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Shared socioeconomic pathways (SSPS) and projected changes in temperature and rainfall: A case study of the Western Province of Sri Lanka

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A B S T R A C T

The Western Province, as the country's principal province, is confronting many challenges prompted by climate change. The repercussions of climate-related phenomena in the Western Province obstruct the overall advancement of Sri Lanka. Consequently, it is imperative to comprehend future climate change trajectories through climate projections. This study endeavors to discern alterations in temperature and precipitation patterns in the Western Province from 2020 to 2100 based on varying Shared Socioeconomic Pathways (SSP) 2-4.5 and 5-8.5 and to propose suitable mitigation strategies. The research utilizes data sourced from the World Bank's Climate Change Knowledge Portal (CCKP) and various government and non-governmental organizations, including the Department of Meteorology, employing descriptive analysis. The findings suggest that the average temperature in the Western Province is anticipated to increase by 1.20°C under SSP2-4.5 and 1.95°C under SSP5-8.5 from 2020 to 2100. Likewise, the annual rainfall is projected to rise by 175.48mm under SSP2-4.5 and 209.78mm under SSP5-8.5. Furthermore, the study indicates that a decline in monthly rainfall coupled with an upsurge in temperature is foreseen in the Western Province as it transitions from SSP2-4.5 to SSP5-8.5 concerning carbon emissions. Thus, it is preferable to maintain carbon emissions closer to SSP2-4.5 rather than SSP5-8.5. Additionally, it is crucial to implement development projects that take into account anticipated future changes in temperature and rainfall.

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1. Introduction

The climate is intricately interwoven with all human endeavors. It holds a pivotal role in various aspects of human existence, encompassing sustenance, attire, and habitation. Climate, in essence, represents the “average weather,” delineating the typical state and variability of atmospheric conditions over a minimum span of 30 years (Radhakrishnan and Sujatha, 2024). Just as the world's landscapes undergo metamorphosis over time, so too does the climate. Throughout the past century, certain atmospheric gases have modified crucial elements such as temperature and rainfall. This overarching transformation in weather patterns is known as climate change. In contemporary discourse, climate change has ascended to prominence not solely among climatologists but across diverse sectors of society. Globally, climate change increasingly jeopardizes economic expansion, food security, public health, sites of cultural significance, social stability, and even national security (Ruiz and Mack-Vergara, 2024). The causation of climate change stems from both natural phenomena and various human activities. While natural climate fluctuations have historically occurred, the velocity of contemporary global climate change has markedly accelerated (Patterson et al., 2022). Natural influences such as volcanic eruptions, variations in solar radiation, and

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ocean currents contribute to climate alteration. Since the onset of the Industrial Revolution, human activities—primarily the utilization of fossil fuels (coal, oil, and natural gas) and deforestation—have significantly amplified the concentration of greenhouse gases in the atmosphere (Nwankwoala, 2015). Gases like carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are particularly instrumental in driving global warming. Initially regarded as a concern primarily for ecologists and climatologists, climate change now necessitates action from every individual. Due to the gravity of climate change, nations worldwide increasingly direct their focus toward it (FAO, 2020).

In this context, Sri Lanka emerges as one of the nation's acutely vulnerable to the ramifications of climate change (Dananjaya et al., 2022). Its geographical location and attendant characteristics render it particularly susceptible to the effects of climate change. As Sri Lanka advances toward sustainable development, the consequences of recent climatic shifts are significantly influencing its social, economic, and environmental endeavors (Approaches and Ohiya, 2023). Notably, Sri Lanka's average temperature has ascended by 0.16°C from 1961 to 1990 (Jayawardene et al., 2020). A comparison of the periods 1990-2000 and 2000-2017 reveals that Sri Lanka's average temperature has surged by 0.8°C since the turn of the millennium. Similarly, an assessment of Sri Lanka's precipitation patterns indicates a 7% reduction in rainfall in 2020 compared to 1900 (Dasandara et al., 2021).

The World Bank Group (2011) elucidates that from 1974 to 2004, the frequency and intensity of floods and droughts escalated in numerous regions of the country, along with the intensity, daily occurrence, and average rainfall (The World Bank, 2021). From 1900 to 2018, the incidence of extreme weather events such as floods, landslides, droughts, and storms surged by 74% (Basnayake et al., 2021). Climate change in Sri Lanka has precipitated an increase in rainfall intensity, storm frequency, average ambient temperature, and sea level rise (ADB, 2022). Climate projections serve as a vital instrument in preparing society for the impending challenges posed by climate change in forthcoming decades (Ghazi et al., 2023). Comprehensive research is being conducted globally concerning climate change, particularly within various sectors including agriculture, infrastructure, public health, and disaster management, to discern potential climatic shifts (Patterson et al., 2022). Although extensive climate change research is underway worldwide, Sri Lanka remains one of the countries that has afforded relatively scant attention to this critical issue. Hence, climate projections are indispensable for evaluating future adverse impacts (Xiang et al., 2022) According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), future climate predictions rely on Representative Concentration Pathways (RCPs). The Sixth Assessment Report utilizes Shared Socioeconomic Pathways (SSPs) (Li et al., 2021).

Forecasting future climate change in the Western Province of Sri Lanka is paramount for steering endeavors aimed at mitigating the impacts of regional development. As a principal national domain situated in the wet zone, characterized by a high population density and economic significance, the Western Province grapples with numerous climate-related challenges. Therefore, predicting and comprehending the future climatic impacts on the Western Province is vital for sustained planning and developmental initiatives.

Although studies related to climate change have been conducted in the Western Province, research focusing on climate projections remains limited. A discernible gap exists regarding research on temperature and rainfall variations. This study aspires to fill this research void by concentrating on the Western Province, encompassing the districts of Colombo, Gampaha, and Kalutara. It will examine the alterations in temperature and rainfall within the Western Province from 2024 to 2100, grounded in diverse Shared Socioeconomic Pathways (SSPs), and propose pertinent recommendations for adaptation to these changes.

2. Material and methods

2.1. Geography of the study area

The Western Province, located along the western coast of the island, is a prominent region of Sri Lanka. It encompasses the districts of Colombo, Gampaha, and Kalutara (Fig. 1). As the most populous province in Sri Lanka, it serves as the principal hub for administrative and commercial activities (Weerasinghe et al., 2018). The province comprises 40 Divisional Secretariats and 2,505 Grama Niladari Divisions. Geographically, it is situated between latitudes 6° 35’ and 7° 10’ N and longitudes 80° 30’ and 79° 85’ E, covering a total land area of 3,684 square kilometers, of which 3,593 square kilometers comprises land while 91 square kilometers constitutes inland water (Sangasumana et al., 2017). Colombo, the capital of the Western Province, stands as the largest commercial center in the nation. According to the 2012 census, the population of the Western Province is 5,821,710, exhibiting a population density of 1,525 individuals per square kilometer (Weerasinghe et al., 2018). The province is situated at an average altitude of 18.45 meters (60.03 feet) above sea level and is traversed by two major rivers, the Kelani and Kalu. It is also the home of Muthurajawela, the largest wetland in Sri Lanka. Characterized by a tropical monsoon climate (Koppen climate classification Af), the Western Province experiences relatively stable, warm temperatures year-round. The average annual temperature is recorded at 28.53°C, which is 1.07% above the national average. The region receives substantial rainfall during the southwest monsoon season (May to September), with annual precipitation ranging from 2,000 mm to 2,500 mm. Due to its low-lying topography, the Western Province is susceptible to coastal flooding, particularly during the rainy season. This vulnerability is exacerbated by extensive urban development, which can prompt rapid flooding owing to the land's limited ability to absorb water. The province also grapples with the urban heat island effect, a consequence of its dense urbanization.

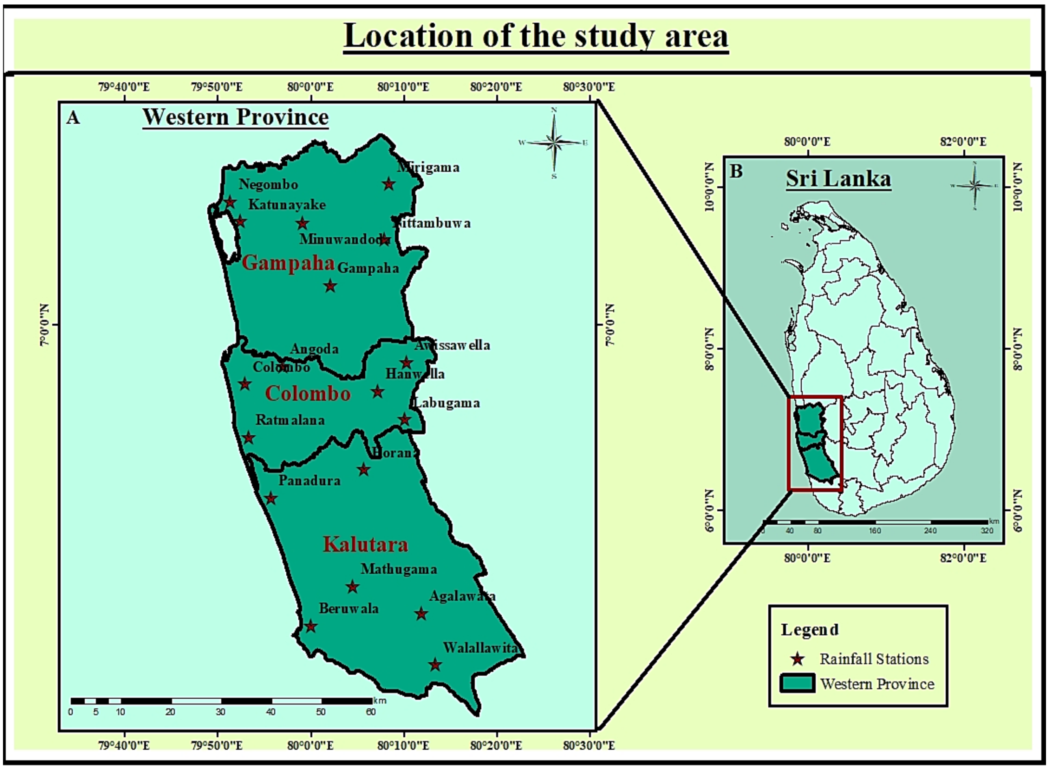

Fig. 1. The study area, Western Provinces of Sri Lanka with district boundaries and rainfall stations.

2.2. Downscaled Data

This study is primarily focused on identifying anticipated anomalies due to climate change within the specified area. While numerous studies have endeavored to project climate change within their respective locales, this marks the inaugural effort for the Western region of Sri Lanka. Future climate change data were procured from the Climate Change Knowledge Portal (CCKP) of the World Bank (Charney, 2018). Additionally, data pertinent to this study were collected through the Global Coordinates System via the Intercomparison Coupled Model Phase 6 (CMP6), which is an output of Coupled Atmosphere-Ocean General Circulation Models (CACGCM) based on the IPCC's sixth assessment report (World Bank Group, 2021).

The scientific community utilizes scenarios to delineate the spectrum of plausible climate futures and to demonstrate the repercussions of various pathways, policy decisions, and technological advancements. These scenarios are conceptualized as 'what if' cases, deliberately selected to encompass a broad range without regard to likelihood. The methodology for formulating these scenarios has evolved from a climate-centric model to a more societal development-oriented framework, thus providing insights into a variety of plausible climatic outcomes. Shared Socioeconomic Pathways (SSPs) are employed in CMIP6, superseding the Representative Concentration Pathways (RCPs) established in CMIP5. CMIP6 presents five SSPs, each reflecting distinct societal development trajectories. The cumulative radiative forcing levels projected for 2100, which quantify greenhouse gas emissions from all sources, are articulated after each pathway (IPCC, 2017; Ruosteenoja and Jylha, 2021; IPCC, 2022; Lescher Soto et al., 2024; Pollitt et al., 2024). CMIP6 is characterized by experimental suites divided into three categories: (1) Decadal Hindcasts and Predictions simulations, (2) long-term simulations, and (3) Atmosphere-only (prescribed SST) simulations for exceptionally computationally intensive models. The IPCC unveiled four emission scenarios in 2022: SSP1-2.6, SSP2-4.5, SSP3-6.0, SSP4-7.0, and SSP5-8.5. However, this study exclusively considers the SSP2-4.5 (medium) and SSP5-8.5 (high) scenarios, each representing distinctly different carbon emission trajectories (Ruosteenoja and Jylha, 2021). Scholars recommend leveraging both scenarios to ascertain future climate change projections most accurately. SSP (Shared Socioeconomic Pathways) scenarios are frameworks used to assess the potential impact of various social, economic, and environmental drivers on climate change and its impacts. SSP 4.5 and SSP 8.5 are two specific pathways that are often considered in climate research. Here’s a breakdown of their importance compared to other scenarios.

SSP 4.5 is a moderate pathway that aims for a level of greenhouse gas emissions stabilization. It assumes a mix of continued fossil fuel use with moderate increases in renewable energy adoption and efficiency improvements. Further, this scenario is often viewed as a more achievable target for governments and policymakers. It reflects a world where climate mitigation efforts are somewhat successful, making it a key benchmark for sustainable development. SSP 4.5 emphasizes the importance of technological innovation, policy measures, and international cooperation to build resilience against the impacts of climate change. This can guide strategic planning and investment. The scenario acknowledges economic growth but within limits that recognize environmental sustainability. It serves as an important contrast to more extreme scenarios. SSP 8.5 represents a world with very high greenhouse gas emissions, primarily driven by reliance on fossil fuels and limited efforts to mitigate emissions. It is often characterized as a "business as usual" scenario. This scenario is critical for understanding the potential extreme impacts of climate change, including severe weather, rising sea levels, and significant biodiversity loss. It underscores the importance of urgent action to prevent such outcomes. SSP 8.5 serves as a wake-up call for policymakers about the consequences of inaction. By modeling a future under this scenario, decision-makers can better understand the urgency of climate action. Analyzing this scenario helps to inform risk assessments and the development of adaptive strategies for vulnerable regions and populations. In comparison to Other Scenarios, both SSP 4.5 and SSP 8.5 provide a spectrum of potential futures that help researchers and policymakers understand the implications of different levels of climate action and socioeconomic development. They complement each other by exploring both moderate and extreme cases. They are often more applicable to current global trends in fossil fuel consumption, technology development, and emissions pathways, making them critical for regional and global climate scenarios.

Other SSP scenarios (like SSP 1, which represents a world moving towards sustainability; and SSP 3, which illustrates a scenario of regional rivalry) also provide insights but may offer less direct applicability to discussions around stabilization and extreme risk. In summary, SSP 4.5 and SSP 8.5 are essential for framing climate change discussions due to their relevance in depicting moderate and extreme future scenarios, informing policy action, and helping understand the risks and opportunities associated with different socioeconomic pathways. These scenarios serve as crucial touchstones for climate action and adaptation strategies.

The figures associated with the SSP signify global greenhouse gas emissions distributed across various scopes. Measurement units are expressed in watts per square meter, reflecting diverse scenarios up to the year 2100. For instance, SSP 2.6 represents an extreme mitigation scenario related to the Paris Conference, while SSPs 4.5 and 6.0 illustrate intermediate stabilization routes characterized by high emissions yet some degree of regulation. Ultimately, SSP 8.5 posits a persistent rise in greenhouse gas emissions devoid of control measures (IPCC, 2021).

A multitude of grid-based data analysis models tailored to various climatic periods has been employed to evaluate forecasted climatic changes worldwide across distinct SSPs. Numerous institutions globally have devised models for the analysis of climate data and to project future climatic trends. For this investigation, several models were employed to generate predictions regarding temperature and precipitation patterns in the Western Province of Sri Lanka. It is imperative to acknowledge that the study places particular emphasis on multi-model ensembles for interpreting the results (World Bank Group, 2021).

Each model utilized in this study necessitates an adequate quantity of historical data to inform future projections. This historical data serves as a reference point, typically extending over 30 years. Climate change investigations, however, may incorporate preferred periods established by the World Meteorological Institute, such as 1971-2000, 1981-2010, and 1990 to 2020, for the entirety of the timeframe. To establish each model's reference period, a segment of historical simulations is required (Facts, 2022). The IPCC recommends a period of twenty years for contemporary climate change studies, whereas this study considers the primary climatic reference period from 1986 to 2005, as advised by the CACGCM. Future projections are delineated for the years 2020-2039, 2040-2059, 2060-2079, and 2080-2099, concentrating on two fundamental parameters: mean monthly temperature and monthly rainfall (precipitation). This study scrutinizes solely two climate scenarios: 4.5 medium-low emissions and 8.5 high emissions. The Climate Change Knowledge Portal of the World Bank Group served as the principal source of grid data for this investigation. The data was configured with a 1°x1° global grid spacing and generated through bi-linear interpolation. The study utilized data downscaled to the geographical coordinates of the Western region of Sri Lanka, situated between latitudes 6° 35' and 7° 10' N and longitudes 80° 30' and 79° 85' E.

- Data Processing Procedures and Protocol for Future Climate Change Analysis:

1. Baseline Climatic Periods: The CMIP6 model simulations were conducted independently to create a standardized dataset, enabling the calculation of two complete climatologies for the current and forthcoming twenty-year intervals (2020-2039, 2040-2059, 2060-2079, and 2080-2099), alongside their relative variabilities in comparison to the reference period of 1995-2014 (Lacombe et al., 2019). Monthly fundamental data were procured, ensuring that the resulting products accurately represented a twenty-year climatic period. These twenty-year segments at the grid level are essential for contextualizing the diverse variabilities throughout the 21st century. Consequently, each 20-year window can be correlated with the standard "present-day" reference period of 1995-2014, and the resultant anomalies exhibit a significant correspondence with the IPCC findings (Stocker et al., 2013).

2. Re-gridding: Since the original model outputs are presented on their respective native grids, the multimodal collection necessitated re-gridding to a cohesive resolution. This objective was attained by creating a uniform 1° x 1° global grid spacing through bi-linear interpolation. The Western region of Sri Lanka is situated between latitudes 6° 35' and 7° 10' N and longitudes 80° 30' and 79° 85' E, necessitating data downscaling for these geographical coordinates, applied in this study (World Bank Group, 2021).

3. Climatology: Twenty-year climatologies were established for each of the four selected essential climate variables across all five SSPs ("SSP1-1.9", "SSP1-2.6", "SSP2-4.5", "SSP3-7.0", "SSP5-8.5") and the CMIP6 'baseline' interval (1995-2014) derived from historical simulations ("hist"), while future climatologies (2020-2039, 2040-2059, 2060-2079, 2080-2099) were computed accordingly. These climatologies produced 12 monthly average values, 4 seasonal average values, and one annual mean value established over the respective periods. To develop the climatologies, all values were derived directly from the absolute temperature and precipitation data procured from the model simulations. It is noteworthy that variations in absolute temperatures and precipitation may exist among models; however, these discrepancies relative to observational data are generally marginal yet can be significant in certain regions. Therefore, for comparative analysis between models, it is more pertinent to examine relative changes rather than absolute values (World Bank Group, 2021).

4. Anomalies: For each model, variable, and future twenty-year time window, anomalies for each month, as well as the annual value, were calculated and evaluated about their corresponding historical reference periods. These metrics are ideally suited for inter-model comparisons, as they consistently reflect the changes simulated by each model. For certain indicators reflecting deviations or occurrences exceeding absolute thresholds, prior bias correction is imperative (for instance, the number of days with minimum nighttime temperatures surpassing 21°C).

5. Ensemble Information: Ensemble values were computed from the anomalies associated with each twenty-year climatological period projected by the models in the collection. These ensembles illustrate how the range of up to 31 CMIP6 models forecasts climatological changes on average. While various methodologies exist for exploring the ensemble distribution, this study primarily adopts the median across individual model values as the representative measure. Additionally, ensemble high (90th percentile) and low (10th percentile) values were generated for all climatological anomalies, aiding users in recognizing the spectrum of probable outcomes influenced by diverse sources of uncertainty. Notably, values are accessible for each model separately, thus allowing users to delve into the distribution with greater specificity. Given that each model possesses a slightly distinct climate sensitivity and simulates different internal climate variability, the projections tend to diverge increasingly over time. Consequently, the ensemble spread typically widens as projections extend into the future. It is important to acknowledge that each model's anomalies can be juxtaposed against the provided ensemble description, which encompasses the range between high (90th percentile) and low (10th percentile) levels of the underlying distribution.

2.3. Methodology for the validation of data

The methodology for validating future climate change data is paramount for effectively utilizing this data in subsequent analyses within this study. To this end, a comparative analysis approach was enacted to evaluate the accuracy of future temperature and precipitation data in the examination of future climate change patterns in the Western region of Sri Lanka. This process involved employing general circulation models to simulate historical data and juxtaposing it against actual observed data to ascertain its credibility. Specifically, actual rainfall data from thirty years spanning from 1990 to 2020 was incorporated for the evaluation of both datasets. Multiple models were utilized to project future climate change data for the study area across varying scenarios. Linear scaling bias correction methods are statistical techniques used to correct systematic biases in model outputs, typically in climate modeling, hydrological modeling, or other applications where simulations may not accurately reflect observed data. These methods can help ensure that model outputs are consistent with historical observations, thus improving their reliability for future projections or assessments. Below are some common linear scaling bias correction methods:

This method involves adjusting the mean of the model output to match the mean of the observed data. The general formula is (Eq. 1):

$$Ycorrected = Ymodel + (Yobs - Y\ model) \quad (1)$$

Where Ymodel is the model output, Yobs is the observed value, and Ymodel is the mean of the model output over a reference period.

Moreover, the historical data, both observed and model-simulated, was scrutinized through a figure-based comparison methodology. This approach involved the utilization of trend line figures to contrast the data in question. An investigation into the annual mean rainfall patterns revealed a remarkable congruence between the observed and predicted historical rainfall in the Western region of Sri Lanka.

Remarkably, the annual rainfall patterns observed over the last thirty years in the aforementioned region demonstrated a deviation of merely 3.3 mm between the recorded precipitation and the model-simulated values, which were 129.7 mm and 126.4 mm, respectively (Fig. 2).

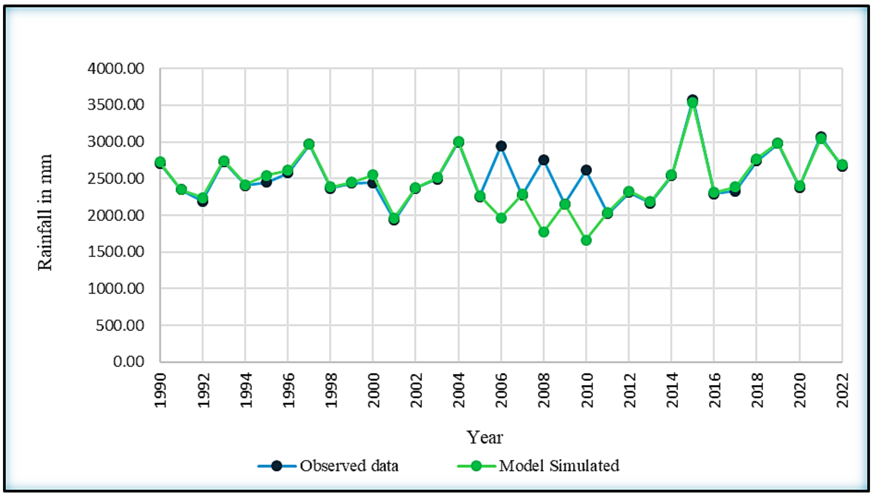

Fig. 2. Observed and modeled simulated annual total rainfall trend for the period from 1990 2022 in the western region of Sri Lanka.

In terms of temperature, the Mean Absolute Deviation (MAD) results reveal a robust correlation between the actual observed data and the model-simulated historical data. Specifically, the MAD values for the observed temperatures and those simulated by the model were recorded at 0.57°C and 0.63°C, respectively. Consequently, there exists a mere 0.06°C divergence between the two temperature datasets in this investigation.

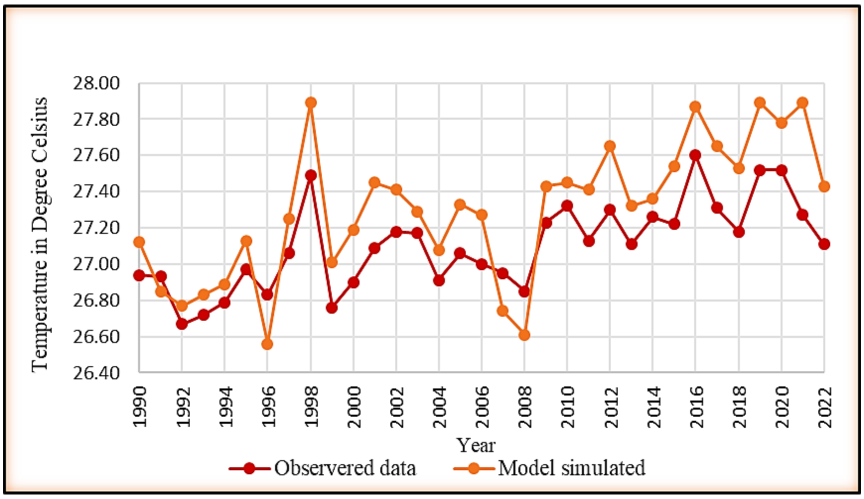

Fig. 3. Observed and model simulated annual total temperature trend for the period from 1990 to 2022 in the western region of Sri Lanka.

3. Results and discussion

The assessment of expected temperature and precipitation patterns in the Western Province of Sri Lanka reveals a significant increase across various Shared Socioeconomic Pathways (SSPs) for different climatic periods. However, multi-model integrations indicate a consistent rise in both temperature and precipitation throughout the climatic interval from 2020 to 2100.

3.1. Future temperature changes under SSP2 4.5

According to the World Bank's Climate Change Knowledge Portal (CCKP), monthly data spanning from 1951 to 2100 has been meticulously analyzed and the findings published (Fig. 3). Upon examining the illustration of temperature fluctuations in the Western Province under SSP2-4.5, it is evident that there is a persistent upward trend. The temperature, which exhibited negative values during the 1950s, is projected to exceed an increase of 1.5°C by the year 2100 across all months from January to December. Specifically, the average monthly temperature from 1951 to 2020 was -0.19°C, while the anticipated average monthly temperature from 2020 to 2100 is expected to rise to 1.22°C. It is forecasted that the monthly temperature will ascend steadily every decade from 2020 to 2100 (Fig. 4). The subsequent Table delineates the average monthly temperature for each subsequent decade into the future (Table 1).

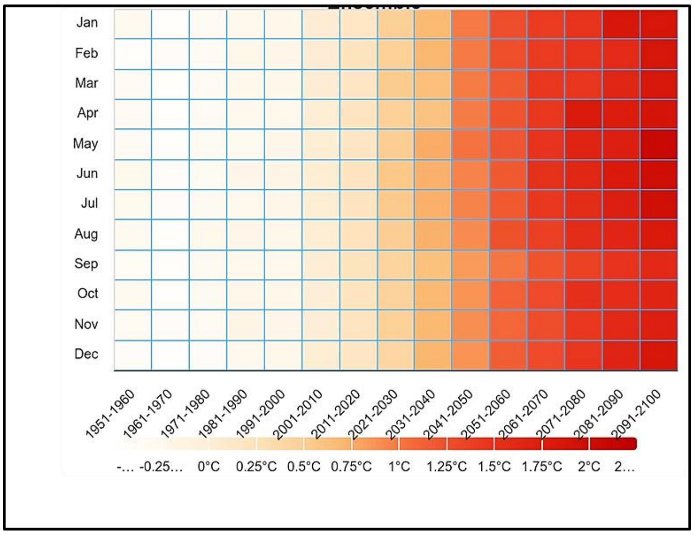

Fig. 4. Projected multi-model ensemble decadal monthly mean temperature for the Western Province of Sri Lanka from 2020 to 2100 under SSP4.5.

Table 1. SSP2-4.5 Projected monthly average temperatures in Western Province from 2020 to 2100.

Year	Projected monthly average temperature	Highest average Temperature month	Lowest average Temperature month
2021-2030	0.48°C	December(0.55°C)	January(0.40°C)
2031-2040	0.71°C	August(0.76°C)	January (0.61°C)
2041-2050	0.95°C	August (1.03°C)	September (0.85°C)
2051-2060	1.18°C	August(1.27°C)	September (1.02°C)
2061-2070	1.39°C	August (1.52°C)	September (1.23°C)
2071-2080	1.55°C	August (1.81°C)	September (1.36°C)
2081-2090	1.68°C	August (1.85°C)	September (1.49°C)
2091-2100	1.85°C	August (2.08°C)	September (1.62°C)

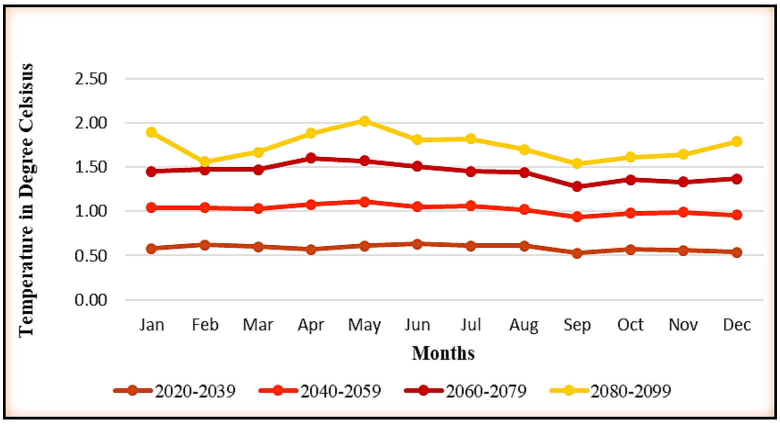

Fig. 5. Ensemble view of projected temperature for the western region of Sri Lanka under SSP2 4.5 in various models for every month.

According to the SSP2 4.5 carbon emission scenario, Figure 5 illustrates a comprehensive projection of how the temperature in the Western Province will escalate from 2020 to 2100. Upon examining Figure 4, it becomes apparent that the temperature increments correspond to the timeframes of 2020-2039, 2040-2059, 2060-2079, and 2080-2099. Specifically, the forecast suggests that the average temperature in the Western Province will rise to 0.59°C between 2020-2039, 1.03°C between 2040-2059, 1.44°C between 2060-2079, and 1.74°C between 2080-2099 under the stipulated SSP2 4.5 scenario.

Following the SSP2 4.5 carbon emission scenario, a conclusive inference can be drawn that the average temperature in the Western Province will increase by 1.20°C from 2020 to 2100. Notably, the maximum average monthly temperature in the Western Province is predicted to rise by 0.63°C between 2020-2039, 1.11°C between 2040-2059, 1.60°C between 2060-2079, and 2.02°C between 2080-2099, with the most pronounced increment observable in June. Conversely, the minimum average monthly temperature is forecast to decline by 0.53°C in 2020-2039, 0.94°C in 2040-2059, 1.28°C in 2060-2079, and 1.54°C in 2080-2099, with the most considerable decrease being registered in September across all timeframes.

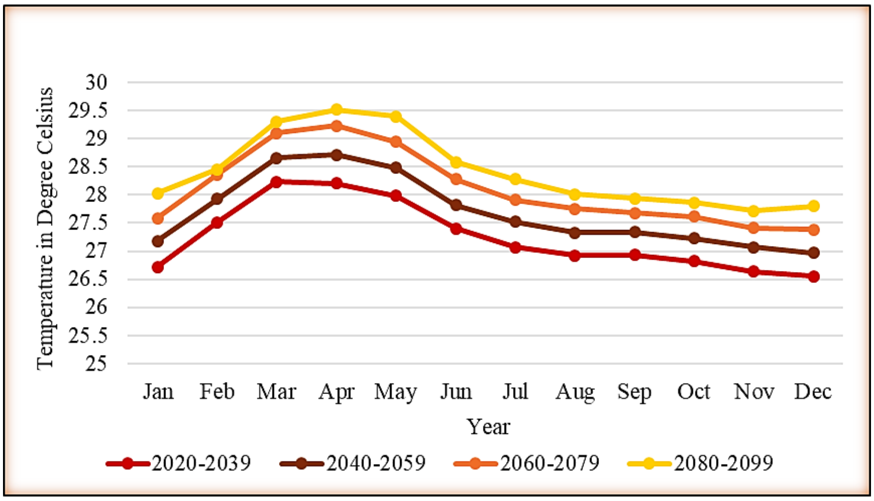

Fig. 6. Ensemble view of projected temperature for the western region of Sri Lanka under SSP2 4.5 in various models for every month.

According to the content of Fig. 5, it is predicted that the highest temperature will be recorded in April for all types of periods. In this context, the temperature is expected to increase continuously, reaching 28.2°C in 2020-2039, 28.71°C in 2040-2059, 29.23°C in 2060-2079, and 29.51°C in 2080-2099. Similarly, it is predicted that the lowest temperature will be recorded in December for all types of periods. In this context, the temperature is expected to decrease continuously, reaching 26.55°C in 2020-2039, 26.97°C in 2040-2059, 27.38°C in 2060-2079, and 27.8°C in 2080-2099.

According to the data presented in Figure 5, it is anticipated that April will witness the highest recorded temperatures across all designated periods. Consequently, temperatures are projected to rise steadily, reaching 28.2°C in the years 2020-2039, 28.71°C in 2040-2059, 29.23°C in 2060-2079, and culminating at 29.51°C in 2080-2099. In a similar vein, December is expected to register the lowest temperatures during all periods surveyed. Within this context, temperatures are forecasted to decline consistently, arriving at 26.55°C in 2020-2039, 26.97°C in 2040-2059, 27.38°C in 2060-2079, and finally 27.8°C in 2080-2099.

3.2. Future temperature changes under SSP 8.5

The subsequent figure (Figure 7) delineates the variations in future temperature change patterns monthly under the Shared Socioeconomic Pathway (SSP) 8.5 scenario, derived from projections of forthcoming climatic shifts. This analysis is grounded in data procured from the World Bank's Climate Change Knowledge Portal, encompassing monthly statistics from 1951 to 2100. According to the findings, temperatures in the Western Province are expected to persistently escalate. While the 1950s recorded temperatures within the negative range, by 2050, a rise of over 1°C is anticipated across all months, from January through December. Moreover, by 2100, a further increase exceeding 3°C is forecasted for each month of the year.

Notably, the monthly average temperature from 1951 to 2020 was observed to be -0.20°C, whereas the expectation for the period from 2020 to 2100 is to elevate to 1.95°C. It is predicted that the monthly temperatures will continue to ascend in each successive decade from 2020 to 2100. The subsequent Table, Table 2, illustrates the average monthly temperatures delineated for each decade.

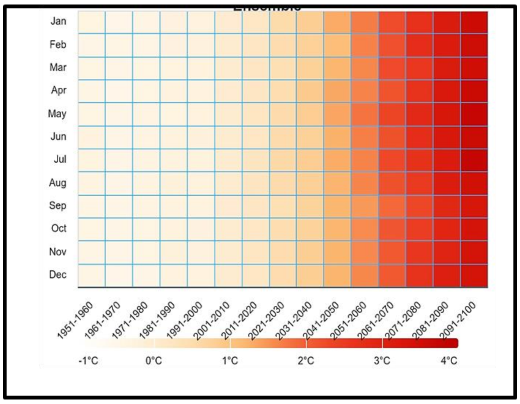

Fig. 7. Projected multi-model ensemble decadal monthly mean temperature of the Western Province of Sri Lanka for the period from 2020 to 2100 under SSP5- 8.5.

Table 2. SSP5-8.5 projected monthly average temperatures in Western Province from 2020 to 2100.

Year	Projected monthly average temperature	Highest average temperature month	Lowest average temperature month
2021-2030	0.51°C	July (0.58°C)	March (0.43°C)
2031-2040	0.79°C	April (0.89°C)	October (0.73°C)
2041-2050	1.24°C	November (1.21°C)	September (1.11°C)
2051-2060	1.63°C	May (1.78°C)	September (1.46°C)
2061-2070	2.17°C	May (2.35°C)	September (1.90°C)
2071-2080	2.62°C	May (2.86°C)	September (2.31°C)
2081-2090	3.13°C	May (2.29°C)	September (2.89°C)
2091-2100	3.53°C	July (3.73°C)	September (3.31°C)

The map illustrated in Fig. 8 depicts the anticipated rise in average temperature within the Western Province from 2020 to 2100, predicated on the SSP5 8.5 carbon emission scenario. It is forecasted that the temperature will incrementally escalate over time, with the most pronounced increases evident in the later decades. Specifically, under the SSP5 8.5 framework, the average temperature in the Western Province is projected to surge by 0.64°C from 2020 through 2039, 1.44°C from 2040 to 2059, 2.40°C from 2060 to 2079, and 3.32°C from 2080 to 2099. In summary, the average temperature in the Western Province is expected to rise by 1.95°C from 2020 to 2100 under the SSP5 8.5 carbon emission scenario.

The text indicates that under the SSP5 8.5 scenario, the average maximum temperature in the Western Province of Sri Lanka is anticipated to elevate by 0.67°C in June between 2020 and 2039, 1.57°C in May from 2040 to 2059, 2.65°C in May from 2060 to 2079, and 3.57°C in May from 2080 to 2099. Conversely, the average minimum temperature is projected to decline by 0.58°C in October between 2020 and 2039, 1.29°C between 2040 and 2059, 2.09°C between 2060 and 2079, and 3.10°C in September from 2080 to 2099. (Fig. 8). The apex temperature is anticipated to occur in April throughout all timeframes. For April, the projected temperatures are: 28.29°C for 2020-2039, 28.17°C for 2040-2059, 30.08°C for 2060-2079, and 31.13°C for 2080-2099. In contrast, the lowest temperature is expected in December across all periods. For December, the projected temperatures are: 26.67°C for 2020-2039, 27.44°C for 2040-2059, 28.42°C for 2060-2079, and 29.23°C for 2080-2099 (Fig. 9).

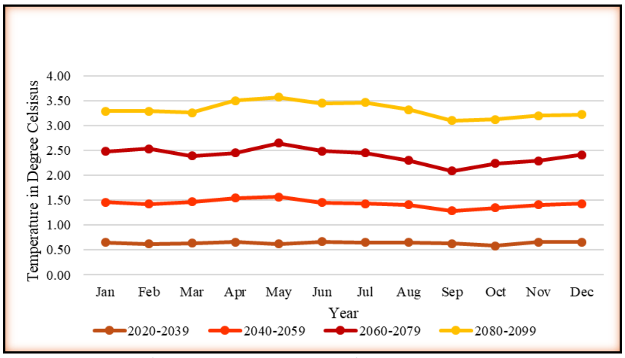

Fig. 8. Ensemble view of projected temperature for the western region of Sri Lanka under SSP5-8.5 in various models for every month.

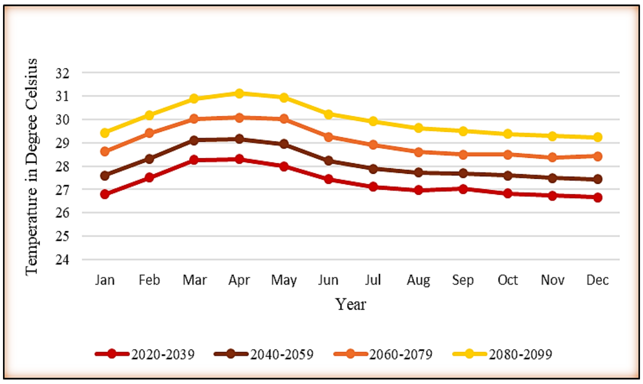

Fig. 9. Ensemble view of projected temperature for the Western Region of Sri Lanka under SSP5 8.5 in various models for every month.

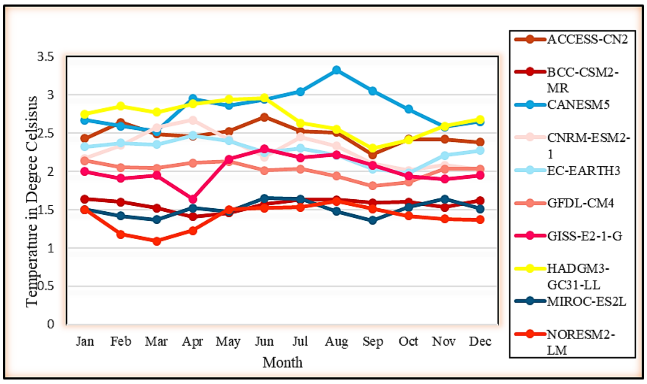

Fig. 10. Various models projected temperature under SSP5 8.5 from 2020 to 2100 in the Western Region of Sri Lanka.

This research on anticipated climate change in the Western Province is based on ten models and delineates various scenarios of future climatic trends within a shared socio-economic framework. Significantly, the study encompasses these ten models and their aggregated conclusions regarding the variability of future climate change characteristics across distinct climatic epochs. In this context, the synthesized findings derived from the models illustrate the projected rise in temperatures in the Western Province from 2020 to 2100, predicated on the carbon emission scenario of SSP5 8.5 (Table 3).

Table 3. Monthly basis projected temperature changes in various models under SSP5 8.5 scenarios for the Western region of Sri Lanka.

Types of models	**Projected average temperature**
ACCESS-CN2	2.48°C
BCC-CSM2-MR	1.57°C
CANESM5	2.83°C
CNRM-ESM2-1	2.28°C
EC-EARTH3	2.26°C
GFDL-CM4	2.02°C
GISS-E2-1-G	2.02°C
HADGM3-GC31-LL	2.69°C
MIROC-ES2L	1.51°C
NORESM2-LM	1.40°C

The models forecast that the highest temperature in the Western Province will reach 2.83°C, as projected by the CANESM5 model, while the lowest temperature is anticipated to be 1.40°C, as predicted by the NORESM2-LM model. There is considerable variance in the temperature predictions among the models for each month. According to these projections, a temperature increases of 2.75°C is forecasted for January between 2020 and 2100, as suggested by the HADGM3-GC31-LL model, whereas the minimum temperature for January is estimated at 1.5°C, according to the NORESM2-LM model. In February, the peak temperature is anticipated to be 2.85°C, again predicted by the HADGM3-GC31-LL model, with a minimum of 1.18°C, as forecasted by the NORESM2-LM model.

For March, the HADGM3-GC31-LL model projects a maximum temperature of 2.77°C, while the NORESM2-LM model predicts a minimum temperature of 1.09°C. The highest temperature values for the initial three months are recorded by the HADGM3-GC31-LL model. For April, the CANESM5 model forecasts a maximum temperature of 2.95°C, while the NORESM2-LM model estimates a minimum of 1.23°C. The lowest temperature value for the first four months originates from the predictions of the NORESM2-LM model. In May, the maximum temperature is projected at 2.95°C by the HADGM3-GC31-LL model, contrasted by a minimum temperature of 1.46°C, as forecasted by the BCC-CSM2-MR model. The HADGM3-GC31-LL model also predicts a maximum temperature of 2.96°C for June, with a minimum temperature of 1.52°C anticipated by the NORESM2-LM model.

The CANESM5 model predicts the highest temperature values for July, August, September, and October, with forecasts of 3.04°C, 3.32°C, 3.05°C, and 2.81°C, respectively. The NORESM2-LM model indicates the lowest temperature for July at 1.53°C. For August and September, the MIROC-ES2L model predicts minima of 1.48°C and 1.36°C, respectively. Likewise, the NORESM2-LM model forecasts the lowest temperatures for October, November, and December at 1.42°C, 1.38°C, and 1.37°C, respectively. Meanwhile, the HADGM3-GC31-LL model predicts the highest temperatures for November at 2.59°C and for December at 2.68°C.

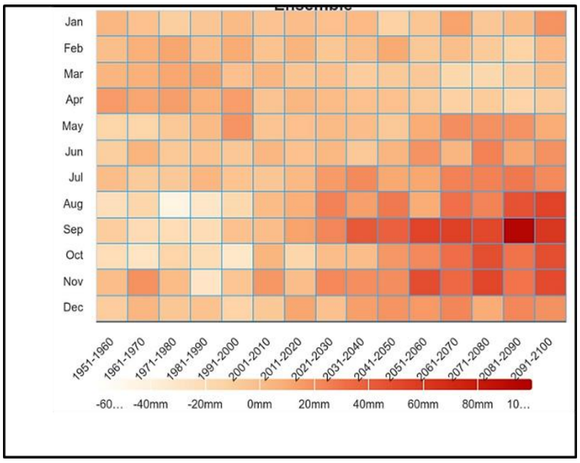

Fig. 11. Projected multi-model ensemble decadal monthly rainfall changes of the Western Province of Sri Lanka for the period from 2020 to 2100 under SSP2 4.5.

3.3. Future projections of precipitation trends under the SSP2 4.5 scenario

A comprehensive investigation conducted by the World Bank's Climate Change Knowledge Portal has scrutinized and published data extracted from a period spanning from 1951 to 2100, with a particular focus on monthly records. Notably, the Western Province is anticipated to exhibit a pronounced shift in precipitation patterns under the SSP2 4.5 scenario. Following an initial period of predominantly negative rainfall during the 1950s, projections indicate a substantial increase by the year 2100. Specifically, the annual precipitation levels observed from 1951 to 2020 stood at a relatively meager -37.16mm, whereas a notable surge to 179.85mm is forecast for the period from 2021 to 2100, as depicted in Fig. 11. A meticulous examination of monthly precipitation data reveals a consistent trend of increasing rainfall from 2021 to 2100, with each decade exhibiting a distinct upward trajectory. The following Table provides a detailed breakdown of monthly rainfall data for each decade (Table 4).

Table 4. SSP2-4.5 Projected Monthly Rainfall Changes in Western Province from 2020 to 2100.

Year	Projected average precipitation	Highest Average Precipitation Month	Lowest Average Precipitation Month
2021-2030	80.62mm	August (24.54mm)	February 5 (-5.12mm)
2031-2040	97.19mm	September (43.43mm)	March (-9.54mm)
2041-2050	120.69mm	September (39.40mm)	January (-12.34mm)
2051-2060	166.99mm	September (53.95mm)	March (-6.75mm)
2061-2070	211.54mm	September (55.88mm)	March (-16.19mm)
2071-2080	217.23mm	November (52.74mm)	March (-16.63mm)
2081-2090	247.14mm	September (95.03mm)	April (12.96mm)
2091-2100	297.44mm	September (61.82mm)	April (-7.65mm)

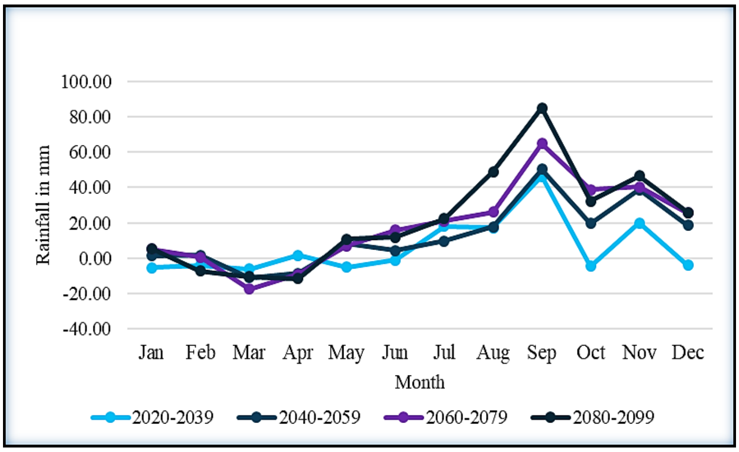

Fig. 12. Ensemble view of projected precipitation for the Western Region of Sri Lanka under SSP2 4.5 in various models for every month.

Fig. 12 elucidates the anticipated shifts in future rainfall patterns under the SSP2 4.5 scenario across various climatic intervals. It delineates the distinct trends in precipitation projected for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099. Under the SSP2 4.5 framework, the annual rainfall in the Western Province is expected to escalate from 72.90 mm in 2020-2039 to 259.76 mm in 2080-2099, representing a cumulative increase of 175.48 mm from 2020 to 2100. September is anticipated to emerge as the month with the most substantial rise in rainfall throughout all four periods. For example, in September, rainfall is forecasted to ascend from 46.37 mm in 2020-2039, to 50.42 mm in 2040-2059, to 64.79 mm in 2060-2079, ultimately reaching 85.15 mm in 2080-2099. In contrast, March is projected to endure the steepest decline in rainfall during the periods 2020-2039 (-6.27 mm), 2040-2059 (-10.94 mm), and 2060-2079 (-17.52 mm). Notably, in the 2080-2099 timeframe, April is expected to witness the most pronounced decrease (-11.68 mm).

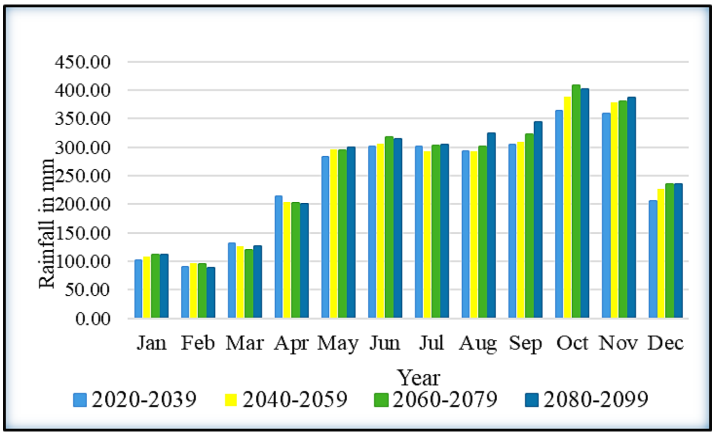

Fig. 13. Ensemble view of projected precipitation changes for the Western Region of Sri Lanka under SSP2 4.5 in various models for every.

The Fig. 13 and Table 5 illustrates the anticipated precipitation levels in October and February for the period spanning 2020 to 2099, under the constraints of the SSP2 4.5 scenario. Notably, it is forecast that October will receive the most substantial rainfall throughout the year, with precipitous increases projected over the coming decades. The predicted rainfall totals for the respective intervals reveal a gradual upward trend: 364.45 millimeters during the years 2020-2039, rising to 388.74 millimeters in the period between 2040-2059, 407.67 millimeters between 2060-2079, and ultimately stabilizing at 401.24 millimeters between 2080-2099. Conversely, February is anticipated to experience the lowest rainfall during the specified timeframe. A downward trend is expected, with forecast amounts decreasing over time: 90.97 millimeters predicted for the years 2020-2039, 96.63 millimeters for the period between 2040-2059, 95.44 millimeters between 2060-2079, and a minimal 87.82 millimeters between 2080-2099.

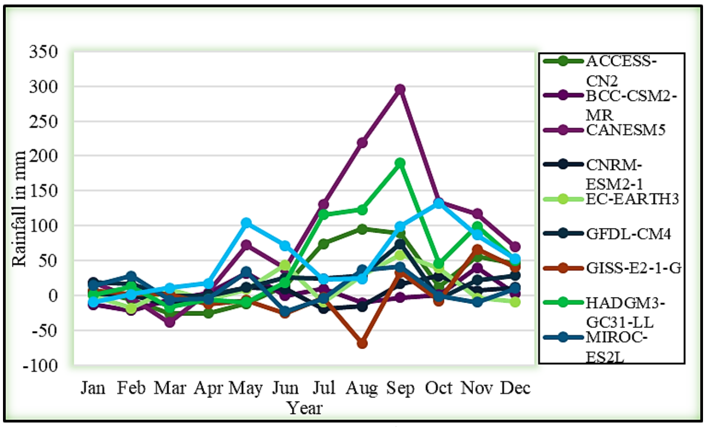

Fig. 14. Various models projected precipitation under SSP2 4.5 from 2020 to 2100 in the Western Region of Sri Lanka.

Table 5. Monthly basis projected precipitation changes in various models under SSP2 4.5 scenarios for the Western region of Sri Lanka.

Types of models	Projected annual precipitation
ACCESS-CN2	324.72m
BCC-CSM2-MR	32.33mm
CANESM5	105.16mm
CNRM-ESM2-1	37.36mm
EC-EARTH3	140.2mm
GFDL-CM4	240.84mm
GISS-E2-1-G	25.48mm
HADGM3-GC31-LL	624.01mm
MIROC-ES2L	113.3mm
NORESM2-LM	614.85mm

The investigation into prospective climate change in the Western Province of Sri Lanka is grounded in the analysis of ten distinct models. These models have been employed to forecast future climatic patterns across various socio-economic scenarios, encompassing several climatic periods. The study encompasses these ten models and the overarching conclusions derived from their analyses. Under the SSP2 4.5 carbon emission scenario, the models project an increase in rainfall within the Western Province from 2020 to 2100 (Fig. 14). While there are disparities in rainfall predictions among the models throughout this epoch, the overarching trend suggests an upward trajectory. According to the CANESM5 model, the province is anticipated to record the highest rainfall (1058.16 mm) alongside the lowest temperature (25.48 °C). The GFDL-CM4 model forecasts January as the month with the greatest average rainfall (18.776 mm), whereas the BCC-CSM2-MR model indicates that the same month will witness the least rainfall (-13.25 mm). Likewise, the MIROC-ES2L model predicts that February will experience the most precipitation (27.64 mm), while the BCC-CSM2-MR model suggests it will also have the lowest rainfall (21.57 mm) during that month.
From March to June, the NORESM2-LM model anticipates the highest levels of precipitation, ranging from 11.07 mm in March to 104.14 mm in June. Conversely, March is expected to record the lowest rainfall according to the CANESM5 model (38.94 mm), while both April and May are predicted to have the least precipitation as per the ACCESS-CM2 model (25.34 mm and 11.88 mm, respectively). Furthermore, June is projected to experience the lowest rainfall according to the GISS-E2-1-G model (25.38 mm). From July to December, the CANESM5 model foresees the highest precipitation levels, ranging from 130.49 mm in July to 295.95 mm in September. The GISS-E2-1-G model predicts the lowest monthly rainfall for June (-25.38 mm), while the CNRM-ESM2-1 model suggests July will see the lowest rainfall (-19.12 mm). Additionally, the GISS-E2-1-G model projects the lowest levels for August (-68.46 mm), the BCC-CSM2-MR model for September (-32.9 mm), the GISS-E2-1-G model for October (-7.81 mm), the MIROC-ES2L model for November (-9.65 mm), and the EC-EARTH3 model for December (-9.04 mm).

3.4. Future precipitation changes under SSP5 8.5

The Climate Change Knowledge Portal of the World Bank has meticulously analyzed and disseminated data regarding anticipated alterations in rainfall patterns within the Western Province under the SSP5 8.5 scenario.

This analysis spans from the year 1951 to 2100. The findings indicate a significant increase in rainfall in the Western Province by 2100 when compared to the levels recorded in 1950. Specifically, the average annual precipitation is forecasted to rise from a deficit of 49.29 mm between 1951 and 2020 to an increase of 198.52 mm between 2021 and 2100. Furthermore, the analysis anticipates a sustained rise in monthly rainfall across each decade from 2020 to 2100. The Table 6 presents the projected average monthly rainfall for every decade. Fig. 15 illustrates these variations.

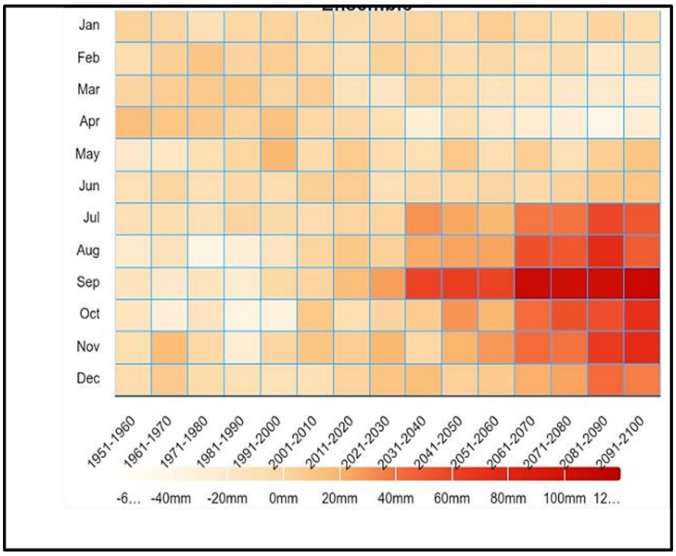

Fig 15. Projected Multi-model ensemble decadal monthly rainfall changes of the Western Province of Sri Lanka for the period from 2020 to 2100 under SSP5 8.5.

Table 6. SSP5-8.5 Projected Monthly Rainfall Changes in Western Province from 2020 to 2100

Year	Projected annual precipitation	Highest average precipitation month	Lowest average precipitation month
2021-2030	21.79mm	September (26.71mm)	March (-16.49mm)
2031-2040	94.93mm	September (60.89mm)	April (-28.11mm)
2041-2050	151.18mm	September (63.91mm)	April (-7.64mm)
2051-2060	123.41mm	September (61.15mm)	April (-18.70mm)
2061-2070	262.15mm	September (106.49mm)	April (-24.40mm)
2071-2080	247.08mm	September (103.33mm)	April (-29.00mm)
2081-2090	339.95mm	September (103.32mm)	April (-40.38mm)
2091-2100	347.68mm	September (108.19mm)	April (-27.22mm)

Figs 16 and 17 illustrate the anticipated transformations in precipitation patterns in the Western Province under the SSP5 8.5 scenario across various timeframes: 2020-2039, 2040-2059, 2060-2079, and 2080-2099. The annual rainfall in the Western Province is expected to see a considerable escalation under SSP5 8.5, rising from 61.16 mm between 2020 and 2039 to 382.45 mm by 2080-2099. This signifies a total augmentation of 209.78 mm throughout the period from 2020 to 2100. The figure further underscores the monthly distribution of rainfall, with September consistently projected to be the wettest month across all four intervals. In contrast, April is anticipated to be the driest month during the earlier periods (2020-2039 and 2040-2059), whereas March will emerge as the driest month in the subsequent periods (2060-2079 and 2080-2099). Monthly rainfall is also expected to rise across all timeframes, with the increase in monthly precipitation from 2020-2039 to 2080-2099 ranging from 5.10 mm to 31.87 mm.

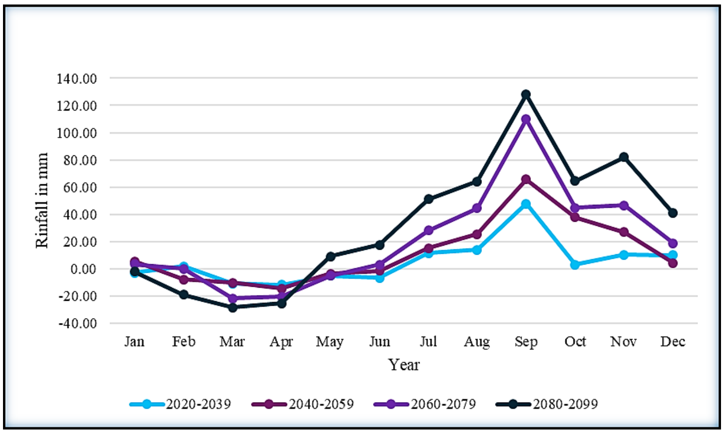

Fig. 16. Ensemble view of projected precipitation for the Western Region of Sri Lanka under SSP8.5 in various models for every month.

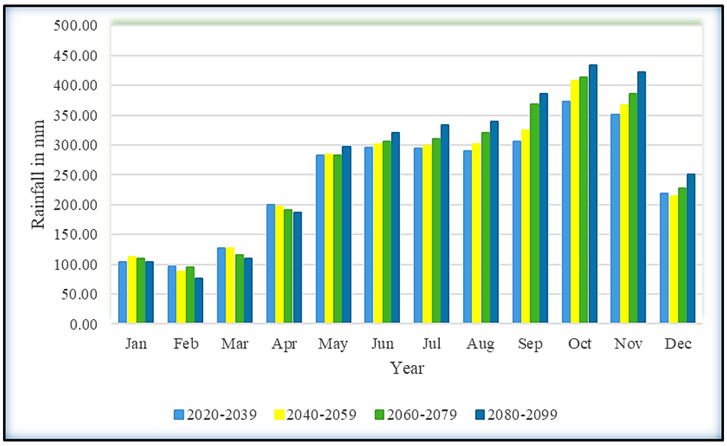

Fig. 17. Ensemble view of projected precipitation for the Western Region of Sri Lanka under SSP5 8.5 in various models for every.

The SSP5 8.5 scenario forecasts a remarkable surge in rainfall during October across all examined time frames. This increase is most pronounced between 2040 and 2059, with anticipated rainfall reaching 406.97 mm, in contrast to 372.01 mm recorded in 2020-2039. The upward trend persists, with projected levels rising to 413.92 mm in 2060-2079 and culminating at 433.35 mm in 2080-2099. In contrast, February is expected to witness a reduction in rainfall, with the most substantial decline occurring during 2040-2059, predicting only 87.11 mm compared to 96.71 mm in 2020-2039. This downward trajectory continues, with further reductions expected to 95.06 mm in 2060-2079 and a mere 76.09 mm in 2080-2099.

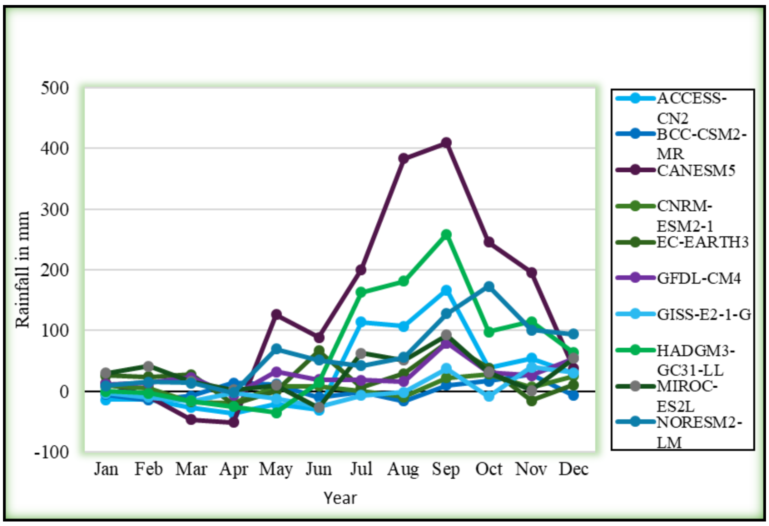

Fig. 18. Various models projected precipitation under SSP5 8.5 from 2020 to 2100 in the Western Region of Sri Lanka.

This study investigates the prospective climate changes in the Western Province, utilizing ten distinct models within the Shared Socioeconomic Pathway (SSP) framework. It delves into the implications of various climate scenarios across different SSPs on future climatic conditions. Notably, the study emphasizes the SSP5 8.5 scenario, which embodies a high greenhouse gas emissions trajectory. The models forecast a considerable augmentation of rainfall in the Western Province from 2020 to 2100 under SSP5 8.5. Additionally, discrepancies in projected rainfall patterns emerge among the models; while certain models anticipate an increase, others indicate a decrease. Nonetheless, the overarching trend suggests a likely elevation in rainfall in the Western Province throughout this period (Table 7).

Table 7. Monthly basis projected precipitation changes in various models under SSP5 8.5 scenarios for the Western region of Sri Lanka.

Types of models	**Projected annual precipitation**
ACCESS-CN2	370.3mm
BCC-CSM2-MR	19.82mm
CANESM5	1593.87mm
CNRM-ESM2-1	67.15mm
EC-EARTH3	273.18mm
GFDL-CM4	319.12mm
GISS-E2-1-G	22.92mm
HADGM3-GC31-LL	815.43mm
MIROC-ES2L	366.36mm
NORESM2-LM	751.05mm

The models present diverse projections for rainfall across various months. For example, January records the highest predicted rainfall of 29.93 mm, according to the MIROC-ES2L model, whereas the ACCESS-CM2 model indicates a strikingly low projection of -13.57 mm. Similarly, February forecasts a maximum of 41.58 mm from the MIROC-ES2L model and a minimum of -14.08 mm from the BCC-CSM2-MR model. March and April also reveal considerable fluctuations; March's highest projection reaches 27.73 mm from the EC-EARTH3 model, contrasted by a nadir of -46.76 mm from the CANESM5 model. April's peak projection is 14.05 mm from the BCC-CSM2-MR model, while its lowest estimate plummets to -51.13 mm from the CANESM5 model. From May to November, the models forecast an upward trend in rainfall, with CANESM5 displaying the most elevated projections for each month. December's apex is forecasted at 94.21 mm from the NORESM2-LM model. The analysis reveals a projection of diminishing minimum monthly average rainfall from May to December across various models. This decline is particularly pronounced in July, where CNRM-ESM2-1 anticipates a substantial drop of -32.39 mm. Additionally, both August and September are anticipated to witness reductions in rainfall, with BCC-CSM2-MR predicting declines of -15.72 mm and 10.07 mm, respectively. October is also expected to register diminished rainfall, with GISS-E2-1-G forecasting -8.58 mm. Similarly, November and December are projected to experience slight downturns in rainfall, with EC-EARTH3 estimating reductions of -15.06 mm and -7.07 mm, respectively. In light of the SSP2 4.5 and SSP5 8.5 carbon emission scenarios, it is anticipated that the Western Province will encounter a notable reduction in rainfall, culminating in heightened drought conditions. This phenomenon is attributable to factors such as population growth, urbanization, and rising temperatures. The interplay of these elements, coupled with decreased rainfall, could intensify drought circumstances in the region. The Table 8 delineates the temperature trend in the Western Province of Sri Lanka from 2020 to 2100, according to the SSP2 4.5 and SSP5 8.5 carbon emission scenarios. Both scenarios indicate a rising temperature trajectory throughout this period, with SSP5 8.5 exhibiting a more pronounced increase compared to SSP2 4.5 and considerable studies related to climate change in Sri Lanka indicating the same results (Jayawardene et al., 2020; Gunaratne et al., 2021; Dananjaya et al., 2022; Senatilleke et al., 2022). When examining the monthly temperature fluctuations, variations are apparent within both scenarios. The Table 8 illustrates how monthly temperatures diverge across different time frames (2020-2039, 2040-2059, 2060-2079, and 2080-2099) under the SSP2 4.5 and SSP5 8.5 scenarios. It succinctly summarizes the average temperature trend from 2020 to 2100 under both emission scenarios.

However, there are variations between the models used in this study and the ensemble considered to conclude the monthly pattern (Dasandara et al., 2021).

Table 8. Results of mean temperature trends from 2020 to 2100 under SSP2 4.5 and SSP5 8.5.

Year	SSP2 4.5	SSP5 8.5
2020-2039	0.59°C	0.64°C
2040-2059	1.03°C	1.44°C
2060-2079	1.44°C	2.40°C
2080-2099	1.74°C	3.32°C
2020-2100	1.20°C	1.95°C

The monthly temperature trajectories for both scenarios are delineated. In each instance, April is anticipated to record the highest temperatures, while December is expected to present the lowest. However, the IPCC models reveal a degree of variability in monthly temperature forecasts among different models. Some models predict a more pronounced increase in certain months, while others indicate a lesser (Dasandara et al., 2021). For the overarching period spanning 2020 to 2100, the CANESM5 model anticipates the most substantial average temperature elevation under SSP5 8.5, at 2.83°C. Conversely, the NORESM2-LM model forecasts the minimal increase, at 1.40°C. The table illustrates the anticipated rainfall patterns in the Western Province of Sri Lanka from 2020 to 2100, predicated on the SSP2 4.5 and SSP5 8.5 carbon emission scenarios. Both scenarios suggest a prevailing trend of increasing rainfall throughout the period, with SSP5 8.5 exhibiting a more pronounced escalation compared to SSP2 4.5. Upon scrutinizing monthly rainfall, fluctuations become apparent in both scenarios. The table depicts the variability of monthly rainfall across distinct time frames (2020-2039, 2040-2059, 2060-2079, and 2080-2099) under each of the SSP2 4.5 and SSP5 8.5 scenarios. It succinctly summarizes the average rainfall trajectory from 2020 to 2100 under both emission projections (Table 9).

Table 9. Results of annual precipitation trends from 2020 to 2100 under SSP2 4.5 and SSP5 8.5.

Year	SSP2 4.5	SSP5 8.5
2020-2039	72.90mm	61.16mm
2040-2059	150.93mm	143.81mm
2060-2079	218.32mm	251.68mm
2080-2099	259.76mm	382.45mm
2020-2100	175.48mm	209.78mm

According to the analysis, the Western Province of Sri Lanka is forecast to experience a precipitous decline in rainfall in the years to come, with the degree of the decline varying significantly depending on the Shared Socioeconomic Pathway (SSP) and climate model utilized (ADB, 2022). Under SSP2-4.5, the average annual rainfall is projected to decrease by a substantial 14.62 mm, whereas under SSP5-8.5, the anticipated decrease is significantly more marked, at 17.48 millimeters. Furthermore, the analysis also indicates that the seasonal distribution of rainfall is likely to undergo a transformation. In both SSP2-4.5 and SSP5-8.5, the most considerable rainfall is anticipated to occur in October, whilst the lowest rainfall is forecast to manifest in February. The climate models employed in the analysis exhibit a diverse array of projections for future rainfall, ranging from a pronounced decrease to a more moderate decrease in precipitation. In particular, the CANESM5 model projects the highest average annual rainfall under SSP2-4.5 (88.18 mm), whilst the GISS-E2-1G model projects the lowest (2.12 mm). Conversely, under SSP5-8.5, the CANESM5 model projects the highest average annual rainfall (132.82 mm), whereas the BCC-CSM2-MR model projects the lowest (1.65 mm). Climate change constitutes a pressing global challenge that permeates every corner of the world, exacting a devastating impact on ecosystems and human societies alike. The Western Province of Sri Lanka is particularly vulnerable to the detrimental effects of climate change, rendering it essential to examine the potential impacts of this phenomenon on the region and devise effective strategies to mitigate its adverse consequences.

4. Conclusion

In accordance with the study, the temperature in the Western Province is projected to rise by 1.20°C under SSP2-4.5 and 1.95°C under SSP5-8.5. This upward trajectory in temperature portends a multitude of adverse consequences, including scorching heatwaves, exacerbated urban heat island effects, and a dearth of potable water. In response to these challenges, the study advocates several measures to be undertaken.

Firstly, it accentuates the pivotal role that individual actions play in reducing greenhouse gas emissions. Secondly, it recommends implementing urban greening initiatives in Colombo and Gampaha to mitigate the urban heat island effect, involving the planting of additional trees, creation of verdant spaces, and promotion of green roofs. Thirdly, it suggests introducing cool roofs in low-income areas of Colombo and Negombo to decrease indoor temperatures. Fourthly, it advises establishing public cooling centers in areas most susceptible to heatwaves to provide relief during periods of extreme heat. Lastly, it recommends upgrading drainage systems in low-lying areas to mitigate the risk of flooding during heavy rainfall events.

A multifaceted approach can be employed to reduce the impact of climate change, including the promotion of public transportation to decrease carbon emissions, imposition of fines on vehicles with low passenger occupancy, and establishment of new routes for vehicles during peak traffic hours. Additionally, it is imperative to take climate change into consideration when granting permits for development projects. Other measures to combat climate change encompass reducing plastic usage, minimizing deforestation, and accelerating the adoption of green technologies. By implementing these strategies, we can significantly diminish the negative effects of climate change on our environment. Notably, the study cautions that the adverse consequences under the SSP5-8.5 scenario will be more pronounced than those under SSP2-4.5. Consequently, it is imperative for individuals to cognizance the reality of climate change and act accordingly.

Acknowledgments

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