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Assessment of rainfall pattern and future change for Kelantan River Basin, Malaysia using statistically downscaled local climate models

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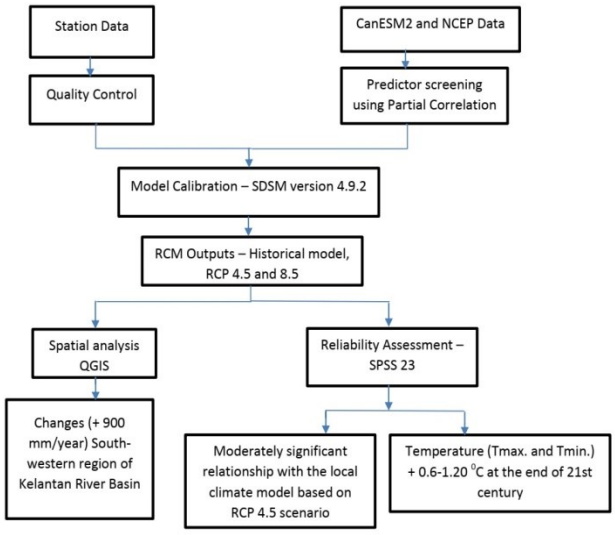
Graphical abstract



Abstract

Climate change has been discussed frequently in recent decades, and it has increased the probability of extreme flood occurrence. This study aims to provide an analysis of future rainfall patterns and flood occurrences specifically for the Kelantan River Basin which is identified as one of flood prone areas in Malaysia. The study area was divided into five regions of the Kelantan River Basin, - Kota Bharu (Northern), Kuala Krai (Center), Pos Lebir (Southeastern), Pos Hua (Southwestern) and Pos Gob (Northwestern). The historical rainfall data (1986-2019) was then retrieved from the Malaysian Meteorological Department (MMD) based on the five regions. The statistical approach was applied to downscaled climate model data from the CanESM2 GCM forced by the Representative Concentration Pathway (RCP) 4.5 and 8.5. The reliability assessment using a Cronbach's Alpha, Linear Regression and Pearson Correlation results show that local climates (2006-2019) forced by RCP4.5 have a similar trend to historical rainfall within the same period. The spatial analysis outcomes showed that the northeastern region of the Kelantan River Basin received its highest average annual rainfall (5,000 mm) in 1990 and caused severe flooding in the area. However, there is a significant change of rainfall pattern in all regions, with a steady increase in annual rainfall in the southwestern region (2021-2100).

Keywords: Kelantan River Basin, statistical downscaling, local climate model, representative concentration pathways (RCPs)

1. Introduction

1.1. Climate change

Climate change is generally considered to result in rising global temperatures and increasing extreme weather occurrence. According to the Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC AR6), the Earth's global surface temperature could increase by 1.5°C since pre-industrial era over 20 years due to increasing Greenhouse Gas (GHG) concentration in the atmosphere (IPCC, 2021). The climate system's response to greenhouse gases is estimated with different climate change's impacts. According to Abram *et al*. (2016), anthropogenic effects on climate change are considered to have begun in the early 1830s, when the human society started to change the chemistry of the Earth's atmosphere by adding carbon dioxide (CO_2) to the air.

As a result of increasing global average temperatures, the likelihood of extreme weather occurrence such as abnormal rainfall intensity and increased frequency of heat waves is expected to increase in the future (Haq, 2019). It is much related to climate change in a specific region, and time-period is known as the long-term weather patterns in a particular area (Molloy *et al*., 2017). The warming trend is happening around the world, including Malaysia, as evidenced by temperature observation records of the past 50 years (Tang, 2019; Rahman, 2018). Abnormal rainfall intensity has also been