

ANCIENT NATURAL DISASTERS TRIGGERED BY SEVERE WEATHER IN SÃO PAULO, BRAZIL

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I. INTRODUCTION

Our lives are strongly influenced by the climate of where we live (Burroughs, 2005), so that a comprehensive knowledge of weather and climate is of great relevance to all aspects of our lives, including our integrity. Notwithstanding, because current conditions are connected to past episodes, the reconstruction of climate is of utmost importance, not only for providing an extension of knowledge back in time, but also for understanding the present climate conditions and predicting future events.

Documentary sources such as personal diaries and official reports that mentioned events such as floods, droughts or any other weather phenomena provide valuable information for past climatic reconstruction. Among the oldest are the measurements of Nile's floods (Bowden et al, 1985) and reports of the flowering of cherry trees in Japan and Korea, which date back over a thousand years. In Europe, there are records for many regions from the year 1500 approximately (Fagan, 2009). For South America, some old information comes from the time of the great discoveries, with compilation of excellent meteorological and geographic information (Silva, 2000).

In Brazil, former climate conditions are still poorly known, although the country has precious information from reports made by naturalists that crossed the country in colonial times to survey natural resources, among them Debret, Rugendas, Kidder, Saint-Hilaire and Luccock. Despite their richness, these reports were not fully analyzed in the light of the climate perspective, but they are an extraordinary source of information.

This study aimed to reconstruct the past climate conditions of the state of São Paulo, Brazil (FIG. 1), evaluating man-made documentary sources of information (i.e., before systematic observations) in view of comparing former and current conditions in the same area as well as possible similarities with other areas in the same period. Further, because the state of São Paulo has experienced quite impressive environmental changes in the last decades, the results of this study might be useful for estimating the degree of the human influence on climate.

II. MATERIAL AND METHODS

Sources of information were manuscripts, newspapers, official and particular correspondences, literary compositions, periodicals, magazines and different sorts of artistic expressions, such as paintings, drawings, maps, photographs and films collected in museums and archives. Other precious source of information comes from reports of exploratory journeys made by naturalists, which contain direct information from instrumental records, as well as indirect and more subjective information of atmospheric



FIG. 1: Brazil and the state of São Paulo (in red).

characteristics obtained by folklore, painting, music and other cultural manifestations. Documentation consulted (scientific registers, periodicals and bulletins) spanned a period from 1869 to 1950. However, within the documents there are mentions of phenomena back in the beginning of the Brazilian colonization by Portugal.

All information collected was organized in a database containing for each episode reported the date and the area in which the event was registered, its characteristics and source of information.

III. RESULTS

Letters written by Jesuits at the time of the foundation of the village of São Paulo (1560) contain important information regarding weather conditions. A clear and lively description of a severe storm associated with strong winds and its damages to buildings and trees was done by the local priest, José de Anchieta, founder of the village of São Paulo, nowadays São Paulo, one of the biggest cities of the world. Anchieta also described the ways in which reconstructions were done in order to minimize damages from future extreme events. By the rich description of damages, full of details (Magazine of the Geographic and Historical Institute of São Paulo, v.46, p.72), one can hypothesize the phenomena was a tornado.

In the 18th. century, mining activities became important in the colony economy (former Brazil): westward incursions by fluvial navigation were done by explorers, in view of looking for minerals and promoting the occupation of lands. River Tietê, in particular, (FIG. 2) were an important via to reach the far west. The explorers recorded all types of environmental information in their diaries and reports, including descriptions of weather. Registers of the Baron Langsdorff expedition (1826-1827), for instance, mentioned a strong cold spell on 25 June 1826 which, in the words of the Russian Langdorff was comparable to the conditions of Siberia, even considering that the expedition members had appropriated clothes (Komissarov and Silva,

1997). Many other reports also mentioned very severe winter conditions, in phase with the Little Ice Age in Europe, demonstrating that areas of Southern Hemisphere also experienced concomitant situation.

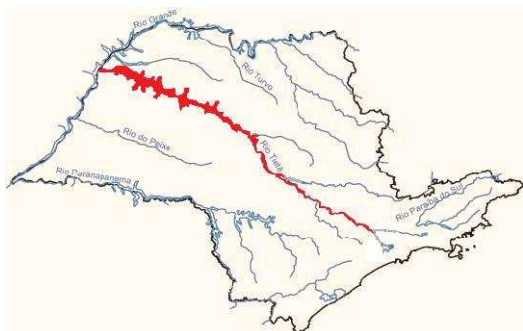


FIG. 2: River Tietê, State of São Paulo (in red).

Around 270 reports on weather and climate for Brazil and other countries were collected from the newspaper *Gazeta de Campinas* between 1869 and 1884, with information particularly focused on extreme episodes, in special, intense cold spells that affected coffee plantation, the main economic item of São Paulo's economy of the time. It follows some examples:

- 3 July 1870 - the effect of a frost was so severe that local authorities considered that the economy of many farmers were completely broken.
- 6 July 1884 - two days after a great frost, a farmer realized, with deep sorrow, that an extensive part of his coffee plantation was completely ruined.
- 25 July 1884 - a coffee farmer testified that since 1855 there was no comparable frost like the one of 26 June: an eight years old coffee plantation in a supposedly safe place completely died. Also, the freezing cracked thick trees in the neighbourhood.
- 8 October 1884 - a frost episode was registered in October, an unusual time for this sort of phenomenon (spring), fact that was considered by many local farmers as a signal of God's punishment.

Considering some Almanacs from 1872 to 1918, around 190 registers concerning atmospheric aspects were found. Information came from collaborators that gave their impressions of climate. This kind of subject was included in the physical description of the cities, related to the local population salubrity. Park (1999) quotes some attempts to explain the climatic phenomena in view of forecasting local weather:

- In threatening weather conditions birds are quitter, because before storms, the atmospheric pressure is lower, the air is less dense and the flight is more difficult.
- When good weather prevails smoke raises straight up, indicating higher-pressure, whereas less dense air associated with bad weather conditions avoids the smoke to ascend.
- Good visibility on the sea is an indicator of bad weather, since the air turbulence avoids the formation of sea misty.
- Echoes that reach longer distances and are better identified are clear signal of rainfall, because low level clouds reflect sound waves.

- Smells are more intense before rainfall, because odours are retained by higher pressures and conversely are dissipated when the pressure comes down.

Another journal, *Provincia de S. Paulo* (currently O Estado de S. Paulo), presented 160 news about extreme weather between 1875 and the 1879. It is worth mentioning that in the years of 1876 and 1877 there was much information on climate extremes for sectors of Brazil, Europe and United States. Examples:

- 16 July 1876 – winter conditions in cities of the province were compared to situations experienced in North Europe.
- 15 August 1876 – a number of areas of coffee plantation were affected by frosts for the first time.
- 23 August 1876 - a letter from New York was published, relating that in July temperatures reached 106 degree Fahrenheit, causing 40 to 50 daily cases of sudden headaches.
- 5 October 1876 – a report stressed that also in Europe the summer of 1876 was particularly hot and would be remembered for a long time.
- 23 December 1876 – referring again to the heat in Europe, a piece of news mentioned many cases of insolation in Spain.
- 27 May – 26 July 1877 – during this period, there were many reports about droughts in Northeast Brazil. They mentioned the aid to the victims that came from other areas of Brazil, as well as famines and epidemics in the affected area.

IV. CONCLUSIONS

Historical sources present considerable potential for studies of current and long-term physical processes, but they have been under explored for interpreting some features of the physical environment, like the atmosphere. They are also important to evaluate the magnitude of the impact of human activities on the physical environment (Hooke, 1982).

Detailed information of climatic characteristics in different periods can be defined through homogeneous and continuous registers but also from distinct data sources collected not systematically that contain information on situations and processes that are affected by the climate. Thus, valuable information can be obtained from instrumental measurements, food production variations (including agriculture, cattle and fishery) in different moments of the human evolution, diseases associated with atmospheric conditions, natural disasters, as well as impacts of long-term extremes on civilizations or social groupings, culminating in historical facts that were influenced by atmospheric conditions, such as numerous wars and their effects on the fate of the nations.

This study showed that Brazil has rich documentation of past climatic information that deserves to be properly explored. A promising aspect for future studies involves further investigation of cooler winters in the 18th century, similar to conditions experienced in Northern hemisphere.

IV. AKNOWLEDGMENTS

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