Chapter 16
Remote Sensing of Bush Encroachment on Commercial Cattle Farms in Semi-Arid Rangelands in Namibia

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ABSTRACT

Bush encroachment is one of the most extensive changes in land cover in semi-arid rangelands and an urgent problem for cattle farming, rapidly reducing the productivity of the rangeland. Despite the severity of these consequences, a complete and accurate assessment of bush encroached areas is still missing at large. This study aims at assessing bush encroachment on commercial cattle farms in central Namibia by employing remote sensing methods to distinguish between areas covered by bush and open rangeland. The authors use different classification techniques and vegetation indices to characterize the nature of vegetation cover. Their analysis shows that results are sensitive to specific classifications of indices. As an accuracy assessment could not be run on these results the authors could not analyze which classification approximates real bush encroachment best. Hence, this study highlights the need for further analysis. Ground truth data, in the form of field mappings, high resolution aerial photographs or local expert knowledge are needed to gain further insights and produce reliable results.

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INTRODUCTION

Changes in land cover in semi-arid rangelands of Namibia have been the subject of research for many years. Bush encroachment is one of the most extensive changes in land cover and is perceived as an urgent problem for cattle farming (Sweet, 1998; Mendelsohn et al., 2002; de Klerk, 2004). Encroachment is caused by a combination of factors including overgrazing, suppression of bushfires and changing climate conditions, leading to a reduction of grazing capacity due to a lower amount of pasture and a reduced penetrability of the rangeland (Mendelsohn et al, 2002; Espach et al., 2006). The central and northern parts of the country are especially affected by an increasing density of bushes (Mendelsohn et al., 2002).

The economic well-being of more than two thirds of the population of Namibia depends directly or indirectly on agriculture and 65% of the national agricultural output is produced on commercial rangeland (Sweet, 1998; Mendelsohn et al., 2002, Espach et al., 2006). Therefore, the condition of the ecosystem has an immediate effect on the economy and bush encroachment severely restricts profitability of cattle farming (Sweet, 1998). However, despite the severity of consequences arising from bush encroachment (de Klerk, 2004), a complete and accurate mapping of bush encroached areas in Namibia is still missing (Wagenseil, 2008).

One way to assess bush encroachment is the in-field assessment of bush densities on the farm land. However, this approach is time consuming and expansive due to the large number of work force necessary to pursue this approach. An alternative approach is remote sensing of vegetation cover. This approach has been applied successfully for mapping of bush encroachment (Wagenseil, 2008).

This study aims at assessing bush encroachment on commercial cattle farms in central Namibia. We approach this problem by applying Geographic Information Systems (GIS) and remote sensing to distinguish between areas covered by bush and open rangeland. We link this to on-site assessments of bush encroachments collected in a survey of commercial cattle farms (Olbrich et al., 2009).

This paper proceeds as follows: Section 2 reviews the use of remote sensing of vegetation and introduces the vegetation indices used in this study. Section 3 presents the study sites, data sources and index classifications. Results are given in Section 4 and are discussed in Section 5. Finally, Section 6 concludes our research.

BACKGROUND

Remote sensing can be defined as "the science of collecting information about objects without coming into physical contact with them" (Hill, 2000). This definition applies to the recording of electromagnetic radiation by aircraft or satellite-born sensors (Richards & Jia 1999; de Lange, 2006; Albertz, 2007). Distinguishing between different objects on the images relies on the difference in their spectral reflectance behavior (Albertz, 2007). Sensors record electromagnetic radiation being reflected by objects on the earth's surface, e.g. plants, buildings, water bodies, or in the atmosphere, e.g. clouds. These objects show characteristic patterns of reflectance across the wavelength spectrum allowing for the determination of specific types of objects (de Lange, 2006). These patterns, referred to as spectral signatures or "spectral fingerprints" (de Lange, 2006), differ among specific types of objects, e.g. vegetation, water and soil, but also between similar objects, e.g. different kinds of vegetation and soils (de Lange, 2006).

The spectral signature of a pixel of a satellite image (ρ_{pixel}) is a function of various factors (Asner, 2004):

ρ_{pixel} = f(geometry, tissue optics, canopy structure, landscape structure, soil optics)