Impact of land use change on flood
-A case study of Ping River basin around Chiang Mai city, Thailand

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1. Introduction

Land use is a main factor that affect watershed hydrologic processes, such as surface runoff, stream discharge, and sediment transportation (Munoz-Villers and McDonnell, 2013). It is also a major global research issue and is considered as one of the most important components of terrestrial environment system. Recently, land development with rapid urbanization has a great influence on flood risk in some developing countries, especially in Southeast Asia.

While most of the previous studies have focused on the impact of land use change on the aspect of river discharge and water resource management (Chien et al., 2009; Yan et al., 2013), few have studied the effect of land use change on flood inundation area on huge rainfall event (Yonehara et al.,2017). Therefore, the objective of this study is to simulate the flood characteristic and inundation of the catchment in the 2011 Ping river flood and compare the hydrological change in different land use scenarios. Finally, we evaluated the impact of land use change on flood inundation.

2. Methodology

2.1 Study area

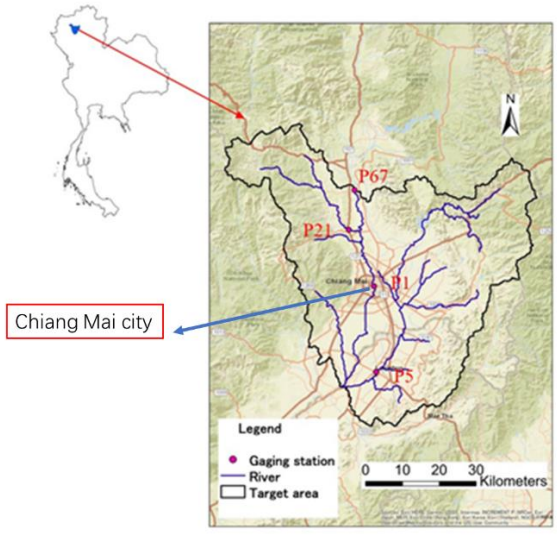


Fig.1 Study Area

The Ping River is one of the main tributaries of the largest river basin within the Chao Phraya river, Thailand. The Ping River is the main river which receive flow from several other tributary rivers. Fig.1 shows a location map of the study river basin. Our study area is a natural catchment along the Ping River which started from P67 observation station and ended at the intersection point of Ping River and its tributaries river. The study catchment area covers around 3300 km^2

2.2 Land use classification

For acquiring the past land use map in different year, supervised classification was used in this study. We chose 1993 year and 2010 year's Landsat image and selected many Regions of Interest (ROIs, also called Training Areas) for each land use class by visual interpretation. Based on ROIs' signature information, maximum likelihood algorithms was used to classify the whole image.

2.3 Flood simulation

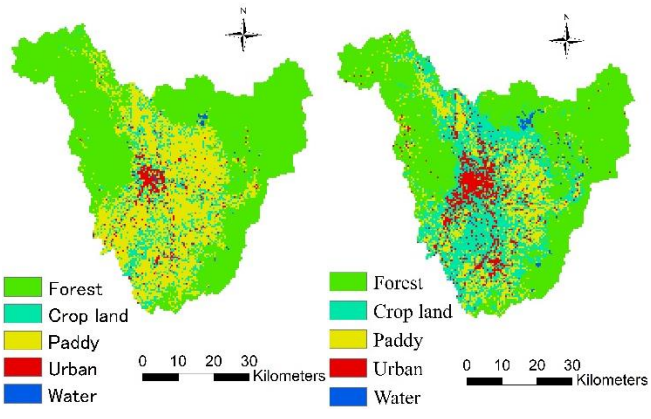
For flood simulation, Rainfall-Runoff-Inundation (RRI) model was used in this study. The RRI model deals with the river channel and slopes separately. In addition, this model can simultaneously simulate rainfall–runoff and inundation caused by flooding; this feature is desirable, especially for detecting large-scale flooding.

Tab.1 Flood simulation

Simulation period	14 days (29 July 2011-11 August 2011)
Spatial resolution	15sec (about 450m)
Boundary condition	P67 observation discharge
Accumulation rainfall	267mm
Temporal resolution	1 hour

3. Result and discussion

3.1 Land use



(a)　　(b)

Fig.2 (a) land use in 1993 by Landsat; (b) land use in 2010 by Landsat

Key words：Land use change, Flood inundation, Satellite image
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Total 121 samples from Google Earth image and 100 samples from Landsat 5 image were used to assess the accuracy for the year of 2010 and 1993, respectively. Result showed overall accuracy of land use classification for 1993 and 2010 were 95.3%,89.8% respectively. The study shows a great amount of paddy land changed to urban and cropland over about twenty-year period from 1993 to 2010.

3.2 Flood simulation

Assume land use in 2010 has almost no changed compared to land use in 2011, land use in 2010 was used to simulate 2011 floods.

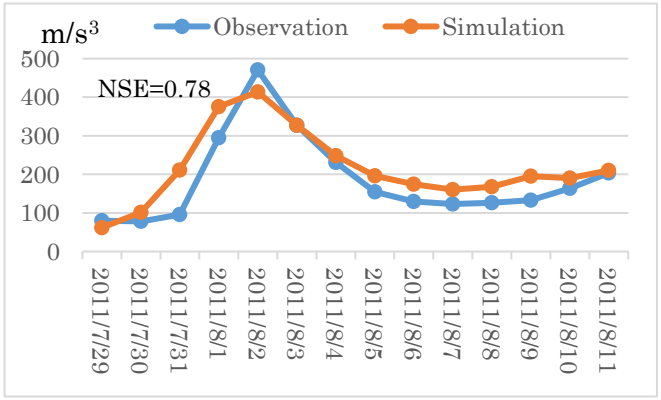
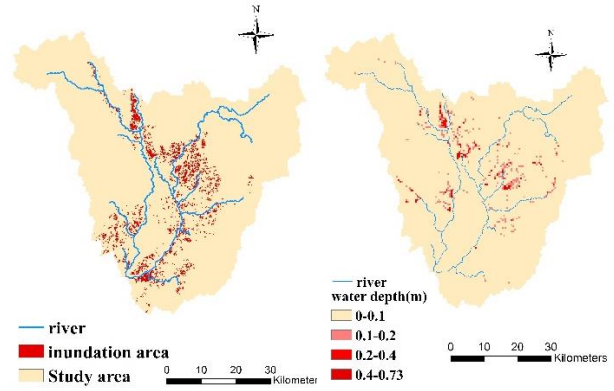


Fig.3 the simulated and observed discharge at P1 gauge



(a) (b)

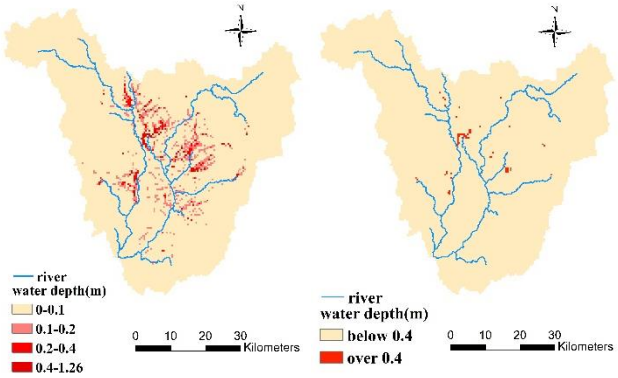
Fig.4 (a) the satellite recorded inundation area in Aug 5th, 2011; (b) simulated inundation area of Aug 2011

Fig.3 shows the comparison between simulated discharge and observed discharge at P1 gauging station. It shows a good agreement with the observed ones with NSE value by 0.78.

Fig.4 shows the result of simulated inundation area and observed satellite data. It shows the inundation area result from simulation only cover 18% of observation inundation area. Especially in the downstream basin, it had much difference. In the future study, the simulation needs to be improved to get better result.

3.3 Impact of land use change on flood

By the same parameter set used for 2011 flood, we simulated the flood using land use in 1993, and we compared with the floods under land use in 2010.



(c) (d)

Fig.5 (c) simulated flood in 1993 (d) inundation over 40cm in 1993

Figure 5 shows the simulated flood in 1993 land use and inundation over 40cm. The inundation area in 1993 land use was larger than 2010. Because there is more paddy field in 1993. Paddy field can be a good water storage. And in many cases, it becomes retarding basin to prevent flood. Moreover, most of water depth below 40cm（93% of inundation area）, thus, it would not cause damage to paddy field.(see Fig.5(d))

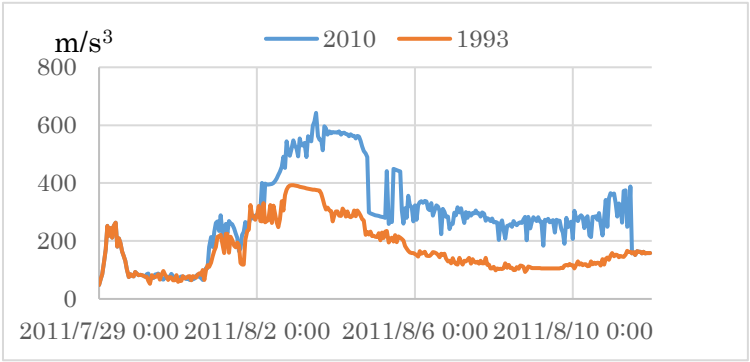


Fig. 6 Compare discharge at outlet in 1993 and 2010 land use

Fig.6 shows the outflow of study area in 2010 was higher than 1993. Therefore, by the reduction of paddy fields in the upstream basin, downstream flows will increase. Namely, it will be increasing the risk of flooding in downstream.

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