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Historic vegetation and environmental changes since the 15th century in the Korean Peninsula

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ABSTRACT

Reconstruction of past vegetation is an important process in understanding vegetation history and global climate change. This research reconstructed the past vegetation range based upon historical records in the Korean Peninsula, especially for conifers and bamboos, and determined the factors responsible for historic change. Time-spatial changes in distribution of three conifer trees, two by-products of red pine and two bamboos from 1454 to 1931 were reconstructed with information about the local produce and tribute descriptions on seven historical documents. Plant distribution data were collated over time and space and plotted on county maps using a GIS software package.

Cold tolerant Korean pines were grown on the northern Democratic People's Republic of Korea (DPRK) and eastern parts of Republic of Korea (ROK) with high mountains and hostile climate but absent from the western and southern lowlands of ROK showing low elevation and mild climate. Warmth tolerant red pines were present nation-wide, apart from the northern high mountains. Reconstructed ranges of red pines based on two by-products, e.g., pine mushroom and tuckahoe, matched well with the distribution of red pines. Warmth loving torreya tree were confined in their distribution to the southwestern tips of ROK with gentle terrains and mild and wet climate, especially in the winter. Giant timber bamboo mainly occurred on the southern parts of ROK, but some in the eastern ROK. Arrow bamboo showed a broader distribution, along the coast of ROK as well as the eastern coast of DPRK.

Historical records can be used as good sources for reconstructing past vegetation change and climate change. Spatiotemporal distributional change of conifers and bamboos in the Korean Peninsula seems to be the result of both climatic change and anthropogenic cultivation, but no clear indication for the little ice age can be found from the historical vegetation.

1. Introduction

Reconstruction of past vegetation has become important in order to understand environmental change and land-use change (Cui et al., 2014). Environmental science has used various methods, such as pollen analysis (Overballe-Petersen et al., 2013), stable isotope analysis (de Tapia and Adriano-Morán, 2012) and historical document analysis (Poska et al., 2014), to measure past vegetation. In particular, historical documents are very valuable in reconstructing past vegetation because these data explain complex interactions between climate, land use and human responses (McCormick et al., 2012).

Vegetation change occurs at temporal and spatial scales that are difficult to measure and interpret (Sisk, 1998). Anthropogenic impact is one of the major drivers of spatiotemporal changes in vegetation through land-use change, and the largest change in

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vegetation due to land-use change occurred during the last millennium (Poska et al., 2014). Spatiotemporal patterns of historical land-use are complex because of various factors, e.g. politics and economics, influence of human activities (Poska et al., 2014). Therefore, the reconstruction of past vegetation requires multiple historical documents as well as paleo-ecological data, e.g. inventory notes, migration reports, population records and historical maps (Veski et al., 2005). For example, the land-use history of Verijarv in South Estonia, changing from open wooded meadow to closed boreal forest community, was reconstructed from pollen and historical data (Poska et al., 2014).

The reconstruction of time-spatial changes in vegetation distributions with historical records has been used for conservation and restoration efforts. For example, Rich et al. (1997) developed vegetation maps for southwestern New Mexico and southern Arizona based on U.S. General Land Office Surveyors' notes, dated 1882–1936. He found the vegetation map potentially useful to assist in management and restoration efforts in the area. Historical records of vegetation change also provided insight into the factors, including climate change, predisposing species to extinction in the face of human impacts (Duncan and Young, 2000).

Ancient vegetation history of the Korean Peninsula based on fossil data has previously been discussed (Kong, 2000; Kong et al., 2014). However, few studies have used historical documents for reconstructing past vegetation to understand anthropogenic impacts on vegetation changes in interaction with climate changes. The reconstruction of past vegetation from historical records is very difficult because the amount and quality of historical documents are highly variable (Beck, 1986; Powell, 1999). However, Korea has high resolution historical documents from the Chosŏn Dynasty (AD 1392–1910) and in the early twentieth century during the Japanese occupation period. This present work aims to reconstruct the time-spatial vegetation changes, especially conifers and bamboos during the last 500 years on the basis of seven historical documents, and account for vegetation history of the Korean Peninsula under climate change and anthropogenic impact.

2. Materials and methods

Seven historical documents from Korea employed for this analysis date back to 1454, 1531, 1660s, 1760, 1842–1845, 1864, and 1931. Korean historical documents are unique in terms of wide ranges of species diversity and micro and local geographic scale, which include 335 counties in an area of 221,000 square kilometers. These historical documents include Saejongsillok Jiriji (1454), Shinzung Donggukyeojiseungram (1531), Donggukyeojiji (1660s), Yeojidoseo (1760), Yimwongyeongjeji (1842–1845), Daedongjiji (1864), and Chosŏnilram (1931). Though Korean characters have been used for writing since 1446, these documents except Chosŏnilram, which was written in Japanese characters by the Japanese Colonial Government, were all written in Chinese characters. Information of plant species in all historical documents was recorded on a county scale, which numbered up to 335 of eight major provinces of Korea during the Chosŏn Dynasty (Fig. 1).

Saejongsillok Jiriji (世宗實錄地理志) or Regional Geography of the King Sejong Period, Annals of the Chosŏn Dynasty with eight volumes, was published by the central government in 1454, and contained detailed descriptions on the local tributes, medicinal herbs, and produces. Shinzung Donggukyeojiseungram (新增東國輿地勝覽) or Augmented Survey of the Geography of Korea with 50 volumes was also published by the central government in 1531, and consisted of chapters for local native produces and distributional data of plant species. Donggukyeojiji (東國輿地志) or Regional Geography of Korea was printed presumably in the 1660s by the central government, and consisted of 9 volumes; unfortunately

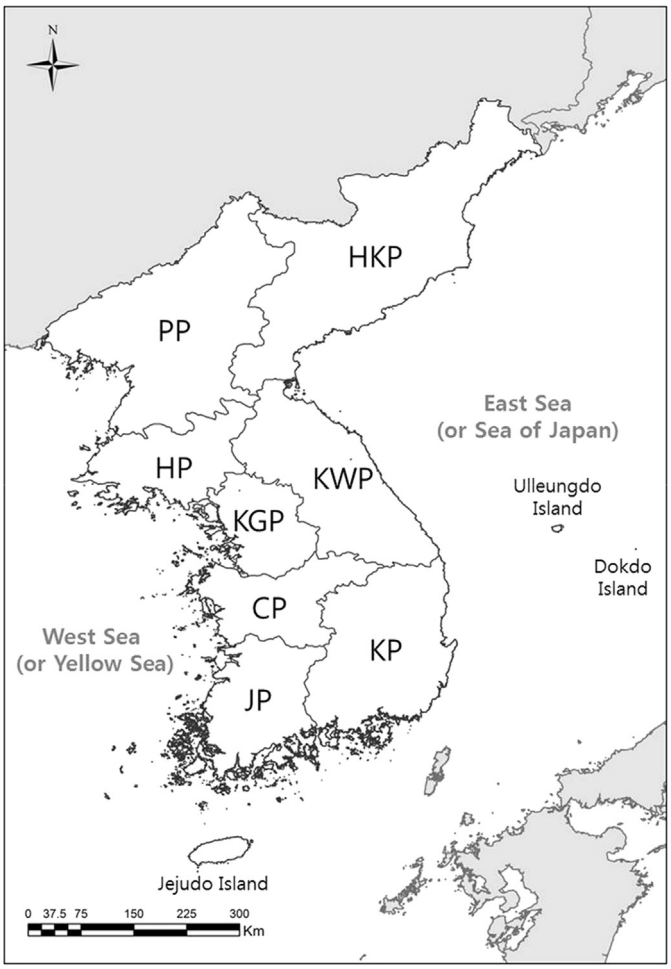

Fig. 1. Provincial boundaries of Korea during the Chosŏn Dynasty (AD 1392–1910). Abbreviations: HKP; Hamkyung Province (NE Korea), PP; Pyungan Province (NW Korea), HP; Hwanghae Province (Mid-western Korea), KWP; Kangwon Province (Mid-eastern Korea), KGP; Kyunggi Province (central Korea), CP; Chungchong Province (mid-central Korea), KP; Kyungsang Province (SE Korea), JP; Jeolla Province (SW Korea).

volume 4, which described Kyungsang Province of the southeastern ROK, is currently not available. Yeojidoseo (輿地圖書) or Geography of Korea with 55 volumes was published in 1760 by the central government, and included information on the distribution of plants in the local products and tributes. Yimwongyeongjeji (林園經濟志) or Sixteen Treatises Written in Retirement was compiled and written by a private individual between 1842 and 1845, and was composed of 113 volumes containing detailed information on plant distribution within the counties. Daedongjiji (大東地志) or Regional Geography of Great Korea of 1864, with 32 volumes, was a privately written document, and included elaborate descriptions on plant resources. Chosŏnilram (朝鮮一覽) or Sketch of the Chosŏn of 1931 was written based on natural resources surveyed by Japanese Colonial Government for the purpose of resources exploitation.

Historical records could be distorted by the chroniclers due to socio-economic reasons, especially to avoid heavy taxation by municipal governments. Despite this limitation, these documents provided quite detailed information to be able to describe the past local plant distribution. Therefore, these records accounted for long term vegetation changes and climate changes in relation to the historical changes of their distributions in the Korean Peninsula.

We used three conifers, two bamboo species, and red pine fungi to explore vegetation changes in Korea. Three conifers included