Remote Sensing based determination of the percentage tree cover for biodiversity assessment in West Africa

Schramm, M.[1,2], Machwitz, M.[1], Landmann, T.[1], Schmidt, M.[1,3], Conrad, C.[1], König, K.[4], and Dech. S.[1,3]

[1]University of Wuerzburg, Department of Geography, Remote Sensing Unit, Wuerzburg, Germany
[2]Leibniz University of Hannover, Institute of Photogrammetry and Geoinformation, Hannover, Germany
[3]German Aerospace Center (DLR) - German Remote Sensing Data Center (DFD), Oberpfaffenhofen, Germany
[4]University of Frankfurt, Institute for Ecology, Evolution and Diversity, Frankfurt/Main, Germany
contact: matthias.schramm@uni-wuerzburg.de

Abstract: Information on the percentage tree cover is fundamental many earth system models. The determination of tree to herbaceous coverage in the context of the climate change research requires high quality and rigorous information about the heterogeneity of woody vegetation. The woody component of vegetation plays a very important role in climate change studies as accumulator of carbon and in local scale biodiversity assessments. Particularly in West Africa, knowledge about the tree cover is important, because land cover change and deforestation rates are extremely severe. This study presents a unique multi-scale approach for consistently mapping and quantifying tree cover. The method presented entails merging two data sets at different scales to render a highly accurate and improved continuous tree density gradient data set at 250 m resolution.

Using multispectral satellite data each pixel can be attributed as a linear combination of representative land cover features weighted by their subpixel abundances within that pixel (Figure 2). So with sufficient accurate land cover features – or endmember spectra – a subpixel proportion estimation is possible. Due to the lack of typical African endmember spectra, a new spectral unmixing approach model was derived within the BIOTA project. The new approach entails that new endmember abundances for pixels are found without a priori knowledge about their spectra. Maps of showing land cover feature abundances in percent fractions (Figure 3) can be produced from the new model. The algorithm can be adapted on all (semi) arid regions with a lack of accurate endmember spectra.

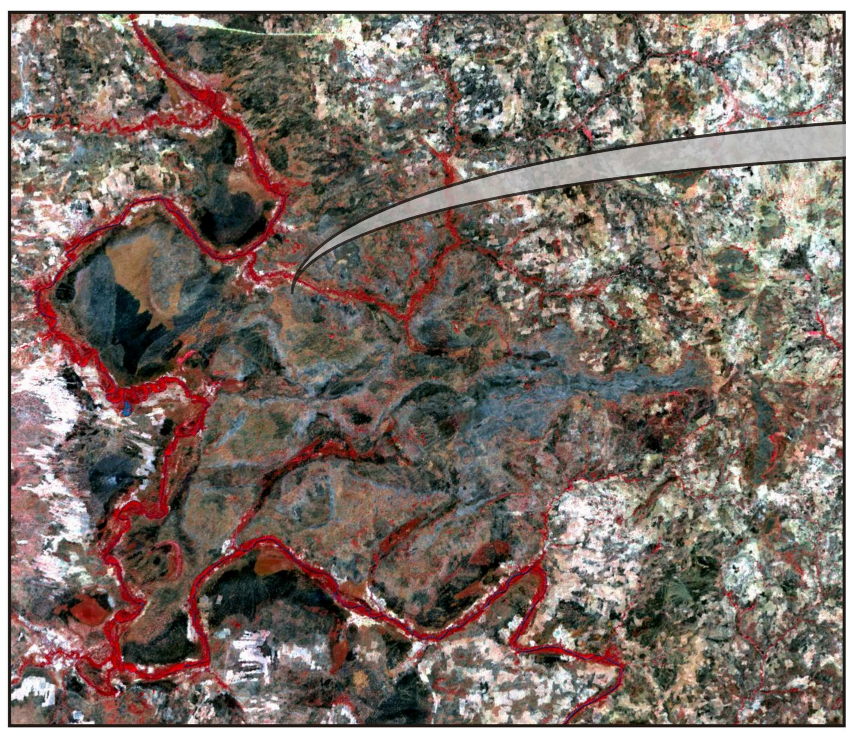


Figure 1: False color 30 m resolution ASTER satellite image, showing the Bontioli National Park, Burkina Faso. Band combination is Infrared, Red, Green, so photosynthetic active vegetation is colored red.

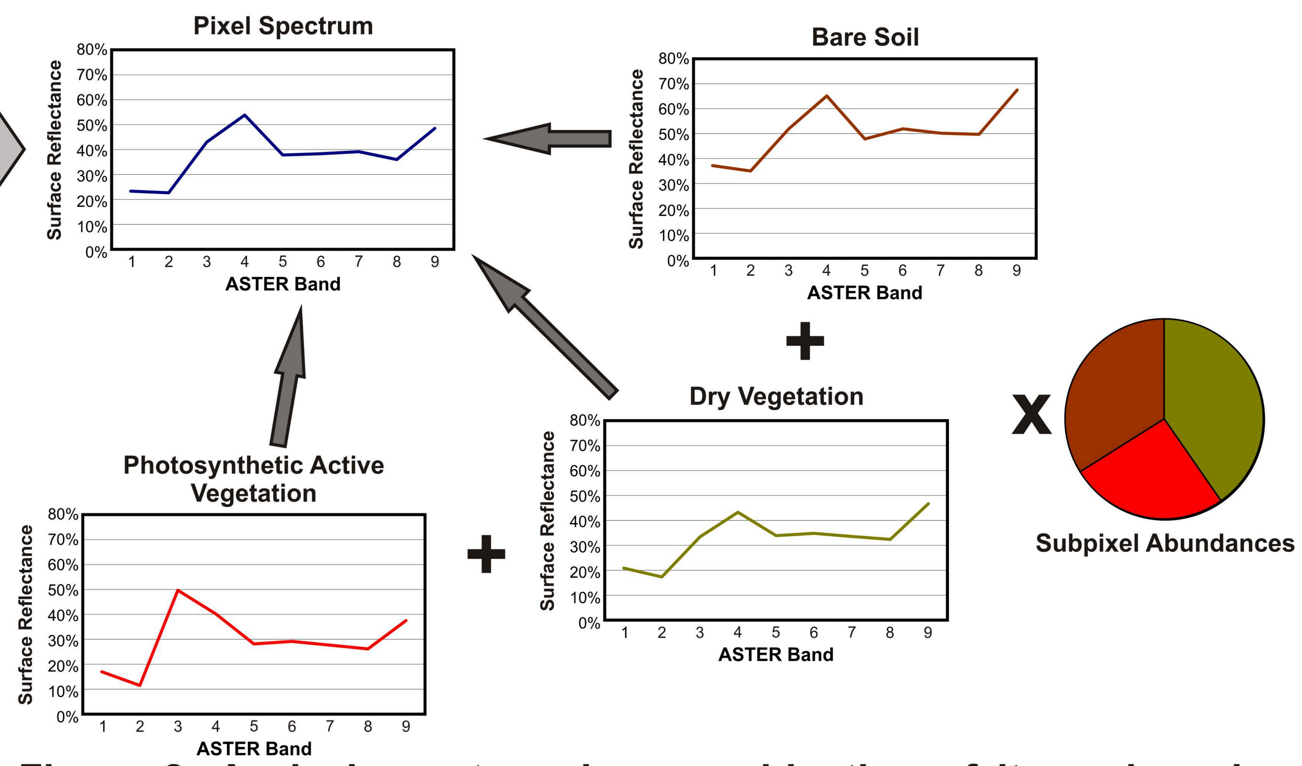


Figure 2: A pixel spectrum is a combination of its endmember spectra weighted by their proportions.

To map ecological meaningful tree cover gradients, using a highest resolution land cover reference classification subpixel proportion information of photosynthetic active vegetation and of shadow were converted to map tree density within the Bontioli National Park in Burkina Faso (Figure 4).

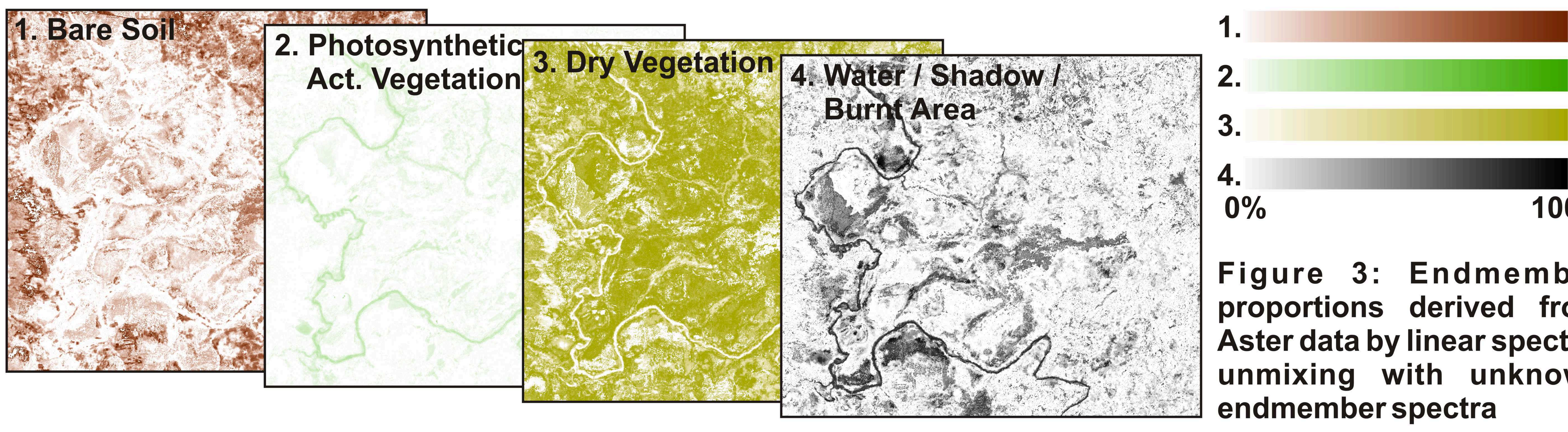


Figure 3: Endmember proportions derived from Aster data by linear spectral unmixing with unknown endmember spectra

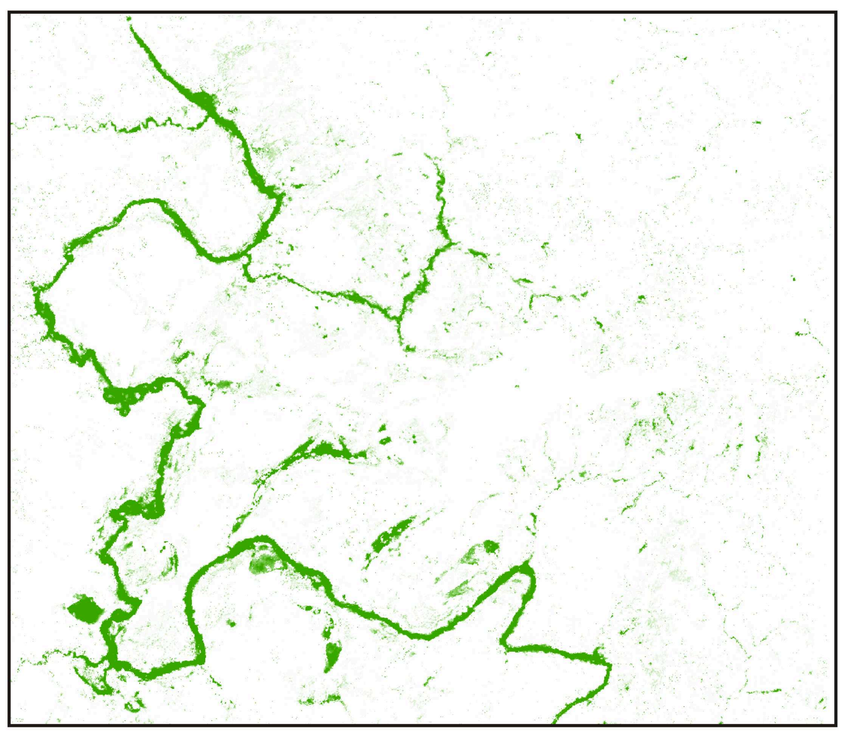


Figure 4: Tree density map of Bontioli National Park (30 m resolution)

0% 100%

In a second step, 250 meter resolution MODIS satellite time-series metrics on vegetation chlorophyll activity (e.g. NDVI, EVI) were compared with the high resolution Bontioli tree density map. The aim of the comparison was to infer a best fitted transfer function to the 250 meter resolution satellite variable data set, and to consequently map tree density at 250-meter resolution. The MODIS time series consists of one satellite image every eight days. Main attention was turned to special metric features like e.g. point of time and intensity of greening up or maximum NDVI period (in MODIS observations). This function was applied to a wider region in West Africa. Since we used contextual and high resolution reference data, the resulting tree density map is a more accurate and finer resolution tree density data set than the commonly used global MODIS VCF product (Figure 5). Due to global cost-free availability of 250 meter resolution MODIS time-series this result can be adapted over large areas, when regional higher resolution tree density details can be calculated. The local scale tree density algorithm works best for flat terrain and here we only showed its feasibility at the end of dry season. However we propagate that the method used herein can be extended to other semi-arid savannas in Africa, where vegetation structural parameter maps are generally scarce.

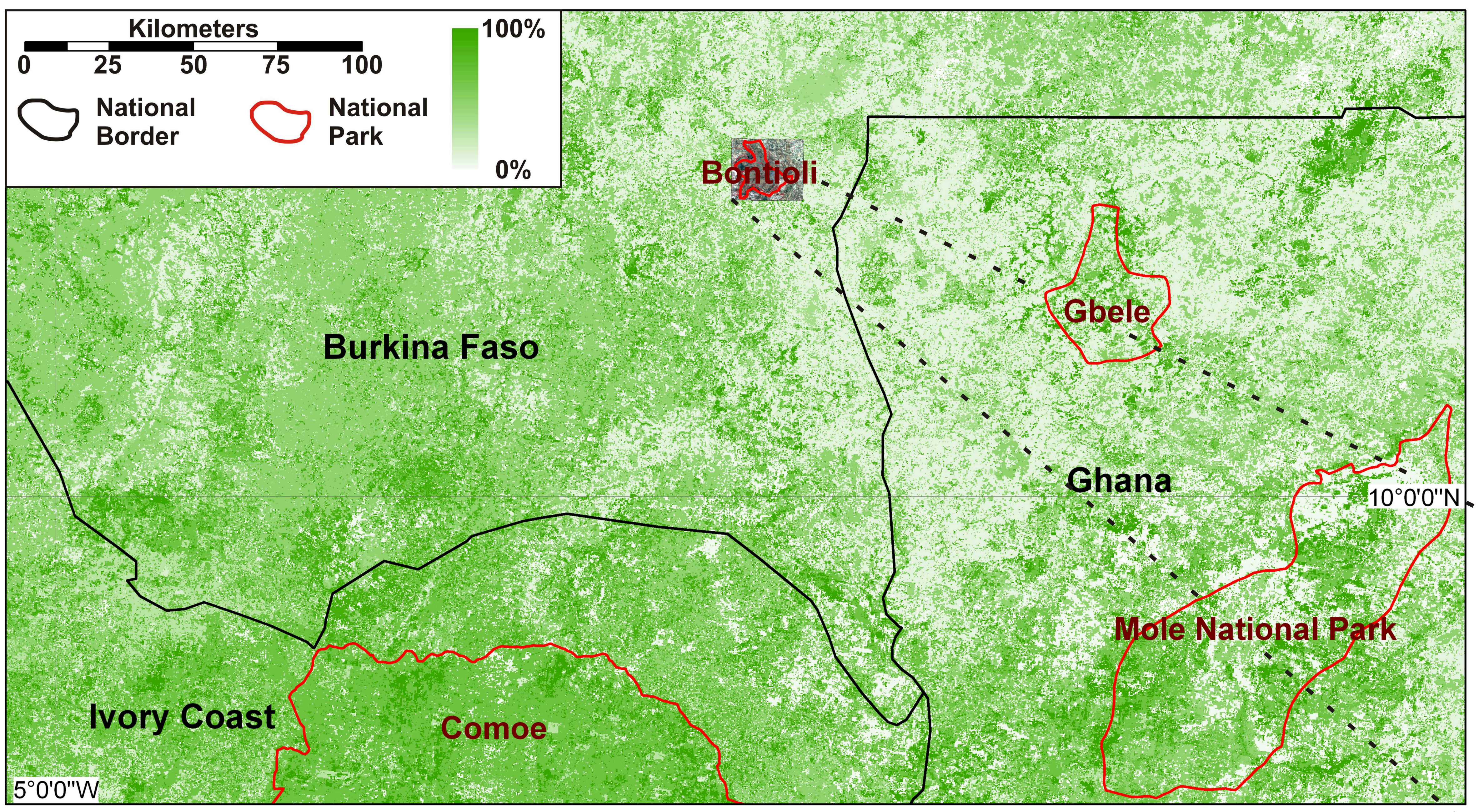
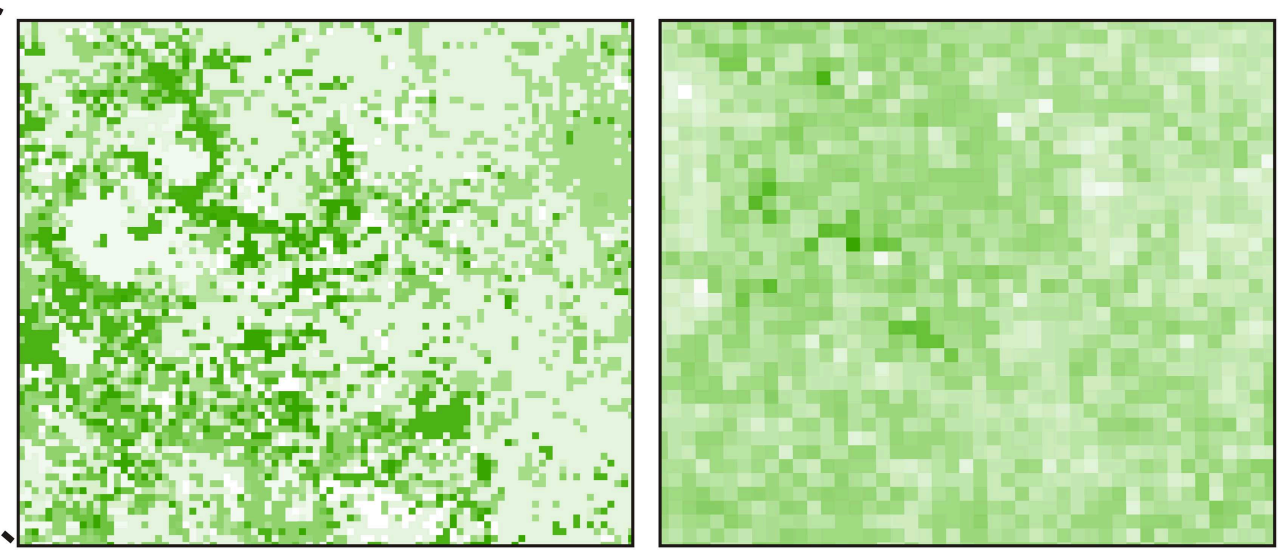


Figure 5 left: Resulting tree density map of a West African region (250 m) with the original ASTER Bontioli image;

Bottom: Comparison of Bontioli National Park subset (left) with standard tree cover fraction MODIS VCF product (500 m - right)



BIOLOG
Projektträger im DLR
Federal Ministry of Education and Research