Evaluation of the long-term impact of forest growth and change on water and sediment yield in forested watershed of Kikuchi river using SWAT model

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The Kikuchi River is the third largest river (996 km^2) flowing into the Ariake Sea lying on the island of Kyū shū in Japan, following the Chikugo River and Midori River.

Eutrophication has become a problem in the Ariake Sea in recent years, and the influence of inflowing rivers has been attracting attention. As more than half of the Kikuchi River basin is forested, and it is assumed that forests have a significant impacts on water balance of the basin, it would be meaningful to elucidate the water cycle process of the Kikuchi River basin.

In recent years, the role of forests as green infrastructures has been particularly attracting attention. Those include such functions as water recharge, runoff and erosion control, and water quality improvement, and it is expected that taking advantages of those functions will lead to improvements in the marine environment in the Ariake Sea.

Although many studies examine the impact of land use on hydrological responses in a watershed using a distributed hydrological model, few analyzes have focused on the long term impacts of land cover/land use change, especially of forest growth within the same site, on the hydrological responses.

The purpose of this study is to quantitatively evaluate the long-term impacts of forest growth and change on forest functions such as water recharge and control of sediment yield in Kikuchi River basin using the Soil and Water Assessment Tool (SWAT), a physically based semi-distributed hydrologic model.

Land use and climate data were prepared for two time points, 2010s and 1970s, to see the impact of forest growth over the last 40 years. Forests, one of the land-use types, were subdivided into four types according to tree type (coniferous and hardwood) and growth stage (early, young, and mature). The same data was used for soil and topography between the two time points, assuming that there was no change for those data.

For the model calibration and validation, we also collect data for daily streamflow from 2005 to 2016 for the 2010s model and from 1976 to 1977 for the 1970s model. Data for sediment yield is available only for 2010s. Calibration and validation for daily streamflow and sediment yield is conducted basically for 2010s model using SWAT-CUP until satisfactory results are obtained. Model performance is evaluated using statistical indicators such as Nash-Sutcliffe model efficiency (NSE), percentage bias (PBIAS), root mean square error and measured standard deviation (RSR).

Once the optimal parameters are adjusted, those parameters are applied to 1970s model to see whether

key hydrological parameters and/or processes exist or not by verifying the difference in parameter behavior between two models, which can provide useful information for developing strategies for sustainable forest and water management, not only for the Kikuchi river basin but also for similar mountainous forest watersheds.

Keywords: SWAT model, Hydrologic and Sediment Transport Modeling, Forest watersheds, Ariake Sea, Long-term valiavility