

PALEOHYDROLOGICAL HOLOCENE CHANGES IN THE AMAZON RIVER AND ITS IMPLICATIONS ON THE CARBON ACCUMULATION IN FLOODPLAIN LAKES

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Abstract

The Amazon basin provides 20% of the total fresh water worldwide and the reconstruction of its paleohydrologic changes is essential for the global paleo-environment. The Amazon River and its tributaries are followed along their upward and downward course by several floodplains lakes that cover a large area around 300 – 500 000 km² (5 to 8% of the total surface area of the Amazon Basin). The floodplains lakes are built due to the fluctuations in the level of the rivers, which causes the formation of bars and accumulation of sediment carried by the rivers and its tributaries. Thus, significant quantities of organic matter can accumulate within these lakes that might represent important carbon sinks. The aim of this work is to evaluate the importance of past climatic changes on sedimentation process in Amazonia floodplain lakes and to determine the role played by the climatic driving forces on the carbon sink. Here, we present data from the sedimentary record of several Amazon floodplain lakes that reveal the presence of rapid and marked paleohydrological changes during the Holocene in the Amazon Basin. For this work, eight sedimentary cores were studied in the floodplain system. The cores were analyzed using radiocarbon dates, apparent density, organic carbon concentration, C/N ratio and $\delta^{13}\text{C}$. Our results point out two important events, at 5700 cal yr BP and 2700 cal yr BP, characterized by high sedimentation rates that indicate deep changes in the floodplain hydrology. Sedimentation data seem to indicate that these changes are due to abrupt climatic events. Both events provoked significantly high carbon accumulation in the floodplain system.

Keywords: organic carbon, floodplain lakes, Amazonia, Holocene

1. INTRODUCTION

The Amazon region contains the largest area of tropical forest in the world, accounting for 17% of the world's forest area. Various studies focussing on the Amazon indicate that forests in this region are accumulating carbon due to the increased level of CO₂ in the atmosphere, so-called 'CO₂ fertilisation'.

Despite the importance that the Amazonia represent to the global carbon cycle, still little is known about the role of sedimentation in Amazonia lakes in the process of carbon buried and its relation to paleoclimatic and paleohydrological changes. Floodplain lakes represent ca of 5 to 10% (Martinez & Le Toan 2007) of the total Amazon surface, these areas are characterized by intense productivity (Junk 1997), and high sedimentation rates (Aalto et al. 2003). Meanwhile sedimentation in the flooded areas is still very little studied and the role of carbon accumulation in these systems is unknown. The aim of this work is to evaluate the importance of past climatic changes on sedimentation process in Amazonia floodplain lakes and to determine the role played by the climatic driving forces on the carbon sink. And finally, to identify the sources of organic matter accumulated in different types of lakes systems.

2. MATERIAL AND METHODS

2.1 Study Site

For this study 4 floodplain lake systems (Figure 1) located in the Brazilian Amazonia were choose. Preto Lake and Janauacá Lake in the Solimões River, Curuai Lake and Comprido-Maraca Lake in the Amazon River. We present data from eight sediment cores.

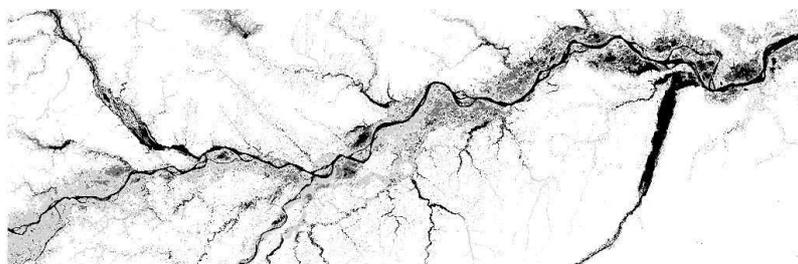


Figure 1: Image of the study area (Central Amazonia, Brazil).

2.2 Methodologies

The cores were opened in cross section, described and then were sliced into sections for analysis of studied parameters.

Shortly after the opening of core, each sample was still heavy wet for further drying in the 40 ° C. The content in water and bulk density was determined for each section, through the weight difference between wet and dry weight.

The chronologies of records were made with accelerator mass spectrometry (AMS) radiocarbon dating. The ages have been properly calibrated, with the Calib 5.0.2 program (<http://radiocarbon.pa.qub.ac.uk/calib/>) to be expressed in cal years B.P.

The determinations of total organic carbon and nitrogen were analyzed in elemental C/H/N analyzer, and the ¹³C of the total sediment samples were obtained in a mass spectrometer coupled to the elemental analyzer (in the Davies Stable Isotope Facility - Department of Agronomy at the University of California, USA and University of Waterloo, Canada).

3. RESULTS AND DISCUSSION

Radio carbon data of several cores show ages varying between about 1000 and 6000 cal yr BP corresponding to core of 50 to 300 cm. In general, the first 30 cm of all cores present an age of about 700 cal yr BP. Carbon content varied between 2 and 40%. C/N ratio and ¹³C indicated different sources of the sedimentary organic matter.

Our data revealed that the flood plains lakes present high fluxes of organic carbon which highlights the role of these ecosystems in the accumulation of organic material. This organic carbon flux, in floodplain lakes, is not constant at last 6000 cal years BP. Very high carbon accumulation related to high sedimentation rates were found in two periods : 2700 cal yr BP and 5700 cal years BP. At the same time, the origin and sources of these matter also changed. The origin of the organic matter buried in floodplains lakes seems to be a complex mixing of different sources: organic matter transported by rivers which has its source mainly in soils drainage, “in situ” production mainly by grass and phytoplankton and the organic matter originated from “Terra Firme” forest. However, it was determined in both flood plains studied that this potential has changed over the past millennia, which accompanied paleohydrological changes in Amazon River.

These first results suggest that the sink of carbon in flood plains lakes could potentially be a very important pool of the Amazonia carbon cycle. It appears that for a more real evaluation and assessment of the carbon accumulation rates in flooded area in the Amazon is necessary to increase spatial resolution of paleolimnological study, and the understanding of possible interconnections of regional events of carbon accumulation associated with climate and paleoclimatic changes in continental aquatic systems.

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