



# Holocene environmental change and its impacts on human settlement in the Shanghai Area, East China



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## ABSTRACT

Archaeological excavations and environmental archaeological studies over many years in the Shanghai Area have provided a wealth of information for Holocene environmental changes, growth and decline of human settlements and man–land interaction. Distribution of archaeological sites between 7000 and 3000 cal. yr BP indicates a regression process and a southward advance of the coastline in the study area. Temporal and spatial analyses of <sup>14</sup>C dates for archaeological sites, shell ridges, buried trees, and peat suggest that Holocene environmental changes may well have been a major cause of the rise and fall of human settlements and their civilization. A relative sea-level curve of the Shanghai Area was derived from dated shell ridges and peat, and correlates well with the reconstructed sea-level curves of the Yangtze Delta and East China. The development of human settlements was interrupted at least four times in the Shanghai Area, matching four periods of high sea-level, peat accumulation, and increase in shell ridges, after which Neolithic communities moved onto the plain and reclaimed their lowlands for rice cultivation. The Chenier Ridges played an important role in sheltering the Neolithic settlers. The collapse of Liangzhu Culture about 4000 cal. yr BP was followed by the less-developed Maqiao Culture. These studies suggest that extreme environmental and hydrological conditions such as terrestrial inundation caused by sea-level rise and heavy rainfall, contributed to the cessation of paddy exploitation and to the social stress that led to the Liangzhu Culture demise.

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## 1. Introduction

The rise and fall of Neolithic human settlement on coastal lowlands, particularly in large river estuaries and deltas, have attracted research to address the emergence of early agriculture, cultural development and exchanges, and human adaptation to coastal changing environments (Kunz et al., 2010; Lespez et al., 2010; Stanley and Galili, 1996; Stanley and Warne, 1994; Veski et al., 2005; Zhang et al., 2005). The Shanghai Area of China is located within the Yangtze Delta. Archaeological excavations over many years in the Shanghai Area have found that the cultural layers in many Neolithic sites are discontinuous, being divided by cultural interruptions, which often correspond to periods of peat formation or burial of palaeotrees. This suggests that they reflected short-term extreme climatic variations (Yu et al., 2000), which had significant

influence on the vicissitudes of the early cultures and associated migrations of Neolithic human settlement in this area (Stanley and Chen, 1996).

Different viewpoints have been held by many scientists concerning climatic variation and its role in the rise and fall of human civilization in the Shanghai Area. Some scholars suggest that the particular natural environment presents special relations between Holocene vegetation, environmental evolution and human activities in the Shanghai Area (Wang et al., 1996). Because of the low-lying land with many lakes and swamps in the area, sea-level changes and expansion of Taihu Lake, for example, greatly affected human settlements during the Neolithic age (Chen and Stanley, 1998; Stanley and Chen, 1996; Zhu et al., 2003). Some historical records in Chinese annals as well as archaeological materials also provide useful information for understanding past environmental changes and their role in early Neolithic human occupation history of this area (Chen, 1987; Shen et al., 2004; Wu, 1998). However, other scholars suggest that social factors played the major role in the rise and fall of early civilizations (e. g. Fu, 2008); and the wars between different tribes probably caused the collapse of the

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Liangzhu Culture in Shanghai Area (Zhou and Zheng, 2000). Some archaeologists suggested that ancient people usually lived on higher places to escape floods (Wu, 1998; Zhang et al., 2004a), but others thought that ancient religious activities and human social position rather than environmental change decided the distribution of human settlement. In this paper, a relief map for displaying distribution features of ancient settlement sites, marine vertebrate bones, as well as numerous  $^{14}\text{C}$  dates for peat, shell ridges, buried palaeotrees and archaeological sites are used to evaluate possible connection between Holocene environmental change and human settlements in the Shanghai Area. The  $^{14}\text{C}$  dates are all taken from published papers or archaeological excavation reports, and were calibrated using the computer calibration program CALIB 6.0.1 (Reimer et al., 2009; Stuiver and Reimer, 1993; Stuiver et al., 1998) to standardize the results.

## 2. Study area

The Shanghai Area ( $30^{\circ}40'–31^{\circ}53' \text{ N}$ ,  $120^{\circ}52'–122^{\circ}12' \text{ E}$ ; Fig. 1) has a humid subtropical monsoon climate and experiences four distinct seasons. The natural vegetation in the study area is dominated by deciduous and evergreen forests (Box, 1995; Ren and Beug, 2002). The mean annual precipitation is 1164.5 mm. Rainfall in summer months accounts for 60% of the total and only 21% falls during winter months.

This area is climatically sensitive because it lies along the demarcation line between subtropical and temperate climate that separates different air-masses. It is also bordered on the east by the East China Sea. Thus it often experiences floods that mostly result from excess rainfall or typhoons during summer, especially June and July (the Plum Rainy Season), when the drifting cold northern winds meet the warm and wet air-masses from the Pacific Ocean (He and Zhao, 2009; Liang and Ding, 2008; Shi et al., 2009). Also the floods are associated with snow melt in the headwaters of the Yangtze River. Geomorphologically, a nearly level plain with an elevation of 3.5–4.5 m above sea-level covers most of this area, making it prone to flooding and sea-level changes.

## 3. Materials and methods

### 3.1. Archaeological sites

Many archaeological excavations indicate the following cultural succession (State Administration of Cultural Heritage, 2008; Zhang, 2011; Zhu et al., 2003): Majiabang Culture (7000–5800 cal. yr BP), Songze Culture (5800–5000 cal. yr BP), Liangzhu Culture (5000–4000 cal. yr BP), and Maqiao Culture (3900–3300 cal. yr BP). Ancient people would choose suitable places for settlements, and more archaeological sites probably await discovery (Chen et al., 2008).

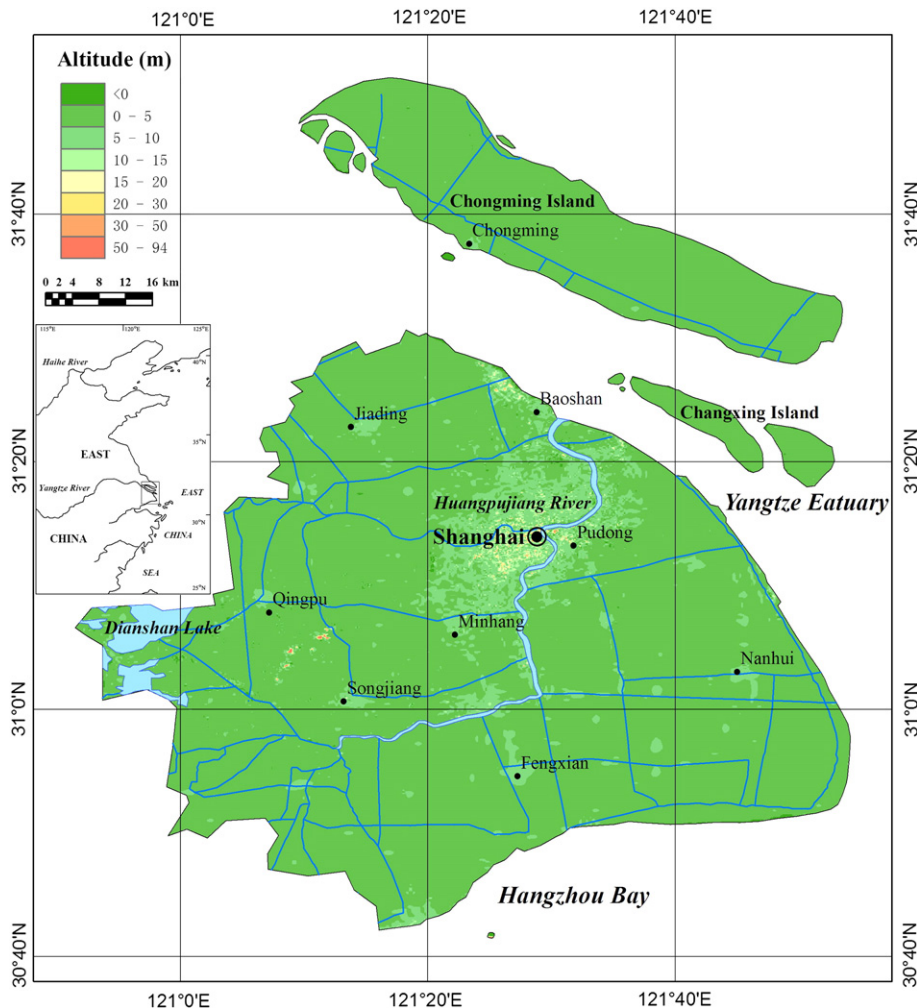


Fig. 1. Location of the study area, showing the present topography.

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