TA-119L

EXPLORING BIAS CORRECTIONS OF RIVER DISCHARGE UNDER DAM OPERATION USING d4PDF IN THE CHAO PHRAYA RIVER BASIN, THAILAND

Background

Climate change and variability impact has resulted in many devastating water-related hazards affecting economies and livelihood and flooding is one of the costliest natural disasters that disrupt the counties economy especially in developing countries more than developed countries. Due to its frequency, intensity, and vulnerability, it has been focused on several studies past decades mainly in environment and water resources communities. Meteorological hazards are the root cause of various disasters like storm surges, floods, landslides, high-intensity winds, etc. (Mori & Takemi, 2016). Hydro-meteorological extreme events are likely to increase both in magnitude and frequency due to climate change (IPCC, 2012). Different climate models have studied the various impact of climate change in the future so as to prepare, adapt and mitigate its severeness.

The d4PDF data is used because it has a long time series period, which has a high advantage in flood prediction and risk assessment (Mizuta et al., 2017). It employs 100 sets of 60 years of data for past climate and 6 Sea Surface Temperatures (SST) models each consisting of 15 sets of 60 years of data which amount to 90 ensemble future climate data. The d4PDF data consists of climates 2K and 4K warmer than the pre-industrial climate, which is simulated for 3240 and 5400 years, respectively, to see the effect of global warming. In this study, we adopt only the 4K warmer scenario Global Circulation Models (GCMs) at a resolution of 60 km (Ishii & Mori, 2020). These global models have to be bias corrected in order to remove the uncertainty. A Quantile-Quantile Mapping (QQM) bias correction is used which is based on the assumption that the equivalent level in the simulated projection can be corrected from the sorted historical simulation or observation data (Bennett et al., 2014).

The objective of this study is to analyze the bias correction techniques for large ensemble climate data for future projection in big basins such as the Chao Phraya River Basin (CPRB). When we consider large basins, there may not be a similar bias-correction factors throughout the basin. Some parts of the basin may be overestimated whereas some may be underestimated which creates a large uncertainty in the study. Therefore, to rule out the effect of bias in a substantially large basins we divide the basin to two parts according to the topography and perform bias correction for the upper part of the basin and lower part of the basin.

Study Area

CPRB is one of the vulnerable basins with respect to fluvial and pluvial flooding as it is situated in a low-slung area with a highly built-up urban dimension (Visessri et al., 2020). Ranked as one of the expensive disastrous events in the history of the world, the 2011 Great Thailand Flood was a huge calamity that claimed hundreds of lives and massive economic damage (The World Bank, 2012). Disturbing the nation's economy, Thailand had not experienced such catastrophic floods in the last half-century with the huge inundated areas. Coping with various stress such as social loss, economic damage due to the impact of climate change on extreme events, many government and non-government institutions are actively participating to bring up the country's economy.

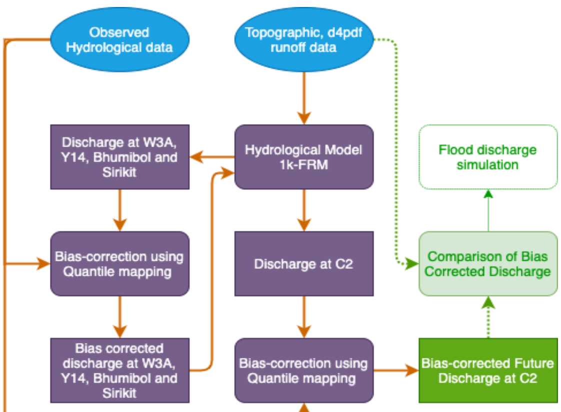
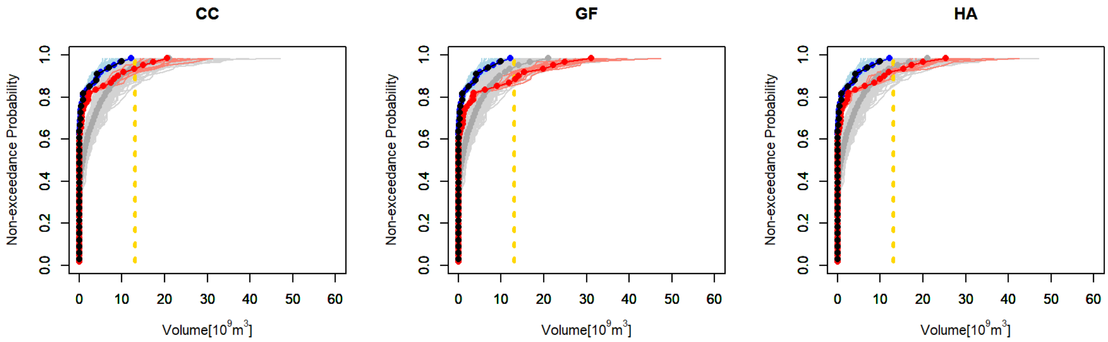


Figure 1: Framework of the study

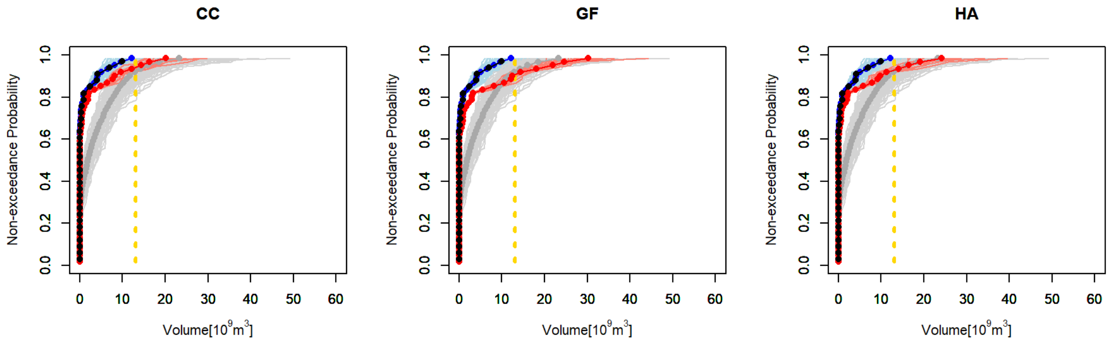
Overall Methodology

K-FRM, developed by the Hydrology and Water Resource Research Laboratory of Kyoto University, was chosen for this study (Hunukumbura & Tachikawa, 2012). This model is used for runoff-to-discharge simulation in the study basin. QQM is used for the bias correction of the discharge at the Bhumibol, Sirikit dam as well as the Nakhon Sawan (C2) which is the outlet of the basin. CC, GF, HA, MI, MP, MR are the 6 GCMs (Ishii & Mori, 2020) selected. The past climate period is from 1951-2020 where as the future climate time period is from 2051 – 2110.

Results and Discussion



(a)



(b)

Figure 2: Non-exceedance probability curve between Observed, Present and Future Climate at the outlet (a)Without bias correction at dams (b) With bias correction at dams.

One of the methods is bias correction of the d4PDF data sets at the outlet of the basin in C2. The other method is we bias correct the river discharge firstly at the two dams (i.e., Bhumibol and Sirikit) and then with its results simulate the model and bias correct the river discharge again at C2. The main objective of this study is to compare the results to make the river discharge simulation more robust and remove the uncertainty in large basins. Three out of six model results of the two cases are shown in Figure 2 (a) and (b). We can observe that both the bias correction methods show a similar trend in future scenarios for all ensembles. There is not much difference between the results in two different cases for Chao Phraya Basin and hence, we can proceed without bias correction at dams.

Keywords: Bias correction; Dam Inflow; Quantile-Quantile Mapping; Chao Phraya River Basin

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