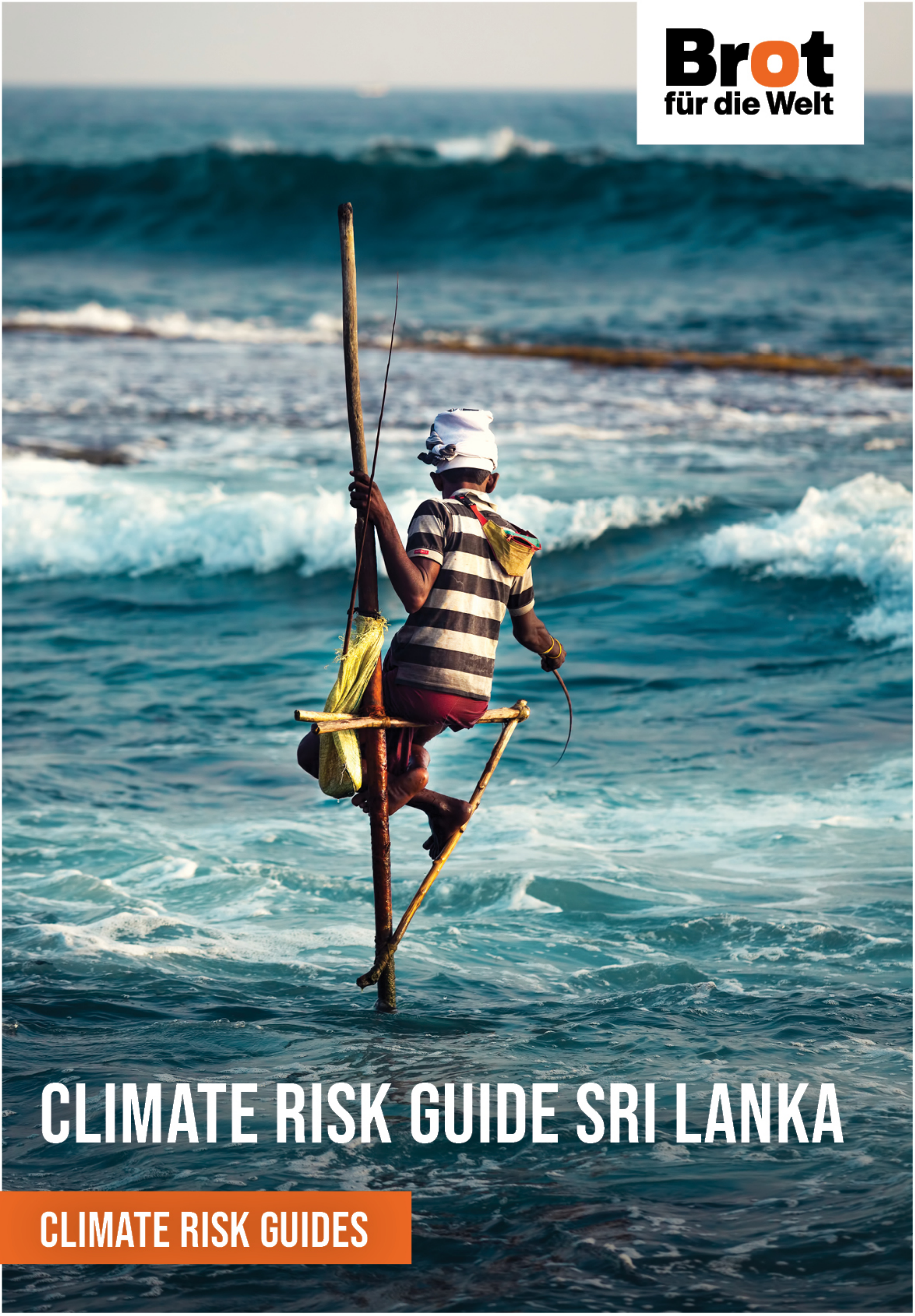
Brot für die Welt



CLIMATE RISK GUIDE SRI LANKA

CLIMATE RISK GUIDES

IMPRINT

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Abbreviations

CO2	Carbon dioxide
CO2eq (tCO2eqq)	CO2-equivalent emissions, usually measured in metric tonnes
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution (the climate pledge of states)
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

The climate is no longer a relatively stable system. It is changing more and more rapidly due to rising emissions of greenhouse gases by us humans. Yet many of these changes are dynamic. This means that climate observations from the past only help us to a limited extent to predict the effects of climate change in the future. This means that traditional coping capacities are increasingly reaching their limits. In addition, some of the potential damages of climate change are so severe, or are about to become so severe, that they exceed the limits of adaptive capacity and therefore need to be covered separately, for example through climate risk insurance.

For these reasons, climate change cannot be ignored when planning projects and programmes. Understanding the climatic conditions in a project region and developing an idea of

- how they might change in the near future,
- what the potential hazards are,
- how vulnerable the project is to them,
- and what the resulting risks are for the achievement of the project objectives, but also for the target groups and the region as a whole

are indispensable foundations of good project and programme planning.

Climate proofing of projects in the concept note development phase is an important part of the application process. If it turns out that projects are particularly climate-sensitive, further steps such as conducting a climate risk analysis are required.

This publication is intended to help with these steps. It is aimed primarily at the staff of Bread for the World and our partner organisations, but also at other interested parties.

In this publication we present the key characteristics of the three main climatic zones of Sri Lanka. We briefly show the trends for the most important climatic parameters for the coming decades for them, taking into account different scenarios in combating climate change. Based on this, we develop a climate risk profile for each of the three zones with hazard potentials, vulnerabilities and resulting specific risks.

This is supplemented by a brief introduction to the most important climatological terms and the elementary principles of climate change, as well as a concluding brief overview of the basics of climate adaptation and a further reading list.

The study of this publication is not a substitute for a deeper examination of the specific climate-related issues in the course of project planning, but it can provide an introduction or a general overview of the challenges of climate change for the different provinces of Sri Lanka.

We hope you enjoy reading!

A Short Guide to Climate and Climate Change

Climate

The **climate** is a long-term pattern of average weather (at least 30 years) in a particular area. Therefore, the climate does not describe the current weather but an average calculation. The climate consists of several variables, such as temperature, precipitation and wind.[1]

The **mean temperature** is defined as the average of minimum and maximum temperature of a year.

Precipitation is expressed in millimetres. One millimetre of precipitation means 1 litre of precipitation on one square meter.

Both precipitation and temperature are shown in a **climate diagram**. The months from January to December are shown on the horizontal axis. The respective temperature at a specific time of the year can be read on the left vertical axis. The red graph shows the maximum temperature, i.e. the maximum temperature in April was 32,36 degrees Celsius. The orange graph shows the average temperature. The minimum temperature is shown in yellow. On the right horizontal axis the precipitation can be read. The precipitation is shown in the diagram as a light blue bar.

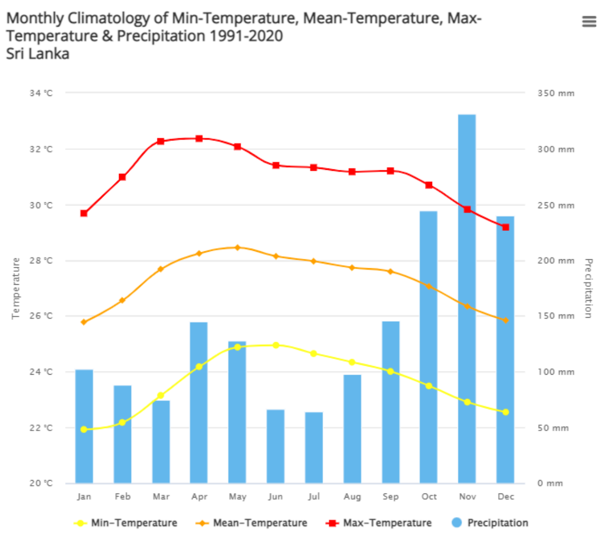

Figure 1: Climate diagram from Sri Lanka. Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical

[1] Intergovernmental Panel on Climate Change (IPCC).Link: https://www.ipcc.ch/sr15/chapter/glossary/.

The **global climate system** is an interactive complex system consisting of five main components. The atmosphere, the oceans, the cryosphere, the land surface and the biosphere. The primary energy source for the climate system is the sun. The way how these components interact at a specific location determines its climate. This is why the climate varies from region to region. The world can be divided in different **climate zones**.

The climate zoning of the world according to the **Koeppen-Geiger climate classification** is based on temperature and precipitation and divides climates in five main climate groups: A tropical, B dry, C temperate, D continental, E polar climate. To further differentiate the 5 main climates, there are further classification options, which describe for example whether the region is a rainforest or a tundra region. Lastly, there is the possibility to further differentiate according to the temperatures in winter and summer. In total, there are 31 possibilities for the assignment of a climate zone for a region.

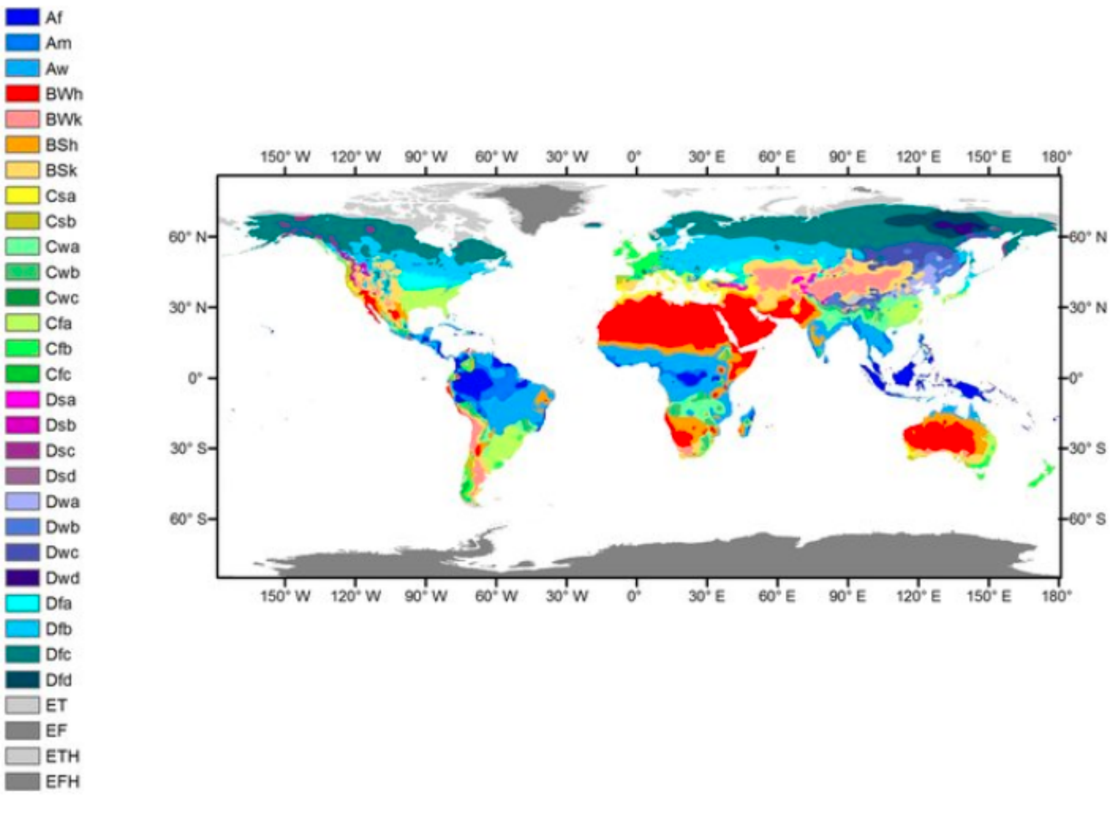

Figure 2: The Koeppen-Geiger climate classification global map. Source: https://doi.org/10.5194/hess-11-1633-2007

The **atmosphere** is the most important component of the climate system. Figure 3 shows the **earth's energy budget** and the influence of the atmosphere on radiation, serving as a filter, or protection shield: Incoming solar radiation is partly reflected by the atmosphere, partly absorbed by it, partly absorbed by the earth surface, and partly reflected by earth. Carbon dioxide and other greenhouse gases, that are part of the atmosphere, play a crucial role for energy budget. Their increase due to man-made emissions in terms of atmospheric concentration causes global warming.

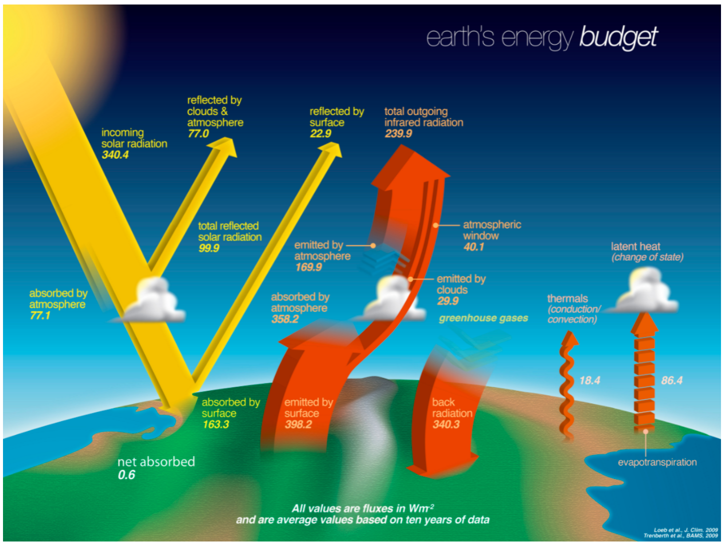

Figure 3: The energy budget of the earth. Source: NASA Link:
https://www.nasa.gov/sites/default/files/thumbnails/image/ceres-poster-011-v2.jpg

The **hydrosphere** includes all liquid surfaces, i.e. fresh water, such as in rivers or lakes, and salt water in seas. Energy, or heat, is not only moved in the atmosphere from places with an energy surplus to places with an energy deficit, but also in oceans, in form of currents. These balancing movements follow the first law of thermodynamics. Furthermore, oceans are important carbon sinks, i.e. they store large amounts of carbon dioxide, and thus, help to mitigate climate change.

The **cryosphere** contains water in solid form, including ice sheets in Greenland and Antarctica, glaciers, permafrost (permanently frozen soils) and snow-covered areas. Important for the climate is the high reflective capacity (albedo) of snow- and ice-covered surfaces. With less ice-coverage, global warming would accelerate significantly.

The **land surface**, especially soils and vegetation, plays an important role in evaporation. In areas such as the tropics, evaporation plays a major role due to high temperatures and the availability of water. Thus, tropical landscapes, especially forests, can produce their own rainfall. The topography, especially the relief, is an important shaping the climate, too. Mountains can serve as effective barriers between different climate zones. Topography is also important for wind systems. The more fissured the surface of the earth is, the more the climate differs, even on a small scale.

The **biosphere**, both terrestrial and marine, has a significant impact on the greenhouse effect. Marine and terrestrial plants, especially forests, can store a large amount of carbon dioxide.

Climate change

The **United Nations Framework Convention on Climate Change (UN-FCCC)**, in its Article 1, defines climate change as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (IPCC).[2]

CO2 released from burning fossil fuels to generate electricity, heat and air conditioning is the main source of **GHG (greenhouse gas) emissions**, followed by CO2, nitrous oxide and methane emissions originating from agriculture, deforestation and other land-use changes. Industries, transportation, construction and the waste sector are the other economic sectors that cause global warming. What are the most emission-intense sectors vary from country to country. In developing countries, agriculture and land-use changes tend to cause most of the national emissions, while the energy sector tends to be the most emission-intense in emerging economies and developed nations. The common goal for all is to achieve GHG neutrality by 2050 – and even 5-10 years earlier in rich nations. Decarbonisation pathways will be as different as current emission profiles. Achieving carbon neutrality requires huge investments, a system change to a circular economy, and international collaboration.

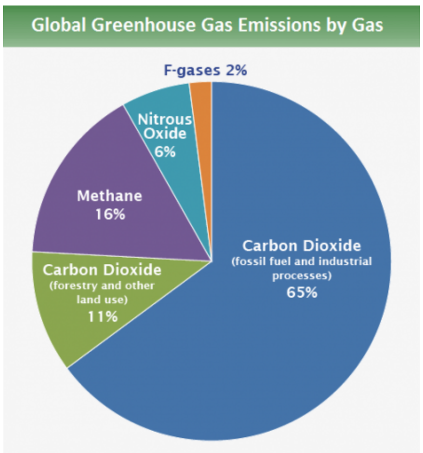

Figure 4: Global greenhouse gas emissions by gas source: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

2 https://www.ipcc.ch/sr15/chapter/glossary/

Greenhouse gas effect: Greenhouse gases effectively trap the sun's warmth in the lower atmosphere, where they allow shortwave solar radiation to enter the atmosphere but block the long-wave radiation reflected from earth. Since the beginning of the industrial revolution, the concentration of carbon dioxide in the atmosphere has risen by almost 50%, first slowly and then increasingly faster since the 1990s, from 280 parts per million (ppm) in 1880 to 418 ppm in May 2021. In 2019, annual manmade GHG emissions totalled 43 billion tons.

Climate change impacts: Rising temperatures melt the ice, including glaciers, Arctic sea ice and ice sheets in Greenland and Antarctica. The melting of this ice causes the sea level to rise. Coastlines can therefore change as a result of **sea level rise**. Due to climate change, **extreme weather events** are intensified by the consequences of climate change, for instance more frequent and more extreme storms; mid-latitude and tropical extreme rainfalls and flooding, particularly in Asia; and severe drought and crop failure. These impacts have a huge potential to undo development successes.

Since 1980, losses caused by climate extremes have quadrupled. Most at risk are vulnerable, predominantly rural populations whose livelihoods depend on intact ecosystems, as in agriculture, forestry and fisheries sectors. How threatening the risk is can be seen in the warning of the insurer Swiss Re Group that 50% of global GDP is in peril, as climate change puts 20% of the world's countries at the risk of ecosystem collapse.

A better world is still possible, if strong and effective climate action is taken now. The IPCC Special Report on Global Warming of 1.5°C (2018)[3] analysed the change needed to avoid a climate catastrophe: halve global carbon dioxide (CO_2) emissions by 2030; immediately switch investments from fossil to renewable energies, achieving 100% renewable energy supply within 15-20 years; turn soils, agrarian land and forests from greenhouse gas emission sources to sinks; and, finally, achieve carbon neutrality, i.e. global net zero emissions by 2050.

[3] https://www.ipcc.ch/sr15/

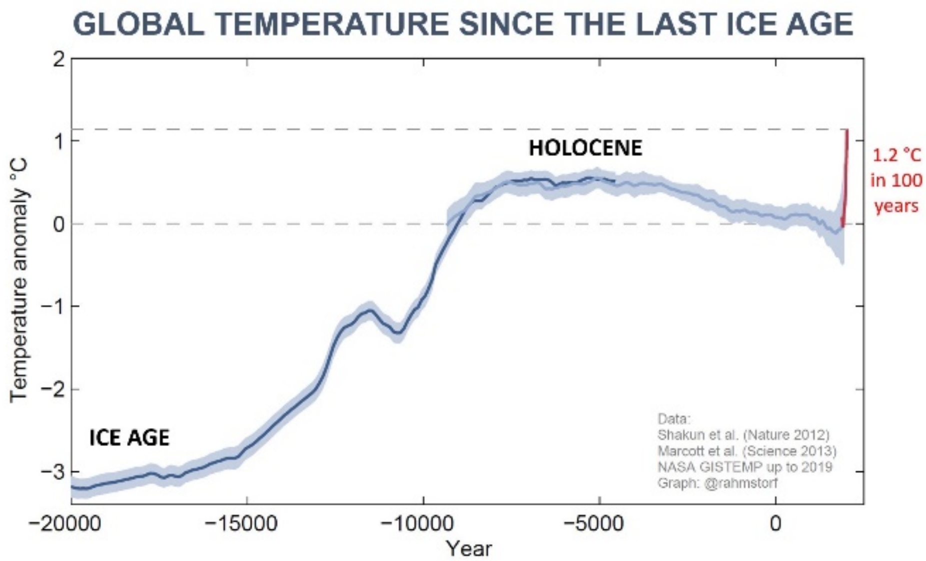

Figure 5: Global temperature rise

The future we get is defined by **climate action** in the 2020s. Only through limiting global warming to 1.5°C global temperature rise can we prevent massive burdens falling on current and future generations. It is incumbent to take ambitious and structured climate actions in all aspects of work. As a first step, a program could calculate its current GHG emissions. A carbon footprint calculator can be found at: https://www.carbonfootprint.com/calculator.aspx

The Climate of Sri Lanka

In this publication, we present the key characteristics of the three main climatic zones of Sri Lanka.

Climatic Zone	**Provinces**
Wet Zone	Southern, Western, Central, Sabaragamuwa
Intermediate Zone	Uva, northern, eastern and southern part of North Western
Dry Zone	Northern, North Central, Eastern and northern part of North Western

Table 1: Sri Lanka's climatic zones and the corresponding provinces. Source: World Bank 2014

The climate in Sri Lanka is tropical. The average annual temperature is between 27 and 28(°C) With a very high average annual temperature of up to 30 degrees, Sri Lanka is one of the hottest countries in the world. The temperature range is between 16°C in the central highlands and 38°C on the north-eastern coast.[4]

Our climate projections show the climate anomalies as compared to the reference period 1995 – 2014. The climate projections are based on climate model data from the Coupled Model Inter-comparison Project 6 (CMIP6), overseen by the World Climate Research Program and building the data foundation of the IPCC 6th Assessment Report (IPCC 2021). This set of climate model data is used to project the future climate in different scenarios of future emission development, as a combined result of different mitigation efforts and pathways of socio-economic development. These scenarios are called Shared Socioeconomic Pathways (SSPs). So far, five of them have been developed:[5]

- SSP 1, the sustainability pathway, allowing to limit global warming well below 1.5°C; 2 sub-scenarios
- SSP2, a middle-of-the-road scenario of decisive but delayed climate action, leading to around 2.5°C temperature increase;
- SSP3, a scenario of delayed action, characterized by regional rivalry, leading to around 3.5°C temperature increase;
- SSP4, another scenario of delayed climate action, characterized by increasing inequality, leading to around 3°C temperature increase

[4] Ross, Russell R, Andrea Matles Savada, Library Of Congress. Federal Research Division, and Richard F Nyrop. *Sri Lanka: a country study*.

[5] https://doi.org/10.5194/gmd-13-3571-2020

- SSP5, the worst-case scenario of far-delayed phase-out of fossil fuels, leading to 4.5°C temperature increase.

How the scenarios 1-3 translate into different climate futures in Sri Lanka's climatic zones is shown in the following chapters.

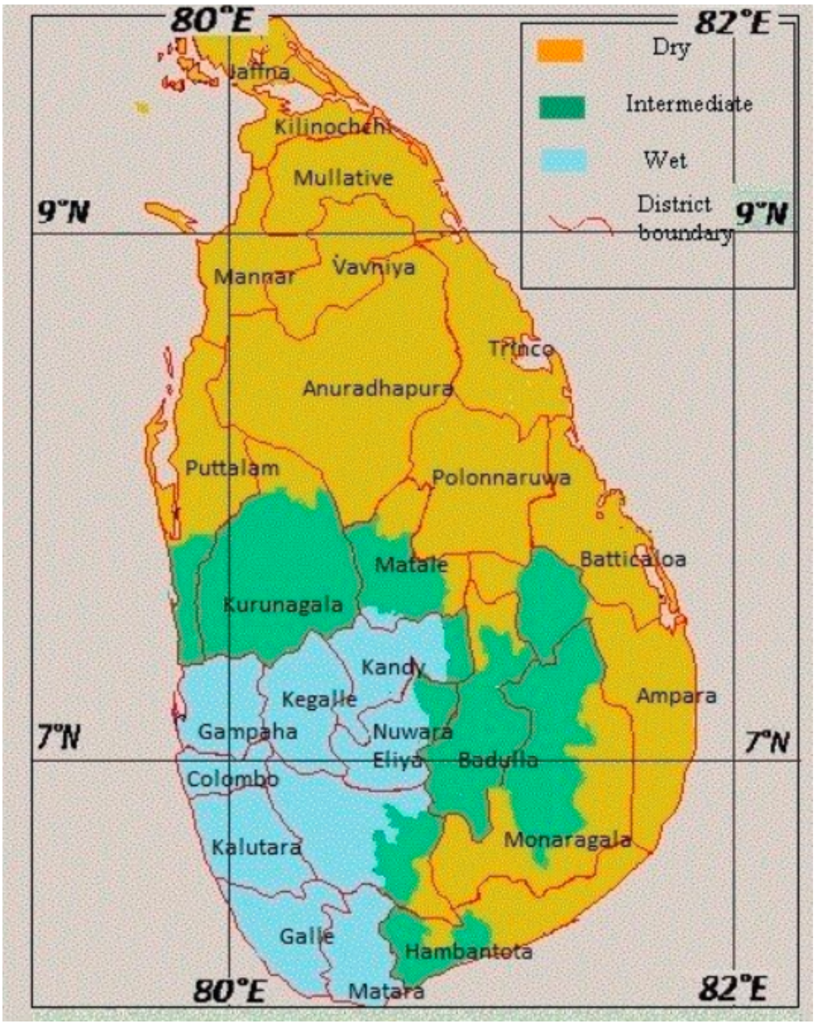

Figure 6: Climatic zones of Sri Lanka Source: Karunaweera 2014

The Wet Zone

The **Wet Zone** comprises the Southern, Western, Central and Sabaragamuwa provinces. The Wet Zone in Sri Lanka consists of the southwestern part of Sri Lanka alongside the Knuckles Mountain Range. The annual average rainfall here is 2500 millimetres (mm).

According to World Bank Knowledge Portal, there are two main seasons in Sri Lanka, the Maha season associated with the northeast monsoon (September – March) and the Yala season associated with the southwest monsoon (May – August).[6] The climate zones in Sri Lanka are defined based on the amount of rainfall. These are strongly influenced by the monsoon. From May to October, moisture is transported by wind from the Indian Ocean to the highlands and falls in the form of heavy rain in the southwestern part of Sri Lanka (Wet Zone). From October to November, a period follows that is characterised by stormy weather and occasional tropical cyclones. From December to February, the monsoons hit the north-eastern coast in the Bay of Bengal. The inter-monsoonal phase from March to May is characterised by light, variable winds with evening thunderstorms.

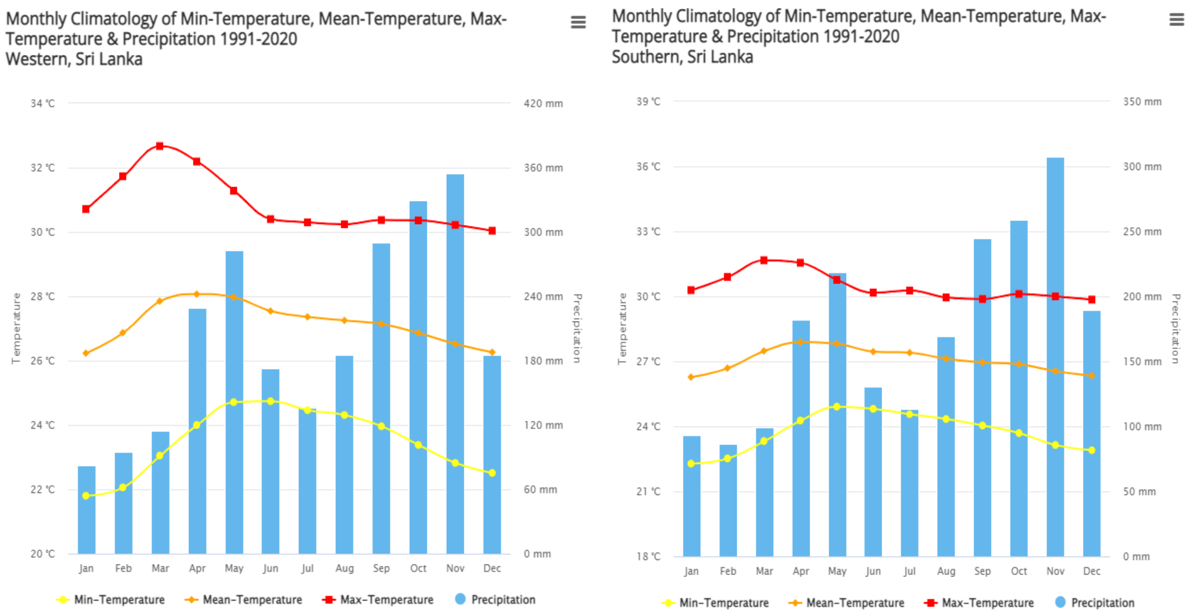

Figure 7: Climate diagrams of Western Sri Lanka and Southern Sri Lanka. Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical

Key trends of observed climate change in the Wet Zone

Temperatures in the Wet Zone have increased in the past thirty years: Since the 1970s, the mean annual temperature has increased by 1.14°C in Western Sri Lanka, 1.13°C in Southern Sri Lanka, and 1.13°C in Sabaragamuwa. Between 1971 and 2020, average temperature increased at a rate of 0.22 per decade, with a steepening rise between 2010 and 2020. Extreme events rise in magnitude and frequency. Hot days are steeply increasing in terms of both number of hot days (especially from March until May) and maximum temperatures reached. Precipitation so far has increased from September until November.

[6] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical

Climate projections for the Wet Zone

In the provinces of Western and Southern Sri Lanka and Sabaragamuwa mean temperatures are projected to increase by 0.27°C by 2030 and in a range from 0.5°C to 0.8°C by 2040 (best- and worst-case scenarios). By 2060, further temperature increase would be quite limited in the best-case scenario. By 2100, the mean temperatures in the Wet Zone (western Sri Lanka) in this scenario would be only 0.5°C higher than in 2013. In the SSP2-4.5 scenario – or 'middle-of-the-road' scenario –mean temperature would increase by 1.7°C in Western Sri Lanka. In the worst-case scenario, temperature would even increase by 3.57°C. Annual mean minimum and maximum temperatures are also projected to increase. Highest temperature levels would be reached in the month of April.

The number of projected hot days with maximum temperature above 35°C are expected to vary in the three provinces between 2 and 6 days annually by 2050 and between 4 and 54 days annually by 2100 – according to the most optimistic and the most pessimistic scenarios, respectively. In the middle-of-the-road scenario there will be an average of 10.12 annual hot days by 2100. Thus, growing heat will have a severe impact on health and livelihoods in the future.

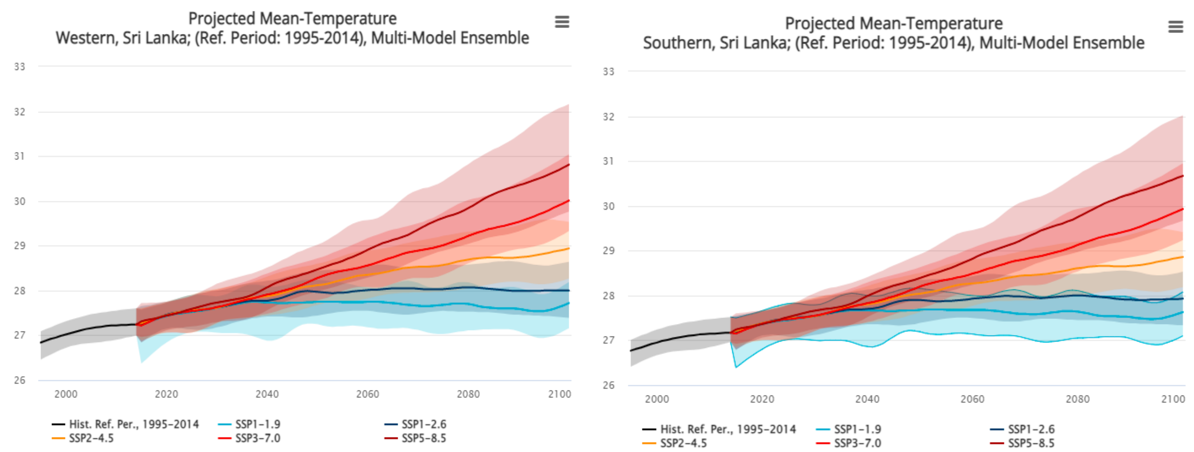

Figure 8: Projected mean temperatures in Western Sri Lanka and Southern Sri Lanka in 2020 – 2100 in different emission pathway scenarios. Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-projections

In the Wet Climatic Zone, the number of projected annual consecutive dry days – with a daily accumulated precipitation under 1mm – are expected to be between 28.05 and 30.77 days in 2050 and between 26.78 and 37.18 days by 2100 for the SSP1-1.9 and SSP4-8.5 scenarios, respectively.

Climate hazards, vulnerabilities and risks in the Wet Zone

The Wet Climatic Zone, which includes the provinces Western and Southern Sri Lanka and Sabaragamuwa, is susceptible to the climate hazards of drought, floods, cyclones, and sea level rise. Rapid onset extreme events such as heat-wave also trigger slow onset events like drought, desertification, the loss of bio-diversity, and land and forest degradation.

The entire region is susceptible to **drought** from February to April – as seen in Figure 9. Droughts and dry spells will occur more frequently and they will last longer. The southwest monsoons (May to September) cause severe flooding in the Wet Zone.[7]

Precipitation-triggered landslides are a hazard especially in the inland mountains. In Sabaragamuwa, an inland province, there is an increasing risk of precipitation-triggered landslides. Due to heavy rainfall and deforestation, the frequency of landslides can/will increase.[8]

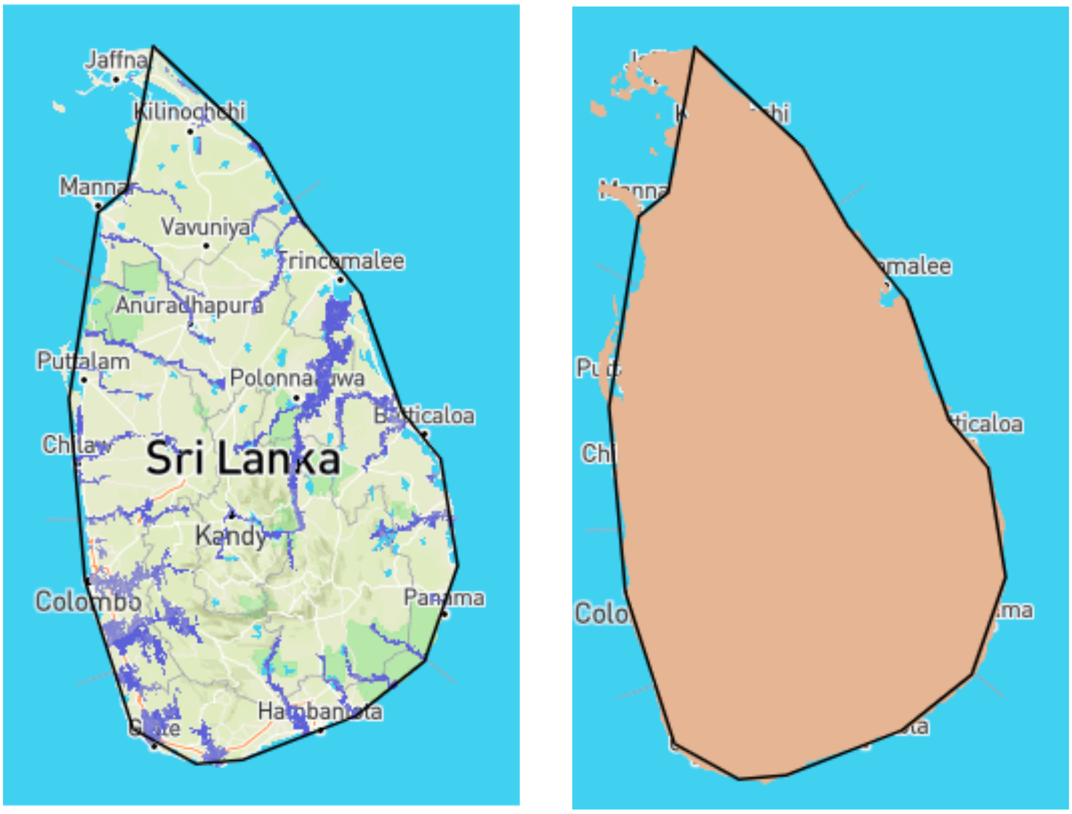

Figure 9: Flood and drought mean projection in Sri Lanka (2020-2040) Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

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[7] https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

[8] https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

Sea level rise has the greatest impact in the west, southwest, and southern coastal belt where about 50% of Sri Lanka's population lives.[9]

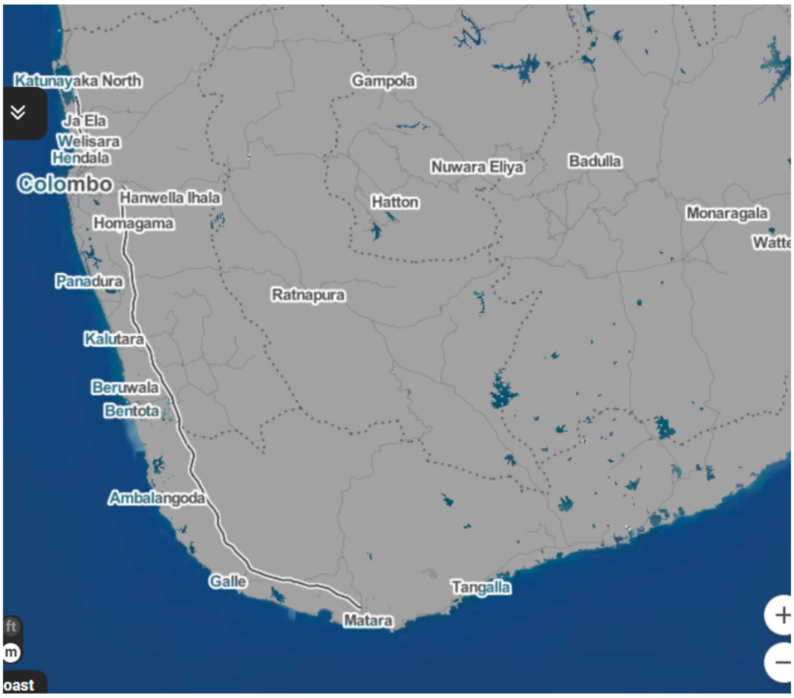

Figure 10: Sea level rise in the Wet Zone Source: https://ss2.climatecentral.org/#9/6.5473/80.4913?show=satellite&projections=0-K14_RCP85-SLR&level=1&unit=meters&pois=hide

To protect the inhabitants from hazards and reduce their **vulnerability**, it is important to protect the coastal areas from floods, cyclones and sea level rise. For example, mangrove forests can be of great importance in reducing the speed of cyclones or floods. However, Sri Lanka, once the country was almost entirely covered by forests, has seen a decline of Sri Lankan forests by over two thirds due to the high rate of deforestation, [10]leaving the people on the coast more exposed to climate hazards.

The Climate of the Intermediate Zone

The **intermediate Zone** includes the North Central, Uva, northern, eastern and southern part of North Western provinces. The climate there is predominantly tropical (Am), according to the Koeppen-Geiger Climate Classification.[11] The rainy season in the intermediate zone lasts from October to January. The dry season lasts from May to September. This zone has average temperatures from 24-28°C. The average annual rainfall is between 1750 millimetres and 2500 millimetres.

[9] https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

[10] https://climateknowledgeportal.worldbank.org/country/sri-lanka

[11] https://climateknowledgeportal.worldbank.org/country/sri-lanka

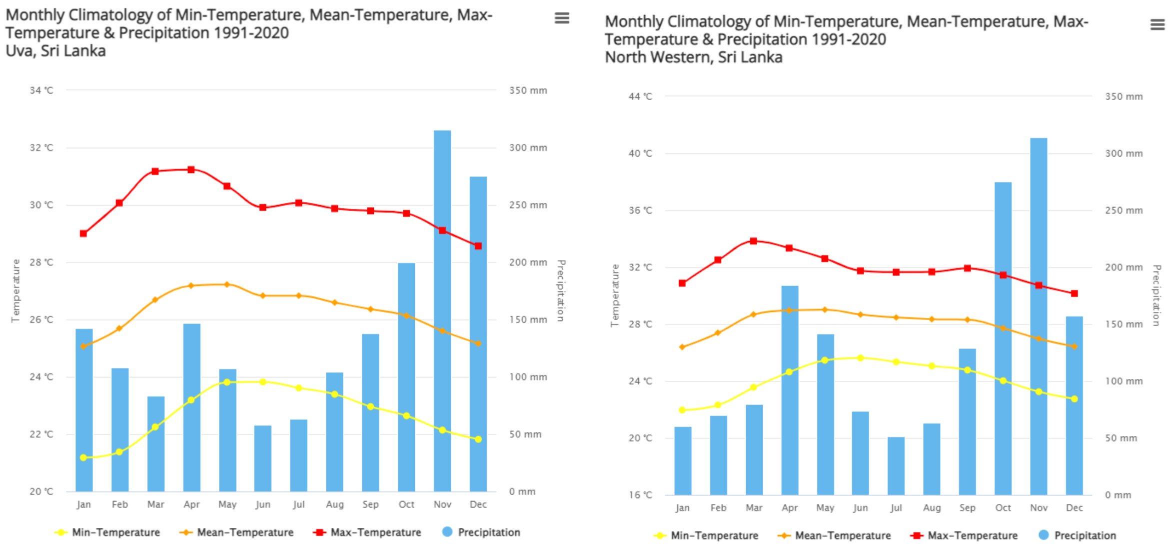

Figure 11: Climate diagrams of Uva and Northern Western Sri Lanka. Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical.

Key trends of observed climate change

Between 1960 and 2020, mean annual temperature has increased by 1.32°C in Northern Western Sri Lanka, 1.31°C in Uva, and 1.33°C in Northern Central Sri Lanka.[12]Warming has significantly increased since the 1980s by approximately 0.22°C per decade, which is almost twice the rate of global warming.[13]The number of very hot days have increased significantly, especially between March and June. There is a significant increase of precipitation can only be seen in November.

Climate projections for the Intermediate Zone

In Uva, mean temperature would increase by 2030 by around 0.42°C as compared to 2014. By 2040, mean temperature would increase in a range between 0.49 – 0.81°C (best- and worst-case scenarios). By 2060, the temperature increase would remain almost the same in case of a sustainability pathway, with net zero emissions by 2050 globally, while temperature increase as compared to 2013 would already be at 1.21°C in the worst-case scenario. In this scenario, in 2100, average temperature in Uva would be 3.45°C higher than in 2013. In the middle-or-the-road scenario, temperature would still be 1,6°C higher than in 2013, while the increase in the best-case scenario would be limited to 0.44°C.

[12] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical

[13] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical

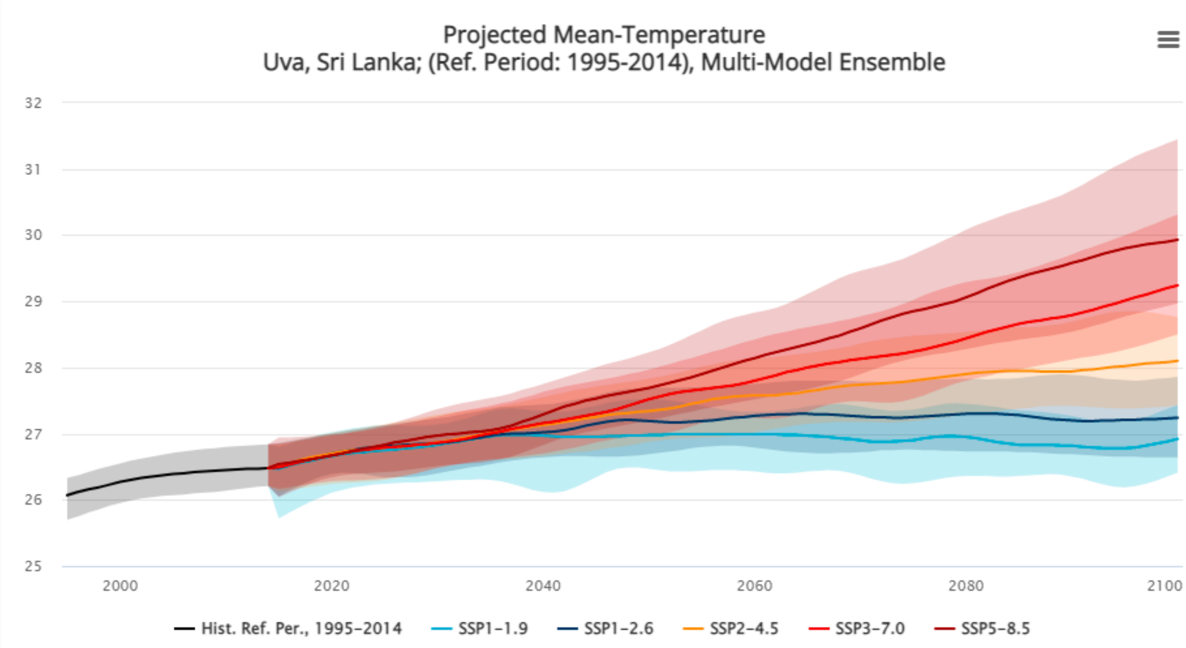

Figure 12: Projected mean temperature in Uva, Intermediate Zone in 2020 – 2100 in different emission pathway scenarios. Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-projections

Annual mean minimum and maximum temperatures are projected to increase in a quite similar order as the average temperature. Particularly notable is the projected steep increase in North Central Sri Lanka of the number of very hot days, i.e. maximum temperature above 35°C from 14.5 days in 2013 to 41 days in 2040 and 187 days in 2100 in the worst-case scenario, while this increase could be halved to 76 days in a middle-of-the-road scenario and limited to 47 days in a scenario with immediate and massive emission reduction.[14]

Climate hazards, vulnerabilities and risks in the Intermediate Zone

The main climate hazards in the intermediate climate zone, composed by coastal provinces North Central, Northern, eastern and southern part of North Western, are floods, heat wave and precipitation-triggered landslides. Apart from these sudden onset extreme events, sea level rise and salinity intrusion are the most important slow onset climate hazards.

Precipitation-triggered landslides are a hazard especially in inland mountains. In Uva, an inland province, landslides are an increasing hazard. Due to heavy rainfall and deforestation, the frequency of landslides can increase. [15]

[14] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-projections

[15] https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

Due to the increase in very hot days and consistently dry days, there is a higher probability that **heat waves** will occur more often and with higher intensity, especially in the dry season (March to June).[16]

Sea level rise of 0.5m would especially affect North Western Sri Lanka. In the second part of the century, higher sea levels will increasingly affect more parts of the coastline of the intermediate climate zone.[17]The risk to the sea level is moderate, but in combination with storm surge the population is exposed and vulnerable to climate hazards.

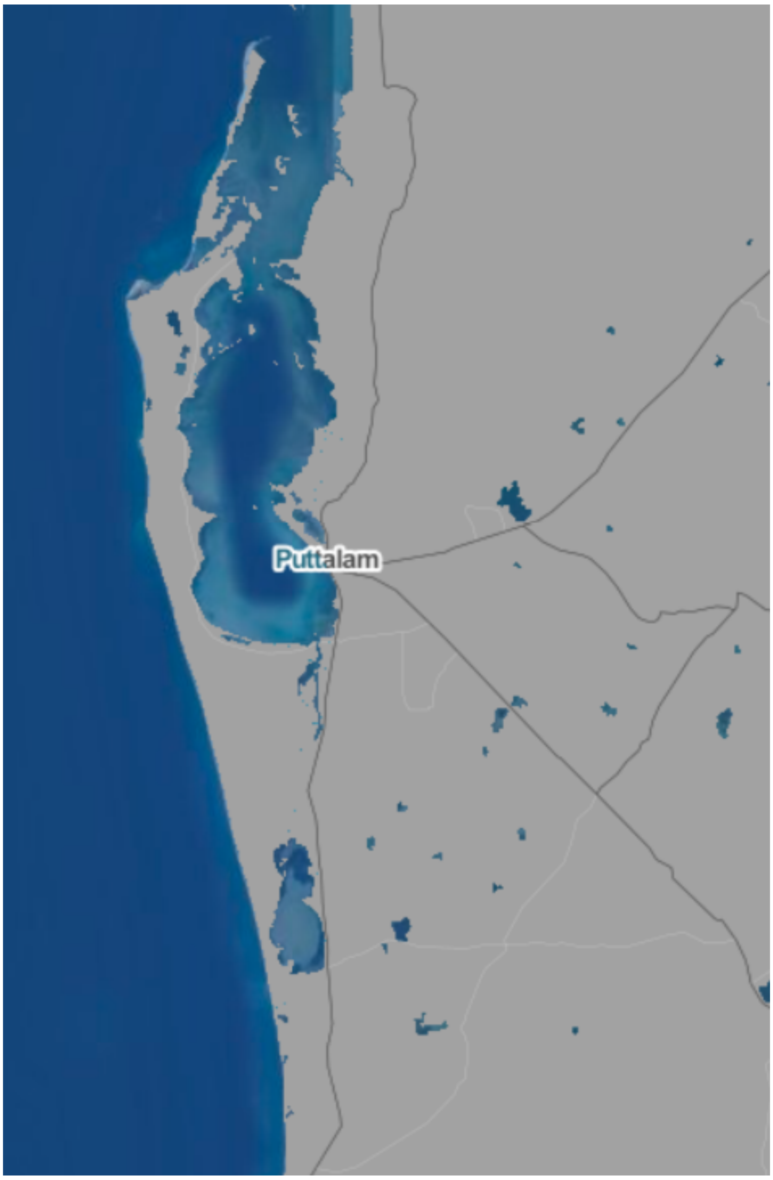

Figure 13: Sea Level Rise in North Western Sri Lanka Source: https://ss2.climatecentral.org/#9/9.5683/80.2441?show=satellite&projections=0-K14_RCP85-SLR&level=0.5&unit=meters&pois=hide

[16] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-projections

[17] https://ss2.climatecentral.org/#9/9.5683/80.2441?show=satellite&projections=0-K14_RCP85-SLR&level=0.5&unit=meters&pois=hide

Resulting climate risks: The combination of hazards makes coastal settlements and infrastructures particularly vulnerable in coastal areas along flood-prone rivers. Most at risk economic sectors are agriculture and fisheries.

In terms of **vulnerabilities**, higher temperatures in combination with higher evaporation and potentially scarcer water sources in the dry season will negatively affect agriculture, which needs to adapt to these changing conditions in terms of crop varieties and planting seasons. Costs of production are likely to increase, because of the need of more and more efficient irrigation. Mangrove forests will be under higher pressure with rising sea levels, leading to higher coastal erosion and increased pressure on sea life. This leads to adaptation needs of the coastal fisherfolk and other people depending on mangrove forests. Rising sea levels also shrink the availability of land, put at risk coastal infrastructure and settlements, and lead to the need of investments in coastal protection and defence. More common and stronger typhoons also worsen vulnerability of coastal population settlements, infrastructure and livelihoods. Higher temperatures, less available water, and more heatwaves aggravates stress to life, leads to more vector-born diseases and pests, and puts elderly people and other people with pre-existing vulnerabilities at risk, leading to more cardiovascular or respiratory diseases, lower work productivity (especially for outdoor activities), and more diarrhoeal diseases, among others.[18]

The Climate of the Dry Zone

The **Dry Zone** includes the Northern, North Central, and eastern part of North Western Sri Lanka, southern part of Uva, and eastern part of Southern provinces. The winter is warm and sunny while the summer is hot and relatively dry, especially in Northern Sri Lanka with a dry tropical savanna climate (As/Aw) according to the Koeppen-Geiger Climate Classification.[19]The average annual rainfall in the Dry Zone is between 1200 and 1900 millimetres. Most of the rain falls between October and January, whereas there is little rainfall during the rest of the year.

[18] https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15507-WB_Sri%20Lanka%20Country%20Profile-WEB.pdf

[19] The climate classification for Sri Lanka according to Köppen-Geiger you find here: https://climateknowledge-portal.worldbank.org/country/sri-lanka

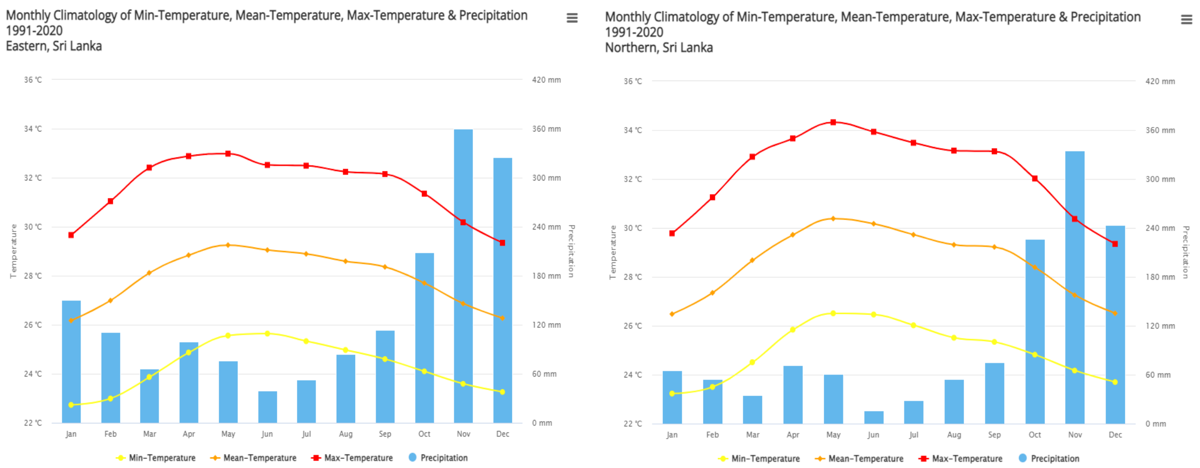

Figure 14: Climate diagrams of Eastern Sri Lanka and Northern Sri Lanka. Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical.

Key trends of observed climate change

Between 1960 and 2020, mean annual temperature has increased by 1.25°C in Northern Sri Lanka, 1.29°C in North Central Sri Lanka, and 1.32°C in North Western Sri Lanka.[20] Warming has significantly increased since the 1980s, with approximately 0.33°C per decade, which is almost twice the rate of global warming.

Climate projections for the Intermediate Zone

In Northern Sri Lanka, mean temperature would increase by 2030 around 0.4°C and by 2040 in a range between 0.47 – 0.8°C (best- and worst-case scenarios) as compared to 2014. By 2060, the temperature increase would remain almost the same in case of a sustainability pathway, with net zero emissions by 2050 globally, while temperature increase would already be at 1.2°C in the worst-case scenario as compared to 2014. In this scenario, in 2100, average temperature in Northern Sri Lanka would be 3.54°C higher than in 2014. In the middle-of-the-road scenario, temperature would still be 1,61°C higher than in 2014, while the temperature increase in the best-case scenario would be limited to 0.46°C.

[20] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-historical

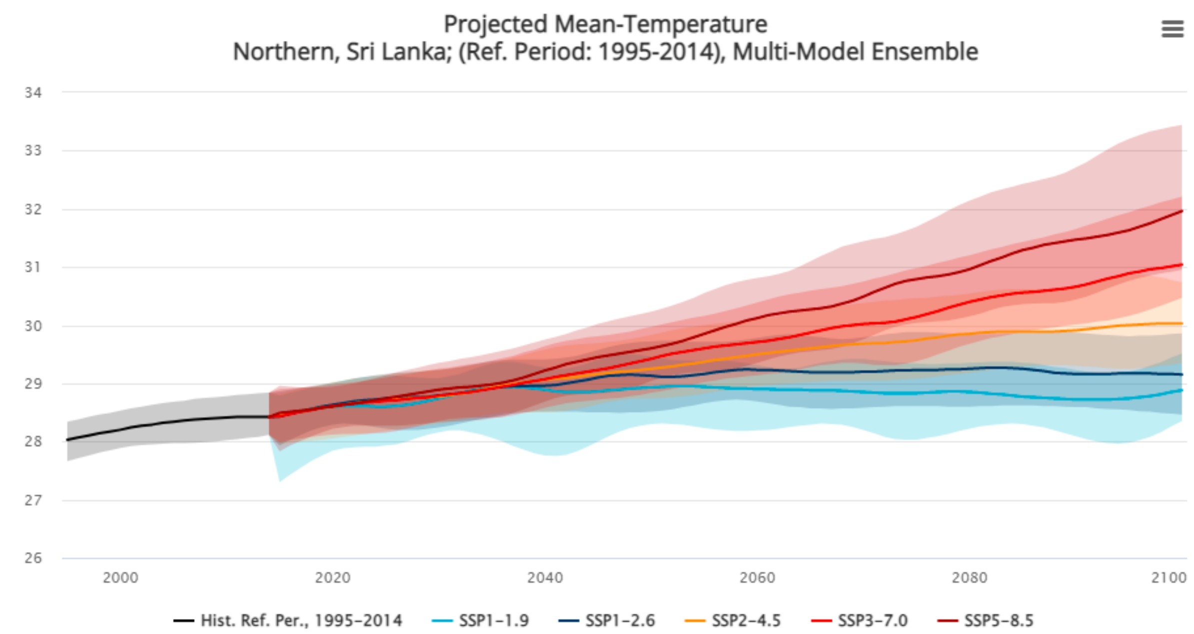

Figure 15: Projected mean temperature in Northern Sri Lanka in 2020 – 2100 in different emission pathway scenarios. Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-projections .

Annual mean minimum and maximum temperatures are projected to increase in a quite similar order as the average temperature. Particularly notable is the projected steep increase of the number of very hot days, i.e. maximum temperature above 35°C, from 29.43 days in 2013 to 57.49 days in 2040 and 214.6 days in 2100 in the worst-case scenario, while this increase could be limited to 68 days in a scenario with immediate and massive emission reduction and at least more than halved to 98 days in a middle-of-the-road scenario.[21]

Climate hazards, vulnerabilities and risks in the Dry Zone

The main climate hazards in the dry zone climate zone, composed by the coastal provinces Northern, Eastern and northern part of North Western, are cyclones, floods and tsunamis – see Figure 16. Apart from these sudden onset extreme events, sea level rise is one of the most important slow onset climate hazards. Almost the entire zone, but especially the northern and central parts are susceptible to cyclones.[22] **Cyclones** often impact the northern region of the country, especially in the months of November and December. According to climate projections, it is likely that in future more severe cyclones will occur in this region, while the frequency of cyclones may also increase.[23]

[21] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-projections
[22] https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability
[23] https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

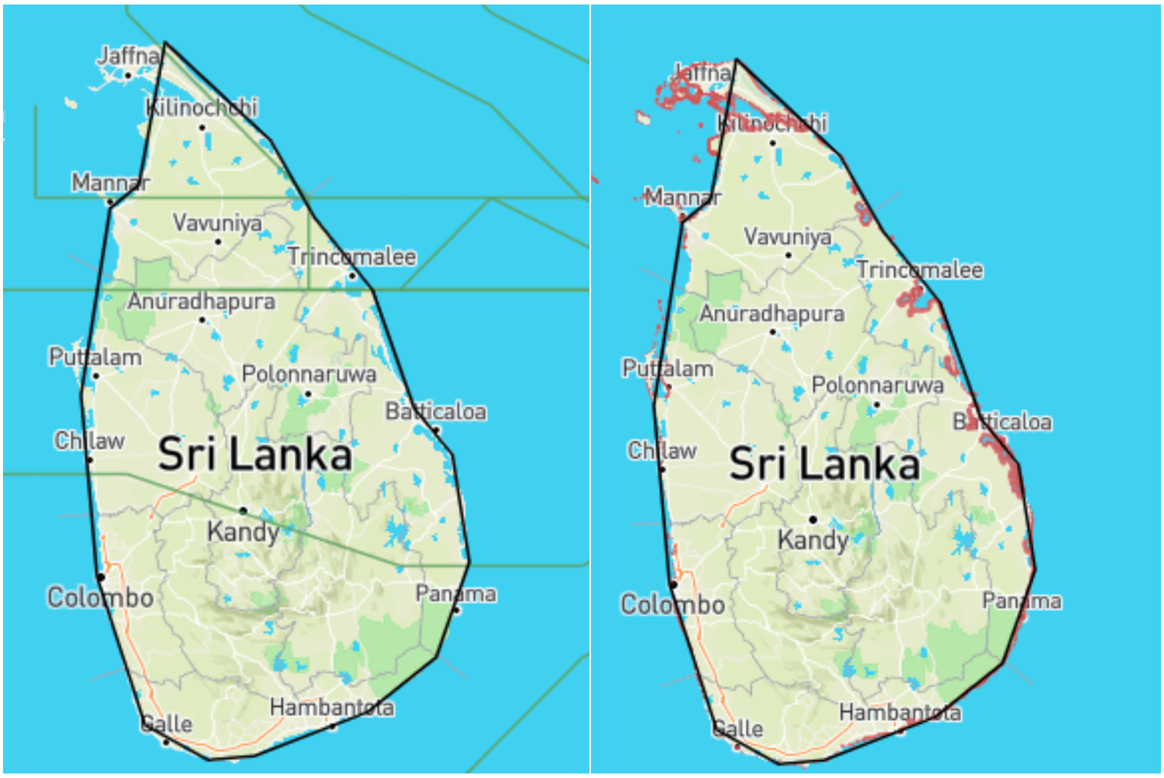

Figure 16: Areas affected by cyclones (left) and tsunamis (right) in Northern Sri Lanka
Source: https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

The high risk of **riverine flooding** and medium risk of coastal flooding along the main rivers and their tributaries is another severe hazard and it is projected to increase with rising temperatures.[24] The most flood-prone areas and river and river systems is the coastal region of Kilinochchi – see Figure 17.

Sea level rise of 0.5m would especially affect North Sri Lanka. In the second part of the century, with higher sea levels, increasingly more parts of the coastline of the intermediate climate zone will be affected.[25] The risk to the sea level is moderate, but in combination with storm surge the population is exposed to a particularly high vulnerability.

Due to the increase in very hot days and consistently dry days, there is a higher probability of more frequent and more intense **heat waves**, especially in the dry season (March to June).[26]Northern Sri Lanka is also exposed to wildfires.[27] Modelled projections identify a likely increase an increase in the frequency of fire weather occurrence in Northern Sri Lanka.

[24] https://thinkhazard.org/en/report/2740-sri-lanka-northern/FL
[25] https://ss2.climatecentral.org/#9/9.5683/80.2441?show=satellite&projections=0-K14_RCP85-SLR&level=0.5&unit=meters&pois=hide
[26] https://climateknowledgeportal.worldbank.org/country/sri-lanka/climate-data-projections
[27] https://thinkhazard.org/en/report/2740-sri-lanka-northern/WF

Figure 17: Sea Level Rise in North Western Sri Lanka Source: https://ss2.climatecentral.org/#9/9.5683/80.2441?show=satellite&projections=0-K14_RCP85-SLR&level=0.5&unit=meters&pois=hide

Resulting climate risks: The combination of hazards makes coastal settlements and infrastructures along flood-prone rivers particularly vulnerable in coastal areas. Most at risk economic sectors are agriculture and fisheries.

In terms of **vulnerabilities**, higher temperatures in combination with higher evaporation and potentially scarcer water sources in the dry season will negatively affect/impact agriculture, which needs to adapt to these changing conditions in terms of crop varieties and planting seasons. Costs of production are likely to increase because of the need of more and more efficient irrigation. Mangrove forests come under pressure with rising sea levels, leading to higher coastal erosion and increased pressure on sea life. This leads to adaptation needs of the coastal fisherfolk and other people depending on mangrove forests. Rising sea levels also shrink the availability of land, put at risk coastal infrastructure and settlements, and lead to the need of investments in coastal protection and defence. Stronger cyclones also enhance vulnerability of coastal population settlements, infrastructure, and livelihoods. Higher temperatures, less available water, and more heatwaves enhances stress to life, leads to more vector-borne diseases and pests, and puts elderly people and other people with pre-existing vulnerabilities at risk, leading to more cardiovascular or respiratory diseases, lower work productivity (especially for outdoor activities), and more diarrhoeal diseases, among others.

Building Climate Resilience – Basic Terms and Adaptation Options for Sri Lanka

Climate change adaptation is an adjustment in natural or human systems in response to current or expected climate stimuli or their effects.

Climate disaster risk management is a systematic process of implementing policies, strategies and measures to reduce the impacts of natural hazards and related environmental and technological disasters. This includes, among other things, disaster risk reduction, preparedness, response, recovery and rehabilitation.

Climate proofing is an approach to identify, address and minimise project-related climate risks.

Climate resilience is defined as the capacity of a socio-ecological system (1) to absorb stresses and maintain function in the face of external stresses imposed upon climate change, and (2) adapt, re-organise and evolve into more desirable configurations that improve the sustainability of the system, leaving it better prepared for future climate change impacts.

Climate risk assessment is a methodology to determine the nature and extent of risk by both analysing hazards and their potential likelihood and intensity and estimating impacts through the evaluation of conditions of vulnerability and the identification of exposed people, property, infrastructure, services, livelihoods and their environment.

Disaster risk refers to the potential disaster losses of sudden or slow-onset events in lives, health, livelihoods, assets and services which could be incurred by a particular community or a society over some specified future time period. Disaster risk is a function of hazard, exposure, vulnerability and capacity.

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Gender sensitivity and gender responsiveness: A gender-sensitive programme considers gendered norms, roles and inequalities and has an awareness of these issues. However, in gender-sensitive programmes, appropriate solutions or actions might not be taken. This is the case for gender-responsive programmes that actively work to address and change inequalities.

Hazard: A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

The National Adaptation Plan (NAP) process was established under the UNFCCC helping countries conduct medium- and long-term climate adaptation planning. It is a flexible programme that builds on each country's existing adaptation programmes and actions, and helps to align adaptation with other national policies.

Nationally Determined Contributions (NDCs) are the pledges of climate action (adaptation and mitigation) of State Parties to the UNFCCC under the Paris Agreement.
Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard and, hence, disaster. There are many aspects of vulnerability, arising from physical, social, economic and environmental factors.

If a project or program is categorized in the climate proofing process as being exposed to climate risks, a climate risk assessment should be done, to fully understand the risks. Based on the results of this diagnosis, a risk reduction and adaptation plan should be developed to avert or minimize the risk. Adaptation plans typically show how the climate impact chain leading to negative impacts on the project can be modified in such a way by taking adaptation measures that risks are minimized.

The following list shows a sample of possible adaptation options for sectors that are at risk:

Sector	Adaptation options	Sources for practical information
Agriculture	Drought-/heat tolerant varieties (Drip water) irrigation (Drought) Vertical gardening (salinity) Floating gardens (flood) Erosion control (landslides) Changing cropping patterns	https://climateportal.ccdbbd.org/solution-navigator/ https://www.adaptationcommunity.net/agroecology/

	Agroecological pest control	
Forestry	Afforestation/reforestation Resilient plant & tree species Sustainable forest management /Agroforestry	https://worldagroforestry.org
Coastal zones	Build typhoon shelters Mangrove reforestation Resilient aquaculture Early warning systems	https://www.adaptation-undp.org/undp-helps-vietnam’s-coastal-communities-adapt-climate-change https://www.giz.de/en/worldwide/18661.html
Settlements	Flood-/storm-proof houses Stormwater management Natural shade & ventilation	https://www.unep.org/news-and-stories/story/5-ways-make-buildings-climate-change-resilient http://bengaluru.urbanwaters.in/about-the-million-wells-campaign/
Energy	Climate resilient infrastructure Decentralized energy systems	https://climateportal.ccdbbd.org/solution-navigator/

Sri Lanka’s key adaptation policies and reports can be found here: https://climateknowledgeportal.worldbank.org/country/srilanka/adaptation.

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Climate data for Sri Lanka:

Data on Average Monthly Temperature and Rainfall in Vietnam (1901-2015)

Tutiempo.net: Climate information of provinces' climate since 1950: Temperature, precipitation, wind speed, and annual days with rain, storm, snow, hail, tornado, and fog.

PSMSL – Permanent Service for Mean Sea Level: Access to global sea level monitoring stations. Free and accessible data from 1960 until 2015.

Climate Change Knowledge Portal of the World Bank: Observed and predicted temperature and precipitation for years 1930-2020 and 2020-2099 respectively. Downloadable and free databases.

National Centre for Hydro-Meteorological Forecasting: Division of eight areas affected by storms in the territory of Vietnam. Good figures on storm impacts on Vietnam with data between 1961-2014

Climate Central Surging Seas: Risk Zone Map.

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