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Application of the topographic position index to heterogeneous landscapes

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ABSTRACT

Topographic position index (*TPI*) is an algorithm increasingly used to measure topographic slope positions and to automate landform classifications. We applied *TPI* to a geoarchaeological research project in northwestern Belgium but its use led to erroneous landform classifications in this heterogeneous landscape. We asked whether deviation from mean elevation (*DEV*) was a better method for landform classification than *TPI*. We found that it enabled more accurate geomorphological assessment when using northwestern Belgium as a case study.

1. Introduction

Over the last decade, geographical information systems (GIS) and digital elevation models (DEMs) have been increasingly used to automatically classify landforms (Burrough et al., 2000; Drăguţ and Blaschke, 2006; Iwahashi and Pike, 2007; Hengl and Reuter, 2009). Disparate techniques incorporate a range of topographic input variables and output a varying number of landform classes (e.g. Irvin et al., 1997; Giles, 1998; Miliaresis and Argialas, 1999; MacMillan et al., 2000, 2004; Hengl and Rossiter, 2003; Bolongaro-Crevenna et al., 2005; Prima et al., 2006). These techniques have been applied to earth surfaces, ocean floors (e.g. Wright and Heyman, 2008; Zieger et al., 2009), and planets (e.g. Bue and Stepinski, 2006). However, Drăguţ and Blaschke (2006) assert that geomorphometric classifications of terrains have focused on either homogeneous regions (Schmidt and Dikau, 1999; MacMillan et al., 2000) or specific features such as hills, mountains (e.g. Miliaresis and Argialas, 1999) and hillslope units (e.g. Irvin et al., 1997; Burrough et al., 2000; MacMillan et al., 2000), thereby making heterogenous landscapes less studied. Additionally, Pike et al. (2009) remarked that no DEM-derived map is definitive, as the parameters can be generated by different algorithms or sampling strategies and can vary with spatial scale.

Following Guisan et al. (1999), Weiss (2001) introduced a customised GIS application for semi-automated landform classification; the so-called topographic position index (*TPI*) or difference from mean elevation (*DIFF*) as defined by Gallant and Wilson (2000). *TPI* measures the relative topographic position of the central point as the difference between the elevation at this point and the mean elevation within a predetermined neighbourhood. Using *TPI*, landscapes can be classified in slope position classes. *TPI* is only one of a vast array of morphometric properties based on neighbouring areas that can be useful in topographic and DEM analysis (see Gallant and Wilson, 2000).

Since the creation of an ESRI ArcView 3.x extension by Jenness (2006), *TPI* has been applied to the fields of geomorphology (Tagil and Jenness, 2008; Liu et al., 2009; McGarigal et al., 2009); geology (Mora-Vallejo et al., 2008; Deumlich et al., 2010; Illés et al., 2011); hydrology (Lesschen et al., 2007; Francés and Lubczynski, 2011; Liu et al., 2011); agricultural science (Pracilio et al., 2006); behavioural ecology (Coulon et al., 2008; Podchong et al., 2009; de la Giroday et al., 2011); forest management (Fei et al., 2007; Zhang et al., 2009; Giorgis et al., 2011; Han et al., 2011; Weber, 2011; Clark et al., 2012); wildlife management (Squires et al., 2008; Lacki et al., 2009; Pinard et al., 2012); climatology (Etienne et al., 2010; Bunn et al., 2011); archaeology (Patterson, 2008; Berking et al., 2010); health care (Clennon et al., 2010; Moss et al., 2011) and risk management (Platt et al., 2011; Wood et al., 2011). Additionally, the bathymetric position index (*BPI*), which is derived from *TPI*, is frequently used in

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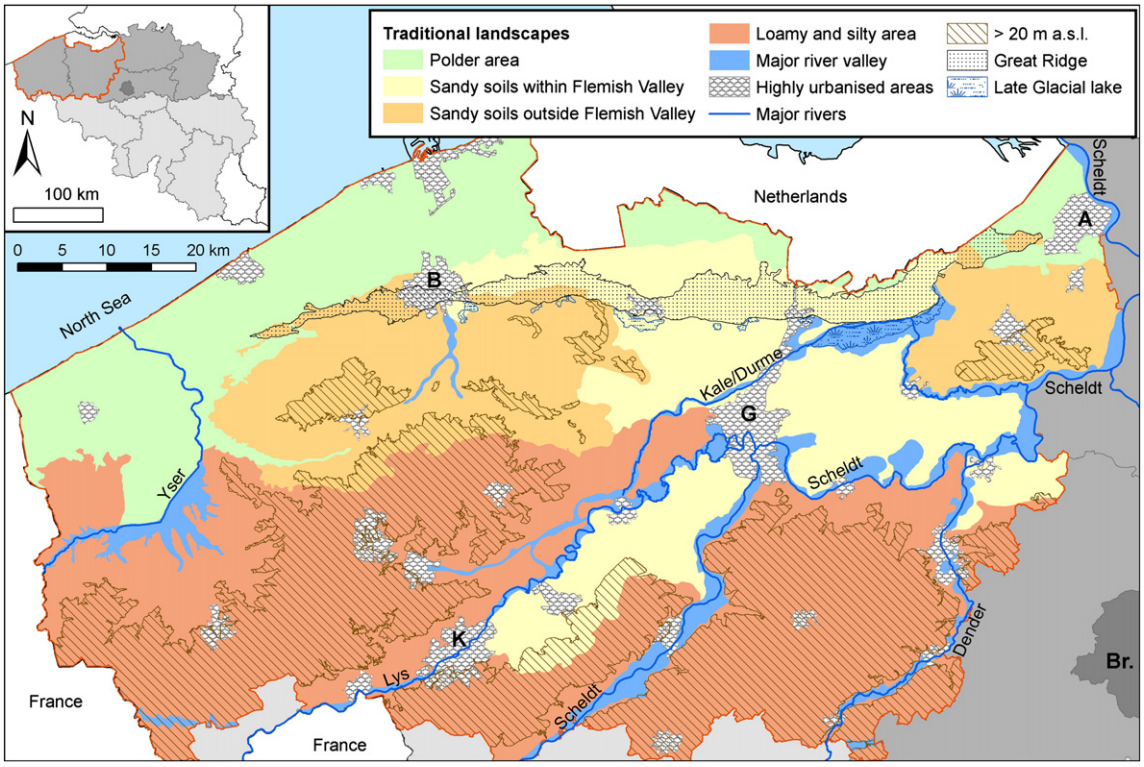

Fig. 1. Map of northwestern Belgium showing main landscape units (major cities: A: Antwerp, B: Bruges, Br. Brussels, G: Ghent and K: Kortrijk).

seafloor mapping (e.g. Iampietro et al., 2005; Lundblad et al., 2006; Verfaillie et al., 2006; Wilson et al., 2007; Wright and Heyman, 2008; Zieger et al., 2009; Young et al., 2011).

Given *TPI*'s ability to subdivide landscapes into morphological classes based on topography, the method is important for archaeological landscape research, aiming to identifying the topographic preference

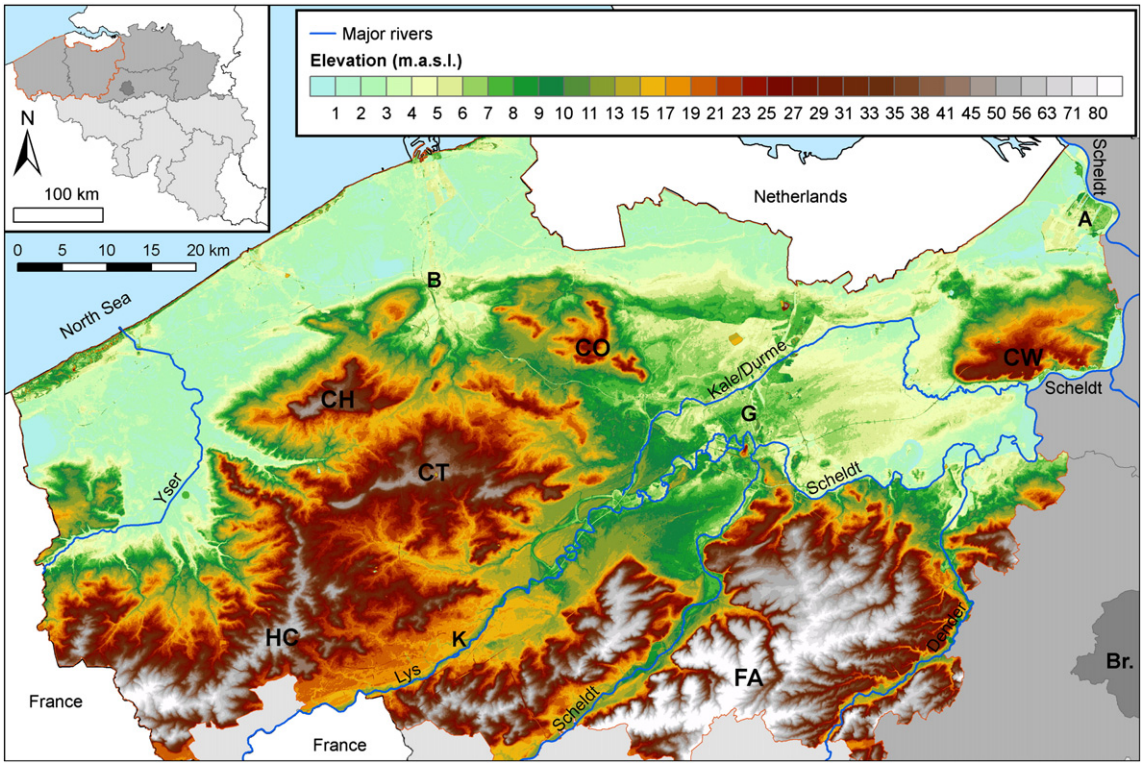

Fig. 2. DEM of northwestern Belgium (cuestas: CH: Hertsberghe, CO: Oedelem, CT: Tielt and CW: Land van Waas; hilly regions: FA: Flemish Ardennes and HC: hills of Central West Flanders; major cities: A: Antwerp, B: Bruges, Br. Brussels, G: Ghent and K: Kortrijk).