Estimation of saturated area in Northeast Thailand using large-scale water balance model

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1. Introduction
Northeastern Thailand is the major rice production region where the most of rice is cultivated in a rainfed lowland paddy without irrigation facilities. Therefore the rice production is highly influenced by a fluctuation of climatic conditions, especially by spatiotemporal versatilities of precipitation. As the beginning time of the transplanting (or seeding) depends on the flooding condition of paddy field, a precise estimation of saturated area allow the evaluation of rice productivity on regional scale. This study describes a large-scale water balance model for estimating surface hydrological elements and the fraction of saturated area in each grid cell and then evaluates the relationships between interannual variability of modeled saturated area and that of rice planted area.

2. Methods
The study area is a part of Indochina peninsula (14°N to 19°N, 100°E to 106°E) which includes the whole of northeastern Thailand. The model developed in this study is a grid-based distributed hydrological model which can estimate land surface water balance components including evapotranspiration, surface and subsurface runoff, mean groundwater depth and changes of soil water content by soil layers (9 layers) on daily time-step. The model also can represent sub-grid scale (30 sec, 1km approximately) variations of groundwater depth depending on topographical features within a grid cell (0.05°, 5km approximately). Fraction of saturated area within each grid cell can be estimated from the simulated mean groundwater depth within the grid and the topographic factor. The model was implemented during from 1977 to 2006 using gridded daily meteorological data which were created by spatially interpolating the observed data. The time series of saturated area estimated by the model was compared with the actual rice planted area in northeastern Thailand.

3. Results and discussions
According to the simulation results, large saturated area is found in the areas where the accumulated precipitations are larger and the water tends to concentrate topographically such as valley or basin. We found that the saturated area at the end of August was highly correlated with the rice planted area (Fig. 1), which implied that the rice planted area can be estimated appropriately from the calculated saturated area. This result also suggests that the transplanting of rice in this region must be finished until the end of August because the rice cannot grow adequately under the condition of day-length during the growing period if the rice is planted after September, which due to the photoperiodic sensitivity of cultivated rice varieties.

Fig. 1. Interannual variability of simulated saturated areas at the end of August (solid triangle) and rice planted areas obtained from the statistical year book of agriculture (white square) from 1992 to 2005.