SAFARI 2000 Modeled Fuel Load in Southern Africa, 1999-2000

Abstract

This data set contains global, spatially explicit (1 km^2 grid cells) and temporally explicit (semi-monthly) modeled output of fuel loads over southern Africa. The fuel types considered in the data set are litter (dead tree leaves), dead grass, green grass, and small-diameter twigs. The Production Efficiency Model (PEM) was used to produce the estimated fuel loads for southern Africa for the 1999-2000 growing seasons. In order to accommodate the southern African growing season, which spans October to May, the PEM was run on twenty-four 15-day intervals from September 1, 1999 to August 31, 2000. The fuel load model was calibrated from measurements recorded in 1996 along the Kalahari Transect, and has been verified from independent site measurements of fuel loads recorded during the SAFARI 2000 dry season field campaign in August and September of 2000 (Alleaume et al., 2003, Hély et al., 2003a) as well as other past campaigns.

This data set consists of gridded binary image files. The single-byte images have a 1 km resolution and the grid is 3900 columns by 4800 rows in size. There are 24 files each for litter, dead grass, and green grass fuel loads, and a single file for the twig fuel loads. For the latter, small twigs (less than 1cm in diameter) are calculated from the tree cover percentage (UMD Tree Cover from Hansen et al., 2000) using an empirical relationship (Alleaume et al., 2003). Therefore, this fuel type is a constant throughout the year.

Background Information

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Project: SAFARI 2000

Data Set Title: SAFARI 2000 Modeled Fuel Load in Southern Africa, 1999-2000

Site: Southern Africa
 Westernmost Longitude: 5° E
 Easternmost Longitude: 42.491537° E
 Northernmost Latitude: 10° N
 Southernmost Latitude: 34.991651° S

Data Set Citation:

Hély C., K. K. Caylor, P. Dowty, R. J. Swap, and H. H. Shugart. 2004. SAFARI 2000 Modeled Fuel Load in Southern Africa, 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.

Data File Information

This data set consists of 73 separate gridded binary image files [band sequential (BSQ)]. The single-byte images have a 1 km resolution and the grid is 3900 columns by 4800 rows in size. For litter, dead grass, and green grass fuel loads, there are two image files per month for each fuel source, representing the first half and the second half of the month, respectively, and showing temporal changes in fuel loads during the study period. There is a single file for the twig fuel loads. Because small twigs (less than 1cm in diameter) are calculated from the tree cover percentage (UMD Tree Cover from Hansen et al., 2000) using an empirical relationship (Alleaume et al., 2003), this fuel type is a constant throughout the year.

All units are in grams of carbon/m^2 * SCALEFACTOR, where SCALEFACTOR is set to 0.7 (i.e., values are reduced to 70 percent of their value). Thus, to get the image values to grams of carbon/m^2, divide each pixel value by 0.7.

The file naming convention is **fuel_type_YY_MM_01** for the first half of the month and **fuel_type_YY_MM_02** for the second half of the month. Therefore, for a given fuel type, dead grass for instance, the first file (September, 1-15, 1999) is "herb_dead_99_09_01" and the last simulated step (August, 16-31, 2000) is "herb_dead_00_08_02".

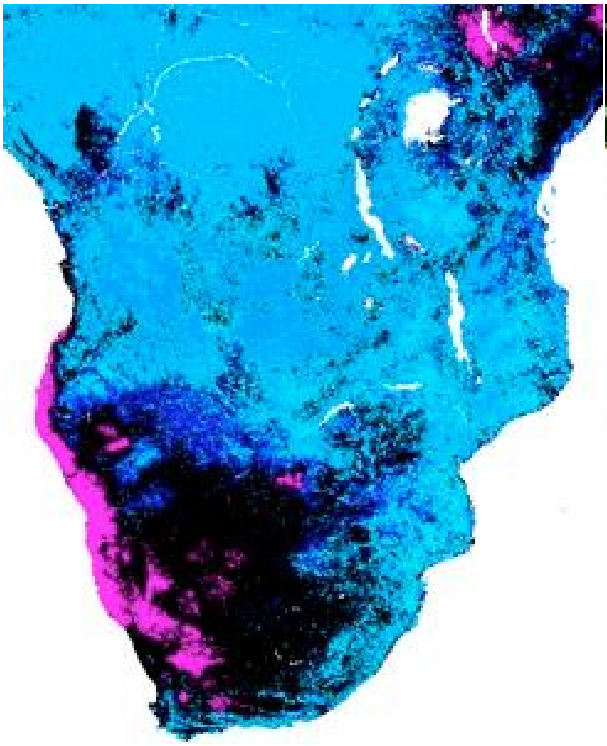
Data Categories

Data Range (before scaling)	Category
0	non-land
1-252	fuel component carbon mass [gram-carbon m-2]
253	land surface, non-vegetated
254	missing data
255	water (ocean, lakes, rivers)

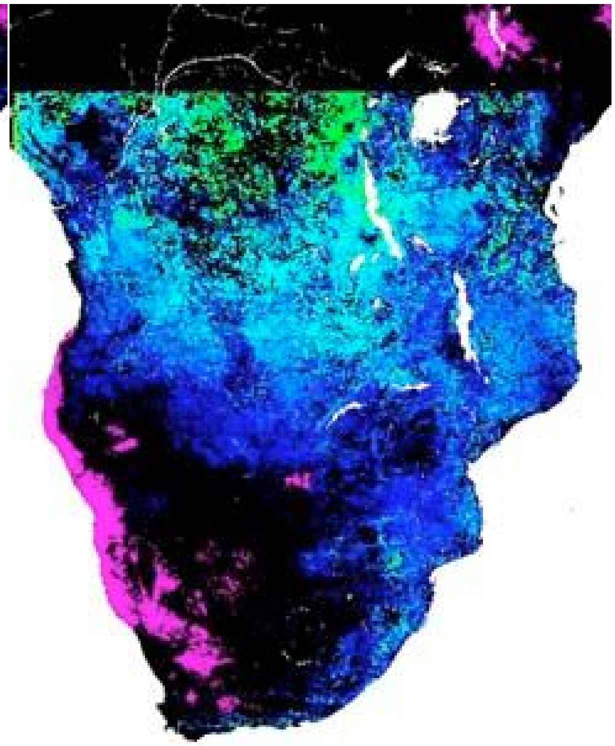
Image Parameters

file format	flat binary file, band sequential (BSQ)
data type	8 bit unsigned integer values
image size	3900 columns by 4800 rows
geographic projection	latitude/longitude
upper left, X	10.004167° E
upper left, Y	4.995833° N
x pixel size	0.00833333
y pixel size	0.00833333

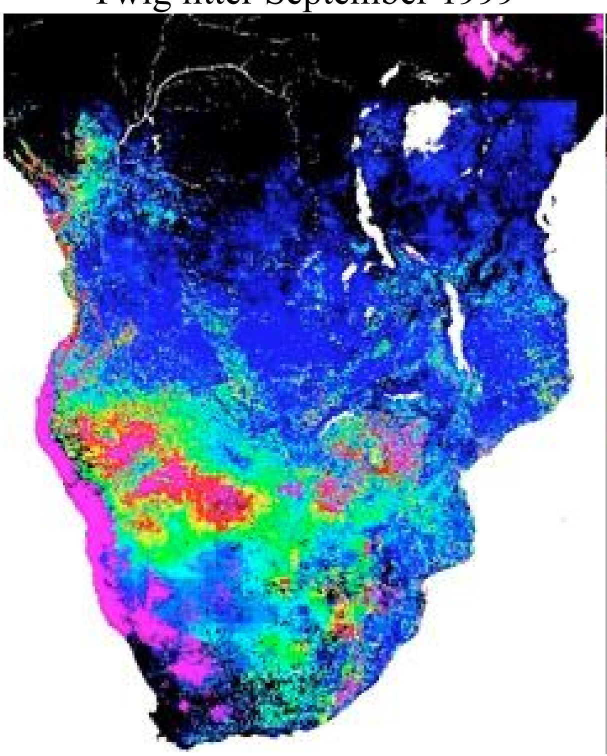
Sample Fuel Load Images



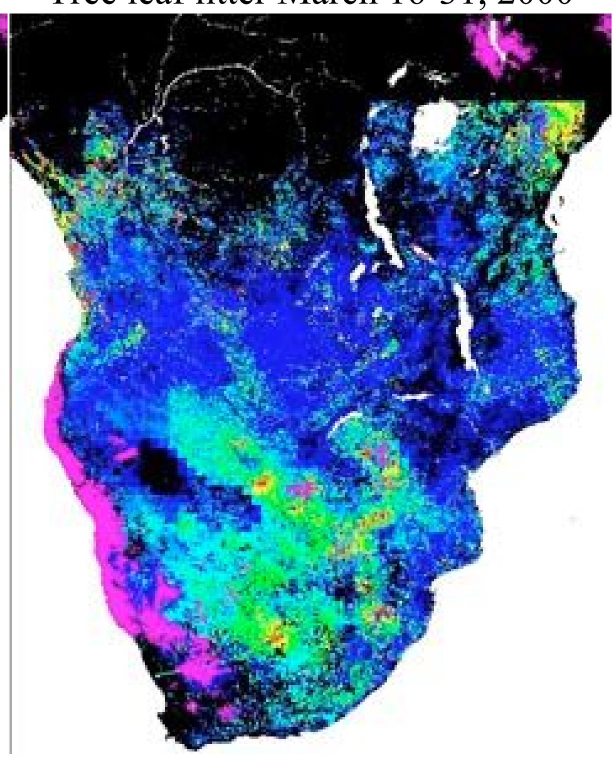
Twig litter September 1999



Tree leaf litter March 16-31, 2000



Grass/herb green March 16-31, 2000



Grass/herb dead March 16-31, 2000

Methodology

The fuel types considered in this data set [litter (dead tree leaves), dead grass, green grass, and small-diameter twigs] have been estimated using a model based on a patch-scale Production Efficiency Model (PEM) scaled up to the regional level using empirical relationships between patch-scale behavior and multi-source remote sensing data (spatio-temporal variability of vegetation, radiation, and climatic variables). Processes such as Net Primary Production (NPP), litterfall, and herbivory have been taken into account in the mechanistic modeling approach. The fuel load model has been calibrated from measurements recorded in 1996 along the Kalahari transect, and verified from independent site measurements of fuel loads recorded during the SAFARI 2000 dry season field campaign (Alleaume, et al., 2003; Hély et al., 2003a) and other past campaigns.

In order to accommodate the southern African growing season, which spans October to May, the PEM was run on twenty-four 15-day intervals from September 1 to August 31 of the following year. Leaf-out occurs when the NDVI records its maximum increase relative to the previous time step, and trees are assumed to produce their entire leaf area in one time step.

PEM Model

The model is driven primarily by the absorption of photosynthetically active radiation (PAR) and light-use efficiency. These factors determine Gross Primary Production in terms of grams of carbon/m^2, which is converted to biomass using a constant fractional carbon ratio of 0.45 (Scholes and Walker, 1993). For each time step, the GPP is partitioned to tree and grass components using the leaf area ratio of trees and grasses. The grass GPP is subsequently reduced to NPP by incorporating respiration costs. Tree NPP corresponding to non-leaf material is tracked but since non-leaf tree material is not part of the fuel load, non-leaf NPP is not reported here. Leaf fall is determined from a leaf stress ratio that compares the Potential Evapotranspiration (PET) to the cumulated precipitation over the time step. If PET is greater than precipitation, tree leaves and grass die proportionally to the stress ratio. Leaf fall increases the magnitude of the dead tree and grass leaf components of fuel load. Loads of live green and dead grass fuel types are also affected by herbivory, which reduces live grass preferentially over dead grass. Fuel load is resolved for each time step as dead tree litter, dead grass, live grass, and small diameter twigs. Because live tree leaves are not considered as fuel, their loads are not presented. Twig litter is estimated empirically from the percent tree cover (Hansen et al., 2000), using a relationship derived from SAFARI-92 data (Shea et al., 1996; Trollope et al., 1996), SAFARI 2000 field data (Alleaume et al., 2003) and additional non-related field campaigns (R.J. Scholes, pers. com., 2001). Therefore the amount of twig litter is constant, and it represents the available load of twigs accumulated over several years between two fire occurrences (fire frequency).

A detailed presentation of the model, the sensitivity analysis performed on the effect of climate variables (incoming radiation, air temperature, and precipitation), and a presentation of the performance of the model over 4 regional rainfall gradient regimes (Etosha National Park, Mongu, Kasama, Kruger National Park) are reported in Hély et al. (2003a).

References

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