Chapter 1
Impact of Climate Change and Its Adaptation in the Semi-arid Environment of Flood-Prone Dechatu Catchment, Dire Dawa, Ethiopia

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Abstract This study aims to assess the future trends, and magnitude of climatic factors (temperature and rainfall) using different representative concentration pathways (RCP4.5 and RCP8.5) integrated with the identification of existing climatic adaptation practices in the Dechatu catchment, Ethiopia. Four global/derived regional climatic models (GCMs/RCMs)—CanESM2, CNRM-CM5, EC-EARTH and MIROC5—were used to understand the changes in temperature and rainfall (2025–2075); and their trend using the Trend-Free Pre-Whitening Mann–Kendall test. The highest annual daily peak rainfall was identified in all models. However, none of the rainfall data series exhibited a trend at a 5% significance level except in CanESM2 of RCP8.5. In contrast, a significant monotonic increase in temperature is forecasted in all RCMs, with higher temperature increments (1–1.50 °C in RCP8.5) in a 25-year interval. Water management, as an adaptation option to climate extremes, is considered in the semi-arid environment of Dechatu. Among others, the use of traditional hand-dug wells, flood plain excavation (locally named *Chirosh*) as drinking water sources, floodwater diversion, contour farming and dropping of shrub branches on the river banks to conserve transported soils are included. Therefore, integrating the local adaptation with conventional water management practices will reduce the impacts of climate change.

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Introduction

Climate variability and change are one of the major environmental challenges of the twenty-first century, posing a threat to human well-being (Wuebbles 2018). The increase in the concentration of greenhouses gases in the atmosphere contributes to a potential change and variability in climate, particularly in precipitation and temperature (Rind et al. 1989), and global warming is indeed occurring (IPCC 2014a, b). Shewmake (2011) explained that the changes in rainfall patterns and shifts in temperature zones are expected to increase the frequency and intensity of climate-related extremes in Sub-Saharan Africa (Ringler 2008). Across the globe, an increase in frequency and intensity of extreme events like floods, droughts, heatwaves, etc. may be anticipated as a result of climate change (IPCC et al. 2021). Future climate change projection also shows that food security will be affected in the drylands of Africa and in the high mountain regions of Asia and South America (Porter et al. 2015; Mbow et al. 2019).

The rainfed agricultural practice in Africa is adversely impacted by climate change due to flooding in coastal areas, water scarcity in arid/semi-arid areas, a decline in agricultural production, worsening desertification inland with low adaptive capacity, and poor infrastructural developments which mitigate the impacts (Mendelsohn and Dinar 2003; Shewmake 2011). Furthermore, indigenous and local ecological knowledge of climate adaptations are side-lined in policymaking and implementation in Africa, particularly in indigenous communities, and climate change has therefore caused a significant strain on those communities (Leal Filho et al. 2021). Therefore, to cope with negative climatic influences, it is necessary to integrate the conventional weather forecasting systems and climate information and policies with the local and indigenous knowledge.

Teshome and Zhang (2019) have demonstrated that there is an increase in extreme drought events in Ethiopia as a result of changes and trends of climate extremes. Moreover, various studies have revealed that prolonged heat stress as a result of high-temperature extremes could impact terrestrial biota, livestock and human lives (Kilbourne 1999; Basu and Samet 2002; Argaud et al. 2007). Billi et al. (2015) have pointed out that an increase in rainfall intensity has caused an increase in the frequency of occurrence of flash floods in Dire Dawa, when compared to the land use change effects due to anthropogenic impacts.

The semi-arid climate of Dire Dawa city has experienced more than 11 major flash flood events since 1945; the 2006 flooding event caused numerous fatalities (339 human deaths) and displacements (9027) of people (Erena and Worku 2018). Consequently, to reduce and cope with the negative impacts of the climate extremes in the Dechatu catchment, it is necessary to understand the future precipitation and temperature patterns, as well as the trends and magnitude, including identification of best existing practices for water management. As such, climate adaptation mechanisms play a substantial role in planning and developing effective adaptation strategies to mitigate climate extremes.

Aims and Objectives

This chapter aims to highlight the future prediction, trends, and magnitude of climatic factors (temperature and precipitation) on a seasonal and annual basis using different emission scenarios or representative concentration pathways (RCP4.5 and RCP8.5), in line with identifying the existing climatic adaptation options—specific to water management aspects—in the flood-prone Dechatu catchment, Dire Dawa, Ethiopia.

Materials and Methods

Study Area

Dechatu Catchment (DC) is part of the Dire Dawa City Administration situated in the eastern part of Ethiopia. Geographically, the area is located between 09° 28.1″ to 09° 49.1″ N Latitude and 41° 38.1″ to 42° 19.1″ E Longitude (Fig. 1.1). The area is characterized as having a semi-arid climate with a relatively low level of rainfall, with the frequent occurrence of flash flooding from the upper catchment of Dechatu. The mean annual rainfall ranges between 812 mm in the highlands to 612 mm at the foothills of Dire Dawa city. The Dechatu catchment (149.83 km^2) includes 4 sub-watersheds (Chiri, Alla, Dure and Gogeti); it experiences river flows only when there is rainfall in a catchment, and it is characterized as a dry river bed with no flowing water on the surface.

Data Used

Four regional climate models, with a spatial resolution of 0.44° for the RCP4.5 and RCP8.5 emission scenarios, were used, as shown in Table 1.1. The ensemble mean data is available in the context of the Coordinated Regional Climate Downscaling Experiment (Giorgi et al. 2009) over Africa at 0.44° resolution for the period 1950–2100 and it has already been used throughout Africa (Nikulin et al. 2012, 2018; Gbobaniyi et al. 2014; Dosio 2017; Osima et al. 2018). The daily observed and the GCMs data from 1981 (considered as historical data) were overlapped and bias-corrected to predict the future climatic scenarios (2025–2075) of RCP4.5 and RCP8.5.
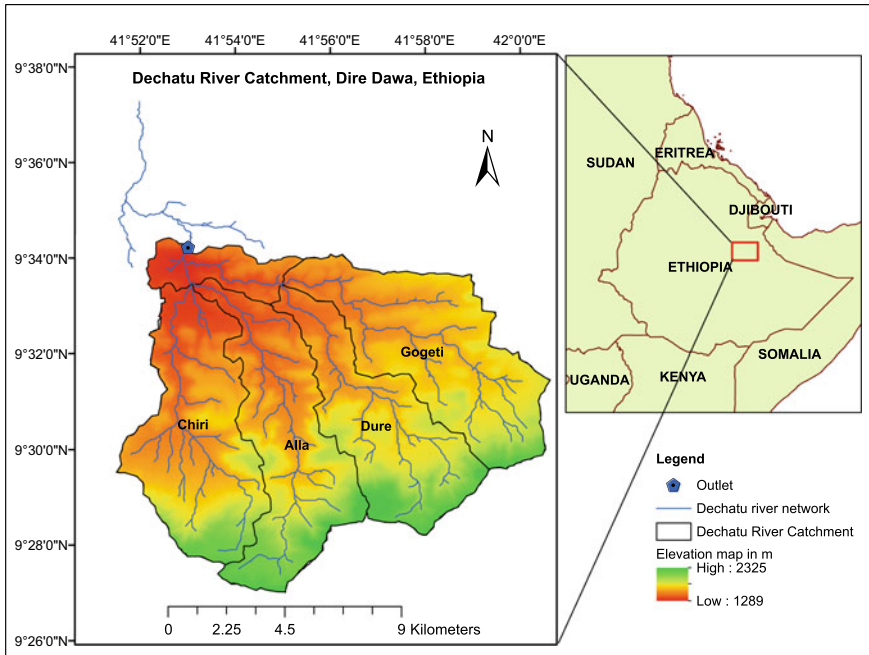
Fig. 1.1 Location map of Dechatu catchment, Dire Dawa Administration, Ethiopia

Table 1.1 Summary of the applied Regional Climate Models (RCMs) and their driving Global Climate Models (GCMs) (http://wcrpcordex.ipsl.jussieu.fr/)

GCMs	RCMs	Institution/source/	URL
CanESM2	CanRCM4_r2	Canadian Centre for Climate Modeling and Analysis (CCCma)	http://climate-modelling.canada.ca/
CNRM-CM5	CCLM4-8-17_v1	Climate Limited-area Modelling Community (CLMcom)	https://esg-dn1.nsc.liu.se/
EC-EARTH	CCLM4-8-17_v1	Climate Limited-area Modelling Community (CLMcom)	https://esg-dn1.nsc.liu.se/
MIROC5	RCA4_v1	Rossby Centre, Swedish Meteorological and Hydrological Institute (SMHI)	https://esg-dn1.nsc.liu.se/

Methods

The daily rainfall, daily peak, monthly and annual rainfall data were used where needed. In addition, the annual maximum and minimum temperature data were generated from the daily data set. The bias correction was adjusted using the past daily-observed rainfall and temperature data (1981–2014) using the power transformation function (for future rainfall data) and variance scaling methods (for future temperature data) via CMhyd software. The Tukey fence method is used to adjust the outliers of the rainfall records between 2025 and 2075. The projected temperature anomaly change (ΔT in °C) and rainfall characterization at different time-scales were analysed using various statistical methods, including the projected trend test via the Trend-Free prewhitened Mann–Kendall (TFPW-MK) test. When the time series data were not random and influenced by autocorrelation, the trend component is removed from the data and is prewhitened before the application of the trend test (Yue et al. 2002). This test analysis was performed using R-Studio Version 1.4.1103. All the graphs in these sections are plotted using Matlab R2020a and the method used for various future climatic models is summarized in Fig. 1.2.
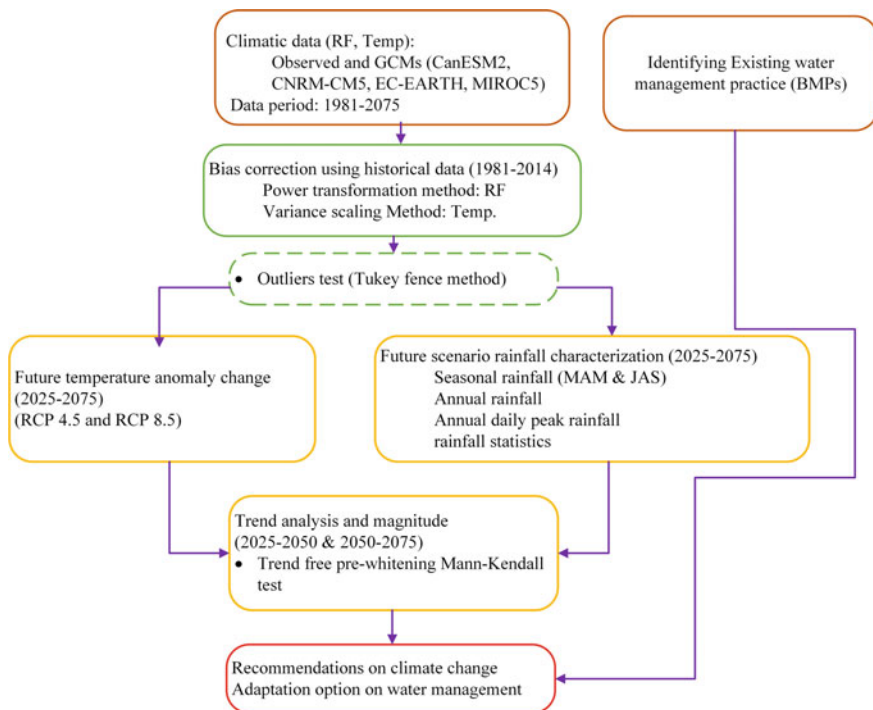

Fig. 1.2 Methodological framework used for the study

Climate Change Adaptation and Mitigation Mechanisms

In this study, various indigenous and local climate change adaptation and mitigation measures in the semi-arid catchment of Dire Dawa were identified. Major causes or challenges of climate change, including under rainfed and irrigation systems and the local mitigation practices for flash flood water management, were investigated via field surveys and the review of various documents for the catchment. In addition, aerial coverage and the types of existing best management practices (BMPs) to control soil erosion, moisture conservation and groundwater recharging mechanisms were identified using field surveys, digital elevation model (DEM) data, land use shapefile, google imageries, and high-resolution satellite imageries downloaded using SAS Planet program.

Results and Discussion

Temperature Anomaly (ΔT in °C) of DRC

The term temperature anomaly (Tanomaly) is defined as a deviation from a long-term average, with positive/negative Tanomaly values, indicating that the observed temperature was warmer/cooler than the reference value (Pyrgou et al. 2019).

The linear regression results of the GCMs temperature records show an increment in temperature anomaly in both RCP4.5 and RCP8.5. Comparing the emission scenario types, the RCP8.5 showed a higher temperature increment on a yearly basis (Table 1.2).

In every 25-year interval (2025–2050 and 2050–2075), a minimum of 0.5 °C (in MIROC5 and CNRM-CM5) and a maximum of 0.75 °C (in CanESM2) mean temperature increments are observed using RCP4.5. Similarly, the RCP8.5 mean temperature anomaly changes range from 1.00 °C (in CNRM-CM5 and EC-EARTH) to 1.50 °C in CanESM2 in every 25-year interval. Also, 1.3 °C increments in mean

Table 1.2 Temperature anomaly change in every year (°C/yr)

GCMs	RCP4.5			RCP8.5		
	T_{max}	T_{min}	Mean	T_{max}	T_{min}	Mean
CanESM2	+0.03	+0.03	+0.03	+0.07	+0.05	+0.06
CNRM-CM5	+0.03	+0.01	+0.02	+0.05	+0.03	+0.04
EC-EARTH	+0.04	+0.01	+0.03	+0.05	+0.03	+0.04
MIROC5	+0.02	+0.02	+0.02	+0.05	+0.04	+0.05

T_{max}: Maximum temperature in °C; T_{min}: Minimum temperature in °C

temperature are depicted in the MIROC5 data set for a given interval (Fig. 1.3 and Table 1.2). This indicates that the heat stress in the catchment is imminent unless appropriate biological and physical soil and water conservation measures for soil moisture retention and recharging of groundwater, including afforestation practices, are utilised in the catchment.

Future Scenario for Rainfall Analysis

The annual daily peak rainfall (ADPRF) data series of four GCMs rainfall data series showed that higher rainfall records between 2036 and 2064 will be detected in RCP4.5 of CanESM2. Similarly, in CNRM-CM5 of RCP4.5, the highest annual daily peak rainfall was predicted in 2040, 2053 and 2065. A higher forecast of rainfall records was identified in RCP8.5 of EC-EARTH (2031, 2054, 2065 and 2069) and MIROC5 (2025–2038), respectively (Fig. 1.4).

The linear regression of the ADPRF trends (RCP4.5 and RCP8.5) shows 4- and 7-mm increments in CanESM2 and 4.6- and 2.31-mm increments in MIROC5 in every 25-year interval (Table 1.3 and Fig. 1.4). EC-EARTH rainfall forecast depicted a decrease in rainfall in both RCPs. However, in the CNRM-CM5 rainfall records, it showed an alternative increment in RCP8.5 (1.03 mm) and a decrease (−2.24 mm) in every quarter of the century. In general, the annual daily peak rainfall amounts showed very high variability yearly, even though the linear regression values showed a relatively small increment or decrement in every 25-year intervals (Table 1.3).

Seasonal and Annual Rainfall Analysis

The mean annual rainfall records for various emission scenarios (RCP4.5 and RCP8.5) exhibited lower estimates in MIROC5 and maximum estimates in CanESM2 for the data analysis range of 2025–2075. The mean annual rainfall ranges between 2025 and 2050 are 421 mm/yr in MIROC5and 740 mm/yr in EC-EARTH and the lowest in MIROC5 (498 mm/yr) and the highest (754 mm/yr) in CanESM2 for RCP4.5 and RCP8.5, respectively. In addition, the lowest (in MIROC5) and the highest (in CanESM2) mean annual rainfall between 2050 and 2075 range from 489 to 714 mm/yr in RCP4.5 and 464–1009 mm/yr in RCP8.5 (Table 1.4, Figs. 1.5 and 1.6). The box plot shows the median, quantile, and range of areal-averaged rainfall using various GCM Models (2025–2075) illustrated in Figs. 1.5 and 1.6.

The bimodal rainfall characteristics of DRC are explained using the seasonal (March–April-May designated as MAM and July–August-September designated as JAS seasons) and annual rainfall conditions. The largest quantile range—between a lower and upper quantile—of rainfall was forecasted in the MAM season of CanESM2 in all four types of the model from 2025 to 2075 in both RCPs except in EC-EARTH of the RCP4.5 records of JAS season (Figs. 1.5 and 1.6). The lowest
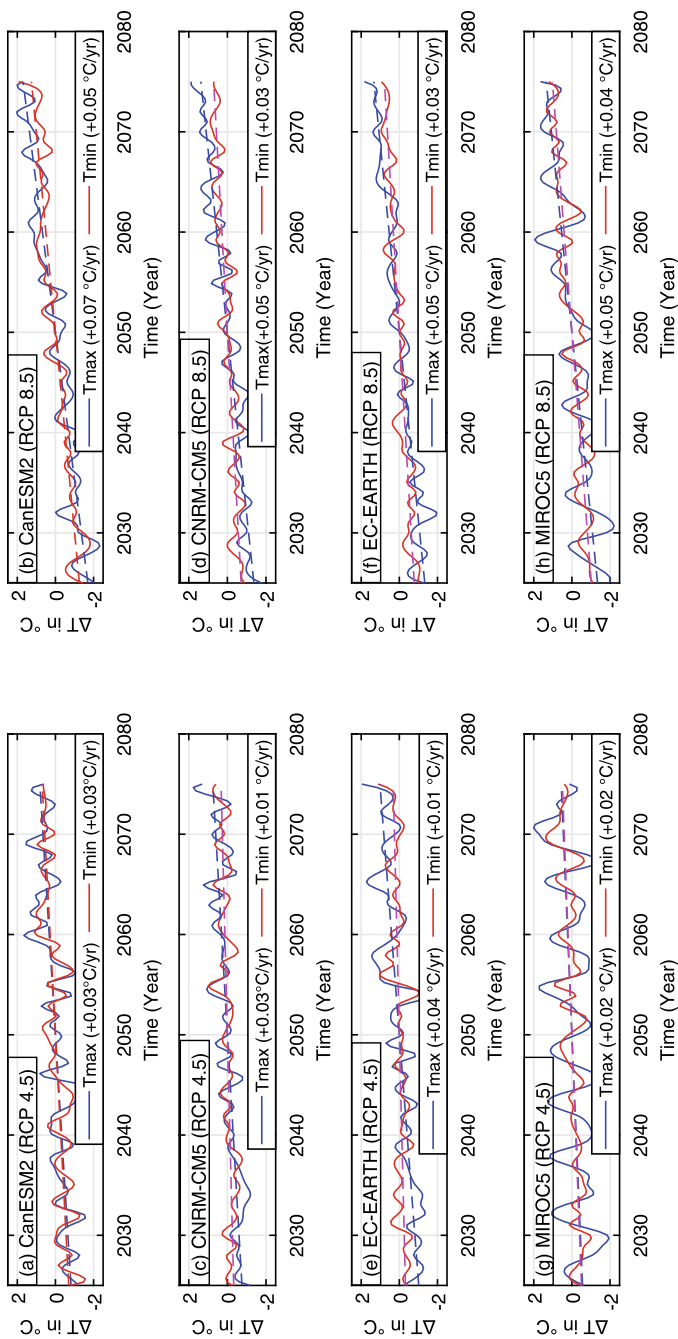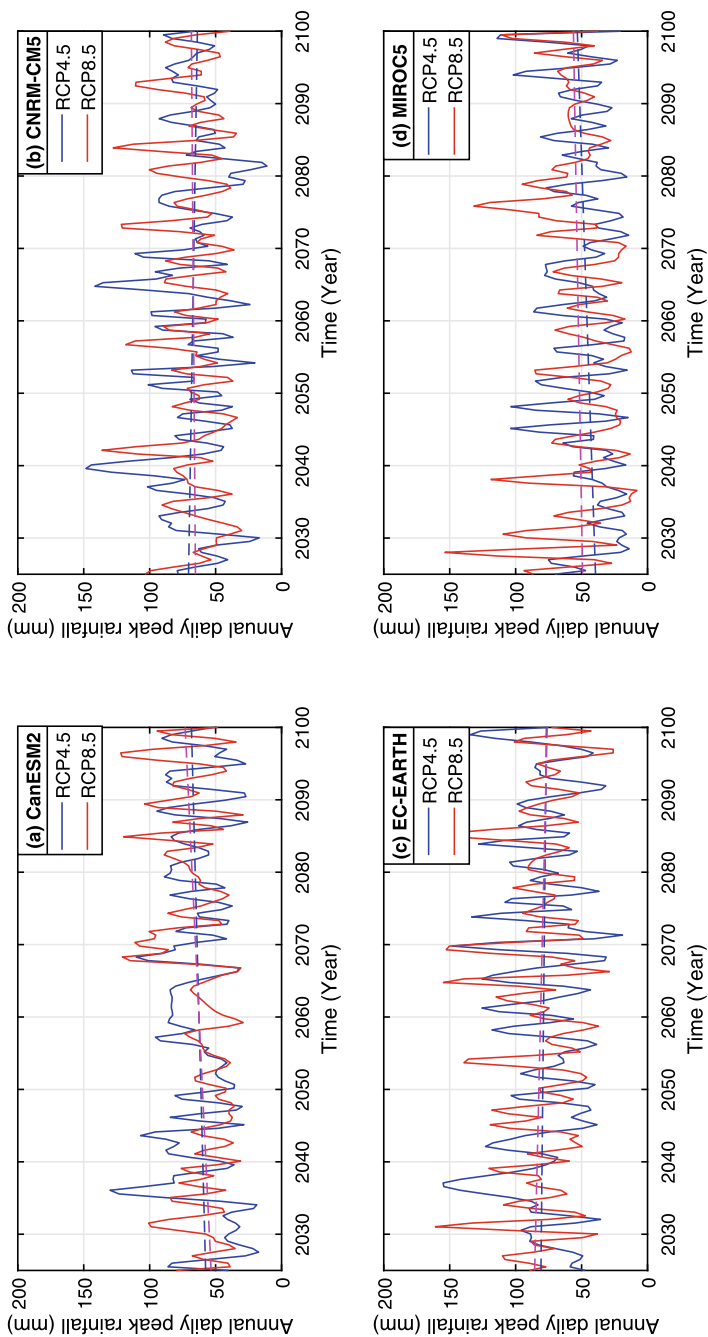
Fig. 1.3 Temperature anomaly (ΔT in °C) for future scenarios of RCP4.5 and RCP8.5

Fig. 1.4 Annual daily peak rainfall of different GCMs models (2025–2100)

Table 1.3 Linear regression of the annual daily peak rainfall trends in every 25 years (2025–2100)

| GCMs	Rainfall changes in 25 years interval (mm)	
	RCP4.5	RCP8.5
CanESM2	3.59	6.55
CNRM-CM5	−2.24	1.03
EC-EARTH	−1.38	−3.17
MIROC5	4.60	2.31

Table 1.4 Seasonal and annual rainfall deviation of Dechatu catchment under various GCMs (2025–2075)

| GCMs	MAM	JAS	Annual	MAM	JAS	Annual
	SD (RCP4.5 of 2025–2050)			SD (RCP8.5 of 2025–2050)		
CanESM2	219	115	326	210	136	309
CNRM-CM5	120	89	240	105	102	178
EC-EARTH	168	117	329	180	105	167
MIROC5	86	60	143	167	137	206
	SD (RCP4.5 of 2050–2075)			SD (RCP8.5 of 2050–2075)		
CanESM2	195	134	255	331	135	548
CNRM-CM5	172	88	287	158	92	170
EC-EARTH	154	107	233	152	116	201
MIROC5	105	128	198	63	72	196

SD Standard Deviation; *MAM* March–April–May seasons; *JAS* July–August–September seasons

standard deviation (SD) of the projected rainfall under different emission scenarios and GCMs for a period of 2025–2050 (the MAM season) are observed in MIROC5 (RCP4.5) and CNRM-CM5 (RCP8.5), respectively (Table 1.4). In the JAS season, the MIROC5 and CNRM-CM5 show the lowest SD in RCP4.5 and RCP8.5, respectively. Moreover, the annual rainfall records depicted a lower dispersion in MIROC5 in RCP4.5 and CNRM-CM5 in RCP8.5 (Table 1.4).

Considering the period from 2050 to 2075, the largest rainfall quantile (25–75% of the rainfall data) ranges are observed in RCP4.5 emission scenarios of CNRM-CM5 (in MAM season), CanESM2 (in JAS season) and MIROC5 (in annual rainfall data), respectively. The RCP8.5 emission scenario of this period is also explained, as the largest quantile ranges in CanESM2 (MAM season) and EC-EARTH (JAS season and annual rainfall series) were observed (Fig. 1.6). Furthermore, the lowest SD in the RCP4.5 emission scenario was noted in MIROC5 during the MAM season and annual rainfall records. However, in the RCP8.5 emission scenarios, the MIROC5 climatic data experienced a lower dispersion from the mean in the MAM and JAS seasons. Similarly, the projected annual rainfall records in CNRM-CM5 also showed a lower SD (Table 1.4).
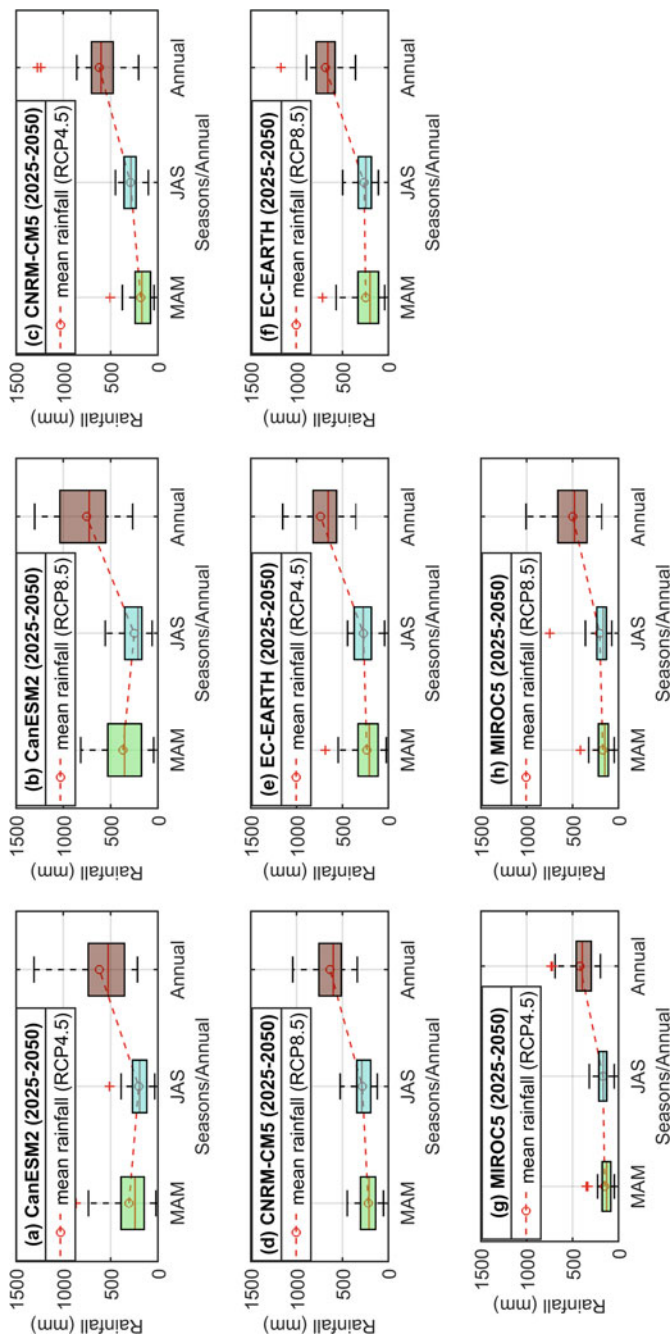
Fig. 1.5 Box plot showing the median, quantile, and range of areal-averaged rainfall using various GCM Models (2025–2050)
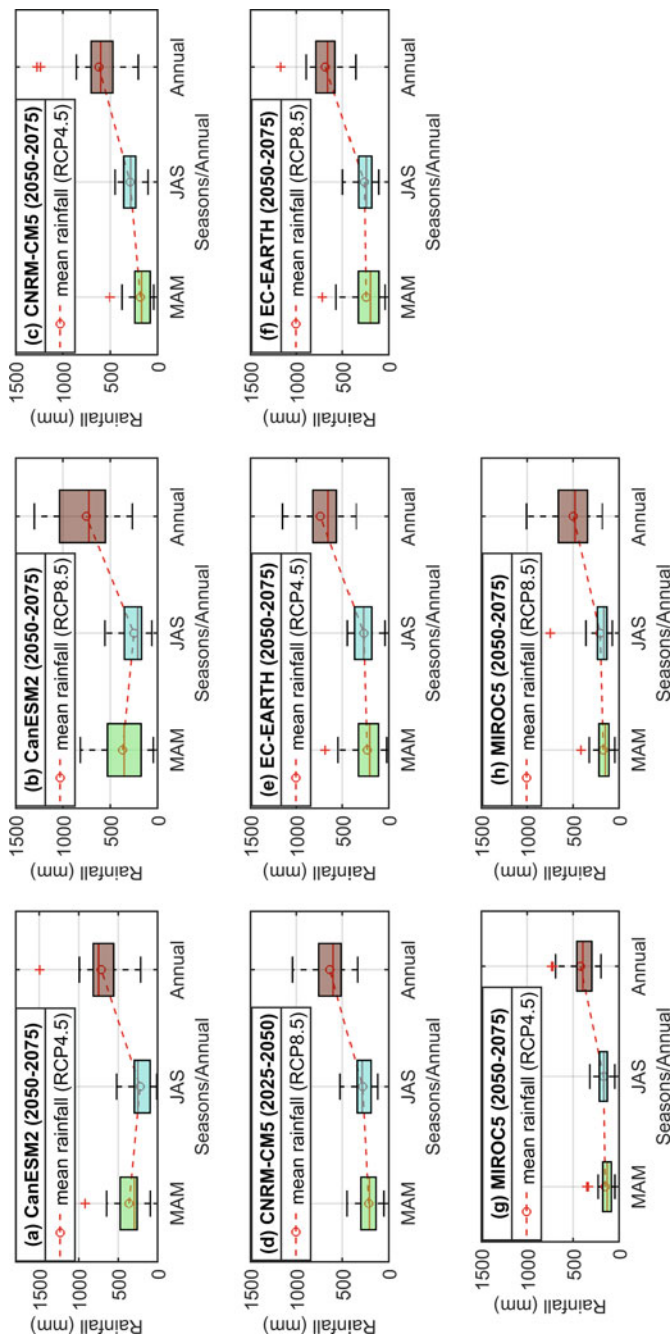
Fig. 1.6 Box plot showing the median, quantile, and range of areal-averaged rainfall using various GCM Models (2050–2075)

Table 1.5 TFPW-MK trend test for annual daily peak rainfall series for future scenarios of RCP4.5 and RCP8.5 (2025–2075)

GCM	Z-value	Sen's Slope	Old Sen's Slope	P-value	S	Tau
	RCP4.5					
CanESM2	0.93	0.06	0.00	0.35	205.00	0.07
CNRM-CM5	−0.16	−0.02	−0.03	0.88	−35.00	−0.01
EC-EARTH	−0.56	−0.09	−0.02	0.58	123.00	−0.04
MIROC5	1.79	0.21	0.17	0.07	393.00	0.14
	RCP8.5					
CanESM2	2.24[a]	0.26	0.23	0.02	491.00	0.18
CNRM-CM5	0.55	0.05	0.01	0.58	121.00	0.04
EC-EARTH	−0.89	−0.10	−0.11	0.37	195.00	−0.07
MIROC5	1.83	0.26	0.20	0.07	401.00	0.14

[a]Shows trend

Rainfall Trends Using the TFPW-MK Test

The trend and magnitude of the annual daily peak rainfall were tested using a modified MK (TFPW-MK) test. The lag-1 autocorrelation coefficient of annual daily peak rainfall records for the period of 2025–2075 was found to be within the recommended interval of the autocorrelation factor. Therefore, it can be concluded that the time series data of rainfall does not exhibit a significant autocorrelation. Then, testing using MK is acceptable after checking the autocorrelation of the data to avoid the biases of the MK test. At a 5% significance level, the annual daily peak rainfall records showed that none of these GCM rainfall data series exhibited a significant trend, except CanESM2 in RCP8.5, even though linear trends with increasing patterns have been detected using the linear regression model (Table 1.5). Daily peak rainfall records with increasing trend was noted in RCP4.5 (CanESM2 and MIROC5) and decreasing trends in CNRM-CM5 and EC-EARTH, respectively. Similarly, only EC-EARTH rainfall data records showed a decreasing trend in the RCP8.5 emission scenario (Table 1.5 and Fig. 1.4).

Temperature Anomaly Trends Using the TFPW-MK Test

The annual maximum and minimum temperature anomaly series for both emission scenarios were analyzed using a modified MK (TFPW-MK) test. The same procedure was followed for detecting the trends of temperature data as was used for the rainfall analysis. The time-series temperature data, except for the minimum temperature data of EC-EARTH with emission scenarios of RCP4.5, showed a significant autocorrelation at a 5% significance level. This shows that the lag-1 autocorrelation

coefficient is found to be outside the interval recommended between the lower and upper bound. Therefore, pre-whitening of the data was performed and tested with MK. The minimum and maximum temperature trends of the Dechatu catchment showed that there is a significant monotonic increase in trends of temperature at a 5% significant level with the change in anomaly as explained in Fig. 1.3, Tables 1.6 and 1.7.

Table 1.6 TFPW-MK trend test for annual maximum temperature anomaly series for future scenarios of RCP4.5 and RCP8.5 (2025–2075)

GCM	Z-value	Sen's Slope	Old Sen's Slope	P-value	S	Tau
	RCP4.5					
CanESM2	4.63	0.03	0.03	0.00	555.00	0.45
CNRM-CM5	5.40	0.03	0.03	0.00	647.00	0.53
EC-EARTH	5.84	0.04	0.04	0.00	699.00	0.57
MIROC5	5.40	0.03	0.03	0.00	647.00	0.53
	RCP8.5					
CanESM2	7.51	0.07	0.07	0.00	899.00	0.73
CNRM-CM5	7.49	0.05	0.05	0.00	897.00	0.73
EC-EARTH	7.51	0.07	0.07	0.00	899.00	0.73
MIROC5	7.49	0.05	0.05	0.00	897.00	0.73

Table 1.7 TFPW-MK trend test for annual minimum temperature anomaly series for future scenarios of RCP4.5 and RCP8.5 (2025–2075)

GCM	Z-value	Sen's Slope	Old Sen's Slope	P-value	S	Tau
	RCP4.5					
CanESM2	4.85	0.03	0.03	0.00	581.00	0.47
CNRM-CM5	3.48	0.01	0.01	0.00	417.00	0.34
EC-EARTH	4.85	0.03	0.03	0.00	581.00	0.47
MIROC5	3.48	0.01	0.01	0.00	417.00	0.34
	RCP8.5					
CanESM2	7.60	0.05	0.05	0.00	909.00	0.74
CNRM-CM5	6.22	0.03	0.03	0.00	745.00	0.61
EC-EARTH	7.60	0.05	0.05	0.00	909.00	0.74
MIROC5	6.64	0.04	0.04	0.00	795.00	0.65

Climate Change Hazards, Adaptation and Mitigation Mechanisms

Climate Change Hazards

Farmers are aware of the climate change and variabilities in Eastern Ethiopia, which includes the semi-arid environment of the Dechatu catchment (Kidanu et al. 2016; Tesfaye and Seifu 2016; Mohammed 2018). This area is known for its extended dry spells in the rainy seasons, drought, extreme heat, and intensive agricultural practices in the hilly part of the catchment. It is further characterized by low productivity, a shortage of grazing land to feed cattle, and flash flooding as the direct influences of climate change in the area (Alemu 2015; Erena and Worku 2018). The projected finding reveals that there is variability in rainfall and an increase in temperature trends in the Dechatu catchment. This result concurs with the findings of Kidanu et al. (2016) using the past historical climatic trends of the Dechatu Catchment.

Water Management for Climate Adaptation and Mitigation

The heat stress and the scarcity of water during most of the productive season has forced the farmers in the region to look for the best water management options of adaptation and mitigation measures in the Dechatu catchment. However, the available soil and water management practices are limited in number and types to ensure resilience in communities that cope with the negative impact of climate change. Based on the field survey data in the catchment, the following moisture-retaining structures were identified for conserving the eroded soil and controlling runoff water, which can be used for either agricultural or recharging purposes (Table 1.8).

In comparing the entire catchment coverage (14,983 ha) from the GIS extracted data, the existing BMPs that were constructed to manage the water resources via water retention structures and mitigate the climate accounted for 17.4% (2,614 ha) of the total catchment area. The catchment is dominated by hilly topography, and the

Table 1.8 Existing best management practices (BMPs) in the Dechatu catchment

Existing BMPs	Land-use type	Area (ha)
Check dam	Bare land	31.5
	Shrubland	72.6
Terrace	Cultivated	929.5
	Cultivated *Khat*	827.2
	Shrubland	715.3
Terrace and trench	Shrubland	19.6
Trenches	Shrubland	17.8
	Total	2613.5

coverage of the existing water management practices is too small compared to the catchment size. In line with the above soil and water conservation measures (Table 1.8), the farmers use various adaptation and mitigation measures for climate change. Among these, the major practices used in the catchment include: traditional hand-dug wells to fetch the stored water in sandy soil during the rainy season and use it later in the dry period, shallow-depth excavation on the flood plain (locally named as *Chirosh*) for drinking water purpose, spate irrigation using floodwater diversion, contour farming, dropping shrub/tree branches on the river banks to conserve transported soils and cultivate the land 2–3 years later are prolifically used practices in the catchment. Some conventional water management practices, like constructing sand storage dams (currently one sand storage dam is identified), along the river course are implemented in the area with farmers' participation, regional climate and environmental offices, and other governmental and non-governmental bodies. These practices improve the resilience of the farmers to a changing climate in the region. Furthermore, the changing cropping patterns, crop types and varieties (short-duration and drought-tolerant crops), and crop diversification are also used as climate adaptation strategies as farm-level solutions in the semi-arid climate of Dire Dawa (Kidanu et al. 2016; Tesfaye and Seifu 2016).

Field et al. (2014) suggested an adaptation action that is either incremental or transformative, depending on the severity and frequency of extreme weather and climatic impacts (Loboguerrero et al. 2019). For example, with less climatic impacts, farmers in the Dechatu catchment can decide to change crop type to those requiring less water for the effective management of water resources, while more severe and frequent climatic impacts might force them to adopt transformative adaptive options. Furthermore, local solutions to climate change adaptation practices in the Dechatu catchment such as effective landscape-planning (development of small reservoirs, sediment storage dams, sand dams, irrigation development, irrigation water-saving technologies) must be implemented in a sustainable manner for all affected, including downstream users. In this catchment, groundwater is a major source of water for irrigation and other purposes; consequently, careful planning is required to avoid abstraction impacts that may cause a decrease in the groundwater reserves.

Conclusions

In this study, we assessed the future trends and magnitude of climatic parameters - mainly temperature and rainfall - and integrated them with the existing climate adaptation options for water management practices in the flood-prone Dechatu catchment, Ethiopia. The key findings of this study show that the projected rainfall exhibited high variability, but none of the rainfall data series exhibited a trend at a 5% significance level except in CanESM2 of RCP8.5. A significant monotonic increase in temperature is forecasted in all RCMs and higher in RCP8.5. This explains that heat stress in the catchment is imminent unless appropriate interventions are adopted to

avert the negative impacts of climate change. Incremental or transformative adaptation action is required to ensure effective water management practices, depending on the severity and frequency of extreme weather and climatic impacts in the semi-arid catchment of Dechatu.

Recommendations

- Establishment of local hydrological, weather, and climatic information services to reduce the impact caused by flash flooding through understanding the trends and seasonal/annual variability in order to effectively plan the water resources in the catchment.
- Implementation of water-saving technologies and landscape planning to minimize the groundwater abstraction impacts.
- Traditional and local knowledge requires a deliberate framework and approach to be considered in policy development, and in order to implement climate change adaptation strategies in line with the conventional water resource management approach.
- Mainstreaming the adaptive scaling approach to reduce competition for the scarce water among sectors in the catchment can create a resilient community that adapts to the negative impacts of climate change.
- As a limitation, this paper is more focused on the technical and traditional water management practices as mitigation mechanisms to climate extremes (flood, drought, heat stress, etc.) in the Dechatu Catchment. Therefore, further investigation on other indigenous coping mechanisms—traditional weather forecasting systems, use of wild edible fruits as a nutritional supplement and traditional medicines and use of indigenous crops, among others—to climate change and how these communities use the natural resources or habitats wisely as adaptation strategies to ensure their survivals under extreme conditions.

Cross-References

- Climate change
- Rainfall variability
- Temperature anomaly
- Climate adaptation
- Climatic model.

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