SAFARI 2000 PAI Estimates from Hemispherical Photography, Kalahari Transect

Abstract

This data set was collected during February-March 2000 wet season and September 2000 dry season field campaigns of SAFARI 2000. Mongu in Zambia and Pandematenga (aka Kasane) and Tshane in Botswana were visited during the wet season campaign. Dry season data are for Mongu only.

Hemispherical photographs, from which Plant Area Index (PAI) estimates were derived, were obtained at the field sites to characterize vegetation structural changes along the Kalahari Transect. At each site, photographs were collected using a Nikon Coolpix 950 digital camera with a fish-eye lens mounted on a tripod, every 25 m along three transects, each 750 m in length.

The methodology of van Gardingen et al. (1999) was applied to process the data. The photographs are classified into sky and vegetation (trunk, green and senescent leaves, and branches) using an unsupervised classification scheme. Derivation of gap fraction estimates was carried out by dividing the azimuth sector for each view zenith into 72 equal area segments with the gap fraction estimated for each segment. The average azimuth segmented gap fraction was used to characterize the gap fraction at the current view zenith angle. This approach attempts to reduce the underestimation introduced by assuming a random distribution in clumped canopies. PAI estimates were derived from the gap fraction data using Miller's (1967) formula for average foliage density.

Background Information

Investigators:
Gareth Roberts (groberts@geog.ucl.ac.uk)

Project: SAFARI 2000

Data Set Title: SAFARI 2000 PAI Estimates from Hemispherical Photography, Kalahari Transect

Site: Kalahari Transect
Westernmost Longitude: 28.19
Easternmost Longitude: 21.893
Northernmost Latitude: -15.43
Southernmost Latitude: -31.5

Data Set Citation:

Roberts, G. 2004. SAFARI 2000 PAI Estimates from Hemispherical Photography, Kalahari Transect. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Data File Information

The PAI estimates are provided in comma-delimited ASCII files, one for each transect at each site. At each site, three transects were established (termed A, B, and N -- spaced 250 m apart) which are 750 m long with measurements made every 25 m (31 measurements per transect). The sample numbers within the data files are numbered in the order that they were collected, starting from either the East or West end of the transect: the lowest number representing the first point measurement on the transect. See the tables in the **Site Information** section below for more information. The file names are as follows:

pai_site_transect_2000-season.csv

where **site** is either Kasane, Mongu, or Tshane; **transect** is either tranA (transect A), tranB (transect B), or tranN (transect N); and **season** is either Wet or Dry.

Within each file, there is a 5-line header, then a blank line, then column names, then the two-column data (sample number and PAI).

PAI Data File Structure

Column	Description
Header	
Title	SAFARI 2000 PAI Estimates from Hemispherical Photography
PI Name	Gareth Roberts (groberts@geog.ucl.ac.uk)
Site	Kasane, Botswana, Mongu, Zambia, or "Tshane, Botswana
Season	Dry Season 2000 or Wet Season 2000
Transect	A, B, or N; and Direction (east to west) or (west to east)
Data	
Sample	The sample number (1 to 31) which designates how many 25 m steps along the transect the data was taken, from the starting point (west or east)
PAI	Plant Area Index, derived from a hemispherical photograph taken at the location

The following is a sample file listing for the file "**pai_kasane_tranA_2000-wet.csv**".

```
SAFARI 2000 PAI Estimates from Hemispherical Photography
Gareth Roberts (groberts@geog.ucl.ac.uk)
Site: Kasane, Botswana
Season: Wet Season 2000
Transect: A (east to west)

Sample,PAI
1,2.67914
2,2.43271
3,2.17801
4,3.05516
5,1.81136
6,2.63701
7,2.56253
8,2.13755
9,2.92244
10,3.21557
11,2.63251
12,2.82883
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13,2.51527
14,1.92841
15,1.79078
16,1.44661
17,1.05483
18,0.861996
19,4.10891
20,1.39539
21,1.70613
22,2.31094
23,1.86654
24,1.38655
25,3.01448
26,2.06585
27,1.14035
28,0.663506
29,0.369354
30,0.343253
31,2.48704
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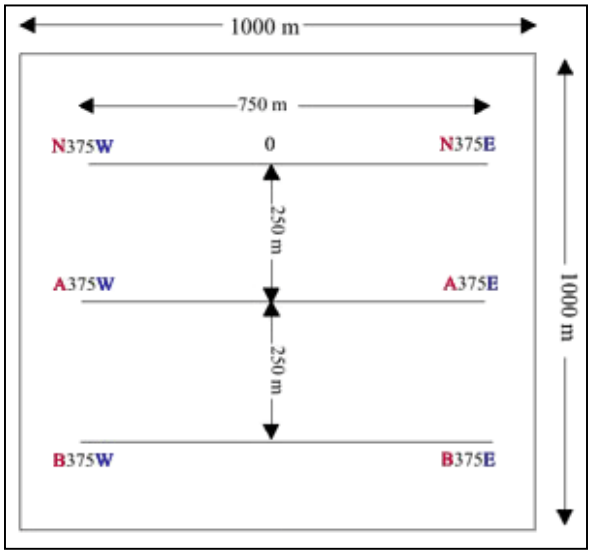
Site Descriptions

The wet season campaign had field sites in Mongu (Zambia), Pandematenga (aka Kasane - Botswana), and Tshane (Botswana) where hemispherical photographs were taken. At each site, three transects were laid (termed A, B, and N -- spaced 250 m apart) which are 750 m long with hemispherical photographs taken every 25 m (31 measurements per transect). The sample numbers within the data files are numbered in the order that they were collected, starting from either the East or West end of the transect: the lowest number representing the first point measurement on the transect.



Site	Season	Transect A		Transect B		Transect N	
		Direction	Camera Height	Direction	Camera Height	Direction	Camera Height
Kasane	Wet	East -> West	203 cm	East -> West	204 cm	East -> West	204 cm
Mongu	Dry	West -> East	148 cm	West -> East	146 cm	West -> East	150 cm
Mongu	Wet	East -> West	140 cm	East -> West	141 cm	West -> East	143 cm
Tshane	Wet	West -> East	65 cm	West -> East	66 cm	West -> East	64 cm

Methodology

These data were collected using a Nikon Coolpix 950 digital camera with fish-eye lens mounted on a tripod. All images were leveled using a digital level to ensure the hemispherical lens was flat and vertical. The approach applied to process the data follow the methodology of van Gardingen et al. (1999). A view zenith angle image at 5 degree increments and a view azimuth image at 5 degree increments are used in this analysis.

Nikon Coolpix 950 Digital Camera with Fish-eye Lens Mounted on a Tripod.

The hemispherical images were first classified into sky and vegetation classes using an unsupervised classification scheme. The vegetation class included trunks, leaves (green and senescent), and branches. As such, the estimates refer to Plant Area Index (PAI) and not Leaf Area Index (LAI) which is defined by the green leaf area per unit area. Derivation of gap fraction estimates were carried out by dividing the azimuth sector for each view zenith into 72 equal area segments with the gap fraction derived for each segment. The average azimuth segmented gap fraction was used to characterize the gap fraction at the current view zenith angle. This approach attempted to reduce the underestimation introduced by assuming random distributions in clumped canopies.

The approach applied to derive PAI estimates from the gap fraction data used Miller's (1967) equation:

LAI_effective = 2 * (integral (0-Pi/2) ln(1/GapFraction) * cos(theta) * sin(theta)) * dtheta

where theta is the view zenith angle and dtheta is the difference between the current and the previous angular bins (i.e., in this case the view zenith was binned into 5 deg segments). The angular integral is the summation over the angular range of the camera 0-90 degrees.

This was similar to that utilized in the LAI-2000. While the azimuth sector was fully sampled, zenith angles were restricted to be those between 20 and 70 degrees zenith. van Gardingen et al. (1999) found this method to produce the most reliable results by minimizing the number of gap fractions of 1 (nadir) and zero (70 degrees view zenith).

Note: Free software, Gap Light Analyser (GLA), is available from http://www.rem.sfu.ca/forestry/downloads/gap_light_analyzer.htm which can be used to process hemispherical images.

Potential Limitations of the Data Set

The main source of uncertainty for this data set relates to the classification of the hemispherical images. The classification was carried out using an unsupervised classification scheme. This has resulted in some mis-classification of sky elements into vegetation and vise versa which will overestimate and underestimate the PAI estimates for that location. Furthermore, due to constraints imposed by the camera tripod, the PAI estimates mainly relate to the upper story only, with the shrub and understory omitted.

Additional Sources of Information

Additional related data sets collected during the Kalahari Transect Wet Season Field Campaign are archived by ORNL DAAC. A list of these data sets is available at: http://www.daac.ornl.gov/S2K/safari.html.

Global Positioning System (GPS) coordinates for the grid transect end points were collected at the Kalahari Transect sites and can be found in the file GPS_Coords_transect_endpts.txt.

References

van Gardingen, P. R., G. E. Jackson, S. Hernandez-Daumas, G. Russell, and L. Sharp. 1999. Leaf area index estimates obtained for clumped canopies using hemispherical photography. Agricultural and Forest Meteorology, 94(3-4): 243-257.

Norman, J. M., and G. S. Campbell. 1989. Canopy Structure, pp 301-325. In: Pearcy, R. W., J. R. Ehleringer, H. A. Mooney, and P. W. Rundel (eds.). Plant Physiological Ecology. Field Methods and Instrumentation. Chapman and Hall, London.

Miller, J. B. 1967. A formula for average foliage density. Aust. J. Bot. 15: 141-144.

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