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ORIGINAL PAPER

Spectral library creation and analysis of urban built-up surfaces and materials using field spectrometry

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Abstract
Hyperspectral remote sensing is useful for the study of urban environment due to its ability to examine the comprehensive spectral characteristics of urban built-up surfaces and materials. This study deals with the creation of a spectral library and statistical analysis of spectral signatures of urban built-up surfaces and materials. Field measurement has been carried out using a spectroradiometer over the wavelength range of 350 to 2500 nm. Further, this study investigates the unique spectral characteristics and complexity of heterogeneous urban environments using mean spectral signatures of major built-up surfaces and materials. The study area belongs to the Udaipur, Rajasthan, India, which is an amalgamation of urban built-up and non-built-up surfaces. The results of the analysis suggest that various built-up surfaces and materials can be identified by investigating different absorption features in different spectral regions of a particular urban built-up class.

Keywords Hyperspectral remote sensing · Spectral library · Built-up surfaces · Engineered surfaces

Introduction

Urban environments characterize only a small percentage of the total land area, but these environments have turned into increasingly populated as larger number of individuals move from rural to urban areas and towns (Lu and Weng 2007; Weng 2012; Weng et al. 2018). A report of United Nations in year 2002 mentioned that urbanization has increased in all over the world, growing from 30% in year 1950 to 47% in 2000, and approximately 60% of the population is likely to reside in the cities by year 2030. Urbanization brings social and economic benefits (e.g., improved quality of life and economic prosperity); it also originates a number of environmental effects, such as degradation in the water quality (Praskievicz and Chang 2009), urban heat island effect, and loss of biodiversity (Xu 2010). Urban environments basically consist of various built-up surfaces, i.e., roads, roofs and pavements, sports infrastructure, and railway tracks as well as non-built-up surfaces, i.e., vegetation, soil, and water. Due to aforementioned major environmental effects, the understanding of urban environment and their spatio-temporal analysis become necessary for urban planning, environmental management, risk assessment, and disaster management. The dynamic behaviors of urban environments demand technologies that are fast and repeatable and offer large areal coverage at a reasonable price, making remote sensing as one of the most feasible technologies (Xu 2010; Weng et al. 2008; Kerekes et al. 2013; Giannandrea et al. 2013; Hecker et al. 2019; Herold and Roberts 2005; Lachérade et al. 2005; Priem et al. 2016; Singh and Sirohi 1995).

Modern advancement in the technology has witnessed the extensive applications of hyperspectral remote sensing (HSRS) in the field of image processing for identification of different urban built-up surfaces and materials on the basis of their unique characteristics (Roberts and Herold 2004; Kerekes et al. 2013; Giannandrea et al. 2013). HSRS technology is very useful for the study of urban environment due to its ability to demonstrate high potential in investigating the spectral properties or characteristics of urban surfaces and materials (Herold et al. 2003, 2004). The spectral properties of a different surfaces and materials are responsible for the identification of various

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