

Probabilistic Analysis of Drought Characteristics in Pakistan Using a Bivariate Copula Model

Muhammad Jehanzaib*, Ji Eun Kim, Ji Yeon Park***,
and Tae-Woong Kim******

.....

Abstract

Because drought is a complex and stochastic phenomenon in nature, statistical approaches for drought assessment receive great attention for water resource planning and management. Generally drought characteristics such as severity, duration and intensity are modelled separately. This study aims to develop a relationship between drought characteristics using a bivariate copula model. To achieve the objective, we calculated the Standardized Precipitation Index (SPI) using rainfall data at 6 rain gauge stations for the period of 1961–1999 in Jehlum River Basin, Pakistan, and investigated the drought characteristics. Since there is a significant correlation between drought severity and duration, they are usually modeled using different marginal distributions and joint distribution function. Using exponential distribution for drought severity and log–logistic distribution for drought duration, the Galambos copula was recognized as best copula to model joint distribution of drought severity and duration based on the KS–statistic. Various return periods of drought were calculated to identify time interval of repeated drought events. The result of this study can provide useful information for effective water resource management and shows superiority against univariate drought analysis.

Keywords: Conditional Probability; Copula; Standardized Precipitation Index (SPI); Severity; Duration.

* Ph.D. Student, Department of Civil and Environmental Engineering, Hanyang University, Seoul 04763, Republic of Korea, E-mail: jehanzaib7@hanyang.ac.kr

** Ph.D. Student, Department of Civil and Environmental System Engineering, Hanyang University, Seoul 04763, Republic of Korea, E-mail: helloje2@hanyang.ac.kr

*** Ph.D. Student, Department of Civil and Environmental System Engineering, Hanyang University, Seoul 04763, Republic of Korea, E-mail: pjyamy@hanyang.ac.kr

**** Professor, Department of Civil and Environmental Engineering, Hanyang University, Ansan 15588, Republic of Korea (corresponding author), E-mail: twkim72@hanyang.ac.kr