# IMPACTS AND CONSEQUENCES OF CLIMATE CHANGE ON THE REPUBLIC OF MAURITIUS

## 1. INTRODUCTION

As a SIDS, the Republic of Mauritius (Mauritius) is highly vulnerable to the negative effects of climate change. It faces challenges such as coastal degradation, marine pollution and coral bleaching. It is one of the most exposed nations to natural hazards due to its geographical location in an active tropical cyclone basin. Mauritius is also susceptible to changes in precipitation and other weather elements.[1] This paper provides evidence on the impact of sea level rise and increased sea surface temperature in its waters and the ensuing economic costs. While the Government of Mauritius has carried out an assessment of the effects of climate change on its main islands[2], it has not yet been able to carry out such an assessment for the Chagos Archipelago which remains under the unlawful occupation of the United Kingdom. Likewise, the Chagos Archipelago is extremely susceptible to the effects of climate change. It comprises more than 60 islands, banks and reefs, totalling a land area of around 52.07 $km^2$ and with a coastline of 293.28 km. The terrain is flat and low lying, which on an average is 1m to 2m above mean sea level.

## 2. SEA LEVEL RISE

Climate change is a major threat to ocean health globally. Sea-level rise is one of the most visible consequences of changes in the Earth's climate. A warming climate causes global sea level to rise principally by warming the oceans[3] which causes sea water to expand, increasing ocean volume and melting land ice, thus transferring water to the ocean. Global mean sea level has risen approximately by 210-240 mm since 1880 with about a third coming in just the last two and a half decades[4].

Rising sea levels create not only stress on the coastline but also on coastal and marine ecosystems. Salt water intrusions may contaminate fresh water aquifers, many of which sustain municipal and agricultural water supplies and natural ecosystems.

Observations from *in-situ* data[5] of mean sea-level at Port Louis (main Island of Mauritius) indicate a long-term sea-level rise of 4.7mm/year between 1987 and 2020. For Rodrigues Island, the mean sea level has increased by 6.4 mm/year for the same period[6]. Compared to the decade 1991-2000, the mean sea level for the main Island of Mauritius has increased by 11.9 mm during the last decade 2011-2020. Sea-level rise is projected to be of the order of 49 cm by 2100[7].

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[1] UNDP study by Heat GmbH, 2021.

[2] Mauritius includes the Islands of Mauritius, Rodrigues, Agalega, Tromelin, Cargados Carajos and the Chagos Archipelago, including Diego Garcia, and any other island comprised in the State of Mauritius. (Section 111(1), Constitution of Mauritius)

[3] Nerem *et al.*, 2018

[4] https://climateknowledgeportal.worldbank.org/country/mauritius/impacts-sea-level-rise

[5] Source: Mauritius Meteorological Services

[6] Data received from Mauritius Meteorological Services (2023)

7 Updated National Climate Change Adaptation Policy Framework, (2021)

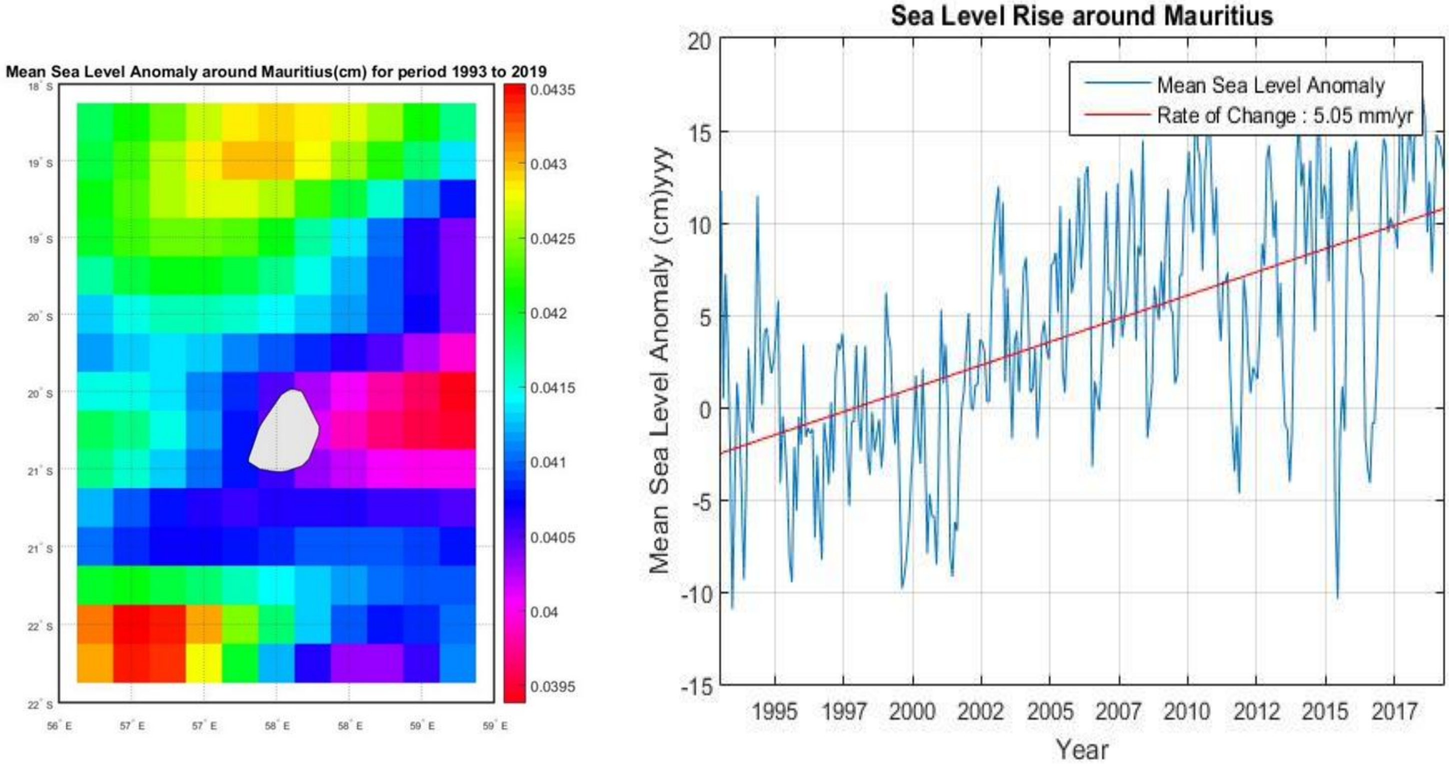


***Figure 1 – Mean Sea Level Anomaly, 1993-2019 (Source: National Centre for Space Studies (CNES) through the AVISO website)***

As shown in Figure 1, data from satellite indicates that from 1993 to 2019, the rate of change of sea-level rise has been estimated to be approximately 5.05 mm/year around the Island of Mauritius. Similarly, for Rodrigues and Agalega, the rate of change of sea-level rise is 4.84mm/year and 3.40mm/year, respectively as compared to the rate of change of the sea-level rise in the Indian Ocean, being 2.81mm/year.[8]

Furthermore, using datasets around main island of Mauritius from the GLORYS2 model re-analysis over the period 1992-2009 and the PSY3 hindcast dataset for 2011-2018, both from Mercator Ocean with a spatial resolution of about 25 km, a time series for the Sea Surface Height (SSH) for the years 1992 - 2018 was worked out as shown in Figure 2[9].

8 Source : Mauritius Oceanography Institute (2019)

9 Source: Department of Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office, Mauritius (2023)

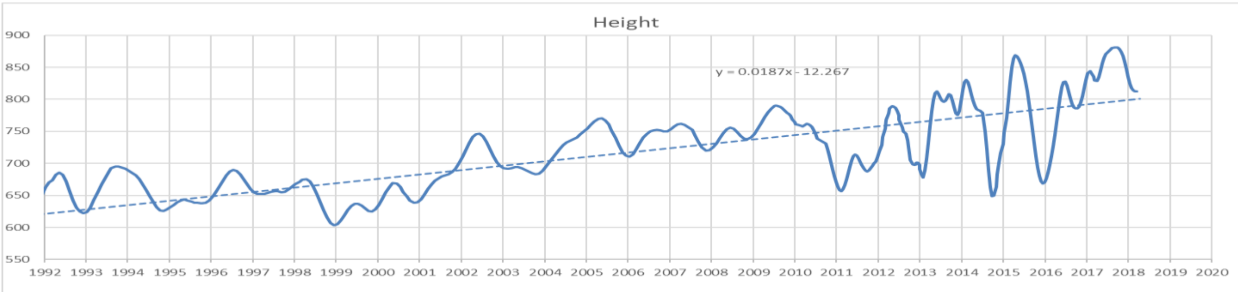

*Figure 2 – Sea Surface Height, 1992-2018 (Averaged GLORYS2/PSY3 model reanalysis from Mercator Ocean)*

It is observed that from 2014 to 2018, the SSH seems to be sharply increasing with the overall trend depicting an increase with a rate of 6.8 mm/ year.

## 2.1 CONSEQUENCES OF SEA LEVEL RISE

The above data clearly demonstrates the rise in sea-level, thus accentuating beach erosion and damaging coastal infrastructure, including the loss of beachfront around the Island of Mauritius. Beach erosion has shrunk the width of the beaches around certain coastal areas by up to 20 m over the last few decades (TNC, 2016). Beaches may slowly disappear and this will negatively affect the tourism industry which is one of the pillars of the Mauritian economy.

Also, Port Louis harbour is exposed to a number of combined risks, including sea-level rise. This phenomenon of sea-level rise has necessitated calls for huge capital investment in coastal protection works (break waters, regular dredging, etc).

## 3. SEA SURFACE TEMPERATURE (SST)

Water covers more than 70% of our planet's surface and plays an important role in regulating the temperature of our oceans though its capacity to absorb a large amount of heat. This ability to store and release heat over long periods of time gives the ocean a central role in stabilizing the Earth's climate system. The main source of ocean heat is sunlight. Additionally, the emission of greenhouse gases is now known to interact directly on the heat content of the ocean by trapping it. As a result, upper ocean heat content has increased significantly over the past few decades as shown in Figure 3[10].

10 Source Climate.Gov (https://www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content)

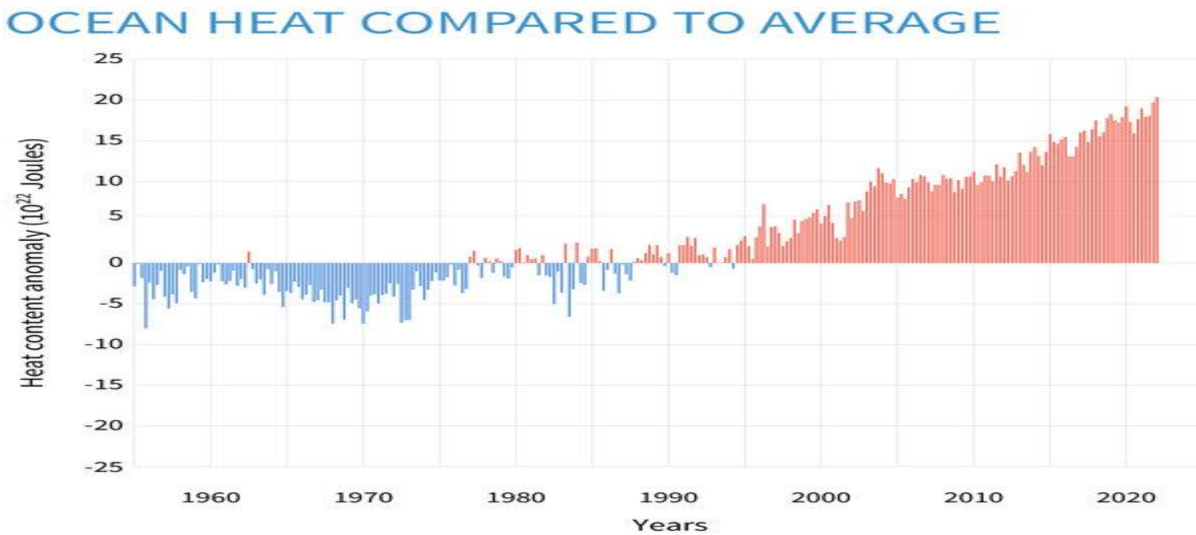


*Figure 3- Seasonal (3-month) heat energy in the top half-mile of the ocean compared to the 1955-2006 average. Heat content in the global ocean has been consistently above-average (red bars) since the mid-1990s. More than 90 percent of the excess heat trapped in the Earth system due to human-caused global warming has been absorbed by the oceans. NOAA Climate.gov graph, based on data (0-700m) from the NCEI Ocean Heat Content product collection.*

According to the analysis carried out by the Department for Continental Shelf, Maritime Zones Administration and Exploration of Mauritius for the period 1992 - 2018 on the evolution of SST in Mauritius waters, episodes of peak temperatures above 29°C were non-existent before 2003 and have since become recurrent. For the year 2015, the data shows a peak at 30°C. The analysis shows that the increase in SST from 1991 to 2018 is largely above the global SST[11] mean which is around 0.2 degree for the past two decades.

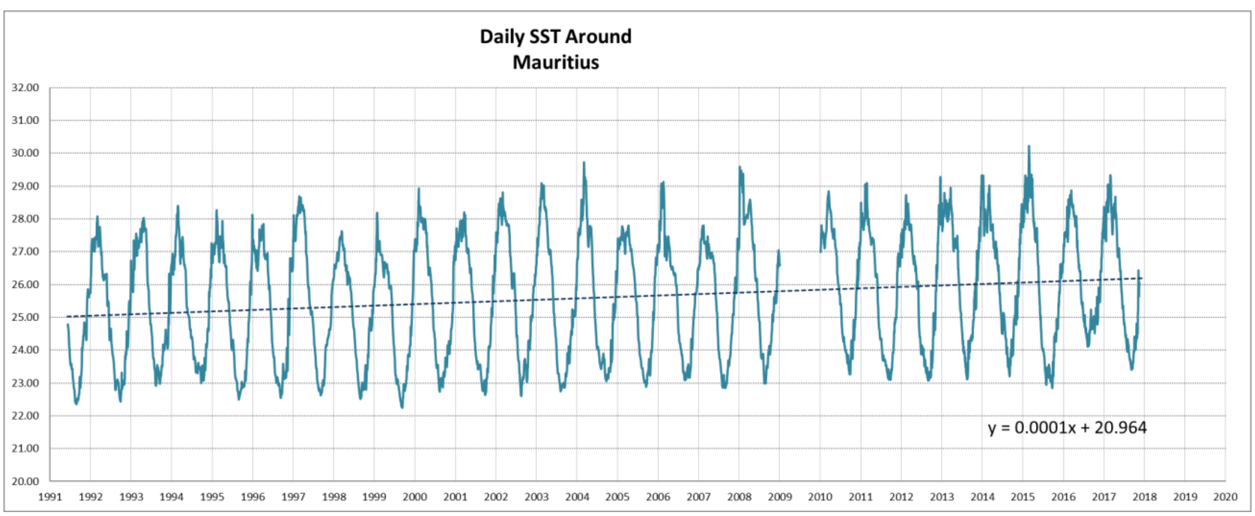


***Figure 4 – Sea Surface Temperature, 1991-2018 (GLORYS2/PSY3 model reanalysis from Mercator Ocean)***

11 Source: https://climate.copernicus.eu/climate-indicators/sea-surface-temperature

## 3.1 CONSEQUENCES OF THE RISE IN THE SEA SURFACE TEMPERATURE

### 3.1.1. CORAL BLEACHING

The Mauritius authorities have been monitoring the coral reefs ecosystem of the Blue Bay and the Balaclava Marine Parks since 1996 and 1998, respectively. Additionally, 21 stations established at 11 sites around the Island of Mauritius are also being monitored on a long-term basis since 1996.

One of the consequences observed was that temperatures above 29°C led to coral bleaching. Successive coral bleaching episodes around the Island of Mauritius were recorded in 2004, 2007, 2009, 2011, 2013, 2016 and 2018/19. In 2018/19, about 60% of corals were subjected to bleaching. Moreover, severe bleaching that led to mass mortality of corals occurred in 2007 and 2009. Lagoon corals and the fringing reef around the main island of Mauritius have thus suffered from recurrent coral bleaching events due to increasing sea surface temperature, leading to a decrease in their protective function against the forces of high waves and their sand regeneration capacity.

Long-term monitoring results have shown a declining trend in the percentage of live coral cover at all sites being monitored. In 1996, at the time of establishment of the monitoring stations, the average live coral cover was 37.4% (see Figure 5) and 38.8% in the Blue Bay and Balaclava Marine Parks, respectively.

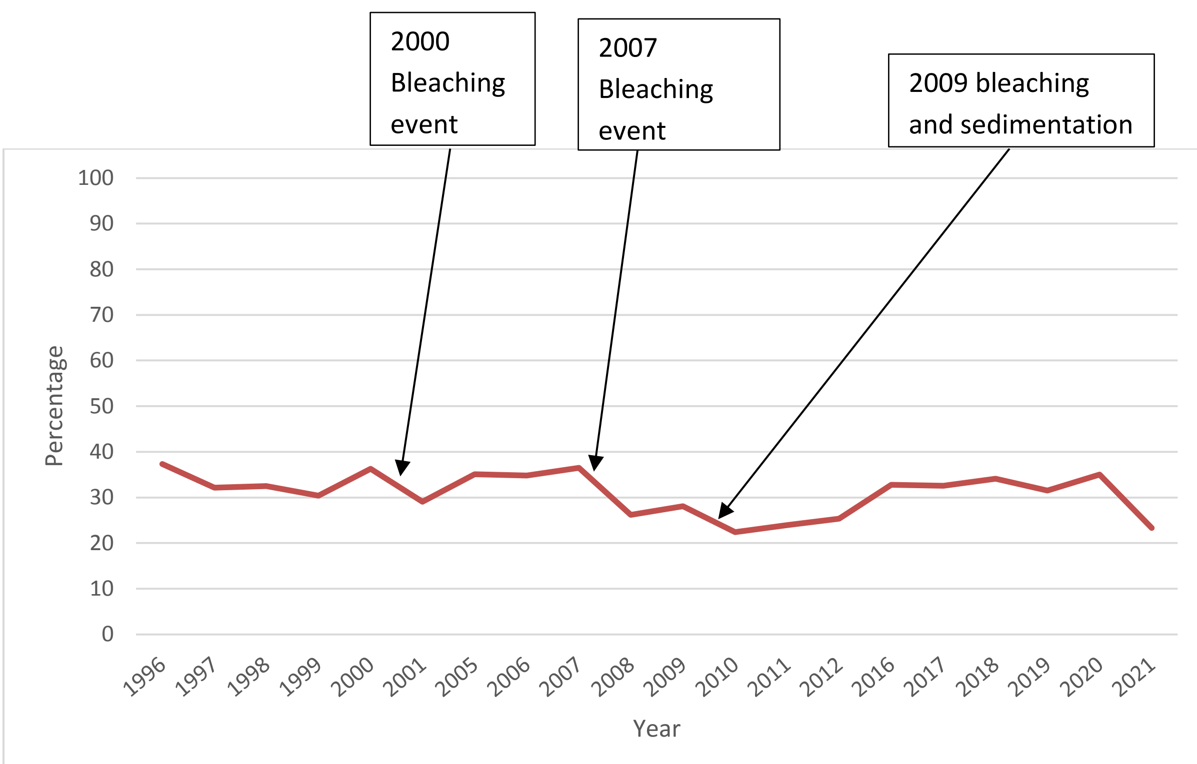


***Figure 5 – Description***[12]

12 Source: Albion Fisheries Research Centre

The decline in live coral cover in the Blue Bay Marine Park was further exacerbated, causing a further decline to 22.4% in 2010 due to sedimentation as a result of the successive flash floods that occurred in 2009. The major mass bleaching event that occurred in 2019 caused another decrease in coral coverage to 31.5%.

### 3.1.2 MARINE LIFE

Phytoplankton make up the foundation of the oceanic food web. To survive, every living thing needs organic carbon [29]. Organic carbon can be found in many different things including sugars (glucose = $C_6H_{12}O_6$), plants and animals. Phytoplankton produce their required sugar through photosynthesis. As they are able to produce their own energy with the help of light, they are considered autotrophic (self-feeding). Phytoplankton and other autotrophs are called primary producers, and make up the bottom of the food web as shown in Figure 5. These organisms are called “primary producer” because all other organisms rely on them (directly or indirectly) as a food source. Phytoplankton are generally consumed by zooplankton and small marine organisms like krill. These creatures are then consumed by larger marine organisms, such as fish. This chain continues up to apex predators, including sharks, polar bears and humans.

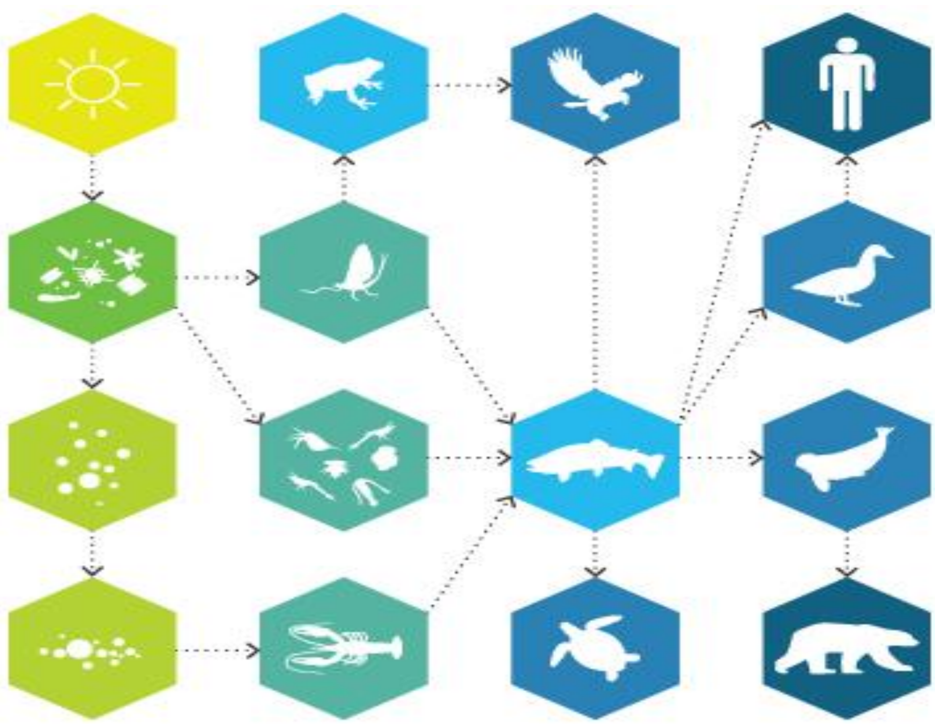

*Figure 6*

The concentration of chlorophyll-a has presently been used as an important parameter for measuring phytoplankton biomass. An analysis[13] carried out by the Department for Continental Shelf, Maritime Zones Administration and Exploration of Mauritius on the evolution of the monthly mean of chlorophyll-a around Mauritius from 2003 to 2019 shows episodes of low chlorophyll-a concentration coinciding with those of high sea surface temperature as shown in Figure 7.

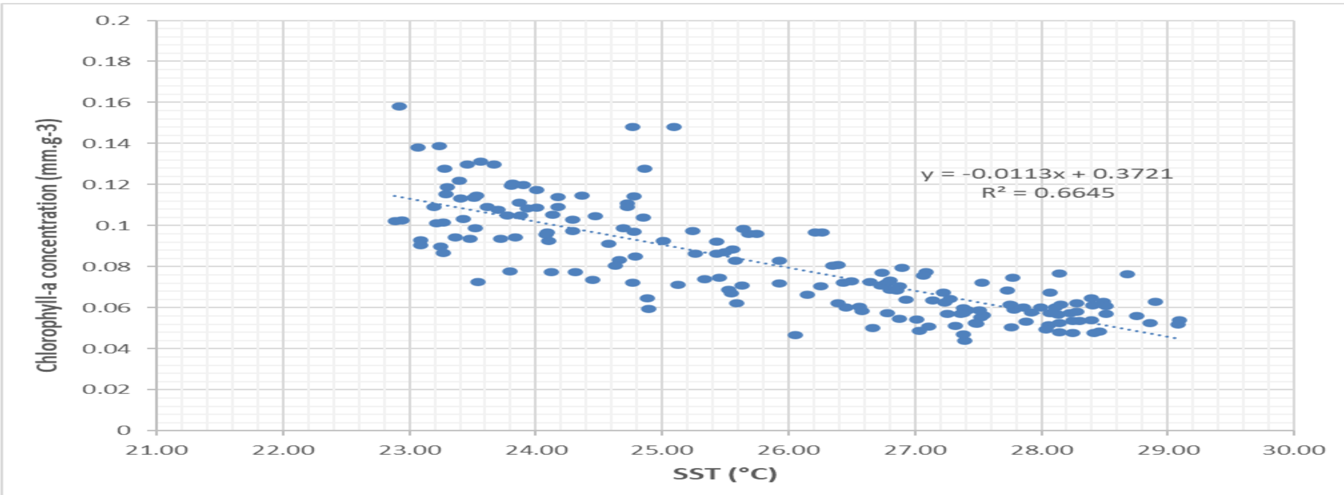


***Figure 7 – Chlorophyll-a/SST, 2003-2019***

On plotting a time series of chlorophyll-a concentration between 2003 and 2019, a general decreasing trend can be depicted (Figure 8). Although the fitted trend line does not significantly account for all the changes in the chlorophyll-a concentration, an indirect correlation between SST and chlorophyll-a is evident from Figure 7 where events of low chlorophyll-a concentrations are associated with high Sea Surface Temperature. Hence an increase in SST can be observed to negatively impact on the population of phytoplankton.

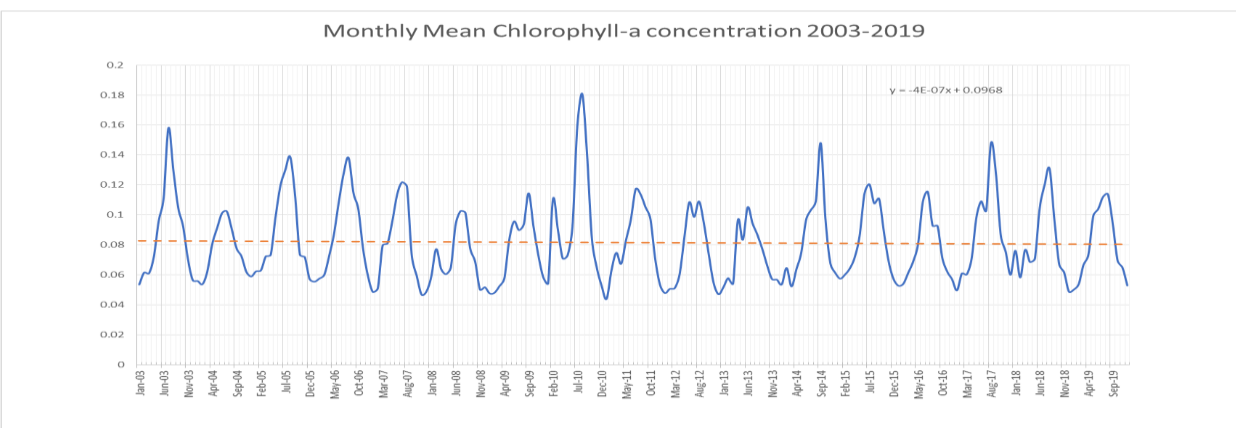


***Figure 8 – Chlorophyll-a, 2003-2019 ( Source AquaModis, NASA/GSFC/OBPG)***

13 Data was retrieved from NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group, MODISA Level-3 Equidistant Cylindrical Mapped Image, NASA/GSFC/OBPG, DOI: 10.5067/AQUA/MODIS/L3M/CHL/2022, accessed on 2020-Apr-16.

## 4. OTHER NEGATIVE IMPACTS OF CLIMATE CHANGE REGISTERED IN MAURITIUS

For the main island of Mauritius, Rodrigues and Agalega, the mean annual temperature per decade has increased by about 0.19 °C, 0.20 °C and 0.20 °C, respectively. Data collected over the past 60 years show that the annual rainfall has decreased by about 104 mm, 234 mm and 207 mm for the main island of Mauritius , Rodrigues and Agalega, respectively.

Other observed impacts of climate change on the rainfall pattern, notably over the Islands of Mauritius and Rodrigues, include the lengthening of the intermediate dry season; a shift in the start of the summer rains which translates into much pressure on the water sector to meet increasing demands of the agricultural, tourism, industrial and domestic sectors; an increase in the number of consecutive dry days together with a decrease in the number of rainy days; an increase in the frequency of heavy rainfall events causing floods and flash floods, despite the decreasing number of rainy days, coupled with unprecedented rainfall intensities,. Moreover, the number of storms reaching tropical cyclone strength (winds above 165 km/h) or stronger is increasing; and rapid intensification of tropical storms is increasing with almost every season in the last decade having at least one rapid intensification.[14]

In the fisheries sector, climate change in Mauritius is already causing erratic and lowered productivity through increased sea surface temperature and sea-level rise. This is consistent with the findings of the Intergovernmental Panel on Climate Change in its Special Report on the Ocean and Cryosphere in a Changing Climate:

> *"Future shifts in fish distribution and decreases in their abundance and fisheries catch potential due to climate change are projected to affect income, livelihoods, and food security of marine resource-dependent communities (medium confidence)."*[15]

## 5. ECONOMIC COST OF CLIMATE CHANGE IN MAURITIUS

The coastal zone of the Republic of Mauritius is a valuable national asset with an estimated total annual economic value of USD 33 million (in 2010). Coastal areas are highly vulnerable to natural hazard events associated with cyclones, flooding, storm surges and heavy swells that are predicted to become more frequent and intense over time.

A projected increase in the mean annual temperature increase, coupled with beach erosion, can lead to a reduction in tourist arrivals accounting for a revenue loss of up to USD 50 million by 2050.[16]

As mentioned in Section 2.1, beach erosion has shrunk the width of the beaches around certain coastal areas by up to 20 m over the last few decades (TNC, 2016). Beaches may slowly

14 Source: Mauritius Meteorological Services (2023)
15 3.2.4, 3.4.3, 5.4.1, 5.4.2, 6.4 [B.8]
16 Third National Communication, 2016

disappear and this will negatively affect the tourism industry which is one of the pillars of the Mauritian economy.

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