Climate change impact study for flood inundation in Jakarta, Indonesia based on dynamical downscaling of future scenarios

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1. Introduction

Jakarta experienced large floods in the years 1996, 2002, 2007, 2013, and 2014. This flood inundation was caused by climate change[1)], land use change[2)], and land subsidence[3)]. In this study, we used rainfall data projections simulated by a general circulation model (GCM) coupled with the regional climate model that is the weather research and forecasting (WRF) model under the Representative Concentration Pathway (RCP) 2.6–Share Socioeconomic Pathways (SSP)1 and RCP8.5–SSP3 scenarios to assess the effects of climate change and urbanization.

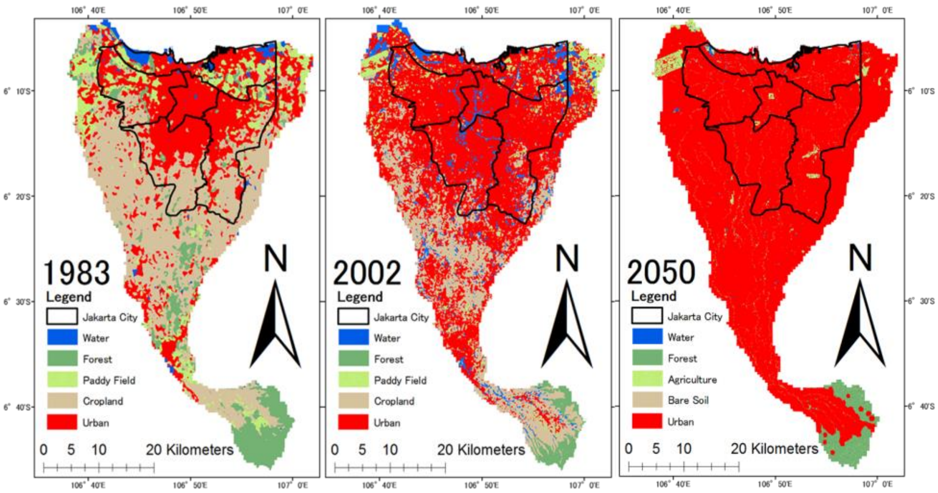

Fig. 1 Study Area and Land Use/Cover Changes[3)]

2. Study Area

Figure 1 shows the study area of Jakarta located in West Java, Indonesia with a total area of 1,346.6 km^2 along with the changes in land use in 1983, 2002, and 2050. For the 2050 data, land use was simulated by the slope, land use, exclusion, urban extent, transportation, and hill shade (SLEUTH) model under the SSP1 urban growth scenario.

3. Methodology

1) Flood Inundation Model

In this study, a flood inundation model was used to investigate the flood inundation in Jakarta. This model consists of a rainfall-runoff module at each sub-basin, hydrodynamic module in river and canal networks, and flood inundation module

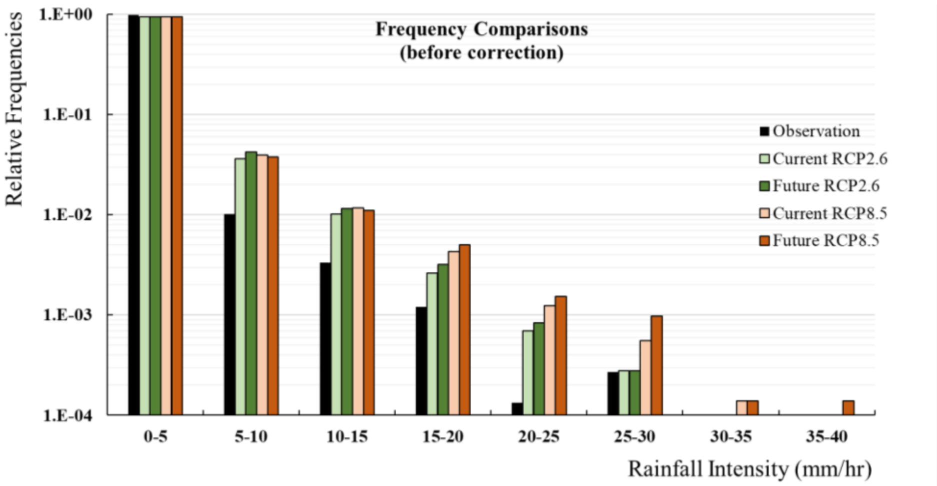

Figure 2. Frequency comparisons of rainfall for current and future RCP 2.6 and 8.5 scenarios.

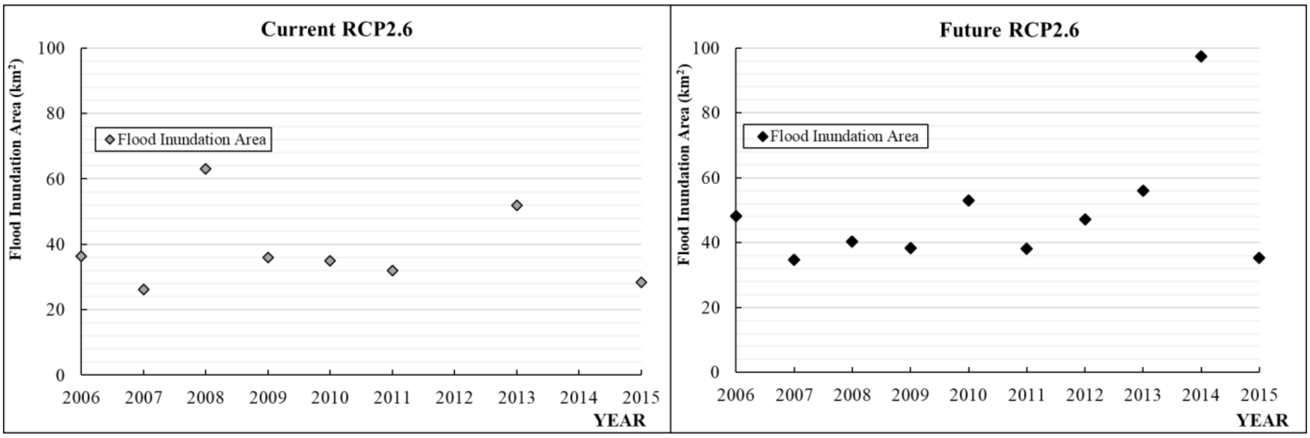

Figure 3. Simulated flood inundation area between current (left) and future (right) periods under the RCP 2.6 scenario.

for floodplains. The details of this model can be found in Moe et al. (2016).

2) Future Urbanization

We investigated the effects of changes in land use on flooding in Jakarta by predicting future land use using the SLEUTH model (Moe et al., 2016) under the SSP1 and SSP3 scenarios and the land elevation data provided by Moe et al. (2016) to evaluate future land subsidence.

3) Bias correction

Future and current projected rainfall data based on the dynamical downscaling using WRF have some biases that contribute errors to the results. Thus, these biases were corrected by implementing the methods of Fajar et al. (2017) based on ground observation rainfall data.

4. Results and Conclusions

Figure 2 shows the comparison of rainfall intensity in the current and future situations under RCP2.6 and RCP8.5 scenarios. The RCP8.5 scenario exhibited higher rainfall intensity compared to the current and RCP2.6 scenarios. This can be attributed to climate change. **Figure 3** shows the comparison of the 10-year simulation flood inundation area under the RCP2.6 scenarios between the current (left) and future (right) periods. In both periods, the flood peak discharge in Jakarta tended to increase due to climate change. The combinations of RCP2.6–SSP1 and RCP8.5–SSP3 scenarios were also computed and analyzed.

The study obtained a negative impact of climate change on flood inundation exhibited by the increase in rainfall intensity and flood discharge. Moreover, future scenarios exhibited more prominent negative implications on flood inundation. It should be noted that this simulation did not consider future urbanization of the SSP3 scenario.

References

1) Januriyadi, N.F., S. Kazama, IR. Moe, S. Kure.: Evaluation of future flood risk in Asian megacities: a case study of Jakarta. *Hydrological Research Letters*, 12(3), pp 14-22, 2018.

2) Farid, M., Mano, A., and Udo, K: Modeling Flood Runoff Response to Land Cover Change with Rainfall Spatial Distribution in Urbanized Catchment, *Anual Jo urnal of Hydraulic Engineering*, Vol.55, pp.19-24, 2011.

3) 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*, Vol.11, No.2, pp.99-105, 2017.