South African Geographical Journal

Uncertainty quantification for the extraction of informal roads from remote sensing images of South Africa

R. N. Thiede [a,] I. N. Fabris-Rotelli[a,] A. Stein[a,b,] P. Debba[c] and M. Li[b]

[a] Department of Statistics, University of Pretoria, Pretoria, South Africa;
[b] Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, Netherlands;
[c] Spatial Planning and Systems, CSIR Built Environment, Pretoria and Visiting Professor, School of Statistics and Actuarial Science, University of Witwatersrand, Johannesburg, South Africa

https://www.tandfonline.com/doi/full/10.1080/03736245.2019.1685404

Abstract

Informal unpaved roads in developing countries arise naturally through human movement without government authorities being informed. These roads are not authorized nor maintained by council, nor reliably mapped in quality-controlled online maps. Information on informal roads is critical for sustainable city growth, and may be gleaned from spatial big data. Attempts to extract such roads from satellite images are sparse, and no automatic or guided semi-automatic approach has yet been employed. In this paper, we consider possible definitions of informal roads, by investigating the effects of their often poorly defined boundaries. We aim to detect these roads using a state-of-the-art method and to address the uncertainties encountered. The method is applied to areas in Gauteng Province and North West Province, South Africa using very high resolution images. The conceptualization of informal road boundaries, and hence the definition of an informal road, must be adapted to address challenges of informal road detection. These include the existence of clear boundaries, the visibility of road edges, road surface heterogeneity, and whether or not it is desirable to use only the central part of the road for transport. This paper contributes uniquely by considering the conceptual and practical challenges of informal road extraction in remote sensing.