

Future Projections of Flood Inundation at Ciliwung River Basin in Jakarta, Indonesia

Bambang PRIYAMBODHO and ○Shuichi KURE (Toyama Prefectural University)
So KAZAMA (Tohoku University)

1. Introduction

Flood disasters in Jakarta occurred in 1996, 2002, 2007, 2013 and 2014. An urbanization in Ciliwung river basin¹⁾ is considered as the main factor of flood inundation in Jakarta. The main objective of this study is to evaluate the effect of urbanization in upstream region of Ciliwung river basin on the flood inundation.

2. Study Area

Jakarta is located in West Java, Indonesia, and Ciliwung River basin, Jakarta city and outside of Jakarta are selected as the study area in this study, totally covering 1,346.6 km². Thirteen major rivers flow northwards through Jakarta into the Java Sea, and Ciliwung River is the main and the longest river in Jakarta which passes through Jakarta and some areas in West Java Province.

3. Methodology

1) Flood Inundation Model

This study investigated flood inundation situations in Jakarta based on rainfall-runoff²⁾ and flood inundation model³⁾. The model consists of rainfall-runoff module at each sub basin, hydrodynamic module in the river and canal networks, and flood inundation module for the floodplains. The hydrodynamic module in the river and canal networks consist of continuous equation, and a momentum equation of steady flow (Saint-Venant equation).

2) Future land-use/cover changes

The urbanization has led land-use/cover changes on Ciliwung River basin. Worst and compact growth are scenarios of land-use/cover changes in the future period. These scenarios were developed using the SLEUTH model⁴⁾. SLEUTH is a tool that can predict urban growth by using historical slope, land use, exclusion, urban growth, transportation, and hill shade data. Varquez *et al*⁴⁾ applied SLEUTH to Jakarta under representative concentration pathways RCP8.5 and shared socio-economic pathway SSP1 scenario⁴⁾. Compact growth was the urban situation under the RCP8.5 – SSP1 scenario and worst scenario was the urban situation under the RCP8.5 – SSP3 scenario⁴⁾.

From 2020 until 2050, urban ratio in Ciliwung river basin has been increased from 0.72 to 0.89 for the compact growth and from 0.79 to 0.93 for the worst scenario. Also, all forest (urban ratio is 0) and all urban (urban ratio is 1) scenarios are analyzed. The compact growth, worst, and all forest and all urban scenarios were evaluated using the flood inundation model.

4. Results and Conclusions

Above land use conditions were evaluated by the flood inundation simulations. Flood inundation areas of compact growth and worst scenarios for 2050 were calculated as 75.39 km² and 76.78 km². Also the flood inundation areas of all forest and all urban were calculated as 17.91 km² and 78.29 km². **Figure 1** shows the simulated flood inundation maps of these scenarios. Also the figure shows observed and simulated flood inundation of 2013 as a model validation. Flood inundation areas of historical simulation for 2013 was calculated as 63.97 km².

As the result of analysis, we concluded and confirmed that the increases of urban ratios in Ciliwung river basin increased the flood inundation risks in Jakarta.

The demand of residential in Jakarta will be increased every year. The government should implement some land-use controls or regulations in ciliwung river basin as soon as possible.

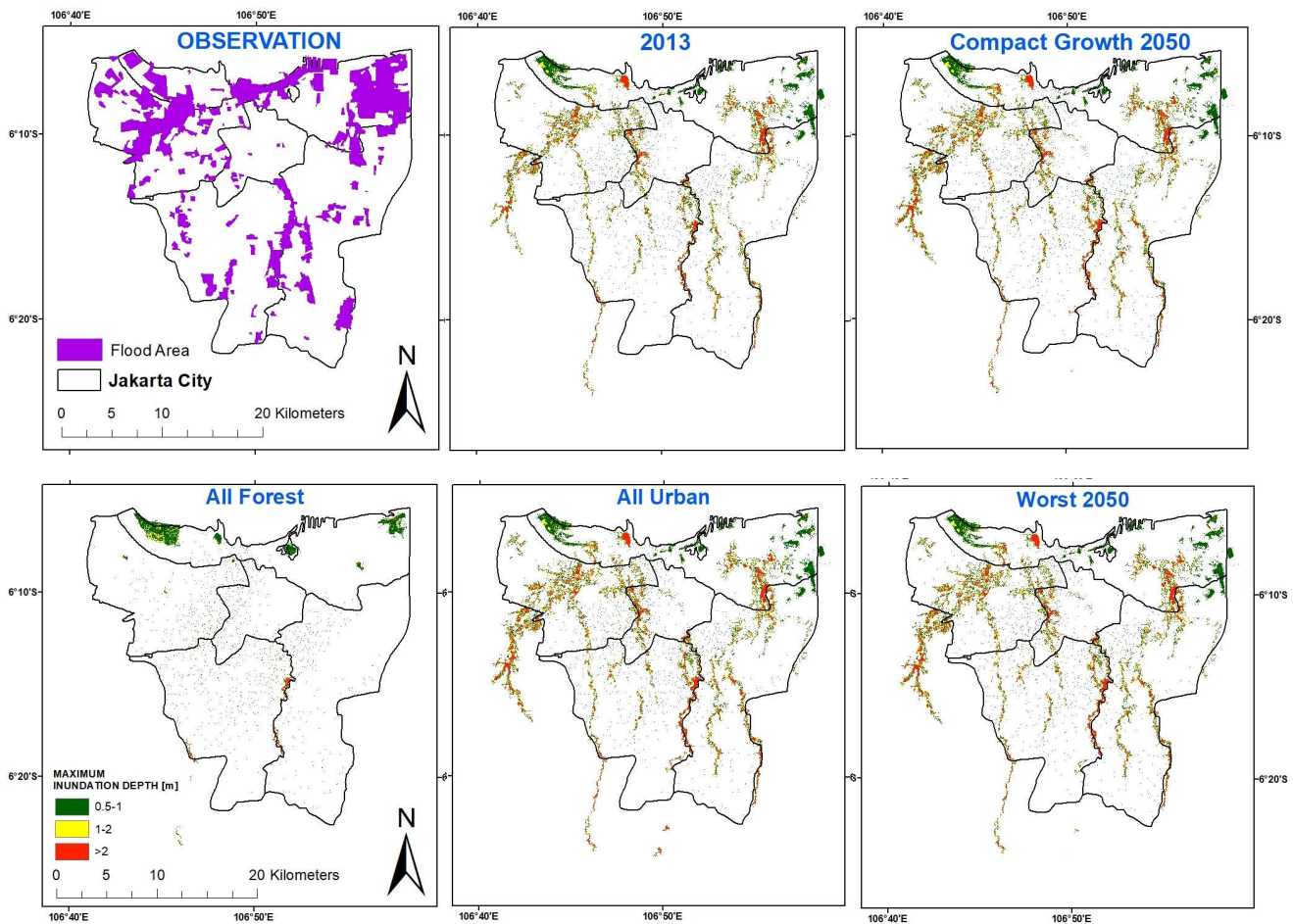


Fig. 1 Simulated flood inundation of 2013 event, compact growth, worst scenario, and all forest and urban scenarios.

Acknowledgments

This research was supported by the Environment Research and Technology Development Fund (S-14) of the Ministry of the Environment, Japan.

References

- 1) Moe, I.R., Kure, S., Januriyadi, N.F., Farid, M., Udo, K., Kazama, S., and Koshimura, S. (2017). Future Projection of Flood Inundation Considering Land Use Change and Land Subsidence in Jakarta, Indonesia. *Hydrological Research Letters*, Vol.11, No.2, pp.99-105.
- 2) Kure, S. and Yamada, T.: Nonlinearity of runoff and estimation of effective rainfall in a slope. Proceedings of the 2nd Asia Pacific Association of Hydrology and Water Resources Conference, Vol.2, pp.76-85, 2004.
- 3) Moe I.R., S. Kure., M. Farid., K. Udo., S. Kazama and S. Koshimura, Numerical Simulation of Flooding in Jakarta and Evaluation of a Countermeasure to Mitigate Flood Damage, *Journal of Japan Society of Civil Engineers, Ser. G (Environment)*, Vol.71, No.5, pp. I_29-I_36, 2015.
- 4) Varques, CGA., Darmanto, N., Kawano, N., Takakuwa, S., Kanda, M., Xin, Z., (2017). Representative urban growing scenarios for future climate models. *Journal of Japan Society of Civil Engineers, Ser: B1 (Hydraulic Engineering)*, Vol.73, I_103-I_108.

Key Words: Jakarta, Indonesia, Flood inundation, Land use/cover change