EVALUATION OF URBAN FLOOD IN JAKARTA BY NUMERICAL SIMULATIONS

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1. INTRODUCTION

The Special Capital Region of Jakarta as famous as Jakarta in Indonesia is now facing the increase of economic development. However, Jakarta has experienced many floods in the past, such as in 1996, 2002, 2007 and 2013 and those floods resulted in not only human casualties but also economic damages (Kure et al, 2014). Heavy rainfall and rapid urbanization in catchment area are considered as main factors contributing to the urban flooding in Jakarta. The main objective of this paper is to quantitatively evaluate the urban flood situation in Jakarta by using flood inundation model.

2. STUDY AREA

Jakarta is the largest metropolitan city in Indonesia and its development is progressing rapidly (Moe et al, 2017). There are thirteen rivers flowing into Jakarta, and the main and the longest river is the Ciliwung River which passes through the city center from upstream region located in the border of Cianjur and Bogor cities as shown in Fig. 1. The Ciliwung River has a catchment area of 382.6 km^2 with the river length of 117 km. The Ciliwung River brings the largest flood damage to Jakarta compared to other rivers that flow into Jakarta. The target area selected in this study includes Jakarta and the Ciliwung River basin totally covering 1346.6 km^2 as shown in Fig. 1.

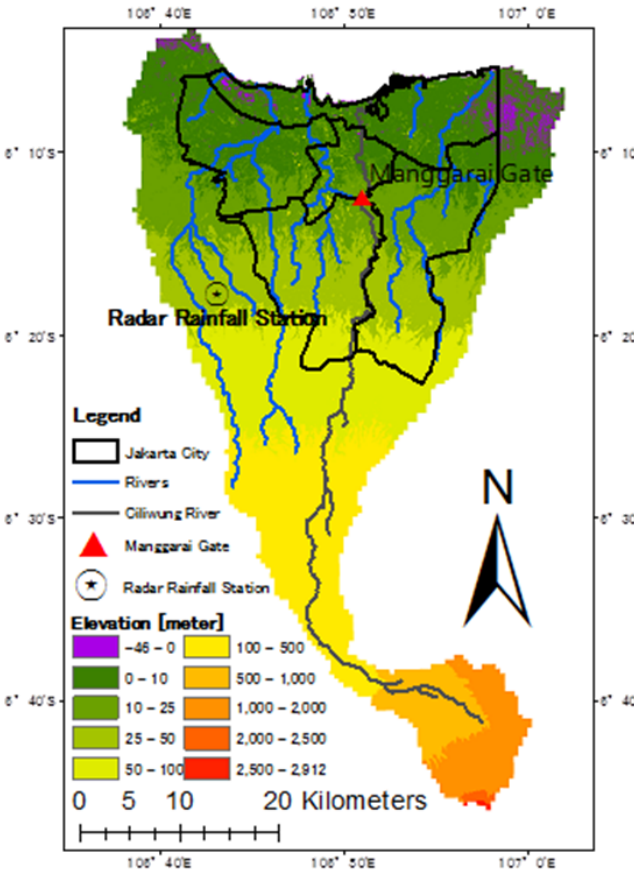

Fig. 1 Study area and the location of Jakarta City.

3. FLOOD INUNDATION MODEL

A flood inundation model used in this study is consist of rainfall-runoff module for each subbasin (Kure and Yamada, 2004), hydrodynamic module in the rivers and canal networks, and flood inundation module on the floodplain. For the details of the model and parameters, see the reference (Moe et al., 2016).

4. EVALUATION OF URBAN FLOOD

The flood inundation model was applied and calibrated to the target areas for the 2013 flood event of January 14 – 18, 2013 (Moe et al, 2017). Fig. 2 shows the observed inundation area in Jakarta and the simulated maximum inundation depth of the target area. The flood volumes were computed by the maximum inundation depth and inundated area in Jakarta derived from the simulation results as shown in Table 1. River flood volumes without urban flooding were computed by simulations without the urban flooding under the assumption that the interaction effects of urban flooding on the river flooding are small, and those volume can be linearly subtracted. The area with the shortage of capacity flow in the lower part of the Ciliwung River contributed 8.2% and the shortage of capacity flow in other rivers contributed 58.6% of the total flood inundation volume.

Keywords: Jakarta, flood inundation model, urban flooding
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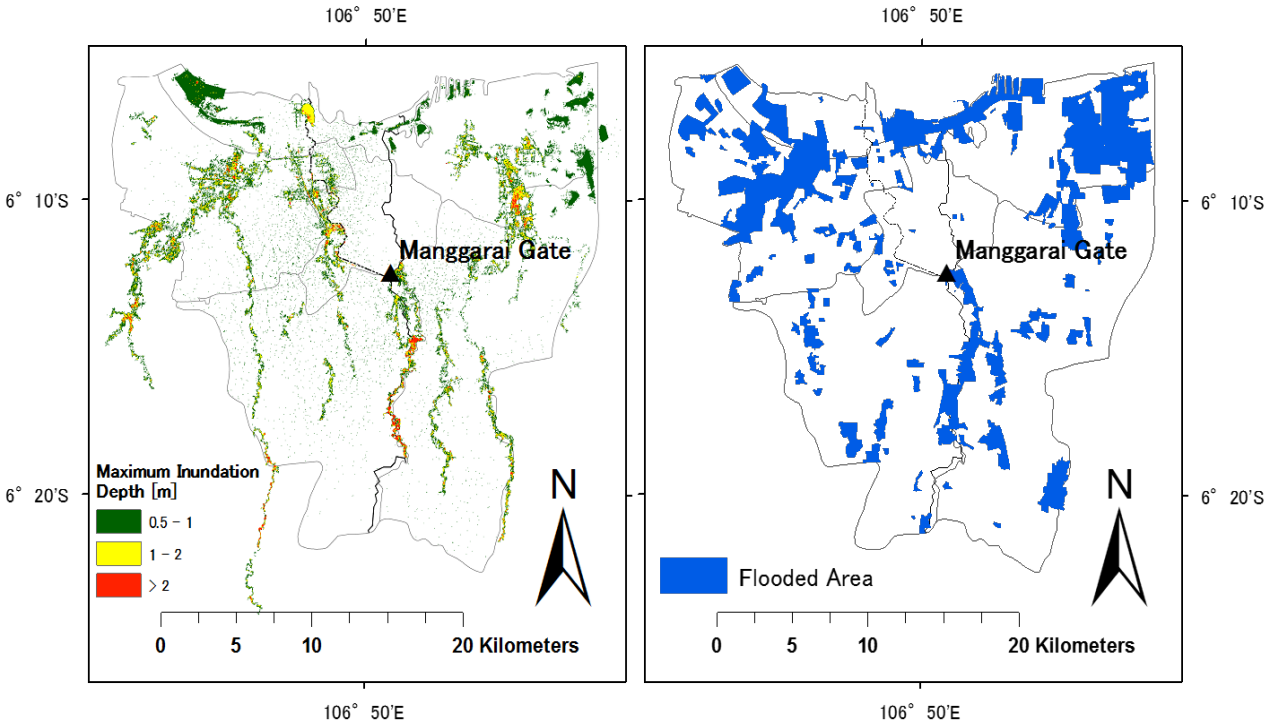

Fig. 2 Comparison between the simulated (left) and observed (right) inundation areas (Moe et al., 2017).

Also, the urban flooding in the Jakarta contributed 33.2% of the total volume. It might be because the highly urbanization and the land subsidence rate in the city (Moe et al, 2016).

5. CONCLUSIONS

Table 1 Summary of the simulated inundation area and volume

Flood Inundation	Ciliwung River	Urban flooding	Other river's flooding	Total
Area [km^2]	3.26	21.98	38.66	63.9
Volume [m^3]	239,415	974,778	1,720,035	2,934,228

In this paper the rainfall runoff and flood inundation model was applied to the 2013 flood event in the Ciliwung River basin and Jakarta by using radar rainfall information as the input. As a result of analysis, we concluded that the the urban flooding contributing 33.2% of the total flood inundation volume in Jakarta. Also, the shortage capacity in others rivers and the Ciliwung Rivers contributing 58.6% and 8.2%, respectively.

ACKNOWLEDGEMENT

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

REFERENCES

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.

Kure S., Farid M., Fukutani Y., Muhari A., Bricker J.D., Udo K., and Mano A.: Several Social Factors Contributing to Floods and Characteristics of the January 2013 Flood in Jakarta, Indonesia, Journal of Japan Society of Civil Engineers, Ser. G, Vo. 70, No.5, pp.I_211-I_217, 2014. (in Japanese with English abstract).

Moe I.R., S. Kure, M. Farid, K. Udo, S. Kazama and S. Koshimura, Evaluation of Flood Inundation in Jakarta Using Flood Inudation Model Calibrated by Radar Rainfall, Journal of Japan Society of Civil Engineers, Ser. B1 (Hydraulic Engineering), Vol.72, No.4, pp. I_1243-I_1248, 2016.

Moe, I.R., Kure, S., Januriyadi, N.F,. Farid, M., Udo, K., Kazama, S., and Koshimura, S. Future Projection of Flood Inundation Considering Land Use Change and Land Subsidence in Jakarta, Indonesia. Hydrological Research Letters, Submitted, 2017.