Climate change and land use change impact assessment on flood and inundation in a river basin in Sumatra island in Indonesia

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Indonesia will face challenges on flood disaster management and environmental problems due to climate change. Previous IPCC AR5 describes that monsoon-related precipitation will increase in Southeast Asian countries. Combined with precipitation increase, larger urban area will be exposed to coastal floods and river floods in Indonesia (Muis et al. 2015). In addition, deforestation and land use change increase of flood hazards in a tropical catchment (Tarigan 2016). Moreover, tropical peatland area is more likely to have the significant impact due to flood hazards, where large area is developed for agriculture plantation.

One of the challenges of climate communities is to reproduce rainfall spatial and temporal patterns by GCM in many islands in oceans between the Indian and Pacific Oceans, which is known as Maritime Continent. This can attribute to coarse resolution of topography or imperfect representation of local weather in Maritime Continent. Regional Climate Models has high potential to represent the local weather at finer resolution. In addition, there are many studies on rainfall projections but their impact on river discharge is still limited in Indonesia (Ammar et al. 2016; Hero Marhaento et al. 2018). Moreover, very limited studies focus on the impact on inundation phenomena at catchment scale.

The primary objective of this research is to assess the possible climate change impact on flood and inundation in a catchment. This study uses Atmospheric General Circulation Model ver. 3.2 (hereafter AGCM) and Non-Hydrostatic Reginal Climate Model (hereafter NHRCM) developed by Japan Meteorological Research Institute (MRI). NHRCM is a regional climate model, which is dynamically downscaled at less than 5 km resolution with boundary condition of AGCM at 20 km resolution (Sasaki et al. 2008). Bias correction is applied to correct AGCM/NHRCM-simulated rainfall and evaluated based on annual maximum (1) daily and (2) 15 days rainfall. We discuss the impacts of the bias correction on hydrological projections using Rainfall-Runoff-Inundation (RRI) model (Sayama et al. 2010) applied to one of the largest river basin in Sumatra Island in Indonesia under current and future climate conditions. We assess the results according to (1) flow duration curve, (2) annual maximum daily discharge and (3) annual maximum inundation pattern/volume. Finally, future impact on flood is analyzed with the most reliable rainfall datasets of non-/bias corrected AGCM and NHRCM. RCP8.5 was used for the future scenario of climate change. Furthermore, future land use data (land use 2040) and climate change (RCP8.5) was applied to RRI model. The results of RRI model and was compared with the results of climate change ones with only RCP8.5 to clarify which impact is more significant.

Keywords: Climate Change, Humid Tropical River Basin, NHRCM, RRI Model, Tropical Peat Land

