THE EFFECT OF CLIMATE CHANGE ON THE HYDROLOGY AND WATER RESOURCES OF THE YONGDAM DAM BASIN, SOUTH KOREA

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Abstract

There is no doubt that the increase in mean global surface temperature by 0.6±0.2□ over the 20th century(IPCC, 2001) is not only a result of climate variability but of enchanced emission of greenhouse gases due to human activities. An increase in surface temperature leads to higher evaporation rates and enables the atmosphere to transport higher amounts of water vapor. Therefore, it is assumed that the global hydrological cycle will be accelerated(Menzel et al, 2002). In contrast to the assessment of global or large scale variations of the climate driving forces for global hydrology, the impact of climate change on the regional hydrology is still unknown for most regions of world; so far only a few studies exist(Menzel et al, 2002).

It is widely accepted that GCMs provided useful large scale spatial-temporal informations, and correctly represent the physics of a CO_2 increase(Gates et al, 1993). But, a grid resolution of 2°~5°, typical for current GCMs, does not allows such details to be resolved. Therefore, there is a scale gap between the modeling of CO_2 forcing and hydrological response. This requires an intermediate step of scale aligment, usually called 'downscaling'.

We could roughly classify the runoff estimation methodologies by the combination of GCM and hydrologic models into two methods of One-way and Two-way. One-way is the simple method which the runoff is estimated as the output of GCM is input to the hydrologic model while Two-way is the one the runoff is estimated by the mutual interaction of GCM and hydrologic models. The most ideal case might be to develop a combinated model of GCM and hydrologic models for the runoff estimation under the $2CO_2$. However, unfortunately, the development level of a combinated model is just beginning stage due to the differences between resolution and structure of GCM and hydrologic model(Kite, 1999), but One-way method is widely introduced and used in the world. Ahn et al.(2001) used the water balance model to investigate the runoff change of Daecheong dam basin, Korea by using the results of GCM. Chiew et al.(1994) simulated the runoffs and soil water contents of 2030 and 2070 years for the 28 basins of Australia by inputting the results from GCM without downscaling to MODHYDROLOG model. Kwadijk et al.(1994) evaluated the climate impact for the runoff of the Rhine river, Germany with the connection of GCM and RHINFLOW. Gellens et al.(1998)

used the seven GCMs and IRMB(Integrated Runoff Model-Bultot) to analyze the impact of climate change for the runoffs of eight basins Belgium(Kite, 1999), Kite(1994; 1999) estimated the runoffs by connection of CCC GCM and SLURP model for Mackenzie and Columbia basins, Canada. Kim et al.(2001) simulated the daily runoff of Xixian basin, China using TOPMODEL. Arnell et al. (2001) list nearly 80 studies published in the late 1990s in which climate change impacts for one or more watersheds were analyzed using an approach that coupled climate models with hydrologic models. Rosenberg et al. (2003) also analyzed the impact of HadCM2 projections for the 18 major water resource regions, using the Soil and Water Assessment Tool (SWAT) watershed model

This study obtains hydrometeorologic data from the climate change simulation by the YONU GCM and statistical downscaling technique for Yongdam dam basin of Korea. First, Multi-variate regression downscaling transforms the YONU GCM grid-box predictions with coarse resolution of climate change into the site-specific values. Then, the values are used to perturb the parameters of the stochastic weather generator in order to simulate the site-specific daily weather values. The data is input to the SLURP which is a semi-distributed rainfall-runoff model, we estimate the streamflow, and analyze the impact of climate change on water resources for the basin. Say, we construct the climate change scenario of Korea by YONU GCM and downscale the scenario for the basin by the Transfer function(Wilby, 2001). We modify the parameters of WGEN(Weather Generation model)(Dubrovsky, 2001) using the downscaled scenario and simulate the daily hydrologic series under the $2CO_2$. The series is input to the SLURP (Semi-distributed Land Use-based Runoff Processes) model and evaluate the impact of climate change on water resources for the basin.