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Exploring the impacts of future tourism development on land use/cover changes

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ABSTRACT

Land use/cover changes (LUCC) are central to tourism because land is used in multiple ways as a resource for tourism-focused activities. Tourism is essentially a geographical phenomenon, encompassing the movement and flow of people (seen as the demand side) and spatial distribution patterns relating to land use consumption (seen as the supply side). However, the impacts of tourism on LUCC are difficult to track and monitor. Contributing factors of this problem include a lack of empirical studies, shortage of micro-level LUCC datasets, and scarce methodological frameworks which can be used for assessments. This paper aims to provide a LUCC modelling approach in order to explore the impacts of tourism development on built-up areas. We developed a Cellular automata model (CA) which integrates Markovian transition probabilities and logistic regression transition suitability maps. LUCC rules for tourism development are framed within the national land use policy guidelines for the development of new tourism accommodation establishments (TAE). This primarily takes into consideration land cover compatibility and the proposed development's proximity to the coastline.

Three scenarios were established to explore the impacts of tourism development in LUCC for the year 2020 in a Portuguese coastal region: business as usual (BAU); tourism trends (TOUR); and natural restrictions (NATR). TOUR results indicate that the tourism and urban land use/cover growth is higher and focuses heavily on the coastal region (within 5,000 m) when compared to the other scenarios. The overall results for BAU and NATR show a general convergence with the land use policy guidelines in terms of tourism nucleation and new TAE distance to the coastline.

1. Introduction

Tourism is a geographically explicit phenomenon that encompasses the movement of people – for leisure related purposes – between their origin and destination(s). Pearce (1979) stated that movement is the fundamental element of tourism, and no other discipline concentrates on spatial patterns of tourism phenomena as much as geography (Mitchell & Murphy, 1991). Tourism geography focuses on major areas of interest including spatial patterns, geography of resorts, movements and flows, and the impact of tourism. Lew (2001) argues that the focus of tourism geography research is mainly on the 'how', 'why', and especially the 'where'.

The use and conversion of lands is central to tourism and can be directly linked to tourism development, for instance, by means of constructing tourism accommodation establishments (TAE), vacation homes, golf courses, shopping areas, roads; or indirectly, such as the production of food to supply hotels and restaurants and to manage waste; among others (Gössling, 2002). Nonetheless, one should notice that the area influenced by tourist activities is larger, including, for example, beaches and natural parks. Areas which are not built-up can also be affected by the fragmentation of neighbouring areas. Even though the use and conversion of lands is central to tourism, it is difficult to calculate and measure (Gossling & Peeters, 2015; Gössling, 2005). This is related to: (i) the lack of micro-level georeferenced datasets, (ii) the large number of assumptions required, and (iii) the difficulty to track tourism-related activities that provide services to tourists and also to local communities (e.g. restaurants).

Traditionally, tourism research has focused on conceptualizing the evolution of destinations (Butler, 1980; Christaller, 1963; Miossec, 1977; Prideaux, 2000, 2009; Smith, 1991), thus overlooking the impacts on LUCC. Methodologies used in traditional

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tourism research show limitations for monitoring, assessing, and modelling LUCC. However, the availability of new datasets and modelling tools, such as Geographical Information Systems (GIS), may provide a basis to advancing LUCC studies in tourism research. This paper aims to develop a LUCC modelling approach to explore the future of tourism development and its impact on built-up areas in close proximity to the coastline. The methodology is supported by a case study of Coastal Alentejo, a Portuguese costal region categorized as NUTS3 (Nomenclature of Territorial Units for Statistics) for statistical purposes. The modelling approach integrates Markovian transition probabilities computed from satellite-derived land cover maps, logistic regression transition suitability maps and Cellular automata (CA).

The paper is divided into six sections. Following this introduction, in Section 2 the relationship between LUCC and tourism development is discussed and empirical studies into traditional research are presented, namely applications of CA in terms of exploring the impacts of tourism development on LUCC. In Section 3, tourism development in Coastal Alentejo is described, focusing on the land use policy guidelines used since the 1980s. Implications for the current regional tourism development model are highlighted. Data and methods used in this research are described in Section 4, while Section 5 presents and discusses the model's results. The main conclusions are presented in Section 6.

2. Theoretical background

2.1. LUCC and tourism development

Tourism is one of the largest industries in the world and accounts for 1 in 11 jobs, generating 9% of global GDP and in 2014 was linked to 6% of all exports (UNTWO, 2014). While visiting a destination tourists engage in activities and produce consumption patterns that can trigger major transformations within the place, particularly in terms of LUCC. In relation to Portugal, since the 1960s the demand for summer vacations resulted in the increase of artificial surfaces to support the development of tourism establishments and second homes in coastal areas. Coastal areas provide the main tourist destinations, thus LUCC occur particularly in these areas. From 1990 to 2000 artificial surfaces registered a 20–35% increase, mostly due to residential sprawl (Freire, Santos, & Tenedório, 2009).

Given the spatial implications that tourism development encompasses one should expect that scholars are exploring its effects on LUCC. However, there are few empirical studies in the literature, mostly because of the lack of micro-level datasets that enable a relationship between both phenomena to be established. LUCC studies are based on land cover maps that rely on remote sensing data, which until recently was often acquired within an inadequate time and spatial scale. Moreover, LUCC caused directly by tourism is difficult to track. Even when considering only the direct impacts of tourism development on LUCC – such as land conversion for the constructions of TAE – georeferenced datasets of implantation polygons of establishments are often unavailable, making it difficult to assess the impacts of direct tourism development on land conversion without thorough fieldwork.

Most of the studies exploring the impacts of tourism development on LUCC use GIS and remote sensing tools (Atik, Altan, & Artar, 2010; Boori & Vozenilek, 2014; Chaplin & Brabyn, 2013; Dong, Yu, & Liu, 2008; Wang & Liu, 2013). These studies are analytical and aim to explore changes that occurred in the past, over a specific period of time. However, LUCC modelling approaches aimed at exploring the different potential futures of tourism development are scarce. Exploratory models can support the forecasting of 'what-if' scenarios by mimicking real-world dynamics, providing a means of assessing future impacts of tourism on LUCC.

2.2. Exploring LUCC related to tourism development using CA

Though the traditional tourism forecasting methods are typically linear and deterministic, the system under study is dynamic and influenced by unpredictable externalities (Baggio, 2008; Faulkner & Russell, 1997; McKercher, 1999). Computational modelling and simulation approaches have been gradually applied in the context of tourism, such as system dynamics (Jamal, Borges, & Figueiredo, 2004), CA (Petrov, Lavalle, & Kasanko, 2009), and agent-based modelling (Balbi, Giupponi, Perez, & Alberti, 2013; Boavida-Portugal, Ferreira, & Rocha, 2015; Johnson & Sieber, 2009, 2010; Johnson et al., 2016; Pizzitutti, Mena, & Walsh, 2014).

The application of CA in geographical modelling was originally proposed by Tobler (1979), the author of the first law of geography which states that "everything is related to everything else, but near things are more related than distant things". This is directly related to LUCC as it is modelled on the means of transition of cellular states, and governed by spatial interactions between each cell and its neighbouring cells according to specific transition rules. CA simulation of dynamic spatial patterns has widely been applied in several LUCC studies and there is an entire body of research on this topic (e.g. Basse, Omrani, Charif, Gerber, & Bódis, 2014; Batty, Xie, & Sun, 1999; Torrens, 2003; Verburg, Schot, Dijst, & Veldkamp, 2004). However, there are still very few studies which apply CA when it comes to exploring the impacts of tourism on LUCC. For instance Petrov et al. (2009) offer a CA based approach to explore future urban LUCC scenarios (e.g. in 2020) for a tourist region in Portugal and explore the implications for urban planning. Mao, Meng, and Wang (2014a, 2014b) applied a system dynamic/cellular automata hybrid model to analyse tourism-affected LUCC (1989–2010) in China. The authors developed scenarios to project the most likely future LUCC under different development assumptions. Results show that tourism development affects LUCC by increasing the demand for construction and growth in built-up areas, while contributing to deforestation and forest degradation.

3. Study area

Coastal Alentejo is a NUTS3 region located in the south of Portugal (Fig. 1), approximately 5,300 km^2 in size and home to 98,000 inhabitants. The sub-region has recognized its tourism potential, as highlighted by the National Strategic Tourism Plan 2013–2015 (PENT) as a touristic development pole. In 2014, the sub-region had 103 TAE classified by the national tourism authority (TP), with a capacity for 6735 guests, and received 220,539 tourists in a total of 521,154 overnight stays (Statistics Portugal, 2015). Coastal Alentejo has a set of distinctive features that provides an attractive atmosphere for tourists. Around 73% of Coastal Alentejo is covered by natural protected areas encompassing several land use restrictions, namely to prevent an increase in built-up areas (presented in Table 1). This fact, together with the projected increase in tourism supply, raises awareness about issues such as the promotion of sustainable tourism development or balancing the trade-offs between TAE development and the preservation of the natural environment.

3.1. Evolution of the national land use policy guidelines

Interventions in land use planning in Coastal Alentejo took a restrictive approach in terms of managing the pressures of tourism development. In the 1980s there were several intended touristic investment opportunities characterized by projects which would