Spatial variability of biophysical vegetation traits in East Africa, measured from space and on the ground

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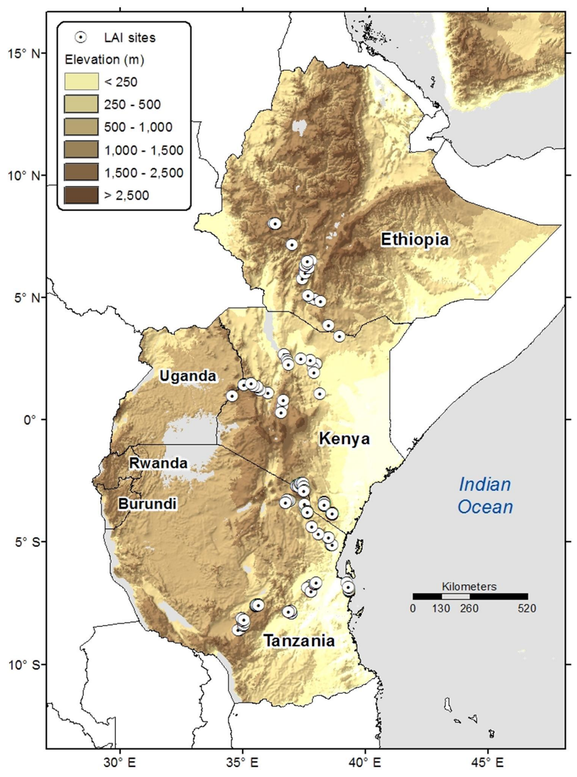
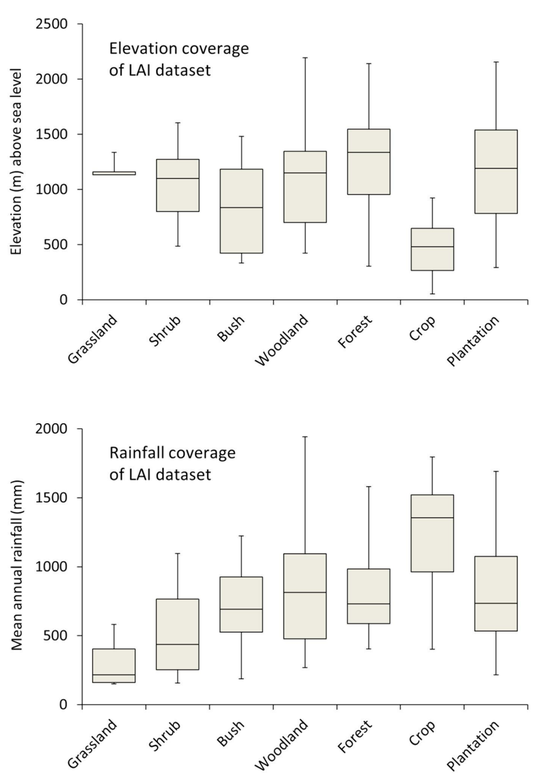
Leaf Area Index

Leaf Area Index (LAI) is a key biophysical trait used to characterise canopy structure and productivity. It is defined to be half the total leaf surface area per unit ground area. Our LAI database covers more than 250 sites across East Africa (Pfeifer & Platts, 2013). We use the data to: (1) estimate LAI for major biomes; (2) analyse LAI response to environmental gradients; (3) develop regional LAI maps for use in ecosystem process models (Pfeifer et al. 2012). We are working to address the 'tropical LAI gap', which limits models of vegetation-atmosphere interaction, hydrological flows and crop productivity.

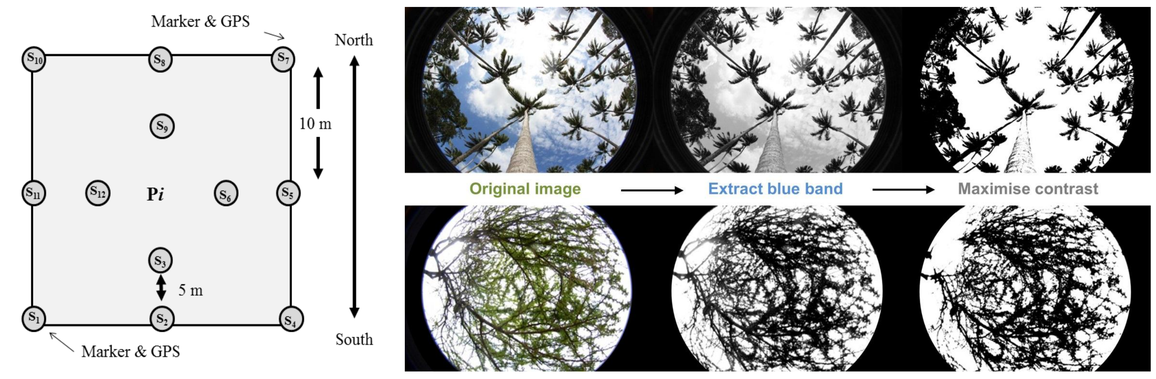




Mapped distribution of sites visited between 2007 and 2012 (N=90, Tanzania; N=150, Kenya; N=30, Ethiopia). LAI was recorded using hemispherical photography (N=270) and the SunScan Delta-T device (N=45). Boxplots summarise coverage by biome type, with respect to altitude (SRTM at 30 arc-sec resolution) and rainfall (TRMM 1997-2006). Boxes span the interquartile range; whiskers extend to the 5th and 95th percentiles.

Methods

LAI was recorded using two methods: (1) Sunscan Delta-T instrument, which measures incident and transmitted photosynthetically active radiation in vegetation canopies; (2) hemispherical photography, using a digital camera plus fisheye lens and tripod.



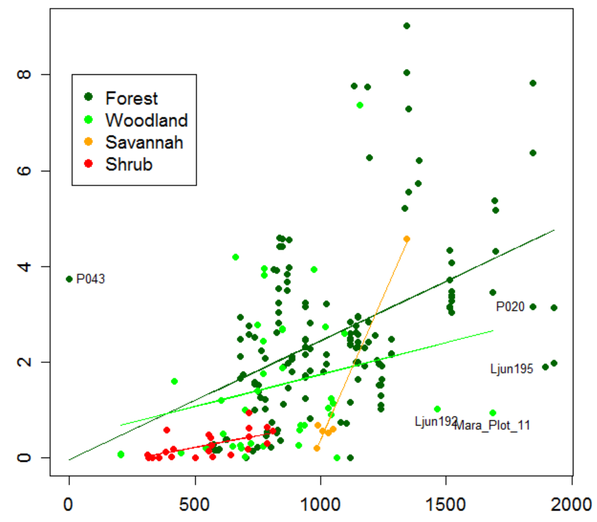
Hemispherical images and SunScan readings are taken in 20m x 20m plots, following a 'VALERI' design to capture sub-pixel vegetation heterogeneity in canopy structure. From the images , we extract the blue band information and maximise contrast between leaf and sky. These dichotomised data can be used to estimate mean gap fraction and mean LAI per plot.

Upscaling

Canopy structure and LAI differ significantly both within and between natural biomes. LAI is shown to increase with long-term mean annual rainfall, with an additional effect of increasing elevation above sea level (linear mixed-effects model):

LAI ~ Rain + Biome + Elevation + (1|Camera)

AIC = 722.1, logLik = -348.1



LAI relationship with mean annual rainfall

Projects

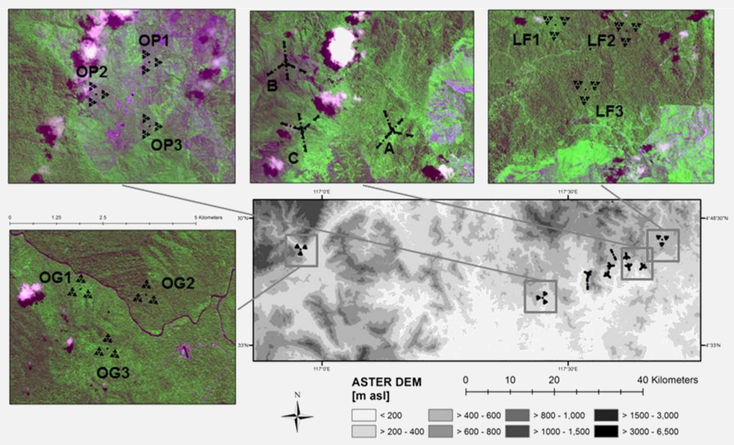
WWF-Tanzania REDD+ Capacity to deliver short and long term data on forest carbon. Can canopy structure be linked to carbon storage?
http://www.reddtz.org/

Marsabit (Kenya) Long-term resource extraction and deforestation in and around a protected area. LAI helps to assess impacts on microclimate, hydrology and carbon

CHIESA Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa

3 transects, 3 mountains, 3 countries: Kilimanjaro, Tanzania; Taita Hills, Kenya; Jimma Highlands, Ethiopia http://www.icipe.org/chiesa/

Pan-tropical links: SAFE Project Biophysical response to land use in Borneo (Malaysia)



Stability of Altered Forest Ecosystems
http://www.safeproject.net/

Background

LAI variation within biomes at landscape scales has rarely been estimated, especially in the tropics. Global scope, earth observation derived LAI maps are available, but accuracy in the tropics is compromised by a lack of data to ground-truth algorithms and validate estimates. This data gap introduces high uncertainties in ecosystem process models, which simulate vegetation-atmosphere interactions at regional and global scales.

References

Pfeifer & Platts, 2013. KITE LAI database for East Africa, v1.1. Accessible at http://www.york.ac.uk/environment/research/kite/

Pfeifer et al. 2012. *Rem Sens Env*, **118**, 103-115

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