lozowski et al., 1989) calculated by $f_i = \sum_{k=1}^{i} \left(x_k - \bar{x} \right)$, which showed an increase/decrease trend by the upward/downward of its gradient. The results were summarized as follows.

Although natural pine forest covered the catchment, ET decreased after a pine forest death by insect damage around 1943. After 1959, when a broad-leaved forest grew, ET has a clear positive relationship to the annual air temperature. The ratio between them became large for the recent years with high temperature after 1991 compared to the previous period. The increase or decrease of the annual loss in each year was highly correlated with the difference of the baseflow runoff rates between the beginning and the end when the catchment was covered with forest, but no correlation was found for periods of 1944-58 with a poor vegetation. This result suggests that ET from a forest was maintained constant by reducing the soil water even in dry years but that this character disappeared in case of a forest absence. We can conclude that ET from forest was still resiliently responded to the climate warming with soil water decrease, but we will have to watch a near-future trend of ET there.