THE EFFECTS OF CLIMATIC CHANGES AND SEA-LEVEL RISE ON MANGROVE DISTRIBUTION FROM NORTHERN BRAZIL DURING THE HOLOCENE

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1. INTRODUCTION

The Brazilian coast contains the world's second largest unitary mangrove region, estimated to cover a total area of 1.38 million hectares, along a coastline of approximately 6800 km (Kjerfve and Lacerda, 1993). This ecosystem is highly susceptible to climatic changes and sea-level oscillations (e.g., Fromard et al., 2004; Versteegh et al., 2004; Alongi, 2008; Berger et al., 2008). The pos-glacial sea-level rise and changes in the river water discharges are considered the main driving forces to the mangrove expansion/contraction phases (Cohen et al., 2008; Lara and Cohen, 2009; Guimarães et al., 2010), although tectonics might have played a role in this geological setting (e.g., Rossetti et al., 2007a; Miranda et al., 2009) on the northern Brazil at least during the Holocene. Thus, mainly the climatic and hydrological factors have produced an evolution in the geobotanical units of the Amazonian coastal region leading to the formation of the marine-influenced littoral (southeastern coastline), dominated by mangroves and saltmarsh vegetation; and a fluvial sector (northwestern coastline), characterized by varzea and herbaceous vegetation (Figure 1)(Cohen et al., 2009). Recent works (Cohen et al., 2008; Cohen et al., 2009; Lara and Cohen, 2009; Miranda et al., 2009; Guimarães, et al., 2010; França, 2010; Smith, 2011; Francisquini, 2011) based on sedimentary structures, pollen and isotope studies have contributed to elucidate the effects of sea-level rise/climatic changes interaction on the Amazon coastal wetlands during the Holocene. Therefore, in order to integrate these data, this work presents a synthesis of some researches that discuss the mangrove development during Holocene in northern Brazil.

2. STUDY AREA

The study site is located along the Pará and Amapá littoral. The studied samples were collected in Bragança Peninsula, Salinópolis, São Caetano de Odivelas (Cohen et al., 2005a; 2005b; , 2009), Lake Arari-Marajó Island (Cohen et al., 2008; Lara and Cohen, 2009; França et al., 2010; Smith et al., 2011), Macapá and Calçoene littoral (Guimarães et al., 2010) (Figure 1).

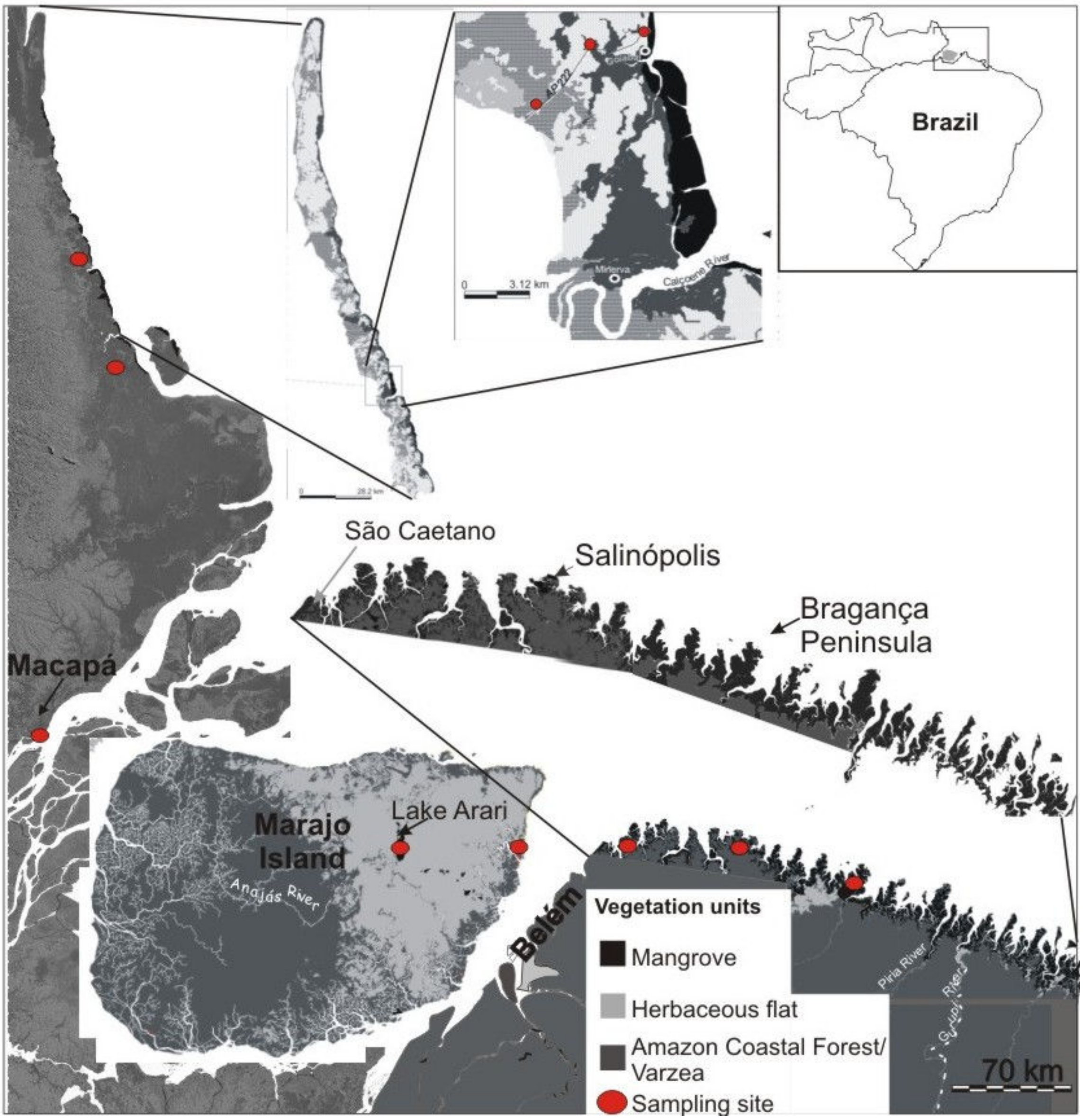

Figure 1- Study site exhibiting the marine and fluvial influenced littoral with the main vegetation units.

3. METHODS

A three-color band composition (RGB 543) LANDSAT image was created and processed using the SPRING 3.6.03 image processing system to individualize geobotanical units (see Cohen and Lara, 2003). Aerial photography, visual observation, photographic documentation, and GPS measurements were used to determine typical plant species and characterize the main geobotanical units. Twenty-four sediment cores were sampled from the bottom of lakes and mud tidal flats colonized by mangroves and herbaceous vegetation. The sediment cores were collected using a “Russian” sampler (e.g.Cohen et al., 2005). The cores were submitted to X-ray to identify internal structures (e.g. Cohen et al., 2008). The sediment color was described using a Munsell soil chart and a spectrophotometer (Cohen et al., 2009b). The sediment grain size distribution was analyzed by laser diffraction in a Laser Particle Size. The pollen analyses followed standard pollen analytical techniques (Faegri and Iversen, 1989). Thirty six subsamples were taken for Accelerator Mass Spectrometer (AMS) radiocarbon dating, performed at the Leibniz Laboratory of Isotopic Research at the Christian Albrechts University in Kiel (Germany), Physikalisches Institut at the University of Erlangen-Nürnberg (Germany), Van der Graaff Laboratory at the Utrecht University (Netherlands), and Center for Applied Isotope Studies at the University of Georgia (USA). The sediment samples were treated according to Pessenda et al.2009.After combustion the purified CO_2 was sent to University of Georgia, USA, for AMS dating. The ages are expressed in years before present (yr BP) and in calibrated ages (cal. yr BP, 2σ).The $\delta^{13}C$, $\delta^{15}N$ and elementar C and N (C/N) analysis were carried out at the Stable Isotopes Laboratory of Center for Nuclear Energy in Agriculture (CENA), University of Sao Paulo (USP), using a Continuous Flow Isotopic Ratio Mass Spectrometer (CF-IRMS).

4. RESULTS

The intertidal zone of the marine littoral is mainly dominated by mangrove and herbaceous flats, typical of brackish waters, with about 3090 and 90 km2, respectively. The fluvial littoral is mainly characterized by várzea and herbaceous vegetation not influenced by the tide, typical of freshwaters. The Amazon Coastal Forest occurs on relatively elevated area (Cohen et al., 2009). The pollen and isotopic data from fluvial littoral indicate that mangrove vegetation was wider than it is today on the Marajó Island (Smith et al., 2011) and Macapá littoral (Guimarães et al., unpublished data), between 7328-7168 and 2306-2234 cal yr B.P. and 5560 – 5470 and 5290 - 5150 cal yr BP, respectively. During the last 2306-2234 cal yr B.P. the freshwater vegetation expanded on the Marajó Island. Therefore, the data indicate higher marine influence during the mid-Holocene. The temporal transition between the marine to fluvial littoral produced significant geomorphologic changes, such as the replacement of old lagoons by lakes (Miranda et al., 2009; Smith, 2011; Francisquini, 2011). Regarding the marine-influenced littoral, currently dominated by mangroves and saltmarsh vegetation, these wetlands has occurred continually over tidal mud flats with deposition of marine organic matter at least during the last 7567 - 7509 cal yr BP (Cohen et al., 2005b; 2009; Guimarães, et al., unpublished data). This vegetation change pattern may be attributed to the association between the eustatic sea-level rise and the low fluvial discharge during the early and mid Holocene, followed by an increase in the river water discharge over the late Holocene. The proposed relatively low fresh water discharge during that time may be a consequence of the dry periods recorded in different parts of the Amazon region (e.g. Pessenda et al., 2001; Behling et al., 1998; Sifeddine et al., 1994; Desjardins et al., 1996; Gouveia et al., 1997, Absy et al., 1991).

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