Advancing drought monitoring via feature extraction

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Abstract

A drought is a slowly developing natural phenomenon that can occur in all climatic zones and can be defined as a temporary but significant decrease in water availability. Over the past three decades, the cost of droughts in Europe has amounted to over 100 billion euros and it is expected to considerably increase as future droughts are projected to be more severe and long-lasting. Although drought monitoring and management are largely studied in the literature, they often fail at yielding precise information on critical events occurrence and associated impacts such as reduction of electricity production or crop failures. This is due to the difficulty of capturing the complexity of drought dynamics, which evolve over diverse temporal (and spatial) scales, including short-term meteorological droughts, medium-term agricultural droughts, and long-term hydrological droughts, as well as the non-physical aspects related to droughts (water management, irrigation, etc.). In this work, we contribute a Machine Learning based framework named FRIDA (FRamework for Index-based Drought Analysis) for the identification of impact-based, site-specific drought indexes. FRIDA is a fully automated data-driven approach that relies on advanced feature extraction algorithms to identify relevant drought drivers from a pool of candidate hydro-meteorological variables. Selected predictors are combined into an index representing a surrogate of the drought conditions in the considered area, including either observed or simulated water deficits or remotely sensed information about the state of the crops. FRIDA is portable across different contexts for supporting the formulation of basin-specific indexes to better inform drought management strategies. Several real-world examples will be used to provide a synthesis of recent applications of FRIDA in case studies featuring diverse hydroclimatic conditions and variable levels of data availability.

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A drought is a slowly developing natural phenomenon that can occur in all climatic zones and can be defined as a temporary but significant decrease in water availability. Over the past three decades, the cost of drought in Europe has amounted to over 100 billion euros and it is expected to considerably increase as future droughts are projected to be more severe and long lasting. Although drought monitoring and management are largely studied in the literature, they often fail at yielding precise information on detecting critical events and their associated impacts, such as reduction of electricity production or crop failures. This is due to the difficulty of capturing the complexity of drought dynamics that evolve over diverse temporal (and spatial) scales, including short-term meteorological droughts, medium-term agricultural droughts and long-term hydrological droughts, as well as the non-physical aspects related to droughts (water management, irrigation, etc.).

In this work we contribute a Machine Learning procedure named FRIDA (FRamework for Index-based Drought Analysis) for the identification of impact-based, site-specific drought indexes. FRIDA is a fully automated data-driven approach that relies on advanced feature extraction algorithms to identify relevant drought drivers from a pool of candidate hydro-meteorological predictors. Selected predictors are then combined into an index representing a surrogate of the drought conditions in the considered area, including either observed or simulated water deficits or remotely sensed information about the state of the crops. The resulting framework is therefore portable across different contexts for supporting the formulation of basin-specific indexes to better inform drought management strategies. A number of real-world examples will be used to provide a synthesis of recent applications of FRIDA in case studies featuring diverse hydroclimatic conditions and variable levels of data availability.