A Drought Early Warning and Preparedness Framework Based on Severity-Duration-Frequency Curves and Standard Precipitation Index

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This study aims to construct a drought early warning and preparedness framework for a water resources system (i.e. Tsengwen Reservoir and its downstream area) in southern Taiwan. Since water demands (i.e. agricultural, domestic and industrial uses) in the downstream area of reservoir highly relies on the water supply of reservoir, the area is extremely vulnerable with enormous economic losses during a critical drought event. Increasing the resilience of the water supply system and mitigating the potential impact of droughts in the area are very crucial. To this end, a drought early warning and preparedness framework based on drought severity-duration-frequency (SDF) curves and standard precipitation index (SPI) is proposed.

Drought SDF curves are an effective tool for water resources planning and drought risk assessment, which can easily quantify the potential drought severity of a water resources system with a given duration and return period. This study constructs the drought SDF curves and inspect whether the existing emergency response actions are sufficient for mitigating the water shortages (severities) of different durations and return periods. Further, the emergency response actions are optimally planned for mitigating the water shortages of different durations and return periods in the study area.

The SPI is a widely used index to characterize meteorological drought on a range of timescales. It quantifies observed precipitation as a standardized departure from a selected probability distribution function that models the raw precipitation data. The current work establishes the relationships among the reservoir storage, SPIs of different timescales (e.g., SPI1, SPI3, and SPI6), and water shortages for different durations (e.g., 30, 60, and 90 days). Based on the established relationships, the water shortages for different durations can be predicted by the reservoir storage and SPIs. The predicted water shortages (severities) for different durations can be linked to the SDF curves for obtaining the corresponding return periods and the suggested emergency response actions, which supports the decision making of the early warning and preparedness. The drought SDF curves are also developed under climate change scenarios to examine the whether the existing emergency response actions are sufficient for mitigating the droughts in the study area.