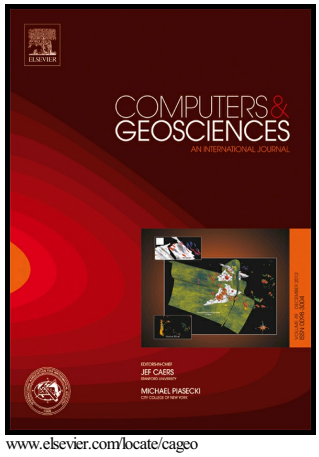
Spatially Explicit Spectral Analysis of Point Clouds and Geospatial Data

Daniel Buscombe



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Daniel Buscombe*

U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, Flagstaff, Arizona, USA

Abstract

The increasing use of spatially explicit analyses of high-resolution spatially distributed data (imagery and point clouds) for the purposes of characterising spatial heterogeneity in geophysical phenomena necessitates the development of custom analytical and computational tools. In recent years, such analyses have become the basis of, for example, automated texture characterisation and segmentation, roughness and grain size calculation, and feature detection and classification, from a variety of data types. In this work, much use has been made of statistical descriptors of localised spatial variations in amplitude variance (roughness), however the horizontal scale (wavelength) and spacing of roughness elements is rarely considered. This is despite the fact that the ratio of characteristic vertical to horizontal scales is not constant and can yield important information about physical scaling relationships. Spectral analysis is a hitherto under-utilised but powerful means to acquire statistical information about relevant amplitude and wavelength scales, simultaneously and with computational efficiency. Further, quantifying spatially distributed data in the frequency domain lends itself to the development of stochastic models for probing the underlying mechanisms which govern the spatial distribution of geological and geophysical phenomena. The software package `PySESA` (Python program for Spatially Explicit Spectral Analysis) has been developed for generic analyses of spatially distributed data in both the spatial and frequency domains. Developed predominantly in `Python`, it accesses libraries written in `Cython` and `C++` for efficiency. It is open source and modular, therefore readily incorporated into, and combined with, other data analysis tools and frameworks with particular utility for supporting research in the fields of geomorphology, geophysics, hydrography, photogrammetry and remote sensing. The analytical and computational structure of the toolbox is described, and its functionality illustrated with an example of a high-resolution bathymetric point cloud data collected with multibeam echosounder.

Keywords: point cloud, spectral analysis, geospatial analysis, roughness, texture, remote sensing

*Corresponding author
Email address: `dbuscombe@usgs.gov` (Daniel Buscombe)