Climate Change and Agriculture in Sri Lanka

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The Paris Agreement is a legally binding international treaty adopted in 2015 that commits 195 parties including Sri Lanka to combat climate change by limiting global warming to well below 2 degrees Celsius, with efforts to limit it to 1.5 degrees Celsius above pre-industrial levels. It aims to strengthen the global response to climate change through a collective effort, with each country setting Nationally Determined Contributions (NDCs) to reduce greenhouse gas emissions.

https://unfccc.int/process-and-meetings/the-paris-agreement

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

Climate change poses significant challenges to agriculture, both through its impacts on agricultural production and as a major source of greenhouse gas emissions. Agriculture is vulnerable to rising temperatures, changing rainfall patterns, and extreme weather events, which can negatively affect crop yields and livestock health. Simultaneously, the sector contributes significantly to greenhouse gas emissions, particularly through livestock farming and fertilizer use. This book based on a literature review together with the author's research findings and theoretical base development provides adequate information on the subject to enable using in universities and development projects. The author's involvement on preparation of Carbon Net Zero 2050: Roadmap and Strategic Plan for Sri Lanka as the Agriculture Sector Expert has brought significant contribution to the Book.

The book begins with an introduction explaining the basic knowledge on climate change and its impact in Chapter one. The Chapter 2 describes the 'Status Quo' of agriculture in Sri Lanka. GHG emission from agriculture, mitigation and adaptation of the impact of climate change and finally strategies and the roadmap 2050 for the agriculture sector of Sri Lanka are described in the preceding chapters.

The book contains 10 chapters providing opportunities to raise the knowledge and awareness of climatologists, agriculture specialists, University lecturers and students, who are dealing with the subject of Climate Change.

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Independent Consultant, 31st July 2025.

CHAPTER ONE

CLIMATE CHANGE IN SRI LANKA

1.1. Climate of Sri Lanka

Climate is one of the main determinants of agricultural productivity in Sri Lanka. Of the major climatic parameters, temperature, rainfall, and humidity are of special significance, as these cause a substantial impact on the agricultural productivity of the country. Consequently, farming systems and agronomic practices in most agricultural regions of Sri Lanka have evolved in close harmony with the prevailing climatic conditions of respective climatic regions of the island. The overwhelming scientific research has provided evidence of two general trends in Sri Lankan climate, i.e., increasing ambient temperatures resulting in more heat stress, and more frequent and severe occurrence of extreme rainfall anomalies such as droughts and floods. Both of these conditions strongly affect the crop and animal production and thus the food security in the country (Marambe et al., 2015).

Sri Lanka, an island country, is located in the low latitudes between 6° and 10° N and surrounded by the warm Indian Ocean. It shows a very typical tropical monsoonal climate, indicating hot and humid all year round with distinct wet and dry seasons. The rainfall is of multiple origins. Monsoonal, convectional, and synoptic-scale "weather systems" formed in the Bay of Bengal account for a major share of the annual rainfall. It varies from 900 mm (Southeastern lowlands) to over 5,500 mm (southwestern slopes of the Central Highlands). Sri Lanka is also at risk of cyclones and intense tropical storms, which are known to lash the island during the months of October to December. On the basis of average annual rainfall along with some other biophysical parameters, a zonal classification of Sri Lanka could be grouped into three major climatic zones as "Wet Zone" in the Southwestern region including Central Highlands of the country, "Dry Zone" covering the Northern and Eastern part of the country. These zones are separated by an "Intermediate zone," moving along the Central Highlands except in the South and the West (Marambe et al., 2015).

The spatial variation of temperature in Sri Lanka is only due to altitude and there is no temperature variation due to latitude. The mean monthly temperatures differ slightly depending on the seasonal movement of the sun, with some modifying influence caused by rainfall. In the lowlands, the mean annual temperature is 27 °C and the mean daily range is 6 °C. In the Central Highlands with altitudes up to 2,400m a cooler climate is experienced (Punyawardena, 2020).

The island is humid all over Sri-Lanka and the relative humidity is over 65% usually. In the coasts, it rises to 90% in the wetter seasons. There are dry desiccating effects due to mountain effects in the windier months and the humidity drops in the eastern region from June to September. There is a weaker desiccating effect on the western mountain slopes.

1.2. Climate Change

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term. The climate change is defined (IPCC, 2012, p. 557) as "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use." Climate change is now affecting every country on every continent. It is disrupting national economies and affecting lives, costing people, communities and countries dearly today and even more tomorrow. People are experiencing the significant impacts of climate change, which include changing weather patterns, rising sea level, and more extreme weather events. The greenhouse gas emissions from human activities are driving climate change and continue to rise. They are now at their highest levels in history. Without action, the world's average surface temperature is projected to rise over the 21st century and is likely to surpass 3 degrees Celsius this century—with some areas of the world expected to warm even more. The poorest and most vulnerable people are being affected the most (WMO, 2025).

The climate change is a global challenge that does not respect national borders. Emissions anywhere affect people everywhere. It is an issue that requires solutions that need to be coordinated at the international level and it requires international cooperation to help developing countries move

toward a low-carbon economy.

To address climate change, countries adopted the Paris Agreement at the COP21 in Paris on 12 December 2015. The Agreement entered into force less than a year later. In the agreement, all countries agreed to work to limit global temperature rise to well below 2 degrees Celsius, and given the grave risks, to strive for 1.5 degrees Celsius.

Implementation of the Paris Agreement is essential for the achievement of the Sustainable Development Goals, and provides a road-map for climate actions that will reduce emissions and build climate resilience. Human activities are the primary cause of climate change, owing to the combustion of fossil fuels such as coal, oil, and gas (Nema, et al., 2012; Letcher, 2019). Fossil fuel combustion produces greenhouse gases which serve as a wrap over the earth, trapping the sun's heat and rising temperatures. As a result of increasing emissions, the earth is currently 1.1°C warmer than it was in the late 1800s and the previous ten years (2011-2020) were the hottest in recorded history.

Intense droughts, water scarcity, devastating fires, rising sea levels, flooding, melting polar ice, catastrophic storms, and dwindling biodiversity are now among the impacts of climate change (Hitz & Smith, 2004; Tol, 2018). Human health, food production, housing, safety, and livelihoods are some of the effects of climate change (Tol, 2018).

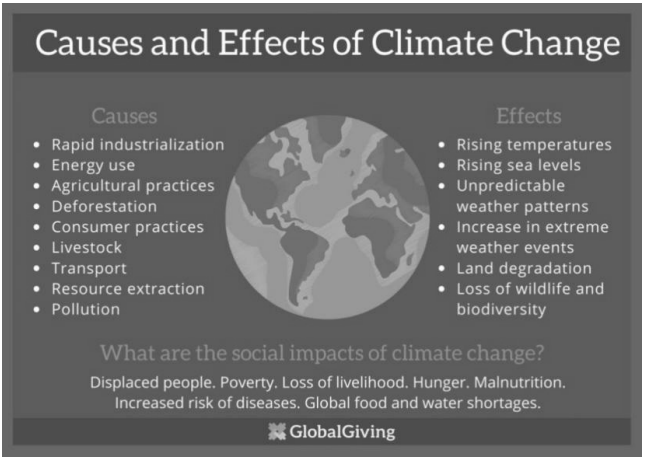
Sea-level rise and saltwater intrusion have forced entire communities for migration and become the cause for prolonged drought which subsequently led people at risk of hunger (IPCC, 2020). The number of "climate refugees" is anticipated to grow significantly. People living in small island nations and other underdeveloped countries, like Sri Lanka, are already more sensitive to climate change (IPCC, 2021). According to the 2021 INFORM Risk Index, Sri Lanka experiences a high catastrophe risk of climate-induced hazards, ranking 89th out of 191 nations (European Union, 2021).

1.3. Climate Change Impact at Global Level

Now it has been fully realized that the climate change is real and human activities are the main cause. According to the International Panel for Climate Change (IPCC, 2023) the concentration of greenhouse gases (GHGs) in the earth’s atmosphere is directly responsible for the increased average global temperature on Earth. Since the time of the industrial

revolution, the GHG concentration has been rising up steadily, and consequently the global temperatures have been increasing. The most abundant GHG, accounting for about two-thirds of greenhouse gases, carbon dioxide (CO_2), is largely the product of burning fossil fuels and vegetation. Methane, the primary component of natural gas, is responsible for more than 25 % of the warming we are experiencing today. It is a powerful pollutant with a global warming potential over eighty times greater than CO_2 during the 20 years after it is released into the atmosphere.

Impacts of a 1.1^0C global atmospheric temperature increase are here today in the increased frequency and magnitude of extreme weather events from heat waves, droughts, flooding, winter storms, hurricanes and wildfires. The global average temperature in 2019 was 1.1^0C above the pre-industrial period. The year 2019 concluded a decade of exceptional global heat, retreating ice and record sea levels driven by greenhouse gases produced by human activities. 30 per cent of the world's population is exposed to deadly heat waves more than 20 days a year (UNEP, 2021). The global mean near-surface temperature in 2023 was 1.45 ± 0.12 °C above the pre-industrial 1850–1900 average. Average temperatures for the five-year (2015-2019) and ten-year (2010-2019) periods are the highest on record. The year 2023 was the warmest year in the 174-year observational record (WMO, 2024). Causes and effects of climate change are well illustrated in Fig. 1.1.

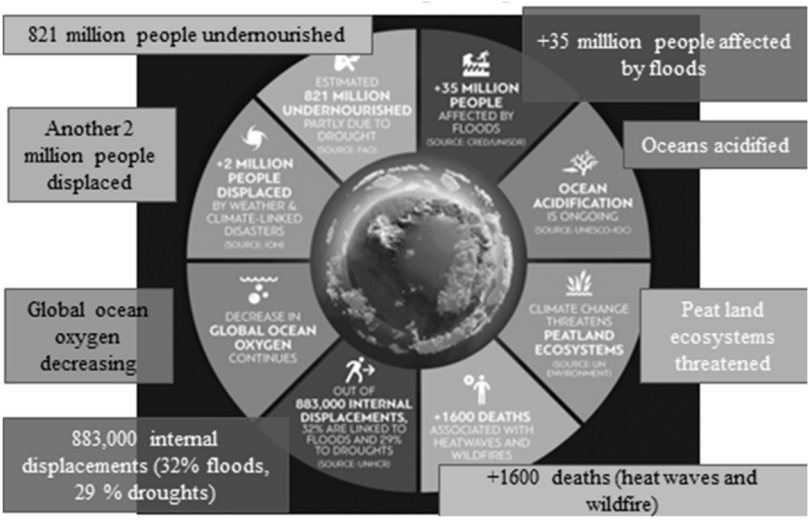


Source: Jeno Trashan, (2023).

Fig. 1.1. Causes and Effects of Climate Change

State of the Climate in 2018 shows accelerating climate change impacts (Fig. 1.2). These impacts include:

i. More than 35 million people were affected by floods;
ii. Oceans are acidified;
iii. Peat land ecosystems are threatened;
iv. More than 1600 deaths were reported due to heat waves and wildfire;
v. internal displacements were taken place for 883,000 persons (32% floods, 29 % droughts;
vi. Another 2 million people were displaced due to weather and climate linked disasters;
vii. Global ocean oxygen level is decreasing continuously; and
viii. About 821 million people are undernourished partly due to drought



Source: WMO, 2019

Fig. 1.2. State of the climate in 2018

The year 2019 was the second hottest year on record. Observed concentrations of the three main greenhouse gases i.e. CO_2, CH_4, and N_2O reached record levels in 2022. Real-time data from specific locations show a continued increase in 2023. CO_2 levels are 50 % higher than the pre-industrial era, trapping heat in the atmosphere. The long lifetime of CO_2

means that temperatures will continue to rise for many years to come.

1.4. Climate Change Impact in Sri Lanka

Climate change is significantly impacting Sri Lanka, leading to increased frequency and intensity of natural disasters like floods, droughts, and landslides, as well as sea level rise and changing rainfall patterns. These changes threaten livelihoods, especially in agriculture, and impact human health and infrastructure (Ministry of Mahaweli Development and Environment, 2016). The most critical impacts are briefed below.

- Impacts on Agriculture - The Dry Zone, crucial for Sri Lanka's rice production, is experiencing more frequent and severe droughts, impacting crop yields and food security.
- Coastal Areas - Sea level rise and storm surges are causing saline intrusion and inundating coastal lands, impacting livelihoods and infrastructure.
- Water Resources - Climate variability leads to unpredictable rainfall, affecting water availability and increasing the risk of water-related diseases like kidney disease.
- Extreme Weather Events - Increased frequency and intensity of extreme precipitation events can cause flooding, landslides, and other damage to infrastructure and human settlements.
- Human Health - Climate change can worsen air and water quality, increase the spread of diseases like dengue and diarrhoea, and alter the frequency or intensity of extreme weather events impacting human health.
- Biodiversity - Rising ocean temperatures and increasing salinity reduce marine biodiversity around Sri Lanka, further impacting coastal communities.
- Vulnerability - Vulnerable populations, including small-scale farmers, women, and youth, are particularly at risk from the impacts of climate change.

Sri Lanka is extremely susceptible to climate change due to its high temperatures, unique and complicated hydrological regime, and susceptibility to catastrophic climate events (World Bank Group, 2020). The Ministry of Environment (MOE) submitted its Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) in 2012, highlighting critical vulnerabilities in the agriculture and water resources sectors and substantial risk to human health and coastal regions

(MOE, 2011). The identified risks and vulnerabilities are discussed under section 1.2.3, emphasizing livelihoods and human settlements. Sri Lanka has an increased risk of tsunamis, cyclones and floods including riverine and flash flooding, while drought is a moderate threat. Nevertheless, heatwaves, droughts, floods, cyclones, and coastal erosion are significant natural hazards induced by direct and indirect consequences of climate change that profoundly impact agriculture, livestock, fishery, and other sectors of the country. The overall impacts of climate change fall under three broad categories; physical impacts, transition impacts, and liability risks (Samaraweera et al., 2024).

Physical Impacts - These include direct consequences of climate change like rising temperatures, more frequent and intense heat waves, droughts, floods, and sea-level rise. These changes can lead to damage to infrastructure, disruptions to ecosystems, and impacts on agriculture and human health.

Transition Impacts - These refer to the economic and social adjustments required to move towards a low-carbon economy. This includes changes in policy, technology, and consumer behavior, as well as potential job losses in some sectors and new opportunities in others.

Liability Risks - These arise from the potential legal and financial consequences of climate change impacts, such as lawsuits related to damage caused by extreme weather events or the failure to mitigate climate change.

Rapid-Onset Events - Rapid-onset climate change events refer to sudden and extreme climate events that severely impact on society and the environment (IPCC, 2012, p. 556). These events can occur over a relatively short period, ranging from hours to weeks, and are often associated with extreme weather phenomena, such as cyclones, landslides, floods, and extreme temperatures.

Floods - Sri Lanka comprises 103 river basins with five major rivers (Mahaweli, Kelani, Kalu, Gin, and Nilwala) flowing across the country and is responsible for yearly floods (Surasinghe et al., 2019). According to Dasandara et al. (2022), multiple types of flooding are prominent in Sri Lanka. River flooding, flash (or pluvial) flooding, and coastal flooding are the three main types of flood events. Floods have known strong links with other vulnerabilities such as landslides and disease transmission, in addition to their direct repercussions, deaths, injuries, and property

damages. Major floods occurred in Sri Lanka in 1907, 1913, 1940, 1947, 1957, 1967, 1968, 1978, 1989, 1992, 2003, and 2017 resulting in significant human casualties (Wickramaratne, et al., 2012; MONPEA, 2017).

For instance, the floods of May 2017 wreaked havoc on towns, villages, and agricultural areas along the riverbanks of the Kalu, Nilwala, and Gin rivers, as well as their tributaries.

Water levels in certain regions rose to 6 meters and stayed there for 4 to 10 days, damaging urban and rural houses, small and medium businesses, micro (mainly informal) businesses, education and health facilities, as well as governmental and private infrastructure (MONPEA, 2017). Floods in 2017 underlined the growing impact of climate-related catastrophes in Sri Lanka which is compounded by unplanned human development. Floods afflicted 64 percent of Sri Lanka's population between 2005 and 2015 (MONPEA, 2017). Since 2011, high-impact disasters have occurred regularly, yearly affecting an average of over 1 million people. According to the United Nations Office for Disaster Risk Reduction (UNDRR), floods are the primary cause of Sri Lanka's annual disaster-related losses, averaging USD 140 million (World Bank Group, 2020).

These impacts are projected to rise due to development and climate change (MONPEA, 2017; World Bank Group, 2020). The situation is anticipated to raise the annual number of vulnerable people by 26,000 persons and the yearly GDP by USD 338 million by the 2030s (World Bank Group, 2020). Table 1.1. exhibits the estimated number of people impacted by extreme river flooding in Sri Lanka from 1971 to 2004 and in the future from 2035 to 2044.

Table 1.1: Estimated Number of People Impacted by Extreme River Flooding in Sri Lanka

Estimate	Population Exposed to Extreme Flood		
	(1971–2004)	**(2035–2044)**	**Increase**
16.7 Per centile	385,942	943,081	557,139
Median	930,866	1,111,418	180,552
83.3 Per centile	1,105,180	1,179,366	74,186

Source: World Bank Group (2020)

The country has been warmed by approximately 0.8°C over the twentieth century, positioning it among the world's hottest countries (Carbon Brief,

2018). Rainfall varies widely, from 900 mm in the driest regions to 5000 mm in the wettest, largely due to monsoonal patterns influenced by El Niño and La Niña events, which affect monsoon cycle of the Indian Ocean and subsequently, precipitation and temperature of Sri Lanka (Alahacoon & Edirisinghe, 2021).

1.5. Impact on Agriculture and Food Security

Sri Lanka has been rated 66th among 113 countries on the Global Food Security Index (2019) with the FAO estimate of 4.1 million people (more than 25% of the population) who lack access to adequate food to live healthy lives (MOE, 2021). The agriculture contributes around 8 % of GDP and about 21 % of export revenues (CBSL, 2020). Food security, livelihoods, and export income are already being threatened by climate change. Climate change-induced alterations in prevailing precipitation patterns, rising ambient temperatures, and extreme weather events have unprecedented impacts on the domestic agricultural sector and food security (Esham, et al., 2018). Rainfall periodicity is the most crucial factor determining the food crop growth performance. Since most plantation crops (tea, rubber, coconut etc.) are perennials grown in wetland areas, the seasonality of rainfall is not a great issue (Esham & Garforth, 2013). However, seasonal crops necessitate planning all farming operations around seasonal rainfall availability (Marambe, et al., 2015).

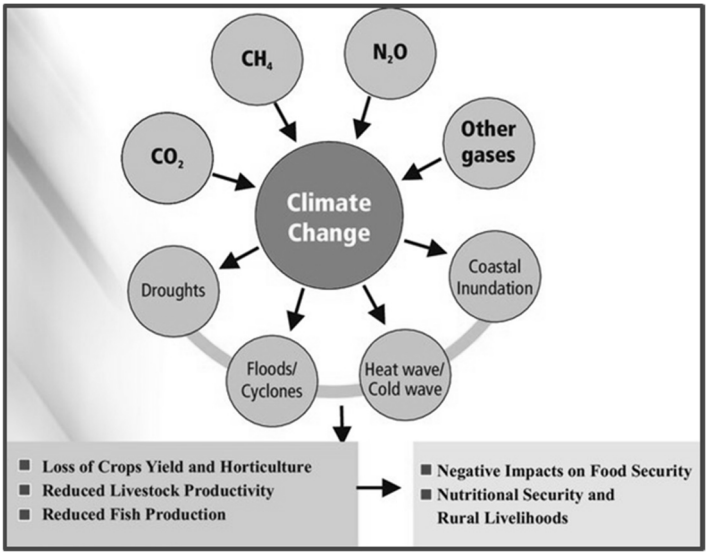
Variation of the rainfall patterns affects the flowering of crops while minimizing the pasture availability for livestock (Giridhar & Samireddypalle, 2015). Frequent occurrence of intensive rainfalls with high cloud cover and increased frequency and severity of floods leads to drainage and water-logging problems, increased soil erosion, and increased susceptibility of crops and livestock to flood hazards. Floods impacted more than one million farmers in 2016 and 2017 in Sri Lanka (MOE, 2021). These could cause reduction of crop, livestock and fishery productivity. For example in 2019, the contribution of the livestock industry to GDP was about 1% (CBSL, 2020). In addition, the frequency of extreme weather events like cyclones and heavy winds is likely to rise with climate change (Mirza, 2011). Therefore, it would reduce marine fish yields while damaging inland crop cultivations and livestock holdings (Thadshayini, et al., 2020). It is noteworthy that the marine and coastal fisheries account for 80 % of the fish harvest, 2.4 million direct and indirect jobs, and 70 % of the population's animal protein intake (MOE, 2021). On the other hand, the livelihoods based on coastal habitats are

adversely affected by the climate change induced losses (Gopalakrishnan & Kumar, 2020). For instance, climate change stimulated ocean acidification and physio-chemical changes in oceanic environments, damaging coral reefs and accelerating structural changes within marine habitats and species composition (MOE, 2021). High sea surface temperatures (3-5° C above normal) during the 1998 El Niño have destroyed coral reefs in the Bar Reef marine reserve by 95 %, Hikkaduwa marine sanctuary by 90 %, Weligama by 60 %, and Rumassala marine sanctuary by 80 % (MOE, 2021). As a result, the reef fish stock and the stock of economically important species change inflicting detrimental consequences on fishers' livelihoods. In a recent evaluation in Sri Lanka, shrimp aquaculture on the North-west coast was found susceptible to the impacts of climate change (MOE, 2021). Changes in temperature, droughts, precipitation, run-off and floods on freshwater ecosystems pose a hazard to inland fisheries (Pushpalatha, 2022). Reduced rainfall during the North-east Monsoon would exacerbate the threat to inland fisheries (Patrick, 2016).

Sri Lanka is experiencing an increasing trend in the day and night ambient temperatures (Mattssona et al., 2015; World Bank Group, 2020). Increased day and night temperatures combined with wind speed escalate the evapotranspiration of grown crops (Fig. 1.3). Further with the regular and extended dry spells and increased frequency and severity of droughts, the crops and livestock exhibit a significant susceptibility to heat stress (Marambe et al., 2015). The phenomenon escalates the water stress on crops and animals by reducing water in reservoirs and groundwater sources (Eriyagama et al., 2010). With high evapotranspiration levels, the soil moisture is significantly reduced while the salinity increases, minimizing the soil quality. The impact of rising night-time mean temperature on rice output is substantial (Esham & Garforth, 2013). In a study conducted at the International Rice Research Institute, paddy output decreased by 10 percent in the dry season for every 18°C increase in growing season low temperature (Peng et al., 2004).

Reduction and uncertainty of rainfall can have an impact on crop productivity and the cropping calendar. In Sri Lanka, shorter agricultural seasons are frequent due to the delayed onset of monsoon (Senalankadhikara & Manawadu, 2009). These impacts ultimately lead to regular crop losses and a decline in expected outputs of crops, livestock, and fishery stock in reservoirs (Marambe et al., 2015). Notably, most of the dry zone farmers rely on water reservoirs, rainfall or agro wells for irrigation (Senaratne & Scarborough, 2011). According to government

estimates, extended drought and floods in 2016 and 2017 interrupted two rice production cycles, affecting over 2 million people, limiting economic growth, and increasing food inflation (ADB, 2019). Further, the alterations of thermal ranges for biological organisms (pests, pathogens, parasites, vectors) increase the risks of pest and disease attacks on crops and livestock (Shahzad & Ullah, 2021). Hence, the costs of health management of livestock and plant protection rise for farmers and livestock holders (Gunaratne, et al., 2021). Dairy is the most significant and vulnerable to climate change (MOE, 2021). Increased sensitivity to temperature and humidity changes might result from the intensification of dairy systems in arid regions employing temperate breeds. In most sections of the Dry Zone, the Temperature Humidity Index is expected to be more than 72 units in 2030, and heat stress will be harmful to the sector if temperate breeds are utilized (MOE, 2021).



Source: Srinivasrao Ch., 2020

Fig. 1.3. Climate change impact on agriculture

Paddy, tea, and coconut, the primary crops grown in Sri Lanka, are extremely susceptible to changes in temperature and precipitation (Peiris, et al., 2004). Tea yields in 2020 fell to a 30-year low due to persistent drought in tea-growing regions (MOE, 2021). Thus, it is expected that both plantation and non-plantation crops will be affected by climate

change. Climate change will have a greater impact on small scale non-plantation agriculture since the vast majority of farmers are small holders who mostly produce rice (Esham & Garforth, 2013). In the growing regions, coconut output is also sensitive to rainfall and dry spells (Peiris et al., 2008). Changes in monsoon rainfall patterns and increases in maximum air temperature are two significant variables impacting the variability of coconut output in the major coconut growing regions (Peiris et al., 2004). When other external variables are not restricted, projected coconut output after 2040 will not be sufficient to meet local demand (Peiris et al., 2004). The country's agricultural production and export earnings are supported by these paddy yields and coconut plantations that extend outside the coastal area (Savundranayagam et al., 1994). The climate change-induced sea level rise leads to the inundation of low-lying coastal regions wherein the enhanced saltwater intrusion increases soil and water salinity while damaging coastal habitats and food systems (Gopalakrishnan & Kumar, 2020). Hence, the salinity development of coastal agricultural lands declines the agricultural productivity in coastal areas (Gopalakrishnan & Kumar, 2020). The farmlands with high salinity levels are no longer productive; hence, the extent of the arable land area is reduced in coastal regions (Marambe, et al., 2015).

Consequently, the impacts of climate change raise severe socioeconomic issues among affected communities (Menike & Arachchi, 2016). With declining agricultural production, productivity, arable extent, and increased cost of production, the expected income and profitability of local farmers, livestock holders and fishers are drastically reduced and, on many occasions, would lead to loss of livelihood opportunities (Esham & Garforth, 2013) driving affected communities to seek alternative livelihood opportunities outside their villages (Esham, et al., 2018). The employed population in agriculture declined annually by an average of 1.15 % during 2013-2019. It means that about 90,000 people yearly leave agriculture sector in Sri Lanka (Samaraweera, et al., 2024).

The cumulative impacts of climate change and the subsequent decline in paddy yields are expected to fall by 12 % to 19 % in the *maha* season and 27 % to 41 % in the *yala* season by 2060s (World Bank Group, 2020). In the setting of a strong local reliance on rice, this is expected to raise poverty rates by 12–26 %. Other main crops, such as coconut, tea, and rubber are also very sensitive to temperature and precipitation fluctuation, according to Esham and Garforth (2013) with higher temperatures and times of low rainfall posing significant risks. As far as the livelihoods of fishers are concerned, coastal shelf fisheries on which many households

rely, are likely

to be restructured as a result of rising temperatures and ocean acidification. According to Barange et al. (2014), Sri Lanka is one of the most vulnerable countries on the planet with a projected 20 % reduction in fish harvest owing to climate change by the 2050s (Barange, et al., 2014). In the lack of external support, farmers are adapting locally to climate impacts on their own initiative. These activities are linked to income diversification and migration in search of off-farm employment (Esham & Garforth, 2013).

1.6. Impacts on Environment

Sri Lanka is a biodiversity hot spot. It has 480 bird species (25 endemic) and 121 amphibious species (88 endemic). The biodiversity of the island is affected by following factors:

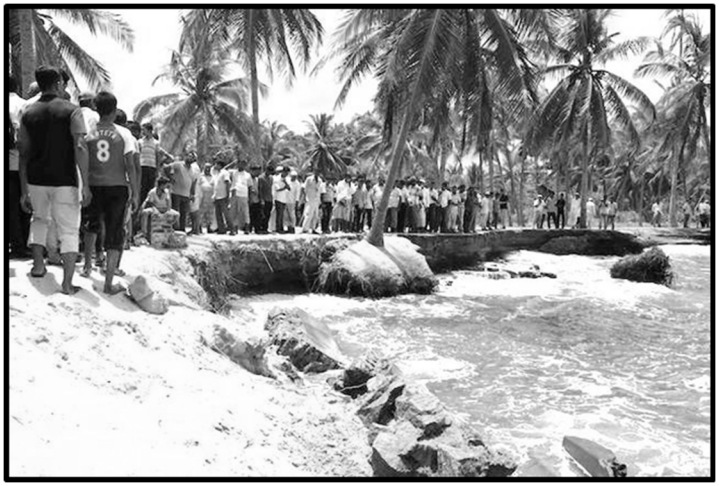
- Temperature and weather changes – A general increase in temperature trends 0.16^0C has been traced over the years of 1961–1990 with the highest increase of minimum temperature in Nuwara Eliya by 2.0^0C per decade. A vast difference is traced in rising temperatures as the 100 year warming trend from 1896 to 1996 is only 0.003^0C per year, meanwhile the 10 year temperature trend from 1987 to 1996 is already 0.025^0C per year. This indicates that the warming trend is accelerating. According to scientists this is due to the increase in the global GHG as well as the rapid urbanization causing the local heat effect (Eriyagama et al., 2010). The mean annual temperature in the country is expected to increase in the near future (2030), and to possibly increase even more in the years surrounding 2050.
- Extreme weather events – Sri Lanka possesses significant differences in climate across variations in topography. The Northwest region has an annual average rainfall of less than 1000 mm, while the Southwest central hills above 5000 mm. And due to the seasonal variations and topography, the country is divided into 3 zones: wet, intermediate, and dry. Even though rain helps in supporting the biodiversity of the dense forests covering around 30% of the country, however, the process of deforestation in wet areas contributes to erosion and dangerous landslides (USAID, 2018) (Fig. 1.4).

Fig. 1.4. Landslides in Sri Lanka (NBRO, 2017)

- Floods and Droughts - Cyclical pattern of floods and droughts is prompting people to stress and making it difficult for them to cope with their lives. Heavy rain on the other hand, in Western and Southern regions, leads to major landslides thus killing more than 500 people and affecting 1.3 million in 2016–2017. Water and vector-borne illnesses can be a direct effect of severe flooding, which can make it even more difficult to maintain sanitation. More than 6 million people have been affected by the drought in the past 30 years. Ironically, in Sri Lanka the number of consecutive wet days decreases while the number of consecutive dry days increased.
- Winds and other storms – As for cyclones, the severity has been recorded to be moderate during the past experience. In the months of November and December the Northern region of the county is affected by them. However, for the future surrounding the year 2050, an accelerated risk of coastal disasters is estimated. For instance, an expected increase of 10-20% in tropical cyclone intensities is triggered by a rise in sea surface temperature, amplification of storm surge heights, and low pressures with tropical storms.
- Sea level rise – Sea level rise is another expected consequence of climate change in Sri Lanka's coastal zone in the 21st century. The tidal gauge data of Colombo seasonally adjusted from 2006 to 2017 shows increase in sea level at a rate of 0.288 ± 0.118 mm/month. In the next 50 years, sea level is expected to rise by about 0.1 m – 0.2 m (Palamakumbure et al (2020). 25% of the population resides in vulnerable to sea level areas (within 1 km of the coast). It is

expected that rising sea levels and storm surges erode shorelines, degrade the health of coastal ecosystems, and potentially displace coastal populations (Fig. 1.5).

- Mangroves and other forms of coastal shrubs and vegetation offer protect shores and reduce vulnerability to tsunamis and cyclones, but only less than one-third of the island is protected by them. Sri Lankan authorities have realized the benefits of coastal vegetation, but more efforts to restore these shrubs and harden unprotected coastlines may be needed. Sea levels could rise by 0.13 meters and up to 0.4 meters by 2030 estimated a linear interpolation of end of century global sea level estimated. Meanwhile, a linear interpolation of end of century global sea level by 2050 is speculated to rise by 0.2 meters and up to 0.58 meters. Thus, in turns, inundation is expected to reach approximately to 41 square km for a rise of 0.3 meters, and 91 km2 for a rise of 1 meter for lowlands along the coastal lines.



Source: Vositha Wijenayake, 2015

Fig. 1.5. Coastal erosion due to sea level rise in Sri Lanka

- Water resources – Climate change threatens both surface water and groundwater sources upon which Sri Lankans depend for domestic use, agriculture, energy generation and industry. The availability of drinking water is the main concern. Nevertheless, increased droughts along with salt water intrusion into coastal aquifers are

expected to seriously deplete freshwater availability. Due to the increased economic activity a high level of groundwater extraction and pollution of existing resources occurs (USAID, 2018).

1.7. Impact on Tourism

Tourism activities are also inherently vulnerable to harsh environmental conditions brought on by drought and floods. Tourism has always been a healthy industry, but these climate hazards will increasingly threaten the ability to provide visitors with a safe and attractive destination. Climate change impacts the tourism industry (Filho, 2021) in many ways, including:

i. Uncomfortable temperatures – High temperatures make outdoor activities uncomfortable for tourists, especially for the elderly, children, and people with medical conditions;
ii. Increased risk of fires – Climate change increases the risk of fires, which can disrupt travel plans and endanger visitors;
iii. Rising sea levels – Rising sea levels and more intense storms threaten beach tourism and infrastructure;
iv. Threats to biodiversity – Climate change accelerates habitat loss, which can impact ecotourism and diminish the appeal of affected regions;
v. Water scarcity – Changing precipitation patterns and increased water demands can lead to water scarcity, which can impact water-dependent activities like swimming, boating, and fishing;
vi. Disrupted travel plans – More frequent and severe weather events, such as hurricanes and heat waves, can disrupt travel plans and infrastructure; and
vii. Economic losses – Extreme weather events can result in economic losses for tourism-dependent communities.

1.8. Impacts on Infrastructure and Livelihoods

These climate stressors immediately have a long-term effect on communities, specifically the damage on local infra-structure and households. Post-disaster poverty, lack of job opportunities, low school attendance and high risk of drop outs is usually evident in districts hit by floods and droughts. This makes Sri Lanka in the front line of war against child labour.