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Applying Conditional Weather Generation Downscaling Model on Long-Term Rainfall Synthesis on a Basin Scale

YuWen Chen (1), ChihChao Ho (2), and LiangCheng Chang (3)

(1) Post-Doctoral Researcher, Department of the Civil Engineering, National Chiao Tung University, Taiwan (bsjacky@gmail.com), (2) Research Assistant Professor, Construction and Disaster Prevention Research Center, Feng Chia University, Taiwan (zz0813@gmail.com), (3) Professor, Department of the Civil Engineering, National Chiao Tung University, Taiwan (lcchang31938@gmail.com)

Under climate changes, extreme hydrological events, such as droughts and floods, occurred more frequently than in previous decades. Water supply shortages for basins caused by extreme events create great challenges for water resource management. To evaluate future climate variations, global circulation models (GCMs) are the most wildly known tools that can be used to show possible weather conditions under pre-defined CO_2 emission scenarios as announced by Intergovernmental Panel on Climate Change (IPCC). Risk analysis of the water supply on a basin scale, two important tasks need to be overcome based on the results of GCMs. First, the regional results of climate change simulated by GCMs cannot be directly used in basin scale management problems and three kinds of downscaling techniques, including simple downscaling, statistic downscaling and dynamic downscaling, are traditionally used to transform the regional climate change into local weather variation, because the mesh scales used in GCMs are much larger than basin scales. Second, Monte Carlo simulation, which can be used to evaluate the water supply risk, requires a great number of supply simulations under different rainfall conditions. A great number of rainfall patterns can be synthesized from historical records or GCM downscaling results with further Monte Carlo simulations that can be used to evaluate the water supply risk. A conditional weather generation downscaling model (CWGDM) that can downscale GCM results to synthesize a great number of rainfall patterns is proposed in this paper.

In the proposed model, the scale relationship between selected regional scale climate predictors, sea level pressure, and basin scale rainfall predictands are described by a non-parametric conditional probability distribution. The pairs between predictors and predictands are plotted on an XY-plain. The range of predictors is divided into several intervals and the distribution of predictands within each interval can be replotted as a histogram. The rainfall data can be synthesized based on the histograms.

This study compares the performance of CWGDM with that of the statistical downscaling model (SDSM), a well-known downscaling model, through synthesis of basin rainfall. The result of this comparison show the statistic parameters such as sample mean and standard deviation of CWGDM synthesis data that is closer to the parameters of observation data than SDSM. This study demonstrates that the CWGDM is an appropriate downscaling model and the data can be used for further risk analysis of water supply shortages on the evaluating of the current water supply systems.