Abstract

Droughts, which occur due to insufficient availability of water, are known to have become more frequent in this era of changing climate. In order to be better prepared for a more extreme future climate, it is important to characterize droughts considering its hydroclimatic synchronisation. Through an improved characterization and better understanding of hydroclimatic teleconnections between global climate variables and regional hydrologic variables, it may be possible to provide reliable drought predictions for better management of water resources.

For hydroclimatic characterization of short-term droughts, an anomaly based index, named as Standardized Precipitation Anomaly Index (SPAI), is proposed in this thesis to overcome the limitations of the existing Standardized Precipitation Index (SPI). Next, considering Indian hydroclimatology as a case, the association between various climate variables and rainfall extremes, identified through SPAI, is investigated. It is observed that apart from the well-known teleconnection patterns, a Global Climate Pattern (GCP), consisting of several climate variables such as sea surface temperature, surface pressure, wind speed, air temperature and total precipitable water from various zones of the world, is responsible for dry and wet events in India. Using the proposed SPAI, drought events in India are identified and the three drought attributes – severity, duration and 'time since last drought' are analyzed through a trivariate copula based model to develop drought severity maps of India.

Long-term characterization of drought propensity of a region on a multi-year temporal scale is achieved in terms of Drought Management Index (DMI), which is developed using soil moisture characteristics. The spatio-temporal variability of DMI across India and the predictability of DMI are examined. For assessment of future trend in drought propensity over the 21st century across the globe, the General Circulation Model (GCM) simulated soil moisture data is used. A new bias correction technique, named as Conditional Quantile-based Bias Correction (CQBC), is proposed to address some of the short-comings of existing bias correction techniques in the context of soil moisture series. Across the globe, an increasing trend in drought propensity is noted over most of the locations, though a decreasing trend as well as 'no trend' is also observed for some locations.

Key words: Drought Characterization and Prediction, Hydroclimatology, Precipitation, Soil Moisture, Drought Indices, Global Climate Pattern, Hydroclimatic Teleconnection, Reliability-Resilience-Vulnerability (RRV), Bias Correction, General Circulation Model (GCM)