Accepted Manuscript

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PII: S1618-8667(17)30393-X
DOI: https://doi.org/10.1016/j.ufug.2018.02.012
Reference: UFUG 26087

To appear in:

Received date: 22-6-2017
Revised date: 16-1-2018
Accepted date: 25-2-2018

Please cite this article as: Sithole, K., Odindi, J.O., Mutanga, O., Assessing the utility of topographic variables in predicting structural complexity of tree stands in a reforested urban landscape.Urban Forestry and Urban Greening https://doi.org/10.1016/j.ufug.2018.02.012

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ACCEPTED MANUSCRIPT

Assessing the utility of topographic variables in predicting structural complexity of tree stands in a reforested urban landscape

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Abstract

The transformation of natural landscapes into impervious built-up surfaces through urbanization is known to significantly interfere with the ecological integrity of urban landscapes and accelerate climate change and associated impacts. Although urban reforestation is widely recognised as an ideal mitigation practice against these impacts, it often has to compete with other lucrative land uses within an urban area. The often limited urban space provided for reforestation therefore necessitates the optimization of the ecological benefits, which demands spatially explicit information. The recent proliferation of tree stands structural complexity (SSC) and topographic data offer great potential for determining the ecological performance of reforested areas across an urban landscape. This study explores the potential of using topographic datasets to predict SSC in a reforested urban landscape and ranks the value of these topographic variables in determining SSC. Tree structural data from a reforested urban area was collected and fed into a tree stand structural complexity index, which was used to indicate ecological performance. Topographic variables (Topographic Wetness Index, slope, Area Solar Radiation and elevation)- were derived from a Digital Elevation Model (DEM) and used to predict SSC using the Partial Least Squares (PLS) regression technique. Results show that SSC varied significantly between the topographic variables. Results also show that the topographic variables could be used to reliably predict SSC. As expected, the Topographic Wetness Index and slope were the most important topographic determinants of SSC while elevation was the least valuable. These results provide valuable spatially explicit information about the ecological performance of the reforested areas within an urban landscape. Specifically, the study demonstrates the value of topographic data as aids to urban reforestation planning.

Keywords: Area solar radiation; Elevation; Partial least squares regression; Slope; Topographic wetness index; Urban ecological integrity.

INTRODUCTION

Urbanization, characterised by transformation of natural landscapes into impervious built-up surfaces, is regarded as a major driver of environmental change (Deosthali 2000, Jusuf et al. 2007). Such transformation is associated with, among others, natural landscape fragmentation and associated adverse effects (Hanski 2005), air pollution (Xu et al. 2016), noise pollution (Singh and Davar 2004), climate change (McDonald et al. 2008), biodiversity loss (Le-Xiang et al. 2006) and thermal stress (Tan et al. 2010). Consequently, urban reforestation (used in this study to mean re-establishment of green

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