

Innovative approaches in agricultural technology for early drought detection using Earth Observation data

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Drought is one of the most severe climate-related hazards affecting Sri Lanka, where a large share of the population depends on rain-fed agriculture for livelihoods and food production. Prolonged dry spells lead to substantial crop failures, economic instability, and rising food insecurity. However, existing drought monitoring and early warning systems in the country remain inadequate: they often lack regional specificity, rely on fragmented datasets, and fail to provide timely alerts that farmers and decision-makers can act upon. To address this critical gap, the present study develops a region-specific drought early warning framework that leverages freely available satellite data from MODIS and Sentinel, combined with drought indices such as the Normalized Difference Vegetation Index (NDVI), Vegetation Condition Index (VCI), and Temperature Condition Index (TCI). Through time-series analysis of remote sensing data, the system detects vegetation stress and surface temperature anomalies that signal drought conditions several weeks before visible impacts occur. Validation with historical drought records and agricultural observations shows improved sensitivity in identifying early warning signals across multiple agro-ecological zones. The framework emphasizes cost-effectiveness and scalability by relying on open-access data and cloud-based geospatial processing, removing the need for expensive ground-based infrastructure. Importantly, outputs can be translated into practical tools such as drought maps and near-real-time alerts, supporting adaptation measures like irrigation planning, crop diversification, and land-use management. By directly targeting the lack of timely, locally relevant drought information, this research provides an operational solution to strengthen resilience among farming communities. Beyond Sri Lanka, the framework presents a transferable model for drought-prone regions worldwide, demonstrating the broader potential of Earth Observation technologies to enhance sustainable agriculture and food security under changing climate conditions.

Keywords: *Agro-ecological zones, Climate risk management, Vegetation stress monitoring, Remote sensing applications, Food security resilience*