

Impact of afforestation on the discharge of the Chao Phraya River in a warmer climate

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Discharge of the Chao Phraya River in Thailand is projected to increase under the global warming (Watanabe et al., 2014), and hence to increase the risk of flood in the late rainy season. In addition, it is concerned that deforestation in mountainous upstream of the Chao Phraya River may enhance floods in downstream. Then afforestation is expected to reduce the risk of flood by increasing water holding capacity and slowing the response of discharge.

In this study, offline experiments with specified meteorological conditions are conducted with a land surface model, MATSIRO (Takata et al, 2003; Nitta et al., 2014) that explicitly considers the processes of vegetation canopy. The present meteorological conditions for the period of 1981-2004 (Kotsuki et al., 2013) and those under the warming for 2080-2099 (Watanabe et al., 2014; using results of a climate model MIROC5 and a climate scenario RCP8.5) are given at a horizontal resolution of 5 arc-minutes. Land-cover is changed from the present vegetation distribution (CTL) to the uniform afforestation with broadleaf ever green forest (BEF), broadleaf deciduous forest (BDF) and mixed forest (MXF) to examine the impacts of afforestation.

The increases in annual runoff (average in the latter 10 years of calculation) with the warming (*i.e.*, warmed climate minus present climate with CTL) in the upstream of the Bhumibol dam (on the Ping river in the northwest of the basin), the Sirikit dam (on the Nan river in the northeast), and the C2 observation point (in Nakhon Sawan) was increased by factors of 2.4, 2.0 and 2.2, respectively. Afforestation with BEF, BDF and MXF reduced the increases in runoff at these locations by 50% at maximum. The reduction rate was large in the order of BEF, BDF, and MXF. Moreover, maximum daily discharges (peak discharge) also show the same features of changes.

These results indicate that the increases in annual runoff and daily maximum discharge are reduced by afforestation, and the amount/rate of reduction differs in accordance with forest type. However, the impacts should be considered as maximums because of the extremely simple condition of uniform afforestation in the whole area. In addition, the largest climate change (*i.e.*, RCP8.5) is used in the calculation, that would lead to rather large changes in runoff. Uniform afforestation is completely unrealistic in a practical adaptation plan. Considerations for afforestation in a realistic regions and moderate climate change scenario (*e.g.*, RCP4.5) would be required. Moreover, impact assessment using multiple climate models is also needed since projections of precipitation by climate models are highly uncertain in monsoon Asia.

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References

Kotsuki, S., et al., Hydrolog. Res. Lett., 7, 7984, 2013.

Nitta, T., et al., J. Clim., 27(9), pp3318-3330, 2014.

Takata, K., et al., Global and Planetary Change, 38, 209-222, 2003.

Watanabe, S., et al., Hydrolog. Res. Lett., 8, 33, 2014.

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