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Settlement scaling and economic change in the Central Andes

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ABSTRACT

There is a longstanding debate in anthropology and history regarding the extent to which the determinants of past economic change are similar in any specific ways to those that operate today. In this paper, we examine the extent to which increasing returns to settlement scale in material outputs, which are apparent in contemporary urban systems, also operated in the Late Pre-Hispanic Tarma and Mantaro drainages of the Peruvian Central Andes. Proxy measures for material outputs across settlements and households show that this region experienced a marked economic expansion following its incorporation into the Inka Empire ca. 1450 CE. We argue that these changes in living standards are consistent with expectations of an emerging framework known as settlement scaling theory that specifies relationships between human aggregation, social connectivity and material outputs. Our results suggest that intensification of human social connectivity and material flows—as measured through settlement size distributions—can be sufficient to raise living standards even in the absence of markets.

1. Introduction

An important question in economic history and related fields is the extent to which human societies experienced economic growth—in the general sense of increased material output per capita and per unit time—prior to the onset of the industrial revolution. A longstanding view is that such changes were rare to nonexistent prior to the 18th century (Galor, 2005; Mokyr, 2006; Wrigley, 2013). However, as empirical data have accumulated it has become clear that many past societies—from Pre-Hispanic Mesoamerica to ancient Greece—did in fact generate substantial per capita increases in material outputs (Allen, 2009; Fouquet and Broadberry, 2015; Pryor, 2005; Scheidel and Friesen, 2009; Stark et al., 2016) energy capture rates (Morris, 2010, 2013), farming surpluses (Sanders et al., 1979), household consumption rates (Jongman, 2014a, 2014b), and wealth accumulation (Morris, 2004; Ober, 2010). This growing awareness of the reality of past economic change has led to considerations of the determinants of that change, with proposals ranging from institutional structures (Acemoglu and Robinson, 2012; North et al., 2009; Ober, 2010) to urbanization (Bowman and Wilson, 2011), expanding long-distance trade (Algaze, 2008; Scheidel, 2008; Temin, 2012), and technological progress (Greene, 2000; Kander et al., 2014; Smil, 2008). In modern economies, these processes are not independent and none is sufficient to generate sustained economic expansion on its own. Thus, the search for deeper mechanisms that articulate various mechanisms of socioeconomic change throughout history remains a topic of great interest.

Here, we consider the extent to which a process often associated with economic development in the modern era— productivity enhancements generated by the concentration of individuals in space (Bloom et al., 2008; Henderson, 2002, 2003; Quigley, 2009)—also operated in pre-modern contexts. Specifically, we analyze an episode of economic change in a portion of the Central Andes following its incorporation into the Inka empire ca. 1450 CE. First, we show that, following incorporation, this region experienced statistically-significant increases in mean settlement population and material standards of living. We then use the analytical framework known as *settlement scaling theory* to show that in this case economic change was driven primarily by increases in the connectivity of local social networks as opposed to expansion of

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long-range trade, market development, or technological progress. These findings suggest increasing returns derived from increasing social connectivity associated with settlement growth and proliferation could and did occur in pre-modern contexts and are measurable as increases in various measures of aggregate socioeconomic outputs. They also illustrate that settlement scaling theory can be used to disentangle different components of economic change in archaeological studies of past societies.

2. Background

2.1. Previous research in the study region

We analyze archaeological data from the Upper Tarma and Mantaro drainages in the central Andes of Peru (Fig. 1). About 1900 km^2 of this region were surveyed as part of the Junin Archaeological Survey Project (JASP) in 1975 and 1976 (Parsons et al., 2000, Parsons et al., 2013), and in the subsequent decade the Upper Mantaro Research Project (UMARP) conducted intensive surface studies and excavations at a number of sites in the southern portion of the JASP study area, known as the Mantaro Valley (Costin, 1986; D'Altroy and Hastorf, 2002; Earle et al., 1987; Hastorf, 1993; LeBlanc, 1981; Russell, 1988). A combination of excellent architectural preservation, systematic full-coverage survey, targeted excavation and extensive publication of results has resulted in a rich dataset for the investigation of economic change in this region.

The JASP survey determined that most of the archaeological sites in this region date from the *Late Intermediate Period* (1000–1450 CE) and *Late Horizon* (1450–1532 CE) of the Central Andean cultural sequence, with far fewer sites dating to the *Middle Horizon* (500–1000 CE) and earlier. The Late Horizon represents the period during which the region was part of the Inka Empire, and ethnohistoric documents indicate that the people who lived in the region at this time referred to themselves as the *Wanka* (or *Huanca*). Follow-up studies by the UMARP determined that the Late Intermediate Period could be subdivided into two periods on the basis of changes in pottery assemblages. These were labeled Wanka I (1000–1350 CE) and Wanka II (1350–1450 CE), with Wanka III being an alternative designation for the Late Horizon. This refinement was not identified until after the JASP survey, and the distinction made it clear that Wanka II settlements were much larger than Wanka I settlements; nevertheless, the majority of sites originally assigned to the Late Intermediate Period by the JASP appear to have had Wanka II components. We therefore consider sites assigned to the Late Intermediate Period by the JASP as reflecting the period from 1350 to 1450 CE (Wanka II), and sites assigned to the Late Horizon as reflecting the period from 1450 to 1532 (Wanka III), with the end point being the year of the Spanish conquest of the Inka.

JASP surveyors recorded the location, areal extent, and primary function of approximately 650 archaeological sites and 950 temporal components within the surveyed areas. In addition, excellent preservation of stone architecture led to the compilation of

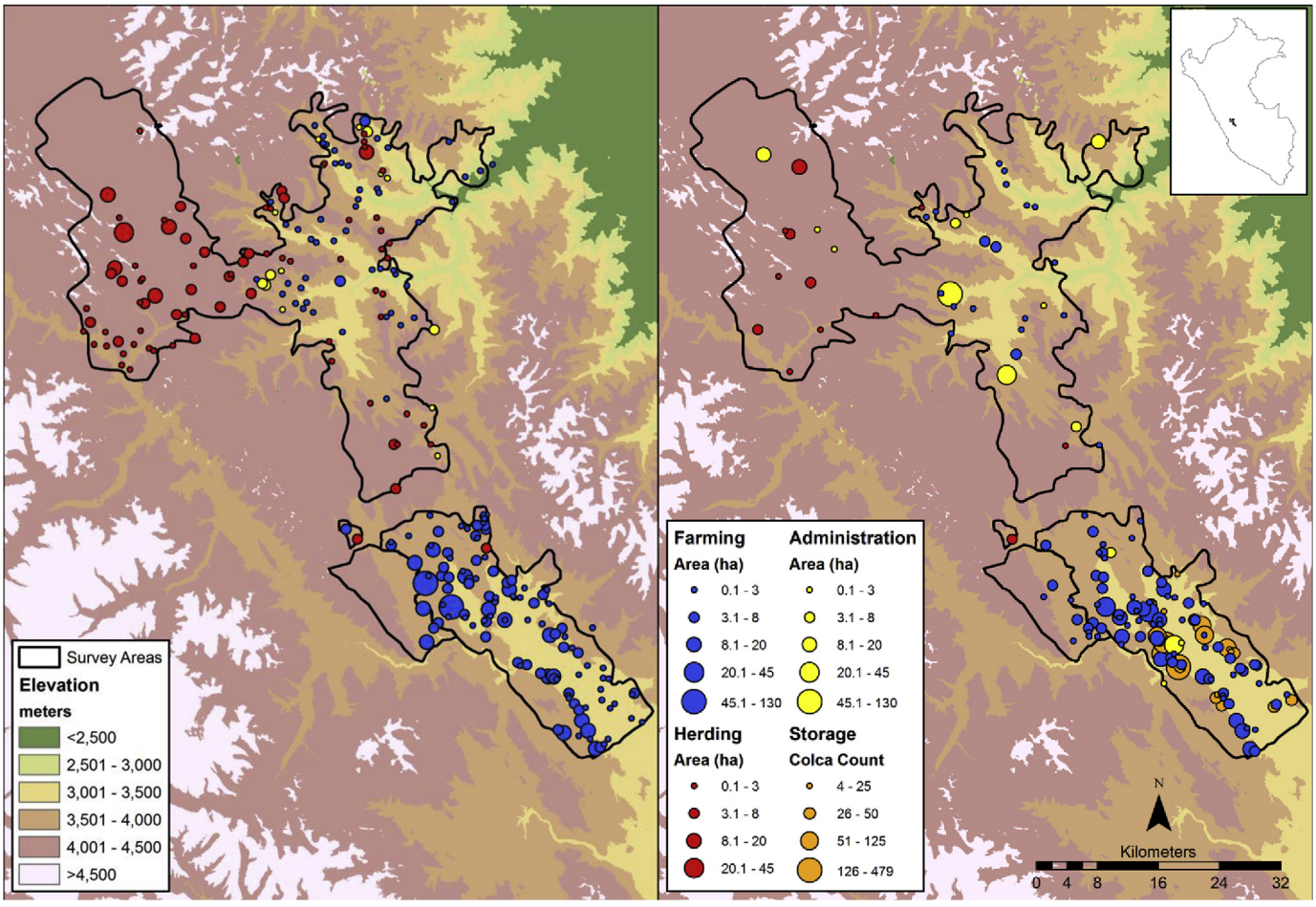

Fig. 1. The Upper Tarma and Mantaro Region, with surveyed areas and settlement distributions for the Late Intermediate Period, left, and the Late Horizon, right. Insert at upper right shows the location of the study area within Peru.