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Review article

Remote sensing of vegetation in the Sudano-Sahelian zone: A literature review from 1975 to 2014

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ABSTRACT

Scarcity of *in situ* vegetation data inhibits research and natural resource management in the Sudano-Sahelian zone (SSZ). Satellite and aerial remote sensing (RS) constitute key technologies for improving the availability of vegetation data, and consequently the preconditions for scientific analysis and monitoring. The aim of this paper was to investigate how the hands-on application of RS for vegetation analysis has developed in the SSZ by reviewing the scientific literature published between 1975 and 2014. The paper assesses the *usages* and the *users* of RS by focusing on four aspects of the material (268 peer-reviewed articles), including publication details (time of publication, scientific discipline of journals and author nationality), geographic information (location of study areas and spatial scale of research), data usage (application of RS systems and procedures for accuracy assessments), and research topic (scientific objective of the research). Three key results were obtained: i) the application of RS to analyze vegetation in the SSZ has increased consistently since 1977 and it seems to become adopted by a growing number of scientific disciplines; ii) the contribution of African authors is low, potentially signalling a need for an increased transfer of knowledge and technology from developed countries; iii) RS has primarily been used to analyze changes in vegetation productivity and broad vegetation types, whereas its use for studying interactions between vegetation and environmental factors has been relatively low. This calls for stronger collaborative RS research that enables the mapping of additional vegetation variables of high relevance for the environmental problems facing the SSZ. Remotely sensed vegetation data are needed at spatial scales that suits the requirements of both research and natural resource management in order to further enhance the usefulness of this technology.

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1. Introduction

The semi-arid Sudano-Sahelian zone (SSZ) is located between the Saharan desert and the humid Guinean zone and stretches from the Atlantic coast to the Red Sea coast (Fig. 1). In this area, human prosperity is tightly coupled to vegetation resources since ~80% of the rapidly growing population relies on traditional livelihood strategies, such as subsistence agriculture and livestock production (UNEP, 2011). Vegetation constitutes a vital source of energy (Bailis et al., 2005), livestock fodder (Le Houéron, 1980), construction material, food stuff, and medicine (Manning et al., 2009), and provides for a number of indispensable ecosystem functions (Mertz et al., 2012; Sinare and Gordon, 2015), including soil erosion control (Wezel and Rath, 2002), soil fertilization (Bayala et al., 2005; Gnankambary et al., 2008), atmospheric carbon sequestration (Saatchi et al., 2011), and ground water recharge (Ilstedt et al., 2007; Bargués Tobella et al., 2014). In addition, vegetation influences the regional climate by controlling the albedo, and thus land–atmosphere interactions (Charney, 1975).

The condition of the vegetation in semi-arid areas in general, and the SSZ in particular, has been a matter of global concern for decades. It culminated in 1994 with the adoption of the United Nations Convention to Combat Desertification (UNCCD: Zeng, 2003), which was one of the three environmental conventions stemming from the Rio Summit in 1992. The predominating narratives of environmental change in the SSZ have conveyed a bleak picture where extensive population growth, destructive land management and strong climatic fluctuations have caused widespread and irreversible destruction of the vegetation cover and the soils, a process often referred to as desertification or land degradation (Lamprey, 1975; Herrmann and Hutchinson, 2005). The United Nations define desertification as 'land degradation in arid, semi-arid and dry sub-humid areas, resulting from various factors, including climatic variations and human activities', while land

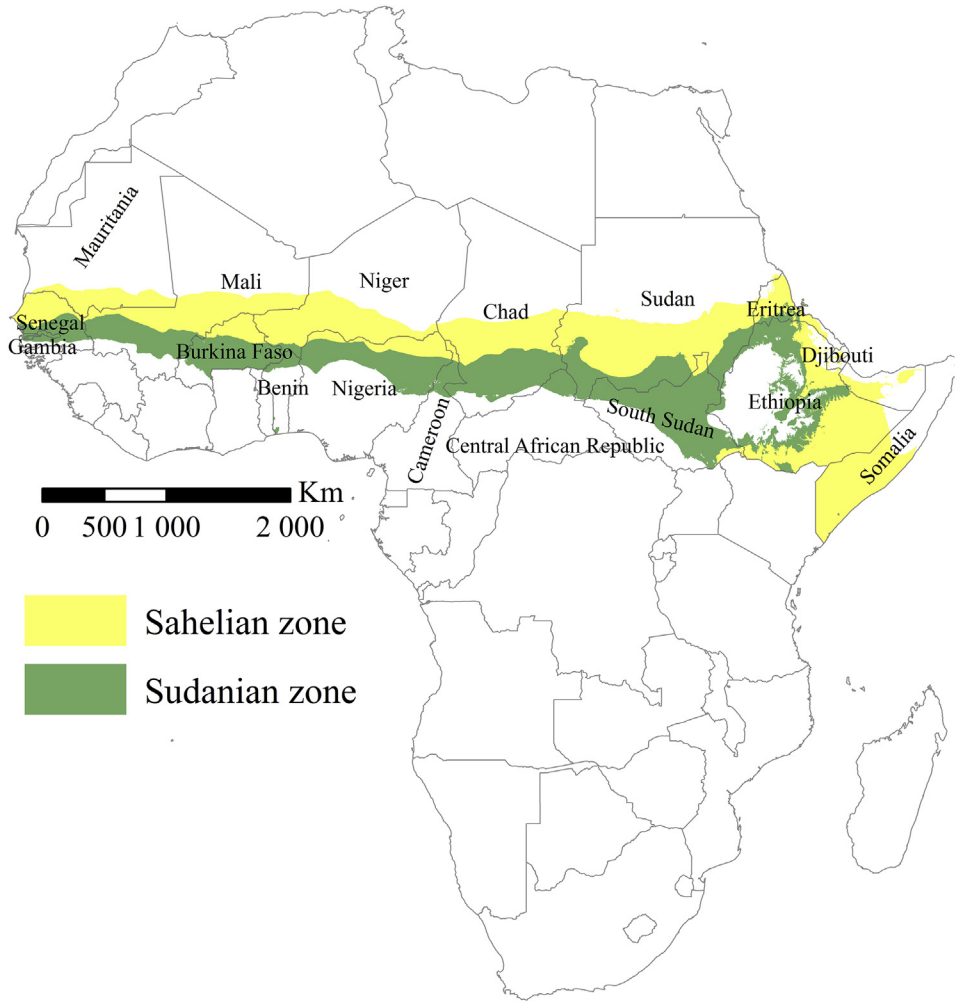

Fig. 1. Map showing the SSZ defined as the area between the 200 mm and 1000 mm isohyets (modified from Hijmans et al., 2005).