

REMOTE SENSING OF MANGROVE FOREST STRUCTURE AND DYNAMICS

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ABSTRACT

On a mangrove peninsula in North Brazil suitable and transferable techniques for the remote sensing and airborne-based classification for the assessment of mangrove forest structures were developed within the framework of the MADAM (Mangrove Dynamics and Management) Project. Examples of this research are presented in this article. On local scale an object based classification rule network, which was developed and applied for airborne photo-transsects, was adapted to Ikonos sub-scene. The transfer of the object based rule network to the whole peninsula however, exposed crucial deficiencies in the overall technical performance. On this level, the rule network was redesigned to fuzzy sets instead of using training sets and nearest neighbour algorithms. The results provide an impressive insight into the structure of mangrove ecosystems and their hinterlands. Change Detection On the landscape level about 7 Landsat TM and ETM scenes ranging from 1986 to 2003 served as a remote sensing database to analyse the performance of several change detection techniques. These proved to be unstable and lead to the development of a new methodological approach based on land cover signature specific conditional queries. It was successfully applied to monitor the dynamics of coastal mangroves covered by four selected images from 1986 to 2001. These are currently compared with field data of the long-term beach profile monitoring programme. Moreover three Corona spy-satellite black & white photos with a resolution of about 4m from 1967-1969 were employed. As these scenes display the mangrove peninsula as an undisturbed ecosystem prior to the road construction in the 70ies, the detection of major changes compared to the Ikonos scene of 2003 were possible.

1. BACKGROUND & OBJECTIVES

The development of suitable and transferable techniques for the remote sensing and airborne-based classification for the assessment of mangrove forest structures, as well as the monitoring of their dynamics and the hinterland at multiples scales were a focal point of the research activities of the geographical research group in the 10-

year Mangrove Dynamics and Management (MADAM) project in North Brazil. The latter project is a long-term co-operation project between Brazil and Germany [2].

Several studies have aimed to determine types of mangrove structure patterns [5, 7, 20, 29]. In many cases mangrove species are not strongly large-scale zoned, nor randomly scattered, but often occur in small discrete mono-specific zones [4, 6, 13]. Conceptually, these landscapes may be characterised as a mosaic of habitat patches, which may change over time. However, little attention was given to the interactions between these different patches encompassing the entire landscape perspective, which is mainly due to difficulties of scale resolution of the information needed for such an attempt.

Despite modern technology, detailed geo-spatial information on this complex ecosystem, which would support such an assessment, is still lacking. This is due to the physical inaccessibility of most of the mangrove environments in the first place. Studies, such as in [8,10, 11, 12, 14, 22, 27] employed remote sensing techniques with high resolution satellites (e.g. Landsat, Spot) to determine the spatial composition of mangrove forest stands. Due to the heterogeneity of mangrove tree distributions, a detailed assessment of the mangrove structure according to species was not satisfactorily achieved so far. This is caused by the difficulties in generating sufficient spatial resolution by the use of satellite imagery in order to detect likely structural patterns. However, the problem emerges when dealing with spatially explicit data (e.g. mangrove structure plots of 30 x 30 m) that spatial patterns of mangrove individuals and/or mangrove species have to be quantified to a larger geographical dimension in order to allow recognition as a certain structure.

Only recently new very high-resolution (VHR) satellite data of the sensor systems Ikonos and Quickbird were tested for their applicability in mangrove research. WANG et al. [31] carried out a comparative analysis of both sensor systems, using the example of the Caribbean mangroves of Panama. In a further study [32] investigated, whether Quickbird-Data is capable of separating mangrove species and which classification

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