INTERNATIONAL JOURNAL OF SOCIAL SCIENCES REVIEW

E-ISSN : 2807-8098

Archival Records of Environmental Hazards and Social Vulnerability to Disasters in Colonial Mauritius, c. 1857-1911

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ABSTRACT

Small Island Developing States (SIDS) are characterized by their smallness and high exposure to global environmental challenges such as climate change. Although high exposure to physical environmental stressors over long periods of time may represent vulnerability, rich local knowledge can result in long histories of responding to disaster risk, demonstrating that smallness does not always lead to vulnerability. This research study focuses on environmental hazards in Colonial Mauritius and their impact on the Mauritian population from 1857 to 1911. Mauritius is one of those small islands with a colonial history and diseases prevalent during colonial times were a consequence of poverty, inadequate food supplies and bad sanitation. However, these factors alone did not account for the rapid spread of diseases. Climate variations often seem to have influenced the incidence of illnesses in many tropical regions. Results showed that Islanders had to face several episodes of epidemics and water-borne diseases such as malaria were likely to increase and decrease after alternate periods of severe rainfall. Island studies on the spread of diseases and climate were increasingly recognized as offering valuable contributions to climate change adaptation in Mauritius. The mid-twentieth century marked the beginning of a new, prevention-oriented, colonial policy towards tropical cyclones and disease control. These catastrophes have led to a growing disaster consciousness in the Mauritian community, and over time, strengthened the coordination ability of institutions to shape the modern-day perspectives of the Mauritian Society.

Keywords: *SIDS, Environmental Hazards, Colonial History, Collective Response, Mauritius*

Background

Small Island Developing States (SIDS) are known to face unique vulnerabilities and development challenges, based largely on their remote geography, finite supply of land, small populations and susceptibility of resources to the negative effects of climate change. This paper used historical records of real-life experiences of some hazardous events to highlight the importance of lessons learnt from past disasters. Local vulnerability to climate change cannot be detached from the context of colonialism, which created social conditions that limit resistance and resilience capacity. People had experienced social inequalities that could potentially limit adaptive capacity and compound the impacts of climate change. At the peak of Indian immigration in Mauritius in the mid-1880s, diseases prevalent in Mauritius were a consequence of poverty, lack of vaccines, overcrowding in small huts, inadequate food supplies, and a bad sanitation. Ignorance and medical beliefs of the natives at that time also contributed to the rapid spread of diseases. Environmental factors often seemed to have influenced the incidence of illnesses among the human population. Water-borne diseases such as malaria and cholera were found to increase and decrease while rainfall increased and decreased. The damage and losses caused by historical disasters in Mauritius are often not widely known, but local communities in Mauritius have developed strategies for addressing and adapting to climate-related adverse effects.

Social interaction and communication of disaster risk have been crucial in building the past resilience of many island communities to extreme weather events (Kelman, 2018). Investigations into cultural knowledge of cyclones around the world have disclosed the use of nature-based local warning signs, for instance, in Bangladesh (Howell, 2003; Paul and Routray, 2013), in Samoa (Lefale, 2010), in Fiji and Tonga (Johnston, 2015) and in Mauritius (Walshe, 2020). These are recent advances in our understanding of tropical cyclones based on traditional knowledge of environmental precursors, in many cases involving changes in animal behavior or weather conditions and providing up to three days of advanced tropical cyclone warning (Paul and Routray, 2013). Yet, such research on cultural knowledge, local practices and understandings of either cyclones, disasters, or climate change remains comparatively few in small islands.

The island of Mauritius faced several episodes of droughts, heavy rainfall, tropical cyclones which often coincided with epidemics. A few outbreaks of diseases were reported in Colonial Mauritius during the period 1857-1911, namely, a deadly malarial episode (1866 – 1868), dengue (1873), "acute anemic dropsy" (1878-1879), smallpox (1889) and bubonic plague (1898) (Boodhoo, 2010). Earlier, people had to face several episodes of cholera, but the epidemics of 1853-1854 were particularly severe (Boodhoo, 2010). People also faced sporadic epidemics of diphtheria and beriberi (Meldrum 1881:29). A severe tropical cyclone struck the island in 1868 and the death toll was compounded with the spread of the malarial epidemic. A major drought occurred in 1886, followed by another tropical cyclone of high intensity in 1892. All these hazards increased the vulnerability of the former slaves and newly settled immigrants. Mauritius had no prior indigenous population. However, the rapid expansion of the sugar industry on the island accelerated human mobility. Immigrants probably constituted the major natural reservoir of recurring disease outbreaks, such as malaria (Bruce-Chwatt and Bruce-Chwatt, 1974; Hurgobin, 2016). Almost a century later, a principal agency for disaster management was set up in Mauritius in 2013 following deadly flash floods and the main legislation for disaster management, namely the National Disaster Risk Reduction and Management Act was enforced in 2016.

Literature Review

SIDS are frequently iconized as being particularly vulnerable to climate change impacts due to their island characteristics (Hall, 2012; Kelman, 2018). Lynn et al. (2011) also concluded that some countries are known for enduring the disproportionate consequences of climate change and are likely to suffer the effects of climate change more severely than others because of their geographic location, their interaction with climate-sensitive environments and their limited access to information and resources. Kelman (2018) argued that social inequalities in the context of climate change are also important because some populations may have less capacity to prepare for, respond to, and recover from climate-related hazards due to the unique socio-economic or political characteristics of their landscapes and populations.

Small island states consist of only 6% of publications on climate change adaptation and cultural knowledge on natural hazards and most studies would segregate indigenous knowledge and consider it as an isolated area of study (Petzold et al. 2020). While many SIDS have been stereotyped as vulnerable, implying need for help, Kelman (2018) studied how SIDS peoples are able to address climate change and its wider challenges due to their human capital such as knowledge, skills, and experience which allow them to make their own mobility decisions.

SIDS peoples have survived social and environmental changes for centuries or millennia, and, consequently, have built strong knowledge, wisdom, and abilities for dealing with them as part of a typical island life (Gaillard, 2007; Méheux et al. 2007). Although many communities have been destroyed by such changes, several island nations have developed unique cultural advantages, support network and a robust knowledge transfer system. For example, the Mauritian community has adopted a long-term and repetitive pattern of cultural responses that have worked out successfully in the past to the largest tropical cyclones (Walshe et al. 2020; Walshe et al. 2022).

Most SIDS have few resources and fragile economies that are largely dependent on major imports, which limit investment in building disaster-resilient infrastructure (Pelling and Uitto, 2001). However, Kelman (2018) argued that SIDS' have been able to overcome several episodes of colonialisation and strengthen their resilience to disasters and consolidate their stability because of their remote geographical location. Despite this long history of coping with and adapting to global environmental changes which emerged since their occupation by colonial powers, SIDS are often under-appreciated and under-documented in the global inventory of academic literature on responses to natural hazards, which results in assumptions of vulnerability and low adaptive capacity (Barnett & Waters, 2016).

A few studies have examined the complex relationship between climate variability and societal response using historical interactions between people and the environment (Enfield, 2012; Roy, 2010). Roy (2010) studied the response to disasters in Colonial India between 1800 and 1850 and highlighted the poor collective response to disasters among inhabitants, who, even though they faced a common storm risk, cooperation was difficult to achieve because of great differentiation in individual capacities and risk perceptions and the greed for personal gains. Gil-Guirado et al. (2016) also studied social vulnerability to climate extremes and concluded that any discussion on vulnerability to climate risks would require knowing how societies have faced disasters in the past. This was further supported by Messerli et al. (2000) who also concluded that the interpretation of the past had potential to contribute to an understanding of the relationship between society and the environment. Konate et al. (2023) also highlighted that climate extremes such as droughts and floods were likely to result in famines, diseases and migrations with a high death toll life.

In Mauritius, the relationship between diseases and environmental hazards was often reported by Consuls from the United States who regularly visited the island for professional purposes. However, the role of climate in the propagation of water-borne diseases was likely to be understood only by the few Scientists and observers, working at Royal Alfred Observatory in Pamplemousses, which was set up in 1851. The first Director of the Royal Alfred Observatory took an interest in studying the link between weather and its associated shifts in infectious diseases among the population whilst the newcomers would often be blamed for introducing new diseases on the Island (Hurgobin, 2016).

Methods and Datasets

Rainfall Dataset

This dataset of annual rainfall was obtained from an open secondary source. Annual rainfall data was collected at ten stations for the period 1871-1911 and recorded at the Royal Alfred Observatory at Pamplemousses. This dataset was published in "*Mauritius Illustrated: Historical and Descriptive, Commercial and Industrial*" by Allister MacMillan in 2000. The mean annual rainfall for the ten stations was calculated to observe any trend in rainfall pattern during the study period. The long-term average for the period 1871-1911 was then calculated and a time series of rainfall anomalies was plotted for the same period.

Tropical Cyclone Dataset

This dataset was obtained from an open secondary source and was also published in "*Mauritius Illustrated: Historical and Descriptive, Commercial and Industrial*" by Allister MacMillan in 2000. This dataset covered a fifty-four-year period spanning from 1857 to 1911 and provided the dates on which Mauritius was severely impacted by tropical cyclones. Years of missing data on tropical cyclones referred to the years when the cyclonic season was inactive, or socio-economic damage levels were low. This dataset also included the percentage losses incurred in the sugarcane industry due to strong cyclonic gusts and the amount of sugar exports for selected years, when exports dropped below 100 000 tons since the sugarcane industry was the main economic activity of the country as that time. It also provided the maximum hourly velocity in miles per hour (mph) for each tropical cyclone recorded.

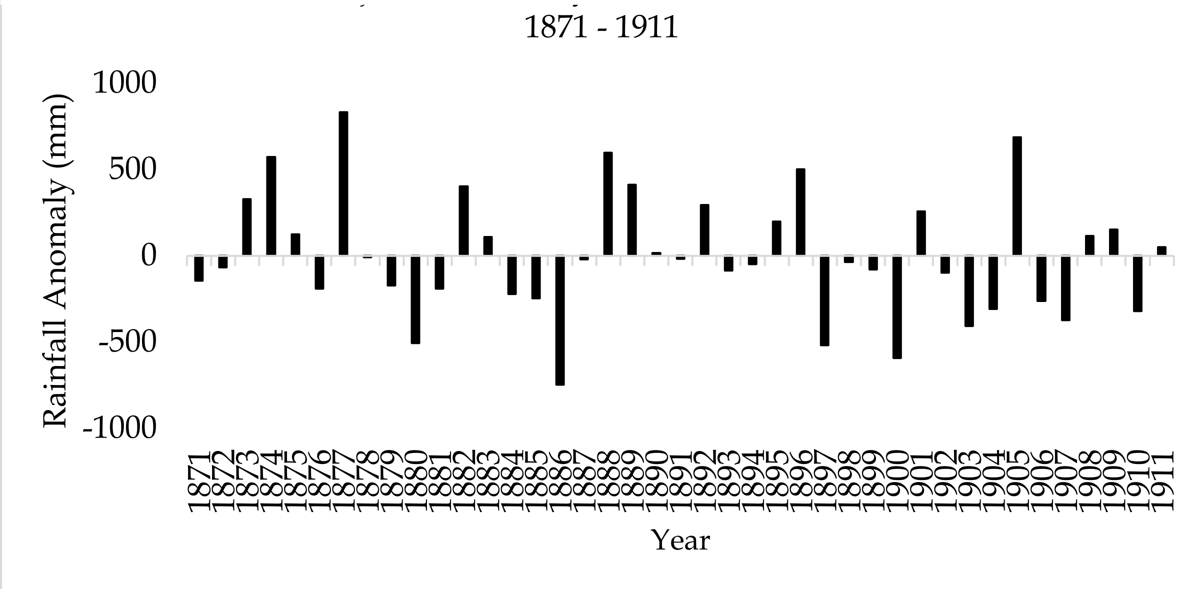
Archival Data Collection

Archival records of environmental hazards, namely, epidemics and tropical cyclones, were obtained from open secondary sources available in the institutional library. This archival dataset comprised of a range of documentary sources such as early scientific books, an electronic subject searching database and reports from the United States Consulates. Endfield (2007) and Walshe et al. (2020) also used archival documentary sources to build a comprehensive long-term history of adaptation and social response to hazards in colonial Mexico and in Mauritius respectively. This study employed reviewed literature from academic journals and scholarly papers that explored the differences in ability of islanders to respond to disasters, as well as literature on impacts of climate variability on island populations.

Results and Discussion

Seventeen years of major wet periods and twenty-five years of dry periods were recorded from 1871 to 1911 as shown by the time series of rainfall anomalies (Figure 1). Rainfall was regular, showing alternately an excess and a deficiency of rain. The highest rain was experienced in 1877 and lowest in 1886.

Figure 1. Time series of rainfall anomalies showing the major wet and dry periods from 1871 to 1911 in Mauritius.



Tropical Cyclones in History

Forty-five tropical cyclones hit Mauritius from 1857 to 1911 as shown in Table I. Some years experienced an inactive cyclonic season. The tropical cyclone of March 1868 was well-known because it was preceded by an inactive cyclonic season and the death toll was compounded with the spread of the malarial epidemic (Table I, Pike 1873: 110). The maximum hourly velocity peaked at 103 mph during the passage of an intense tropical cyclone on 29th April 1892 (Table I).

Economic Losses

The amount of sugar exports dropped considerably with the passage of severe tropical cyclones and the prevalence of epidemics (Table I). Profits earned in the sugar industry were frequently used up by the repair of storm-damaged buildings, thereby worsening the living conditions of an already vulnerable population. Sugar exports from Mauritius dropped below 80 000 tons in 1868 and 1892 (Figure 1) when damage exceeding 30% was caused to sugarcane plantations as the maximum hourly velocity reached at least 85 mph (Table I). Sugarcane was either entirely uprooted or broken, or the leaves were stripped away, leading to a complete cessation of the growth due to cyclonic gusts. Epidemics and tropical cyclones occurred altogether in 1868 and 1879, causing sugar exports to fall below 100 000 tons, and affecting economic growth and social stability.

Table 1. Yearly classification of environmental hazards and economic losses from 1857 to 1911 in Mauritius.

Year	Date	Maximum Hourly Velocity (mph)	Damage to Sugarcane Crops (%)	Annual Sugarcane Exportation (in tons)	Annual Rainfall Anomaly (Below/Above Average)	Disease Outbreak
1857	January 28th	70	2.8	-	-	-
	December 5th, 6th	80	1.0	-	-	-
1858	-	-	-	-	-	-
1859	March 9th	36	-	-	-	-
1860	January 12th, 13th	33	-	-	-	-
	February 27th	33	-	-	-	-
	March 22nd, 23rd	37	-	-	-	-
1861	February 11th-16th	75	7.2	-	-	-
	March 2nd, 3rd	-	-	-	-	-
1862	December 1st	32	-	-	-	-
1863	January 13th, 14th	80	13.8	-	-	-
1863	February 20th	80		-	-	-
1864	-	-	-	-	-	-
1865	-	-	-	-	-	-
1866	April 16th	37	-	-	-	Malaria
1867	-	-	-	-	-	Malaria
1868	January 16th	30	32.5	78,000	-	Malaria
	March 12th	85			-	
1869	-	-	-	-	-	-
1870	-	-	-	-	-	-
1871	January 5th	60	0.2	-	Below	-
1872	February 15th	60	0.9	-	Below	
1873	-	-	-	-	Above	Dengue
1874	March 26th - 28th	80	19.0	80,000	Above	
1875	December 21st	32	-	-	Above	-
1876	January 8th	30	-	-	Below	-
1877	February 10th	65	1.8	-	Above	
1878	-	-	-	-	Below	Acute anaemic dropsy
1879	February 26th	64	29.2	82,000	Below	Acute anaemic dropsy
	March 20th,21st	80				
1880	December	39	-	-	Below	-

	18th, 19th					
1881	January 21st	50	0.5	-	Below	-
1882	February 7th	24	-	-	Above	-
1883	December 6th,7th	45	-	-	Above	-
1884	-	-	-	-	Below	-
1885	January 18th	28	-	-	Below	-
1886	-	-	-	-	Below	-
1887	-	-	-	-	Below	-
1888	January 5th	41	-	-	Above	-
1889	-	-	-	-	Above	Small Pox
1890	-	-	-	-	Above	Small Pox
1891	-	-	-	-	Below	-
1892	February 12th	47	48.3	64,000	Above	-
	April 29th	103				-
1893	January 21st, 22nd	35	-	-	Below	-
1894	January 13th	41	-	-	Below	-
	February 21st,22nd	62	3.6	-		-
1895	January 13th,14th	39	-	-	Above	-
1896	February 19th-21st	51	1.1	-	Above	-
1897	December 5th,6th	71	0.5	-	Below	-
1898	-	-	-	-	Below	Bubonic Plague
1899	March 6th	44	-	-	Below	-
1900	-	-	-	-	Below	-
1901	January 12th,13th	72	6.2	-	Above	-
1902	February 5th,6th	78	18.2	-	Below	-
	February 9th	54		-		-
1903	-	-	-	-	Below	-
1904	March 21st	62	-	-	Below	-
1905	January 23rd	49	-	-	Above	-
1906	-	-	-	-	Below	-
1907	-	-	-	-	Below	-
1908	March 1st	63	9.3	-	Above	-
1909	-	-	-	-	Above	-
1910	January 11th, 12th	45	-	-	Below	-
1911	March 30th	48	10.0	-	Above	-

Some scientists disseminated essential information on the environmental threats which the Mauritius faced during colonial times, namely large-scale deforestation for sugarcane plantation, the combination of floods and droughts and changing prevailing winds (Cianciosi, 2023). While scientists identified natural agents such as tropical cyclones and biological vectors for altering the island's ecology, local authorities blamed newcomers for introducing new diseases on the Island (Hurgobin, 2016). Results indicated that the island experienced alternate wet and dry spells from the late 1850s to the early 1900s. (Pike, 1973: 103) highlighted the atmospheric influences on malarial germs. Heavy rains, followed by subsequent droughts would be power agents to malarial germs, that would, otherwise lie dormant. As rivers swelled in times of heavy rains, they carried into their floods a mass of decaying organic matter from the hills and Indian camps which had accumulated on their banks. At the end of 1866, the exceptional heat and severe drought caused rivers to dry up, leaving fermenting mass of organic matter exposed to the sun. As decomposition of all matter followed, plants grew, and when matured, the spores of the malaria-carrying "ague plants" were set free, poisoning the surrounding environment. "Ague plants" had large spores which grew best in a hot dry season following a wet and were responsible for dangerous fevers. Rivers were a major source of water supply to the inhabitants at that time. Diseases easily spread among those who lived nearby streams and who used the unfiltered water daily (Pike 1873:102).

Results also showed that tropical cyclones contributed to the spread of diseases. In January 1868, a tropical cyclone hit the island on the East South East coast and wind veering, associated with the cyclone, caused malarial disease to spread from contaminated regions to healthy regions (Pike, 1873; 102). Since cyclonic gusts were sufficiently strong (30mph), fever germs proliferated from heavily impacted regions of Black River to healthy regions as the spores of the ague plant were carried from place to place by the wind. These misfortunes were compounded when the island was struck by another tropical cyclone of "extraordinary violence" on March 12, 1868, leaving groups of poor people, wet and still burning in fever with the malarial epidemic, in the greatest distress and misery (Pike, 1873:110). However, some parts of the island completely escaped the malarial fever in 1867; for instance, the sugar estate in Creve Coeur and its neighbouring estate St Lucia escaped the malarial fever due to their elevation above the fever line and the absence of stagnant water (Pike, 1873: 102).

Diseases are most common in the tropics, where rains are seasonally heavy, temperatures are high, vegetation cover is dense and insect life is rife. In 1873, the dengue fever, an insect-borne disease, occurred when heavy rain poured (Figure 1) after two years of below average rainfall (Figure; Table I). The dengue lasted for almost four months, as reported in the Edinburgh Medical Journal, entitled "*Epidemic of Dengue in the Island of Mauritius in 1873*" (Labonté and Brakenridge, 1874). Unusual precipitation after a prolonged drought can result in an increase of pathogens, causing a disease outbreak (Wilby et al. 2005). There is a positive correlation between vector-borne infectious diseases and the rainy season (Wu et al. 2016; Zell, 2004) as intensive rain may stir up sediments in water, leading to the accumulation of fecal microorganisms (Jofre et al. 2010). Heavy rain and high temperatures may increase the reproduction rate mosquito vectors in small ponds and accelerate larval development (Hoshen and Morse, 2004). On the other hand, low rainfall amounts may limit the quantity and quality of breeding sites for mosquitoes , thus reducing the vector population and slowing down the disease transmission (Gage et al. 2008). However, Kuhn et al. (2005) argued that rainfall is not always beneficial to vector-borne diseases since excessive precipitation may also sweep away the breeding sites of mosquitoes and affecting larval development.

In December 1898, an outbreak of the epidemic of plague was highlighted in the *Public Health Reports (1896 – 1970)* (Campbell, 1899). Dry and hot conditions are known to have a harmful effect on the survival of fleas and to slow down the transmission of plague. Therefore, the prevailing dry conditions from the years 1897 to 1900 (Figure 1; Table I) and the lack of precipitation (Figure 1; Table I) could not have favoured the transmission of plague. Instead, Campbell (1899) attributed the spread of the disease to widespread insanitary conditions on the island. Climate variability has influenced economic growth, socio-cultural behaviours and demographic trends, across the world (Hsiang and Burke, 2014; Weiss and Bradley, 2001; Zhang and Delworth, 2007). However, the current approaches to study climate variability are flawed in several locations because of the growing exposure of populations and livelihoods to natural hazards (Easterling et al. 2000). Consequently, the analysis of social vulnerability to climate variability is essential to understand gaps in response and recovery efforts and to draw lessons from past recurring errors to build a disaster resilient future (Helbling, 2007).

Epidemic losses, severe tropical cyclone disruptions and poor sugar harvests profoundly altered colonial attitudes towards public health management in Mauritius (Čaval, 2023). Attempts to reduce social vulnerability to environmental hazards gained importance and vaccinations were introduced to prevent the rapid spread of infectious diseases (Ciansosi, 2023) and burial grounds were also developed (Čaval, 2023). Tropical cyclones that made landfall produced social meaning that fuelled reconstruction efforts to build 'cyclone-proof' housing estates that are resistant enough to withstand strong cyclonic gusts (Rouphail, 2021). The Mauritian economy, which was largely dependent on sugar exports, has become more diversified, as the tourism industry flourished to become a substantial source of revenue, thus improving socio-economic conditions on the island (Bruce-Chwatt & Bruce-Chwatt, 1974).

Conclusion

This study concluded that Mauritius had been stricken by long-lasting adversity since its early colonialisation. Social networks and community engagement contributed to fortify social resilience. Colonial decisions changed and reflected a shift from disaster response to disaster risk mitigation. Lessons were drawn from the past to shape the modern-day perspectives of the societal response to disasters in Mauritius.

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