Spatial Extreme Value model for Drought Events in the Chi Watershed, Thailand

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The objectives of this research were to acquire a geographic information system model and to design a spatial drought extreme forecast of drought-prone areas in the Chi watershed, Thailand. To design a model of an extreme geospatial GIS database for accurate water management in repeated drought areas. The researchers focused on 1) analyzing three types of drought indices: three meteorological drought indices, three hydrological drought indices, and one agricultural drought index; and 2) analyzing the 10-day moving cumulative rainfall data with extreme value theory analysis. Furthermore, the highlight of this research is to correlate the cumulative maximum rainfall with climate variables using copula analysis as a basis for constructing a spatial extreme value theory model to characterize both the minimum and maximum value of the 10-day moving cumulative rainfall, which can be identified in critical areas along the upper, middle, and lower Chi watershed on a 2D map. In addition, the return level forecast for the return periods of 2 years, 5 years, 10 years, 25 years, 50 years, and 100 years was made by developing an algorithm using the R program with the ArcGIS program.

The results showed that behavioral patterns of meteorological and hydrological data such as daily maximum rainfall, the 10-day moving cumulative rainfall, runoff volume, water flow rate, etc. are altered from the past by a suitable distribution model for these data, such as exponential distribution, generalized pareto distribution, and gamma distribution. It was found that the extreme value copula was appropriate to study the relationship of the 10-day moving cumulative rainfall with climate variables and meteorological variables because it was a suitable method for analyzing the relationship between variables with non-linear correlation. Moreover, the researchers found that spatial analysis with extreme value theory, which simultaneously analyzes spatial data and extreme value properties, is suitable for developing a spatial model. This is because the geographic variables are related to the maximum and minimum values of cumulative rainfall per 10 days moving in the same and opposite directions. Thus, it is an important covariate in spatial modeling. The analysis of the highest cumulative rainfall level in each return period of the spatial model with the highest value with the max stable process revealed that the area with the highest rainfall was in Roi-Et province and Maha Sarakham province, respectively. The area with the lowest rainfall is Chaiyaphum Province. When considering the return level of rainfall in the Chi watershed in Thailand, it was found that the area with the highest rainfall was Roi Et Province, followed by Maha Sarakham Province, which was an area with repeated floods and a recurring drought due to a lack of good management. Thus, the researcher hopes the results are to be the most beneficial in planning to solve the repeated flooding and drought. Besides, it is a guideline for assessing the value of damage in advance and for building a drainage system and water storage that is suitable to optimize performance in the central Chi watershed area in northeastern Thailand.

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