

# Projected climate change impact on runoff and water quality from Nakdong River watershed, Korea

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## 1. Introduction

Human activities associated with the burning of fossil fuels have propelled global climate change, increasing air temperature as well as changing evaporation, precipitation, and runoff. Climate change has the potential to significantly alter not only available water resources but also water quality, with consequent impacts on biogeochemical cycling and ecosystems of natural bodies of water. Although there are still many uncertainties in forecasting the extent and impact of climate change, it is necessary to assess scientific understanding of the impact and vulnerabilities of climate change on water quality when considering policy implications and directions. In this study, a rainfall-runoff modelling system has been developed for Nakdong River, a regionally important watershed in Korea that assesses projected changes, in response to climate change stressors, and their impacts on water quality.

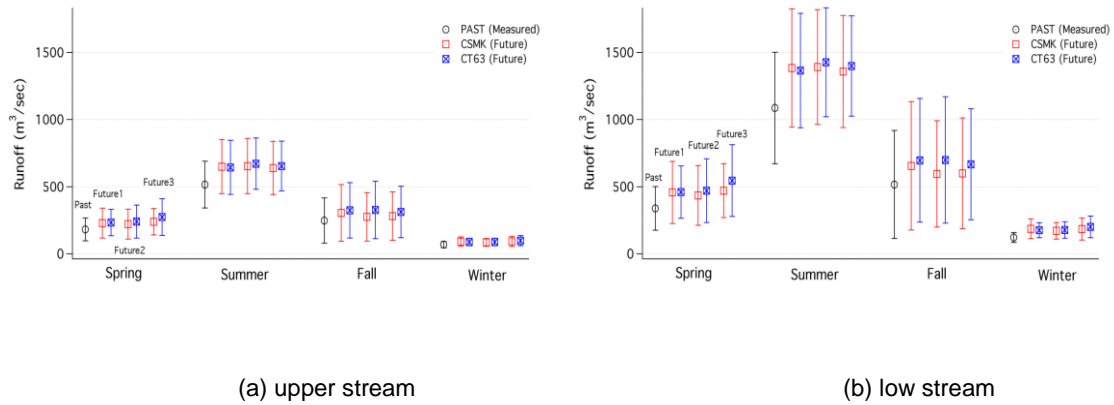
## 2. Method and Material

Two Global Circulation Model (GCM) simulations (CSMK and CT63) on the A1B scenario were converted to regional scale data using the statistical downscaling method known as MSPG (Multi-Site Precipitation Generator). A Soil and Water Assessment Tool (SWAT) model was applied to simulate rainfall-runoff and pollutant loading in the Nakdong watershed. The study area was divided into 67 hydrologically connected sub-basins and their stream reaches based on the topography and stream network of the watershed and burn-in options (digitized streams) using the BASINS tool. The model used a land-use map (1:25,000 scales in shape-polygon format) from the Environmental Geographic Information System and a detailed soil map with soil textures (1:25,000 scales in shape-polygon format) from the National Institute of Agricultural Science and Technology. A SWAT was fitted to the observed daily stream flow and sediment data from 67 points for an 8-year period (2002–2009), with the first two years (2002–2003) used to stabilize the model runs. The simulated values were evaluated using graphical observations and quantitative statistics such as percent difference index, Nash-Sutcliffe model efficiency (Nash and Sutcliffe, 1970), and R<sup>2</sup>.

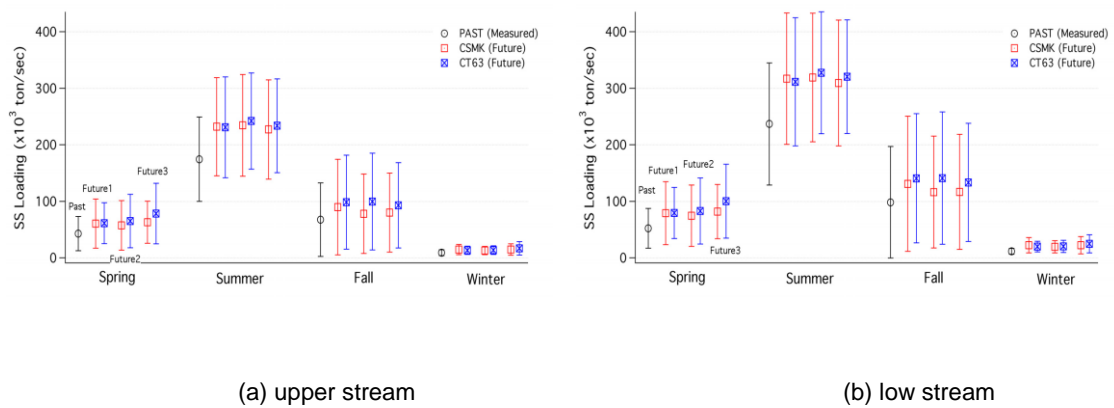
## 3. Results and Discussion

The calibration and validation results showed that the SWAT model was able to simulate the daily stream flow well, with % difference, a coefficient of determination, and Nash-Sutcliffe efficiency as less than 20%, greater than 0.7, and 0.6, respectively, for both the calibration and validation periods. The model simulations demonstrate that precipitation in the future (2011–2100) will increase 11–20% as compared to the last 30-year average. The annual summer precipitation is projected to increase by about 20–60 mm and, especially this phenomenon is more pronounced in the upper basin during winter season with increasing by 28–69%. Likewise, projected increases in temperature for this region are consistent with trends of precipitation. The impact of climate change on hydrology and SS load was quantified by driving the calibrated SWAT model with the past condition and RCM generated weather corresponding to future scenario (CSMK and CT63) in Figure 1 and 2. Annual average stream flow increased by 23–34% because of climate

change, with the largest increase occurring in summer. Seasonal variation rate in winter is predicted with 29-33% for upper stream and 50-53% for downstream. Accordingly, the runoff increase results in escalation of pollutant loading by average 23~34% for SS annual load. More specifically, the rate of pollutant loading increase is expected to continue its acceleration until 2040.



**Figure 1.** Seasonal variation of streamflow in Nakdong River watershed



**Figure 2.** Seasonal variation of SS load in Nakdong River watershed

#### 4. Conclusion

The model produced stream flow and SS load with reasonable accuracy on daily bases. Impact of climate change was then assessed by using three 30-year scenario periods (2010s ~ 2100s) generated by RCM into a global climate model (CSMK and CT63). The results demonstrate that the climate change may increase surface runoff and thereby SS load to the stream in Nakdong River Watershed. The impact is more pronounced in the upper basin during winter season, and the rate of pollutant loading increase is expected to continue its acceleration until 2040.

#### Acknowledgements

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