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Regional Drought Monitoring Based on Multi-Sensor Remote Sensing

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Drought originates from the deficit of precipitation and impacts environment including agriculture and hydrological resources as it persists. The assessment and monitoring of drought has traditionally been performed using a variety of drought indices based on meteorological data, and recently the use of remote sensing data is gaining much attention due to its vast spatial coverage and cost-effectiveness. Drought information has been successfully derived from remotely sensed data related to some biophysical and meteorological variables and drought monitoring is advancing with the development of remote sensing-based indices such as the Vegetation Condition Index (VCI), Vegetation Health Index (VHI), and Normalized Difference Water Index (NDWI) to name a few. The Scaled Drought Condition Index (SDCI) has also been proposed to be used for humid regions proving the performance of multi-sensor data for agricultural drought monitoring.

In this study, remote sensing-based hydro-meteorological variables related to drought including precipitation, temperature, evapotranspiration, and soil moisture were examined and the SDCI was improved by providing multiple blends of the multi-sensor indices for different types of drought. Multiple indices were examined together since the coupling and feedback between variables are intertwined and it is not appropriate to investigate only limited variables to monitor each type of drought. The purpose of this study is to verify the significance of each variable to monitor each type of drought and to examine the combination of multi-sensor indices for more accurate and timely drought monitoring. The weights for the blends of multiple indicators were obtained from the importance of variables calculated by non-linear optimization using a Machine Learning technique called Random Forest.

The case study was performed in the Republic of Korea, which has four distinct seasons over the course of the year and contains complex topography with a variety of land cover types. Remote sensing data from the Tropical Rainfall Measuring Mission satellite (TRMM) and Moderate Resolution Imaging Spectroradiometer (MODIS), and Advanced Microwave Scanning Radiometer-EOS (AMSR-E) sensors were obtained for the period from 2000 to 2012, and observation data from 99 weather stations, 441 streamflow gauges, as well as the gridded observation data from Asian Precipitation Highly-Resolved Observational Data Integration Towards Evaluation of the Water Resources (APHRODITE) were obtained for validation. The objective blends of multiple indicators helped better assessment of various types of drought, and can be useful for drought early warning system. Since the improved SDCI is based on remotely sensed data, it can be easily applied to regions with limited or no observation data for drought assessment and monitoring.