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Modeling the effects of tourism and land regulation on land-use change in tourist regions: A case study of the Lijiang River Basin in Guilin, China

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ABSTRACT

To a large extent, tourism development triggers an economic boost in certain regions. However, given its complex and dynamic forms of land use, tourism development also causes changes to land-use demands and patterns in tourist regions, which directly and indirectly interfere with local environments. The development of tourist regions must achieve a series of trade-offs to meet sustainability goals. This paper discusses the effects of tourism on land-use change and how land regulation policies integrate tourism development with land use. We employed a system dynamic-cellular automata hybrid model using the Lijiang River Basin as an example to translate tourism-affected land dynamics into spatial distributions and project their likely future changes under various development scenarios. We determined three major outcomes. (1) Tourism development causes a quantitatively increasing demand for construction land. With effective spatial regulations, the expansion of construction land does not necessarily suggest the loss of eco-land; rather, land-use pressures accordingly shift to cropland. Under these circumstances, land regulation policies help to balance land demand and optimize land-use patterns. (2) Tourism development causes a continuous spatial interference with landscapes. Land regulation policies have the positive and active effect of ignoring this interference rather than counteracting it. (3) The strict implementation of land regulation policies does not necessarily improve land-use patterns. Flexible policies achieve a better balanced land-use pattern than a combination of individual strict policies. However, the former cannot reduce as much vulnerability as the latter. Hence, policy assembly represents a trade-off with regards to balancing land demands, and it should vary based on regional land-use patterns and targets.

Introduction

Healthy tourism development can stimulate local economic growth, create jobs, and facilitate other positive spillover effects accompanied by the effective use of resources while minimizing the effects on the local environment. In fact, the tourism sector has boosted the economy throughout the world for years. In 2010, the number of tourists reached 9.39 billion, and tourism income was 928 billion dollars, with a growth rate of 5% (World Tourism Organization, 2012). China welcomed 2.24 billion tourists, and its tourism income reached 1.258 trillion yuan (approximately 0.20 trillion dollars) with an annual growth rate of 23.53%. However, rapid growth is not necessarily healthy. Recent studies have reported a series of negative effects with regard to the ecosystems and human activity associated with boosts in tourism, including deforestation, loss of biodiversity, pollution, water scarcity, cultural effects, and resident inequity (Wang et al., 2005; Pickering and Hill, 2007; Strickland-Munro et al., 2010; Niu et al., 2012).

Because it involves a dynamic and complex set of land use, tourism has received close scrutiny with regard to land-use change. Land-use change is a decisive factor that can affect climate change, the functions of an ecosystem, and human vulnerability as well as biophysical and anthropogenic processes (Hou and Cai, 2004; Verburg et al., 2009). Over the last several decades, human-driven land use change has gradually emerged as a consequential process with regard to global environment change (Linderman et al., 2005;

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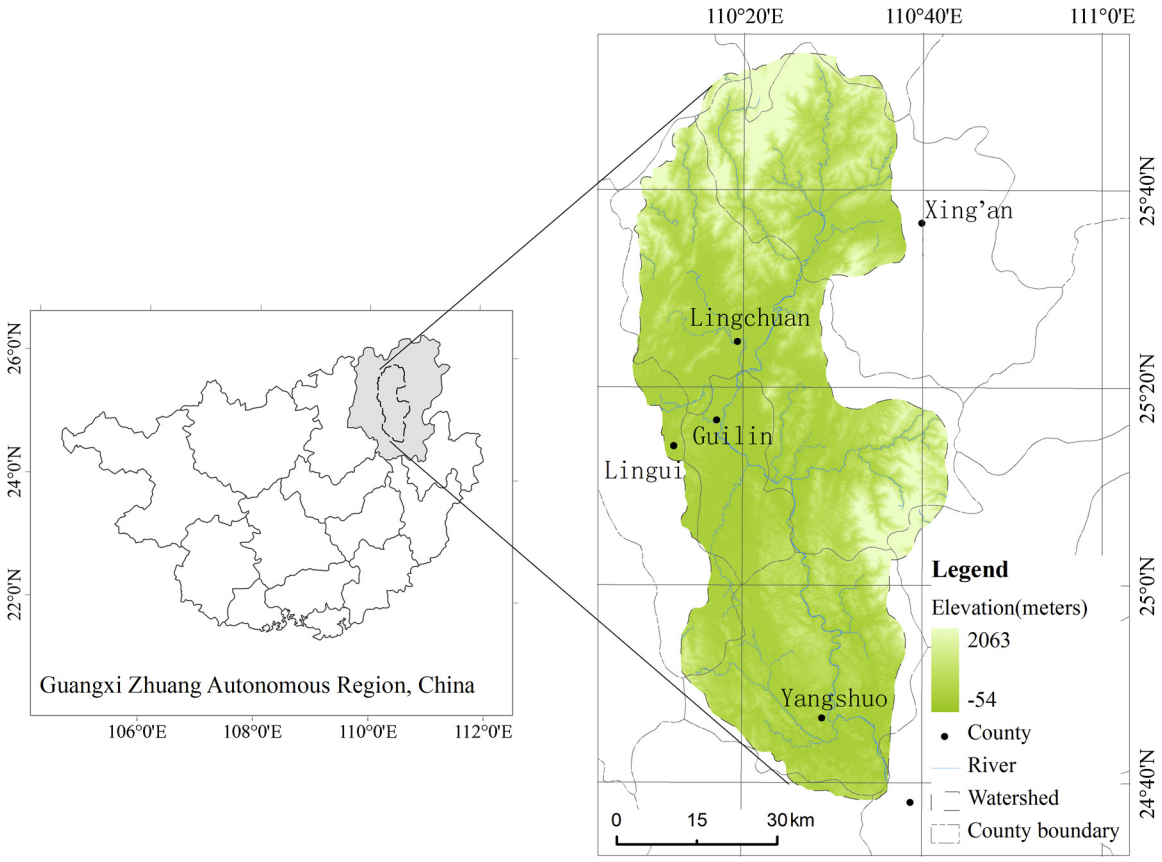

Fig. 1. Study area (Lijiang River Basin, Guilin).

Wijesekara et al., 2012). This change is manifested by land degradation, disturbed water balance, vegetation deterioration, and a loss of biodiversity consistent with intense human activities (Fu et al., 2001). Tourism development is a typical form of human activity in certain regions. Similar to land-use change, tourism is closely related to multiple societal, economic, and environmental factors. At a regional level, tourism must manage the trade-offs between industrial sectors, society, and ecosystems (Wu, 2001; Gossling, 2002; Marin-Yaseli and Martinez, 2003; DeFries and Eshleman, 2004; Petrov et al., 2009). At an individual level, tourism must take the interests of relevant stakeholders into account, including citizens, farmers, government personnel, developers, and endangered species (Liu et al., 2009; Williams and Shaw, 2009; Carte et al., 2010). Therefore, examining tourism with regard to land-use change might help to foster tourism development while mitigating its negative environmental effects.

Tourism land-use is a typical human–environment system with complicated factors that require an integrated approach. Simulated land-use models are a useful approach due to their ability to describe complex and non-linear processes. As a result, a series of simulation models is widely used to project dynamic land processes including the system dynamic model (SD; He et al., 2004; Zheng et al., 2012), cellular automata (CA; Clarke et al., 1997; Wu and Webster, 1998; Li and Yeh, 2002; Tayyebi et al., 2011), the conversion of land use and its effects at small regional extent model (CLUE-s model; Verburg et al., 2002; Verburg and Overmars, 2009), and the multi-agent simulated model (Evans and Kelley, 2004; Mialhe et al., 2012). The SD and CA models are both dynamic but embody different features that are advantageous when representing the relationship between the elements in a land-use system. The SD model is a top-down model given its strength when projecting land dynamics with temporal feedback and its weakness when considering the spatial attributes of land-use change (He et al., 2006). Unlike the SD model, the CA model simulates the changing status of each land unit with neighborhood effects represented by transformation rules. The CA model can simulate the evolution of land-use patterns but cannot represent influential macro-level factors (e.g., those of the economy, society, and institutions). In contrast to the SD model, the CA model is a bottom-up model. Due to their complementary attributes, a hybrid model combining SD and CA might reinforce their respective strengths and minimize their weaknesses. The application of this hybrid model can integrate multi-disciplinary information and consider the elements of land-use change at various scales (Castella et al., 2007). Several applications of this hybrid model have supported its feasibility (He et al., 2006; Wang et al., 2011).

This paper explores the effects of tourism on local environments with regard to land-use change. Using the Lijiang River Basin as a case study, a SD–CA hybrid model is employed to simultaneously represent the relationships among the elements of land-use systems at a macro-level, translate land dynamics into a spatial distribution, and consider the effects of the influential factors at a micro-level. In addition, a scenario analysis is used to examine the effect of tourism and current land-use policies on local environments. Several landscape indices are introduced to evaluate the status of the environment with regard to land-use pattern.

Study area and data

Study area

The Lijiang River Basin, a famous tourist region in China, is located in the city of Guilin, which is located in the northeastern Guangxi Zhuang Autonomous Region (Fig. 1). It covers