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Research Paper

Factors of spatial distribution of Korean village groves and relevance to landscape conservation

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ABSTRACT

Our study aims to understand the spatial context of community-based landscape systems for conservation planning. To this end, the present study analyzes the factors affecting spatial distribution of Korea's traditional village groves, which form a distinctive component of Korea's traditional community-based landscape. Using maximum entropy (MaxEnt) modeling, we identified four strongest contributory factors that affect the current occurrences of village groves. First, the probability of occurrences declined with increasing human population density within a 300 m radius, and, second, it was lower where there was high forest cover (> 80%) within a 500 m radius. Third, we found a unimodal pattern for the occurrence probability for precipitation during the coldest quarter with the probability peaking in areas where mean precipitation is 118 mm, while the occurrence probability for mean diurnal temperature range was generally positively correlated. Based on the assumption that spatial analysis could highlight priorities and implications for conservation, our results reveal the importance of understanding the grove landscape as a manifestation of the linkages between nature and humans as well as the importance of modern scientific approaches to manage the spatial elements of traditional landscape systems.

1. Introduction

A clear analysis of the factors of rural landscape changes is necessary for devising appropriate strategies for landscape conservation and sustainability. Whereas some landscape changes are natural phenomena, most of the recent rapid changes are the result of intensive human activities that diminish landscape diversity and affect its characteristics (Antrop, 2005; Foley et al., 2005). Globally, demographic changes, agricultural intensification, economic policies, and market forces are the primary drivers of rural landscape changes (Brown & Schulte, 2011; Ribeiro et al., 2018; Wu et al., 2009). Agricultural intensification is one of the most proximal factors of human induced landscape degradation; it reduces soil fertility and biodiversity, and increases ground water pollution and greenhouse gas emissions resulting in local and non-local environmental impacts (Andela et al., 2017; Burney, Davis, & Lobell, 2010; Matson, Parton, Power, & Swift, 1997). In comparison, locally adapted, traditional agroecological practices provide several cultural and ecological benefits, such as traditional ecological knowledge, biodiversity conservation, crop diversification, soil enrichment, air and water quality enhancement, and support to sociocultural structures (Altieri, 2004; Jose, 2009; Lomba, Alves, Jongman, & McCracken, 2015).

A wide range of locally adapted landscape management systems and practices have been documented as being effective in conserving biodiversity and enhancing social-ecological resilience: agroforestry or croplands with restored ecosystems (Foley et al., 2005; Jose, 2009; McNeely & Schroth, 2006); multiple species management, resource rotation and succession, landscape patchiness (Berkes, Colding, & Folke, 2000); and small-scale community-based systems (Agrawal & Gibson, 1999; Chan, Shaw, Cameron, Underwood, & Daily, 2006). Of these, community-based landscape management systems have been seen to be particularly effective in maintaining or improving ecosystem services (Fischer, Hartel, & Kuemmerle, 2012), such as the sacred groves in India (Bhagwat & Rutte, 2006), Satoyama landscapes in Japan (Takeuchi, 2010), and terraced rice paddies in China (Liu, Duan, & Yu, 2013). There are three common aspects inherent to these community-based systems that ensure social-ecological benefits (Agrawal & Gibson, 1999): small spatial units, homogenous social structure, and shared

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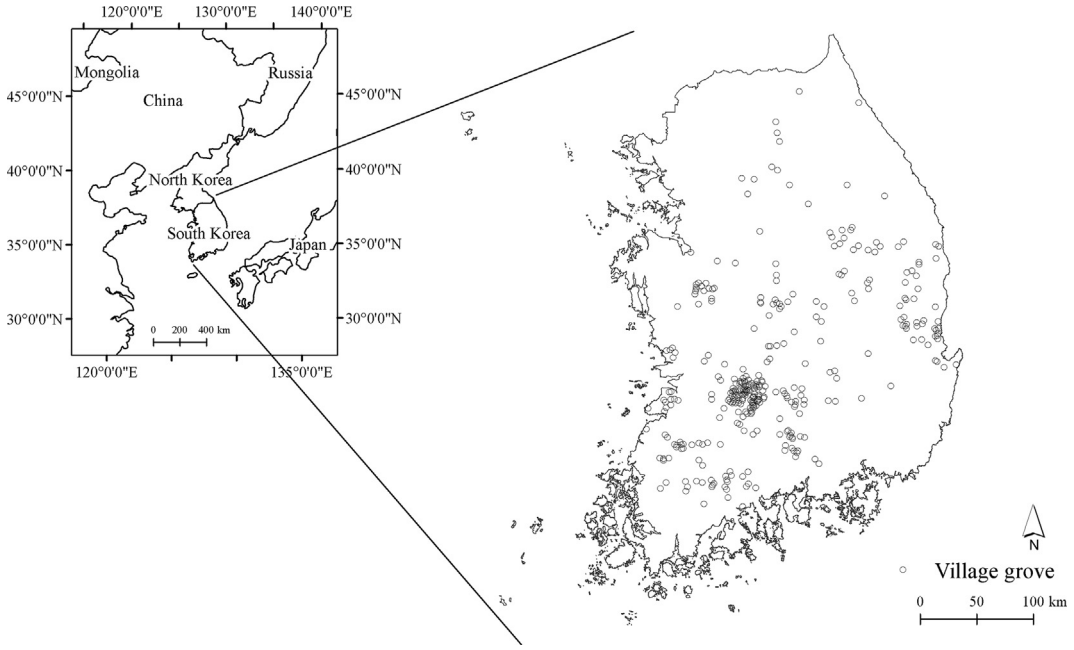

Fig. 1. Current distribution of traditional village groves in South Korea.

norms.

The Korean traditional rural landscape management system exhibits these three aspects of community-based management, with distinct biophysical and cultural characteristics. It is similar to the Japanese Satoyama landscape management system, in that they are both integrated systems adapted to local social-ecological conditions in a village spatial unit. In addition, the Korean system has specific landscape configurations and social-ecological characteristics (Lee, 2017) that are influenced by local traditional knowledge and belief systems that aid in finding or creating auspicious landscapes; these belief systems are collectively known as geomancy (Koh, Kim, & Lee, 2010; Lee, 2017). Korean traditional village groves or forest commons, colloquially called *maeulsoop* (pronounced má-ùl-soop) or *bibosoop* (pronounced bee-bo-soop), are examples of landscapes that have been created and managed through geomancy-related norms and practices to auspiciously complement a village's physical geography (Koh et al., 2010; Lee & Krasny, 2015).

Globalization and rural development have impacted Korean traditional landscapes. Rural residents are migrating to urban areas for socioeconomic opportunities and few remaining residents use or manage the traditional landscape as in the past (Fischer et al., 2012). This has weakened community-based social-ecological management systems (Yu, Anderies, Lee, & Perez, 2014) and the functioning of characteristic rural landscapes such as the village groves. Where village groves are still managed well, they provide several ecological and social functions, such as serving as windbreakers, vegetative buffer strips, wildlife corridors, bird habitats, and community spaces for spiritual practices and commemorative events (Joo & Park, 2012; Lee, 2003; Lee, Koh, & Park, 2007).

Social-ecological system studies highlight the services of village groves in appending natural resource management capacity (e.g., Lee & Krasny, 2015; Yu et al., 2014), yet focus primarily on their conservation value and social-ecological practices in relation to conservation. In the context of the changing rural social and economic conditions, the conservation of small scale landscapes within community-based management systems, requires a sound understanding of the geographical and spatial context of the target communities; this facilitates the development and implementation of strategic actions at appropriate spatial-temporal scales (Ban et al., 2013), which can be effectively scaled up to enhance local ecosystem services and biodiversity, and landscape sustainability (Chan et al., 2006).

Taking the village grove landscape as a spatial unit, this study assesses multiple village groves in South Korea and examines the following questions in relevance to conservation of small-scale landscapes: (a) what social and environmental factors affect the current geographic distribution of village groves, and (b) how can the spatial understanding of village grove landscapes contribute to conservation efforts. This analysis of multiple landscapes offers the benefit of a more comprehensive understanding of the relevant factors. The study uses a modeling distribution method to identify the factors for the current spatial distribution of village grove landscapes and derive inferences for conservation.

2. Materials and methods

2.1. Study system

The remaining traditional village groves in South Korea have been investigated by a governmental agency since 2007 (Park, Cho, Sung, Woo, & Kang, 2015). Through the survey, the following features of village groves have been recorded: name of village, management authority, address, inspector, survey date, GPS point, main tree species, and the type of grove. There are six general types of village groves that depend on spatial location (Lee, Koh, Kang, & Park, 2010). For our study, we selected 350 archetypal groves, traditionally called *sugu-magi*, referring to the retention of water downstream from a village and the protection of the village from inauspicious outside energy by locating groves at the mouth of the watershed. The dominant species in *sugu-magi* groves are *Pinus densiflora* and *Zelkova serrata*. The *sugu-magi* village groves occur throughout South Korea (Fig. 1); consequently, only those separated by a minimum distance of 1 km were selected to avoid spatial autocorrelation of data (Legendre et al., 2002).

There is substantial evidence for Korea's traditional rural landscape embracing village groves as a community-based landscape system in relation to its spatial unit, social structure, and shared norms. First, the concept of traditional rural landscape spatial units is often related to water availability. People traditionally resided in areas with relatively easy access to water, creating rural landscapes within watersheds in village units (Koh et al., 2010; Lee, 2003). It is also known that indigenous people possess ecosystem-like concepts with regard to their