Effects of Regional Climate Change on Flood Inundation in Jakarta, Indonesia

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1. Introduction

Flood disasters in Jakarta occurred in 1996, 2002, 2007, 2013 and 2014. Extreme flooding events may become more frequent due to a combination of urbanization in the upstream region (e.g., Moe et al. 2017) and the effects of climate change (e.g., Januriyadi et al. 2018). The main objective of this study is to evaluate the effect of regional climate change on the flood inundation in Jakarta, Indonesia considering the sea level rise impacts.

2. Study Area

Jakarta, officially known as the Special Capital Region of Jakarta, is the capital and largest city of Indonesia, with a population of approximately 9.6 million. Study area is located in West Java, Indonesia, and total area covering in this study is 1,346.6 km^2 as shown in **Figure 1**. Thirteen major rivers flow northwards through Jakarta into the Java Sea. Ciliwung River is the main and the longest river in Jakarta which passes through Jakarta and some areas in West Java Province.

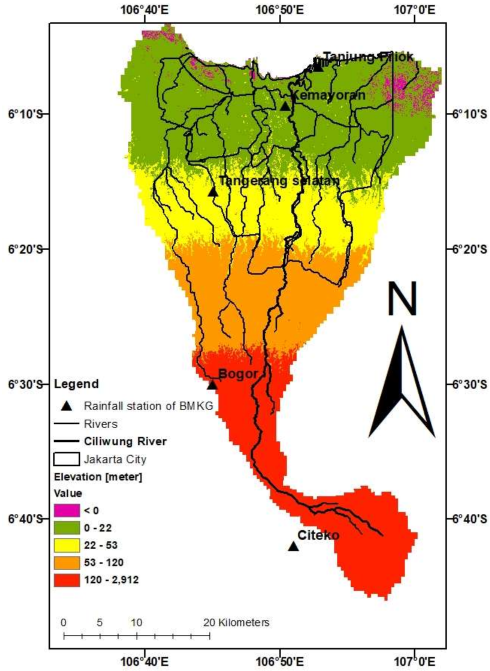


Fig. 1 Study Area

3. Methodology

1) Flood Inundation Model

This study investigated flood inundation situations in Jakarta based on rainfall-runoff and flood inundation model (Moe et al. 2017). 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) GCM outputs of future rainfall

Future rainfall data were provided by Januriyadi et al. (2018) who used the future rainfall data from eight general circulation models (GCMs) and three emission scenarios (RCP 2.6, RCP 4.5, and RCP 8.5) to assess the effects of climate change in the future.

3) Future sea level rise

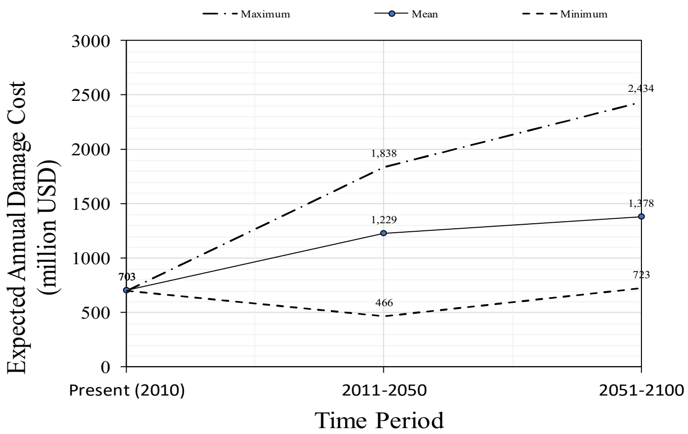
Future sea level projection was provided from Takagi et al. (2016) who concluded that land subsidence would be the main driver of coastal floods in the north coastal area of Jakarta by projecting the sea level rise under future climate change and land subsidence conditions. However, their study did not consider river flooding due to heavy rainfall, so we considered flood events from the ocean and the river, including the possibility of these occurring at the same time.

4) Flood damage cost

Januriyadi et al. (2018) used a global modeling approach to estimate the cost of future flood damage. The expected annual damage costs (EADC) were calculated to explain the severity of the flood risk. Additionally, a global approach was used to estimate the asset values by comparing the common parameters (e.g., gross domestic production (GDP) or population). This method is used to estimate the flood damage costs after the flood inundation simulation in this research.

4. Results and Conclusions

We explore the future flood risk under future scenarios (i.e., climate change with and without sea leve rise). The EADC was used to represent the change in flood risk. **Figure 2** presents the change in the EADC due to only climate change without the sea level rise, and **Figure 3** shows the change in the EADC due to climate change with the sea level rise in the near future and far future. Climate change without sea level rise alone increases the mean of the EADC for the near future by 54–100%. The far future has a more severe flood risk and higher uncertainty compared to the near future. It was found that the sea level rise will slightly increases the future flood risk as shown in **Figure 3**. However, the effects are small compared to the future rainfall change. It is noted that in these simulations, land use change and land subsidence were not considered. These effects might significantly increase future flood risk in Jakarta.



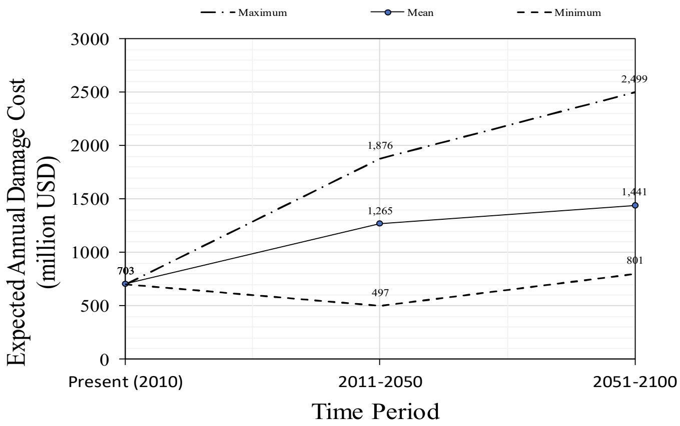


Fig. 2 and **3** Future projection of EADC without sea level rise (left) and with sea level rise (right)

Acknowledgments

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Key Words: Jakarta, Indonesia, Flood inundation, Climate change, Sea level rise