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Historical Note

Climate-data Records and Reforestation Efforts in the Eighteenth and Nineteenth Century Coromandel Region in Peninsular India

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ABSTRACT

Efforts to establish 'new' forests and record climate data by German and Scottish residents in the Coromandel region in the eighteenth and nineteenth centuries appear conspicuously in the pages of vegetation history of peninsular India, because forest-based industries and economies in India, at that point of time, were of far less significance. This note brings to light the contributions of three European residents in the Presidency of Madras: a German missionary J.E. Geister (also referred in literature as G.E. Geisler) and Scottish surgeons W. Roxburgh and E.G. Balfour. Geister and Roxburgh have documented weather data of reasonable accuracy with limited equipment. Roxburgh with a focus on 'utilitarian conservation' made efforts to revegetate the semi-arid land stretches with drought-resistant and water-efficient plants. Balfour introduced scientific methods in promoting forest conservation and reforestation. Roxburgh's attempts to record climate data and to revegetate parts of the Coromandel (the northern *Circar*s) have been influenced by the thoughts of Stephen Hales and Duhamel du Monceau of the eighteenth century. Balfour's interest in proposing reforestation models in peninsular India was triggered by Henri Bernardin de Saint-Pierre, an engineer in Mauritius, and also by the thoughts of Jean-Baptiste Boussingault of the nineteenth century. Further to noting the contributions of the three people, this note also includes a brief notation to climate in the Presidency of Madras, which constituted the bulk of peninsular India of the eighteenth and nineteenth centuries, and what consequences those climate ramifications had on the social dynamics, thus setting the context for the climate-data records made by Geister and Roxburgh and the reforestation efforts by Roxburgh and Balfour.

Key Words: E.G. Balfour, Climate Changes, Eighteenth Century, J.E. Geister, Nineteenth Century, Peninsular India, Presidency of Madras, Reforestation, W. Roxburgh, Weather Data.

INTRODUCTION

Based on the explanation provided by the Cambridge naturalist and geologist John Woodward [1665–1728][1] on water relations of plants in 1699 (Meidner 1985), the British naturalist and science philosopher Stephen Hales [1677-1761] blazed new trails in the explanation of plant transpi-ration and translocation. On his election to the Fellowship of the Royal Society in 1718, Hales presented the paper *Upon the effect of ye sun's warmth in raising ye sap in trees*. This paper described reliable and novel techniques to measure sap pressure, velocity, and movement and reinforced their criticality as plant features. Hales based his proposal on Woodward's explanation in measuring moisture moving into the atmosphere from trees and demonstrated that transpiration drew plant sap and water towards leaves, synchronizing with the rate at which the roots moved them upwards (Hales 1726).

[1] Dates in square brackets refer to the life span of the person in context.

Besides contributing to several aspects of plant physiology in general and the role of trees in recycling moisture into the atmosphere in particular[2], Hales constructed his investigations on Newtonian experimental philosophy (Shank 2008, page 404). Fascinated by the relationship established between vegetation and atmosphere by Hales, the French naturalist Georges–Louis Leclerc de Buffon [1707–1788] of the Royal Botanical Garden in Paris translated Hales's *Vegetable Statiks* (1726) into French (de Buffon 1735). This work attracted the attention of Duhamel du Monceau [1700–1782], a French vegeta-tion scientist — also recognized as a meteorologist, an agrarian writer, and a chemist (Withers 2007: page 132) — to propose his concepts on the links between the physiology of water movement in trees and climate (Duhamel du Monceau 1758) based on his *Observations botanico-météorlogiques*, which included long-term data on weather, crop performance, and public health. Issues relative to public health were considered critical at that point of time, because climatic vagaries resulted in droughts and famines and consequently several public-health issues arose necessitating a comprehensive understanding towards a better management of large-scale epidemics.

The first colonial forest reserves were established in the West Indies and Mauritius in the late 1760s. Introduction of plantations in these tropical islands resulted, over the years, in environmental degradation prompting development of policies on preventative control in Barbados and other West-Indian colonies in the 1670s and in St Helena in 1709 (Grove 1990). The preventative-control policies supported the creation of forest reserves, and thus preventing soil erosion, for example. Influenced by the proposals of Stephen Hales and Duhamel du Monceau on the tree physiology – climate relationships, the colonial adminis-trators reconciled to the fact that forest reserves were vital, because these British and French colonies essen-tially thrived as economies driven by plantation-based industries.

However, similar efforts in peninsular India in general and in the Presidency of Madras[3] in particular in establishing 'new' forests and detailed recording of climate data made by the European residents in the eighteenth and nineteenth centuries appear conspicuously in the pages of vegetation history of peninsular India, because forest-based industries and economies in India were of far less significance compared with West-Indies and Mauritius at that point of time. British investment in plantations and human-made forests in India developed rapidly only in the second half of the nineteenth century, synchronizing with the organization and expansion of railways (O'Callaghan 1942). A scientific investigation was made in 1800 searching for *Tectona grandis* L.f. (teak) in Malabar (10º15'–12º18' N; 75º14'–76º56'E), because the *Hortus Malabaricus*-fame Hendrik Adriaan van Rheede tot Drakenstein [1636–1691] had introduced teak in Sri Lanka in 1680 (Perera 1962). The government of the Presidency of Madras appointed the first conservator of forests to explore opportunities and methods for the large-scale production of *T. grandis* and other timber materials suitable for ship building in 1806 (Negi 1994); plantations of *T. grandis* were established in Nilambur (11˚16' N; 76˚13' E) in 1840 (Puri 1960), of *Acacia* spp. (wattles) in 1840 (Kumar 2005) and the *Eucalyptus globulus* Labill. (Tasmanian blue gum) in the Nilgiris (11˚24' N; 76˚42' E) in 1843 (Yegnaswami 1960). Through the proclamation of the *Minute on Forest Policy*, Lord Dalhousie [1812–1860], the Governor–General of India, streamlined forest conservation in 1855 (Barton 2002, p. 57).

The purpose of this note is to bring to light the contributions of three European residents in the Presidency of Madras in the eighteenth and nineteenth centuries: a German missionary J.E. Geister (also referred in literature as G.E. Geisler; Glaser et al. 1991), and two Scottish surgeons, W. Roxburgh and E.G. Balfour, because persons of such calibre and enthusiasm have been ignored by ecologists and environmental scientists. Geister and Roxburgh have documented weather data with minimal facilities at a level of details that could not even be imagined in the timeframe they lived. Roxburgh recommended to the then Government to vegetate the semi-arid parts of the Presidency of Madras with economically useful trees and introduced the idea of 'utilitarian plantations' to the government. Balfour introduced scientific methods in promoting forest conservation and reforestation.

[2] Stephen Hales was the first to measure human blood pressure, establishing its vitality as a representation of heart function.

[3] The Presidency of Madras, at its greatest extent, occupied much of the peninsular India, with the modern *Tamil Nadu*, the northern part of the modern *Kerala* (the *Malabâr*), the *Lakœadweep* Islands, coastal *Ãndra Pradesh* (*Râyalaseema*), *Berhâmpur* and *Gânjam* districts of the modern *Orissa*, and *Bellâry* district of the modern *Karnataka*; the capital was Madras city (now *Çennai*): Thurston 1913).

This note also includes a brief reference to climate patterns in the Presidency of Madras in the eighteenth and nineteenth centuries and what consequences those climate ramifications had on the society, thus setting a context for the efforts of Geister, Roxburgh, and Balfour.

CLIMATE AND ITS SOCIAL IMPACTS IN THE PRESIDENCY OF MADRAS

A comprehensive and chronological summary of the famines, a serious consequence of changed patterns – both short and extensive – in climate, of the world up to the second half of the nineteenth century is available (Walford 1879). Among the 12 factors identified as the reasons for famines, Walford (1879: page 20) ranks rain, frost, drought, and meteorological phenomena as the first four. Elaborating on 'rain' as a critical cause, Walford (1879: page 21) remarks:

> *"Unfortunately in this country ([sic] United Kingdom) we have no meteorological records by which the rainfall over any lengthened period of time can be ascertained".*

Keeping this remark in the background, the present paper refers to climate-data recorded in a part of a tropical British colony in the eighteenth and nineteenth centuries. Between 1750 and 1880, the Presidency of Madras experienced several moderate to severe famines. Famines of 1769–1770 and 1781–1783 resulted in intense shortage of food grains. The famine that followed the 1781–1783 drought led to the establishment of a charity facility (*Monégar Choultry*) in the district of Madras (13˚4' N; 80˚15' E; later, the city of Madras) in 1808, where the poor were supplied raw materials for making porridge *gratis* every day. Consequent to the 1790–1792 famine, the government banned rice export from *Tanjore* (10˚47' N; 79˚10' E; on the river *Kaveri*, the 'rice bowl' of Tamil Nadu) to other Indian Presidencies and regulated (rationed-?) rice distribution within the Presidency. The famines of 1812–1814 and 1824–1825 occurred due to lack of rainfall, but were moderate compared with the famine of 1833–1835. The 1833–1835 famine, documented as the *Guntur famine* (Guntur: 16˚23' N; 80˚30' E) was severe and costed *c.* 200,000 human lives. The 1853–1854 and 1876–1878 famines were equally intensive and extensive; the latter resulted in the deaths of 3.5 million people and costing *c.* Rs. 10 million to the Government of India (Visaria and Visaria 1983). The principal cause for all of these famines was failure of monsoon rains (Bhatia 1963).

Between 1768 and 1771, different regions in India experienced severe droughts resulting in the death of several million people. These drought events and consequent famines had serious repercussions on the administration of British India. Warren Hastings [1732–1818], while being the Governor-General of Bengal, overhauled Bengal administration and established the British-run, district-level administration including administration of forests, which in later years extended throughout the British India.

JOHANN ERNST GEISTER

After 1709, a year of famine, anomalies of climate occurred in lesser frequency than what occurred in the preceding 125 years. However, such climate-change events after 1734, for the first time, were recorded in some detail in the Presidency of Madras. J.E. Geister, a German missionary attached to the *Tranquebar* Mission (*The Royal Danish Lutheran–Protestant Mission*, also known as the *Halle Mission*), maintained weather notes (diaries) from October 1732 to July 1737. Geister's notes offer useful information on the mode of onset of climate changes that led to the events of 1737, recognized today as an *El Niño* factor (Grove 2007). In high likelihood, Geister had only a weather vane. A facsimile copy of one page from Geister's notes dated 1735 and a transcribed version are available in a web page of the University of Freiburg, Freiburg, Germany (HISKLID 2005–2009).

Geister's weather records include notes on general weather, followed by *Wind und Wetter Observationen* (WWO). The WWO includes every day observations of wind movement, and superficial notes on cloud patterns and rainfall. References to wind strength, storms, and temperature are also available, although infrequently. An annual climate overview with summary remarks is also exists with comments on harvests, food prices, and everyday social events (Glaser et al. 1991, Walsh et al. 1999).

WILLIAM ROXBURGH

That the drought years 1789–1794 in India were of global consequences was first formally recognized by Alexander Beatson, the Governor of the British colony St Helena. Beatson suggested that the 1791 drought events of simultaneous occurrence in India, St Helena, and Montserrat were a part of a 'connected phenomenon' (Beatson 1816). The background data and indicators to what was recognized as a 'connected phenomenon' by Beatson were picked from the climate records of William Roxburgh, who was in employment in the East-Godavari District (16º30'–18º N; 81º 30'–82º30' E) of the Presidency of Madras. Roxburgh gathered temperature and atmospheric pressure data from 1770 and using those datasets he forecasted the droughts that occurred subsequently in 1789.

William Roxburgh [1751–1815], a medical doctor, is remembered for his contributions to medicine and botany in India. He scrupulously obtained large volumes of data for nearly a decade and a half, while serving in different parts of the Presidency of Madras, and has thus pioneered in the field of climate research. He started gathering climate data from the time he set foot in Madras; he obtained relevant measurements three times a day, using a *Ramsden*® barometer and *Nairne* & *Blunt*® thermometer made by reputed scientific-instrument makers of that time in Britain. I reproduce below the first paragraph from his paper presented at the meeting of the Royal Society (Roxburgh 1778, p. 180).

> From *A Meteorological Diary kept at Fort St George in the East Indies*[4] by William Roxburgh (1778) communicated by Sir John Pringle, read on Jan. 29, 1777:
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> *"The manner in which I keep my meteorological observations is as follows: A thermometer without doors; a barometer and thermometer within doors: the barometer and thermometer within doors are kept close together, for the sake of correcting the barometer if required. I observe them three times a day as per diary. I also set down the direction and strength of the wind and the state of the weather. I distinguish four degrees of strength of the wind; namely, gentle, brisk, stormy, and what we call a tufoon in India, which you will find marked with the numbers 1, 2, 3, and 4 besides no sensible wind, which is marked with a cypher."*

He continues to say that he was ashamed that his rain gauge (spelt 'rain-gage') was 'indifferent' and he could not measure the rainfall with certainty. Pages 182–192 in this paper include tables with seven columns with captions, indicated here in italics: (1) *date of recording* (starts from 1 October 1776), (2) *hour from noon* (time of observation), (3) *Therm. within* (temperature reading made from the thermometer located within the building), (4) *Therm. without* (temperature reading made from the thermometer located outside), (5) *Barom.* (pressure reading with a barometer), (6) *Winds* (*str*.: speed; *Points*: direction), and (7) *State of the weather, &c. at Fort St. George* (notes on general weather patterns, i.e., cloudy, some rain in the night). Page 193, the last page of this article, includes a table, which refers to human illnesses diagnosed by him. This table is presented with six columns: (1) *1776/7* (years of notes made), (2) *at the end of October*, (3) *November*, (4) *December*, (5) *January*, and (6) *February*. Under the column captioned *1776/7*, Roxburgh lists 26 illnesses (e.g., fevers, liver, liver cough, liver flux, epilepsy, fistula). Under the columns captioned with month names, either single or double-digit numbers exist, which may be referring to the number of patients he had examined who came to him with the illnesses referred to in the table. However, neither a legend nor an explanation exists in the article linking this table to the weather data reported in pages 182–192.

Detailed measurements obtained over many years led Roxburgh to construct an opinion on the widespread famine and patterns of climate change in British India. A reference to an article by Roxburgh published in 1790 exists in literature with a title identical to that of his 1778 article; my efforts to get a copy of the 1790 article were unsuccessful.

Roxburgh was transferred from Fort St George (Madras) to Nagore (10˚49' N, 79˚50' E), a town near *Tanjavur* in 1778, where he continued to record meteorological details, until he was posted as the superintendent of the Botanic Gardens in Calcutta, succeeding Robert Kyd [1746–1793], in 1793. James Capper (a senior accounts officer of the Army) had also obtained every day daily meteorological measurements, including those of atmospheric pressure, at Fort St. George in Madras from March 1777 to May 1778 (Capper, 1801). No match occurs between Capper's and Roxburgh's data, although an overlap occurs in the time spans of their records. When adapted to monthly values, the Capper records indicate a convincing relationship with the seasonal cycles of pressure in the long-term means of the Madras monthly sea-level pressure data from 1796 to recent times; Roxburgh's observations appear less amenable to seasonal cycles of

[44] The letter 's' written as 'f'; e.g., 'close' written as 'clofe'.

pressure data of Madras (Allan et al. 2002). Nonetheless, the *Circars* (15º4'–16º5' N; 80º1'–80º6' E) suffered severe famines in 1780 and 1789–1792; Roxburgh considered that the irrigation methods practised at that time were more efficient in the specific context of climatic and geographical conditions of the *Circars* than what were practiced in the colonial days; he criticized that the East-India Company's water-management strategies were badly designed and were essentially responsible for the land's response with famines (Roxburgh 1793). Roxburgh's comments (1793) to the Government were transmitted to Robert Kyd (Superintendent of the Calcutta Botanic Garden) by the Madras *Nopalry* founder and a medical doctor James Anderson [1739–1809], which were relayed by Kyd to Alexander Beatson, Governor of St Helena, who could find a link among the drought events that occurred in India and elsewhere in the world and propose the idea of a 'connected phenomenon'.

Further to documenting details and datasets on the seriousness and impact of the climate change in India, Roxburgh launched an extensive tree-planting programme in the Presidency of Madras (and also in the Presidency of Bengal, later) to mitigate unfavourable environmental changes by planting *T. grandis*. Especially while at *Samulcottah* (*Samalkot*; 16º42' N, 81º31' E), he supervised the construction of a botanical garden and trialled tree-planting experiments involving *Coffea Arabica* L. (coffee), *Cinnamomum zeylanicum* Blume (cinnamon), *Myristica fragrans* Houtt. (nutmeg), *Bixa orellena* L. (annatto), *Caesalpinia sappan* L. (sappan wood), *Artocarpus altilis* (S. Parkinson ex Z) Fosb. (breadfruit), and *Morus alba* L. (mulberry); he experimented cultivating *Saccharum officinarum* L. (sugarcane) and different species of *Piper* (pepper) (King 1895). He advised local administrators to plant drought-resistant and water-efficient food-product yielding palms, such as *Cocos nucifera* L. (coconut), *Metroxylon sagu* Rottb. (sago), *Phoenix dactylifera* L. (date palm), and *Borassus flabellifer* L. (palmyra), and non-palm taxa such as *Musa paradisiaca* L. (banana), *Artocarpus heterophylla* Lam (jack), and species of *Opuntia* along village streets and canal banks to ensure better supplies of edible plant products to rural people (Roxburgh 1793). His recommendation was accepted by the then Government of the Presidency of Madras, by procuring either saplings or seeds of *C. nucifera* from Colombo (Sri Lanka), *M. sagu* from Travancore (modern southern Kerala), and *A. altilis* from the Nicobar Islands for establishment in the Madras Presidency (Love 1870).

Roxburgh was honoured for promoting plantation-based utilitarian conservation in India by the Royal Society for the Encouragement of Arts in 1805 and 1814 (Sangwan 1995). John Hope's [1725–1796] tutelage seems to have influenced Roxburgh's scrupulous skill in data collection. Roxburgh's interest in systematic meteorology may have stemmed from the influence of John Hope as well as his experiences at the Royal Society of Arts, which in the early 1770s, was greatly influenced by the climate theories proposed by Stephen Hales and Duhamel du Monceau (Grove 1993).

EDWARD GREEN BALFOUR

E.G. Balfour [1813–1889], a Scottish medical doctor in the Madras Medical Service, was another key person in the nineteenth century Madras Presidency, who recognized the effects of changing climate patterns, and contributed significantly to improve the overall environment of the Madras Presidency. He will be remembered for his efforts in setting up the museum and the zoological garden in Madras and also for his book series entitled the *Cyclopaedia of India and of eastern and Southern Asia* (first published in 1857; subsequently a 5-volume tome in 1871–83) (Anonymous 1889).

Writings on vegetation-conservation in Mauritius by the French engineer Jacques-Henri Bernardin de Saint-Pierre [1737–1814] and those on the effects of forest clearance and water loss by the French chemist Jean-Baptiste Boussingault [1802–1887] (Boussingault 1837) influenced Balfour, who pioneered forest conservation schemes in India, especially after 1840. The Indian schemes born out of Balfour's efforts formed the model for most of forest conservation projects, which were followed later in several other British and French colonies (Grove 1995: p. 262). During Balfour's study time in Edinburgh, Scottish medical training emphasized the role and importance of water in human health, and in high likelihood, this element of professional training prompted him to recognize the finiteness of water in the biosphere and take an interest to study the role played by forests in recycling water. Balfour found it both logical and expedient to consider the 'forest problem' as being fundamentally a public-health issue demanding the kind of interventionist solutions in the countryside that were being adapted in the urban sanitary landscape (Grove, 1995: p. 448). Balfour's studies were steeped in reason via statistical tests and analyses; his climate-related health studies on army personnel were presented at the meetings of the Statistical Society of London. Balfour's scientific acumen and temperament are positively reflected in his essay on the connections between water and forest cover (Balfour 1849), in which he articulates the links between famine and deforestation. His several reports to the Famine Commission (e.g., IV. *The influence exercised by trees on the climate and productiveness of the peninsula of India*) are considered invaluable even today. The East-India Company took note of his precautionary remarks and launched forest-conservation schemes in the 1840s. Historian Thompson (1980) lauds Balfour's contribution to reforestation and forest conservation efforts in peninsular India as follows:

> *"It should be noted that supposed deterioration of climate caused by tree cutting was not just a European and North American concern. It had global ramifications and extended far into areas of European influence such as, for example, British India where as early as 1849 a British surgeon, Dr Edward Balfour, published a lengthy essay (heavily derivative of Boussingault and others) entitled* Notes on the Influence exercised by Trees on Climate".

The reader is referred to the sub-chapter 'The environ-mentalism and radicalism of Edward Green Balfour' by Grove (1995: 441–453) for an extensive commentary. Grove's (1995: p. 441) following sentence summarizes Balfour's character:

> *"Balfour stands as the clearest example of an apparent duality of humanist reform and conservation concerns".*

CONCLUSION

The purpose of this article was to bring to light the efforts of three European residents in the Madras Presidency – Geister, Roxburgh, and Balfour – in either maintaining records of weather details or making efforts to mitigate the vagaries of climate. The three worked in the Coromandel under extremely trying circumstances, compared with the sort of facilities and equipment of today. The article by Walsh et al. (1999) explains the scientific climatology as noted by Geister by interpreting his notes in contemporary scientific language. Extensive commentaries on the relevance of the notes made by Roxburgh and Balfour are available in Richard Grove's book (1995) and articles (1990, 1993, 2007). Geister, Roxburgh, and Balfour stand a shade above many of their Indian contemporaries by their meticulous efforts to understand patterns of climate change and mitigate the impacts because of those changes, as much as they could.

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