SAFARI 2000 Woody Vegetation Characteristics of Kalahari and Skukuza Sites

Abstract

An international group of researchers completed an intensive field campaign in Botswana and Zambia in February and March of 2000. This campaign represented one of the main activities of the SAFARI 2000 program. It included participants from a number of institutions with research projects spanning plant physiology, ecological and hydrological processes, meteorology and atmospheric aerosols, and ground validation of satellite-derived data products. The campaign was organized around the rainfall gradient of the Kalahari Transect (Chanda et al., 1998; Scholes and Parsons, 1997) and represented a convergence of many independently sponsored research activities.

The data presented here include the species composition, basal area, height, and crown cover of all woody plants at the six sites along the Kalahari Transect visited between February 29 and March 16, 2000. Also included are measurements taken at the Skukuza Flux Tower site in Kruger National Park, South Africa, in June of 2000. The Skukuza site is not on the Kalahari Transect; however, it is a core SAFARI 2000 and Earth Observing System (EOS) validation site that was the focus of several studies during SAFARI 2000 campaigns. The purpose of this data collection was to document the species composition and structural characteristics of the woody vegetation at the sites, which were to be used for EOS sensor validation as part of the Southern African Validation of EOS (SAVE) and SAFARI 2000.

Background Information

Investigators:
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Project: SAFARI 2000
Southern African Validation of EOS (SAVE)

Data Set Title: SAFARI 2000 Woody Vegetation Characteristics of Kalahari and Skukuza Sites

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

Data Set Citation:

Scholes, R. J. 2004. SAFARI 2000 Woody Vegetation Characteristics of Kalahari and Skukuza Sites. 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

Canopy Composition and Structure Data Files

The woody vegetation data (basal area, height, density, and biomass) by species are contained in the files:

  kt_tree_data.csv
  skukuza_tree_data.csv

The files are in comma-delimited ASCII format, with the first line listing the data set, author, and date. The data records follow and are described in the tables below. In addition to the measurements provided for each species, the files also include a record of totals for all species at each site. A value of -9.99 indicates no data.

Column	Description	Units/Format
SITE	k=Kataba forest, p=Pandamatenga, m=Near Maun, e=HOORC/MPG Maun tower, o=Okwa river crossing, t=Tshane, skukuza=Skukuza Flux Tower	ASCII
SPECIES	Scientific name up to 25 characters	ASCII

BA	Woody plant basal area	$m^2\ ha^{-1}$
SEBA	Standard error of BA	$m^2\ ha^{-1}$
DENSITY	Woody plant density (number of trees per hectare)	ha
SEDEN	Standard error of DENSITY (n=42 for KT, n=49 for Skukuza)	ha
STEMS	Number of stems per hectare (/ha)	ha
HEIGHT	Basal area-weighted average height	$m^2\ ha^{-1}$
WOOD	Aboveground woody plant wood dry biomass	$kg\ ha^{-1}$
LEAF	Aboveground woody plant leaf dry biomass	$kg\ ha^{-1}$
LAI	Leaf Area Index calculated by allometry	$m^2\ m^{-2}$

LAI Data Files

The LAI data are provided in the files:

kt_lai.csv
skukuza_lai.csv

The files are in comma-delimited ASCII format, with the first line listing the data set, author, and date. The data records follow and are described below. A value of -9.99 indicates no data.

Column	Description	Units/Format
SITE	Site name	ASCII
DATE	Date of data collection	yyyymmdd
LATITUDE	Latitude coordinate of measurement	degrees, negative south
LONGITUDE	Longitude coordinate of measurement	degrees, positive east

LAIACC1	Leaf area index from Accupar instrument at 1 m above ground level (0 m at Skukuza)	$m^2\ m^{-2}$
LAIACC1SE	Standard error of LAIACC1 (n=42 for KT, n=49 for Skukuza)	$m^2\ m^{-2}$
LAIACC0	Leaf area index from Accupar instrument at 0 m above ground level (Skukuza only)	$m^2\ m^{-2}$
LAIACCSE	Standard error of LAIACC0 (n=49)	$m^2\ m^{-2}$
LAIMASS	Leaf area index from allometric calculation of leaf mass and area per mass (maximum tree leaf area index)	$m^2\ m^{-2}$
ORIENT	Canopy orientation (ratio of horizontal axis of ellipsoid to vertical axis), KT sites only.	dimensionless
Comment	Comments on measurements (Skukuza only)	ASCII

Skukuza Herbaceous Layer Data File

The herbaceous layer data are contained within the file:

skukuza_herb_data.csv

The files are in comma-delimited ASCII format, with the first line listing the data set, author, and date. The data records follow and are described below. A value of -9.99 indicates no data.

Column	Description	Units/Format
Genus Species	Scientific name up to 25 characters	ASCII
Basal area	Species basal area	percent

SEBA	Standard error of basal area	percent
Biomass	Standing crop dry biomass	$g\ m^{-2}$

Included Software Code and Raw Data Files

Also included are data input and output files as well as the software code (written in TurboPascal) used to process the data on a Windows PC. The file names for each site are listed in the site table in the next section of this document.

- The **xTREES.TXT** files are the raw input data to the **CIRCPLOT.EXE** program. They are useful for those who want to know the size distribution of stems for performing demographic studies, since this information is lost in the synthesis.
- The **xTREESUM.TXT** files are the output of **CIRCPLOT.EXE**. They represent the site-by-site summaries of species composition and structure which are the key content of this data set.

Site Descriptions

Six sites along an aridity gradient from Zambia south through Botswana were visited. The latitudes and longitudes refer to the central point in a 300 x 300-m square, or its southwest corner. The coordinates and elevation were determined using a Global Positioning System (GPS). Elevation data are +/- 30-m, and locations +/- 10-m.

The Skukuza site in the Kruger National Park in South Africa is not on the Kalahari Transect. However, it was the focus of several studies during the SAFARI 2000 campaigns. The methods for vegetation description used at Skukuza were essentially the same as those used for sites on the Kalahari Transect and thus the data are described together here.

Site Name	Latitude (deg S)	Longitude (deg E)	Lat-Lon Location	Elevation (m)	Date	Raw Data & Summary Files

Kataba (Mongu)	-15.43892	23.25298	centre	1195	29 Feb 2000	KTREES. TXT KTREESUM. TXT
Pandamatenga	-18.65651	25.49955	centre	1138	7 March 2000	PTREES.TXT PTREESUM. TXT
Maun 1	-19.92558	23.59038	SW corner		7 March 2000	MTREES. TXT MTREESUM. TXT
Maun 2	-19.91641	23.5594	SW corner		11 March 2000	ETREES. TXT ETREESUM. TXT
Okwa River	-22.41226	21.70962	SW corner		11 March 2000	OTREES. TXT OTREESUM. TXT
Tshane	-24.16837	21.88806	campsite 200 m West		16 March 2000	TTREES. TXT TTREESUM. TXT
Skukuza	-31.49688	25.01973	centre	365	June 2000	STREES.TXT STREESUM. TXT

Methodology

Sampling protocol was the same at each site, with a slight variation at Skukuza. A grid of 42 points (7 rows by 6 columns) was laid down on a magnetic north-south, east-west orientation, with 50-m spacing between grid points. At each grid point, all woody plants within a circular plot of a fixed radius were identified and measured. The radius of the plots were fixed at each site, but varied between sites, depending on the tree density, and ranged 3 to 6- m (see table below). Whether a plant was inside or outside the circular plot was determined using a Haglof sonic distance

measuring equipment, with the transponder located at the grid intersection. The instrument has an uncalibrated accuracy of about 1%. The definition of what was a woody plant varied per site. In the dense woodland sites (Kataba, Pandamatenga, Maun) only trees taller than 2-m qualified. The shrub layer was sampled separately, using a line intercept method. At the drier sites (Okwa and Tshane) even low shrubs (>0.5 m) were included in the circular plot sample.

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Site	Radius of plots (m)	Number of transects (m)	Length of transects (m)
Kataba	4	8	20
Pandamatenga	5	24	50
Maun	5	14	20
Maun MPG	5	14	40
Okwa	6	42	20
Tshane	6	16	50
Skukuza	6	20	50

Stem circumference was measured just above the basal swelling (typically about 10-20 cm above the ground) on all stems, to the nearest cm, using a dressmaker's tape. For multi-stemmed shrubs where the stem diameter was less than 5 cm, the median stem circumference was usually estimated by eye, and the number of stems was recorded. The basal area per stem was derived by dividing the circumference squared by 4π, was summed by species, then divided by the circular plot area (πr^2) and expressed as m^2 ha^{-1} (numerically the same as cm^2 m^{-2}). The mean and standard error of the basal area for the 42 circular plots, per species, are the values in the data set.

Tree and stem density (DENSITY and STEMS, respectively) were determined from actual counts of the number of trees and stems in subplots and extrapolated to hectares. The woody plant height was determined using a Suunto clinometer and the distance meter. The weighted mean height (WMHEIGHT) and its standard error were calculated as:

$$WMHEIGHT = \sum (BA * ht) / (n * \sum (BA))$$

e.g., it is the sum per species of the height (ht) of each individual multiplied by its basal area (BA), and then normalized by the total basal area of that species per site, multiplied by the number of individuals (n) of that species.

The aboveground woody biomass and the peak leaf area index were estimated for the sites using published allometric relationships. If a species-specific relationship was not available, the generalized relationships

$$M_{wood} = 0.035D^{2.5} \text{ and } M_{leaf} = 0.01D^2$$

were used, where M= dry mass (kg) and D=diameter (cm). A specific leaf area of 6 m^2 kg^{-1} was assumed when better data were not available.

All the above calculations were performed using a dedicated program written in TurboPascal. The code is provided among the data files. The executable and the software code are included in the files circplot.exe and circplot.pas, respectively. Also included here are the input and output data files for the circplot program for each site, as listed in the site table. The input files are useful for those who want to know the size distribution of stems for demographic studies, since this information is lost in the synthesis. The species names follow the spelling and authority of *Memoirs of the Botanical Survey of South Africa* No. 56 (Gibbs-Russell, 1987), or subsequent sources if a name change had occurred.

Tree projected canopy cover was measured by line intercept. Transects of variable length per site (range 300 to 1200 m) were laid out along the rows of the grid system. Using the sonic distance measuring equipment, the beginning and end of each intercepted canopy was recorded. Where canopies overlapped, the species was assigned to the tree with the tallest canopy. The % canopy cover was calculated as the intercepted length divided by the total line length, times 100.

LAI Measurements

A grid of 42 points, 6 rows of 7 columns, each 50 m apart, was laid down in an area 300 m x 350 m for the Kalahari Transect sites. At Skukuza, the grid was 7x7, or 350 m x 350 m, centered on the tower site, yielding 49 points.

A Decagon Accupar instrument was used in PAR measurement mode, with the probe segmented into twenty 5 cm intervals. The instrument was held horizontal, pointing north, at 1 m above the ground, and data were collected at each grid point. This took about 40 minutes for all points. Two Licor PAR sensors, one fitted with a shadow band, were attached to a Licor 2000 leaf area instrument in datalogging mode to record incoming direct and diffuse PAR in an area close to the site (<100 m) but without canopy cover. After downloading the data from the Accupar and from the Licor, the 'gap fraction' was calculated for each grid point following the algorithms described in the Decagon manual.

The measurements were repeated at two times of the day: one when the solar zenith angle was around 60 degrees (from vertical, about 0800 or 1600) and one when the solar zenith angle was about 0 degrees (1130 to 1230). Using the latitude, longitude, day of year, and time, the exact solar zenith angle was calculated for each grid point, and the LAI and leaf orientation were solved for. The mean and standard error of the LAI were calculated for the 42 (49) points.

Note that these data refer to the LAI of woody plants above 1 m. At some of the sites, however, the LAI at ground level (which includes woody plants, shrubs, herbs, and grass) was also collected.

On the day prior to LAI measurement, the stem diameter and height of a representative sample of trees in each site were measured. Using published allometric relations, or

$$\text{Leaf Mass (kg)} = 0.01 * \text{diameter}^2$$

where no relationship was available, the leaf mass per species was estimated. The leaf area was determined by multiplying the leaf mass by the published Specific Leaf Area ($m^2\ kg^{-1}$) for the species or by 6.0 where no SLA data were available, and expressed per m^2 of the sampled area.

Herbaceous Layer Basal Cover, Biomass, and Species Composition

The herbaceous layer was sampled at the Skukuza tower flux site on June 24, 2000. Grass rooted basal area and soil cover state were measured using a Bruce-Levy frame 1.5 m long, with 10 needlepoints. The frame was placed in each cardinal

direction, 2 m away from each of the 50 sample locations, making a total of 2000 points. The grass and forb standing crop was estimated at the 50 locations with a disk pasture meter (Bransby and Tainton, 1977), calibrated with 15 clipped plots each 0.5 m x 0.5 m. The pasture disk was calibrated at 15 locations by clipping, drying, and weighing the herbaceous layer within 0.25 m^2 quadrants. The contribution per species to the herbaceous layer mass was estimated using the Dry Weight Ranking technique (T'Mannetje and Heydock, 1963).

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.

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