BURN SEVERITY MAPPING IN PENDJARI NATIONAL PARK (BENIN) USING LANDSAT ETM+ DATA AND FIELD OBSERVATIONS

Noellie A. Rüth[1], T. Landmann[1], M. Schmidt[2],
S. Konaté[3], K. E. Linsenmair[4], S. Dech[5]

[1] University of Wuerzburg, Department of Remote Sensing in cooperation with DLR, Am Hubland, 97074 Wuerzburg, phone: +49(0) 931 88147, fax: +49 (0) 931 888 4961, email: yao@mail.uni-wuerzburg.de

[2] CONABIO, National Commission for the Knowledge and Use of the Biodiversity - Department of Geomatics, Liga Periférico-Insurgentes Sur, Núm. 4903, Col. Parques del Pedregal, Delegación Tlalpan, 14010, Mexico City, D.F., Mexico

[3] Tropical Ecology Station of Lamto, Univ. of Abobo-Adjamé, Cote d´Ivoire

[4] Department of Animal Ecology and Tropical Biology, Univ. of Wuerzburg, Germany

[5] DLR/DFD, German Aerospace Centre (DLR), German Remote Sensing Data Centre, DFD, Germany

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ABSTRACT

Remote Sensing based methods have been used in many studies to quantify and map the burned area and burn severity; however in West Africa such data sets are scarce. Burn severity is characterised by the change levels in vegetation that is caused by the impact of the fire. Fire severity can be assessed through an image differencing index (ΔNBR), which is calculated by subtracting the Normalized Burn Ratio (NBR), derived post-fire, from the NBR calculated from pre-fire data.

The calculation of the NBR index uses the two spectral bands that are most sensitive to landscape change caused by burning. These bands are located in the Near Infrared (NIR) wavelength between 0.7 and 0.9 µm and in the Shortwave Infrared (SWIR) between 2.0 and 2.4µm. The exact location of the bands varies between the satellite systems MODIS, LANDSAT and ASTER. The NIR shows high reflection as being the presence of green and dense vegetation, whereas sparse or removed vegetation leads to low reflection in the NIR. Contrarily, at SWIR wavelengths, the existence of vegetation is shown by a low reflection, whereas reflectance is increases when soil is exposed or leaf water content is low.

To understand the impact of fire on vegetation, which is expressed by the degree of fire severity, the Pendjari National Park in Benin (West Africa) was chosen for this study. This park is characterised by various types of savannas ranging from woody to grassland savannas,

including gallery forests, dry and clear forests. Each year, the vegetation is submitted to burning so as to maintain the dynamics of these savannas.

To carry out this study, several Landsat ETM+ scenes of the National Park were used (path 193 rows 052/053). The data are snap shots taken on 05th October 2007 and 26th February 2008. Field observation to measure the burn severity was carried out in February 2008. The burned area was visually observed in order to estimate the percentage of the biomass consumed by fire. The estimations varied from 0%, if the vegetation remained intact or if no fire scorched the vegetation, to 100 %, if all vegetation was consumed by fire.

The Landsat ETM+ band 4 and band 7, which correspond to NIR and SWIR wavelength respectively were then used to calculate the NBR index.

Four burn categories, namely very low burned, low burned, moderate burned and high burned, were mapped from the Landsat data. The validation of these categories was made through the field observation. For this purpose, GPS points from the field observation, each characterized by the percentage of biomass removed, were correlated with the ΔNBR value of Landsat image.

The results show a good positive relation between the ΔNBR value and the field observation value, with R^2= 0.76. The analysis of the correlation coefficient according to Pearson is r= 0.84 and according to Spearman-Rho is r= 0.86.

These results show that the burn severity can be objectively mapped in Pendjari National Park using the NBR index as delta. These field observations can therefore be used to validate the remotely-sensed change within savanna biomes.