Impact of land-use change on terrestrial water balance in the Chao Phraya River Basin

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Deforestation in the mountainous upper-reaches of the Chao Phraya river has been worried to enhance floods in the lower reaches. To cope with this issue, afforestation is expected to reduce the risks of floods by increasing water holding capacity and slowing the response of discharge. On the other hand, afforestation has impacts not only on the terrestrial water balance and the water resources/uses, but also on the social and economical issues, e.g., reduction in income due to decreases in croplands. Thus, the impacts of deforestation/afforestation should be carefully assessed. The water resource assessment has been conducted by a global hydrological model (H08; Hanasaki et al., 2008ab) in this region, but effects of land-use change have not explicitly examined since a bucket-type model without an explicit consideration for vegetation type is used for the land surface scheme of H08. Then, another land surface model, MATSIRO (Takata et al, 2003; Nitta et al., 2014) that includes processes of vegetation canopy is used to examine the impacts of vegetation change on the terrestrial water balance in the Chao Phraya river basin. In the numerical experiments, near surface meteorological conditions were given, and the results with the present and cultivated vegetation distributions were compared. The preliminary experiments were conducted at a horizontal resolution at $1^{\circ}\times1^{\circ}$ from 1 January, 1979 to 31 December, 2007 with the meteorological data by Kim et al., (2009).
The calculated river discharge in the northwestern upper-reaches of the basin, where natural vegetation is broad-leaf evergreen forest, has been compared with the observed inflow of the Bhumipol dam, and that in the northeastern upper-reaches where natural vegetation is mixed forest has been compared with the observed inflow of the Sirikit dam. The observed seasonal change of river discharge, that shows an increase from July to September and a decrease in October, has been roughly presented by the calculation on the northwestern point, but the observed small peaks in May and June has not appeared. Besides, the calculated discharge was concentrated in August on the northeastern point where observed one showed a gradual increase in July and a decrease in September. Moreover, the calculated annual discharges were smaller by a few factors than observed ones. As for the calculated differences due to the land-use change, the beginning time of river discharge was later and the annual discharge was smaller for broad-leaf evergreen forest than cropland, implying the mitigation effect for floods by forest. In contrast, the beginning time of discharge did not show a significant difference and the annual discharge was larger for mixed forest than cropland.
A high-resolution experiment will be conducted using a 5'×5' meteorological data in the Chao Phraya river basin (Kotsuki et sl., 2013). The model and its settings will be improved for better representation of the observed river discharge. The reason for different response to land-use change for different types of forest will be examined, to understand and quantify the impacts of land-use change on the terrestrial water balance and the water resources.

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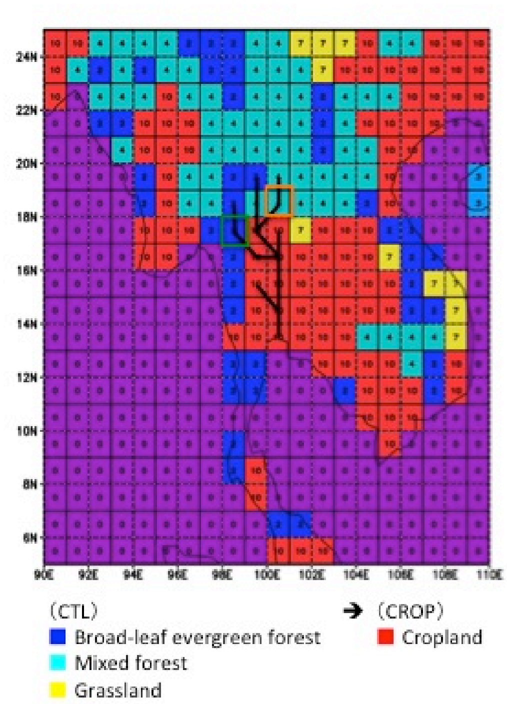

Figure Land-use distribution used in the preliminary experiment. Black lines indicate river route of the Chao Phraya river. Boxes (orange and green) are the grid points compared with observed river discharge.