Climate Risk Screening for the Tonle Sap River Basin and the Mekong Delta River Basin, Cambodia

December 2019

Authors
Corjan Nolet
Jack Beard
Anthony Green
Johannes Hunink
Gijs Simons

Client
Asian Development Bank
Project No: TA-7610 CAM

FutureWater Report 208

FutureWater
Costerweg 1V
6702 AA Wageningen
The Netherlands

+31 (0)317 460050

info@futurewater.nl

www.futurewater.nl

Executive Summary

This report presents a Climate Risk Screening analysis in relation to proposed activities and investments to improve access to water resources in several selected basins in Cambodia as proposed by the Ministry of Water Resources And Meteorology (MOWRAM). This report is presented parallel to the detailed Surface Water and Resources Assessment (SWRA) which includes scenario analysis of several possible investment strategies. This Climate Risk Screening has considered historical trends in climate and extreme climatic events and used an ensemble of GCM projections to assess potential future trends for two time horizons (2020-2050, 2070-2099) under two climate change pathways (RCP4.5, RCP8.5). Key conclusions for the main basins are also included in the main SWRA report.

Project sensitivities are found to relate particularly to the following:

- Precipitation changes – Leading to changes in water availability and demand
- Temperature increases – Forcing changes to crop suitability, water requirements and yield, potential risks of wildfire
- Flooding – Incurring damage to irrigation infrastructure and irrigated areas, also leading to increased erosion and sedimentation problems
- Drought – Leading to reduction in the productivity of irrigated areas and increasing water resources and management issues in relation to water storage and distribution
- Typhoons and landslides – Leading to damage to water and agricultural infrastructure

Climate change projections indicate the following for the near future horizon (2020-2050):

- An increase in average annual precipitation in all basins, in the range of 5-15%. This is fairly uncertain due to a range of predictions within the GCM ensemble.
- An expected increase in temperatures for all Basin Groups, in the range of 0.9-1.2°C. Respective uncertainty is lower in the case of temperature but increases with more extreme climate scenarios.
- Extreme precipitation events (represented by an indicator for maximum annual 1-day precipitation) are likely to increase in intensity by 10-70%. Uncertainty in this prediction is fairly high.
- Trends in drought events (represented by an indicator of consecutive dry days) are unclear, with some GCMs predicting increases and some decreases. Uncertainty in this prediction is very high.
- Extreme temperature events (represented by an indicator for maximum annual 1-day temperature) are likely to increase in intensity by 1-2.2°C. Uncertainty in this prediction is medium.

Principal potential climate risks are found to stem largely from flooding, drought, and cyclones. These may impact proposed project components by directly damaging them, but also may lead to decreased returns from investments due to compromising agricultural productivity and water availability. It is therefore suggested that project components be designed to be resilient to these main risks, considering potential climate impacts. Generalized adaptation measures may include the improvement of hydrometric forecasting, investments in early warning systems and hazard management plans, and potential diversification of agricultural practices.

This assessment shows that an extended Climate Risk Assessment is required to support the Project Preparation phase. This should identify appropriate adaptation measures to be incorporated into each intervention to increase their respective resilience to future changes in climate and extreme events. It is recommended that according to the latest guidelines of ADB, that this assessment is performed using a “bottom up” methodology to allow for greater control on the part of decision makers involved in implementation.

Table of contents

Figures

Tables

1 Introduction

1.1 Background

The Asian Development Bank (ADB) is working in support of the Water Resources Management Sector Development Program in Cambodia, aiming to achieve enhanced food security and more resilient access to water for the region. The Ministry of Water Resources and Meteorology (MOWRAM) have identified, as part of its Roadmap and Investment Program for Irrigation and Water Resources Management, several focal projects to help support this effort. These are part of a more general move away from infrastructure focused on facilitating subsistence level farming towards works that target profitable agriculture, with investment based on farmers' needs.

The Rapid Assessment of the State of Water Resources report helped MOWRAM to make informed, evidence-based water resources management and irrigation investment decisions through better understanding of water resources and ecosystems of two river basin groups: the Tonle Sap and the Mekong Delta in Cambodia. This report helped to identify a number of Basin Groups, in total five, as appropriate for further consideration. Chosen investments target increasing water storage, expanding irrigation networks or redirecting water flows from areas with water surpluses to areas with shortages. These are located in the Mekong and Tonle Sap basins.

A detailed Surface Water Resources Assessment is performed on three of these five Basin Groups, and in the two others additional more specific questions are addressed. The report on this work is published parallel to this Climate Risk Screening report. This report presents a Climate Risk Screening Analysis on the five Basin Groups, considering the type of projects that are foreseen, and the likely changes in climate as projected by an ensemble of General Circulation Models (GCMs).

Figure 1. Location of "Basin Groups" identified by MOWRAM within Cambodia.

1.2 Scope of work

Since 2014, the Asian Development Bank (ADB) has required that all investment projects consider climate and disaster risk and incorporate adaptation measures in projects at-risk from geo-physical and climate change impacts. This is consistent with the ADB's commitment to scale up support for adaptation and climate resilience in project design and implementation, articulated in the Midterm Review of Strategy 2020: Meeting the Challenges of a Transforming Asia and Pacific (ADB, 2014a), in the Climate Change Operational Framework 2017–2030: Enhancing Actions for Low Greenhouse Gas Emissions and Climate-Resilient Development (ADB, 2017), and in the Climate Risk Management in ADB Projects guidelines (2014b).

The principal objective of a climate risk and vulnerability assessment (CRVA) is to identify those components of the project that may be at risk of failure, damage and/or deterioration from natural hazards, extreme climatic events or significant changes to baseline climate design values (ADB, 2011, 2014 and 2017). This serves to improve the resilience of the infrastructure to the impacts of climate change and geo-physical hazards, to protect communities and provide a safeguard so that infrastructure services are available when they are needed most. As part of this process, the nature and relative levels of risk are evaluated and determined to establish appropriate actions for each Basin Group which will help minimize climate change associated risk.

This report considers likely impacts of climate change and related phenomena on of the Basin Groups and related components prioritized by MOWRAM. This analysis is performed using the ADB's Climate Risk Management framework (ADB, 2014) to identify and reduce risks resulting from climate change on investment projects. A first step of this framework is a screening analysis, in which potential risks are presented and recommendations are provided for a more detailed Climate Risk Assessment. This should inform the design phase of the investment program.

To this end, this report:

- Analyzes for all Basin Groups the trends in temperature and precipitation based on downscaled climate model-dataset NASA-NEX, considering the multi-model-variability (=uncertainty) in the projections;
- Analyzes so-called climate extreme indices based on the climate projections, describing expected changes to drought- and flood-related indicators;
- For the proposed project components in each Basin Group, performs a climate risk categorization;
- Provides recommendations for a full climate risk and vulnerability assessment.

Chapter 2 summarizes the approach taken for this study. Chapter 3 considers expected project sensitivity to different climate variables. Chapter 4 discusses historical trends in key climate-related variables. Chapter 5 explores climate change projections for each of the project areas, focusing on trends in climate means and climate extremes. Chapter 6 explores potential risks for the project areas imposed by climate change, given project sensitivities and current and projected trends. Finally, Chapter 7 provides recommendations based on the perceived climate risk and vulnerabilities.

2 Climate risk screening method

2.1 General considerations

Generally, Climate Risk Assessment (CRA) tools and methodologies are selectively used depending on the sector and purpose. Many recent studies make a distinction between climate scenario-driven impact assessment approaches, often referred to as "**top-down**" and vulnerability-oriented approaches called "**bottom-up**." Figure 2 shows the main distinction between the top-down and the bottom-up approach; this relates to the way in which the two methodologies utilize GCM projections. The top-down approach is constrained to specific GCM projections, while the bottom-up approach considers a continuous range of potential changes in climate. Further discussions on this top-down and bottom-up approaches are presented by the World Bank (2015).

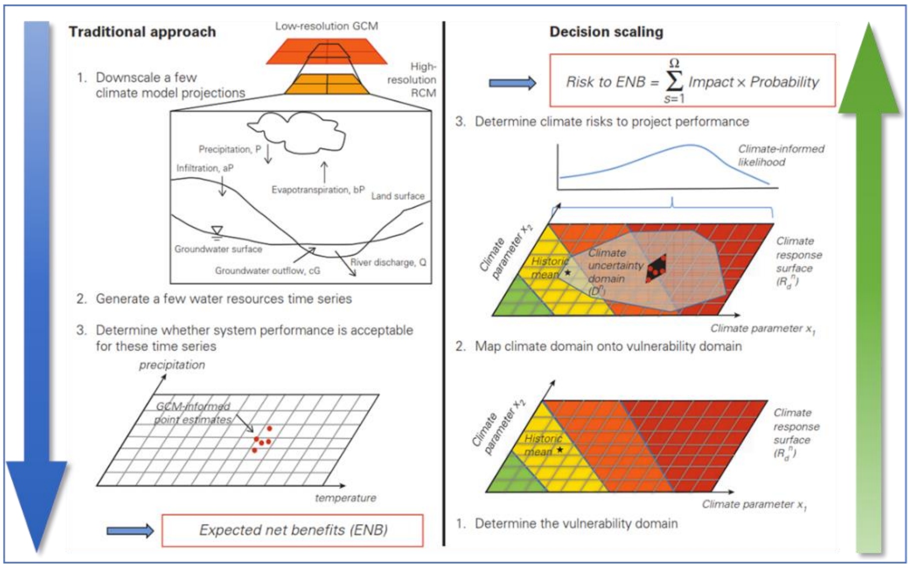


Figure 2. Schematic comparison of decision scaling, a bottom-up approach, (right) with traditional approach (left) to Climate Change Risk Assessment (based on World Bank, 2015).

Originally the name Climate Risk and Vulnerability Assessment (CRVA) was used by the ADB. However, since vulnerability is part of risk, often just the term Climate Risk Assessment is adopted. CRAs use a variety of often confusing definitions relating to risk and climate change. In this study the following definitions are used (adapted from IPCC, 2014), with links between concepts shown in Figure 3:

- Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected by climate change and variability.
- Sensitivity: The degree to which a system, asset, or species may be affected, either adversely or beneficially, when exposed to climate change and variability.
- Potential impact: The potential effects of hazards on human or natural assets and systems. These potential effects, which are determined by both exposure and sensitivity, may be beneficial or harmful.
- Adaptive capacity: The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of hazards.

- Vulnerability: The extent to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. It depends not only on a system's exposure and sensitivity but also on its adaptive capacity.
- Likelihood: A general concept relating to the chance of an event occurring. Generally expressed as a probability or frequency.
- Risk: A combination of the chance or probability of an event occurring, and the impact or consequence associated with that event if it occurs.

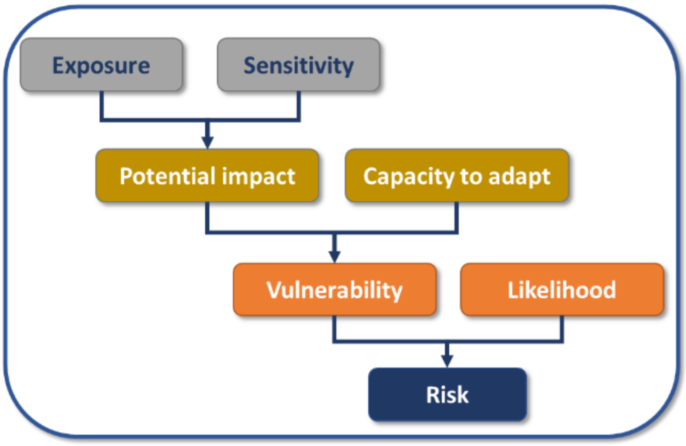


Figure 3. Climate Risk components. (based on http://www.ukcip.org.uk).

ADB has developed specific guidelines for climate proofing of investments and CRAs. Some relevant publications are:

- Climate risk management in ADB projects (ADB, 2014)
- Guidelines for Climate Proofing Investment in Agriculture, Rural Development, and Food Security (ADB, 2012)
- Guidelines for Climate Proofing Investment in the Water Sector: Water Supply and Sanitation (ADB, 2017)

These guidelines have in common that they stipulate the following main characteristics of climate risk proofing:

- To characterize climate risks to a project by identifying both the nature and likely magnitude of climate change impacts on the project, and the specific features of the project that make it vulnerable to these impacts.
- To identify the underlying causes of a system's vulnerability to climate change.
- To acknowledge that many of the future impacts of climate change are fundamentally uncertain and that project risk management procedures must be robust to a range of uncertainty.
- To ensure that adaptation measures are locally beneficial, sustainable, and economically efficient.

According to the ADB guidelines, Climate Risk Management of Investment Projects has several phases and steps in each phase. The first phase is the Climate Risk Screening (see Figure 4). After the Climate Risk Screening and depending on the risk level of the project components, a full Climate Risk Assessment should be performed, with adaptation options assessed during the Project Preparation Phase.

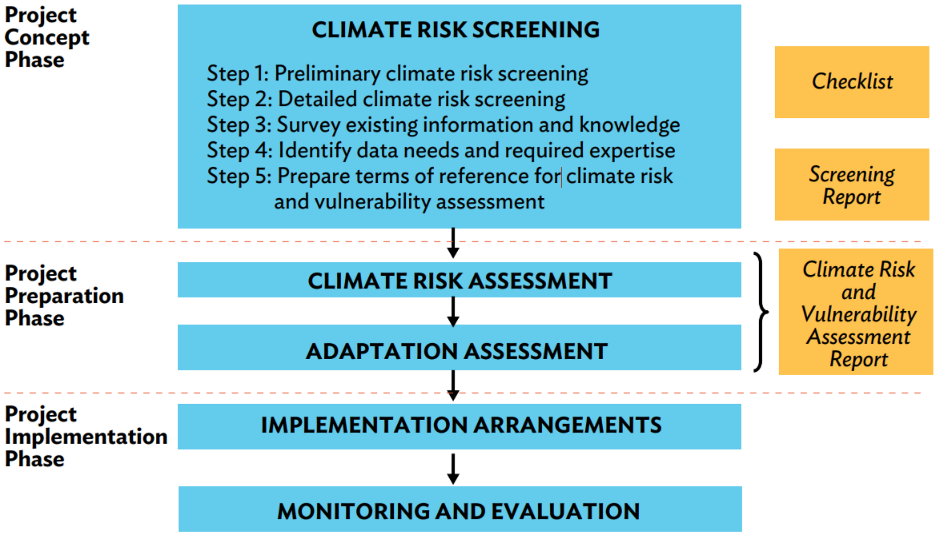


Figure 4. Step for Climate Risk Management of Investment Projects (ADB, 2016).

A detailed climate risk screening includes information pertaining to:

- climate sensitivity of key project components;
- current trends in key climate-related variables in project area;
- broad understanding of projected change in key climate variables in project area;
- categorization of potential climate risks; and
- if needed, recommendations for the undertaking of a climate risk and vulnerability assessment.

This report covers all these aspects for the five Basin Groups.

2.2 Approach for this study

For this climate risk screening analysis, the expected sensitivity of the investment program to climate change is explored, trends in relevant climate-related variables are assessed, and climate projections are analyzed. Then, based on the current natural hazard distribution and levels, the climate risks and vulnerabilities are discussed in the context of the proposed investment program. Based on these, recommendations are done for a detailed climate risk assessment.

Climate change projections are constructed using the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) dataset. This dataset comprises of global downscaled climate scenarios that are derived from the General Circulation Model (GCM) runs conducted under the Coupled Model Intercomparison Project Phase 5 (CMIP5) that were developed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). The spatial resolution of the dataset is 0.25 degrees (25 km x 25 km at the equator). Figure 5 shows a map with the five areas of interest and a grid that shows the resolution of the climate projection dataset.

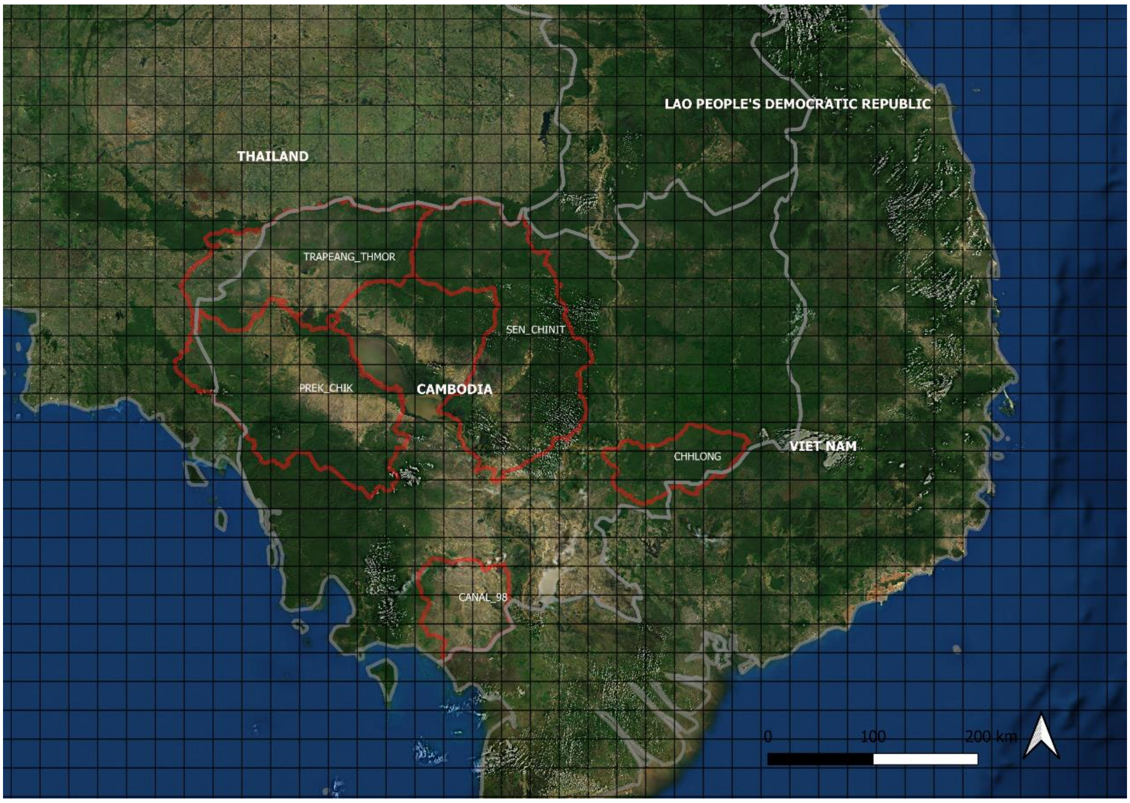


Figure 5. The five Basin Groups with NASA-NEX-GDDP data grid overlaid at 0.25 degrees resolution.

Climate projections are analyzed in terms of means and extremes, for different horizons and for temperature and precipitation. Projections for changes in climate extremes leading to extreme weather events have been constructed using the CLIMDEX Climate Extremes Indices (www.climdex.org), which are developed by the Expert Team on Climate Change Detection and Indices (ETCCDI). For wind speed trends, two global reanalysis datasets were used.

Climate risks and vulnerabilities have been qualitatively assessed based on the information currently available in the project, in particular:

- ADB Draft Report TA7610: *Rapid Assessment of the State of Water Resources, Cambodia;*
- ADB 2012 guidance document: *Guidelines for Climate Proofing Investment in Agriculture, Rural Development, and Food Security;*
- ADB 2012 guidance document: *Guidelines for Climate Proofing Investment in the Water Sector: Water Supply and Sanitation.*

3 Sensitivity to climate variables

3.1 Proposed projects

Cambodia has - in theory - plentiful water resources for agricultural purposes, while sustaining also other water uses, as domestic and environment. In many areas, however, irrigation and distribution systems are old, poorly maintained or non-existent. This means that although annual rainfall is high, secure access to water for agriculture may be difficult in certain areas. The uneven distribution of precipitation over the year also means that storage may be required to buffer water resources delivered during the monsoon season. Although storage infrastructure does exist in many regions of Cambodia, in several regions there may be potential to expand this, granting increased access to water year-round. Within this context, three key forms of investment are identified as relevant to the area:

- Modernization and rehabilitation of irrigation networks
- Increasing storage by building new reservoirs or raise existing dams
- Creating interbasin water transfers to supplement shortages

Depending on each basin and location, these investment options could help transition the country away from subsistence farming and toward larger scale profitable agriculture, as outlined in the MOWRAM *Roadmap and Investment Program for Irrigation and Water Resources Management*. Important though is that environmental uses are not affected negatively, something which is further addressed in the detailed Surface Water Resources Assessment study. A number of possible interventions are under consideration (shown in Figure 5):

1. **Prek Chik: Sangker-Pursat** Basin Group: Modernization, cropping intensification interbasin transfers to Moung Russei.
2. **Trapeang Thmar: Sreng-Sisophon** Basin Group: Modernization, cropping intensification, interbasin connections from Sreng to Ang Trapaeng Thmar reservoir
3. **Canal 98: Slakou-Toan Han** Basin Group**:** Rehabilitation and extension of canal in the southern part of the Mekong Delta River Basin Group into Kampot province to supplement water shortages.
4. **Sen Chinit**: Stung Sen Basin: Main developments considered are irrigated area expansion and rehabilitation, and further development of water storage upstream.
5. **Chhlong** Basin**:** Several schemes in a largely undeveloped river basin. Main focus on creating irrigation networks

For more detail, the reader is referred to the Surface Water Resources Assessment (SWRA) report produced under this TA.

3.2 Expected sensitivities

Water resources and agriculture projects are sensitive to weather and climate conditions and thus will be affected by changes to precipitation, temperature and extreme events (drought, flooding). This may adversely affect the performance and lifetime of investments and should be carefully considered in project planning. Changes in air temperature, precipitation, and associated extreme weather events can result in several impacts on agriculture (ADB, 2012) and water resources (ADB, 2017) related projects – these are summarized in Table 1.

Table 1. Potential sensitivities of climate change on agricultural and water resources investment projects (adapted from ADB 2012 and 2017).

Climate and weather conditions	Expected sensitivities	Related project components
Sea level rise	• Increased salinity of brackish surface water sources. • Assets on the coasts or in floodplains may be at increased risk from flooding, storm damages, and coastal erosion.	• Irrigation infrastructure • Irrigation networks • Irrigated areas
Temperature changes		
Warmer temperatures	• Changes in watershed vegetation may alter the recharge of groundwater aquifers and change the quantity and quality of runoff into surface waters. • Increased evaporation in surface sources of water. • Increasing biological and chemical degradation of water quality. • Changes in watershed vegetation and increased wildfire and pest risks in watershed areas. • Changes in watershed agricultural practices and in the resulting pollution loads from agriculture.	• Reservoir storage • Irrigation networks • Irrigated areas (existing and expanded)
Increases in very hot days and heat waves	• Modification in crop suitability and productivity (heat stress). • Increased in weeds, crop pests and disease outbreaks. • Changes in crop water requirements. • Increase risk of wildfire.	• Irrigated areas (existing and expanded)
Fewer cold days and nights	• Potential decreases in yields in paddy rice (FutureWater, 2014).	• Irrigated areas (existing and expanded)
Precipitation Changes		
Increase in intense precipitation events	• Increased turbidity and sedimentation of surface water. • Changes in nature of rainfall pattern leading to inadequate infiltration / groundwater recharge resulting in reduced flow and/or yield of water. • Potential loss of reservoir storage as a result of increased erosion in watershed. • Increased loading of pathogenic bacteria and parasites in reservoirs. • Increased waterlogging, inability to cultivate lands. • Damage to drainage systems due to flooding. • Increased extent and intensity of erosion and waterlogging. • Increased pest incidence.	• Canals • Dams • Irrigation networks • Irrigated areas (existing and expanded)
Increases in drought conditions	• Reduced replenishment rates of groundwater resulting in declining water tables where net recharge rate is exceeded. • Lower yields from crop damage, stress, and/or failure. • Loss of arable land as a result of land degradation and wind erosion. • Increased risk of wildfires.	• Irrigation networks • Irrigated areas (existing and expanded)

Changes to extreme events		
Increase in the frequency of floods and droughts	• Crop failure and damage to crops due to flooding. • Yield decreases. • Land degradation and soil erosion, loss of arable land. • Increased competition for water (drought).	• Irrigation networks • Irrigated areas (existing and expanded)
More frequent strong tropical cyclones	• Damage to crops and rural infrastructure • Damage to water storage structures	• Canals • Dams • Irrigation networks • Irrigated areas (existing and expanded)

4 Current trends in climate-related variables in project areas

4.1 General

A crucial step in a climate screening analysis involves the examination of current trends in key climate-related variables in the project area. This involves the evaluation of trends in precipitation and temperature, but for a full picture a range of climate-dependent natural hazards should also be considered.

Cambodia is exposed to a variety of natural hazards. These stem in part from the variation in hydrological regime the country experiences. Natural hazards applicable to Cambodia include flooding, drought, cyclones and landslides. Exposure of people and assets to climate-related hazards is high, with more than 50% of the population exposed to flood risk in some form. Tropical storms, such as typhoon Ketsana in 2009, regularly cause large scale damages in many of the Eastern provinces. In 2015, adverse impacts stemming from climate change totaled over 10% of annual GDP (USAID, 2019). All of this points to a profile of general moderate to high level of risk from climate impacts in the country. This threatens the general development of the country and shows that, without adequate assessment of risks and the implementation of appropriate adaptation measures, it is likely that new infrastructure projects will experience impacts in the future.

The below sections discuss observed trends in the relevant climate-related variables for the selected Basin Groups.

4.2 Current climate

4.2.1 *Spatial variability*

Cambodia is roughly bowl shaped, with a large relatively flat interior flanked by low mountain ranges. The northern border with Thailand is made up by the Dangrek mountain range, with a maximum elevation of around 600m; and in the west and south east of the country are the Cardamom and Damrei ranges, with a maximum elevation of 1813m. The interior of the country is largely flat (ranging from 10-100m), with large areas made up by fertile alluvial floodplain, much of which has been converted to rice cultivation. This flat topography leads to a complicated hydrodynamic regime whereby flow directions between the Mekong Delta area and the Tonle Sap basin are reversed at different periods of the year. The selected Basin Groups are generally located in areas of low elevation with the exception of the Prek Chik area, which is bounded to the south by the Cardamom mountain range.

The climate of Cambodia is monsoon-dominated, with a large proportion of rainfall occurring over a relatively short period of the year, generally between May and October. Total average annual rainfall is around 1500 mm, increasing with elevation and with highest total rainfall falling in the south east and over the Cardamom mountain range in the west. Temperatures are generally high year-round, ranging from around 24-35°C, with January and April generally the coolest and hottest months respectively. Basin Groups have generally uniform mean annual temperatures (24-27°C). Precipitation is more variable, with the Chhlong area and highland regions of the Prek

Chik area receiving relatively higher precipitation (2000-2500mm) than other proposed investment areas (1200-2000mm).

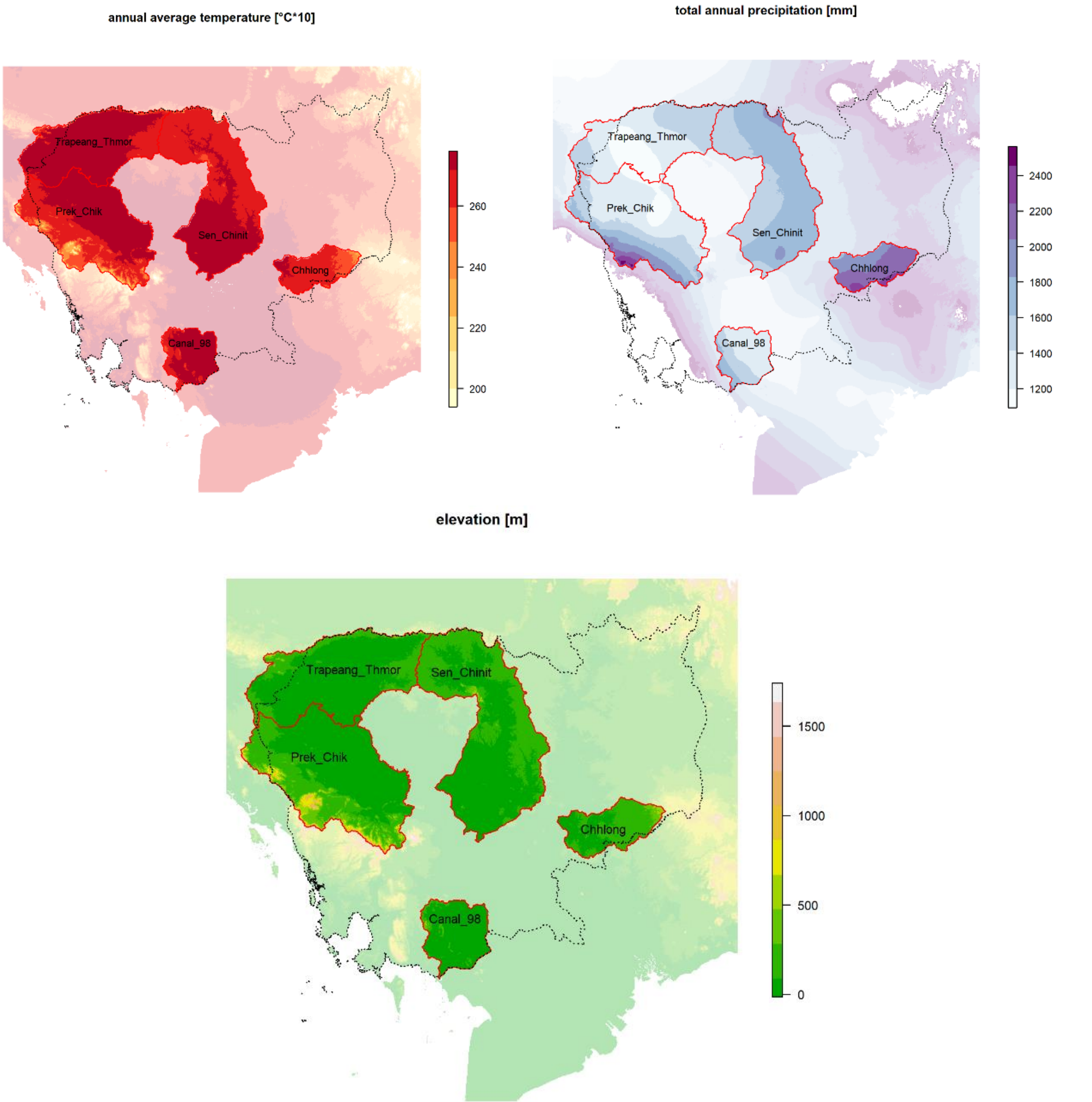


Figure 6. Geography and average climatic conditions of the five basin groups. Above: average temperature (ºC), middle: mean annual rainfall (mm), below: evaluation (m.a.s.l.)

4.2.2 *Historical trends*

Several previous studies have considered climate trends in Cambodia. In terms of general trends in climate, a past FutureWater publication conducted for the Mekong River Commission (MRC) considered a variety of reanalysis products corrected using observational data for the Mekong Basin. This concluded that:

"Temperature in the LMB has increased by about 0.2°C per 10 years over the last 30 years. Precipitation increased by about 50 mm/10 years over the last 30 years. Also a weak signal of a seasonal shift in monsoon has been observed towards a slightly earlier start and end of the monsoon" (FutureWater, 2013).

The MRC also assessed meteorological data for precipitation, temperature and the occurrence of typhoons covering the period 1980-2010 (Kiem, 2017), finding trends over this period toward a hotter and drier climate, with a clear relationship between changing climate and the occurrence of typhoons.

A USAID (2013) study of climate impacts in Cambodia found that increases in both temperature and precipitation are likely to continue into the coming century, with distinct seasonality dictating decreased and increased trends in precipitation for wet and dry seasons respectively. Further analysis here helped reach the conclusion that these climate change induced trends were likely to amplify negative effects on agricultural production and economic growth in the lower Mekong basin

For the basins of interest, a quick analysis was done to see if any trend can be detected based on annual satellite-based rainfall estimates. Annual precipitation, averaged for the extent covered by the selected Basin Groups, is presented in Figure 7 for a period of 38 years. Values vary between 1,010 mm/yr in 1992 and 1,676 mm/yr in 2013. To evaluate extremes, maximum daily precipitation over the same 1981 – 2018 period is shown in Figure 8. It should be noted that these maximum values are valid for a 5 x 5 km grid size, so locally experienced extremes will be higher.

Based on these historical satellite-based data records, no significant trend can be distinguished. Obviously for particular locations, and possibly using weather station data, there may be past trends. However, particularly in Cambodia, weather station data is sparse and of poor quality.

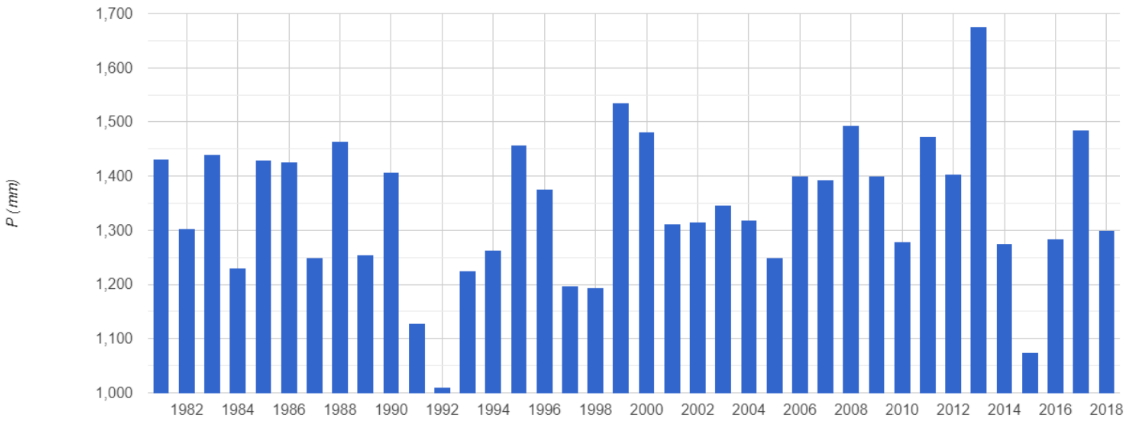


Figure 7. Annual average rainfall in the Basin Groups since 1981 (data source: CHIRPS data, Google Earth Engine[1]).

[1] http://earthengine.google.com

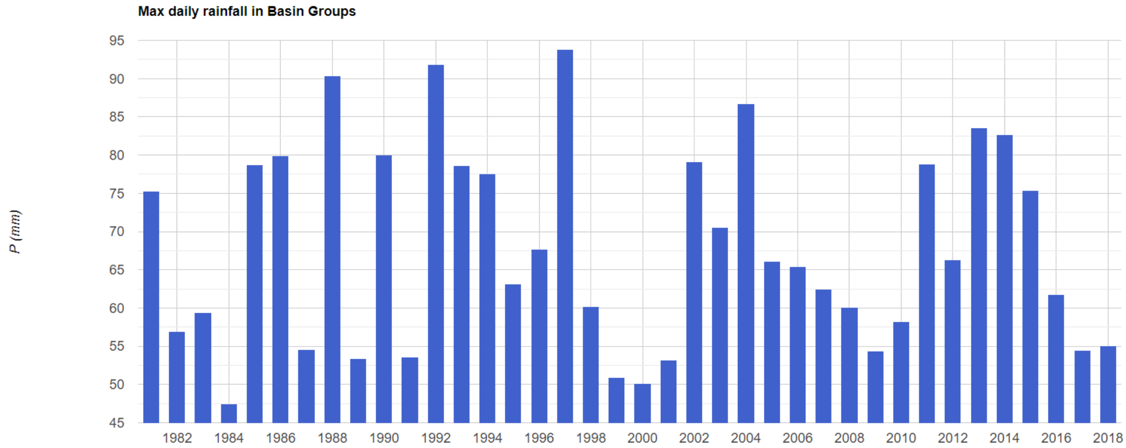


Figure 8. Maximum daily rainfall in the Basin Groups since 1981 (data source: CHIRPS data, Google Earth Engine[1]).

4.1 Flooding

Over recent decades, Cambodia has suffered from multiple severe flash flooding events, notably in 2000, 2011 and 2013. Flooding occurs in the monsoon season and tends to affect the areas surrounding the Tonle Sap lake and in the south around the Mekong delta. Also this year (2019), Cambodia has faced large scale flooding.

To analyze if there are changes in flood frequency over the last decades, Figure 9 presents the chances in surface water occurrence across the basin groups, based on high-resolution satellite data from 1984 – 2018. Green colors indicate that surface water was observed more frequently in 2000 – 2018 than in the 1984 – 1999 period. This may be related to increased flooding in these areas, for example due to deforestation upstream or climate change effects.

Still, it has to be noted that bright green colors occur particularly in paddy rice areas. Thus, the increased flooding may be actually indicative of expansion or intensification of rice cultivation, where fields are intentionally flooded. But even also in these areas, increased flooding frequency may also be associated with increased damages and crop yield losses. For example, in the Canal 98 area, which is highlighted in bright green in the southern part of the map, is known for extensive flooding which prohibits crop cultivation due to insufficient drainage of the excess water.

Thus, based on these data, it is difficult to untangle the contribution to increased flood frequency from climate change versus land use change. Still, previous work by USAID (2013) has shown that flood frequency is likely to increase in the future. Currently, GIZ is financing a study for the MRC to assess in detail flood risk for the Lower Mekong countries.

[1] http://earthengine.google.com

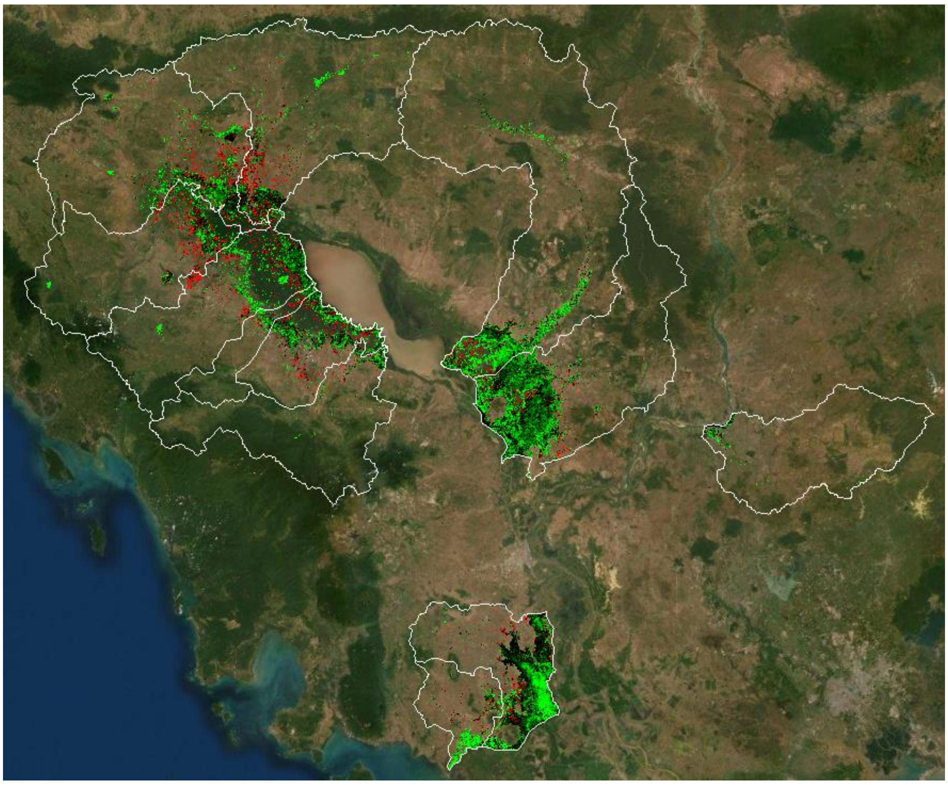


Figure 9. Flood occurrence change across the Basin Groups with increases shown in green and decreases in red. Changes were calculated for the period 2000-2018 with respect to 1984-1999. Black areas are those areas where there is no significant change in the water occurrence during the 1984 -2018 period. The intensity of the color represents the degree of change; bright red areas show greater loss of water than light red areas (data source: JRC[1]).

4.2 Drought

Drought is a problem for several regions of Cambodia, with recently significant drought periods noted in 2016 and 2019 affecting crop yields and putting strains on reservoirs. Droughts typically occur before the oncoming monsoon season between the months of April and June, with the northwestern provinces known to be particularly vulnerable (Battambang especially).

Figure 10 shows the spatial distribution of drought risk, mapped by FutureWater in a previous study (Terink et al., 2011). This integrated Drought Risk Index was derived from an assessment of hazard and vulnerability based on satellite observations and GIS datasets, integrating indicators of both meteorological and agricultural drought.

[1] https://global-surface-water.appspot.com/

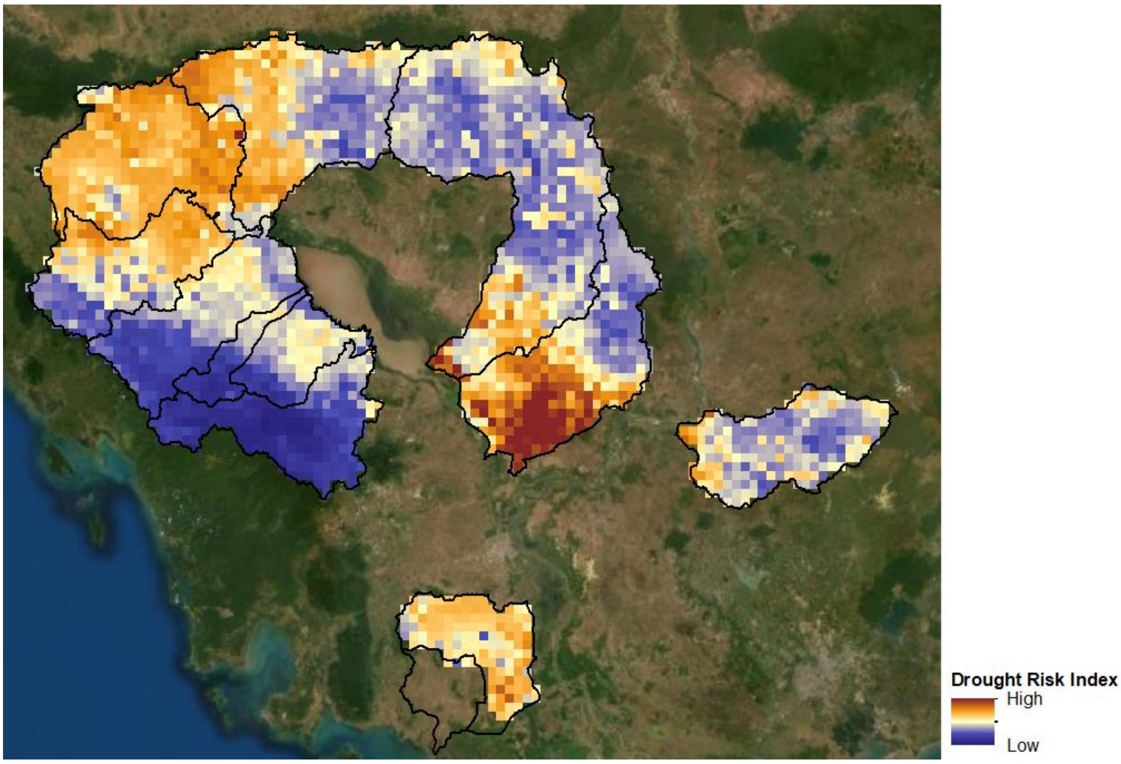


Figure 10. Drought Risk Index (source: Terink et al., 2011).

To assess whether a trend is present in drought occurrence, the Standard Precipitation Index (SPI) can be used, which is a widely used index to characterize meteorological drought on a range of timescales. Figure 11 shows the values over the last 40 years extracted from data on the national scale. Similar to Figure 7 and Figure 8, no significant increasing or decreasing trend can be identified for this drought index.

Still, as was understood from stakeholders and MOWRAM, it is the impression that drought occurrence does increase. Most likely this perception mainly relates to hydrological drought, as opposed to meteorological drought. Increased hydrological drought occurrence is also highly influenced by changes upstream in the basins, in water use and forest cover. In fact, it is evident that changes in water allocation, storage and use in the Mekong basin, as well as changes in forest cover in the Tonle Sap river basin group influence the hydrological regime of the regions of interest in Cambodia, and will thus likely also affect hydrological drought occurrence and severity.

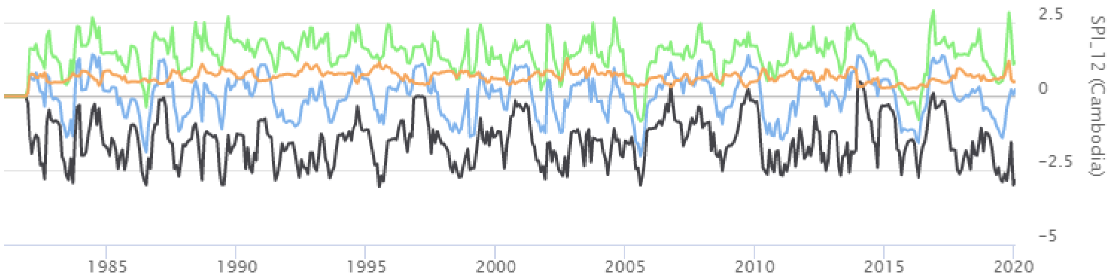


Figure 11. Monthly Standard Precipitation Index in Cambodia based on a 12-month period. Green, blue, and black lines respectively show the maximum, average, and minimum value

occurring. The orange line shows the standard deviation (source: SERVIR Mekong Regional Drought and Crop Yield Information System[1].

4.3 Vegetation greenness

Water availability and drought occurrence are influenced by changes in land-cover. For example, changes in forest cover typically changes the hydrological regime, increasing hydrological extremes. Vegetation health, or greenness of the vegetation, can be seen as a proxy of land degradation processes, crop productivity, and forest cover. Vegetation greenness therefore integrates the influence of climate with human management actions. A common indicator to express vegetation greenness is the Normalized Difference Vegetation Index, or NDVI.

Figure 13 shows the average NDVI in the Basin Groups for the period 2003 – 2018, calculated based on data from the MODIS sensor on board of the Aqua satellite using the Google Earth Engine platform. A slightly negative trend can be distinguished over this period. In order to examine where in the Basin Groups positive and negative impacts on vegetation are observed, Figure 12 presents a map of NDVI anomaly. This anomaly is calculated by averaging NDVI values for a reference period (2003 – 2013), and comparing the average NDVI from a more recent period (2014 – 2018).

The reddish colors in the map indicate that vegetation cover has reduced in the past five years considerably. But there is also quite some greenish colors which indicate that vegetation greenness is higher. Hotspots of lower vegetation greenness occur particularly in the eastern Basin Groups Prek Chhlong, Stung Sen, Stung Chinit, and Stung Sreng, in areas known for forest loss.

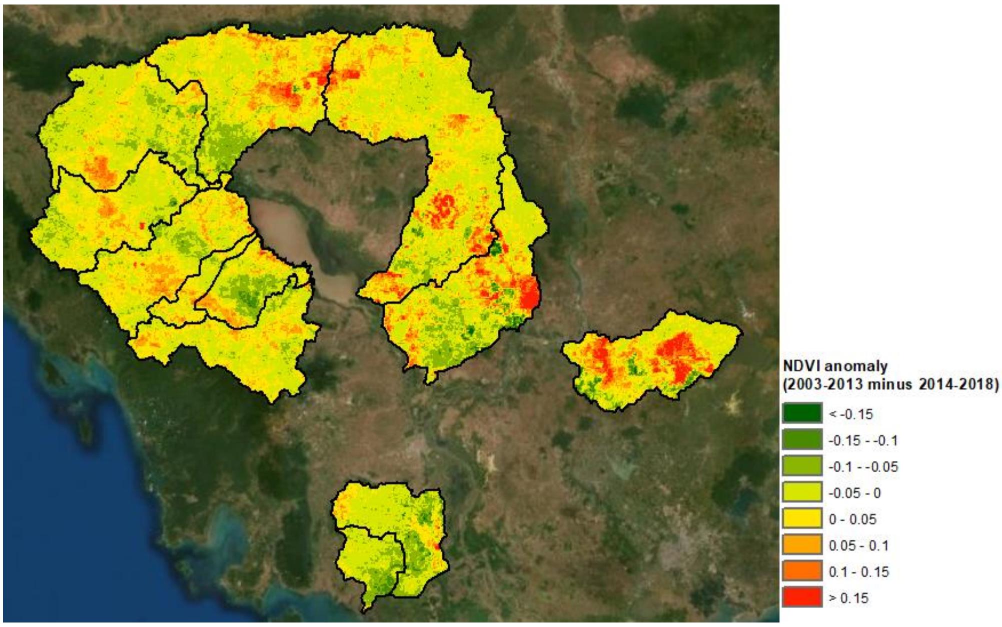


Figure 12. Map of NDVI anomaly values. Areas where the vegetation greenness in 2014-2018 is lower than in 2003-2013 are shown in red. Green colors indicate areas where, on average, an increase in NDVI was detected. Analyses are based on MODIS Aqua data.

[1] https://rdcyis-servir.adpc.net/map

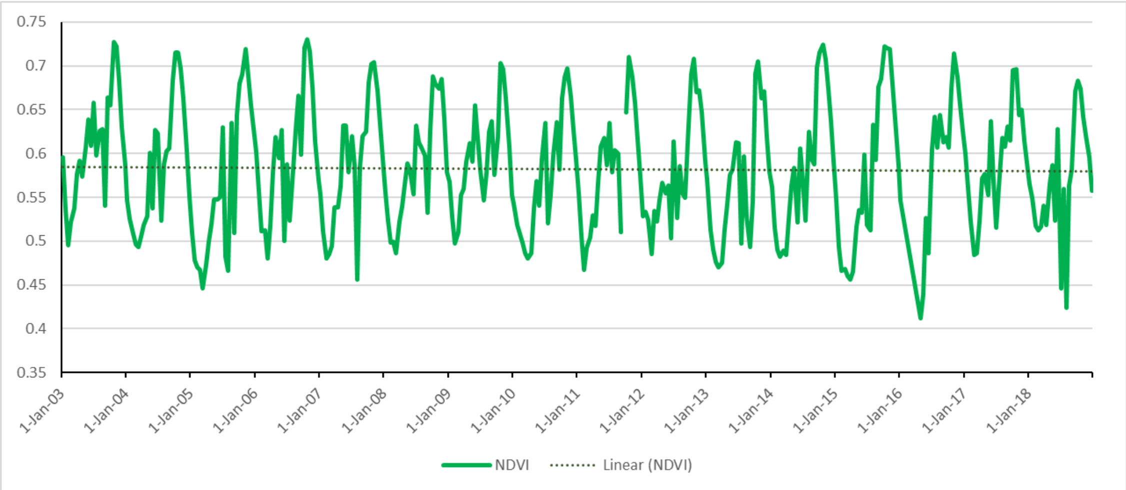


Figure 13. Average NDVI in the selected basin groups for the 2003 – 2018 period, based on MODIS Aqua data.

4.4 Cyclones

The cyclone hazard (also known as hurricane or typhoon) is typically classified as high. This means that there is a relatively high chance of potentially damaging wind speeds in Cambodia. Cyclones are mainly of concern in the eastern area of Cambodia. Of the basin groups studied, the Chhlong basin appears the most exposed (Figure 14).

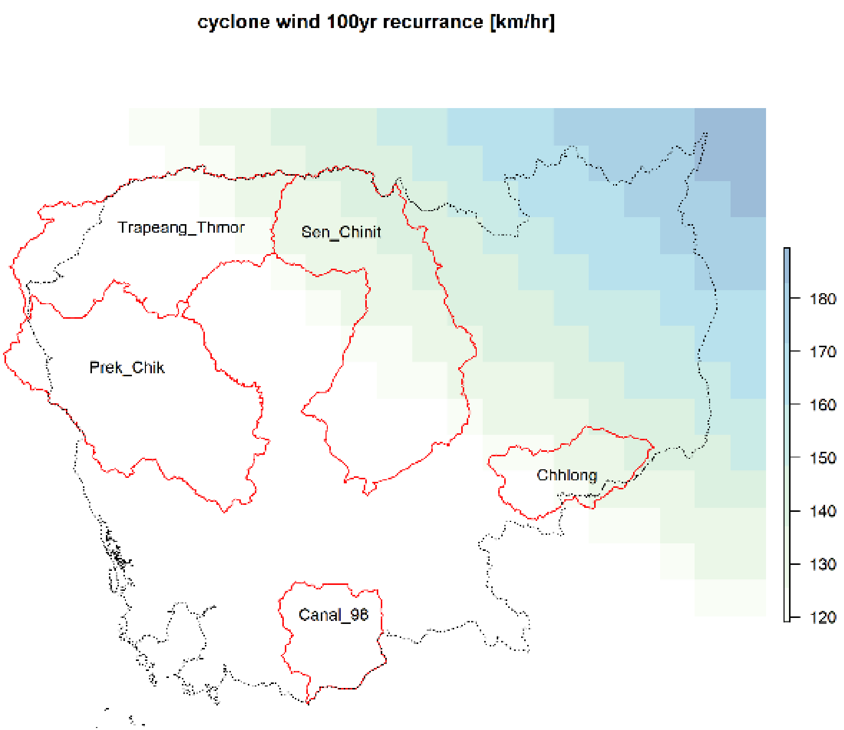


Figure 14. Cyclone hazard in the Basin Groups (source: https://preview.grid.unep.ch).

4.5 Landslides

Cambodia is exposed to some extent to the hazard of landslides induced by precipitation events, with the areas of highest exposure located in mountainous areas (Figure 15). This hazard therefore relates mainly to the Prek Chik basin group which intersects the Cardamom mountains to the south.

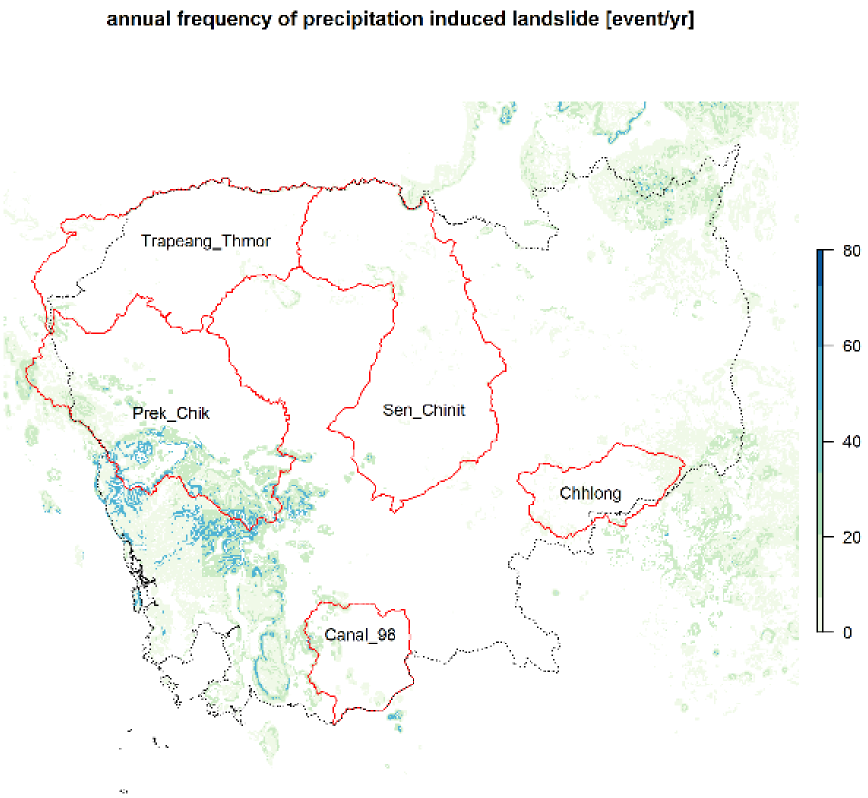


Figure 15. Landslide hazard in the Basin Groups (source: https://preview.grid.unep.ch).

5 Climate change projections in project areas

5.1 Changes in Climatic Means

Climate change projections for the Basin Groups (Prek Chik, Trapeang Thmar, Sen Chinit, Chlong, Canal 98) are constructed using the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) dataset[1]. This dataset comprises global downscaled climate scenarios that are derived from the General Circulation Model (GCM) runs conducted under the Coupled Model Intercomparison Project Phase 5 (CMIP5) and across two of the four greenhouse gas emissions scenarios known as Representative Concentration Pathways (RCPs). The CMIP5 GCM runs were developed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). The NEX-GDDP dataset includes downscaled projections for RCP 4.5 and RCP 8.5[2] from the 21 models and scenarios for which daily scenarios were produced and distributed under CMIP5

Each of the climate projections includes daily maximum temperature, minimum temperature, and precipitation for the periods from 1950 through 2100 For this climate risk and vulnerability assessment (CRVA), the NASA-NEX-GDDP projections for the Basin Groups are evaluated for the near future [2030] (2020 – 2049) and distant future [2080] (2070 – 2099) and compared to a reference period [1990] (1976 – 2005) covering the same time span. The spatial resolution of the dataset is 0.25 degrees (25 km x 25 km at the equator). The full results are presented in Appendix 1, the most relevant projected changes in climatic means are summarized below.

5.1.1 *Precipitation trends*

The analysis of the NASA NEX-GDDP dataset indicates that for precipitation (annual sum) the range in the climate change projections is large, meaning that there is a large uncertainty in the future precipitation. Overall, however, the GCM ensemble under both the RCP4.5 and RCP8.5 (top panels Figure 18, Figure 19, Table 2 show increasing precipitation trends for all five Basin Groups compared to the reference period:

Prek Chik

- For the near future [2030] the annual precipitation sum is expected to increase by 5% under the RCP 4.5 (from 2205 to 3221 mm/yr) and by 11% under the RCP 8.5 (from 2205 to 2456 mm/yr)
- For the distant future [2080] the annual precipitation sum is expected to increase by 10% under the RCP 4.5 (from 2205 to 2432 mm/yr) and by 21% under the RCP 8.5 (from 2205 to 2667 mm/yr)

Trapeang Thmar

- For the near future [2030] the annual precipitation sum is expected to increase by 6% under the RCP 4.5 (from 1383 to 1465 mm/yr) and by 10% under the RCP 8.5 (from 1383 to 1524 mm/yr)

[1] https://nex.nasa.gov/nex/projects/1356/

[2] Since the release of Intergovernmental Panel on Climate Change's fifth Assessment Report, four representative concentration pathways (RCPs) have been defined as a basis for long-term and near-term climate modeling experiments in the climate modeling community. The four RCPs together span the range of radiative forcing values for the year 2100 as found in literature, from 2.6 to 8.5 Wm^{-2}. Climate modelers use the time series of future radiative forcing from the four RCPs for their climate modeling experiments to produce climate scenarios. RCP4.5 is a medium stabilization scenario implying a stabilization of greenhouse gas concentrations halfway the 21st century and RCP8.5 is a very high baseline emission scenario (business as usual).

- For the distant future [2080] the annual precipitation sum is expected to increase by 12% under the RCP 4.5 (from 1383 to 1549 mm/yr) and by 22% under the RCP 8.5 (from 1383 to 1691 mm/yr)

Canal 98

- For the near future [2030] the annual precipitation sum is expected to increase by 5% under the RCP 4.5 (from 2067 to 2179 mm/yr) and by 8% under the RCP 8.5 (from 2067 to 2224 mm/yr)
- For the distant future [2080] the annual precipitation sum is expected to increase by 11% under the RCP 4.5 (from 2067 to 2293 mm/yr) and by 21% under the RCP 8.5 (from 2067 to 2499 mm/yr)

Sen Chinit

- For the near future [2030] the annual precipitation sum is expected to increase by 7% under the RCP 4.5 (from 1588 to 1695 mm/yr) and by 15% under the RCP 8.5 (from 1588 to 1820 mm/yr)
- For the distant future [2080] the annual precipitation sum is expected to increase by 12% under the RCP 4.5 (from 1588 to 1783 mm/yr) and by 27% under the RCP 8.5 (from 1588 to 2014 mm/yr)

Chhlong

- For the near future [2030] the annual precipitation sum is expected to increase by 7% under the RCP 4.5 (from 1652 to 1770 mm/yr) and by 14% under the RCP 8.5 (from 1652 to 1880 mm/yr)
- For the distant future [2080] the annual precipitation sum is expected to increase by 11% under the RCP 4.5 (from 1652 to 1840 mm/yr) and by 28% under the RCP 8.5 (from 1652 to 2114 mm/yr)

In terms of spatial trends, the highest increases in precipitation occur in eastern regions (Sen Chinit notably) for all future periods and pathways (Figure 16). The area in the west of the Prek Chik area which currently experiences the highest amounts of precipitation is predicted as experiencing the smallest increases.

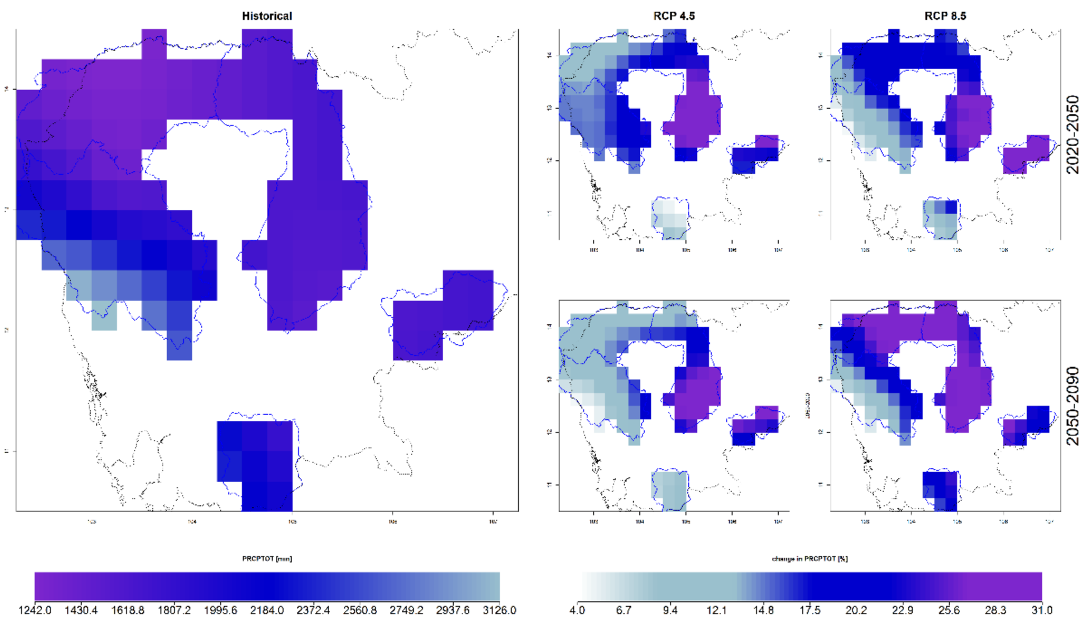


Figure 16. Spatial distribution of percentage change in GCM ensemble mean total annual precipitation for the near (2030) and distant (2080) future under the RCP 4.5 and RCP 8.5 (GCM ensemble).

5.1.2 *Temperature trends*

The analysis of the NASA NEX-GDDP dataset indicates that the air temperature shows strong increasing trends for all GCMs under both RCPs, but the uncertainty range of future temperature is larger for RCP 8.5 compared to RCP 4.5 (see also Figure 19). In contrast to annual precipitation totals, the five Basin Groups show comparable future temperature projections compared to the reference period:

Near future [2030]

- Annual daily maximum temperature is expected to increase by 0.9 – 1.2°C under both the RCP 4.5 and RCP 8.5 (from 33 to 34°C)
- Annual daily minimum temperature is expected to increase by 1.0 – 1.3°C under both the RCP 4.5 and RCP 8.5 (from 23 to 24°C)

Distant future [2080]

- Annual daily maximum temperature is expected to increase by 1.8 – 2.0°C under the RCP 4.5 (from 33 to 35°C) and by 3.2 – 3.6°C under the RCP 8.5 (from 33 to 36°C)
- Annual daily minimum temperature is expected to increase by 1.9 – 2.0°C under the RCP 4.5 (from 23 to 25°C) and by 3.4 – 3.7°C under the RCP 8.5 (from 23 to 27°C)

In terms of spatial trends, increases in temperature are fairly uniformly distributed (Figure 18). In the RCP8.5 scenario variation is evident, with the highest increases occurring in the north of Cambodia (north Sen Chinit Basin Group).

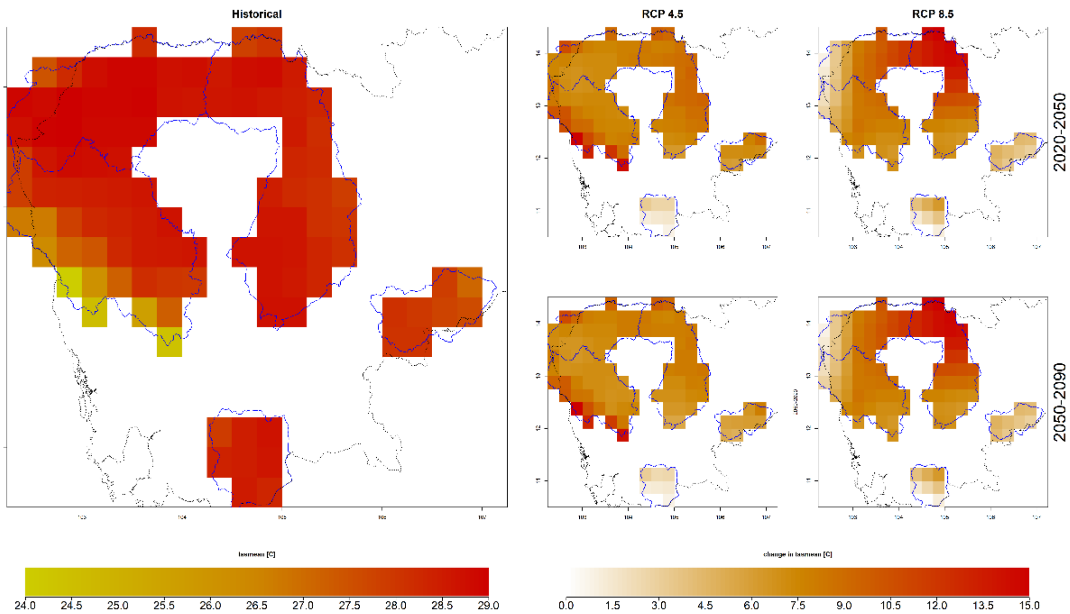


Figure 17. Spatial distribution of absolute change [°C] in GCM ensemble mean annual temperature for the near (2030) and distant (2080) future under the RCP 4.5 and RCP 8.5 (GCM ensemble).

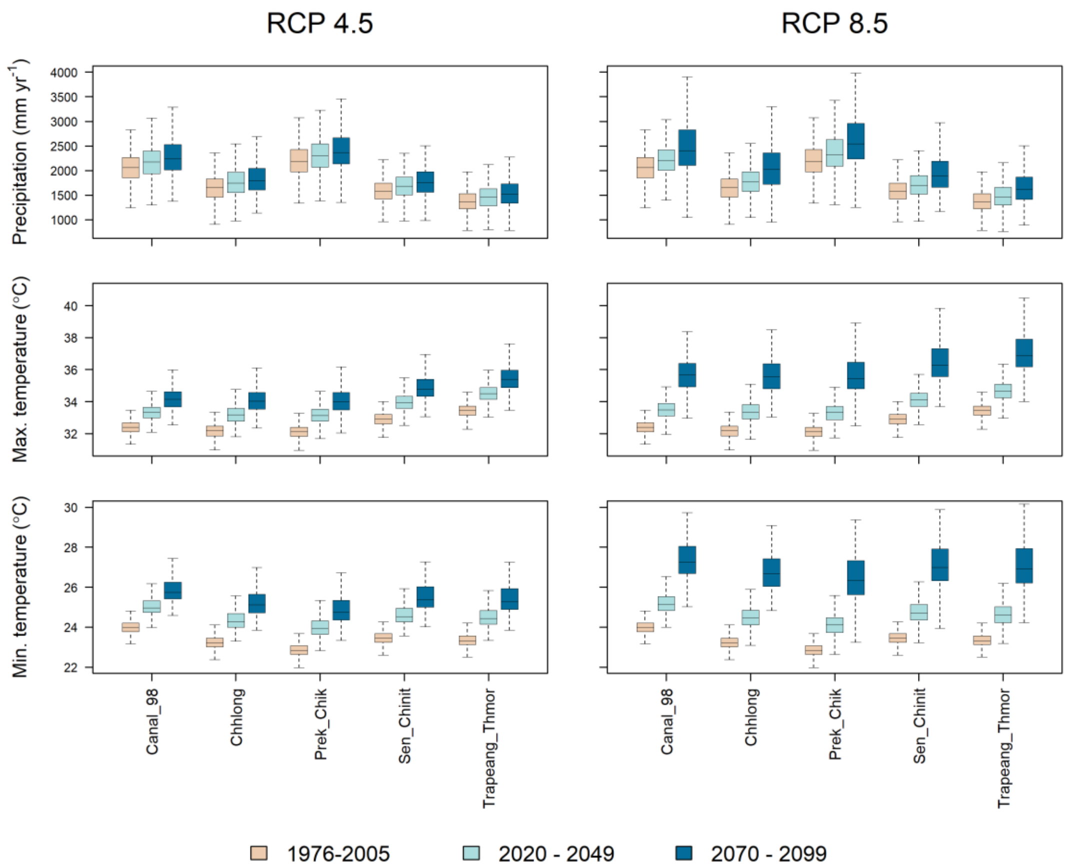


Figure 18. Distribution of climate (change) projections for the reference period (1976 – 2005), near future (2020 – 2049) and distant future (2070 - 2099) for the 21 GCMs under RCP 4.5 and RCP 8.5.

Table 2. Average GCM ensemble climate projections under RCP 4.5 and RCP 8.5.

Intervention area	Historical 1976 - 2005			RCP 45 2020 - 2049			RCP 45 2070 - 2099		
	pr	T_{max}	T_{min}	pr	T_{max}	T_{min}	pr	T_{max}	T_{min}
Canal_98	2066.5	32.4	24.0	2179.4	33.3	25.0	2293.0	34.2	25.8
Chlong	1651.8	32.2	23.2	1770.2	33.2	24.3	1840.3	34.1	25.2
Prek_Chick	2205.0	32.1	22.9	2321.5	33.2	24.0	2432.4	34.1	24.8
Sen_Chinit	1587.5	32.9	23.5	1695.1	34.0	24.6	1783.4	34.9	25.5
Trapeang_Thmar	1382.6	33.5	23.4	1465.2	34.5	24.5	1548.6	35.4	25.4

Intervention area	Historical 1976 - 2005			RCP 85 2020 - 2049			RCP 85 2070 - 2099		
	pr	T_{max}	T_{min}	pr	T_{max}	T_{min}	pr	T_{max}	T_{min}
Canal_98	2066.5	32.4	24.0	2224.2	33.5	25.2	2499.4	35.6	27.4
Chlong	1651.8	32.2	23.2	1880.0	33.4	24.5	2114.1	35.6	26.8
Prek_Chick	2205.0	32.1	22.9	2456.0	33.3	24.1	2675.9	35.6	26.4
Sen_Chinit	1587.5	32.9	23.5	1820.1	34.2	24.8	2014.3	36.5	27.1
Trapeang_Thmar	1382.6	33.5	23.4	1524.1	34.7	24.7	1691.1	37.0	27.0

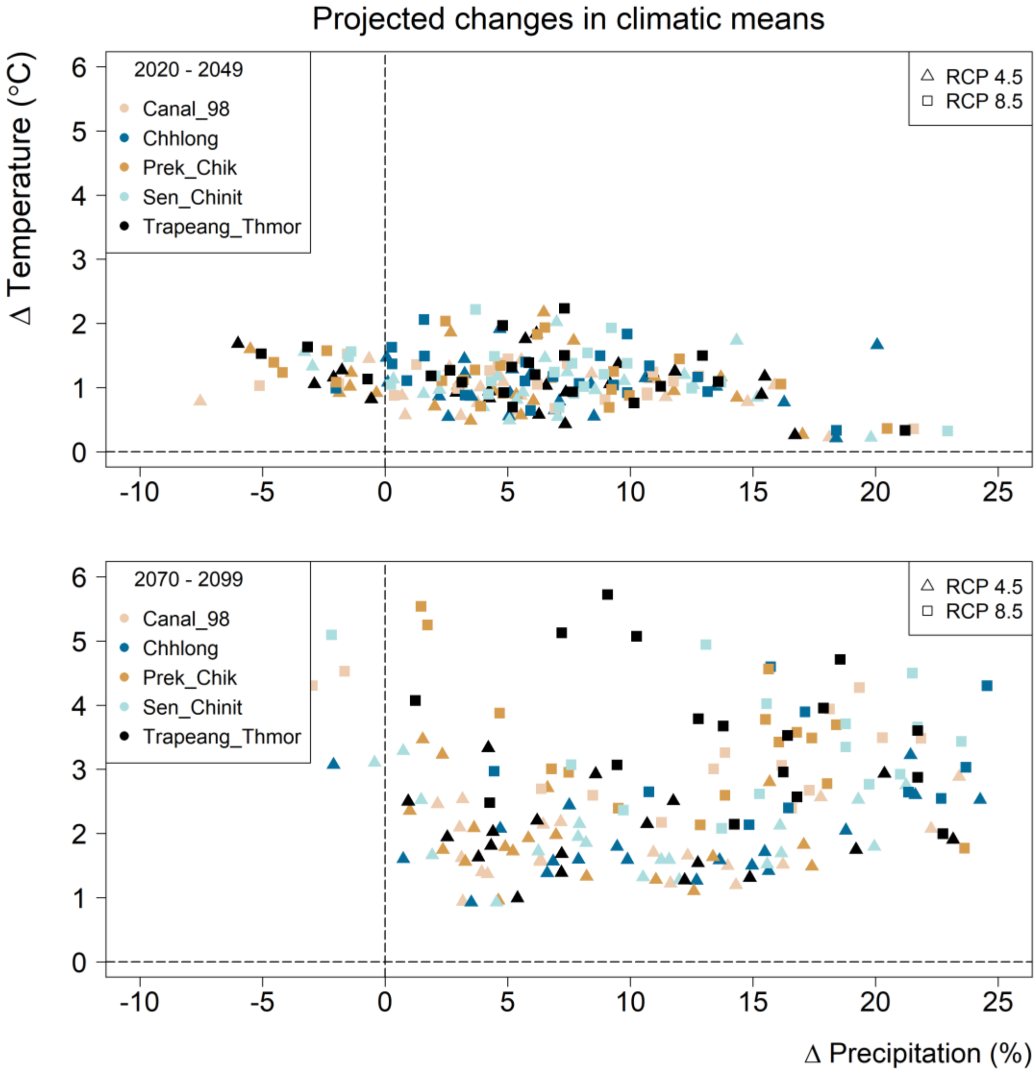


Figure 19. Projected changes in climatic means for the near (2030) and distant (2080) future (w.r.t. 1990 reference period) for 21 GCM's under the RCP 4.5 and RCP 8.5.

5.2 Changes in climate extremes

Besides long-term trends in the climate means, foreseen changes in climatic extremes can be very important for the investment program. Projections for changes in climate extremes have been constructed using the CLIMDEX Climate Extremes Indices (www.climdex.org), which are developed by the Expert Team on Climate Change Detection and Indices (ETCCDI). The 21 downscaled GCMs included in the NASA NEX-GDDP dataset have been used as input to construct the CLIMDEX Climate Extremes Indices. All 27 indices related to precipitation (11) and temperature (16) have been constructed using the GCM ensemble under the RCP 4.5 and RCP 8.5. For both RCPs, one GCM is omitted (ACCESS1-0) because it has projection values far out of the range of all other GCMs.

The estimation of changes in precipitation and temperature extremes is done by analyzing the distribution of the change (in % for precipitation and °C for temperature) for each downscaled GCM. Different percentiles of this distribution are considered (5th, 25th, 50th, 75th, 95th), besides the mean of the GCM ensemble, and separately for RCP 4.5 and RCP 8.5. The full results are presented in Annex 1; the most relevant projected changes in climate extremes are summarized below.

5.2.1 *Rainfall extremes*

Maximum one day rainfall per year (*R_x1day*) was chosen from the CLIMDEX indices as a representative indicator for changes in rainfall extremes over time. This is considered an appropriate indicator for shorter periods of intense rainfall which may lead to flooding events. Results of other rainfall extreme-related indices are given in Appendix I.

Trends in *R_x1day* predicted by the GCM ensemble suggest that the intensity of extreme rainfall events will increase into the future for all basins (Figure 20). These increases are predicted into the future, with a greater amount of increase predicted for the RCP8.5 scenario. Changes range from 8-16% for RCP4.5 and 28-69% for RCP8.5 for all Basin Groups considered. This suggests a fairly extreme increase in extreme precipitation severity over time. These values must, however, be approached tentatively as there is a wide range of uncertainty present in GCM predictions, manifest in a large amiunt of overlap between predictions for each time horizon and pathway (shown in Figure 20).

Spatial trends in Rx1day show a large amount of variability, with highest increases evidently centred over north western (Trapeang Thmar) and eastern (Chhlong) areas (Figure 21). Some decreases in rainfall intensity are also evident in certain areas, notably in the Prek Chik Basin Group.

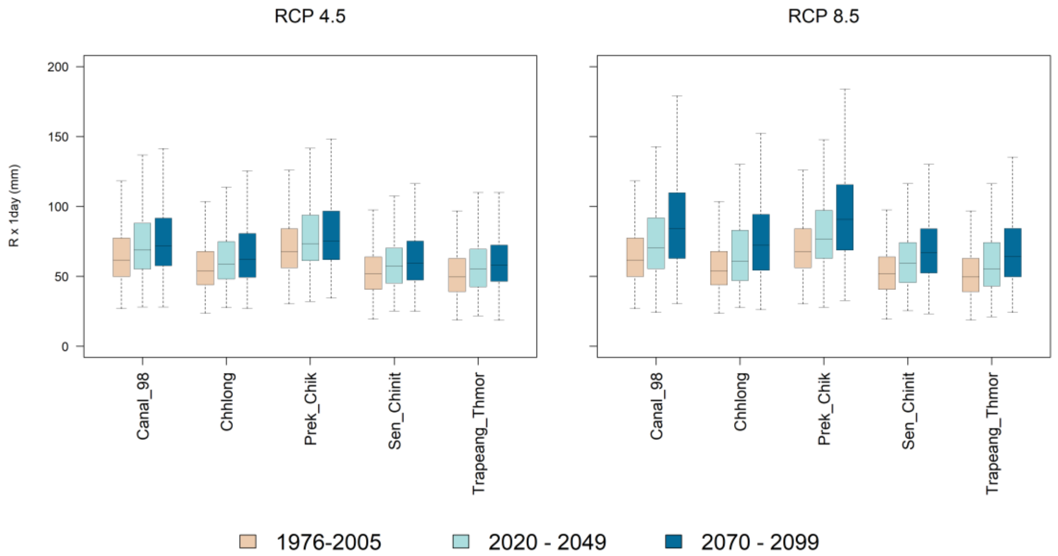


Figure 20. Distribution of changes predicted by the GCM ensemble in annual max 1-day precipitation averaged over the two climate change scenarios and three time horizons considered.

Table 3. *R_x1day* - Annual maximum 1-day precipitation RCP 45 (GCM ensemble mean)

R_x1day	Historical (1976 – 2005)	RCP 45 (2020 - 2049)	RCP 45 (2070 - 2099)	Δ RCP 45 (2020 - 2049)	Δ RCP 45 (2070 - 2099)
	(mm)	(mm)	(mm)	(%)	(%)
Canal_98	66.9	73.6	77.7	10.1	16.2
Chlong	58.2	63.7	67.1	9.4	15.3
Prek_Chick	72.8	79.6	81.8	9.3	12.4
Sen_Chinit	55.0	59.6	63.2	8.4	15.0
Trapeang_Thmar	52.6	58.2	61.5	10.5	16.8

Table 4. Rx1day - Annual maximum 1-day precipitation RCP 85 (GCM ensemble mean).

R_x1day	Historical (1976 – 2005)	RCP 85 (2020 - 2049)	RCP 85 (2070 - 2099)	Δ RCP 85 (2020 - 2049)	Δ RCP 85 (2070 - 2099)
	(mm)	(mm)	(mm)	(%)	(%)
Canal_98	66.9	85.8	98.2	28.3	46.9
Chlong	58.2	91.4	98.4	57.1	69.1
Prek_Chick	72.8	98.5	107.4	35.3	47.5
Sen_Chinit	55.0	77.9	84.6	41.7	54.0
Trapeang_Thmar	52.6	73.4	75.5	39.4	43.4

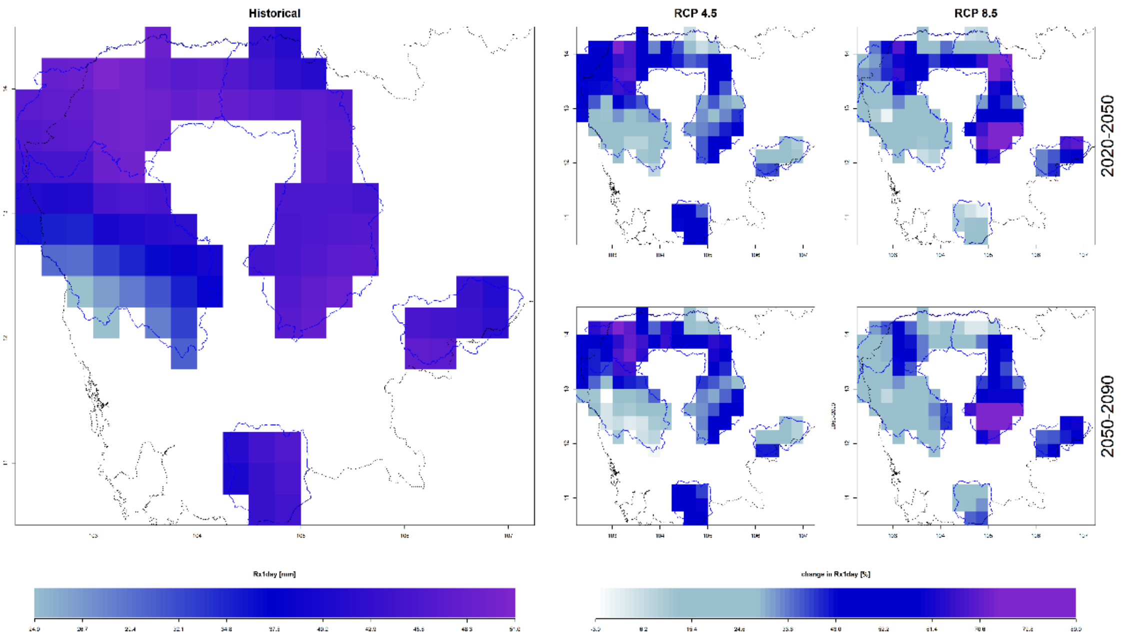


Figure 21. Spatial distribution of percentage change (%) in GCM ensemble mean annual max 1-day precipitation for the near (2030) and distant (2080) future under the RCP 4.5 and RCP 8.5 (GCM ensemble).

When different return periods are considered (Figure 22), trends in Rx1day are less clear. The GCM ensemble predicts in most cases that the intensity of extreme rainfall events at all return periods will increase into the future but this is not the case for all basins at all future time horizons, especially for return periods of 100 years (see full values in Appendix 0). Moreover, there is some disagreement between results in terms of the effects of the more extreme climate scenario on Rx1day at different return periods.

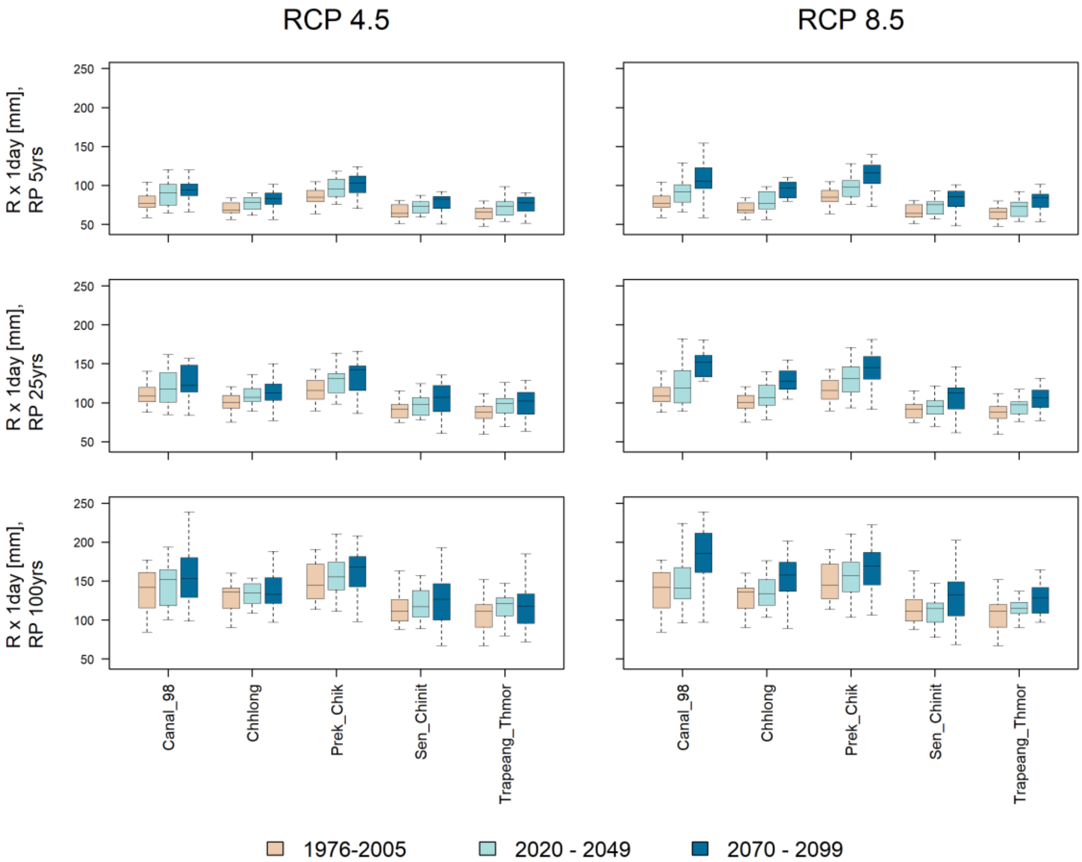


Figure 22. Distribution of changes in annual max 1-day precipitation predicted by the GCM ensemble under different return periods for the two climate change scenarios and three time horizons considered.

5.2.2 *Drought*

The Consecutive Dry Days (CDD) index was chosen from the CLIMDEX indicators to represent changes in drought over time. Extended dry periods are a commonly used indicator of meterological drought, which when combined with high temperatures is likely to lead to hydrological and agricultural drought.

A clear variation between Basin Groups in terms of CDD is shown, with the longest periods of CDD predicted in Sen Chinit and Trapeang Thmar areas for both pathways and time horizons (Figure 23). Trends in CDD over time are unclear, with small decreases in CDD predicted for all Basin Groups with the exception of Canal 98 under RCP4.5 (0.6-3.5% decrease). Canal 98 is predicted as experiencing the largest increases in CDD of any basin group for all return periods. Overall, it must be noted, however, that a large amount of uncertainty is present in projections of CDD, with lots of overlap between GCM predictions. It is therefore impossible to derive an overall trend for the Basin Groups.

Spatially, GCM ensemble predictions suggest that western (Prek Chik) and southern (Canal 98) areas have historically been the least exposed to long periods of CDD (Figure 24). Future projections suggest that this will change in the future, with the highest increase in CDD predicted in these areas for both time horizons and climate scenarios. This suggests these areas may become exposed to increased issues of drought into the future.

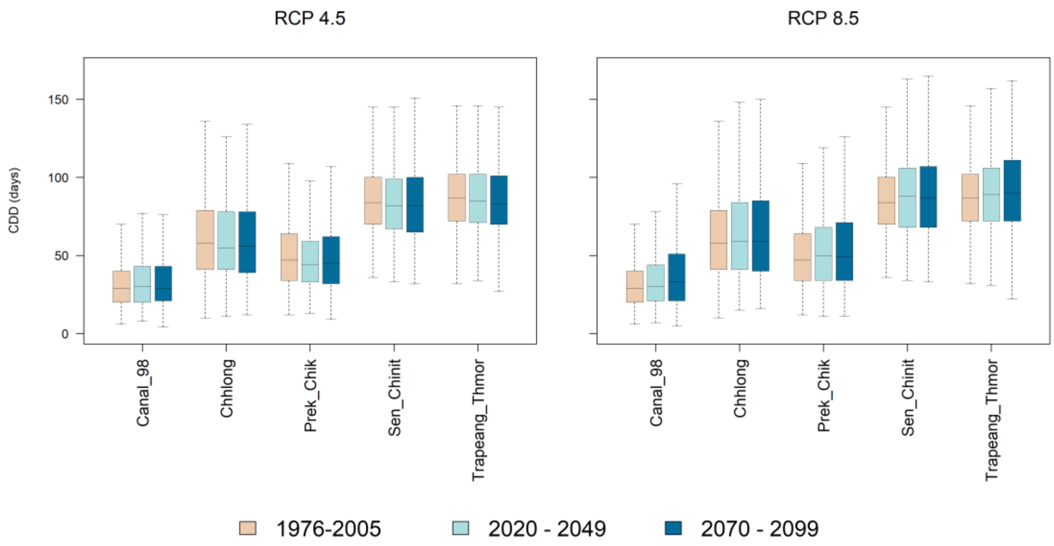


Figure 23. Distribution of changes predicted by the GCM ensemble in CDD averaged over the two climate change scenarios and three time horizons considered.

Table 5. CDD - Annual consecutive dry days RCP 45 (GCM ensemble mean)

CDD	Historical (1976 – 2005)	RCP 45 (2020 - 2049)	RCP 45 (2070 - 2099)	Δ RCP 45 (2020 - 2049)	Δ RCP 45 (2070 - 2099)
	(days)	(days)	(days)	(%)	(%)
Canal_98	32.7	33.9	33.8	3.5	3.3
Chlong	61.4	60.7	61.0	-1.1	-0.6
Prek_Chick	50.2	48.5	49.0	-3.5	-2.5
Sen_Chinit	85.0	83.4	83.8	-2.0	-1.5
Trapeang_Thmar	88.0	87.4	86.3	-0.7	-1.9

Table 6. CDD - Annual consecutive dry days RCP 85 (GCM ensemble mean)

CDD	Historical (1976 – 2005)	RCP 85 (2020 - 2049)	RCP 85 (2070 - 2099)	Δ RCP 85 (2020 - 2049)	Δ RCP 85 (2070 - 2099)
	(days)	(days)	(days)	(%)	(%)
Canal_98	32.7	35.7	39.5	8.9	20.5
Chlong	61.4	64.4	64.9	4.8	5.7
Prek_Chick	50.2	53.9	54.6	7.2	8.7
Sen_Chinit	85.0	87.9	88.3	3.3	3.9
Trapeang_Thmar	88.0	90.3	92.2	2.6	4.8

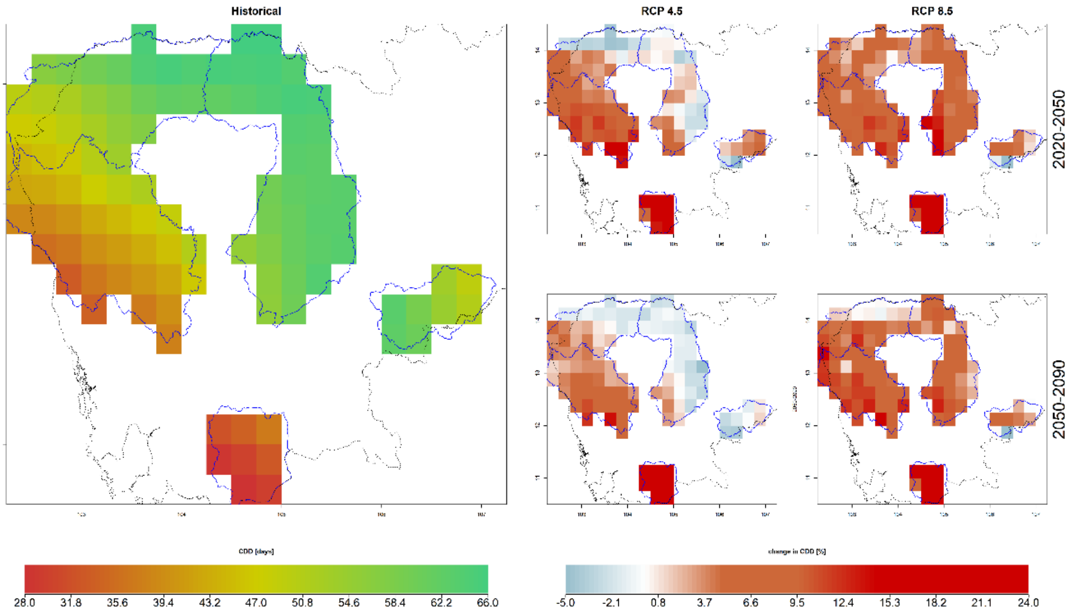


Figure 24. Spatial distribution of percentage change (%) in GCM ensemble mean annual consecutive dry days for the near (2030) and distant (2080) future under the RCP 4.5 and RCP 8.5 (GCM ensemble).

When return periods are considered, an equally uncertain picture of trends in CDD is presented, with some GCMs predicting increases over time and others predicting the opposite (Figure 25). This signal becomes even less clear when greater return periods (25, 100 years) are considered.

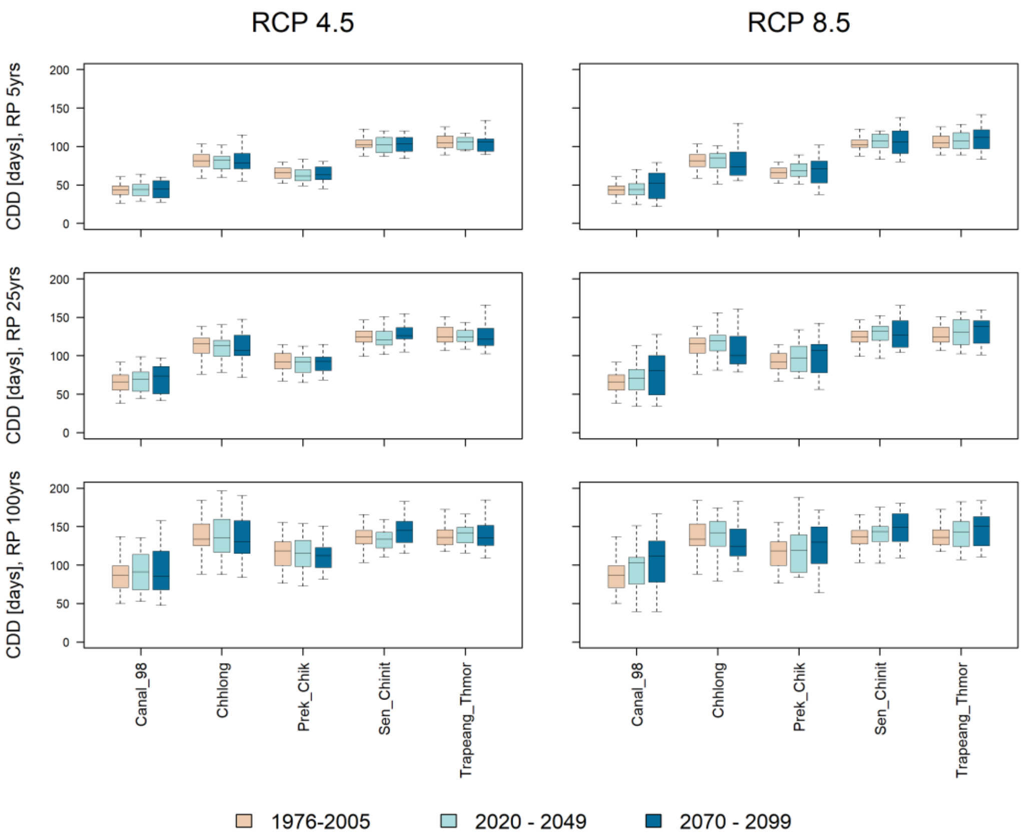


Figure 25. Distribution of changes in CDD predicted by the GCM ensemble under different return periods for the two climate change scenarios and three time horizons considered.

5.2.3 *Temperature extremes*

Average maximum annual temperature per period considered (*TXX*) as predicted by the GCM ensemble is chosen as a representative indicator for determining how temperature extremes may be exacerbated by climate change. This is a useful indicator for exploring the severity of heatwaves. Average minimum annual temperature per period considered (*TNN*) is used to explore how the severity of extreme low temperatures may change over time.

A clear picture is presented in terms of changes in extreme temperature of increases in the severity of heatwaves over time (Figure 26). Indeed, *TXX* increases for all basins and at all time horizons, with a range of increase of 1-2.2°C experienced under RCP4.5 and 1.1-4°C for RCP8.5. A fair amount of uncertainty is evident in these predictions, with some overlap between GCM predictions for both time periods and pathways. Trends in TNN are very similar, with increases predicted over time and at higher RCP scenarios.

In terms of spatial changes in temperature extremes, the GCM ensemble suggests that extreme temperatures will increase most in western areas of the Prek Chik Basin Group, which currently experiences the least heat stress. The Canal 98 area shows the lowest level of increase in extreme heat of all the Basin Groups (2-4°C).

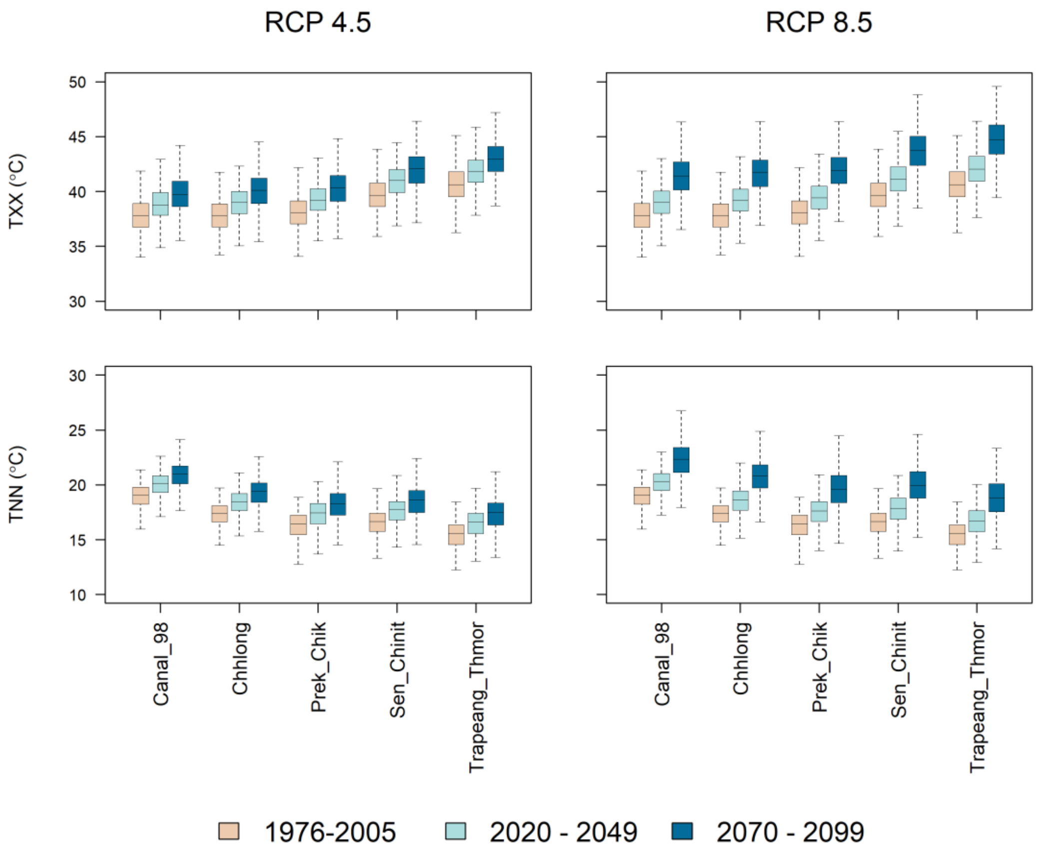


Figure 26. Distribution of changes predicted by the GCM ensemble in *TXX* and *TNN* averaged over the two climate change scenarios and three time horizons considered.

Table 7. *TXX* - annual max daily max temperature RCP 45 (GCM ensemble mean)

Index	Historical (1976 – 2005)	RCP 45 (2020 - 2049)	RCP 45 (2070 - 2099)	Δ RCP 45 (2020 - 2049)	Δ RCP 45 (2070 - 2099)
TXX	(°C)	(°C)	(°C)	(°C)	(°C)
Canal_98	37.9	38.9	39.8	1.0	1.9
Chlong	37.9	39.0	40.1	1.1	2.2
Prek_Chick	38.1	39.3	40.3	1.1	2.1
Sen_Chinit	39.8	40.9	42.0	1.2	2.2
Trapeang_Thmar	40.7	41.9	43.0	1.2	2.2

Table 8. *TXX* - annual max daily max temperature RCP 85 (GCM ensemble mean)

Index	Historical (1976 – 2005)	RCP 85 (2020 - 2049)	RCP 85 (2070 - 2099)	Δ RCP 85 (2020 - 2049)	Δ RCP 85 (2070 - 2099)
TXX	(°C)	(°C)	(°C)	(°C)	(°C)
Canal_98	37.9	39.0	41.4	1.1	3.4
Chlong	37.9	39.2	41.7	1.3	3.8
Prek_Chick	38.1	39.5	42.0	1.3	3.8
Sen_Chinit	39.8	41.2	43.7	1.4	3.9
Trapeang_Thmar	40.7	42.1	44.7	1.4	4.0

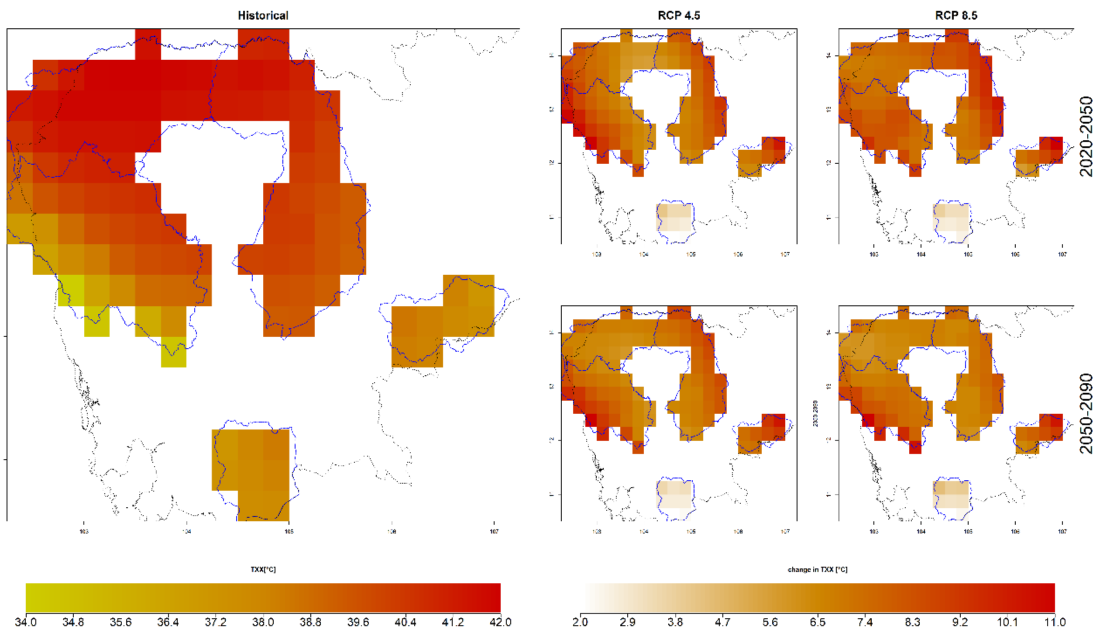


Figure 27. Spatial distribution of absolute change [°C] in GCM ensemble mean *TXX* for the near (2030) and distant (2080) future under the RCP 4.5 and RCP 8.5 (GCM ensemble).

In terms of *TXX* values at different return periods, the GCM ensemble predicts similar trends of increase over time. The GCM ensemble predicts increases in extreme *TXX* values (100-year return period) of up to 6°C by later time horizon (2070-2099). Notably, at all return periods, increases in *TXX* values between the first future time horizon (2020-2049) and the second (2070-2099) are much greater than between the historical period and the first future time horizon, suggesting the occurrence of extreme heat events will be greatly exacerbated toward the end of the century.

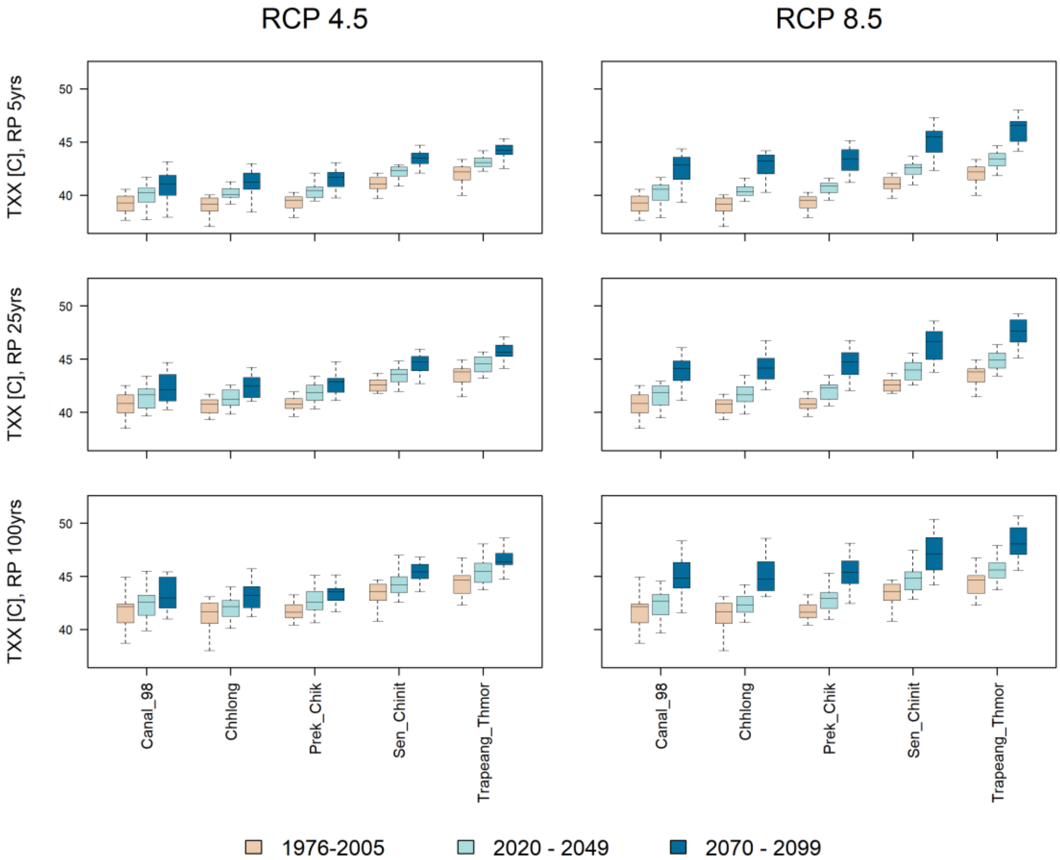


Figure 28. Distribution of changes in *TXX* predicted by the GCM ensemble under different return periods for the two climate change scenarios and three time horizons considered.

6 Potential climate risks

Based on the synthesis of expected project sensitivities (Chapter 3), historical trends in climate-related variables (Chapter 4), projections concerning precipitation and temperature (Chapter 5), and relevant additional literature, this chapter discusses and categorizes the potential climate risks in the context of the foreseen investment projects.

6.1 Flooding

The analysis of GCM ensemble predictions of maximum 1-day rainfall from Section 5.2.1 suggests that extreme precipitation events will likely become more severe at both time horizons. It is therefore likely that this will be reflected by more extreme streamflow and the increased occurrence of flooding events. Other studies (Deltares, 2016; USAID, 2013) support this proposition, suggesting that flooding is likely to become increasingly problematic into the future under a changing climate. This may be of concern as current flood hazard maps show areas which are affected by flooding in all the Basin Groups, with the Canal 98 and Sen Chinit areas most exposed to flooding.

Increased flood frequency and intensity may adversely affect the targeted Basin Groups via damaging both irrigation infrastructure and agricultural crops. This would negatively impact on crop yield and reduce project returns over the horizons considered. Furthermore, increased flood events may lead to the loss of viable agricultural land due to increased levels of soil erosion and persistent waterlogging. Increased flooding and intense precipitation would also lead to a higher sediment yield delivered to dam and canal structures, reducing the lifetime of these structures without significant maintenance costs. It may be that the delivery of flood waters could to an extent increase crop yields through delivering nutrients to agricultural areas, but this effect is likely outweighed by negatives.

It should also be considered that the proposed investments may also have effects on flooding dynamics themselves, potentially changing the spatial distribution of flooding within basins. For this reason, further analysis is currently occurring in the Canal 98 area as to how this may occur, which is presented in the SWRA report.

In terms of climate-related hazards, an analysis of future flood risk in Cambodia under a changing climate found that higher peak discharges in rivers were likely to lead to increased flood hazard in the country (Deltares, 2016). This, combined with projected increases in population and economic growth, highlights an increasing climate change related risk. The USAID (2013) study also suggests that climate change is likely to increase the size and intensity of storm events, with increases in the occurrence of agricultural drought also predicted.

More recent studies by JBA (2017, 2019) commissioned by the MRC suggest that increases in hazards and exposure for both flooding and drought can be expected into the coming century in the Lower Mekong region and Tonle Sap basin (Cambodia) respectively. These studies combine to show a trend of increased climate related hazards into the future which are likely to impact upon the selected Basin Groups in a variety of ways.

6.2 Drought and extreme heat

Meteorological drought impacts mainly rainfed agriculture and environmental water use, but given the high reliance of irrigated agriculture in Cambodia on direct rainfall, it also influences irrigation. Section 5.2.2 shows that the large climate model ensemble that was considered for this study does not predict a clear trend in patterns of meteorological drought for the target areas.

A firmer conclusion can be drawn though on hydrological drought, for which there is sufficient evidence that it is likely to increase in the future. Hydrological drought is of relevance for systems (irrigation and environment) that rely on the flow regime. Water use and land use changes upstream in the Mekong and Tonle Sap will likely cause (and are already) causing significant changes (JBA, 2019; MRC, 2017). These water and land use changes are partially influenced by climate change, but also economic factors.

For extreme heat events, based the indicators analyzed, it can be concluded that the severity of these events will increase in all areas. Increases in temperature paired with drought periods may also lead to the increased occurrence of wildfire in the region, leading to further potential negative impacts on crop yields and infrastructure.

Given the unclear signal in drought trends and future drought characteristics, both for meteorological as hydrological drought, it is recommended that any future investment in water resources infrastructure or irrigation should consider these uncertainties, in order to prepare a robust design and operations. For the agricultural sector, potential damages from drought include crop failure and damage, yield decreases and the loss of arable land. Increased and persistent extreme temperatures may also lead to heat stress in crops and increased water demands, reducing the yields of certain crops. Damages to the proposed investments may be incurred by wildfires and extreme temperatures.

6.3 Cyclones

Projections of the influence of climate change on cyclones in Eastern Cambodia vary, but studies do point toward a trend of decreasing frequency but increasing intensity (Mei and Xie, 2016; Ying, 2012). This may be negative for project areas as higher intensity storms may be more likely to travel further into Cambodia. Cyclones negatively impact the proposed investments through causing damage to crops and infrastructure.

Based on this information, the impact of cyclones must be considered in all phases of the project, in particular during design and construction. Project planning decisions, project design, and construction methods should take into account the level of cyclone hazard. Note that damages can not only occur due to wind but also cyclone induced heavy rainfall and subsequent flooding as well as coastal floods in coastal areas.

6.4 Landslides

Landslides are particularly relevant to the Prek Chik basin group, which intersects the Cardamom mountains to the south (Figure 15). Literature suggests that the incidence of precipitation induced landslides will increase with a changing climate due to increased intensity of precipitation events (Gariano and Guzzetti, 2016). This, in combination with predictions of more intense precipitation events for the local areas by the GCM ensemble suggests that incidences of landslides will indeed increase in Cambodia over both time horizons. This has consequences for the proposed interventions; in Prek Chik this may cause structural damage or blockages to canal structures proposed for interbasin transfers. Sediments released by landslides may also cause sedimentation and capacity loss of reservoirs.

Next to the above discussion, which is focused on specific investment projects, it is evident that increased erosion will negatively affect fertility and productivity of upland agricultural soils.

6.5 Categorization of risks

The screening analysis presented here strongly suggests that the proposed investments should incorporate risks from climate change in the feasibility and design phase. Considering the climate hazard analysis in the Basin Groups, and the area-specific climate change projections, it is concluded that climate change-induced increases in the following should be considered, requiring more in-depth study at the project level:

- Flooding, especially in areas with large extents inside the 100-year recurrence period flood map (Canal 98 area);
- Drought, especially in the west of the country where previous severe droughts have taken place (Prek Chik, Trapeang Thmar areas), focusing on hydrological drought characteristics;
- The increase severity of cyclones, especially in the east of the country (Chhlong, Sen Chinit areas).

Project components should be designed with careful consideration of potential increases in these risks which may become relevant over the expected project horizon and may affect the expected return on investment.

A qualitative assessment was performed on the climate change risks to the main project components which will be possibly included in the investment program. This assessment is based on previous considerations, natural hazard screening, climate projections for the project area, and the information on the planned investments available so far. Table 9 lists for the main investment-categories, the identified climate change impact and an estimated risk level, considering the data and information presented in this climate risk screening analysis. Given the The last category does not link directly with the envisioned

Table 9. Climate risks to individual potential project components.

Investment categories	Potential climate impact	Risk level
Modernization and rehabilitation of canals and irrigation networks	Structural damage from flooding	High
	Structural damage from typhoons/tropical storms	Medium
	Drying out of networks due to drought, reduced groundwater recharge	Medium
	Precipitation induced landslides blocking network	Low
	Blocking of channels through increased siltation	High
New or enhanced reservoirs and dam structures	Extreme precipitation events leading to dam overtopping, structural damage, dam breach	High
	Structural damage from typhoon/tropical storms	Medium
	Drying out of reservoirs during drought periods	Medium
	Sedimentation of storage due to increased delivery from high intensity events, landslides	High
New irrigated areas and cropping intensification	Reduced irrigation water quality due to vegetation changes, less dilution	Medium
	Modification in crop suitability and productivity (heat stress), changes to crop water requirements	Medium
	Loss of agricultural land due to erosion	Low
	Changes in crop water requirements	High
	Increased waterlogging of agricultural land leading to redundancy	Low
	Crop failure, damages due to flooding	High
All previous categories	Increased competition in water resources use	High
	Upstream deforestation and other forms of unsustainable land management, leading to downstream sedimentation	High

Project planning decisions, project design, and operation and maintenance of the investments should take into account the above climate risks. A detailed Climate Risk and Vulnerability Assessment is needed for each individual investment project. The following chapter includes several recommendations for appropriate further actions to identify adaptation options to mitigate these risks.

7 Recommendations for Climate Risk and Vulnerability Assessment

The climate risk screening analysis has indicated that several project components have medium to high potential climate risks. This means that a full Climate Risk Assessment, as follows from the ADB's Climate Risk Management framework (ADB, 2014), is needed for the Project Preparation Phase.

7.1 Approach to be followed

This section provides some guidance on steps towards realizing an effective CRA for the project preparation phase. In terms of approach, ADB guidelines provide a simple series of steps to follow (Step 1-5 are the so-called climate screening steps addressed in this report):

- Step 6: Identify Vulnerability of Project Components
- Step 7: Identify Biophysical Drivers of Vulnerability
- Step 8: Identify Socioeconomic Drivers of Vulnerability
- Step 9: Develop Appropriate Climate Change Scenarios
- Step 10: Estimate Future Biophysical Impacts
- Step 11: Assess Impacts on Investment Projects

Multiple approaches are possible to address the above steps, with a clear distinction between climate scenario driven impact assessment approaches, referred to as "**top-down**" and vulnerability-oriented approaches, often called "**bottom-up**" (see Section 2.1). ADB guidelines are not restrictive and recognize that both approaches are appropriate are applicable in certain situations and may also be conducted in parallel. Increasingly, however, a shift in focus toward bottom up approaches is evident as these assessments allow for the decision maker to take a stronger role in determining what are likely climate change related vulnerabilities in the Project Preparation Phase.

Overall, it is therefore suggested that a bottom up focused CRA should be performed for the proposed water resources investments. This assessment should more explicitly link potential climate impacts with their effects on specific investments. Climate impacts and project vulnerabilities should be treated as separate phases as recommended by ADB (Figure 29). Overall, the CRA should consist of the following steps (steps (a) and (b) already partially covered in this study):

a) Analysis of historic climate events
b) Projections of future climates
c) Impact and vulnerability assessment, considering climate change
d) Adaptation options and recommendations for design

This study has already identified several more general recommendations in terms of adaptation measures which should be taken forward into the CRA. These are as such, relating to water resources and agriculture projects in Cambodia:

- The development of better hydrometric forecasting and early warning systems in relation to floods, drought and typhoons will help increase preparedness relating to infrastructure projects. Recommendations have already been identified here by GFDRR (2013).

- Investment in new flood defense infrastructure and increasing the extent and design of existing structures e.g. dikes. Catchment scale management measures which contribute to flood alleviation should also be considered e.g. tree planting.
- Drought management planning should be implemented, with alternative water resources and operational norms identified in these periods to alleviate stress on infrastructure.
- Diversifying agricultural practices may help increase longevity of investments. Planting more drought resistant crops in certain areas and transitioning to more efficient irrigation practices may be central to this.

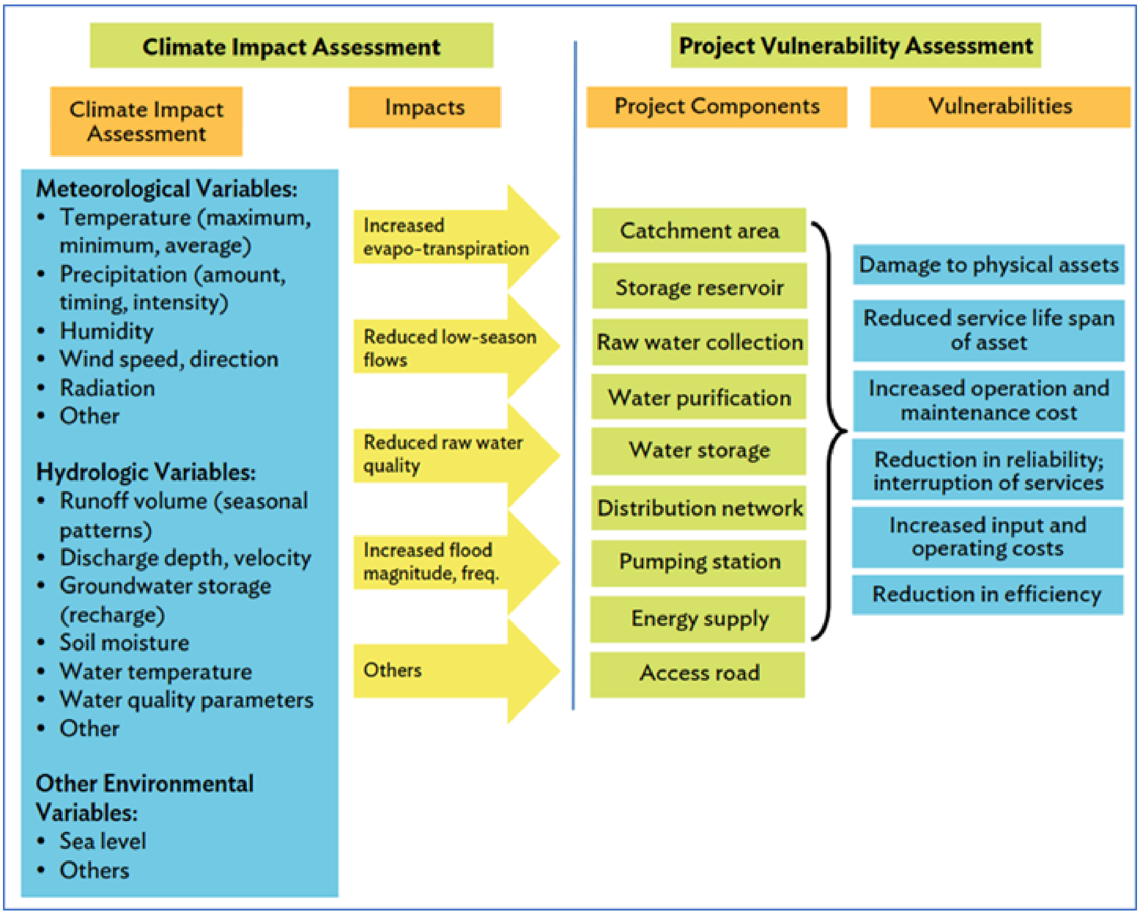


Figure 29. Climate Impact and Project Vulnerability Assessment (ADB, 2016)

7.2 Data needs and tools

Much of the relevant data for the CRA has already been gathered for the detailed SWRA which was performed parallel to this assignment. However, data specific to the planned project component will have to be made available, to assess the project vulnerability. Typical data are:

- Design requirements (e.g. return-periods)
- Canal dimensions, maximum flow or storage capacities
- Irrigation channel dimensions, maximum flow or storage capacities
- The location and extent of irrigation networks
- Locations of any vulnerable project components e.g. pumps
- Recent streamflow data, if available

To accomplish this target, it is recommended that modelling studies which relate temperature and precipitation changes to water availability take place. This may use the WEAP model (see

FutureWater, 2018) or similar water distribution model to determine how predicted changes in climate may impact project components and outcomes on a variety of time horizons. This approach allows a range of possible climate scenarios to be considered, with a high level of license in terms of interpretation thereby devolved to local project decision makers. An example of this process is given in a FutureWater (2018) report which applies the WEAP model to assess climate risk in a river basin in Indonesia. In this process, the following approach should be applied (adapted from Poff et al., 2015):

1. Determine key climate change drivers to be evaluate. Most relevant to be chosen ones are:
    a. changes in temperature (dT)
    b. changes in precipitation (dP)
    c. changes in precipitation extremes/frequencies (dPf)
    d. changes in wind speed (dW)
    e. changes in sea level rise (dSLR)
2. Determine the ranges in climate change drivers used in the impact assessment. This step is where the fundamental difference between the bottom-up and the top-down approach appears as ranges in the top-down approach are based on GCM outputs only, while the bottom-up approach obtains a range in climate drivers and outcomes:
    a. historic observations / events
    b. expert knowledge
    c. GCMs/RCMs
    d. decision makers' interests
3. Select the appropriate impact tool(s) / model(s) (see section hereafter)
4. Setup, calibrate, validate the selected impact tool/model
5. Run the tool/model for the full ranges of all selected climate drivers
6. Evaluate and present the results

In addition, impact models that assess how climate change may affect the water productivity and agricultural production may be considered. For example, a study done in 2014 assessed productivity changes and put these against food demand changes in the Lower Mekong region[1].

In order to increase confidence in the climate model outputs feeding into a detailed CRA, different approaches for climate model selection may be considered. For example, Lutz et al., (2016) propose an combination of an envelope-based approach for climatic means and extremes with model skill criteria to select suitable models for a specific regions. Using Regional Climate Models rather than GCMs may also be an option, if there these model outputs are available.

7.3 Required expertise

A variety of expertise will likely be needed to complete a CRA for the proposed investments. Typically, a CRA is performed by

- Overseen by the team leader
- A climate change specialist, which analyzes climate trends and climate model outputs
- An experienced hydrologist assessing hydrological impacts (floods, droughts, etc).
- Economic expertise is also desirable to assess how climate change may impact the economic viability and assets.

[1] https://www.futurewater.nl/wp-content/uploads/2014/04/Food_CC_LMB_v09.pdf

- Local expertise is also necessary for a more informed perspective of how identified impacts are likely to manifest themselves in the different identified areas of Cambodia given qualitative historical knowledge of the situation.

The interaction of these different roles is schematized according to guidance by ADB (Figure 30).

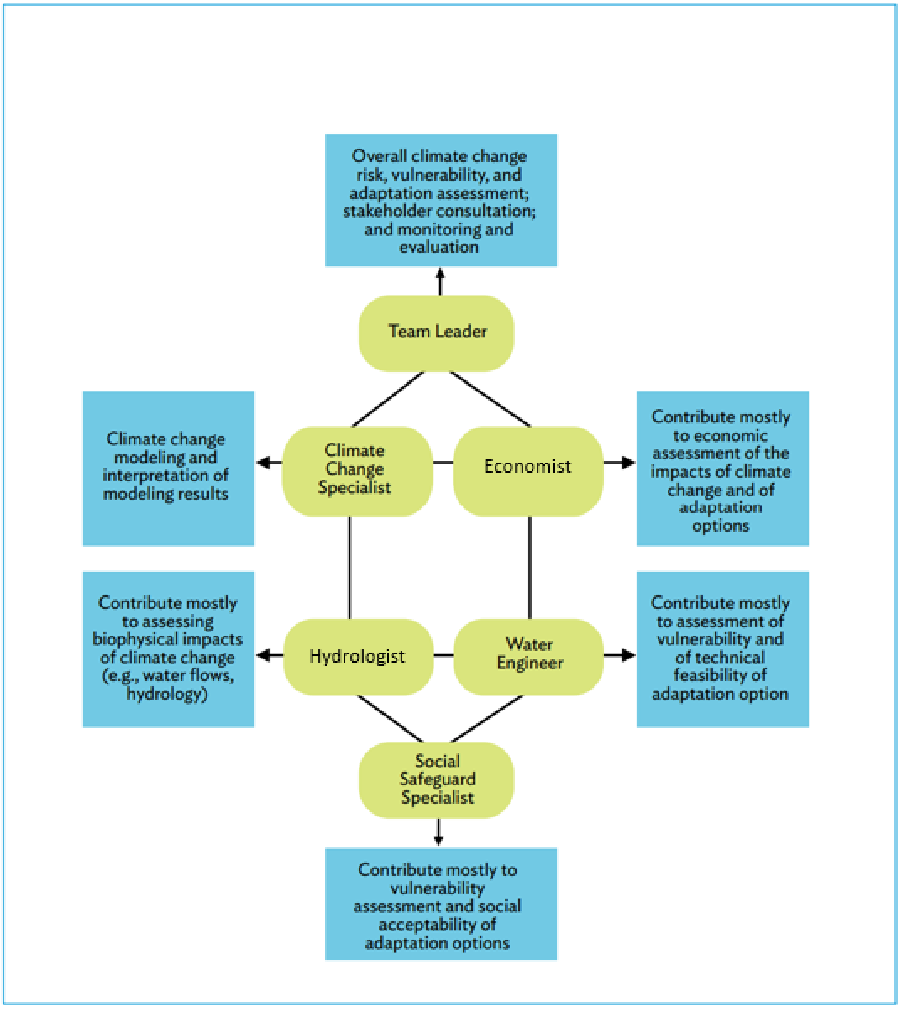


Figure 30. Interrelation of roles required for the assessment of climate change related risk, vulnerability, impacts and adaption as visualized by ADB.

References

ADB: Guidelines for Climate Proofing Investment in Agriculture, Rural Development, and Food Security., 2012.

ADB: CLIMATE RISK MANAGEMENT IN ADB PROJECTS., 2014.

ADB: Guidelines for Climate Proofing Investment in the Water Sector Water Supply and Sanitation GuIDelIneS for ClImAte ProofInG InveStment In the WAter SeCtor Water Supply and Sanitation ASIAn DeveloPment BAnK., 2017.

Deltares: Analyzing future flood risks in Cambodia., 2016.

FutureWater: Development of baseline climate data set and trend analysis in the Mekong River Basin., 2013.

FutureWater: Food Supply and Demand under Climate Change in the Lower Mekong Basin., 2014.

Gariano, S. L. and Guzzetti, F.: Landslides in a changing climate, Earth-Science Rev., 162, 227–252, doi:10.1016/j.earscirev.2016.08.011, 2016.

GFDRR: COUNTRY ASSESSMENT REPORT FOR CAMBODIA: Strengthening of Hydrometeorological Services in Southeast Asia., 2013.

JBA: Transboundary Water Resource Management in the Lower Mekong Basin - JP Flood and Drought Thailand and Cambodia subbasins 9T/9C REPORT B - Modelling of Flood and Drought Hazard & Vulnerability., 2019.

Kiem, A.: Mekong River Commission Climate Change and Adaptation Initiative Analysis of historical trends, variability and changes in hydroclimatic conditions for the Lower Mekong Basin (LMB)., 2017.

Lutz, A. F., ter Maat, H. W., Biemans, H., Shrestha, A. B., Wester, P. and Immerzeel, W. W.: Selecting representative climate models for climate change impact studies: an advanced envelope-based selection approach, Int. J. Climatol., 36(12), 3988–4005, doi:10.1002/joc.4608, 2016.

Mei, W. and Xie, S. P.: Intensification of landfalling typhoons over the northwest Pacific since the late 1970s, Nat. Geosci., 9(10), 753–757, doi:10.1038/ngeo2792, 2016.

MRC: Climate Change Impacts., 2017.

Terink, W., Immerzeel, W. W. and Droogers, P.: Drought Monitoring and Impact Assessment in the Mekong River Basin., 2011.

USAID: USAID Mekong ARCC Climate Change Impact and Adaptation Study ., 2013.

USAID: Climate Risk Profile Cambodia., 2019.

Ying, M. K. T. L. T.-C.: Impacts of Climate Change on Tropical Cyclones in the Western North Pacific Basin. Part II: Late Twenty-First Century Projections, Trop. Cyclone Res. Rev., 1(2), 231–241, doi:10.6057/2012TCRR02.09, 2012.

NASA-NEX-GDDP Projections of Future Climate

Table 10. GCMs included in the NASA-NEX-GDDP dataset

Model	Research centre	Country	Resolution (Original)		Resolution (NASA-NEX)	
			Lat (°)	Lon (°)	Lat (°)	Lon (°)
ACCESS1-0	BCC	Australia	1.25	1.88	0.25	0.25
BCC-CSM1-1	GCESS	China	2.79	2.81	0.25	0.25
BNU-ESM	NSF-DOE-NCAR	China	2.79	2.81	0.25	0.25
CanESM2	LASG-CESS	Canada	2.79	2.81	0.25	0.25
CCSM4	NSF-DOE-NCAR	USA	0.94	1.25	0.25	0.25
CESM1-BGC	NSF-DOE-NCAR	USA	0.94	1.25	0.25	0.25
CNRM-CM5	CSIRO-QCCCE	France	1.40	1.41	0.25	0.25
CSIRO-MK3-6-0	CCCma	Australia	1.87	1.88	0.25	0.25
GFDL-CM3	NOAAGFDL	USA	2.00	2.50	0.25	0.25
GFDL-ESM2G	NOAAGFDL	USA	2.02	2.00	0.25	0.25
GFDL-ESM2M	NOAAGFDL	USA	2.02	2.50	0.25	0.25
INMCM4	IPSL	Russia	1.50	2.00	0.25	0.25
IPSL-CM5A-LR	IPSL	France	1.89	3.75	0.25	0.25
IPSL-CM5A-MR	MIROC	France	1.27	2.50	0.25	0.25
MIROC5	MPI-M	Japan	1.40	1.41	0.25	0.25
MIROC-ESM	MIROC	Japan	2.79	2.81	0.25	0.25
MIROC-ESM-CHEM	MIROC	Japan	2.79	2.81	0.25	0.25
MPI-ESM-LR	MPI-M	Germany	1.87	1.88	0.25	0.25
MPI-ESM-MR	MRI	Germany	1.87	1.88	0.25	0.25
MRI-CGCM3	NICAM	Japan	1.12	1.13	0.25	0.25
NorESM1-M	NorESM1-M	Norway	1.89	2.50	0.25	0.25

The NASA-NEX-GDDP Projections are evaluated at the following time horizons:

- Reference period [1990] : 1976 – 2005
- Near future [2030] : 2020 – 2049
- Distant future [2080] : 2070 - 2099

CLIMDEX Climate Extremes Indices

Table 11. CLIMDEX precipitation indices

Index name	Description	Unit
1. PRCPTOT	Annual total wet-day precipitation; annual sum of precipitation in days where precipitation is at least 1mm	mm
2. SDII	Simple precipitation intensity index; sum of precipitation in wet days during the year divided by the number of wet days in the year	mm
3. Rx1day	Annual maximum 1-day precipitation	mm
4. Rx5day	Annual maximum 5-day consecutive precipitation	mm
5. R95pTOT	Annual total precipitation exceeding 95th percentile threshold (very wet days); annual sum of precipitation in days where daily precipitation exceeds the 95th percentile of daily precipitation in the reference period	mm
6. R99pTOT	Annual total precipitation exceeding 99th percentile threshold (extremely wet days); annual sum of precipitation in days where daily precipitation exceeds the 99th percentile of daily precipitation in the reference period	mm
7. R1mm	Annual count of days where daily precipitation exceeds 1mm per day; number of wet days	days
8. R10mm	Annual count of days where daily precipitation exceeds 10mm per day; number of heavy precipitation days	days

9. R20mm	Annual count of days where daily precipitation exceeds 20mm per day; number of very heavy precipitation days	days
10. CCD	Annual maximum consecutive dry days; annual maximum length of dry spells, sequences of days where daily precipitation is less than 1mm per day.	days
11. CWD	Annual maximum consecutive wet days; annual maximum length of wet spells, sequences of days where daily precipitation is at least 1mm per day	days

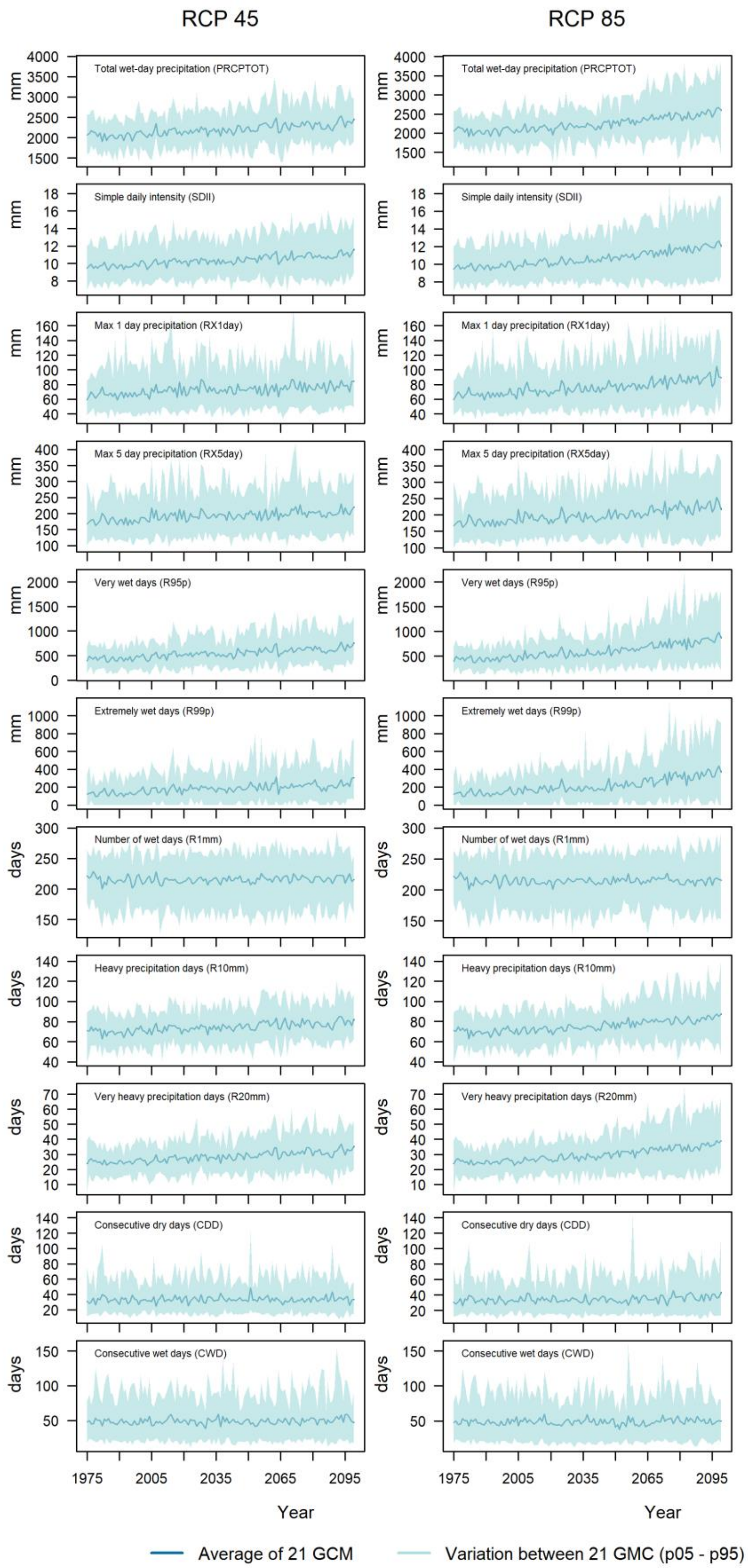
Table 12. CLIMDEX temperature indices

Index name	Description	Unit
12. TXx	Annual maximum of daily maximum temperature	Celsius
13. TXn	Annual minimum of daily maximum temperature	Celsius
14. TNx	Annual maximum of daily minimum temperature	Celsius
15. TNn	Annual minimum of daily minimum temperature	Celsius
16. DTR	Mean annual diurnal temperature range; annual mean difference between daily maximum and daily minimum temperature	Celsius
17. SU	Summer days; annual count of days where daily maximum temperature exceeds 25 degrees Celsius	days
18. TR	Tropical nights; annual count of days where daily minimum temperature exceeds 20 degrees Celsius	days
19. FD	Frost days; annual count of days where daily minimum temperature drops below 0 degrees Celsius	days
20. ID	Icing days; annual count of days where daily maximum temperature is below 0 degrees Celsius	days
21. WSDI	Warm spell duration index; annual count of days which are part of a warm spell, defined as at least 6 consecutive days where the daily maximum temperature exceeds the 90th percentile of daily maximum temperature for a 5-day running window surrounding this day during a reference period.	days
22. CSDI	Cold spell duration index; annual count of days which are part of a cold spell, defined as at least 6 consecutive days where the daily minimum temperature is below the 10th percentile of daily minimum temperature for a 5-day running window surrounding this day during a reference period.	days
23. GSL	Growing season length; annual count of days between the start of the first spell of warm days in the first half of the year, and the start of the first spell of cold days in the second half of the year. Spells of warm days are defined as six or more days with mean temperature above 5 degrees Celsius; spells of cold days are defined as six or more days with a mean temperature below 5 degrees Celsius.	days
24. TX90p	Warm days; annual percentage of days above the 90th percentile of reference daily maximum temperature	%
25. TN90p	Warm nights; annual percentage of days above the 90th percentile of reference daily minimum temperature	%
26. TX10p	Cold days; annual percentage of days below the 10th percentile of reference daily maximum temperature	%
27. TN10p	Cold nights; annual percentage of days below the 10th percentile of reference daily minimum temperature	%

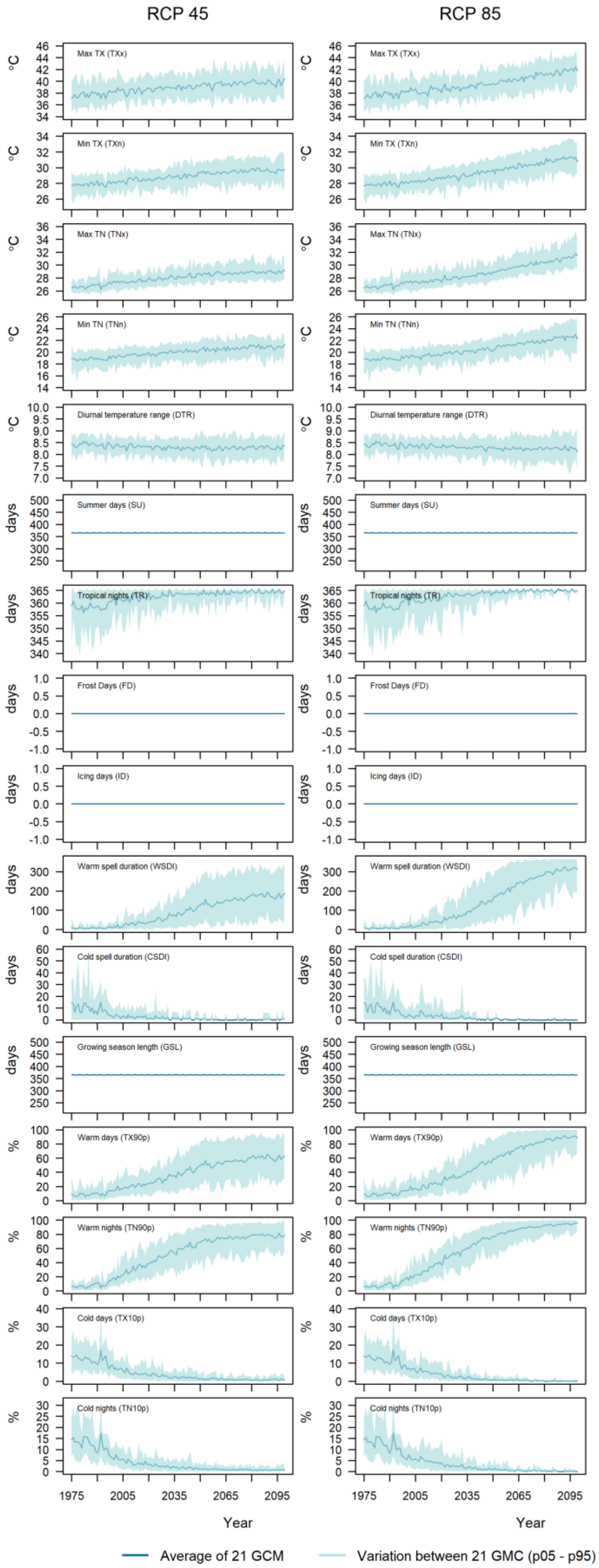
Results for each Basin Group

Canal_98

Precipitation indices:



Temperature indices:



Rx1day – Percentage change (%) Return Period per GCM:

RCP 45 Rx1day	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2080] (2070 - 2099)		
	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.4	-10.7	-19.8	15.4	30.4	51.9
BNU.ESM	-12.9	-20.7	-27.8	-2.1	-9.4	-17.4
CanESM2	4.3	10.5	19.8	31.0	31.6	31.2
CCSM4	15.9	12.2	8.1	22.1	18.5	14.0
CESM1.BGC	-0.4	-2.5	-3.6	15.0	11.6	7.6
CNRM.CM5	13.6	14.4	14.1	4.5	26.2	59.9
CSIRO.Mk3.6.0	0.4	-6.8	-13.7	21.1	7.3	-3.9
GFDL.CM3	-0.2	-9.8	-20.0	37.6	35.5	30.3
GFDL.ESM2G	43.8	38.2	28.3	16.3	11.4	6.2
GFDL.ESM2M	4.0	21.3	48.4	19.8	19.1	17.7
inmcm4	8.1	-6.2	-16.6	11.6	-2.8	-12.5
IPSL.CM5A.LR	33.2	23.0	9.9	20.0	6.9	-7.2
IPSL.CM5A.MR	41.9	22.1	0.4	41.8	22.9	3.3
MIROC.ESM.CHEM	2.4	-16.4	-37.6	5.7	-17.0	-38.7
MIROC.ESM	27.2	36.4	48.7	12.8	14.4	16.4
MIROC5	5.3	2.8	-4.0	12.3	16.3	15.7
MPI.ESM.LR	19.5	12.3	6.1	35.3	50.2	64.6
MPI.ESM.MR	17.1	30.9	44.8	15.8	16.2	17.3
MRI.CGCM3	3.4	7.0	10.3	7.0	3.1	0.4
NorESM1.M	12.1	18.5	25.6	13.9	14.4	16.9

RCP 85 Rx1day	Δ Return Period [2030] (2020 – 2049)			Δ Return Period [2080] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-9.0	-23.0	-34.0	8.4	10.6	19.0
BNU.ESM	-11.4	-5.9	1.2	24.2	27.5	26.3
CanESM2	20.0	28.5	35.6	32.8	73.1	130.1
CCSM4	14.2	23.0	29.4	33.6	30.2	26.3
CESM1.BGC	14.7	2.6	-7.9	24.8	16.1	7.2
CNRM.CM5	13.4	13.5	12.9	28.1	42.6	55.8
CSIRO.Mk3.6.0	-4.7	-11.9	-17.2	35.1	45.7	58.4
GFDL.CM3	23.3	37.7	49.7	33.3	43.8	52.1
GFDL.ESM2G	22.8	15.6	8.2	53.7	30.2	8.3
GFDL.ESM2M	44.8	70.2	93.5	70.2	73.7	72.2
inmcm4	-2.0	-21.2	-34.3	30.2	13.8	1.4
IPSL.CM5A.LR	16.9	7.1	-4.9	35.8	15.8	-2.1
IPSL.CM5A.MR	40.3	25.1	8.3	85.2	38.7	2.4
MIROC.ESM.CHEM	13.8	-7.1	-29.7	0.9	-22.0	-45.0

MIROC.ESM	12.4	25.1	44.0	0.1	18.9	43.4
MIROC5	2.6	-5.3	-14.9	12.7	23.4	32.5
MPI.ESM.LR	19.5	12.3	6.1	35.3	50.2	64.6
MPI.ESM.MR	17.1	30.9	44.8	15.8	16.2	17.3
MRI.CGCM3	3.4	7.0	10.3	7.0	3.1	0.4
NorESM1.M	12.1	18.5	25.6	13.9	14.4	16.9

CDD – Percentage change (%) Return Period per GCM:

RCP 45 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	10.9	16.0	19.3	10.4	29.5	51.2
BNU.ESM	-8.1	2.6	12.7	-8.0	11.2	33.5
CanESM2	18.4	5.8	-5.7	15.6	16.9	17.2
CCSM4	5.6	-9.6	-20.2	-0.4	-15.9	-27.0
CESM1.BGC	12.8	-6.6	-23.9	-3.7	-14.6	-22.8
CNRM.CM5	-5.5	-15.1	-22.1	9.7	28.1	47.2
CSIRO.Mk3.6.0	5.9	-1.0	-9.2	20.3	-3.1	-21.0
GFDL.CM3	2.8	-10.1	-22.0	1.2	-12.8	-23.6
GFDL.ESM2G	-19.0	-8.5	5.5	-26.4	-25.0	-21.2
GFDL.ESM2M	-15.6	2.8	29.2	-14.0	8.5	37.5
inmcm4	-23.2	-40.5	-53.2	-27.9	-42.0	-52.3
IPSL.CM5A.LR	14.9	10.6	4.3	18.1	34.6	61.2
IPSL.CM5A.MR	36.4	39.9	44.0	32.9	27.2	22.7
MIROC.ESM.CHEM	14.3	21.0	26.6	-7.4	-6.8	-8.0
MIROC.ESM	-9.3	-16.4	-21.9	-11.5	-25.2	-35.7
MIROC5	6.0	15.1	23.6	-20.1	-29.6	-37.5
MPI.ESM.LR	20.5	21.0	15.9	41.7	39.0	27.5
MPI.ESM.MR	33.1	35.7	36.2	53.6	64.8	70.7
MRI.CGCM3	9.6	7.9	6.5	4.3	7.0	10.1
NorESM1.M	-13.5	4.0	24.3	-8.6	-19.7	-28.9

RCP 85 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-7.5	3.2	19.7	3.6	-9.1	-20.6
BNU.ESM	-6.9	7.3	21.8	-7.1	39.1	99.4
CanESM2	18.0	-5.4	-23.8	85.4	53.1	23.8
CCSM4	5.3	-13.4	-26.6	0.8	-7.4	-11.7
CESM1.BGC	32.7	7.9	-15.3	27.8	-5.1	-29.7
CNRM.CM5	-8.9	19.6	54.0	26.6	47.2	67.2
CSIRO.Mk3.6.0	15.6	16.0	13.9	42.5	31.4	21.7
GFDL.CM3	2.2	6.9	19.6	18.1	20.2	21.6

GFDL.ESM2G	-16.1	-8.1	4.2	-27.5	-20.5	-12.4
GFDL.ESM2M	-11.0	-1.4	12.1	-35.0	-24.3	-6.9
inmcm4	-23.2	-44.0	-58.0	-24.5	-34.4	-43.3
IPSL.CM5A.LR	42.7	38.8	32.2	67.2	62.4	59.1
IPSL.CM5A.MR	6.3	-4.2	-9.7	35.7	37.4	40.2
MIROC.ESM.CHEM	10.6	16.2	18.1	-8.3	-14.0	-21.2
MIROC.ESM	-9.3	-13.0	-16.6	-17.3	-33.4	-44.6
MIROC5	-1.1	15.7	32.3	-24.2	-30.1	-35.6
MPI.ESM.LR	21.9	20.1	13.8	88.0	82.6	72.3
MPI.ESM.MR	29.6	62.8	104.4	73.8	56.6	38.7
MRI.CGCM3	-4.3	10.2	29.2	21.3	48.7	78.4
NorESM1.M	-18.5	-32.6	-42.8	-34.8	-15.4	12.9

TXX – Change (°C) Return Period per GCM:

RCP 45 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.0	1.3	1.6	1.7	2.2	2.6
BNU.ESM	0.4	0.9	1.6	1.5	1.8	1.9
CanESM2	2.0	1.8	1.5	2.1	1.9	1.6
CCSM4	0.3	-0.1	-0.2	1.2	1.1	1.2
CESM1.BGC	0.5	-0.4	-1.0	1.2	0.3	-0.5
CNRM.CM5	0.5	0.4	0.4	1.2	0.6	0.3
CSIRO.Mk3.6.0	1.5	1.4	1.3	3.5	3.5	3.6
GFDL.CM3	1.4	1.0	0.5	3.4	3.2	2.7
GFDL.ESM2G	-0.1	-0.9	-1.3	0.7	0.6	0.5
GFDL.ESM2M	-0.2	-1.2	-2.0	0.3	-0.7	-1.5
inmcm4	-1.7	-2.3	-1.8	-1.4	-1.7	0.2
IPSL.CM5A.LR	1.2	1.3	1.1	3.1	2.3	1.2
IPSL.CM5A.MR	1.6	1.6	1.5	2.7	2.8	2.8
MIROC.ESM.CHEM	2.1	2.8	3.5	2.9	3.3	3.7
MIROC.ESM	1.6	1.3	1.2	2.9	2.8	2.8
MIROC5	2.0	2.8	3.2	0.6	1.4	2.8
MPI.ESM.LR	0.8	0.8	0.7	1.6	2.2	2.8
MPI.ESM.MR	0.2	0.5	1.3	1.9	1.3	0.8
MRI.CGCM3	1.1	0.6	-0.2	2.6	2.2	1.6
NorESM1.M	0.7	0.4	0.2	1.0	0.4	0.0

RCP 85 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.3	1.4	1.4	3.0	3.5	4.1
BNU.ESM	0.5	0.2	0.1	3.0	2.9	2.8

CanESM2	1.9	1.7	1.3	4.9	4.9	4.7
CCSM4	0.7	0.8	1.0	3.0	2.5	2.2
CESM1.BGC	1.1	0.2	-0.5	3.1	2.3	1.6
CNRM.CM5	0.6	0.9	1.3	2.5	2.4	2.5
CSIRO.Mk3.6.0	1.8	1.9	1.8	4.3	3.8	3.4
GFDL.CM3	1.8	1.9	1.8	4.6	4.5	4.2
GFDL.ESM2G	0.3	0.0	-0.1	2.1	2.1	2.2
GFDL.ESM2M	0.7	-0.3	-1.1	1.4	0.1	-0.9
inmcm4	-1.5	-2.7	-3.4	-0.1	0.0	1.9
IPSL.CM5A.LR	1.8	1.3	0.6	5.2	4.6	3.7
IPSL.CM5A.MR	1.4	1.0	0.7	4.4	4.2	4.0
MIROC.ESM.CHEM	2.0	2.2	2.3	5.1	5.5	6.0
MIROC.ESM	1.8	1.9	1.9	4.8	4.3	3.9
MIROC5	0.9	0.9	0.7	1.9	3.5	5.7
MPI.ESM.LR	0.5	0.5	0.6	3.7	4.4	5.4
MPI.ESM.MR	1.1	1.6	2.3	3.7	4.7	6.1
MRI.CGCM3	1.1	0.3	-0.5	3.3	2.1	1.0
NorESM1.M	1.0	1.1	1.1	2.5	2.7	2.7

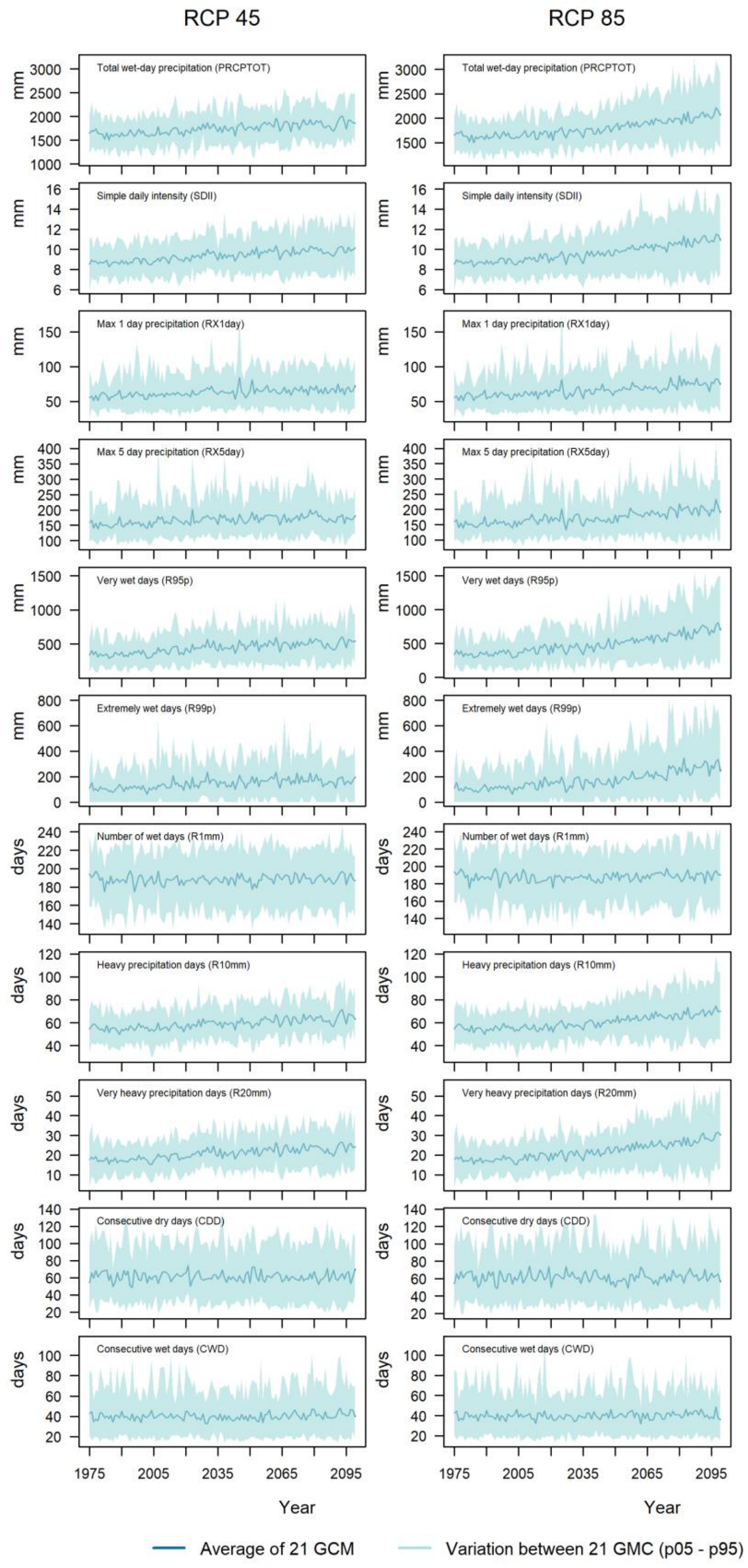
TNN – Change (°C) Return Period per GCM:

RCP 45 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.7	0.6	0.6	1.6	1.7	1.8
BNU.ESM	0.8	0.8	0.8	1.5	1.3	1.2
CanESM2	1.1	1.1	0.9	2.1	2.0	1.8
CCSM4	1.1	0.9	0.9	1.5	1.2	1.0
CESM1.BGC	1.2	0.4	-0.2	1.9	1.2	0.6
CNRM.CM5	1.0	0.9	0.8	1.7	1.9	2.1
CSIRO.Mk3.6.0	1.7	1.7	1.6	3.9	4.0	4.0
GFDL.CM3	1.6	2.2	2.7	2.2	2.4	2.7
GFDL.ESM2G	0.4	0.5	0.4	0.6	0.5	0.4
GFDL.ESM2M	0.3	0.5	0.6	0.9	1.1	1.3
inmcm4	0.4	-0.2	-0.7	1.3	0.8	0.5
IPSL.CM5A.LR	1.3	1.4	1.4	2.0	1.7	1.6
IPSL.CM5A.MR	1.2	1.0	1.0	2.1	2.6	3.1
MIROC.ESM.CHEM	1.3	1.2	1.1	2.7	2.6	2.5
MIROC.ESM	1.2	0.9	0.6	2.5	2.8	3.1
MIROC5	1.4	1.4	1.5	1.9	2.2	2.4
MPI.ESM.LR	1.3	0.7	0.1	2.6	2.2	1.9
MPI.ESM.MR	1.2	1.3	1.5	1.6	1.8	2.0
MRI.CGCM3	0.9	1.0	1.0	1.7	1.9	1.9
NorESM1.M	0.8	0.8	0.8	1.6	1.8	2.0

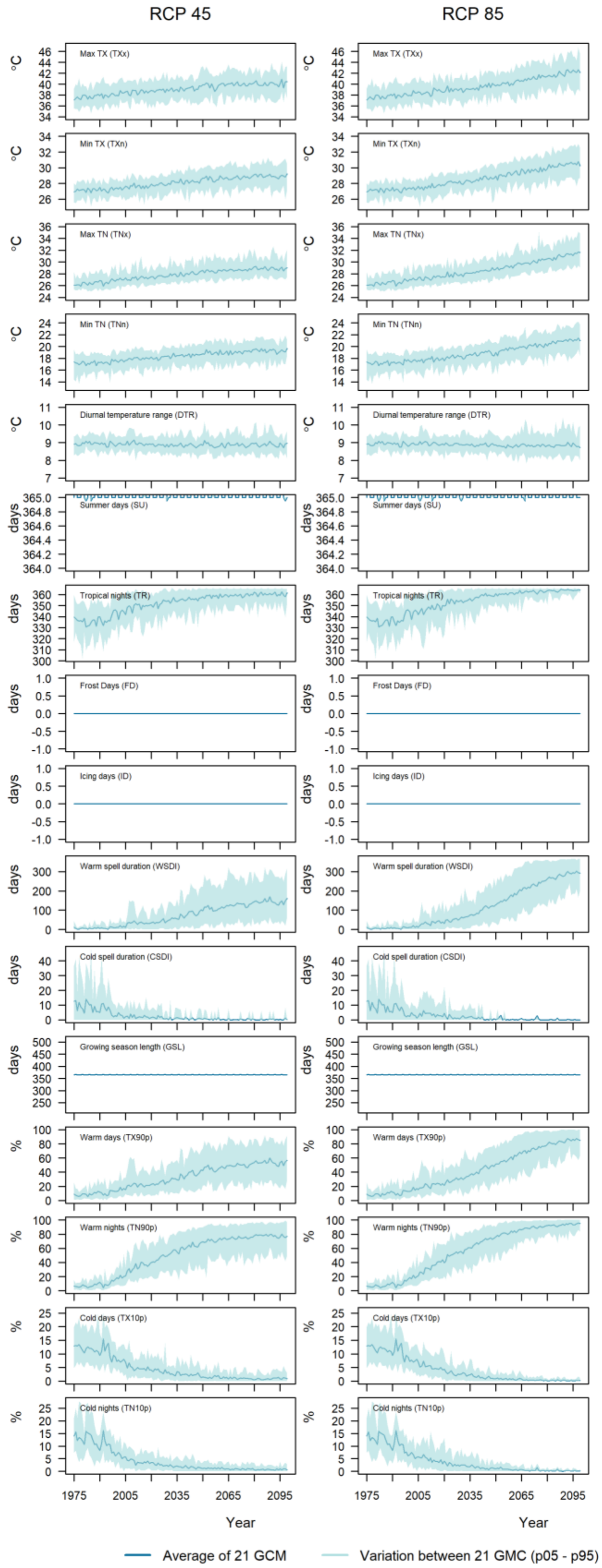
RCP 85 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.1	1.4	1.7	2.8	2.7	2.6
BNU.ESM	0.8	0.9	0.9	2.4	2.6	2.8
CanESM2	1.6	1.4	1.2	3.7	3.6	3.5
CCSM4	1.1	1.2	1.2	2.6	2.4	2.3
CESM1.BGC	1.2	1.0	0.9	2.9	2.4	1.9
CNRM.CM5	0.9	0.8	0.8	3.2	2.9	2.7
CSIRO.Mk3.6.0	1.6	1.5	1.4	5.8	6.3	6.7
GFDL.CM3	1.1	1.3	1.5	3.7	3.9	4.2
GFDL.ESM2G	0.8	0.5	0.2	1.2	1.4	1.5
GFDL.ESM2M	0.8	1.0	1.1	1.3	1.5	1.7
inmcm4	0.3	-0.4	-0.9	1.1	0.3	-0.3
IPSL.CM5A.LR	1.6	2.0	2.3	4.0	4.3	4.5
IPSL.CM5A.MR	1.5	1.8	1.9	3.9	4.6	5.2
MIROC.ESM.CHEM	1.4	1.5	1.5	5.2	5.2	5.1
MIROC.ESM	1.7	1.7	1.7	4.5	4.1	3.8
MIROC5	1.1	1.3	1.6	3.4	4.0	4.4
MPI.ESM.LR	1.8	1.6	1.3	4.3	4.2	4.0
MPI.ESM.MR	1.5	1.5	1.6	4.7	4.7	4.6
MRI.CGCM3	1.7	2.4	2.7	2.8	2.7	2.7
NorESM1.M	1.1	0.7	0.5	3.0	3.0	3.0

Chhlong

Precipitation indices:



Temperature indices:



Rx1day – Percentage change (%) Return Period per GCM:

RCP 45 Rx1day	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2080] (2070 - 2099)		
	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-7.69	-26.30	-40.58	5.31	1.31	-3.74
BNU.ESM	1.11	5.43	8.96	3.66	5.77	6.35
CanESM2	23.64	38.98	64.55	66.13	67.72	64.38
CCSM4	5.54	-2.03	-10.40	20.34	24.60	27.82
CESM1.BGC	11.52	5.36	0.39	25.36	18.85	11.54
CNRM.CM5	4.85	5.15	7.66	1.06	-5.98	-12.10
CSIRO.Mk3.6.0	13.83	7.00	-0.74	16.31	6.17	-4.91
GFDL.CM3	6.88	2.15	-5.84	15.73	4.94	-7.94
GFDL.ESM2G	25.62	11.32	-0.05	26.47	24.19	21.46
GFDL.ESM2M	14.66	40.32	72.99	12.11	15.97	23.10
inmcm4	23.21	31.80	40.55	22.54	14.62	9.49
IPSL.CM5A.LR	19.52	31.01	45.65	26.17	23.52	18.17
IPSL.CM5A.MR	14.15	2.51	-8.34	37.81	16.64	-4.38
MIROC.ESM.CHEM	1.09	4.65	7.65	-5.34	-3.66	-1.80
MIROC.ESM	-1.58	-5.98	-7.49	-12.93	-19.64	-22.80
MIROC5	-0.39	-4.05	-7.66	11.01	23.48	35.75
MPI.ESM.LR	-3.50	-6.93	-8.29	2.60	-5.51	-12.87
MPI.ESM.MR	11.03	36.59	73.28	8.28	19.02	36.09
MRI.CGCM3	0.72	-2.85	-5.07	29.87	17.57	5.55
NorESM1.M	21.55	7.86	-8.97	30.50	12.15	-8.78

RCP 85 Rx1day	Δ Return Period [2030] (2020 – 2049)			Δ Return Period [2080] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	5.10	-6.74	-16.95	23.58	11.87	-0.29
BNU.ESM	9.47	14.44	16.35	40.13	38.42	33.11
CanESM2	32.14	45.13	56.69	67.00	64.03	58.55
CCSM4	4.86	-4.87	-14.25	22.41	10.13	-0.87
CESM1.BGC	19.62	18.30	15.87	29.61	25.60	24.19
CNRM.CM5	2.23	-8.11	-16.55	17.87	7.92	-1.08
CSIRO.Mk3.6.0	27.17	17.03	4.40	31.40	19.01	6.02
GFDL.CM3	3.99	-1.70	-9.93	21.68	31.96	38.89
GFDL.ESM2G	44.66	82.99	127.12	56.80	56.39	52.49
GFDL.ESM2M	16.16	9.07	1.48	59.59	59.86	59.83
inmcm4	0.35	7.16	19.35	55.36	55.71	56.90
IPSL.CM5A.LR	16.64	20.76	21.87	36.49	24.61	15.52
IPSL.CM5A.MR	5.62	-7.08	-19.63	42.51	19.43	0.14
MIROC.ESM.CHEM	-6.05	6.98	25.11	-27.01	-23.99	-15.91

MIROC.ESM	-12.57	-18.02	-17.68	-23.41	-27.50	-28.76
MIROC5	1.13	-1.97	-7.14	3.44	17.97	34.49
MPI.ESM.LR	9.80	8.92	7.70	15.63	12.50	8.32
MPI.ESM.MR	20.63	21.69	25.37	42.66	50.16	55.38
MRI.CGCM3	29.55	28.25	25.31	43.22	31.22	21.38
NorESM1.M	16.76	2.79	-12.23	36.75	10.87	-12.87

CDD – Percentage change (%) Return Period per GCM:

RCP 45 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.4	23.1	48.9	-6.1	-6.1	-4.9
BNU.ESM	-3.0	-7.0	-10.4	-1.5	-10.3	-18.1
CanESM2	11.0	-2.6	-13.0	0.4	6.4	11.5
CCSM4	-9.0	-13.5	-16.1	-0.2	-0.4	2.4
CESM1.BGC	-2.8	-22.5	-35.8	-13.7	-25.3	-34.4
CNRM.CM5	-8.7	-13.3	-16.8	-13.9	-13.5	-12.8
CSIRO.Mk3.6.0	-1.5	7.4	13.8	11.7	-3.7	-11.0
GFDL.CM3	-7.0	12.9	36.9	-2.7	2.1	7.4
GFDL.ESM2G	-9.0	-24.3	-33.8	-17.6	-18.3	-17.6
GFDL.ESM2M	-17.3	-2.1	15.8	-5.5	8.7	23.9
inmcm4	-15.7	-13.0	-6.9	-26.7	-33.9	-39.2
IPSL.CM5A.LR	15.5	19.3	23.0	27.9	22.0	15.8
IPSL.CM5A.MR	16.6	2.8	-8.3	8.2	-11.6	-27.1
MIROC.ESM.CHEM	-10.7	-22.0	-30.2	-10.1	-8.7	-9.5
MIROC.ESM	11.6	21.4	29.8	18.6	22.5	23.8
MIROC5	5.3	24.0	46.6	-11.0	-10.8	-10.7
MPI.ESM.LR	-5.6	15.4	36.5	2.5	28.7	53.2
MPI.ESM.MR	7.0	11.1	17.7	21.7	21.7	20.4
MRI.CGCM3	-6.7	-7.7	-9.0	5.4	-6.9	-16.9
NorESM1.M	-16.3	-16.0	-15.8	-10.2	5.6	22.6

RCP 85 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-12.5	-11.4	-10.3	-4.4	11.0	31.9
BNU.ESM	1.4	3.7	7.0	-15.8	-12.0	-7.7
CanESM2	19.7	29.3	37.7	26.5	5.8	-8.7
CCSM4	-1.6	-4.5	-6.9	2.0	-3.9	-9.0
CESM1.BGC	1.6	-8.5	-17.4	5.2	-11.0	-22.9
CNRM.CM5	-16.1	-6.8	1.1	-1.9	-12.1	-18.5
CSIRO.Mk3.6.0	-2.3	-2.8	-2.4	26.3	22.8	22.2
GFDL.CM3	5.0	17.4	30.4	-4.2	-4.9	-5.1

GFDL.ESM2G	6.0	-2.9	-8.5	-20.0	-32.9	-40.8
GFDL.ESM2M	-3.5	4.8	12.5	-34.2	-23.9	-11.1
inmcm4	-16.4	-10.1	-0.8	-30.3	-32.4	-33.4
IPSL.CM5A.LR	26.4	9.4	-2.1	26.1	28.9	33.9
IPSL.CM5A.MR	11.2	11.5	11.8	-1.1	-3.1	-3.8
MIROC.ESM.CHEM	-7.2	-8.3	-11.3	-3.1	-13.4	-22.2
MIROC.ESM	3.4	2.1	0.8	10.7	4.4	-1.3
MIROC5	15.5	7.3	0.2	-23.6	-17.0	-9.6
MPI.ESM.LR	-17.9	-1.5	14.8	10.4	28.7	47.0
MPI.ESM.MR	23.8	30.1	34.1	17.5	23.1	28.1
MRI.CGCM3	-5.4	-11.7	-15.9	16.4	-8.7	-24.2
NorESM1.M	-20.9	-25.5	-27.9	-29.2	-20.2	-11.0

TXX – Change (°C) Return Period per GCM:

RCP 45 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.9	0.6	0.4	1.6	1.7	1.8
BNU.ESM	0.6	1.2	1.7	1.4	1.4	1.5
CanESM2	2.5	2.1	1.4	3.3	2.6	1.8
CCSM4	0.4	-0.4	-0.9	1.3	0.5	0.0
CESM1.BGC	1.0	0.7	0.6	1.9	1.5	1.1
CNRM.CM5	0.6	0.1	-0.1	2.0	2.1	2.2
CSIRO.Mk3.6.0	1.2	0.7	0.2	2.7	2.8	3.1
GFDL.CM3	1.5	0.8	-0.1	3.2	2.2	1.0
GFDL.ESM2G	0.2	-1.0	-2.1	1.0	0.5	-0.1
GFDL.ESM2M	0.5	-0.4	-1.4	1.1	0.2	-0.9
inmcm4	-1.6	-1.6	-0.8	-0.9	-0.5	0.9
IPSL.CM5A.LR	1.5	1.7	1.9	2.7	2.7	2.7
IPSL.CM5A.MR	0.8	0.2	-0.1	2.4	2.4	2.6
MIROC.ESM.CHEM	3.6	4.8	5.8	4.7	4.5	4.1
MIROC.ESM	2.8	3.1	3.3	5.1	5.6	6.1
MIROC5	1.6	1.7	1.6	0.8	0.5	0.4
MPI.ESM.LR	0.6	0.3	0.0	1.2	1.6	2.1
MPI.ESM.MR	0.7	1.1	1.6	2.3	1.8	1.5
MRI.CGCM3	1.4	1.7	1.8	3.0	3.2	3.2
NorESM1.M	1.2	0.8	0.4	1.9	1.5	1.2

RCP 85 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.1	1.4	1.7	3.3	3.7	4.2
BNU.ESM	0.9	0.5	0.3	3.2	2.9	2.7

CanESM2	2.3	1.9	1.3	5.5	4.9	4.1
CCSM4	0.7	0.0	-0.4	3.5	2.8	2.3
CESM1.BGC	1.6	1.4	1.2	4.1	3.7	3.3
CNRM.CM5	0.8	1.0	1.2	2.7	2.2	1.9
CSIRO.Mk3.6.0	1.8	1.2	0.5	4.1	4.1	4.5
GFDL.CM3	1.9	1.9	1.6	4.9	4.4	3.6
GFDL.ESM2G	0.9	0.2	-0.6	2.6	2.2	1.5
GFDL.ESM2M	1.1	0.4	-0.5	1.9	1.3	0.7
inmcm4	-1.2	-1.8	-2.1	0.9	1.8	3.5
IPSL.CM5A.LR	1.8	1.7	1.6	5.0	5.1	5.0
IPSL.CM5A.MR	1.1	0.9	0.8	4.3	4.0	3.7
MIROC.ESM.CHEM	4.1	3.9	3.2	8.7	9.5	9.8
MIROC.ESM	2.9	4.2	5.1	6.3	6.4	6.5
MIROC5	1.1	0.3	-0.6	2.1	1.5	0.7
MPI.ESM.LR	0.7	0.1	-0.3	4.1	5.0	6.0
MPI.ESM.MR	1.1	2.3	3.8	3.9	5.0	6.2
MRI.CGCM3	1.8	2.2	2.5	3.4	3.3	3.3
NorESM1.M	1.1	1.2	1.2	3.0	3.1	3.1

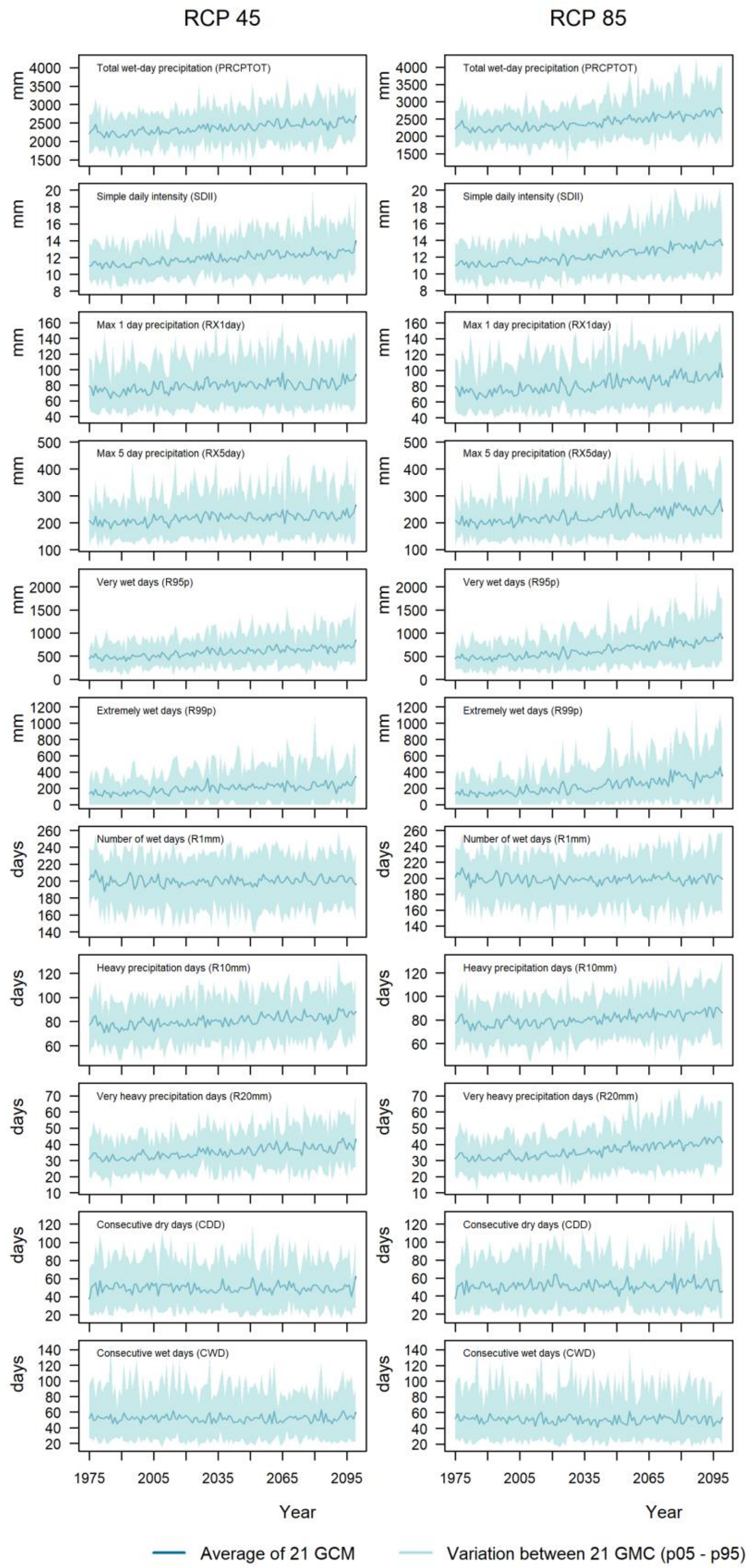
TNN – Change (°C) Return Period per GCM:

RCP 45 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.7	0.7	0.7	1.6	1.4	1.2
BNU.ESM	1.0	1.1	1.2	1.7	2.1	2.5
CanESM2	1.2	1.4	1.4	2.3	2.3	2.1
CCSM4	1.1	0.7	0.5	1.8	1.6	1.5
CESM1.BGC	1.1	0.1	-0.8	2.0	1.0	0.2
CNRM.CM5	0.9	0.7	0.6	1.7	1.9	2.1
CSIRO.Mk3.6.0	1.6	1.9	2.2	3.7	4.0	4.3
GFDL.CM3	1.9	2.3	2.6	2.1	2.5	2.8
GFDL.ESM2G	0.4	0.6	0.6	0.5	0.5	0.4
GFDL.ESM2M	0.1	0.1	0.2	0.7	0.8	0.8
inmcm4	0.2	-0.4	-0.7	1.2	0.9	0.7
IPSL.CM5A.LR	1.5	1.4	1.3	2.0	2.1	2.1
IPSL.CM5A.MR	1.0	0.9	0.8	1.9	2.4	2.9
MIROC.ESM.CHEM	1.0	1.2	1.2	2.6	2.6	2.6
MIROC.ESM	1.3	1.2	1.1	2.6	2.6	2.5
MIROC5	1.7	1.7	1.7	2.3	2.7	3.0
MPI.ESM.LR	1.3	0.5	-0.1	2.5	2.0	1.4
MPI.ESM.MR	1.5	1.7	1.9	2.4	2.5	2.7
MRI.CGCM3	1.4	1.7	2.0	1.8	1.8	1.7
NorESM1.M	0.8	0.6	0.4	1.1	1.4	1.7

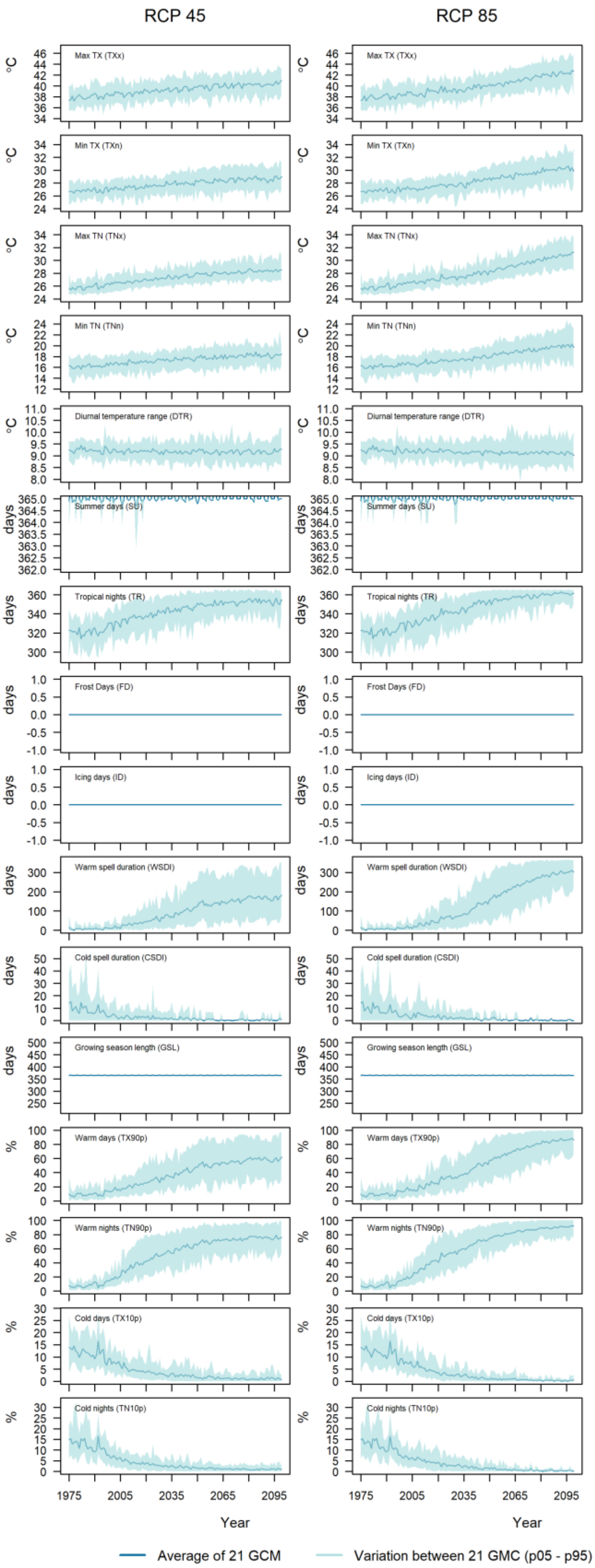
RCP 85 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.4	1.7	2.0	3.1	2.7	2.5
BNU.ESM	1.0	1.4	1.7	2.8	3.0	3.2
CanESM2	1.6	1.9	2.0	4.2	4.5	4.7
CCSM4	1.1	1.3	1.5	3.0	2.8	2.7
CESM1.BGC	1.2	1.2	1.3	2.8	1.9	1.0
CNRM.CM5	1.0	1.2	1.4	3.6	3.3	3.2
CSIRO.Mk3.6.0	1.8	2.4	2.8	5.7	6.3	6.7
GFDL.CM3	1.2	1.9	2.4	3.9	4.5	4.9
GFDL.ESM2G	0.8	0.5	0.2	0.8	0.8	0.8
GFDL.ESM2M	0.5	0.5	0.5	1.5	1.8	2.1
inmcm4	0.4	-0.4	-0.9	1.1	0.6	0.3
IPSL.CM5A.LR	1.7	1.8	1.9	3.8	3.9	4.0
IPSL.CM5A.MR	1.1	1.4	1.5	3.7	4.1	4.4
MIROC.ESM.CHEM	1.6	1.9	2.1	5.1	5.2	5.2
MIROC.ESM	1.8	1.6	1.4	4.2	4.1	3.9
MIROC5	1.4	1.8	2.1	3.8	4.4	4.9
MPI.ESM.LR	1.6	1.2	0.8	4.4	4.0	3.7
MPI.ESM.MR	2.1	2.2	2.3	5.0	5.1	5.0
MRI.CGCM3	1.4	1.6	1.5	2.8	2.4	2.1
NorESM1.M	1.0	0.4	0.1	3.1	2.8	2.5

Prek_Chik

Precipitation indices:



Temperature indices:



Rx1day – Percentage change (%) Return Period per GCM:

RCP 45 Rx1day	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2080] (2070 - 2099)		
	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.1	-0.1	1.4	1.9	0.8	1.0
BNU.ESM	7.2	-10.2	-27.0	12.6	-7.5	-26.9
CanESM2	26.1	8.0	-8.0	30.2	24.8	18.8
CCSM4	-1.1	8.7	17.7	20.3	22.5	23.8
CESM1.BGC	10.7	9.9	10.7	4.9	0.9	-1.8
CNRM.CM5	13.1	17.3	23.1	17.9	4.3	-8.2
CSIRO.Mk3.6.0	18.5	34.1	53.6	38.1	47.9	56.0
GFDL.CM3	6.3	24.5	46.2	33.3	40.4	44.3
GFDL.ESM2G	32.3	20.2	5.5	16.3	14.5	11.0
GFDL.ESM2M	21.5	17.2	8.2	45.4	44.4	35.3
inmcm4	9.2	-3.6	-17.0	21.1	10.5	-3.6
IPSL.CM5A.LR	19.2	13.6	6.8	15.0	19.3	23.7
IPSL.CM5A.MR	2.8	4.3	6.7	13.9	24.3	32.7
MIROC.ESM.CHEM	1.4	-10.5	-21.3	0.4	-8.8	-16.7
MIROC.ESM	9.9	6.3	0.7	-4.5	-17.2	-29.2
MIROC5	12.6	7.9	-2.2	-0.6	-3.4	-7.0
MPI.ESM.LR	25.8	28.0	27.9	19.3	31.3	44.2
MPI.ESM.MR	8.0	-4.4	-15.3	12.8	1.6	-7.5
MRI.CGCM3	32.7	35.2	33.7	29.7	42.3	47.8
NorESM1.M	-2.2	-1.2	1.6	4.5	2.7	1.9

RCP 85 Rx1day	Δ Return Period [2030] (2020 – 2049)			Δ Return Period [2080] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.5	7.4	17.4	18.4	4.5	-6.5
BNU.ESM	15.0	-1.2	-17.5	31.8	5.5	-18.2
CanESM2	12.5	-4.7	-18.5	47.4	30.4	12.8
CCSM4	8.4	17.7	27.0	25.0	25.9	26.2
CESM1.BGC	11.5	3.8	-3.6	33.0	26.6	20.2
CNRM.CM5	22.4	22.7	19.1	25.1	15.4	5.5
CSIRO.Mk3.6.0	15.0	27.5	39.9	55.4	53.9	51.0
GFDL.CM3	-8.2	1.6	14.7	49.7	70.5	85.7
GFDL.ESM2G	29.8	12.9	-4.9	37.1	25.0	10.3
GFDL.ESM2M	30.0	28.1	22.0	55.3	23.4	-3.4
inmcm4	11.6	-6.9	-25.3	30.7	-1.3	-26.3
IPSL.CM5A.LR	19.5	4.4	-11.1	24.8	45.0	68.7
IPSL.CM5A.MR	5.8	21.7	42.3	21.1	11.3	3.4
MIROC.ESM.CHEM	9.4	0.7	-8.0	-8.0	-16.6	-25.0
MIROC.ESM	7.8	-3.3	-15.3	-0.3	-5.5	-12.6

MIROC5	9.5	-0.6	-13.1	2.3	-2.4	-8.3
MPI.ESM.LR	29.5	42.2	55.4	42.0	41.1	38.6
MPI.ESM.MR	3.5	-1.6	-4.7	28.8	17.3	8.3
MRI.CGCM3	16.9	31.2	41.6	45.2	59.1	66.4
NorESM1.M	3.8	0.4	-2.3	32.9	28.1	22.1

CDD – Percentage change (%) Return Period per GCM:

RCP 45 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-9.2	-1.6	7.5	1.2	1.1	0.5
BNU.ESM	-6.1	-10.7	-15.7	-6.6	-9.2	-12.6
CanESM2	-1.9	-3.0	-3.7	3.8	-19.3	-37.1
CCSM4	-14.5	-6.4	5.4	1.9	10.5	19.2
CESM1.BGC	-3.0	-1.6	-1.0	2.6	-2.5	-7.3
CNRM.CM5	-13.9	-12.1	-11.1	3.6	16.4	29.3
CSIRO.Mk3.6.0	-3.8	2.8	7.4	-1.3	0.6	3.0
GFDL.CM3	2.0	2.5	2.0	-7.1	-10.6	-13.6
GFDL.ESM2G	-20.2	-24.9	-26.0	-18.8	-10.4	-1.0
GFDL.ESM2M	-12.2	-4.9	4.7	-9.2	-1.2	7.5
inmcm4	-1.0	-3.5	-5.5	-9.9	-15.0	-18.4
IPSL.CM5A.LR	-7.5	12.8	34.2	11.6	22.8	32.5
IPSL.CM5A.MR	22.1	33.5	43.2	16.1	29.9	38.9
MIROC.ESM.CHEM	12.6	22.3	29.7	-4.1	11.0	25.2
MIROC.ESM	-14.8	-28.5	-38.3	-4.9	-11.1	-17.1
MIROC5	-29.8	-15.2	8.2	-21.4	-18.6	-14.6
MPI.ESM.LR	6.2	17.2	26.4	17.6	13.5	6.0
MPI.ESM.MR	-1.1	-11.6	-19.8	0.4	-14.6	-25.8
MRI.CGCM3	5.1	-5.9	-14.7	1.5	-4.5	-9.7
NorESM1.M	-8.7	-23.0	-35.2	-16.2	-19.7	-22.2

RCP 85 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	3.2	0.3	-2.8	-13.7	-2.0	10.6
BNU.ESM	10.0	8.7	4.7	0.3	-1.8	-7.1
CanESM2	14.9	3.9	-6.8	24.8	26.8	23.8
CCSM4	3.8	14.1	24.7	-3.9	6.9	20.6
CESM1.BGC	10.7	17.2	21.0	0.2	-0.8	3.4
CNRM.CM5	-20.9	-9.7	1.8	13.1	28.7	41.4
CSIRO.Mk3.6.0	6.2	20.8	32.5	7.6	18.7	33.9
GFDL.CM3	5.9	7.4	7.9	18.2	15.6	12.1
GFDL.ESM2G	-4.3	-20.3	-30.1	-16.1	-17.9	-18.6

GFDL.ESM2M	-7.1	-3.0	1.1	-23.6	-14.0	-2.4
inmcm4	8.0	6.5	3.8	3.1	3.2	5.1
IPSL.CM5A.LR	18.3	18.4	18.2	49.5	72.7	91.6
IPSL.CM5A.MR	17.0	37.3	61.6	24.8	34.5	41.3
MIROC.ESM.CHEM	0.3	5.2	9.9	-9.9	-9.2	-9.0
MIROC.ESM	-6.2	-15.4	-23.7	-25.6	-37.4	-45.4
MIROC5	-14.6	-9.4	-3.2	-34.3	-34.0	-32.8
MPI.ESM.LR	36.2	37.1	32.0	60.2	60.8	57.2
MPI.ESM.MR	-1.1	-18.4	-30.3	23.6	3.4	-11.0
MRI.CGCM3	12.1	13.4	15.6	27.5	11.2	-1.9
NorESM1.M	-4.0	-17.1	-29.2	-30.0	-33.9	-37.3

TXX – Change (°C) Return Period per GCM:

RCP 45 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.0	1.2	1.5	2.1	2.2	2.2
BNU.ESM	0.3	0.4	0.6	1.8	2.2	2.4
CanESM2	2.6	1.9	0.5	3.0	2.1	0.6
CCSM4	1.1	1.2	1.4	1.9	1.9	2.0
CESM1.BGC	0.1	-0.7	-1.1	1.6	1.2	0.8
CNRM.CM5	0.3	0.2	0.2	1.4	1.0	0.7
CSIRO.Mk3.6.0	1.5	1.9	2.2	3.1	3.4	3.8
GFDL.CM3	1.5	1.0	0.4	3.4	2.6	1.8
GFDL.ESM2G	0.1	0.3	0.7	0.7	0.9	1.1
GFDL.ESM2M	0.2	-0.2	-0.4	0.7	0.6	0.8
inmcm4	-0.3	0.1	0.4	0.0	0.4	0.7
IPSL.CM5A.LR	1.2	1.4	1.5	2.5	2.2	2.1
IPSL.CM5A.MR	1.3	0.9	0.5	2.4	2.0	1.6
MIROC.ESM.CHEM	3.4	3.7	3.8	4.4	5.0	5.7
MIROC.ESM	2.5	2.3	1.9	4.6	4.4	3.9
MIROC5	1.8	2.5	2.8	0.9	1.4	2.0
MPI.ESM.LR	0.8	0.7	0.6	1.7	1.2	0.7
MPI.ESM.MR	0.4	1.0	2.1	2.4	1.7	1.0
MRI.CGCM3	0.8	0.2	-0.4	2.2	1.8	1.3
NorESM1.M	0.9	0.2	-0.5	1.7	1.0	0.2

RCP 85 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.3	0.9	0.5	3.7	3.5	3.1
BNU.ESM	0.7	0.3	0.0	3.5	3.9	4.3
CanESM2	2.4	1.5	0.0	5.8	4.7	3.0

CCSM4	1.2	1.6	2.0	4.1	4.3	4.6
CESM1.BGC	1.4	0.9	0.4	3.3	2.7	2.3
CNRM.CM5	0.6	0.5	0.6	2.6	2.7	2.9
CSIRO.Mk3.6.0	1.8	2.2	2.5	4.5	5.6	6.7
GFDL.CM3	2.0	2.4	2.5	4.6	4.8	4.8
GFDL.ESM2G	0.4	0.4	0.5	2.4	2.7	2.9
GFDL.ESM2M	0.9	0.3	-0.1	1.9	1.5	1.4
inmcm4	-0.5	0.0	0.5	1.3	1.4	1.6
IPSL.CM5A.LR	1.9	1.9	1.7	5.0	5.2	5.3
IPSL.CM5A.MR	1.4	0.8	0.3	4.5	3.9	3.3
MIROC.ESM.CHEM	2.7	2.7	2.6	6.5	6.4	6.3
MIROC.ESM	2.5	3.2	4.0	6.8	6.0	4.8
MIROC5	1.1	1.0	0.7	2.4	3.4	4.1
MPI.ESM.LR	1.0	0.5	0.1	4.7	4.8	4.9
MPI.ESM.MR	1.3	1.7	2.1	3.7	4.3	5.1
MRI.CGCM3	1.8	1.5	1.2	3.5	2.5	1.6
NorESM1.M	0.9	0.5	0.2	2.8	2.3	1.6

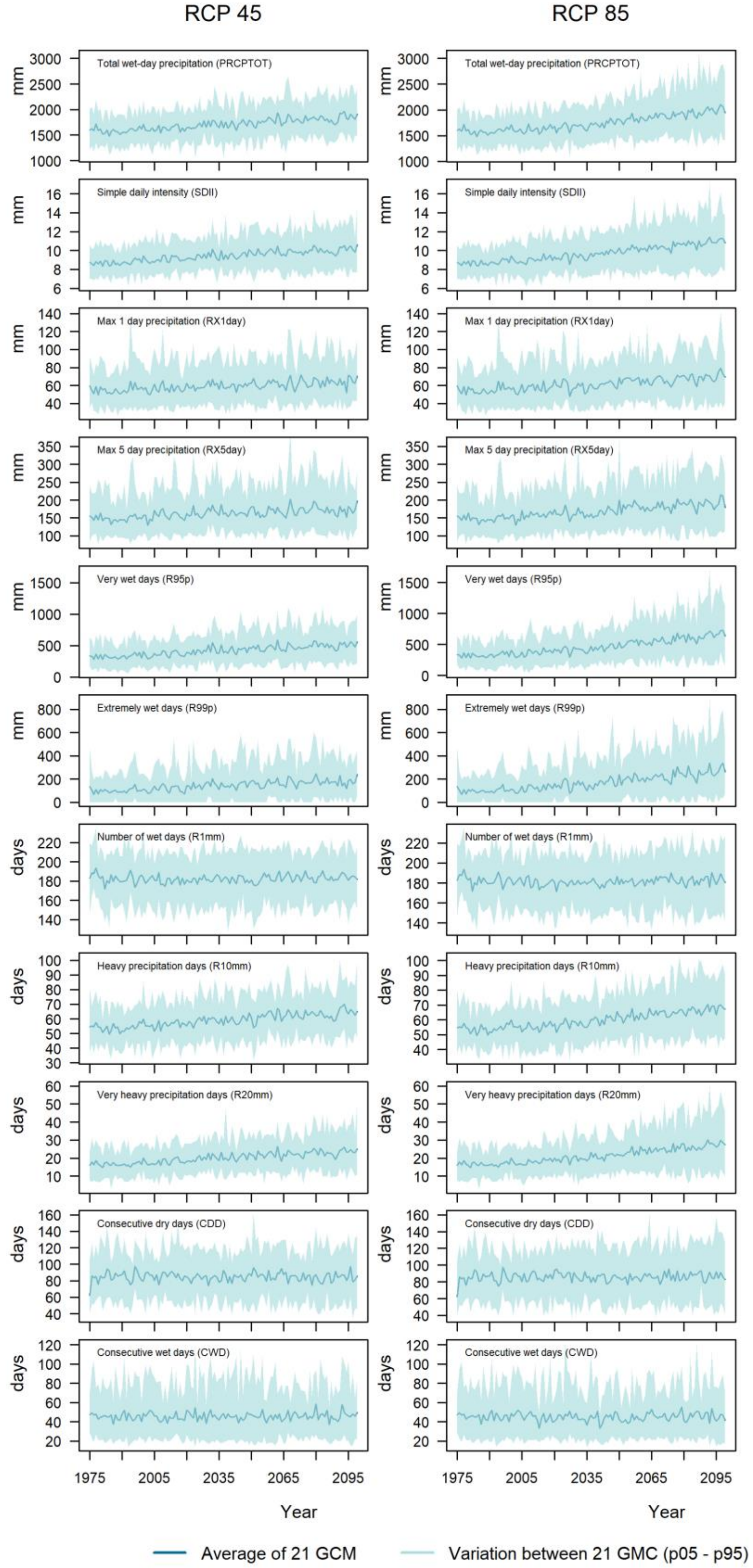
TNN – Change (°C) Return Period per GCM:

RCP 45 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.7	0.7	0.7	1.4	1.5	1.7
BNU.ESM	0.9	0.9	0.8	1.5	1.3	1.1
CanESM2	1.4	1.3	0.9	2.5	2.0	1.4
CCSM4	1.3	1.0	0.8	1.8	1.8	1.8
CESM1.BGC	1.0	0.3	-0.1	1.7	1.2	0.9
CNRM.CM5	0.5	1.0	1.6	1.4	1.5	1.7
CSIRO.Mk3.6.0	1.8	2.1	2.1	4.1	4.6	4.9
GFDL.CM3	1.6	2.4	3.0	2.0	1.9	1.9
GFDL.ESM2G	0.3	0.1	-0.1	0.5	0.5	0.4
GFDL.ESM2M	0.4	0.6	0.8	0.9	0.8	0.8
inmcm4	-0.2	-0.5	-0.6	0.6	0.4	0.4
IPSL.CM5A.LR	1.2	1.3	1.5	1.6	1.4	1.3
IPSL.CM5A.MR	0.7	0.7	0.7	2.0	2.3	2.7
MIROC.ESM.CHEM	1.5	1.5	1.6	3.4	3.7	4.0
MIROC.ESM	1.3	1.4	1.4	2.8	3.1	3.5
MIROC5	1.3	1.5	1.6	1.8	2.4	2.9
MPI.ESM.LR	1.5	1.2	1.0	2.6	2.5	2.3
MPI.ESM.MR	1.3	1.7	2.0	1.6	1.6	1.6
MRI.CGCM3	1.1	1.0	0.9	1.6	1.7	1.6
NorESM1.M	0.9	1.0	1.1	1.6	2.2	2.6

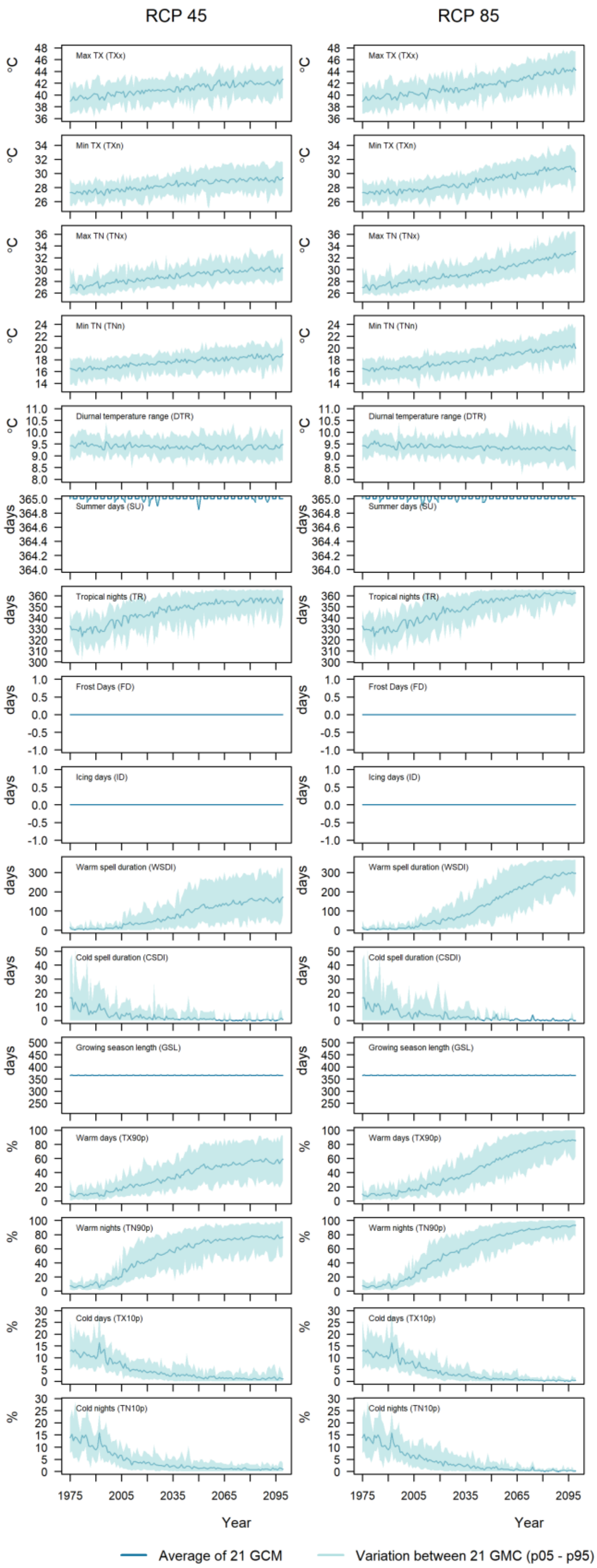
RCP 85 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.2	1.6	1.9	2.9	2.8	2.8
BNU.ESM	0.9	1.0	1.0	2.5	2.6	2.7
CanESM2	2.1	1.6	0.9	4.0	4.0	4.0
CCSM4	1.0	1.5	1.8	2.4	2.7	3.0
CESM1.BGC	1.1	1.2	1.4	3.0	2.9	2.8
CNRM.CM5	0.8	0.6	0.4	3.2	3.4	3.5
CSIRO.Mk3.6.0	1.7	1.7	1.6	6.0	6.5	6.7
GFDL.CM3	1.4	1.6	1.7	3.7	3.9	4.0
GFDL.ESM2G	0.7	0.8	0.9	1.1	1.3	1.6
GFDL.ESM2M	0.5	0.4	0.4	1.4	1.6	1.8
inmcm4	-0.3	-0.5	-0.5	0.0	-0.1	0.0
IPSL.CM5A.LR	1.2	1.1	1.1	3.3	3.1	3.0
IPSL.CM5A.MR	0.9	0.9	0.8	3.3	3.4	3.3
MIROC.ESM.CHEM	1.7	1.9	2.1	5.8	6.1	6.3
MIROC.ESM	1.7	2.1	2.5	5.4	5.5	5.4
MIROC5	0.9	1.1	1.4	3.0	3.8	4.6
MPI.ESM.LR	1.9	2.2	2.6	4.8	4.6	4.5
MPI.ESM.MR	1.3	1.4	1.5	4.7	4.8	4.9
MRI.CGCM3	1.8	2.2	2.3	3.0	3.0	2.9
NorESM1.M	1.4	1.0	0.6	3.1	2.8	2.6

Sen_Chinit

Precipitation indices:



Temperature indices:



Rx1day – Percentage change (%) Return Period per GCM:

RCP 45 Rx1day	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2080] (2070 - 2099)		
	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-0.3	-10.1	-19.8	3.7	0.1	-5.1
BNU.ESM	0.7	9.3	17.8	14.9	17.9	19.5
CanESM2	29.0	10.3	-5.2	30.4	20.9	12.3
CCSM4	-2.2	16.0	35.4	14.4	20.7	26.4
CESM1.BGC	9.8	21.0	32.2	8.1	1.8	-2.1
CNRM.CM5	11.1	11.4	7.8	18.2	10.0	-4.6
CSIRO.Mk3.6.0	11.1	-6.4	-23.4	12.5	-17.5	-39.7
GFDL.CM3	5.1	17.1	29.3	42.5	54.1	60.4
GFDL.ESM2G	29.3	9.4	-11.1	38.9	25.8	7.6
GFDL.ESM2M	6.0	-2.5	-12.0	43.3	35.4	21.7
inmcm4	8.8	2.7	-0.5	25.1	13.6	4.8
IPSL.CM5A.LR	28.0	16.7	5.5	17.2	19.2	24.9
IPSL.CM5A.MR	19.9	-4.9	-27.9	28.7	26.7	18.1
MIROC.ESM.CHEM	14.1	-1.1	-17.8	0.1	-23.8	-42.1
MIROC.ESM	3.7	7.8	14.7	-15.0	-21.9	-26.1
MIROC5	-8.5	-10.4	-13.2	11.7	12.0	11.5
MPI.ESM.LR	-1.4	2.0	7.6	3.8	13.2	24.3
MPI.ESM.MR	9.9	16.7	24.5	11.7	10.3	11.5
MRI.CGCM3	33.3	49.7	61.5	31.4	51.8	72.9
NorESM1.M	17.3	6.4	-2.8	16.9	11.0	5.6

RCP 85 Rx1day	Δ Return Period [2030] (2020 – 2049)			Δ Return Period [2080] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-4.4	-15.3	-25.7	18.5	0.1	-17.9
BNU.ESM	7.1	9.7	11.2	20.1	12.4	6.1
CanESM2	8.6	0.1	-6.4	35.1	17.5	2.1
CCSM4	0.0	-8.9	-14.5	11.1	19.3	28.6
CESM1.BGC	18.5	28.1	37.6	26.5	54.5	93.5
CNRM.CM5	20.3	11.9	-3.4	34.9	17.7	-2.6
CSIRO.Mk3.6.0	17.5	-11.1	-34.4	35.5	8.8	-13.6
GFDL.CM3	1.6	17.9	38.4	29.0	43.4	58.4
GFDL.ESM2G	25.8	-0.7	-23.3	53.4	34.5	10.8
GFDL.ESM2M	16.8	4.8	-8.2	52.7	29.1	6.7
inmcm4	11.7	9.2	7.7	29.6	16.5	10.1
IPSL.CM5A.LR	22.4	9.4	-4.0	32.1	24.2	16.2
IPSL.CM5A.MR	11.3	-8.5	-27.9	29.5	10.2	-7.6
MIROC.ESM.CHEM	9.9	5.4	-2.4	-9.6	-27.8	-43.1
MIROC.ESM	-4.2	-10.6	-14.5	-19.1	-17.2	-12.9

MIROC5	4.2	-8.6	-21.3	-8.0	-2.5	14.9
MPI.ESM.LR	-2.0	1.7	8.4	10.8	15.6	23.2
MPI.ESM.MR	10.4	3.7	-1.3	19.1	4.5	-5.8
MRI.CGCM3	20.6	28.0	30.9	53.9	66.1	74.3
NorESM1.M	21.4	26.2	29.7	41.2	47.1	54.7

CDD – Percentage change (%) Return Period per GCM:

RCP 45 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.4	8.9	14.9	-0.8	5.0	9.0
BNU.ESM	-2.8	-10.6	-16.5	-4.2	-8.6	-12.2
CanESM2	-7.4	-1.8	5.8	-5.7	14.3	39.8
CCSM4	4.2	3.0	0.0	0.0	-8.8	-16.3
CESM1.BGC	2.1	0.5	0.3	9.4	11.6	10.6
CNRM.CM5	-13.0	-12.6	-11.1	-2.8	5.3	14.3
CSIRO.Mk3.6.0	-1.7	-7.5	-10.8	-4.5	-3.6	0.0
GFDL.CM3	6.4	-0.8	-6.9	-6.3	3.3	14.9
GFDL.ESM2G	-10.4	-14.6	-20.0	-10.3	-21.0	-30.4
GFDL.ESM2M	-3.2	-3.4	-3.7	-0.8	10.1	18.5
inmcm4	-2.9	-5.2	-6.8	2.2	-1.8	-5.6
IPSL.CM5A.LR	5.3	7.0	6.9	12.3	24.0	34.2
IPSL.CM5A.MR	-5.2	-1.0	3.3	5.9	13.6	18.9
MIROC.ESM.CHEM	1.5	10.1	17.8	-4.5	10.2	23.5
MIROC.ESM	-3.5	7.4	14.6	-0.6	12.6	21.6
MIROC5	-5.3	-3.4	-1.8	-6.9	-10.6	-12.5
MPI.ESM.LR	1.8	2.6	1.7	13.2	19.0	21.1
MPI.ESM.MR	10.1	18.7	25.4	2.9	11.8	18.3
MRI.CGCM3	-5.6	-2.4	1.6	-8.3	-11.8	-13.6
NorESM1.M	1.1	-3.5	-8.7	3.4	6.7	6.8

RCP 85 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-4.6	-3.6	-2.9	4.6	4.4	3.8
BNU.ESM	6.7	0.9	-4.5	-0.1	-11.0	-18.5
CanESM2	3.8	3.7	4.5	11.8	18.3	23.6
CCSM4	6.8	-4.2	-14.2	2.0	-10.6	-20.8
CESM1.BGC	14.7	21.5	24.5	7.2	14.9	21.9
CNRM.CM5	0.5	2.1	3.2	1.7	5.3	8.9
CSIRO.Mk3.6.0	-2.5	-2.6	-2.4	5.5	9.5	14.8
GFDL.CM3	8.0	5.9	3.0	12.7	20.1	26.8
GFDL.ESM2G	-5.4	-11.2	-16.9	-12.2	-23.5	-32.9

GFDL.ESM2M	-3.3	15.3	31.9	-19.4	2.9	30.3
inmcm4	2.7	2.1	1.0	-6.2	-2.2	1.2
IPSL.CM5A.LR	7.8	9.0	9.4	16.1	20.5	25.2
IPSL.CM5A.MR	3.5	14.0	25.5	6.5	15.6	22.3
MIROC.ESM.CHEM	6.8	8.0	8.4	2.8	6.3	8.3
MIROC.ESM	-4.1	-0.2	2.1	-15.8	1.6	21.5
MIROC5	0.5	-1.8	-3.2	-14.7	-11.7	-9.3
MPI.ESM.LR	3.9	6.3	7.6	31.9	28.4	24.5
MPI.ESM.MR	7.5	12.9	17.2	15.1	20.1	24.2
MRI.CGCM3	-1.2	-2.3	-2.9	1.8	1.0	2.1
NorESM1.M	-2.8	-7.5	-12.3	-11.2	-3.4	0.9

TXX – Change (°C) Return Period per GCM:

RCP 45 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.2	1.4	1.5	2.1	2.5	2.9
BNU.ESM	0.5	0.7	1.2	1.9	1.8	1.5
CanESM2	2.4	1.8	0.8	3.2	2.1	0.7
CCSM4	0.8	1.0	1.3	1.7	2.4	2.9
CESM1.BGC	0.7	-0.1	-0.6	1.3	1.6	1.8
CNRM.CM5	0.6	0.2	-0.1	1.6	1.4	1.3
CSIRO.Mk3.6.0	1.7	1.3	0.7	3.7	3.3	2.6
GFDL.CM3	1.5	1.0	0.3	3.3	2.8	2.1
GFDL.ESM2G	0.3	0.4	0.6	0.6	0.7	1.0
GFDL.ESM2M	0.5	-0.2	-0.7	1.2	0.6	0.1
inmcm4	-0.7	0.0	0.7	-0.2	0.7	1.7
IPSL.CM5A.LR	1.5	1.8	2.1	3.1	2.9	2.7
IPSL.CM5A.MR	0.9	-0.2	-0.9	2.5	2.6	2.9
MIROC.ESM.CHEM	3.1	3.7	4.2	4.7	5.4	6.0
MIROC.ESM	2.0	1.7	1.6	4.4	4.1	3.9
MIROC5	2.1	2.5	2.6	0.6	0.9	1.8
MPI.ESM.LR	0.7	0.9	1.2	1.8	1.6	1.4
MPI.ESM.MR	0.4	1.3	2.6	2.4	1.8	1.3
MRI.CGCM3	0.7	0.1	-0.4	2.1	1.5	1.0
NorESM1.M	1.1	0.7	0.3	1.9	1.2	0.7

RCP 85 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.5	1.4	1.3	4.0	4.3	4.4
BNU.ESM	1.0	0.5	0.0	3.4	2.8	2.3
CanESM2	2.1	1.5	0.6	5.8	4.9	3.5

CCSM4	1.1	2.4	3.8	3.7	3.8	3.9
CESM1.BGC	0.8	0.9	1.1	3.3	3.2	3.2
CNRM.CM5	0.5	0.5	0.7	2.6	2.1	1.7
CSIRO.Mk3.6.0	2.6	2.1	1.2	5.1	5.2	5.2
GFDL.CM3	2.0	2.1	2.1	4.9	4.9	4.5
GFDL.ESM2G	0.7	0.7	0.8	2.4	2.1	1.7
GFDL.ESM2M	1.2	0.6	0.0	1.9	1.2	0.6
inmcm4	-0.5	0.1	0.7	1.5	1.7	2.0
IPSL.CM5A.LR	2.2	2.1	1.9	5.5	5.7	5.8
IPSL.CM5A.MR	1.4	1.0	0.8	4.4	4.0	3.8
MIROC.ESM.CHEM	3.4	3.9	4.3	7.6	7.8	7.9
MIROC.ESM	1.9	2.9	4.2	6.9	6.6	6.3
MIROC5	1.3	0.9	0.6	2.0	2.8	3.8
MPI.ESM.LR	1.0	0.7	0.6	4.9	5.1	5.2
MPI.ESM.MR	1.3	2.1	3.1	3.9	4.9	6.0
MRI.CGCM3	1.5	1.4	1.3	3.0	2.4	2.0
NorESM1.M	0.9	0.4	0.0	2.8	2.5	2.3

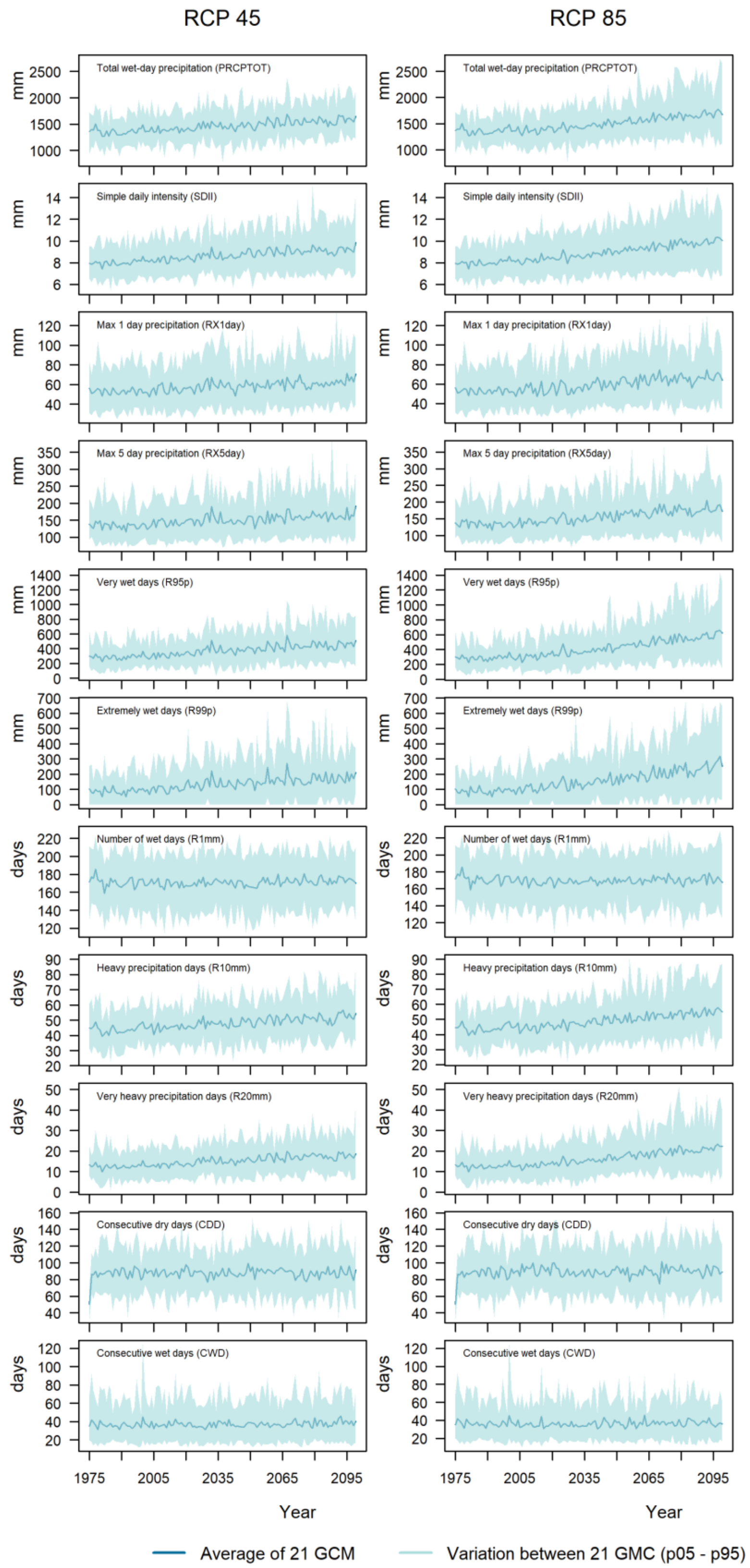
TNN – Change (°C) Return Period per GCM:

RCP 45 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.5	0.4	0.4	1.3	1.2	1.1
BNU.ESM	0.8	1.0	1.2	1.7	1.8	1.9
CanESM2	1.3	1.2	1.0	2.3	1.6	1.1
CCSM4	1.2	0.6	0.3	1.8	1.8	1.8
CESM1.BGC	1.5	0.8	0.2	2.3	1.6	0.9
CNRM.CM5	0.7	0.3	-0.2	1.6	1.2	0.9
CSIRO.Mk3.6.0	2.0	2.4	2.6	4.1	4.6	5.0
GFDL.CM3	1.6	2.7	3.6	2.0	2.3	2.5
GFDL.ESM2G	0.3	0.2	0.0	0.5	0.4	0.3
GFDL.ESM2M	0.2	0.2	0.2	0.7	0.9	1.1
inmcm4	-0.3	-0.7	-0.9	0.7	0.4	0.2
IPSL.CM5A.LR	1.3	1.3	1.3	1.9	2.0	2.1
IPSL.CM5A.MR	0.6	0.8	1.0	1.8	2.1	2.4
MIROC.ESM.CHEM	1.2	1.0	0.8	3.0	3.1	3.2
MIROC.ESM	1.2	1.3	1.4	2.6	2.9	3.2
MIROC5	1.7	1.9	2.0	2.3	3.0	3.5
MPI.ESM.LR	1.3	0.8	0.5	2.5	2.2	2.0
MPI.ESM.MR	1.4	1.7	1.9	2.1	2.4	2.7
MRI.CGCM3	1.1	0.7	0.3	1.8	1.3	1.0
NorESM1.M	1.0	1.1	1.1	1.8	2.1	2.3

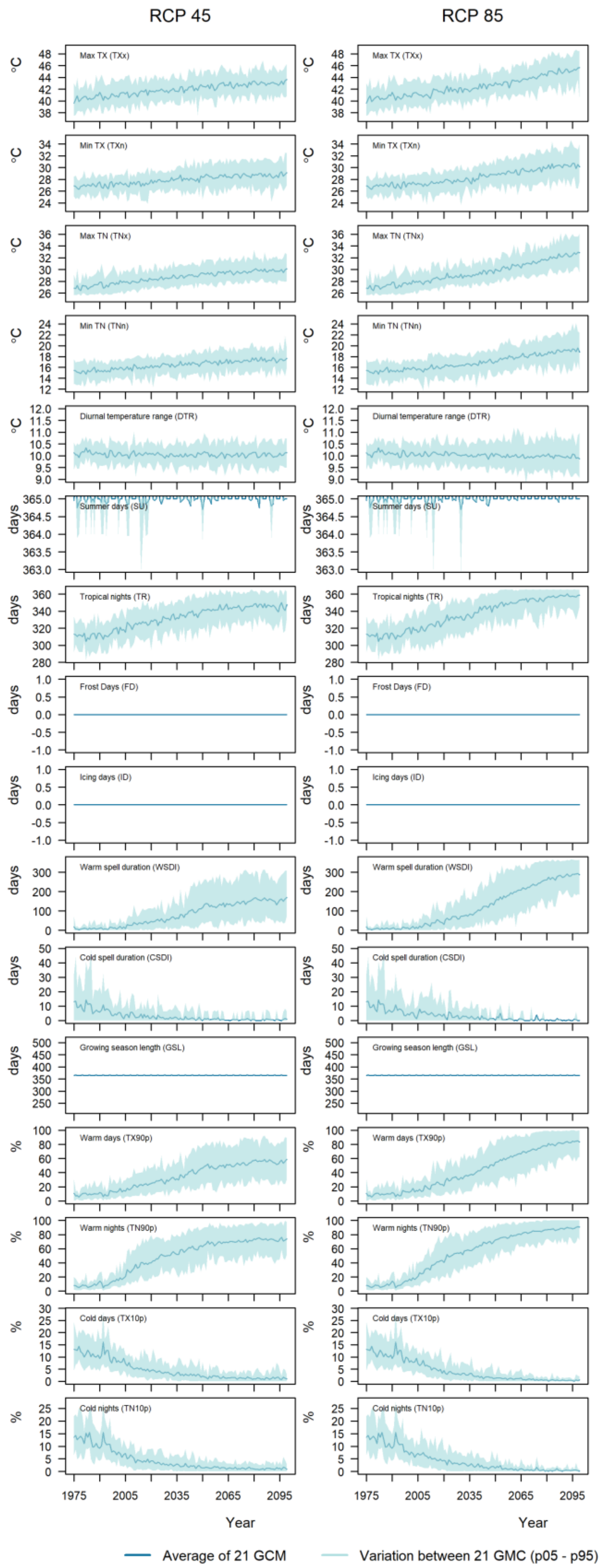
RCP 85 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.3	1.3	1.2	3.0	2.6	2.3
BNU.ESM	1.3	1.4	1.5	2.6	3.0	3.2
CanESM2	2.0	1.7	1.3	4.0	4.0	4.0
CCSM4	1.0	1.2	1.3	2.7	2.6	2.6
CESM1.BGC	1.5	1.8	2.2	3.4	2.4	1.6
CNRM.CM5	1.1	0.6	0.1	3.6	3.1	2.5
CSIRO.Mk3.6.0	2.1	2.1	2.1	6.3	6.8	6.9
GFDL.CM3	1.3	2.2	2.9	3.9	4.6	5.1
GFDL.ESM2G	0.8	0.6	0.4	0.8	1.0	1.2
GFDL.ESM2M	0.3	0.2	0.2	1.3	1.5	1.8
inmcm4	-0.2	-0.5	-0.7	0.5	0.4	0.3
IPSL.CM5A.LR	1.4	1.6	1.8	3.8	3.5	3.4
IPSL.CM5A.MR	1.1	1.3	1.6	3.6	4.0	4.2
MIROC.ESM.CHEM	1.7	1.7	1.8	5.5	5.6	5.6
MIROC.ESM	1.6	1.8	1.9	5.0	4.9	4.8
MIROC5	1.1	2.0	2.8	3.7	4.7	5.4
MPI.ESM.LR	1.9	2.3	2.6	4.3	4.4	4.5
MPI.ESM.MR	1.7	1.8	2.0	4.7	4.8	4.8
MRI.CGCM3	1.4	1.8	2.0	2.6	2.6	2.6
NorESM1.M	1.1	0.7	0.3	3.0	2.4	2.0

Trapeang_Thmar

Precipitation indices:



Temperature indices:



Rx1day – Percentage change (%) Return Period per GCM:

RCP 45 Rx1day	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2080] (2070 - 2099)		
	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-2.3	-1.5	-2.9	14.8	3.4	-11.6
BNU.ESM	15.5	25.9	34.5	21.5	17.8	13.7
CanESM2	30.7	9.2	-10.6	22.2	7.1	-7.0
CCSM4	5.3	-4.3	-18.1	17.4	15.3	8.1
CESM1.BGC	31.3	26.0	18.5	15.6	12.8	8.9
CNRM.CM5	28.3	25.7	21.2	21.6	21.6	18.4
CSIRO.Mk3.6.0	13.2	9.8	6.4	20.5	9.7	1.3
GFDL.CM3	-7.4	5.0	19.5	21.5	20.3	18.0
GFDL.ESM2G	18.6	15.7	11.6	19.6	26.8	35.0
GFDL.ESM2M	5.4	25.1	47.5	40.1	41.4	40.2
inmcm4	3.2	-0.2	0.0	15.6	-1.3	-11.9
IPSL.CM5A.LR	13.3	15.7	18.7	31.1	26.9	24.1
IPSL.CM5A.MR	14.7	8.4	2.1	19.5	27.1	37.2
MIROC.ESM.CHEM	8.6	-9.9	-27.3	0.5	-21.2	-38.9
MIROC.ESM	22.8	45.8	79.7	26.1	31.2	34.8
MIROC5	-7.0	-0.2	8.0	3.2	27.9	61.5
MPI.ESM.LR	3.0	0.8	-1.6	-6.4	-23.1	-34.0
MPI.ESM.MR	10.3	3.5	-3.7	19.5	5.2	-7.6
MRI.CGCM3	29.3	37.7	42.3	28.5	44.6	59.3
NorESM1.M	21.5	20.9	20.7	21.8	21.5	23.0

RCP 85 Rx1day	Δ Return Period [2030] (2020 – 2049)			Δ Return Period [2080] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.5	-3.6	-9.1	14.1	4.0	-9.7
BNU.ESM	13.4	28.0	45.1	34.3	32.8	30.9
CanESM2	7.7	0.1	-6.6	36.6	16.2	-2.6
CCSM4	4.0	-10.8	-25.8	13.1	4.6	-5.2
CESM1.BGC	14.4	11.4	7.4	33.3	28.2	22.7
CNRM.CM5	29.6	22.2	11.3	35.5	19.8	4.4
CSIRO.Mk3.6.0	12.6	7.6	3.3	22.7	12.8	7.7
GFDL.CM3	-6.9	-8.5	-9.9	34.5	44.6	51.8
GFDL.ESM2G	15.1	6.8	-1.8	35.0	24.8	15.4
GFDL.ESM2M	10.1	27.9	48.5	52.4	56.0	55.2
inmcm4	10.2	13.9	17.5	27.9	14.8	7.5
IPSL.CM5A.LR	19.7	27.4	34.0	18.0	30.4	44.2
IPSL.CM5A.MR	20.7	7.8	-2.3	36.6	34.0	33.5
MIROC.ESM.CHEM	4.9	1.2	-0.1	4.2	-4.1	-12.6
MIROC.ESM	17.3	31.4	49.8	13.3	31.1	58.6

MIROC5	-1.0	16.1	34.0	-9.6	3.8	22.7
MPI.ESM.LR	2.7	-5.7	-11.4	9.3	5.3	3.3
MPI.ESM.MR	10.2	4.8	-1.5	22.3	17.9	14.0
MRI.CGCM3	15.6	25.1	30.7	53.0	64.1	71.1
NorESM1.M	17.4	18.2	19.3	37.4	29.0	22.2

CDD – Percentage change (%) Return Period per GCM:

RCP 45 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-0.1	11.9	23.1	2.1	2.3	1.4
BNU.ESM	2.5	-7.8	-16.1	3.0	7.4	8.1
CanESM2	3.0	0.7	0.7	-7.1	-4.3	0.8
CCSM4	1.5	-7.2	-12.9	7.1	-8.7	-18.9
CESM1.BGC	-8.1	-10.6	-12.2	-8.4	-8.7	-7.4
CNRM.CM5	-3.8	-3.7	-2.1	-2.9	2.4	7.8
CSIRO.Mk3.6.0	0.5	6.6	11.9	6.3	18.4	33.7
GFDL.CM3	5.5	-0.1	-4.9	-10.6	-1.7	7.1
GFDL.ESM2G	4.2	3.2	2.4	-8.7	-12.8	-15.7
GFDL.ESM2M	-8.8	0.9	9.6	-1.7	-0.7	-0.6
inmcm4	-0.4	-1.9	-3.5	0.2	-1.9	-4.0
IPSL.CM5A.LR	1.8	5.4	8.3	16.0	21.4	23.9
IPSL.CM5A.MR	2.9	-4.1	-9.5	17.3	12.9	7.1
MIROC.ESM.CHEM	6.0	1.9	-2.7	0.3	-3.7	-8.0
MIROC.ESM	-3.9	1.9	6.6	-2.2	-1.6	-2.1
MIROC5	-11.2	-4.8	-0.4	-14.9	-13.9	-13.0
MPI.ESM.LR	2.0	3.7	4.5	-1.7	2.6	5.2
MPI.ESM.MR	6.2	14.5	21.8	0.9	0.3	0.3
MRI.CGCM3	-3.4	-8.2	-10.2	-5.2	-10.1	-13.0
NorESM1.M	-4.7	-1.2	1.9	-8.9	-4.2	0.6

RCP 85 CDD	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	-1.3	-5.7	-8.9	-0.4	5.8	12.6
BNU.ESM	5.0	4.1	1.1	-0.9	1.1	1.3
CanESM2	2.4	0.3	-0.8	11.8	24.3	38.8
CCSM4	8.9	0.6	-4.6	3.0	-3.7	-7.7
CESM1.BGC	5.6	6.7	5.7	-1.1	-6.9	-12.3
CNRM.CM5	-1.6	0.6	2.7	5.3	3.6	1.3
CSIRO.Mk3.6.0	6.1	7.1	7.7	10.8	11.6	12.9
GFDL.CM3	1.6	4.7	6.9	16.2	21.2	23.9
GFDL.ESM2G	-0.7	-2.0	-2.4	-12.6	-13.8	-13.3

GFDL.ESM2M	-6.6	-5.9	-6.3	-3.3	14.5	28.7
inmcm4	4.6	7.2	8.6	14.9	14.5	12.2
IPSL.CM5A.LR	10.2	8.7	7.2	21.2	14.9	10.4
IPSL.CM5A.MR	0.6	1.0	-0.1	6.5	-0.8	-8.0
MIROC.ESM.CHEM	1.5	-0.7	-3.4	4.3	1.8	-0.6
MIROC.ESM	-7.8	-9.6	-9.7	-14.9	-8.5	-1.4
MIROC5	-4.9	-0.6	2.3	-21.0	-17.0	-14.4
MPI.ESM.LR	5.7	16.4	27.2	28.8	25.2	22.1
MPI.ESM.MR	0.3	-3.5	-6.4	14.2	16.0	18.2
MRI.CGCM3	9.0	3.0	-1.9	8.1	0.6	-3.8
NorESM1.M	-11.9	-11.0	-10.8	-15.4	-13.0	-11.2

TXX – Change (°C) Return Period per GCM:

RCP 45 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.0	0.7	0.4	2.1	2.3	2.4
BNU.ESM	0.5	0.3	0.4	2.0	2.0	1.9
CanESM2	2.5	1.2	-0.9	2.9	1.6	-0.5
CCSM4	0.9	1.5	2.4	1.8	2.2	2.9
CESM1.BGC	0.5	0.2	0.3	1.4	2.0	2.9
CNRM.CM5	0.1	-0.1	-0.3	1.3	1.4	1.8
CSIRO.Mk3.6.0	1.8	1.9	1.8	3.0	3.3	3.8
GFDL.CM3	1.7	1.6	1.3	3.5	3.0	2.3
GFDL.ESM2G	0.2	0.7	1.2	0.9	1.2	1.7
GFDL.ESM2M	0.5	-0.3	-1.0	1.2	1.0	1.0
inmcm4	0.0	0.0	-0.1	0.4	0.2	0.0
IPSL.CM5A.LR	1.3	1.7	2.1	2.7	3.1	3.4
IPSL.CM5A.MR	0.7	0.1	-0.3	2.3	1.9	1.6
MIROC.ESM.CHEM	2.5	2.1	1.7	4.2	4.1	3.9
MIROC.ESM	2.3	1.7	0.9	4.3	4.0	3.6
MIROC5	2.3	3.1	3.5	1.3	1.8	2.6
MPI.ESM.LR	1.1	1.0	1.0	1.8	1.1	0.5
MPI.ESM.MR	0.4	1.6	3.3	2.5	2.5	2.4
MRI.CGCM3	0.9	0.8	0.7	2.4	2.0	1.5
NorESM1.M	1.0	1.0	1.0	2.0	1.8	1.7

RCP 85 TXX	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.3	0.8	0.3	4.0	3.5	2.9
BNU.ESM	0.8	0.2	-0.4	3.5	3.2	2.8
CanESM2	2.2	1.1	-0.8	5.7	4.3	2.1

CCSM4	0.8	1.8	3.2	4.2	4.4	4.7
CESM1.BGC	1.6	1.6	1.4	3.5	3.2	2.9
CNRM.CM5	0.6	-0.1	-0.6	2.3	1.8	1.5
CSIRO.Mk3.6.0	2.1	1.8	1.4	5.1	5.4	5.6
GFDL.CM3	2.0	2.3	2.4	5.2	5.2	4.9
GFDL.ESM2G	0.5	1.1	1.9	2.3	2.3	2.3
GFDL.ESM2M	1.1	0.3	-0.3	1.9	1.1	0.5
inmcm4	0.0	0.2	0.4	1.8	1.4	1.1
IPSL.CM5A.LR	2.0	2.3	2.5	5.5	6.0	6.4
IPSL.CM5A.MR	1.2	1.4	1.8	4.4	3.9	3.5
MIROC.ESM.CHEM	3.4	3.3	3.0	7.4	7.4	7.1
MIROC.ESM	1.8	1.9	2.1	7.1	6.1	5.0
MIROC5	1.3	1.1	0.9	3.0	4.2	5.1
MPI.ESM.LR	1.4	0.8	0.4	4.8	4.7	4.7
MPI.ESM.MR	1.4	2.0	2.6	4.0	5.0	5.9
MRI.CGCM3	1.7	1.3	0.9	3.5	2.6	1.8
NorESM1.M	0.9	1.0	1.3	2.9	2.8	2.7

TNN – Change (°C) Return Period per GCM:

RCP 45 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	0.5	0.6	0.6	1.4	1.3	1.2
BNU.ESM	0.7	0.8	0.9	1.6	1.6	1.5
CanESM2	1.4	1.1	0.6	2.2	1.3	0.5
CCSM4	1.2	0.7	0.3	1.6	1.5	1.5
CESM1.BGC	1.1	0.9	0.8	1.8	1.5	1.3
CNRM.CM5	0.6	0.8	0.9	1.7	1.7	1.8
CSIRO.Mk3.6.0	1.7	2.2	2.5	4.1	4.7	5.0
GFDL.CM3	1.7	2.6	3.4	2.0	2.0	2.0
GFDL.ESM2G	0.3	0.3	0.3	0.6	0.8	0.9
GFDL.ESM2M	0.5	0.8	1.0	0.9	1.0	1.0
inmcm4	-0.2	-0.4	-0.6	0.4	0.5	0.8
IPSL.CM5A.LR	1.3	1.3	1.4	1.6	1.7	1.9
IPSL.CM5A.MR	0.6	0.1	-0.2	1.8	1.5	1.3
MIROC.ESM.CHEM	1.3	1.3	1.3	3.3	3.5	3.6
MIROC.ESM	1.3	1.3	1.3	2.8	3.2	3.7
MIROC5	1.5	1.6	1.7	2.1	3.0	3.7
MPI.ESM.LR	1.5	1.0	0.6	2.6	2.3	2.0
MPI.ESM.MR	1.4	1.9	2.3	1.8	1.7	1.8
MRI.CGCM3	0.9	0.6	0.4	1.5	1.4	1.3
NorESM1.M	0.8	1.1	1.3	1.7	2.1	2.3

RCP 85 TNN	Δ Return Period [2030] (2020 – 2049			Δ Return Period [2030] (2070 - 2099)		
GCM	1:5 year	1:25 year	1:100 year	1:5 year	1:25 year	1:100 year
bcc.csm1.1	1.1	1.5	1.8	2.9	2.6	2.4
BNU.ESM	1.1	1.3	1.4	2.6	2.9	3.1
CanESM2	2.1	1.7	1.0	4.0	3.8	3.5
CCSM4	0.9	0.9	0.9	2.3	1.9	1.6
CESM1.BGC	1.0	1.8	2.8	3.0	3.2	3.4
CNRM.CM5	1.1	1.1	0.9	3.7	3.4	3.2
CSIRO.Mk3.6.0	1.9	1.9	1.8	6.2	6.5	6.5
GFDL.CM3	1.6	2.1	2.4	3.9	4.4	4.8
GFDL.ESM2G	0.8	1.0	1.2	1.1	1.6	2.0
GFDL.ESM2M	0.4	0.3	0.3	1.4	1.5	1.7
inmcm4	-0.8	-0.4	0.0	-0.2	0.5	0.9
IPSL.CM5A.LR	1.2	1.5	1.8	3.8	3.5	3.4
IPSL.CM5A.MR	1.2	1.0	0.8	3.9	3.8	3.6
MIROC.ESM.CHEM	1.7	1.9	2.1	6.0	6.3	6.5
MIROC.ESM	1.8	2.3	2.8	5.6	5.7	5.6
MIROC5	1.0	1.8	2.8	3.5	4.6	5.7
MPI.ESM.LR	1.9	2.2	2.5	4.4	4.1	3.9
MPI.ESM.MR	1.5	1.6	1.8	4.6	4.8	4.9
MRI.CGCM3	1.6	1.9	2.0	2.7	2.6	2.5
NorESM1.M	1.4	1.2	0.9	3.2	2.8	2.5