SAFARI 2000 Reflectance of Fire Residue, Kruger National Park, Dry Season 2000

Abstract

The goal of this study was to understand the change in reflectance caused by the action of fire and the heterogeneity of fire effects (i.e., the fraction of the observation that burned and the combustion completeness of that observation). A spectral mixture model and field and satellite observations were used to compare changes in Landsat reflectance associated with fire and combustion completeness derived from field measurements at prescribed fire sites in South Africa and to substantiate and illustrate the model findings.

Fire residue samples were collected from experimental burn plots in Kruger National Park during the SAFARI 2000 Dry Season Campaign in August-September of 2000. The residues include 3 different ash types: pure white ash; black ash; and residual non-photosynthetic fuel biomass (senescent grass, twigs, leaves, and bark). The samples were analyzed in the laboratory to determine their multi-spectral reflectance using an Analytic Spectral Devices (ASD) radiometer, which measures spectral reflectance in the range 0.45-2.2 µm at intervals of 0.01 µm. The ASD measurements were made under diffuse illumination conditions in the spectral range of 350 nm to 2500 nm, with the ASD radiometer aligned perpendicular to the samples to simulate nadir remote sensing conditions.

The data file contains reflectance measurements (fraction, 0-1) for replicate samples of 3 different ash types (white ash, black ash, and non-photosynthetic vegetation) recorded at 10 nm intervals over the wavelength spectral range of 350 nm to 2500 nm. The data are stored in a single ASCII file in comma-separated-value format (.csv).

Background Information

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Project: SAFARI 2000

Data Set Title: SAFARI 2000 Reflectance of Fire Residue, Kruger National Park, Dry Season 2000

Site: Kruger National Park, South Africa
Westernmost Longitude: 21.83
Easternmost Longitude: 22.32944
Northernmost Latitude: -24.16
Southernmost Latitude: -25.75

Data Set Citation:

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Data File Information

The data file contains reflectance spectra measurements for 3 different ash types (white ash, black ash, and non-photosynthetic vegetation) every 10 nm from 350 nm to 2500 nm from samples collected at prescribed burn sites within Kruger National Park. The data are stored in an ASCII file in comma-separated-value format (.csv).

Data file information for knp_ash_spectra.csv is provided below:

Column Number	Column Name	Definition	Units/Format
1	Wavelength	Wavelength of measurement, every 10 nm	nm
2-11	KPW1, KPW2, KPW3,...KPW10	Reflectance of replicate samples of white ash from KNP fires	fraction (0-1)
12-21	KPA1, KPA2, KPA3,...KPA10	Reflectance of replicate samples of black ash from KNP fires	fraction (0-1)
22-31	KPC1, KPC2, KPC3,...KPC10	Reflectance of replicate samples of residual senescent leaf, twig and grass litter on KNP burned areas (non-photosynthetic vegetation)	fraction (0-1)

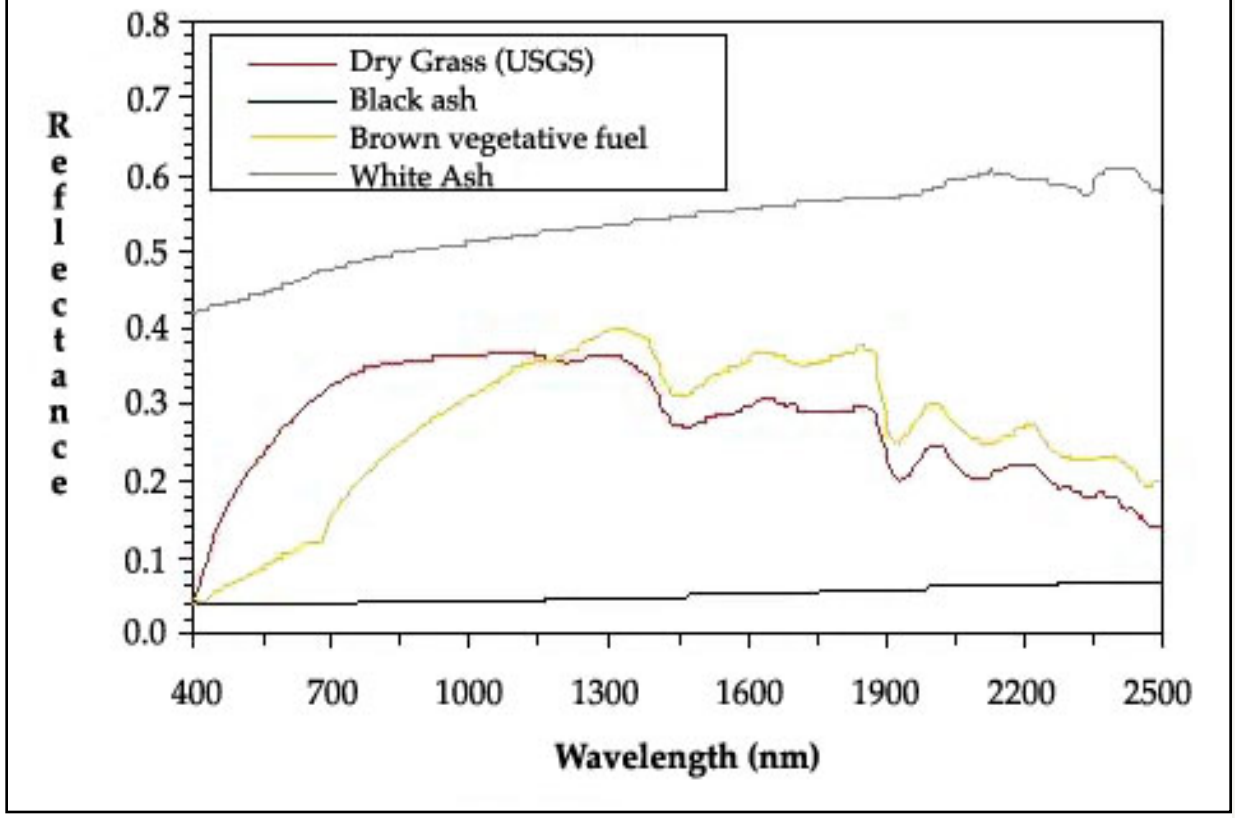
Study Area

The Kruger National Park (KNP) in South Africa, located along the border of Mozambique, was the site of prescribed fires from which ash samples were collected and spectral reflectance was measured. The KNP is located within a savanna ecosystem where the soil properties, precipitation, and plant and animal competition regulate the biomass available for burning. The prescribed burning took place during the SAFARI 2000 Dry Season Campaign in August-September of 2000. In South Africa most burning occurs in the dry season, from approximately June to October, when the vegetation fuel (litter, grass, fine leaves, and branches) is senescent. The prescribed fires were primarily head fires started from line ignitions aligned along the perimeters of demarcated areas and along road and seepage lines.

Fire residue samples from experimental burn plots (EPBs) in the south west (near Pretoriuskop) and center (near Satara) of Kruger National Park were collected for analysis. The Pretoriuskop plots are in parkland Sourveld savanna (Gertenbach, 1983) with dominant *Combretum collinum/C zeyheri*,Terminalia sericea tree species, Sicklebush *(Dichrostachys cineria)* and *Acacia* shrub species, and tall growing *Hyperthelia dissoluta* grasses (Shea et al., 1996, Trollope and Potgieter, 1986). The plots near Satara are in less wooded Marula Knobthorn savanna (Gertenbach, 1983) with *Sclerocarya caffra* (Marula) and *Acacia* tree species and shorter growing grasses such as *Aristida* (Trollope and Potgieter, 1986). All of the KNP plots had relatively small amounts of exposed soil (less than approximately 5% of surface area). The prescribed fires consumed the majority of the litter and much of the grass, shrub, and tree canopy material below approximately 2 meters. Trees taller than 2 m were moderately scorched. Some large fallen wood litter (diameter > 1.5 cm) was left unburned at the Pretoriuskop plots. Prior to the fires, the vegetation in the different Pretoriuskop plots was observed to be approximately 30-60% green and in the Satara plots, approximately 10-15% green.

Reflectance Spectra Measurements

The sample EBPs were burnt on the morning of 14 August 2000 under the same micrometeorological conditions, and were noted by the investigators to be homogeneously burnt. After the fire, 500 g of pure white ash, 500 g of representative black ash. and over 1 kg of residual non-photosynthetic fuel biomass (senescent grass, twigs, leaves and bark) samples were collected. The samples were analyzed in the laboratory to determine their multi-spectral reflectance using an ASD radiometer, which measures spectral reflectance in the range 0.45-2.2 μm at intervals of 0.01 μm. The ASD measurements were taken in the laboratory to reduce field measurement errors and because the investigators were concerned only with obtaining representative spectral measurements for illustrative modeling. The measurements were made under diffuse illumination conditions in the spectral range of 350 nm to 2500 nm, with the ASD radiometer aligned perpendicular to the samples to simulate nadir remote sensing conditions.



Reflectance spectra of black and white ash and non-photosynthetic vegetation fuel samples made using an ASD radiometer. The samples collected from the Kruger National Park (KNP) and the Madikwe Game Reserve (MGR), South Africa. The KNP reflectance spectra is compared to dry long grass spectra provided by the U. S. Geological Survey (USGS) Digital Spectral Library (Clark et al., 1993).

Dry long grass spectra shown in the above figure were collected from the Pierre shale, Canon City, Colorado. The most obvious spectral change evident in this figure is the decrease in reflectance from unburned non-photosynthetic vegetation fuel to black ash over all but the shortest wavelengths of the 350-2500 nm region. The white ash samples have higher reflectance than the black ash and are higher than both the non-photosynthetic vegetation fuel and the USGS dry long grass spectra. The investigators conclude that these results illustrate two important issues. Fires that are sufficiently hot to produce white ash may not be detected using methods that expect a drop in reflectance associated with biomass burning. Similarly, methodologies to relate change in reflectance to fire properties, such as combustion completeness, may be biased significantly by the presence of white ash.

Additional Sources of Information

References

Clark, R. N., G. A. Swayze, A. J. Gallagher, T. V. V. King, and W. M. Calvin. 1993. The U.S. Geological Survey, Digital Spectral Library: Version 1: 0.2 to 3.0 microns. U.S. Geological Survey Open File Report 93-592, 1340 pp. [http://speclab.cr.usgs.gov/].

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