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Remote sensing of tropical vegetation properties in response to fire return time

Ramesh K. Ningthoujam[1,2], Nayane Cristina Candida dos Santos Prestes[3], Marcelo Feitosa de Andrade[4], Maria Antonia Carniello[4], Corli Wigley Coetsee[5], Mark E. Harrison[6,13], Kitso Kusin[7], Azad Rasul[8], Agata Hoscilo[9], Adam Pellegrini[10], Imma Oliveras[11], Ted R. Feldpausch[12], Susan Page[13], Keith J. Bloomfield[2], Sandy P. Harrison[1,14], and Iain Colin Prentice[1,2]

[1]Leverhulme Centre for Wildfires, Environment and Society
[2]Georgina Mace Centre for the Living Planet, Department of Life Sciences, Imperial College London, London, UK
[3]Programa de Pós-Graduação em Ecologia e Conservação, Universidade do Estado de Mato Grosso (UNEMAT), Nova Xavantina, Brazil
[4]Universidade do Estado de Mato Grosso (UNEMAT), Brazil
[5]Savanna Node, Scientific Services, Kruger National Park, SANParks, South Africa and School of Natural Resources, George Campus, Nelson Mandela Univ., South Africa
[6]Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Exeter, UK
[7]Centre for International Cooperation in Sustainable Management of tropical Peatlands, University of Palangka Raya, Palangka Raya, Central Kalimantan, Indonesia
[8]Soran University, Iraq
[9]Institute of Geodesy and Cartography, Poland
[10]Department of Plant Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EA, UK
[11]Environmental Change Institute, School of Geography and the Environment, University of Oxford, South Parks Road, OX13QY Oxford, UK
[12]Geography, College of Life and Environmental Sciences, University of Exeter, Exeter, UK
[13]School of Geography, Geology and the Environment, University of Leicester, Leicester, UK
[14]Geography and Environmental Science, University of Reading, Reading, UK

Fire modifies vegetation spectral reflectances in the optical, thermal and microwave domains due to the changes it induces in vegetation canopy components (leaves, needles, branches) and in soil properties. Freely available satellite-derived (Landsat) Vegetation Indices (VIs) and PALSAR Mosaic backscatter measurements (known to be sensitive to vegetation structure) were used to help understand vegetation properties (species richness, basal area) in relation to fire return time (FRT) across a range of tropical biomes (open savanna, savanna forest, evergreen forest, peat-swamp forest) in Mato Grosso (Brazil), Kruger National Park (South Africa) and Central Kalimantan (Indonesia).

For each site, we combined: (i) post-fire Landsat imagery (30 m) to derive VIs sensitive to vegetation diversity with (ii) PALSAR (25 m) backscatter that employes a longer wavelength (21 cm) and dual polarisation (Horizontal-Horizontal, Horizontal-Vertical) enabling the capture of strong backscattering of signal by branches and trunks.

Most of the Landsat VI values showed greater variability in forests compared to open savanna, reflecting the greater diversity in species' composition and growth form. A strong positive relationship was found between VIs and FRT across biomes and especially in forests. The amount of vegetation burned per fire as recorded by the magnitude of changes in these VIs, was highest in annual burn regimes (FRT = 1 year). Green and red-edge bands provided better discrimination of vegetation species richness and basal area. A significant positive relationship to basal area in response to fire return time was also found using PALSAR data due to its deeper canopy penetration level and strong backscattering from woody components. The observed responses of VI- and PALSAR-inferred species' richness and basal area in response to FRT in different tropical biomes suggest that the green and red-edge channels from optical and longer wavelength HV-backscatter are useful metrics to quantify post-fire tropical vegetation dynamics.