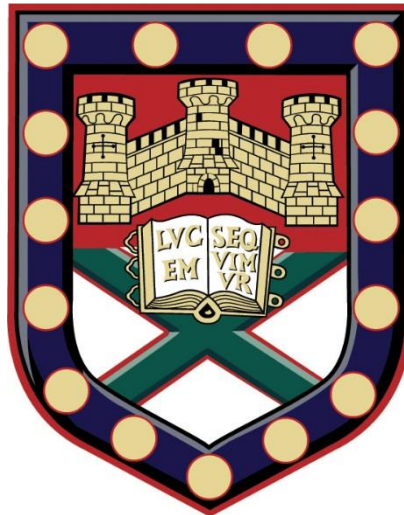


Protected Area Performance in the Dry Forests and Savannahs of West Africa: a Study using L-band Synthetic Aperture Radar



Submitted by Andrew Cox to the University of Exeter
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ABSTRACT

Tropical ecosystems harbour the highest concentrations of biodiversity on Earth and play a pivotal role in the global carbon cycle, yet deforestation and degradation continue unabated in many regions, with net forest loss at 5.5 million ha yr⁻¹ between 2010 and 2015. Protected areas offer a partial solution to this problem, with a growing body of evidence demonstrating their effectiveness for habitat conservation in the dense forests of Amazonia, Central Africa and Southeast Asia. Despite containing over a quarter of global biodiversity hotspots and being low density but significant carbon stores, tropical drylands have received far less attention in conservation terms, and research into protected areas in these ecosystems is far more limited. The overall effectiveness of protected areas in different dryland regions, and the factors influencing performance, are less understood. By measuring protected area performance as a function of aboveground biomass change, this study investigated the effectiveness of protected areas in the savannah belt of Nigeria, a country with a long history of environmental degradation. L-band Synthetic Aperture Radar (SAR), a form of remote sensing that penetrates the vegetation canopy, provided a means of consistently monitoring aboveground biomass change over time. Twenty-one areas, ranging in size from 117,000 ha to 608,410 ha, and offering varying levels of protection according to IUCN designations, were selected, with aboveground biomass changes between 2007 and 2017 determined by subjecting L-band SAR data to a novel approach called 'Biomass Matching'. The combination of SAR and Biomass Matching allowed aboveground biomass changes within these protected areas to be detected and estimated without the need for supplementary field data, which is usually required to calibrate such remote sensing data. All but four protected areas experienced increases in aboveground biomass over the study period, with mean change being +1.22 Mg ha⁻¹, compared to +0.26 Mg ha⁻¹ for a set of twelve similar unprotected areas. Furthermore, their performance was affected by an array of factors, though accessibility and management efficacy were deemed the most influential. These results suggest that, with appropriate monitoring and resourcing, protected areas in Nigerian dry forests and savannahs can provide effective habitat conservation, though more inaccessible areas will inherently perform better.

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ABBREVIATIONS AND ACRONYMS

AGB = aboveground biomass

ALOS = Advanced Land Observing Satellite

AW3D30 = ALOS World 3D – 30m

BGB = belowground biomass

C = carbon

CA = control area

CH₄ = methane

CIESIN = Center for International Earth Science Information Network

CITES = Convention on International Trade in Endangered Species

CO₂ = carbon dioxide

DBH = diameter-at-breast-height

FAO = Food and Agriculture Organisation of the United Nations

GDP = gross domestic product

GHG = greenhouse gas

GIS = Geographic Information Systems

GPWv4 = Gridded Population of the World, Version 4

gROADSv1 = Global Roads Open Access Data Set, Version 1

HH = horizontal-send, horizontal receive

HV = Horizontal-send, vertical receive

IPCC = Intergovernmental Panel on Climate Change

IUCN = International Union for Conservation of Nature

JAXA = Japanese Aerospace Exploration Agency

LiDAR = light detection and ranging

LULCC = land-use and land-cover change

MODIS = Moderate Resolution Imaging Spectroradiometer

N₂O = nitrous oxide

NDC = Nationally Determined Contributions

PA = protected area

PADDD = protected area downgrading, downsizing and degazettement

PALSAR = Phased-array type L-band synthetic aperture radar

RCS = radar cross-section

SAR = synthetic aperture radar

SDG = Sustainable Development Goal

SEDAC = Socioeconomic Data and Applications Center

SRTM DEM = Shuttle Radar Tomography Mission digital elevation model

UN = United Nations

UNDP = United Nations Development Programme

UNEP-WCMC = United Nations Environment World Conservation Monitoring Centre

UNFCCC = United Nations Framework Convention on Climate Change

WDPA = World Database on Protected Areas

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