Dendrochronologia 35 (2015) 14–23

Contents lists available at ScienceDirect

Dendrochronologia

journal homepage: www.elsevier.com/locate/dendro

Orginal article

Influence of regional rainfall and Atlantic sea surface temperature on tree-ring growth of *Poincianella pyramidalis*, semiarid forest from Brazil

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ARTICLE INFO

Article history:
Received 6 August 2014
Received in revised form 18 May 2015
Accepted 25 May 2015
Available online 11 June 2015

Keyword:
Caatinga
Caesalpinioideae
Tropical dendro-ecology
Dry forest
Spatial correlation
Climate

ABSTRACT

A tree-ring width chronology was developed from samples of thirteen *Poincianella pyramidalis* trees from the Caatinga semiarid region of northeastern Brazil, where the climate is characterized by marked seasonality in precipitation levels. Although a thin continuous marginal parenchyma band represents the limit of seasonal xylem production, and in spite of the presence of false rings, cross-dating is possible. In this sense, an interseries correlation of 0.572 was found indicating a considerable degree of consistency in the variability found among trees. Precipitation between January and July has a direct influence on growth, while a five month dry season interrupts the active division of cambial cells. A significant positive correlation was also found between sea surface temperatures (SSTs) in the tropical Atlantic and tree growth, but with a lag of six months. As the rainfall regime of northeastern Brazil presents a great deal of inter-annual variability due to fluctuations in global factors such as the SSTs of the tropical Atlantic and the intertropical convergence zone, the close relationship observed between *P. pyramidalis* tree growth and regional climate fluctuations appears as a logical plant-environment interaction that can be used as a reliable parameter for dendroecological inferences on tree growth dynamics and the reconstructions of past droughts in the Caatinga region.

1. Introduction

In the tropics, seasonal dry forests occur in semiarid regions, and are generally subject to severe or absolute periods of drought (Mooney et al., 1995). As a consequence, many tree species are highly sensitive to unfavorable hydrological conditions, and interrupt their cambial activity during drought periods, leading to the formation of anatomically discernible growth rings (Worbes, 1995; Fichtler et al., 2004).

A number of studies have confirmed the presence of growth rings in tree species found typically in semiarid environments, although they have also emphasized the problems associated with the identification of rings, which may be narrow or irregular, often with poorly-defined limits (Cherubini et al., 2003; Schöngart et al., 2006). However, other studies have found well-defined and synchronizable growth rings in tree species native to semiarid environments, enabling the extraction of dendrochronological data on tree age, growth rates, and their relationship with environmental factors (Fichtler et al., 2004; Sass-Klaassen et al., 2008).

In Brazil, the largest semiarid forest system is known as the Caatinga, which is characterized as a spiny deciduous savanna (Tsuchiya, 1995). The Caatinga is located in northeastern Brazil, covering a total area of approximately 850,000 km^2. Temperatures are relatively constant, at around 25 °C throughout the year, while evapotranspiration rates are high (1500–2000 mm year^{-1}), and the soils are shallow, with a reduced capacity for water absorption. The mean annual precipitation ranges between 300 mm and 1000 mm, depending on the region, with the rainy season being restricted to a 3–4 month period, followed by a prolonged dry season of between 8 and 9 months (Sampaio, 2010). As the rains are concentrated in

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http://dx.doi.org/10.1016/j.dendro.2015.05.007
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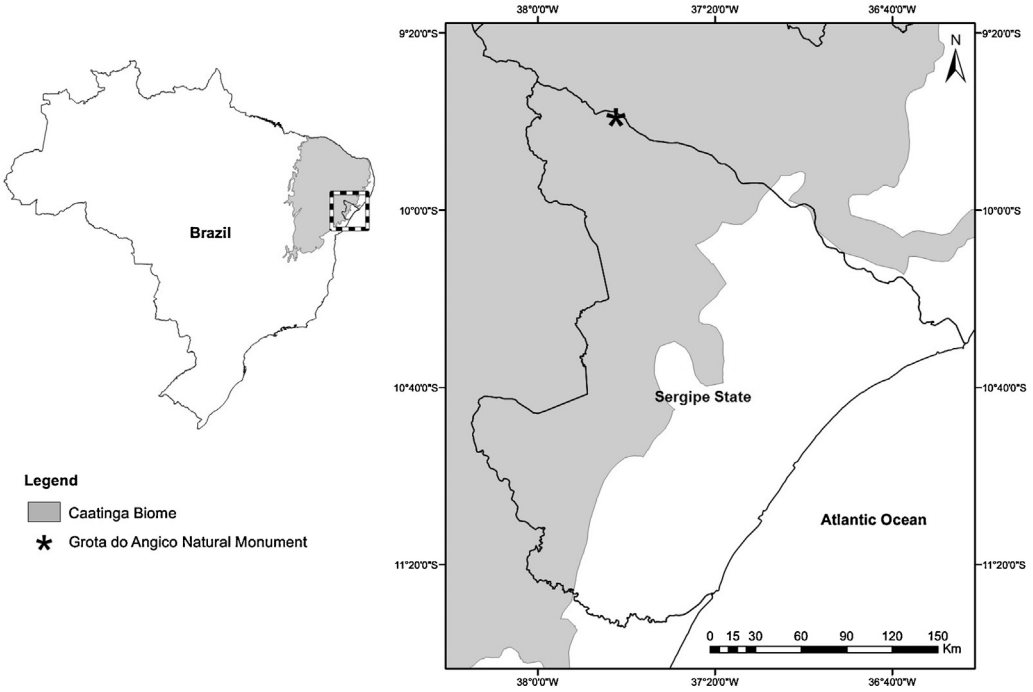

Fig. 1. Location of the semiarid zone in Brazil and detailed map of the study site Grota do Angico Natural Monument in the state of Sergipe.

a relatively short period, the hydrological deficit of the dry season tends to be high (Tsuchiya, 1995).

The climate of the semiarid zone of northeastern Brazil is determined by influences of atmospheric and oceanic processes that determine the spatial and temporal distribution of precipitation patterns. The primary factors are the inter-tropical convergence zone (ITCZ), the southeast trade winds, and atmospheric disturbances originating in the Atlantic Ocean. These disturbances are modulated by the sea surface temperatures (SSTs), both in the tropical Atlantic and the equatorial Pacific, global-scale factors that determine wetter and drier years in the Brazilian Northeast region (Magalhães, 2012).

The Caatinga is characterized by considerable variations between years in total precipitation, reflecting the effects of these large-scale atmospheric systems on the region's climate (Andreoli and Kayano, 2007). This annual variation in rainfall includes prolonged droughts in some years, and an extended rainy season in others, which may often be characterized by major local downpours (of over 100 mm) concentrated irregularly into a few days or even hours (Nobre, 2012).

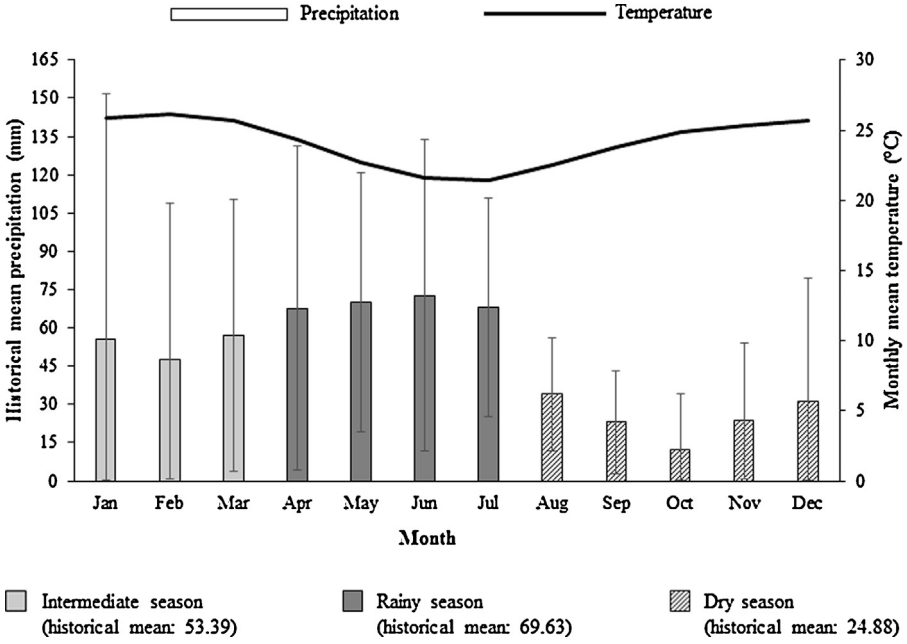

Fig. 2. Mean monthly precipitation (with standard deviation) between 1963 and 2010, and air temperatures between 1977 and 1983, recorded in Poço Redondo, Sergipe, Brazil (Source: SEMARH, 2013).