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

Platts PJ1, Marchant R1, Pfeifer M1-2

1 York Institute for Tropical Ecosystems, Environment Department, University of York
2 Natural Sciences, Imperial College London

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.

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.

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

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.

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.

LAI relationship with mean annual rainfall

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):

\[
\text{LAI} = \text{Rain} + \text{Biome} + \text{Elevation} + [1](\text{Camera})
\]

AIC = 722.1, logLk = -348.1

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

References

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

Supported by FP7-People-IEF-2008 No. 234394, European Space Agency (C1P 6972), British Institute in Eastern Africa, Ministry for Foreign Affairs of Finland.