A COMMON CHARACTER OF FOREST EVAPOTRANSPIRATION IN RESPONSE TO CLIMATE CHANGE

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Although terrestrial ecosystems support a sound environment necessary for our 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. It is important to examine such influences of climate on ET from a resilience and threshold perspective. Among the terrestrial ecosystems, forest has a striking character on ET derived from a long life of tree individuals. This paper first describes the character, a strong resistance against dryness with a dependency on climate change, obtained from an analysis of annual water budget in a temperate small catchment in Japan where a long-term hydrological observation with high accuracy is conducted by Forestry and Forest Products Research Institute. Secondly, we have a discussion that such a character on ET is commonly detected under both tropical and boreal forests.

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. Although natural pine forest covered the catchment, ET decreased after a pine death by insect damage around 1943. After 1959, when a broad-leaved forest grew up, 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. Increase or decrease of the annual loss in each year was highly correlated with a difference in the catchment water storage between the beginning and end of year when the catchment was covered with forest, but no correlation was found for periods of 1944-58 with a poor vegetation after the pine death. This result shows 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.

The remarkable character of forest ET was also found in a strong ET resistance during dry seasons under tropical climates. Flux studies conducted in tropical rain forests in Amazonia and in Malaysia and in seasonal forests in Thailand and Cambodia commonly revealed this character. This sustainability of ET was supported by a deep root system and clayey soil with a low hydraulic conductivity, as revealed in hill evergreen forest in Thailand. Additionally, ET from boreal forests with permafrost was maintained even in an unusual dry summer using water supplied in the previous wetter summer through the freezing/melting process during winter, as demonstrated in Siberia and Alaska. These evidences clearly demonstrate a homeostatic mechanism of forest against a dry spell. We may have to recognize that forest can cover the land

surface only when it can access water by a sophisticated mechanism even in dry spells which often appear during a long year of tree life.

Finally, we should emphasize a different impact of forest ET on the water resources conservation in each geographical region. Because forest ET is not only large but also resistant against dryness, this effect may contribute to a sustainability of humid climate in an inland region of a continent through a constant water supply necessary for a valuable source of precipitation. In an island or a peninsular, however, such a character of forest ET may only result in a decrease of river water because precipitation is brought from the ocean ET. Forest clearing in a small area of a catchment is rather efficient for using water particularly in a dry spell. The normal forest operation to get the same timber harvest every year should be reminded in geographical regions surrounded by ocean like Japan. If such a common character of forest ET is not carefully considered in both forest and watershed managements, positive interactions between poor forest managements and highly-fluctuating water cycle will lead us into an environmental devastation.