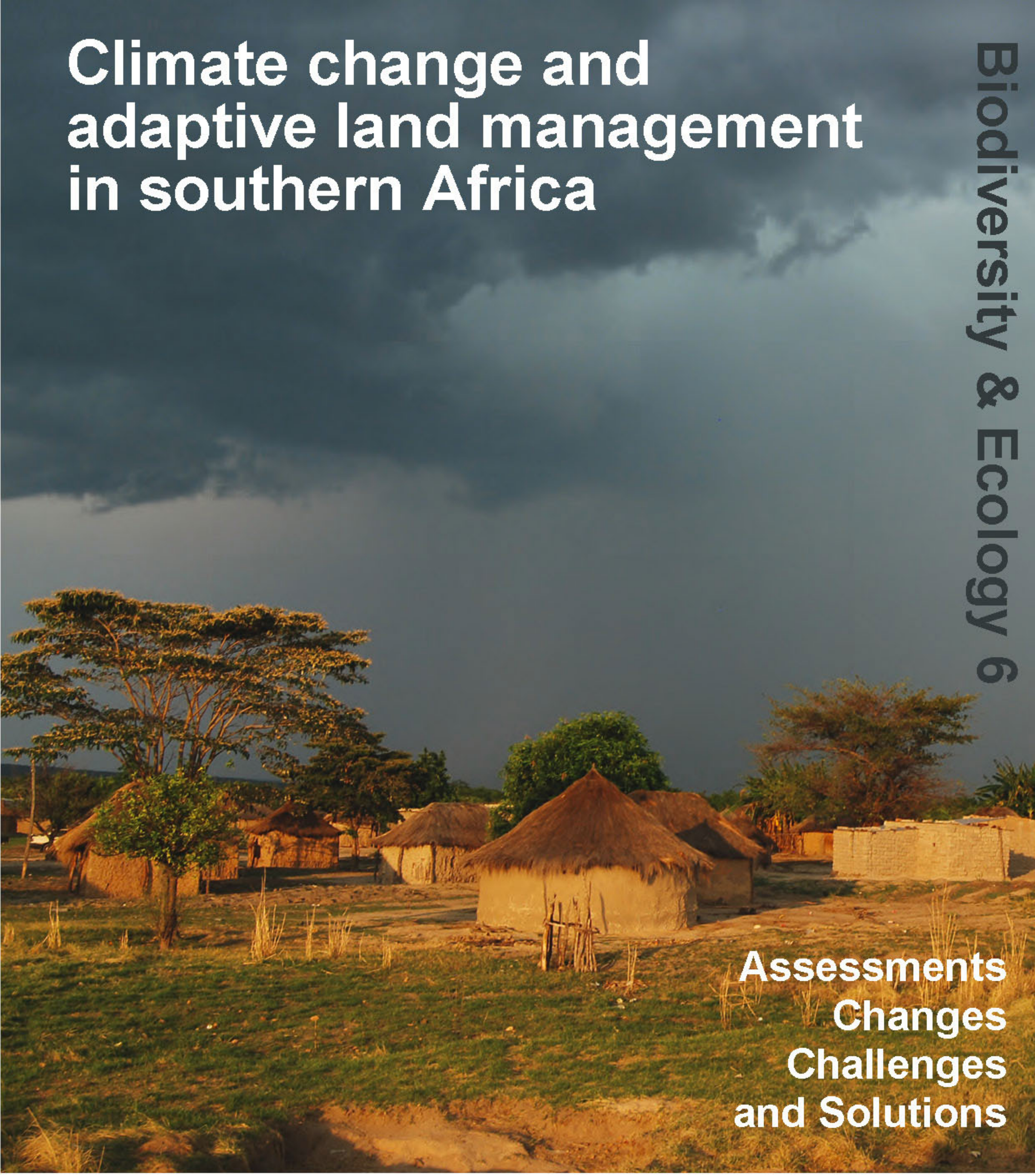
Climate change and adaptive land management in southern Africa

Biodiversity & Ecology 6



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Changes
Challenges
and Solutions

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Climate change and adaptive land management in southern Africa

Assessments, changes, challenges, and solutions

Edited by

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The Extreme Climate Index (ECI), a tool for monitoring regional extreme events

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The Extreme Climate Index (ECI) is an objective, multi-hazard index capable of tracking changes in the frequency or magnitude of extreme weather events in Africa. The index is geared towards identifying broad-scale climate extremes that may affect several countries at once and could impact food security as well as countries' individual ability to manage such events. The index is intended to be included in the climate index insurance scheme by African Risk Capacity (ARC) towards calculation of payouts.

The index is calculated per 2.5° grid points across Africa. The index is calculated from two observational datasets. These are the NCEP Reanalysis (Kalnay et al., 1996) daily temperature data together with the CHIRP (Climate Hazards Group InfraRed Precipitation; Funk et al., 2015) dataset for monthly rainfall. The higher-resolution rainfall dataset (0.05° spatial resolution) is resampled to the coarse resolution of the temperature data.

To identify extreme conditions, the ECI is calculated by combining a rainfall- and a temperature-based index:

- The Standardized Heat Index (SHI): Calculated from daily maximum temperature, considering maximum temperature relative to the statistical distribution of the historical time series.
- The Standardized Precipitation Index (SPI; McKee et al., 1993): Derived from monthly rainfall data. The SPI has been used widely and is considered to be a robust representation of the rainfall situation for any location with a historical rainfall dataset.

Based on the variability of rainfall as represented by the three-month SPI, seven large homogenous areas are identified through cluster analysis (Fig. 1). For each cluster, the index is calculated separately. The mean of the SPI per cluster and the mean of the SHI per cluster, per day, are standardized. The combination of these standardized input indices allows for the identification of various types of extreme conditions such as cold and wet, warm and dry, warm and wet, etc., per cluster.

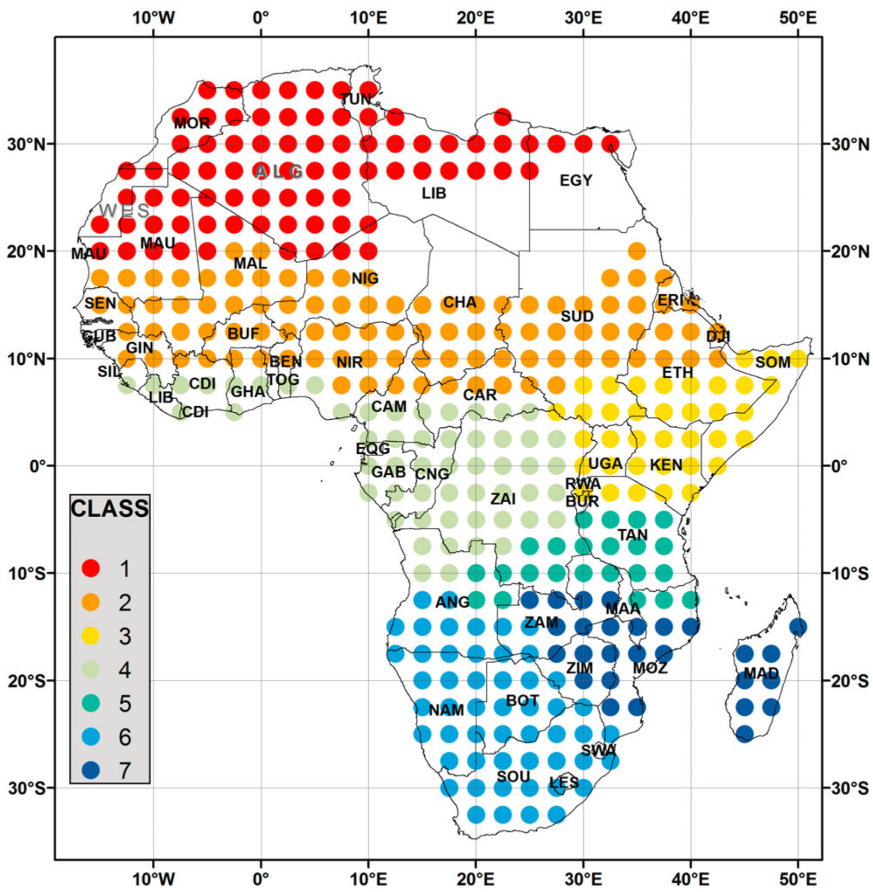

Figure 1: Climate clusters for the ECI across Africa, obtained by adopting the three-month Standardized Precipitation Index (SPI) as an underlying cluster object to identify relatively homogenous zones.

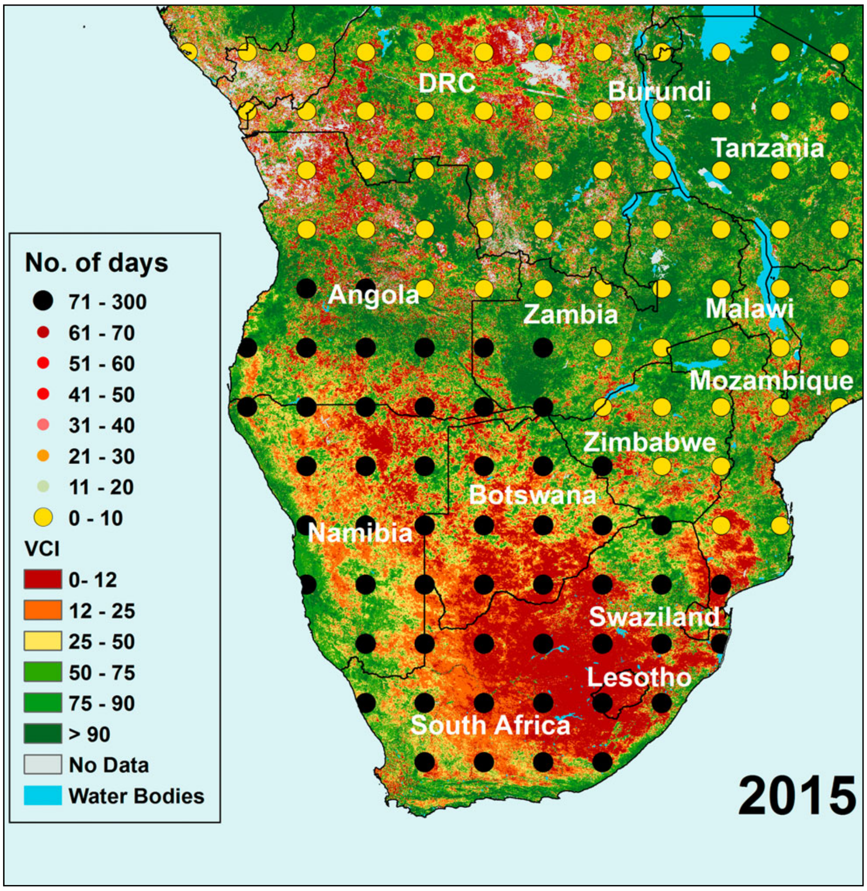

Figure 2: Vegetation Condition Index (VCI) by late December 2015 (green-to-brown colours) overlain by the 2.5° ECI grid (dots) indicating the number of days during 2015 when the index reached extreme values (> 95th percentile). Warm colours of the VCI indicate vegetation stress (here related to drought).

The Council for Scientific and Industrial Research (CSIR) in South Africa and SASSCAL evaluated the potential of anthropogenic climate forcing to influence the behaviour of the index through the 21st century. Towards this end, we consider also the ability of the index to identify extreme events under current conditions. Utilizing various evaluation datasets for southern and eastern Africa such as disaster relief, river flow, and crop production data, the index identified the most extreme events since 1982 with an accuracy of 72%.

The most recent drought over large parts of southern Africa occurred during the summer of 2015/2016 (Archer et al., 2017). During this drought event, the largest rainfall deficits occurred during October to December 2015, resulting in largest negative effects on vegetation activity already by December 2015. The map in Figure 2 shows the ability of the ECI to identify the most severely affected areas as indicated by drought-related vegetation stress by late December 2015. To identify drought-related stress, the Vegetation Condition Index (VCI; Quiring & Ganesh, 2010) is shown in green to brown colours. The legend was chosen to identify vegetation stress in brown. It is clear that the most severe stress, over a wide region, occurred across South Africa, Botswana, and Namibia. The VCI is overlain by the 2.5° gridded ECI, showing the number of days per ECI cluster (Fig. 1) during 2015, when the index reached extreme values (> 95th percentile). It demonstrates how the index correctly identified, at a regional scale, the most affected area as shown by an unrelated vegetation index.

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