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High-resolution drought monitoring with Sentinel-1: A case-study over Mozambique

Samuel Massart, Mariette Vreugdenhil, Sebastian Hahn, Pavan Muguda Sanjeevamurthy, Carina Villegas-Lituma, and Wolfgang Wagner

TUWien, Faculty of Mathematics and Geoinformation, Department of Geodesy and Geoinformation, Wien, Austria
(samuel.massart@geo.tuwien.ac.at)

Droughts are characterized by periods of below-average precipitation leading to an imbalance in the hydrological cycle and reduced water availability.

In the last decades, higher average temperatures and shifts in annual rainfall patterns have increased the frequency, intensity, and length of droughts across the globe.

With the majority of its population living in rural areas and a high economic dependency on rain-fed agriculture, Mozambique is particularly vulnerable to droughts, as water shortages have devastating environmental, agricultural, and economic impacts. Therefore, monitoring droughts in Mozambique is key to developing early warning systems and adequate planning for drought impact mitigation.

In this study, we propose a novel approach to retrieve a drought index at a kilometer-scale resolution based on surface soil moisture (SSM) products derived from Sentinel-1 (S1) and ASCAT. First, both SSM products are processed over the Mozambican region using a change detection method (Sentinel-1 sampled at 1km and ASCAT at 6.25km) and compared to SSM from ERA5-Land. Then, by combining the long-term ASCAT data record with the high spatial resolution of Sentinel-1, we generate a monthly kilometer-scale drought index for the period 2016 to 2023 over six study areas located in South-central Mozambique (Chokwé, Mabote, Massinga, Buzi, Muanza and Govuro). The S1-ASCAT indicator is then evaluated against state-of-the-art drought indices based on precipitation data (Standardised precipitation index from CHIRPS (Rainfall Estimates from Rain Gauge and Satellite Observations)) and vegetation data (Normalized difference vegetation index from the Copernicus Global Land Service).

This study explores the potential of high-resolution SSM based on active microwave remote sensing to monitor agricultural droughts. Our results show that a drought indicator based on Sentinel-1 and ASCAT can temporally and spatially capture sub-regional drought patterns over Mozambique.