

## Investigation and forecast of droughts in Brazil: a historical view

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In the beginning of the Brazilian history, the Northeastern --currently one of the five administrative regions of Brazil-- played a central role in the economy of the time due to the production of some important items in Europe, such as pau-brazil tree and sugar cane. With the decline of these economical activities, *Nordeste* has been treated as a marginal region in Brazil, noticeably the hinterland dry area called *sertão*. Even today there is a considerable gap between the “rich” South and the “poor” North, and the socio-economic differences among these areas are still partially attributed to the weather conditions prevailing in the region. This fact obviously hides the real reasons behind the differences in the country, being a convenient excuse for the lack of political measures towards the social justice in Brazil. The area known as *Nordeste* presents large intra- and inter-annual precipitation variability, in great extension due to the interplay between oceanic and continental circulation, locally modified by geographical features. Considering the precipitation amounts, the region can be divided into three diverse compartments: the humid region (*Zona da Mata*); the semi-arid region (*sertão*); the *Agrreste*: transitional sector between the humid coast and the semi-arid *sertão*.

Aware of the dramatic conditions prevailing in *Nordeste*, which brought tremendous suffer to the population, the naturalist Orville Adelbert Derby presented over a period spanning 35 years (1878 to 1913) eight scientific reports on the climate of the region, published as newspapers articles, scientific papers and reports sent to politicians. These scientific contributions attest his searching for solutions to the semi-arid portion of Brazil, in order to minimise the drama of the society, aspect that appears in many parts of his articles. Derby drove his attention to analyse the climatic conditions in the *sertão nordestino*, pursuing solutions to minimise the population suffer, with special attention to mechanisms that could present potential to forecast drought episodes.

To a better understanding of these works, it is important to give a historical outline. By the 1840's coffee had become the principal Brazilian export, and its importance would continue to increase until well into the twentieth century. The spread of coffee plantations to the "old West" of the state of São Paulo brought about the emergence of a new social group within the coffee plantation owners, a "modernising" élite. As the coffee of the western part of São Paulo State became ever more important as an export good, the political clout of this new oligarchy on the national scene continued to grow, a situation which prevailed since the establishment of the Republic, in 1889, until 1930. These "modernises" – as well as other members of the élites – were in synchrony with the scientific emphasis of the time. The demands and issues put forward by agriculture, in particular, stimulated the creation of a set of scientific institutions, from those linked to Public Health (concerned with the control of epidemic diseases) to those in charge of the survey of the territory. An important one was founded in 1907: the Geological and Mineralogical Survey of Brazil (hereafter SGMB), inspired by the institutional model of the widespread geological surveys (Turner, 1987). It is possible to state that since its creation the interests of agriculture were behind the direction of research and the results obtained.

The geologist and naturalist Orville Adelbert Derby (1851-1915) was the first person to conduct the SGMB. Immediately after leaving the direction of the *Geographical and*

*Geological Commission of São Paulo*, in 1905, Orville Derby was entrusted with the direction of the Survey of Lands and Mines of the State of Bahia (Lamego, 1951) by the Secretary of Agriculture of the State, Miguel Calmon du Pin e Almeida. Shortly afterwards, however, with the rise of Miguel Calmon to the Ministry of Industry, Railroads and Public Works of the national government of Afonso Pena, Derby was charged with the creation of the *Geological and Mineralogical Survey of Brazil* (SGMB) in 1906<sup>i</sup>.

Derby is considered by several authors - whether contemporary to him or not - one of the best and most prominent geoscientists Brazil has ever had. During his scientific life he published 173 papers dealing with a wide range of geoscientific subjects including mineralogy, palaeontology, petrology and petrography, geology, economic geology, meteorites, geography, cartography, meteorology and history (of cartography and geology). For the ensemble of his “*petrographical researches on nepheline-bearing rocks, on the sources of the rarer minerals, and on the ore deposits of the Jacupiranga district*”<sup>iii</sup> Derby was awarded the prestigious Wollaston Prize --the senior award given by *The Geological Society of London* and funded from the Wollaston Fund-- getting international recognition.

The *Geological and Mineralogical Survey of Brazil* became a reality on January 10, 1907<sup>iii</sup> and was charged with “*making the scientific study of the geological structure, petrology, and mineral resources of the territory of the Republic, considering above all the exploitation of these mineral resources and both surface and subterranean water resources, as well as the compilation of information about the geological and physiographic nature of the land, to serve as the basis for the organization of projects involving transportation and other public works, especially those dealing with the prevention of the effects of droughts*”<sup>iv</sup>.

The SGMB was also intended to conduct studies for practical application, generally following the model of the geological surveys. One of the most important aspects of the action of the Survey concerned attempts to overcome the longstanding problem of droughts in the Northeast and to explore the possibility of irrigation. This fact may probably be understood if, on the one hand, one reminds the above mentioned context of agriculture and the efforts made to diversify it, both in terms of products for exportation, as well as of productive regions.

In 1909, the involvement of the institution with the problem was so great that an agreement was even reached between the organ and the *Department of Projects for the Combat of Droughts*<sup>v</sup>, and the SGMB produced a study about the legal question of Brazilian waters<sup>vi</sup> elaborated jointly by its legal consultant and the technical team which systematically covered the interior of the country. Encompassing legal, climatological, hydrographic, and agricultural information, this publication again suggested the importance of taking seriously a regular meteorological survey and the irrigation of arid and semi-arid regions in the Northeast of the country.

Derby included in his scientific interests the analyses of the climatic conditions in the *Nordeste* of Brazil, pursuing the understanding of the mechanisms behind the semi-arid conditions in the *sertão*. Notwithstanding, being a geologist he established many times direct or indirect associations between atmospheric and geological phenomena. Examining his numerous contributions<sup>vii</sup> towards a better understanding of the recurrent drought of Northeastern Brazil (severe ones were reported in 1722, 1778, 1792, 1825, 1845, 1877), Derby showed to be an up-dated researcher, quoting recent scientific inputs in view of setting up basis to his view points. Some of the themes of his concern were quite original, like the connections between sunspots and the droughts in *Nordeste*, a topic in its early stage that time, which appeared after the contribution of the astronomer William Herichel, who proposed in the early nineteenth century that changes in the Sun’s output could influence the weather. In 1843 Heinrich Schwabe discovered that the sunspots vary in a regular and predictable way and since then there has been many efforts to show that the cyclic behaviour

of solar activity is reflected by variations in weather. However, it remains doubts about whether the small changes in the output of the Sun during the 11-year sunspot cycle (less the 0,1%) are capable to account for the observed recent changes in global temperature, although this variability is concentrated in the ultra-violet spectral region, which could promote subtle physical processes not totally understood (Burroughs, 1997). Additionally, the most recent report of the IPCC (2001) also underlined the uncertainties regarding the relation between sunspot and climate variability. In fact, some of the linkages between sunspot and droughts established in some papers published in the nineteenth century proved to be mistaken in the light of modern understanding. The drought of 1792, for instance, was connected to a another climatic control (El Niño), which affects rigorously many other regions, like India and Egypt (Fagan, 2000).

Additionally, an interesting feature presented in Derby's studies was the association among remote aspects (both geographically and scientifically) and the atmospheric conditions, in searching of explaining the functioning of the world, a typical science characteristic at the time. For instance, in his paper of 1878 he defined the sunspots as an expression of the solar energy, comparing with volcano eruptions, an expression of internal forces (as previously mentioned, connecting geology and climatology). Convinced that there would be relationship among the solar energy manifestations and several terrestrial phenomena, he evaluated the correlation of sunspots and droughts in *Nordeste*, listing previous studies applied to areas in which these associations were assessed (Oxford, Edinburgh, Mauritius Island, Western India, India, central Europe and North America).

Orville Derby drove special attention to the finding of periodicities and general rules and laws to forecast droughts in the region (papers of 1878, 1906(b) and 1907). As example, in his analyses of the historical rainfall series (16 years), he tried to establish the duration of dry and wet periods. However, one must highlight this short period is not sufficient to provide any conclusion; in spite of this fact, he tried to institute rules to the precipitation behaviour by means of detailed and sometimes tedious descriptions.

Some of his reports had the goal to provide scientific information for economic purposes (1906a, 1907 and 1913). He pursued rules linking precipitation and profitable agriculture, presenting solutions as the use of extensive irrigation, river flow deviation and the additional advantages of some areas due to the presence of navigable rivers and railways, suitable to transport the production. Derby also argued over the importance of establishing a general code for the use of the water (1913), a fact that as the previous one is valid even nowadays. In fact, many aspects raised by Derby are extremely contemporary. Nevertheless, some others are clearly "temporal", i.e., reveals the period in which his studies were performed: for instance he demonstrated a mechanistic vision of the nature: if for some reason the nature was not "working properly" (recurrent droughts), measures should be taken to "reorganise" it. He used this kind of argument to justify irrigation methods, a way to correct the "errors of the nature" (1907).

Orville Derby proved to be a tireless researcher. His studies --marked by systemic perspective-- provided contributions of utmost importance to the Brazilian environment. He attributed fundamental role for Science to minimise social problems, but recognised the importance of establishing a bridge to unify political actions and scientific knowledge. In many parts of Derby's studies it is easily identifiable the period in which they were developed (searching of cycles, periodicities, mechanistic vision, meticulous descriptions). But the droughts in Northeastern Brazil --the theme to which Derby offered contributions for more than three decades -- is still up-date.

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<sup>i</sup> Letter from Orville A. Derby to Horace E. Williams. Rio de Janeiro, December 2, 1906. Document on file at the Companhia de Pesquisa dos Recursos Minerais in Rio de Janeiro.

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<sup>ii</sup> See *The Geological Magazine*, 1892, v.9, p.184.

<sup>iii</sup> Decree no. 6.323.

<sup>iv</sup> For detailed reportage see the thesis of Martins (1989).

<sup>v</sup> Official letter no.126, Livro de Registro de Ofícios do Serviço Geológico e Mineralógico do Brasil (Book 3). December 16, 1909. Rio de Janeiro: Seção de Paleontologia, DNPM-RJ.

<sup>vi</sup> Official letter no.99, Livro de Registro de Ofícios do Serviço Geológico e Mineralógico do Brasil (Book 3). September 30, 1909. Rio de Janeiro: Seção de Paleontologia, DNPM-RJ.

<sup>vii</sup> Derby, O.A. (1878), ‘As manchas solares e as secas’, *Jornal do Comércio*, Rio de Janeiro, June 8 and 9.

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### **Biographical Sketch**

Silvia Figueirôa (Dr.) Associate professor at the State University of Campinas, Brazil. Graduated geologist, with a Masters degree and a Ph.D. in History of science, she is lecturer of under-graduated and post-graduated courses. Published many articles and some books on the history of geological sciences and mining, particularly in Brazil. She belongs to the International Commission on the History of Geological Sciences (INHIGEO). She is founding member of the Brazilian Society on the History of Science, acted as president (1995-1998) of the Latin American Society on the History of Science and Technology (SLHCT), and of the History of Earth Sciences Society (HESS) (2001-2002). She is currently president of the “Sciences & Empires” International Commission (IUPHS/DHS).

Lucí Hidalgo Nunes (Dr.) Geographer specialised in climate variability and change, the impact of extreme precipitation in urban areas and the human dimensions associated to climate change, having published in all of these fields. Strong interest in the history of the atmospheric sciences, particularly in the role of the weather/climate events which shaped the history. Currently working at UNICAMP, being lecturer in a number of under-graduation and post-graduation disciplines. Co-ordinates the Climatology Laboratory and the Climate Change Group at UNICAMP, and is a member of numerous scientific committees, ICHM included. Has been involved in Brazilian and international scientific researches/groups.