SAFARI 2000 Leaf Area Index and Canopy Structure, Kalahari Transect, 1999-2000

Abstract

Data from the Tracing Radiation and Architecture of Canopies (TRAC) instrument were collected at five sites along the International Geosphere-Biosphere Programme (IGBP) Kalahari Transect, including Mongu in Zambia and Pandamatenga, Maun, Okwa River Crossing, and Tshane in Botswana, during the 2000 wet season field campaign (March-April) of SAFARI 2000. At the Mongu site, TRAC measurements began in August of 1999 and continued beyond the 2000 wet season field campaign, about every month for the rest of 2000.

The TRAC instrument contains pyranometers that are sensitive to photosynthetically active radiation (PAR) at 400–700 nm. The TRAC measures the PAR flux transmitted through the overstory canopy continuously at 32 Hz. The parameters derived from the TRAC instrument include estimates of plant or leaf area index (PAI, LAI), overstory gap fraction, and clumping index.

At each site, the TRAC instrument was carried along three parallel transects, each 750 m long and spaced 250 m apart. Measurements were made every 25 m along the transects. The length and spacing of the transects were chosen to sample an area large enough to be representative of a 1 km MODIS pixel.

Background Information

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Project: SAFARI 2000
Southern Africa Validation of EOS (SAVE)

Data Set Title: SAFARI 2000 Leaf Area Index and Canopy Structure, Kalahari Transect, 1999-2000

Site: Kalahari Transect
Westernmost Longitude: 21° 42' 47"
Easternmost Longitude: 25° 30' 01"
Northernmost Latitude: -15° 26' 16"
Southernmost Latitude: -24° 09' 51"

Data Set Citation:

Privette, J. L. and M. Mukelabai. 2004. SAFARI 2000 Leaf Area Index and Canopy Structure, Kalahari Transect, 1999-2000. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Web Site: http://modarch.gsfc.nasa.gov/MODIS/LAND/VAL/terra/privette/

Data File Information

The data files are stored as ASCII text files, one file per transect, site, and date, with column headers. The file naming convention is **site_dd_mm_y.txt**, where **site** is a single-character indicator for site (see Site Table below), **dd** and **mm** are the day and month of data collection, and **y** is the last digit of the year of data collection. The mean solar zenith angle at the time of the measurements is included at the end of the LAI data records for each file.

File Description

Column Name	Definition	Units/Format
Segment Number	Identification of the sequential 25 m segment along the 750 m transect (usually starting from west end)	unitless
LAI	leaf area index, assuming stem_area=0 and accounts for clumping	m^2/m^2
PAIe	effective plant area index, does not account for clumping	m^2/m^2
Omega	Clumping Index	fraction
GapFrSZA	Gap Fraction at the solar_zenith_angle	fraction
GapFrVert	Gap Fraction overhead (i.e., at zenith)	fraction

Sample Records

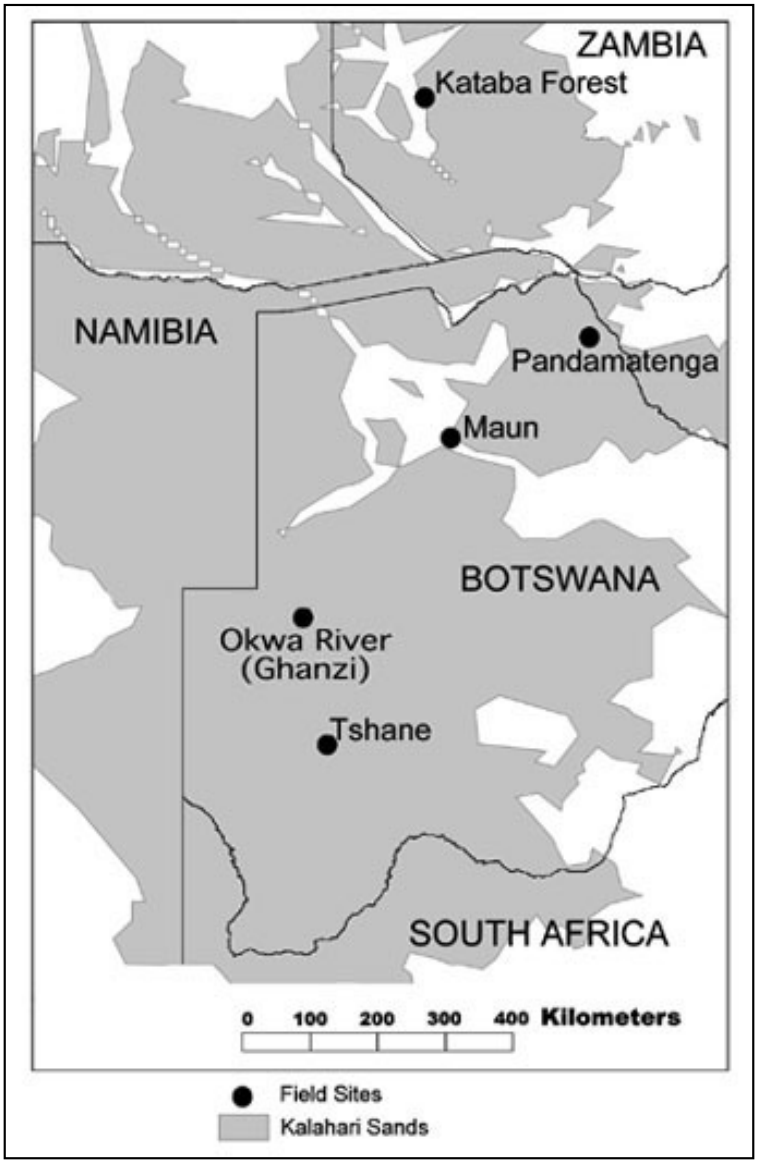
Segment	LAI	PAIe	Omega	GapFrSZA	GapFrVert
1	0.280	0.277	0.989	0.573	0.871
2	0.291	0.283	0.972	0.565	0.868
3	0.437	0.421	0.964	0.428	0.810
4	0.329	0.329	1.000	0.515	0.848
5	0.413	0.358	0.867	0.486	0.836

Study Sites

Measurements were taken during the SAFARI 2000 wet season campaign at five sites along a portion of the Kalahari Transect extending from Mongu, Zambia in the north to Tshane, Botswana in the south (see map below). This portion of the Kalahari Transect covers a mean rainfall gradient from 879 mm in Mongu to 365 mm in Tshane. The Kalahari Transect is marked by fairly constant arenosol soils, typically tens of meters deep (the Kalahari sands). The Transect's vegetation includes near-continuous Kalahari woodlands (Miombo woodland on sand) to the north and increasingly sparser woodlands and savannas southward. All field sites were on the southern African plateau with elevations of about 1000 meters. All sites in Botswana exhibited signs of light grazing. The region experiences a hot continental climate with pronounced wet and dry seasons. Nearly all of the rain occurs from November to April, while typically no rainfall occurs from June to September. The vegetation is generally semi-deciduous, responding to the seasonal variation in rainfall. Additional site summary information is available in Otter et al. (2002), Dowty et al. (2000), and Scholes et al. (2002).

Locations of the Kalahari Transect sites:

Sites	Country	Site Abbreviation	Latitude	Longitude
Mongu (Kataba Forest)	Zambia	**M**	-15° 26' 16"	23° 15' 10"
Pandamentanga	Botswana	**P**	-18° 39' 19"	25° 30' 01"
Maun/Okavango Delta	Botswana	**D**	-19° 55' 22"	23° 35' 40"
Ghanzi/Okwa River Crossing	Botswana	**O**	-22° 24' 33"	21° 42' 47"
Tshane	Botswana	**T**	-24° 09' 51"	21° 53' 34"



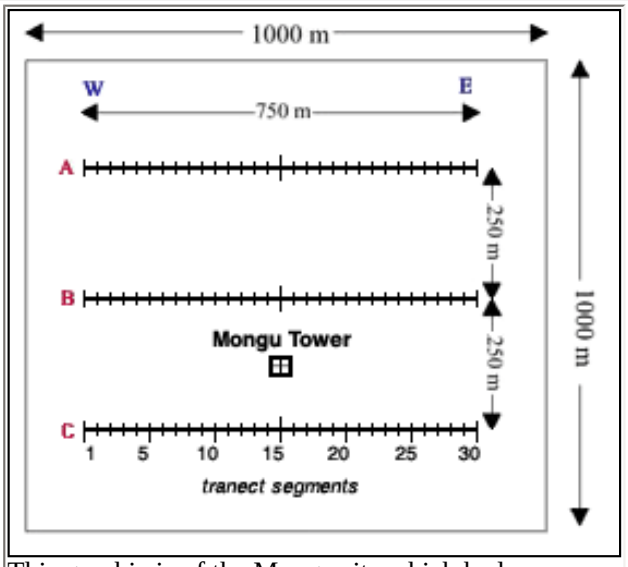
Theory of Measurements

This study examined LAI through the seasons at Mongu, and over the IGBP Kalahari Transect's large precipitation gradient for the other sites. There is much theory written about determining LAI from canopy gap probability information. The particular approach used by TRAC was developed by Jing Chen of the University of Toronto. TRAC's particular feature is the estimation of true LAI by correcting the effective LAI for vegetation clumping (determined from the same instrument).

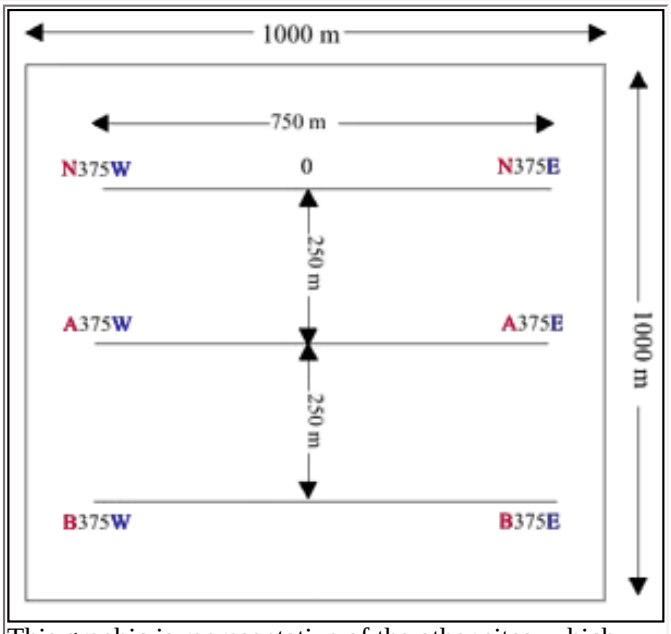
Data Collection

The TRAC data were collected by slowly walking along the transects, holding the instrument level to the ground (as much as possible) with the TRAC in front, generally heading in the direction of the sun. The sensor head was held about 0.7 m above the ground. Data were only collected when the sun was not obscured by clouds. The TRAC measures the PAR flux transmitted through the overstory canopy continuously at 32 Hz. A time stamp was imprinted into the data set at stake flags located along the transects every 25 m, demarcating the end of each segment.

Measurements with the TRAC were made at each site along three parallel transects oriented east-west, each 750-m long. At Mongu, the northern-most transect was labeled A, the middle transect B, and the southern-most transect was named C. The Mongu flux tower was located midway between the B and C transects. At all other sites, the northern-most transects were labeled N, the middle transcet A, and the southern transect B. The parallel transects were laid out 250 m apart. Data reported represent measurements for each 25-m segment, numbered 1 to 30, along the 750 m transects. The length and spacing of the transects were chosen to sample an area large enough to be representative of a 1 km MODIS pixel.



This graphic is of the Mongu site which had a different transect naming scheme than the other sites. The transects were named A, B, and C, from north to south, respectively.



This graphic is representative of the other sites, which were centered on the provided coordinates, and the transects were named N, A, and B, from north to south, respectively.

Data Processing

The raw TRAC data were first checked and corrected such that data from the 30 segments are properly delineated in the data set. The data were then processed with the TRAC software (TRACWin 2.3.3, proprietary software) from instrument vendor. A 40 mm characteristic leaf diameter was assumed. The TRACWin software produces estimates of LAIe, LAI, and gap fraction (along the sensor-sun vector). Finally, the zenith gap fraction is estimated by correcting the TRACWin gap fraction (Privette et al., 2004).

Transect "B" at the Okavango/Maun site (file 'O09030B') had only 29 segments, and therefore was only 725 m long. To facilitate automated processing, we created a 30th segment by copying segment 29 into that position. The overall effect on results should be minimal.

Quality Assessment

LAI and gap fraction results reported here are consistent with data measured by SAFARI investigators using other instruments (see Privette et al., 2004; Scholes et al., 2002) at the same sites. There are no independent measures of clumping index.

Errors and Limitations:

Since TRAC measures the light transmittance through the canopy, it is sensitive to all materials in the canopy, both leaves and branches. Although many investigators use PAI and LAI interchangeably, more accurate LAI estimates are possible by subtracting the Stem Area Index (SAI) from the PAI. For Kalahari Transect sites, SAI was not measured. Privette et al. (2002) suggests a value of 0.3 to 0.4 based on data from other locations. As we can assume the change in branch area is small over the temporal coverage, then observed changes in LAI from the TRAC are due to changes in leaf area.

The instrument did not measure vegetation below about 70 cm height. Therefore, the true vertical PAI or LAI values may be slightly higher. In most cases, the grass layer was fairly insignificant. At Okwa, however, there was abundant grass. Therefore, results for Okwa are questionable since most of the vegetation at that site was grass and below the TRAC sensor height. See Privette et al. (2002) for a picture and more details.

While the gap fraction in the direction of the sun is measured, the overhead (zenith) gap fraction is approximated by assuming the vertical canopy clumping equals the measured canopy clumping (along the sun-sensor vector; see Privette et al., 2004). This approximation is probably reasonable but was not validated.

Only two transects (A and B) were measured at the Maun site since the northern transect (A) was mostly in dense shrubbery. This shrubbery is mostly below the TRAC sensor operational height, and its size and density made a linear transect impractical. The 'B' transect at Maun was missing one flag at 'B150W'. Therefore, transect flags jump from B175W to B125W, and the full transect is only 725 m. In the .txt file containing the gap fraction estimates, the 29th segment was copied to the 30th position to allow full 750 m transect processing.

Manufacturer of Sensor or Instrument

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Additional Sources of Information

Related Data Sets

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.

Additional TRAC data were collected approximately monthly at Mongu in 2001 and 2002:

Privette, J. L., M. M. Mukelabai, and K. F. Huemmrich. 2005. SAFARI 2000 FPAR TRAC Data for Mongu, Zambia, 1999-2002. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

TRAC LAI data were also collected at Skukuza, Kruger National Park, South Africa (Lat: 25 deg 01 min 12 sec; Lon: 31 deg 29 min 48 sec), an EOS Land Validation Core Site. These data are available by contacting the investigator.

References

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