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Climate change impacts on extreme rainfalls over Rize Province, Turkey

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Abstract

Providing a catchment-scale comparison between two GCM-RCM combinations, namely ECHAM5-RegCM3 and CCSM3-RegCM3, this paper investigates the effect of the A2 greenhouse gas emission scenarios on the variability of extreme rainfalls over Rize Province, Turkey. For this aim, firstly, three rainfall-borne climatic statistics have been defined to evaluate the efficiency of each GCM-RCM combination. Then, using different probability distributions, a grid-based comparative analysis between projected design storms at three future levels (2040, 2070, and 2099) and those of reference period (1961-1990) has been accomplished. The intercomparison results indicated that ECHAM5-RegCM3 provides higher performance than CCSM3-RegCM3 for annual maximum rainfall reproduction. Based upon A2 emission scenario, up to 40% decrease in the magnitude of 100-year design storm is projected for different portions of the province. The results also demonstrated that the best distribution model for characterizing the historical extreme events is not necessarily the best for those of projected extreme events.

Keywords: Climate change, General circulation models, Design storms, Catchment-scale.

1. INTRODUCTION

According to the Intergovernmental Panel on Climate Change (IPCC), climate changes is a long-term, typically decades or longer, change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties. It may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or land [1]. Based upon significant effect of climate change on water resources [2], general circulation models (GCMs) are becoming increasingly important as a source of information required to sustainable water resources management specifically in the regions vulnerable to climate change. Among the potentially significant impacts of future climate, variation in frequency and intensity of extreme rainfall events is of paramount importance to water resources engineers. A common way to assess the hydrologic impacts of climate change on the variation of extreme rainfall events is to use the extreme value analysis (EVA) of GCM projections at specified emission scenarios. Using a regional climate model (RCM) the corresponding climate projections are downscaled over the study region. Since RCMs are fed by GCM outputs, the uncertainties propagate down to the RCM outputs [3]. Hence, the performance evaluation of GCM driven RCM outputs is essential as an initial step to extreme value analysis that helps modelers to identify more reliable GCM-RCM combination among available models for the region.

To evaluate the characteristics of projected extreme rainfall events, several studies have been carried out [e.g., 4, 5 and 6]. Semmler and Jacob [7] applied the HadAM3H-REMO 5.1 combination and pointed out that in mountainous regions of Europe, the differences between simulated and observed return levels are larger than in flat regions. Mladjic et al. [8] investigated changes in return levels of one- to ten-day maximum rainfall amounts over Canada correspond to the SRES-A2 emission scenario using Canadian Regional Climate Model (CRCM). According to their results, northern Canadian climatic regions exhibit the lowest absolute but highest percentage change in 20-, 50-, and 100-yr return levels of rainfall extremes. To the best of our knowledge, there is no study in the relevant literature that reflects the catchment-scale climate change impact on design storm variation in Turkey. With the aim of providing more reliable design storms for adaptive floodplain management in Rize Province, this study investigates the possible variability in the magnitude of extreme rainfall events at different recurrence intervals correspond to the SRES-A2 greenhouse emission scenario.