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Contextualizing human migration in different agro-ecological zones in ancient China

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ABSTRACT

Unique agricultural practices engender regional variations in cultural customs, which pave the way for diverse regional migration patterns at discrete geographic levels. In this regard, the long-term fluctuation of land carrying capacity and its association with the frequency and pattern of migration in China at the sub-national level has not been scientifically investigated. In the present study, we base on fine-grained historic migration records, together with statistical analysis (correlation analysis, Granger Causality Analysis, and multi-variate linear and Poisson regression analyses), to explore the relationship between land carrying capacity and migration in China at the sub-national level over the past two millennia. Our results quantitatively demonstrate that in the pastoral region, climate change, which is one of the major determinants of land carrying capacity, has a major role in triggering migration. In the rice region, migration is more influenced by population pressure, another major determinant of land carrying capacity. The wheat region, located between the pastoral and the rice regions, displays the combined patterns of the two regions. Our findings also reveal the importance of regional cultural and geographic context in shaping migration patterns in various agro-ecological zones in ancient China. Based on our results, the application of a "Push–Pull Model" in interpreting historic Chinese migration is revisited with quantitative evidence. This study provides timely empirical proof of a "nature–human" interaction founded on diverse cultural traditions over an extended period which other scientists and policymakers can use as reference in initiating actions that can prevent agriculturalist–pastoralist conflicts.

1. Introduction

The geographic variation of cultural traditions in China is largely attributable to her diverse regional environmental settings (Duara, 1988; Siu, 1993; Fan, 2000). Recently, it has been further suggested that psychological differences among the modern Chinese population are rooted in different agricultural practices (Talhelm et al., 2014). In a macro-historic perspective, the cultural differences between pastoral and agricultural people in China, which have also been revealed by their distinct territories (Pei and Zhang, 2014), have been seen to drive cyclic geo-political changes in Chinese history (Zhang et al., 2015).

The patterns of migration are considered as a manifestation of culture, closely related to the cultural background of migrants (Sowell, 1996; Kirmayer and Minas, 2000). Owing to diverse cultural customs, migration patterns vary among the globe's several continents: North America, South America (deMenocal, 2001), Europe, Africa, and Asia (Rouse, 1986). It is also possible to identify regional variations in migration dynamics within the territory of China. For instance, contemporary scholars generally believe that farmers in "agrarian China" were generally reluctant to leave their ancestral homes (Lee, 1978). In contrast, the nomadic minorities in the pastoral region were more willing to migrate (Fang and Liu, 1992). This phenomenon can be traced through human genetic records (Diamond, 1998).

Although migration patterns in different agro-ecological zones in Chinese history have been addressed in previous studies (Ge et al., 1997), most of them are qualitative and grounded on individual cases. So far, a quantitative large-sample study on the topic is very rare. There are at least four issues related to the topic

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that remain unresolved: First, those studies tend to investigate the momentum of migration in a socio-economic perspective (Rozelle et al., 1999; Yi et al., 2007), while the influence of land carrying capacity, which is the essential basis for agriculture and the fundamental issue in historical research (Sayre, 2008) on migration, has not been thoroughly examined. Given that land carrying capacity varies across space, migration patterns in various geographic regions in China and their relationship to the fluctuations of land carrying capacity should be further investigated. Second, it has been stated that population density has always been low in pastoral regions and hence, population pressure could not result in large-scale nomadic migration (Hu, 1983; Li, 2007). In contrast, the importance of population pressure in driving migration in southern China is widely accepted (Marks, 1998). Nevertheless, the above notions have not been scientifically verified. Third, some scholars have addressed the manner in which migration is engendered by the change of land carrying capacity in the whole of China (Fang and Liu, 1992; Pei and Zhang, 2014). However, migration in China at the sub-national scale remains insufficiently explored. At different spatial scales, we may have dissimilar findings regarding the same phenomenon (Sayre, 2005). Even though there are some studies which examine migration dynamics in specific regions in Northern China (Fang et al., 2013; Zheng et al., 2014; Xiao et al., 2015), their study time spans are only confined to recent centuries (i.e., Ming and Qing Dynasties). Hence, a holistic picture of the longer-term pattern and migration dynamics in ancient China is still missing. Finally, the inter-relationship of migration among different geographic regions (i.e., whether migration in a geographic region also triggers migration in another geographic region) has rarely been discussed.

In this study, we aim to demonstrate how human migration in different geographic regions in ancient China is driven by the fluctuation of land carrying capacity. Fine-grained historical data together with various statistical methods are employed. Land carrying capacity is co-determined by both climatic conditions and population pressure (Cohen, 1995; Lee and Zhang, 2013). Hence, we focus on how migration events are driven by the changes in climate and population pressure. In addition, we hypothesize that such a relationship will be mediated by the regional cultural and geographic context, as the notion has been emphasized in climate-migration research (McLeman and Hunter, 2010). Therefore, migration frequency in various agro-ecological zones, characterized by diverse cultural and geographic settings (Talhelm et al., 2014; Zhang et al., 2015) in ancient China, is examined. Our findings are primarily derived from quantitative analysis at a long-term and sub-national scale. Also, migration events are taken as aggregate rather than individual incidents to generate the statistical law in history (Bunge, 2009; Pei et al., 2014). This approach, although limited in some ways, suits the scope of this study.

2. Materials and methods

2.1. Study area and study period

Although the territory of China has been changed several times in history, the current territory of China covers the major epochs as well as the geopolitics between pastoral minorities and agriculturalists in Chinese history (Zhang et al., 2015). Following the common practices in studying historic Chinese society (Zhang et al., 2006; Fan, 2015), we delimit current Chinese territory as our study area. We further divide China into three agro-ecological zones, namely rice, wheat and pastoral regions according to the general zonation of Chinese agricultural geography (Zhao, 1986; Ren, 1999). The Yangtze River is the major physical divide in China; the region south of the river is rice-cultivated area, while the region north of the river is wheat-cultivated area (Talhelm et al., 2014). From the historic economic viewpoint, there is a long tradition of rice cultivation south of the Yangtze River (Barker et al., 1985). Xinjiang, Inner Mongolia and the Tibet Plateau are the traditional pastoral regions in China. Northeastern China, which was occupied by nomads, has never been a major agricultural zone throughout Chinese history, though part of the region is suitable for farming (Cosmo, 1994). Therefore, Northeastern China is merged with Xinjiang, Inner Mongolia and the Tibet Plateau to form the pastoral region (Zhao, 1986; Ren, 1999). The locations of the three agro-ecological zones are presented in Fig. 1, and the same geographic delineation has been employed in our previous study (Pei and Zhang, 2014).

Our study period is set between 220 BC and AD 1900, which covers almost all the periods of Imperial China (Keay, 2008). This study time span also makes our findings comparable to previous studies on climate change and pastoral migration in Imperial China (Fang and Liu, 1992; Pei and Zhang, 2014).

2.2. Data sources

To guarantee data reliability, only those data that are published in international refereed journals or further confirmed by Western scholars in their research are employed in this study. All of our employed data time-series are shown in Fig. 2, with their sources stated below, respectively.

2.2.1. Migration in the three agro-ecological zones

Migration data were obtained from the latest chronological table printed in the compilation entitled *Chinese Migration History*, which provides migration data for the whole of China starting from 2100 BC to AD 1950 (Ge et al., 1997). The value of this dataset in studying historic Chinese migration has also been highlighted by other scholars (Campbell et al., 2002). The volume includes the collected records of ancient royal historians and scientists from the empires of both agriculturalists and pastoralists, and provides information regarding departure place and destination of migration events at the provincial level. Using that information, we work out the number of as well as the route of migration events in the three agro-ecological zones. There are 4030 migration events at the provincial level in total in our study period (i.e., 220 BC and AD 1900), in which 948, 1514 and 1568 of them happen in the pastoral (Fig. 2B), wheat (Fig. 2D) and rice (Fig. 2F) regions, respectively.

2.2.2. Climatic indicators: precipitation and temperature

Precipitation and temperature are the two key variables considered to identify climatic conditions (Gimmi et al., 2007). Unfortunately, precipitation and temperature reconstruction at the agro-ecological zone level with a time span of 2000 years are unavailable at the moment. As a remedy, we adopt the precipitation reconstruction by Pei et al. (2014) and temperature reconstruction by Yang et al. (2002). Pei et al.'s (2014) annually-resolved precipitation index represents the past wet–dry patterns of the whole of China and covers the period from 220 BC to AD 1900 (Fig. 2A). Yang et al.'s (2002) series features decadal temperature throughout China and covers the period from AD 1 to 2000 (Fig. 2H). Both of these reconstructions have been employed to examine climate–human interactions in pastoral and agricultural regions in China in other studies (Pei and Zhang, 2014; Fan, 2015; Zhang et al., 2015).

It is important to note that only the change of averaged weather conditions lasting over periods of 30 years or longer are considered as climate change (IPCC, 2007). Furthermore, in this study, both drought and cooling are considered as climate deterioration, as

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