N8 AgriFood
Food Systems Policy Hub

Durham University

Remote sensing could enable more evidence-based policy to monitor and manage tropical dryland forests

Key Messages

- Remote sensing and Earth Observation technologies help to assess and monitor forest ecosystems and provide spatially explicit, operational, and long-term data to assist the sustainable use of tropical environment landscapes.
- However, few studies assess carbon storage or biomass, and there is little research on EO methods for assessing REDD+ initiatives in dryland forests in most Southern African countries.
- Africa has the potential to emulate other continents, such as Latin America, that have made notable progress in employing freely available remote sensing data to monitor tropical dryland forest area change and biomass on a large scale.
- Greater use of a wider range of EO products could enable more evidence-based policy to prioritise sustainable use of forests, enabling the policy community to learn what works to reduce deforestation and forest degradation, to improve livelihoods in a changing climate.

The Research

Researchers have assessed the evidence base for a number of tropical dryland forests-remote sensing options, asking how remote sensing technology was used to monitor and estimate changes in dryland forests in southern Africa. The researchers considering evidence from over 130 peer-reviewed papers including research on land-use/land-cover, forest cover/types, biomass, forest structure, biodiversity/habitats, phenology, plant traits, and disturbances from drought and fire. It considered publication trends over time, study location, remote sensing sensor/platform used, spatial and temporal coverage, remote sensing product (e.g., biophysical indices) used, and application areas of the study (e.g., land cover, forest biomass).

Key findings and evidence

Publication trends	Although the volume of scientific literature has demonstrated a sharp increase, the use of remote sensing is still limited, and up until 2013, the number of publications on tropical dryland forests was relatively small.
Time scales	Time series analysis on dryland forests, which enables tracking changes is scarce, only 22 (16%) out of 137 studies feature time series lengths that exceed 15 years and only 11 (8%) studies that cover more than 20 years. Longer time series of remote sensing data afford the ability to assess the dynamics of forest structures, biodiversity, degradation, disturbance from climatic extremes, and change in phenology, in which a gap still exists.

Spatial scales	Despite new sensor and EO data availability, it is clear that a systematic and consistent regional monitoring of dryland forests is not yet fully exploited and is still in its infancy in Southern Africa. In fact, the majority of publications 88 (64%) concentrated their research efforts on local scale investigations. To fully assess regional and long-term implications for tropical dryland forest change studies, analyses on large(r) scales are needed, ideally with higher spatial resolutions and longer temporal duration.
Geographical focus	The Republic of South Africa is, by far the most studied nation across all categories in Southern Africa and the dryland forests of Angola, Mozambique, Lesotho, Swaziland, and Zambia are noticeably very poorly studied. In terms of National Parks, a large proportion of studies were undertaken in the Kruger National Park, leaving many other private and international protected areas relatively understudied. Future efforts to estimate important variables such as forest cover and biomass need not be restricted by country boundaries.
Research categories	Most studies focused on forest cover/types 41 (26%) and land cover/land use 36 (23%) categories while there is limited research on forest biomass and structures, disturbances from drought, phenology, plant traits, and biodiversity/habitats.
Vegetation indices	More than half of the studies, 84 (54%) of papers utilised the normalized difference vegetation index (NDVI, and few studies used other vegetation indices. Testing other vegetation indices beyond NDVI such as the Sentinel-2 red-edge related indices is needed in tropical dryland forests.
Remote sensing sensors	Imagery from optical sensors is most commonly used, out of all sensor types. More than 90% of papers investigated used optical sensors, 6% used SAR data and only 4% used a combination of SAR and Optical sensors. Further improvements should focus on extensive combination and fusion of SAR and optical data.
Validation and accuracy assessments	Our results show there is limited information on sources of error and uncertainty levels of the estimates provided by most studies, with only 54 (39%) of the studies appearing to have performed some form of accuracy assessment. Evidence indicates a need for more frequent use of field observation and inventory data, a greater use of validation/accuracy assessments.
Use of innovative remote sensing platforms	Only nine papers (6%) out of 137 used cloud-based geospatial analysis platforms such as Google Earth Engine (GEE) to access or analyse remote sensing data. The web-based platforms that reduce the need for costly local infrastructure (e.g., GEE), is an opportunity to overcome the limitations previously enforced by data scarcity, large volumes of data, and the scale of analysis.

Limitations

- There is limited information on sources of error and uncertainty levels of the estimates provided by most studies assessed. As a result, for some interventions, there is not sufficient evidence to determine whether the number of studies done equates to research quality, which remains difficult to articulate from a review of this nature.
- One major problem encountered is that commonly used vegetation indices and classification schemes are generalised from better-studied ecosystems, such as temperate and rain forests and this has led to poor accuracy results when extrapolated to, for example, tropical dryland forests, making it difficult to create robust syntheses for decision-makers in policy and practice.

Find out more

For more information, please contact:

Ruusa-Magano David
Email: ruusa-magano.david@durham.ac.uk
Department of Geography, University of Durham

N8 AgriFood Food Systems Policy Hub
Email: policy@n8agrifood.ac.uk
Website: https://policyhub.n8agrifood.ac.uk

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