CLIMATE RISK COUNTRY PROFILE

CAMBODIA

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This profile is part of a series of Climate Risk Country Profiles developed by Climate Change Group of the World Bank Group (WBG). The country profiles aim to present a high-level assessment of the climate risks faced by countries, including rapid-onset events and slow-onset changes in climate conditions, many of which are already underway, as well as summarize relevant information on policy and planning efforts at the country level.

The country profile series are designed to be a reference source for development practitioners to better integrate detailed climate data, physical climate risks and need for resilience in development planning and policy making.

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Unless otherwise noted, data is sourced from the WBG's Climate Change Knowledge Portal (CCKP), the WBG's designated platform for climate data. Climate, climate change and climate-related data and information on CCKP represents the latest available data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. The team is grateful for all comments received from climate and development specialists, as well as climate research scientists and institutions for their advice and guidance on the use of climate related datasets.

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FOREWORD

Climate change is a major risk to good development outcomes and presents an existential threat to the World Bank Group's (WBG) twin goals of ending extreme poverty and promoting shared prosperity in a sustainable way. The WBG is thus committed to supporting client countries to invest in a low-carbon and climate-resilient future.

Our approach is outlined in the *WBG Climate Change Action Plan (CCAP) 2021–2025*, which focuses on helping countries integrate climate into their development agendas, with the goal to combine mitigation and adaptation with economic growth and poverty reduction. Guided by the *CCAP*, the WBG prioritizes climate action across five key systems: energy; agriculture, food, water, and land; cities; transport; and manufacturing. Only through transforming these systems can we begin to address climate change, achieve a resilient and low-carbon future, and support natural capital and biodiversity, while achieving development goals.

A key element of this strategy relies on the capacity to systematically incorporate and manage climate risks in development operations. We are thus investing in processes and tools that allow us to inform lending with climate data.

The Climate Change Knowledge Portal (CCKP) is an online 'one-stop-shop' for foundational climate data at the global, regional, and country levels. CCKP provides inputs to the WBG's Climate and Disaster Risk Screening Tool, which contributes to assessing short- and long-term climate and disaster risks in operations as well as national or sectoral planning processes.

Supplementing this effort, the *Climate Risk Country Profile* you are about to read is a signature product of CCKP which supports a better understanding of the impacts of physical climate risks. Guided by the Climate Risk Country Profile, WBG, key external partners, and development practitioners may conduct initial assessments of climate risks and opportunities that will eventually inform upstream country diagnostics, policy dialogue, and strategic planning for developing countries.

It is my hope that these efforts will spur the prioritization of long-term risk management and deepen the WBG's commitment to integrate adaptation planning into strategic country engagements and lending operations.

Jennifer J. Sara
Global Director
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KEY MESSAGES

- **Observed Climate:** Cambodia has a moist tropical monsoon climate and subtropical conditions at higher elevations (average mean temperature of 27.41°C), both with one rainy and dry season annually and influenced interannually by El Niño Southern Oscillation (ENSO).
- **Observed Temperature:** Between 1971 and 2020, Cambodia's average mean temperature increased by 0.29°C per decade.
    - **Northern provinces** observed the greatest mean temperature changes over this period, most widespread during winter months.
- **Projected Temperature:** Under SSP3-7.0, Cambodia's temperatures are projected to increase 0.57°C (0.31°C, 1.09°C) from the historical reference period to 28.34°C (27.88°C, 28.97°C) for the period 2020–2039 and 1.24°C (0.70°C, 1.95°C) to 29.00°C (28.24°C, 29.86°C) for the period 2040–2059.
- **Extreme Heat Risk:** By midcentury, Cambodia is likely to experience higher minimum and maximum temperatures, and hotter apparent conditions due to high atmospheric moisture content. The following key metrics for temperature illustrate these risks under the SSP3-7.0 scenario for the period of 2040–2059, compared to the historical reference period of 1995–2014.
    - Number of High Heat Index Days, Days Surpassing Heat Index of 35°C: Cambodia's high atmospheric moisture content over certain seasons makes the number of days surpassing the Heat Index >35°C annually increase from the reference period to 150.21 (91.64, 204.61) total nationwide by midcentury. This not only exacerbates human health concerns, but also presents risks to water and food security.
        - **Southern provinces** observed the greatest number of high Heat Index days annually and during summer months by midcentury.
    - Number of Tropical Nights, T-min>26°C: The number of tropical nights with a minimum temperature >26°C is projected to increase 87.32 (50.15, 146.27) nationwide from the reference period to 133.33 (74.60, 194.56) total nights annually by midcentury. The combination of increased high heat days and tropical nights disproportionately concern: the elderly, pregnant women, children and newborns, people with chronic illnesses and disabilities, outdoor workers, low-wage earners, and people living in areas with poorly equipped and ill-prepared health services.
        - **The southern plains** are projected to experience large increases every season except during the winter months by midcentury.
- **Observed Precipitation:** Over the 50-year period of 1971–2020, Cambodia experienced seasonally varied changes in annual precipitation per decade. Over this period:
    - **Central and eastern provinces** were significantly drier annually, especially during summer wet monsoon months.
    - **Westernmost provinces** were significantly wetter annually, especially during spring months.
- **Projected Precipitation:** Projected precipitation patterns under SSP3-7.0 nationally demonstrate drier dry seasons and wetter wet seasons annually by midcentury, with greater seasonal and regional variability.
    - **Northern provinces** are expected to experience the greatest decreases in annual precipitation by 2020–2039 under SSP3-7.0, especially during spring months.
    - **Southern and eastern provinces** are expected to experience the greatest increases in annual precipitation by 2040–2059, especially near the end of the wet monsoon season.
- **Precipitation Risk:** By midcentury, Cambodia is likely to experience more intense precipitation though the timing and severity of extreme anomalies vary by region. The following key metrics for precipitation illustrate

these shifts for the period of 2040–2059 under SSP3-7.0, compared to the historical reference period of 1995–2014.

- Average Largest 5-Day Precipitation: Increases in the average highest precipitation amount over a 5-day period, which rise 8.91 mm (–62.44 mm, 72.27 mm) nationwide from the reference period to 155.75 mm (121.98 mm, 220.67 mm) by midcentury, pose risks for flood management and do not always coincide with months experiencing the largest anomalies in total projected precipitation volumes.
  - **Northern provinces** are expected to experience the largest increases in average largest 5-day precipitation by midcentury, especially during the end of the wet monsoon season.
  - **Southern provinces** are expected to experience the largest seasonal decreases in precipitation intensity by midcentury during dry season months.

- **Extreme Precipitation Occurrence:** By midcentury, Cambodia is likely to more frequently experience extreme precipitation event occurrence. The future return period of a 100-year event associated with 5-day largest cumulative precipitation amounts is projected to occur every 63.55 (23.13, 156.13) years nationally by midcentury. These conditions pose risks for flood-related safety, health, and critical infrastructure.
  - **Provinces in the western highlands** are projected to be nearly twice as likely to experience extreme events with 5-day cumulative precipitation amounts and 100-year historical return periods by midcentury under SSP3-7.0.
- **Climate-Related Hazards:**
  - Sea level rise and inundation will increasingly threaten Cambodia's **coastal zone**, particularly along the northernmost portions.
  - The frequency and intensity of flooding and drought **across the Mekong River Valley and Tonle Sap basin** have increased and will likely continue to persist.

For National Policies, see key documents linked at the end of this profile.

COUNTRY OVERVIEW

Cambodia, located in Southeast Asia between 10°N–15°N latitude, encompasses vast river basins and plains bordering Laos, Thailand, Vietnam, and the Gulf of Thailand (**see Figure 1)**. The country's land area of 176,520 km^2 is grouped into 24 subnational provinces (or *khet*) and one autonomous municipality (the capital Phnom Penh) comprising three main geographic regions.[1] The (1) central low-lying alluvial floodplains (<25 meters high), which make up the majority of the nation's land area, are dominated by the Mekong River which flows from Laos in the north to the Mekong Delta of Vietnam in the south and feeds into Cambodia's Tonle Sap (Great Lake). Tonle Sap, the largest freshwater lake in Southeast Asia, experiences significant bidirectional fluctuations in water levels (a difference in surface area of 10,000 km^2) between wet and dry seasons that support agriculture, flooded forests, grasslands, and wetlands as well as one of the world's most diverse and productive inland fisheries.[2] To the

FIGURE 1. Topographic and Administrative Map of Cambodia[3]

Note regional divisions of western highlands, eastern highlands, and central floodplains. Kampong Cham (west of the Mekong River) separated from Tboung Khmum (east of the Mekong River) when it became its own province.

[1] Overton, L. C., and Chandler, D. P. (2023). Cambodia. Encyclopedia Britannica. URL: https://www.britannica.com/place/Cambodia
[2] USAID (2019). Climate Risk Profile: Cambodia. URL: https://www.climatelinks.org/resources/climate-risk-profile-cambodia
[3] Open Development Initiative (2015). Geographical Relief of Cambodia. URL: https://data.opendevelopmentcambodia.net/dataset/geographical-relief-of-cambodia

east, the central plains rise to form (2) forested mountains and plateaus that join the Annamite Mountains (up to around 1,000 meters high within Cambodia) while to the north, the central plains meet the steep face of the Dangrek Mountains (up to 550 meters high). In the west between Tonle Sap and the Gulf of Thailand are (3) the sparsely inhabited Cardamom (Kravanh) and Elephant (Damrei) Mountains, which include the country's highest peak Mount Aoral at 1,813 meters (m).

According to the World Bank's DataBank,[4] Cambodia has an estimated 2022 population of 16.8 million with an annual population growth rate of 1.1% (**see Table 1**). While 75% of the population currently lives in rural areas, Cambodia is experiencing a 2.9% annual rate of urbanization and more than half of its urban population resides in the capital city. Overall, Cambodia ranks 146 out of 191 on the Human Development Index for 2021, a medium level of human development considering factors such as life expectancy, education, and income per capita.[5] As a lower-middle-income country, it has a 2022 Gross Domestic Product (GDP in current $US) of $30.0 billion, annual GDP growth rate of 5.2%, and GDP per capita of roughly $1,800 (current $US). While only 17.7% of Cambodia's population lived below the national poverty line as of 2014, 37.2% were classified as living in multidimensional poverty. Poverty rates declined by 1.6% annually between 2009 and 2019 due to rising wages but increased since the COVID-19 pandemic.[6] The agricultural sector (especially rice cultivation, forestry, and fishery production) remains a dominant employer, accounting for 21.9% of GDP but 38.85% of the workforce in 2021. Manufacturing, particularly garment exports since the late 20th century, account for an increasing proportion of the economy while rapidly growing tourism activities concentrated in Phnom Penh and Siem Reap led to increasing GDP and employment in the service sector.[7]

[4] World Bank (2023). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators

[5] UNDP (2022). Human Development Report 2021/2022. URL: https://hdr.undp.org/system/files/documents/global-report-document/hdr2021-22pdf_1.pdf

[6] World Bank (2023). Cambodia Overview. URL: https://www.worldbank.org/en/country/cambodia/overview

[7] Overton, L. C., and Chandler, D. P. (2023). Cambodia. Encyclopedia Britannica. URL: https://www.britannica.com/place/Cambodia

TABLE 1. Key Development Indicators[8]

Key Demographic Indicators	Most Recent Value	Global Rank
Population Density (people per sq km, 2021)	93.98	109 (out of 216)
Life Expectancy (for total population in years, 2021)	69.58	139 (out of 209)
Fertility Rate (total births per woman, 2021)	2.34	90 (out of 210)
Dependency Ratio (dependents per 100 working-age people, 2022)	53.27	119 (out of 217)
Key Economic and Social Development Indicators	**Most Recent Value**	**Global Rank**
GDP per Capita (in current $US, 2022)	$1,786.56	149 (out of 185)
% Population Below National Poverty Line (2014)[9]	17.7%	83 (out of 100)
Unemployment Rate (% of total labor force, 2022)	0.36%	182 (out of 183)
% Employed in Agriculture (2021)	38.85%	40 (out of 185)
% Employed in Industry (2021)	25.43%	42 (out of 185)
% Employed in Services (2021)	35.72%	169 (out of 185)
% Population with Access to Electricity (2021)	82.50%	166 (out of 215)
% Population Using at Least Basic Sanitation Services (2022)	76.72%	137 (out of 191)

Data for each indicator's most recently measured year is ranked compared to all countries and entities globally in the far-right column, as tracked by the World Bank's Data Bank. Global ranking for the population below the national poverty line only includes countries classified as developing by UNDP.

The Royal Government of Cambodia launched its first Climate Change Strategic Plan (CCCSP) in 2013, which acts as the country's ten-year overarching policy framework on climate change mitigation and adaptation. Cambodia submitted its Initial Nationally Determined Contribution (INDC) in 2016 and Updated Nationally Determined Contribution (NDC) in 2020, which set a goal of reducing carbon emissions 41.7% by 2030 compared to baseline conditions and targeted the agricultural sector for the greatest share of these expected reductions. The NDC also set forth a goal of cutting deforestation rates in half by 2030, which aligns with the trajectory set forth in the 2021 Long-Term Strategy for Carbon Neutrality (LTS4CN). This strategy aims to achieve carbon neutrality by 2050 primarily through efforts reforming the forestry and land use sector. Additionally, Cambodia's NDC established adaptation commitments across nine key sectors and various national ministries, considering its high dependency on climate-sensitive sectors such as agriculture, water resources, forestry, fisheries, and tourism. These measures are further outlined in the government's Third National Communication to the UNFCCC (NC3) in 2022, following its Second National Communication to the UNFCCC (NC2) from 2016.

[8] World Bank (2023). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators

[9] UNDP (2022). Global Multidimensional Poverty Index 2022. URL: https://hdr.undp.org/system/files/documents/hdp-document/2022mpireportenpdf.pdf

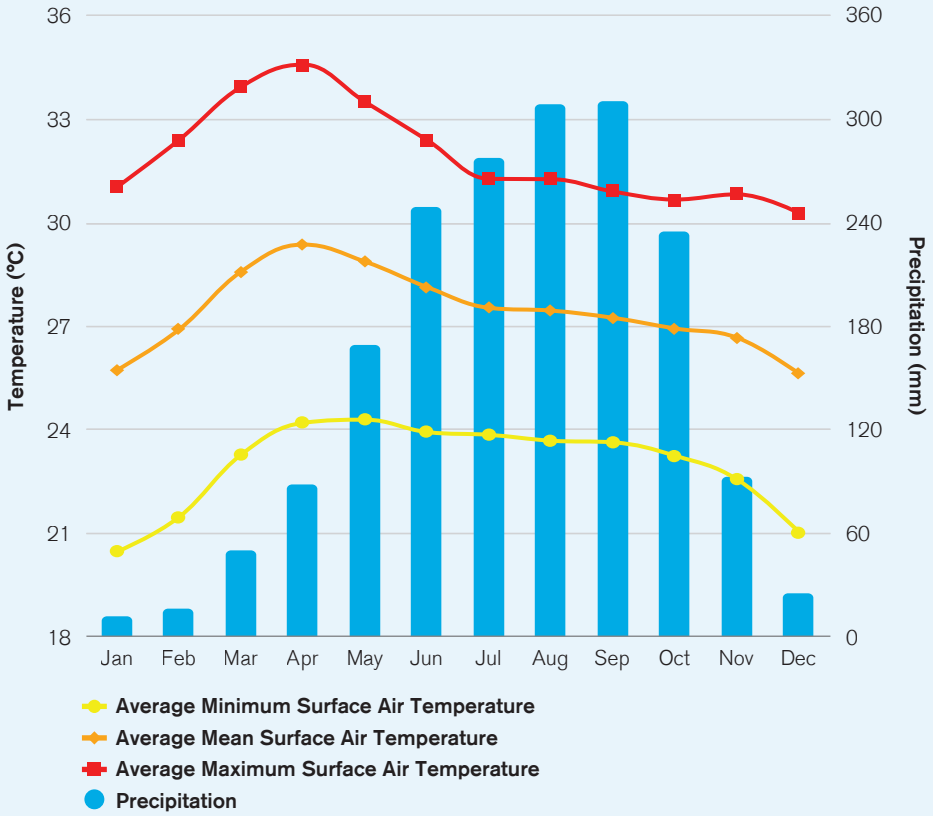
Data Overview

The data presented are from the World Bank Group's Climate Change Knowledge Portal (CCKP).[10] Historical, observed data is derived from the Climatic Research Unit, University of East Anglia (CRU), CRU TS version 4.07 gridded dataset (data available 1901–2022) and ERA5 reanalysis collection from ECMWF (1950–2020).

Climate Overview

Cambodia has a moist tropical monsoon climate and subtropical conditions at higher elevations, both with one rainy and dry season annually influenced interannually by El Niño Southern Oscillation (ENSO). Over the current climatology (1991–2020, **see Figure 2**), Cambodia observed a mean annual temperature

FIGURE 2. Observed Monthly Climatology of Cambodia's Temperature and Precipitation, 1991–2020



Note the coolest and driest conditions during winter months, warmest temperatures around the onset of the wet monsoon during spring months, and the rainy monsoon season (May to October) that peaks in September nationally.

[10] World Bank Climate Change Knowledge Portal (2023). Cambodia Climatology. URL: https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-historical

of 27.41°C. During the 1991–2020 period, the warmest month of April ranged from an average minimum temperature of 24.18°C to an average maximum temperature of 34.59°C, while the coolest month of December ranged from a minimum average temperature of 20.99°C to a maximum average temperature of 30.27°C. As shown in **Table 2**, the warmest average temperatures occur during spring months nationwide around the onset of the rainy monsoon season. Banteay Meanchey in the northwest plains possesses the warmest mean temperature (30.53°C) in April and warmest annual mean temperature (28.30°C) in Cambodia. The coolest average temperatures occur during the dry winter months. Ratanak Kiri in the mountainous northeast possesses the coolest monthly average temperature (23.39°C in January) and coolest annual average temperature (26.13°C) along with Mondul Kiri.

TABLE 2. Observed Temperature and Precipitation Trends for 1991–2020 Climatology Across Cambodia's Provinces

Climatic-Topographic Region and Province	Observed Warmest (Top) and Coolest (Bottom) Months by Mean Temp.	Duration of Wet and Dry Seasons	Observed Wettest and Driest Months per Season	Observed Annual Precip.
Western Highlands and Coastal Plain (Tropical and Subtropical Moist)				
Pailin (north)	Apr: 28.97°C (23.57°C, 34.39°C)	W: May–Oct	W: Aug (430.37 mm)	2,373.79 mm
	Dec: 25.85°C (20.88°C, 30.87°C)	D: Nov–Apr	D: Dec (13.87 mm)	
Battambang (north)	**Apr: 29.66°C** (24.02°C, 35.35°C)	W: May–Oct	W: Sept (331.88 mm)	**1,920.69 mm**
	Dec: 26.09°C (21.22°C, 31.02°C)	D: Nov–Mar	**D: Jan (11.66 mm)**	
Pursat (north)	Apr: 28.56°C (23.21°C, 33.95°C)	W: June–Oct	W: Aug (474.54 mm)	2,458.05 mm
	Dec: 25.71°C (21.08°C, 30.38°C)	D: Nov–Apr	D: Dec (15.65 mm)	
Koh Kong (south)	Apr: 27.97°C (23.23°C, 32.76°C)	W: June–Oct	**W: Aug (674.04 mm)**	**3,272.99 mm**
	Jan: 25.75°C (21.01°C, 30.54°C)	D: Nov–May	D: Dec (33.94 mm)	
Kampong Speu (south)	Apr: 28.66°C (23.51°C, 33.86°C)	W: June–Oct	W: Aug (366.44 mm)	2,070.37 mm
	Dec: 26.12°C (21.96°C, 30.33°C)	D: Nov–Apr	D: Jan (18.38 mm)	
Preah Sihanouk (south)	Apr: 28.66°C (23.96°C, 33.41°C)	W: June–Oct	W: Aug (498.07 mm)	2,607.29 mm
	Dec: 26.49°C (22.55°C, 30.49°C)	D: Nov–May	D: Feb (40.19 mm)	
Kampot (south)	Apr: 28.78°C (23.85°C, 33.76°C)	W: June–Oct	W: Aug (356.89 mm)	2,039.30 mm
	Dec: 26.46°C (22.63°C, 30.34°C)	D: Nov–Mar	D: Jan (28.06 mm)	
Kep (south)	Apr: 28.74°C (23.85°C, 33.68°C)	W: June–Oct	W: Aug (361.76 mm)	2,061.55 mm
	Dec: 26.46°C (22.68°C, 30.29°C)	D: Dec–Mar	D: Jan (31.84 mm)	

TABLE 2. Observed Temperature and Precipitation Trends for 1991–2020 Climatology Across Cambodia's Provinces (*Continued*)

Climatic-Topographic Region and Province	Observed Warmest (Top) and Coolest (Bottom) Months by Mean Temp.	Duration of Wet and Dry Seasons	Observed Wettest and Driest Months per Season	Observed Annual Precip.
		Central Plains (Tropical Moist)		
Banteay Meanchey (northwest)	**Apr: 30.53°C** (24.65°C, 36.47°C)	W: May–Oct	W: Sept (261.33 mm)	1,364.51 mm
	Dec: 25.81°C (20.40°C, 31.26°C)	D: Nov–Mar	D: Jan (7.48 mm)	
Otdar Meanchey (northwest)	Apr: 30.25°C (24.37°C, 36.19°C)	W: May–Oct	W: Sept (253.22 mm)	**1,317.78 mm**
	Dec: 25.12°C (19.52°C, 30.78°C)	D: Nov–Apr	D: Jan (2.70 mm)	
Siem Reap (northwest)	Apr: 30.31°C (24.50°C, 36.16°C)	W: May–Oct	W: Sept (267.28 mm)	1,418.18 mm
	Dec: 25.90°C (20.84°C, 31.01°C)	D: Nov–Apr	**D: Jan (2.27 mm)**	
Kampong Chhnang (central)	Apr: 29.45°C (24.12°C, 34.83°C)	W: June–Oct	**W: Sept (304.03 mm)**	**1,747.86 mm**
	Dec: 26.36°C (22.01°C, 30.76°C)	D: Nov–Apr	D: Jan (7.97 mm)	
Kampong Thom (central)	Apr: 30.00°C (24.62°C, 35.43°C)	W: May–Oct	W: Sept (287.67 mm)	1,573.77 mm
	Dec: 26.03°C (21.33°C, 30.78°C)	D: Nov–Apr	D: Jan (3.10 mm)	
Kampong Cham (central)	Apr: 29.80°C (24.55°C, 35.10°C)	W: May–Oct	W: Sept (255.95 mm)	1,445.54 mm
	Dec: 26.39°C (22.06°C, 30.75°C)	D: Dec–Apr	D: Jan (6.15 mm)	
Kandal (south)	Apr: 29.69°C (24.52°C, 34.92°C)	W: May–Oct	W: Oct (261.44 mm)	1,492.36 mm
	Dec: 26.81°C (22.84°C, 30.82°C)	D: Dec–Apr	D: Jan (10.36 mm)	
Phnom Penh (south)	Apr: 29.61°C (24.42°C, 34.85°C)	W: May–Oct	W: Sept (269.86 mm)	1,557.07 mm
	Dec: 26.78°C (22.76°C, 30.86°C)	D: Dec–Mar	D: Jan (9.18 mm)	
Takeo (south)	Apr: 29.46°C (24.41°C, 34.55°C)	W: June–Oct	W: Oct (264.22 mm)	1,689.63 mm
	Dec: 26.88°C (23.03°C, 30.72°C)	D: Dec–Mar	D: Jan (17.74 mm)	
Prey Veng (south)	Apr: 29.80°C (24.60°C, 35.05°C)	W: May–Oct	W: Oct (258.21 mm)	1,444.64 mm
	Dec: 26.71°C (22.68°C, 30.80°C)	D: Nov–Mar	D: Jan (9.95 mm)	

(*continues*)

TABLE 2. Observed Temperature and Precipitation Trends for 1991–2020 Climatology Across Cambodia's Provinces (*Continued*)

Climatic-Topographic Region and Province	Observed Warmest (Top) and Coolest (Bottom) Months by Mean Temp.	Duration of Wet and Dry Seasons	Observed Wettest and Driest Months per Season	Observed Annual Precip.
Svay Rieng (south)	Apr: 29.84°C (24.64°C, 35.09°C)	W: May–Nov	W: Oct (255.80 mm)	1,548.74 mm
	Dec: 26.69°C (22.59°C, 30.86°C)	D: Dec–Apr	D: Feb (9.49 mm)	
Tboung Khmum (south)	Apr: 29.73°C (24.54°C, 34.97°C)	W: May–Nov	W: Sept (250.39 mm)	1,474.66 mm
	Dec: 26.18°C (21.85°C, 30.56°C)	D: Dec–Apr	D: Jan (6.75 mm)	
Eastern Highlands and Plains (Tropical and Subtropical Moist)				
Preah Vihear	**Apr: 30.15°C** (24.68°C, 35.68°C)	W: May–Oct	W: Aug (290.85 mm)	**1,593.35 mm**
	Dec: 25.43°C (20.21°C, 30.69°C)	D: Nov–Apr	**D: Jan (1.14 mm)**	
Stung Treng	Apr: 29.55°C (24.72°C, 34.44°C)	W: May–Oct	**W: July (336.04 mm)**	1,837.46 mm
	Jan: 24.85°C (19.19°C, 30.55°C)	D: Nov–Apr	D: Jan (5.82 mm)	
Ratanak Kiri	Apr: 28.22°C (23.85°C, 32.64°C)	W: May–Nov	W: Sept (316.14 mm)	**1,879.61 mm**
	Jan: 23.39°C (18.66°C, 28.18°C)	D: Dec–Apr	D: Feb (13.98 mm)	
Mondul Kiri	Apr: 28.42°C (23.83°C, 33.05°C)	W: May–Oct	W: Sept (291.73 mm)	1,728.04 mm
	Jan: 24.05°C (19.29°C, 28.85°C)	D: Dec–Apr	D: Jan (6.29 mm)	
Kratie	Apr: 29.63°C (24.63°C, 34.67°C)	W: May–Oct	W: Sept (287.61 mm)	1,625.30 mm
	Dec: 25.46°C (20.87°C, 30.10°C)	D: Nov–Apr	D: Jan (3.99 mm)	

Climatic zones are classified according to characteristics in Sayre et al. and grouped by topo-geographic region (western highlands and coastal plains shaded light green, central plains shaded dark green, and eastern highlands and plains shaded light blue).[11] Each province's warmest month corresponds with the month before the onset of the rainy season and the coolest month during the winter dry season. For the column listing mean monthly temperatures, the minimum (left) and maximum (right) temperatures are shown in parentheses. Precipitation regimes indicate wettest (W) and driest (D) months, both further interpreted in the text.

[11] Sayre, R., Karagulle, D., Frye, C., Boucher, T., Wolff, N. H., Breyer, S., et al. (2020). An assessment of the representation of ecosystems in global protected areas using new maps of World Climate Regions and World Ecosystems. Global Ecology and Conservation, 21, e00860. DOI: https://doi.org/10.1016/j.gecco.2019.e00860

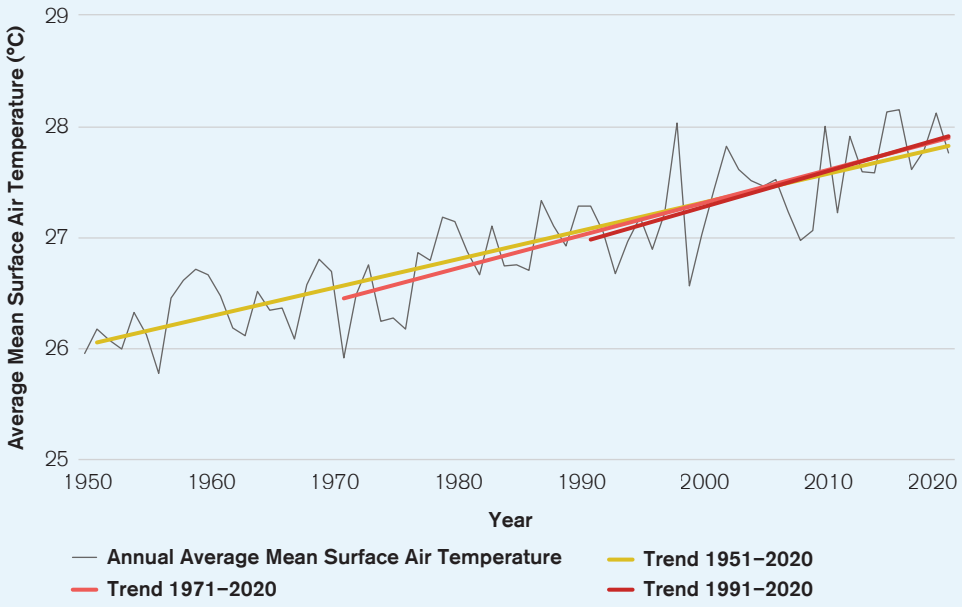
Cambodia's annual average rainfall is 1,836 millimeters (mm) over the current climatology (1991–2020) at the national level. During this period as **Table 2** illustrates, the southwestern coast and highlands generally received more than 2,000 mm annually, the eastern mountains and plains received between 1,500–1,900 mm annually, and the central plains received between 1,300–1,800 mm annually. The wet monsoon-driven rainy season occurs from May to October with southwesterly winds ushering in clouds and moisture that account for 85% of annual rainfall. Precipitation volumes peak during August and September nationally (310.60 mm in September) on average, but maximum precipitation volumes occur earlier in the west and north and later in the south. Koh Kong on the west coast observed Cambodia's wettest annual average precipitation over the most recent climatology (3,272.99 mm) with the heaviest average monthly maximum in August of 674.04 mm, followed by Preah Sihanouk (498.07 mm) and Pursat (474.54 mm) over the same month. Compared to the moister slopes of the western highlands, the central floodplains exhibited monthly rainfall peaks between 250–300 mm. During the wet season, tropical cyclones, heavy monsoonal rains, and runoff from the highlands result in flooding along the Mekong River and Tonle Sap. This benefits the nation's agriculture by replenishing the soil, enabling productive rice harvests and fisheries, and supporting food security and agricultural exports. As the Intertropical Convergence Zone (ITCZ) migrates south, winds predominantly blow from northeast and characterize the beginning of the cooler dry season (November–April with regional variation in onset), resulting in the lowest monthly precipitation totals. The northwest plains contain the driest monthly average precipitation during January (1.14 mm in Preah Vihear, followed by 2.27 mm in Siem Reap). The driest annual average precipitation over the same time period (1,317.78 mm) occurred in Otdar Meanchey in the northwest plains.

Interannual variation in precipitation is primarily driven by El Niño Southern Oscillation (ENSO), which influences the nature of the monsoons in the region and generally bring warmer and drier winter conditions across Southeast Asia during an El Niño phase and cooler, wetter conditions during a La Niña phase. Due to climate change, Cambodia is expected to experience more frequent and intense hazards such as flooding and drought, both of which already have severe impacts to the populations in Cambodia. Further details on ENSO are provided in the profile's section on climate-related hazards.

Temperature

Between 1971 and 2020, Cambodia's average mean temperature increased by 0.29°C per decade (see Figure 3), with the greatest changes observed in the northern provinces and most widespread warming during the winter months. Nationwide, average minimum temperatures increased 0.29°C per decade between 1971–2020, while average maximum temperatures increased 0.32°C per decade over the same period. The northeastern province of Ratanak Kiri recorded the highest annual average mean temperature increase per decade (0.33°C). The northeastern province of Mondul Kiri recorded the highest average minimum temperature increase per decade (0.35°C). The north central plains (Banteay Meanchey, Battambang, Kampong Thom, Kampong Chhnang) recorded the highest maximum temperature increases per decade (0.35°C). By comparison, the lowest significant temperature increases over this period occurred along the southwest coast and northwest plains. Kep (southwest coast) observed a 0.21°C mean increase per decade and 0.22°C maximum increase per decade, while Otdar Meanchey (northwest plains) observed a 0.22°C minimum increase per decade. Winter months exhibited the greatest seasonal mean, minimum, and maximum increases in temperature per decade, with changes approaching or exceeding 0.40°C in central and eastern provinces. During winter months, Battambang (northwest) recorded an

FIGURE 3. Average Annual Mean Temperature Trends Nationally per Decade, 1951–2020



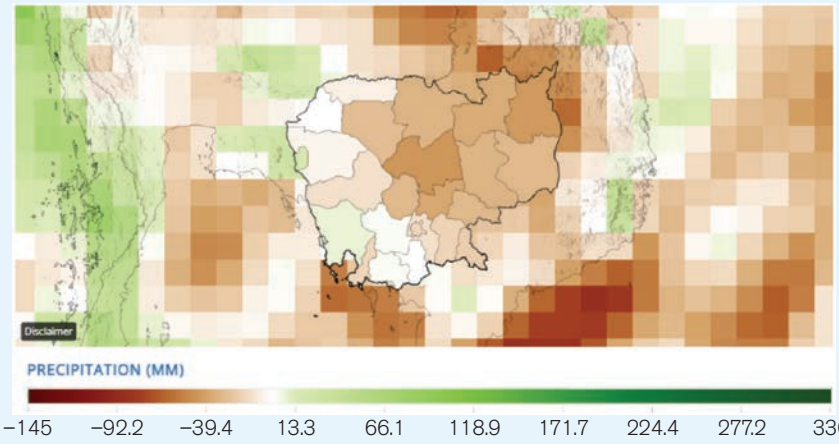
Significantly positive trendlines over the 30-year, 50-year, and 70-year climatologies indicate a steadily rising rate of mean temperature increases, from an increase of 0.25°C per decade between 1951–2020 (yellow line) to an increase of 0.33°C per decade between 1991–2020 (red line).

average mean temperature increase of 0.42°C per decade, followed by Kampong Cham and Phnom Penh (central plains, 0.41°C and 0.40°C per decade, respectively). During winter months, Battambang also recorded an average maximum temperature increase of 0.39°C per decade. Tboung Khmum recorded a minimum temperature increase of 0.44°C per decade during winter months. Observed number of tropical nights (T-min >20°C) from 1971–2020 significantly increased 6.06 nights per decade nationally.

Precipitation

Over the 50-year period of 1971–2020, Cambodia experienced seasonally varied and significant decreases in precipitation per decade across its central and eastern provinces but significant increases per decade across some western provinces (see Figure 4). During the 1971–2020 climatology, the central province of Kampong Thom and eastern province of Ratanak Kiri observed the largest total decreases in precipitation per decade (–44.71 mm and –43.44 mm, respectively), with the strongest effects during summer wet monsoon months. Provinces encompassing the eastern slopes of the western highlands, including Takeo, Kampot, Kampong Speu, and Battambang observed little annual change in precipitation per decade, with small increases during spring months and the greatest drying during fall months. In contrast, several western provinces observed significant precipitation increases over the same time period, especially during spring months. Pailin in the western highlands observed the largest annual increase per decade (+17.95 mm), followed by Koh Kong along the western coast (+8.02 mm). The implications of ENSO on variable monsoon seasons, including the 1971–2020 climatology and beyond, are discussed further below under climate-related hazards.

FIGURE 4. Observed Precipitation Trend per Decade (1971–2020) Annually



Note significant decreases in most of the country except in parts of the western and southern provinces.

PROJECTED CLIMATE

Data Overview

Modeled climate data is derived from CMIP6, the Coupled Model Intercomparison Project, Phase 6. The CMIP efforts are overseen by the World Climate Research Program, which supports the coordination for the production of global and regional climate model compilations that advance scientific understanding of the multi-scale dynamic interactions between the natural and social systems affecting climate. CMIP6 is the foundational data used to present global climate change projections presented in the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC). CMIP6 relies on the Shared Socioeconomic Pathways (SSPs), which represent possible societal development and policy scenarios for meeting designated radiative forcing (W/m^2) by the end of the century. Scenarios are used to represent the climate response to different plausible future societal development storylines and associated contrasting emission pathways to outline how future emissions and land use changes translate into responses in the climate system. Model-based, climate projection data is derived from the Coupled Model Inter-comparison Project-Phase 6 (CMIP6). CMIP is a standard framework for the analysis of coupled atmosphere-ocean general circulation models (GCMs) providing projections of future temperature and precipitation according to designated scenarios. CMIP6 projections are shown through five shared socio-economic pathway (SSP) scenarios defined by their total radiative forcing (a cumulative measure of GHG emissions from all sources) pathway and level by 2100. These represent possible future greenhouse gas concentration trajectories adopted by the IPCC.

The following assessment explores projected climate conditions and changes under multiple scenarios[12] for the near (the 2030s; 2020–2039) and medium term (2050s; 2040–2059) using data presented at a 0.25° × 0.25°

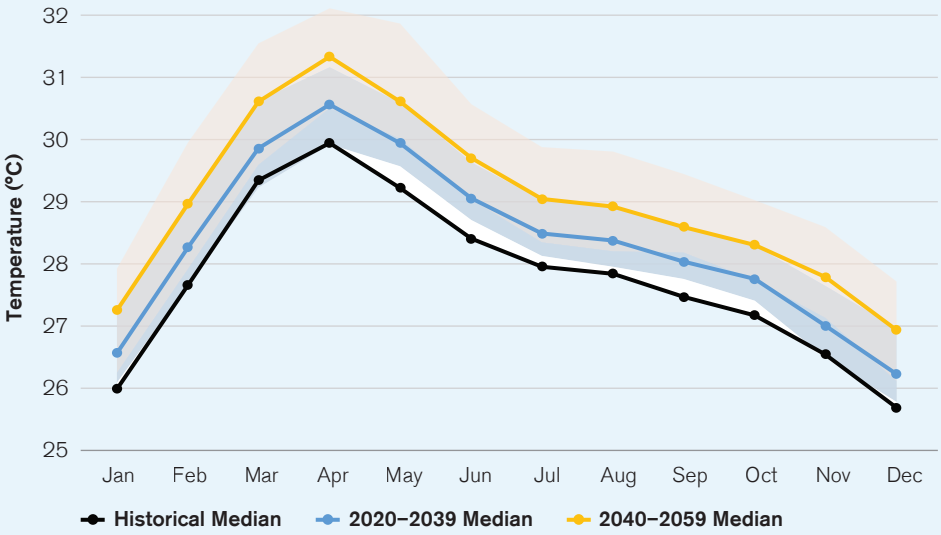
[12] SSP3-7.0 represents a higher emissions scenario and is considered a more realistic worst-case scenario in which warming reaches ~3.5–4°C by 2100. When considering 'risk' it is most prudent to use higher scenarios in order to not dangerously under-estimate potential changes and risk conditions.

(25 km × 25 km) resolution.[13] This risk profile focuses primarily on SSP3-7.0. Other SSPs are highlighted where appropriate given different trends and outlooks that should be noted. Projections for extreme precipitation events use data presented at a 1.00° × 1.00° (100 km × 100 km) resolution.[14]

Temperature

Under SSP3-7.0, temperatures are projected to continue increasing and become more common by midcentury (see Figure 5). Mean temperature nationwide increases from the historical reference period of 1995–2014 to 28.34°C (27.88°C, 10th percentile, 28.97°C, 90th percentile) for the period 2020–2039, and to 29.00°C (28.24°C, 29.86°C) for the period 2040–2059. Minimum temperature nationwide increases from the historical reference period to 24.28°C (23.85°C, 24.89°C) for the 2020–2039 period, and 24.96°C (24.25°C, 25.77°C) for 2040–2059. Maximum temperature increases to 32.40°C (31.87°C, 33.07°C) for the 2020–2039 period, and 33.05°C (32.16°C, 34.00°C) for 2040–2059. Projected maximum and minimum temperature changes under SSP1-2.6 are lower but under SSP2-4.5 are roughly the same as SSP3-7.0.[15] Under SSP3-7.0, the largest seasonal change occurs during spring months, when mean monthly temperatures nationally increase from the historical reference period to 30.85°C (30.03°C, 31.84°C) over the 2040–2059 period. Over this period

FIGURE 5. Projected Climatology of Mean Temperature Countrywide for 2020–2039 and 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0



Areas shaded gray indicate 10th and 90th percentiles. The projected climatology of mean temperature countrywide for each month (2040–2059 period) increases roughly two times the projected climatology for 2020–2039 above the reference period, except in May (lower than two times) and November (higher than two times).

[13] World Bank Climate Change Knowledge Portal (2023). Cambodia Climate Projections. URL: https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-projections

[14] World Bank Climate Change Knowledge Portal (2023). Cambodia Extreme Events. URL: https://climateknowledgeportal.worldbank.org/country/cambodia/extremes

[15] Under SSP1-2.6, minimum temperature nationwide increases to 24.69°C (24.16°C, 25.37°C) and under SSP2-4.5, increases to 24.92°C (24.35°C, 25.57°C) by 2040–2059. Under SSP1-2.6, maximum temperature increases nationwide to 32.84°C (32.21°C, 33.67°C), and under SSP2-4.5, increases to 33.02°C (32.37°C, 33.80°C) by 2040–2059.

during spring months, the largest projected increase of 1.47°C (0.71°C, 2.48°C) from the reference period occurs in the mountainous eastern province of Stung Treng and the lowest projected increase of 1.18°C (0.59°C, 1.83°C) occurs in the southwest coastal province of Kep. The largest mean increases annually (>1.20°C) by midcentury occur in the northern provinces while slightly lower increases (<1.20°C) occur in the southern provinces.

Under future climate conditions, Cambodia would be exposed to much higher heat risks nationally by midcentury, especially considering regional and seasonal variations. According to the SSP3-7.0 scenario, the average annual number of hot days (T-max > 35°C) increase nationally from the 1995–2014 reference period to 60.17 (39.43, 87.01) days over 2020–2039 and to 82.87 (46.73, 124.53) days by midcentury. The greatest number of hot day anomalies occur during spring months throughout the central plains. However, as detailed in **Table 3**, the number of days surpassing the Heat Index >35°C increase much higher countrywide according to the SSP3-7.0 scenario from the historical reference period (1995–2014) – to 97.34 (63.54, 141.38) days annually over the 2020–2039 climatology and to 150.21 (91.64, 204.61) days annually over the 2040–2059 climatology. Since Cambodia is projected to

TABLE 3. Annual Projected Number of High Heat Index Days and Tropical Nights by Province for 2020–2039 and 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0

Province	2020–2039	2040–2059
	High Heat Index Days (No. Days T-max >35°C)	
Cambodia	97.34 (63.54, 141.38)	150.21 (91.64, 204.61)
Pailin (north)	40.04 (16.95, 80.20)	89.80 (33.50, 160.34)
Battambang (north)	**124.66** (85.20, 170.14)	177.39 (115.08, 226.02)
Pursat (north)	73.61 (50.93, 104.14)	110.88 (71.69, 152.49)
Koh Kong (south)	10.75 (3.47, 30.81)	38.14 (12.12, 92.63)
Kampong Speu (south)	61.27 (36.12, 100.22)	111.30 (60.17, 172.98)
Preah Sihanouk (south)	26.49 (12.19, 60.54)	75.85 (28.96, 155.08)
Kampot (south)	52.15 (27.04, 88.70)	103.46 (49.32, 170.22)
Kep (south)	66.34 (34.21, 115.58)	**137.58** (62.52, 220.30)
Banteay Meanchey (northwest)	157.53 (108.75, 208.10)	209.22 (139.13, 253.10)
Otdar Meanchey (northwest)	120.64 (79.41, 171.90)	176.31 (104.32, 227.62)
Siem Reap (northwest)	139.91 (97.31, 190.31)	196.94 (128.89, 246.82)
Kampong Chhnang (central)	144.01 (102.10, 190.11)	198.95 (142.38, 249.02)
Kampong Thom (central)	143.45 (98.92, 192.80)	201.09 (137.90, 250.62)

(*continues*)

TABLE 3. Annual Projected Number of High Heat Index Days and Tropical Nights by Province for 2020–2039 and 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0 (*Continued*)

Province	2020–2039	2040–2059
Kampong Cham (central)	159.36 (111.47, 206.53)	215.10 (157.02, 260.88)
Kandal (south)	161.86 (114.23, 211.20)	222.16 (163.97, 267.23)
Phnom Penh (south)	160.48 (114.08, 210.33)	220.18 (163.96, 266.08)
Takeo (south)	**126.29** (77.50, 179.66)	**196.22** (122.22, 252.79)
Prey Veng (south)	155.61 (107.19, 206.69)	217.42 (157.48, 263.73)
Svay Rieng (south)	136.40 (86.63, 192.46)	204.71 (136.70, 256.80)
Tboung Khmum (south)	125.81 (79.56, 181.61)	189.60 (118.88, 246.86)
Preah Vihear	94.76 (59.45, 146.79)	158.11 (85.44, 217.78)
Stung Treng	87.91 (53.95, 137.40)	147.61 (80.46, 207.60)
Ratanak Kiri	42.76 (22.08, 77.86)	87.82 (39.62, 149.81)
Mondul Kiri	43.40 (23.60, 79.33)	87.34 (39.60, 147.97)
Kratie	**109.25** (69.15, 163.56)	**172.81** (100.46, 230.94)
Tropical Nights (No. Nights T-min >26°C)		
Cambodia	82.90 (51.59, 128.91)	133.33 (74.60, 194.56)
Pailin (north)	19.41 (5.73, 51.47)	52.86 (14.32, 123.32)
Battambang (north)	105.47 (67.01, 150.17)	158.42 (94.94, 209.63)
Pursat (north)	72.12 (51.54, 98.14)	101.29 (68.40, 140.06)
Koh Kong (south)	27.69 (15.84, 49.45)	53.21 (28.56, 92.24)
Kampong Speu (south)	44.98 (24.56, 80.28)	90.16 (41.18, 148.25)
Preah Sihanouk (south)	75.68 (53.59, 113.45)	120.40 (76.57, 173.73)
Kampot (south)	67.46 (43.27, 105.27)	116.17 (66.14, 173.96)
Kep (south)	**192.99** (149.31, 247.80)	**256.45** (199.61, 298.80)

TABLE 3. Annual Projected Number of High Heat Index Days and Tropical Nights by Province for 2020–2039 and 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0 (*Continued*)

Province	2020–2039	2040–2059
Banteay Meanchey (northwest)	134.76 (80.08, 190.53)	197.52 (106.88, 247.14)
Otdar Meanchey (northwest)	97.02 (57.14, 153.29)	154.39 (74.20, 217.44)
Siem Reap (northwest)	140.25 (97.81, 190.42)	193.97 (124.62, 246.22)
Kampong Chhnang (central)	132.32 (87.14, 182.43)	191.58 (123.71, 248.15)
Kampong Thom (central)	119.05 (78.34, 175.36)	177.87 (108.19, 244.12)
Kampong Cham (central)	154.44 (98.28 ,211.52)	219.41 (141.39, 271.70)
Kandal (south)	162.71 (105.83, 216.54)	231.47 (154.01, 275.60)
Phnom Penh (south)	**163.22** (105.77, 216.98)	229.05 (155.67, 274.89)
Takeo (south)	116.99 (73.43, 174.39)	193.73 (111.46, 247.86)
Prey Veng (south)	152.00 (98.34, 207.92)	223.31 (143.29, 270.76)
Svay Rieng (south)	116.22 (70.78, 173.02)	**191.30** (105.58, 254.47)
Tboung Khmum (south)	99.94 (58.25, 163.65)	172.69 (89.22, 249.07)
Preah Vihear	54.61 (29.76, 108.75)	107.49 (45.74, 190.53)
Stung Treng	54.59 (30.13, 105.42)	105.47 (48.99, 183.30)
Ratanak Kiri	24.70 (10.26, 55.26)	56.33 (20.60, 119.50)
Mondul Kiri	29.16 (13.70, 64.60)	62.94 (24.80, 133.84)
Kratie	**80.62** (47.28, 145.06)	**145.47** (73.45, 229.89)

10th percentile and 90th percentile values shown in parentheses. Largest anomalies (>50 days) are shaded orange and the largest anomalies in each region are bolded. Note high Heat Index and tropical night anomalies increase most across the southern plains. See text for interpretation.

experience more days with high temperatures and moisture content during the wet monsoon season and its spring onset (March through July), the number of days with high apparent heat conditions surpassing the Heat Index >35°C rise particularly high countrywide. While Kampong Cham in the central plains possesses the largest annual number of high heat days during the reference period, the greatest annual increase (roughly 70 days over 2020–2039) is projected for Takeo followed closely by the other provinces in the southern plains, including the capital Phnom Penh. High heat days are projected to increase the most in Takeo (roughly 140 days) by midcentury, but widespread heat risks occur throughout all of Cambodia except the western and eastern highlands. For example, Kep on the southern

coast experiences more than four months of high heat days annually by midcentury, compared to less than one month during the reference period, and the capital Phnom Penh and surrounding Kandal Province record the greatest total number of high heat days nationally by midcentury (more than seven months of the year).

A similar spatial pattern represented in **Table 3** holds for an even higher threshold of projected days surpassing the Heat Index >41°C by midcentury. Compared to virtually no median days surpassing this threshold over the 2020–2039 period, the number of more extreme high heat days (Heat Index >41°C) increases from the reference period by roughly one month across the central plains by midcentury – to 29.93 (5.54, 80.76) days in Kampong Thom, 28.75 (5.15, 84.46) days in Banteay Meanchey, and 22.58 (2.98, 66.61) days in Phnom Penh. Furthermore, an escalating trend of Warm Spell Duration Index (WSDI) WSDI days over time – reaching roughly 200 warm spell days across the country by 2100 – illustrates a shift in long-term temperatures from the historical baseline.[16] The southwest coastal provinces of Preah Sihanouk and Kep are projected to experience the highest WSDI values (>330 days with 10th percentiles around 200 days and 90th percentiles around 360 days) per year by 2100. The lowest increases over the same time period rise to 208.16 (83.61, 275.34) days per year in Ratanak Kiri (east) and 204.06 (79.34, 264.59) days per year in Otdar Meanchey (northwest), still substantial. As a whole, these projected changes indicate the likely seasonal expansion of hot and humid conditions and raise the risk of heat waves and associated human health impacts, especially during spring and summer months.

Daytime temperature increases coupled with high nighttime temperatures (i.e., tropical nights) exacerbate Cambodia's potential for extreme heat risks everywhere except for the southwest coast and highlands. On nights temperatures do not go below 20°C, the human body reaches a biophysiological threshold where it cannot adequately cool down to achieve restorative sleep. Since Cambodia maintains a relatively high historical number of nights with minimum temperatures above 20°C, its projected number only increases to 253.48 (235.74, 268.64) nights annually by midcentury under SSP3-7.0. However, the number of tropical nights with a minimum temperature >26°C, an even higher threshold, illustrates a more widespread shift in future heat conditions. Compared to the historical reference period, such tropical nights increase the most in the southern plains during summer months by midcentury (2040–2059). As illustrated in **Table 3**, Svay Rieng (southern plains) is projected to experience the largest increase from less than two months on average annually during the reference period to 191.30 (105.58, 254.47) nights annually by 2040–2059, most of which occur during the spring and summer months. However, large increases by midcentury occur throughout the central plains. In fact, the capital Phnom Penh experiences approximately the same increase in tropical nights by midcentury as Svay Rieng, as well as a slightly higher increase during the 2020–2039 period. This exposes a large number of Cambodia's population to higher heat risks and places additional burden on infrastructure to meet rising energy demand. The SSP3-7.0 scenario forecasts the highest number of tropical nights >26°C by midcentury compared to the SSP2-4.5 and SSP1-2.6 scenarios, and the annual number projected by SSP3-7.0 increases more than two times higher than the number projected by the SSP1-2.6 scenario at the end of the century (see Annex for more detail).

Precipitation

Projected precipitation patterns under SSP3-7.0 demonstrate greater regional and seasonal variability by midcentury but drier dry seasons nationally. At the national level, annual precipitation totals increase from the 1995–2014 reference period by 14.48 mm (–106.38 mm, 128.27 mm) over 2020–2039 under SSP3-7.0

[16] This value indicates the number days with consecutive daily maximum temperatures greater than the 90th percentile of daily maximum temperature calculated over a five-day window annually. Warm Spell Duration Index projections use 1.00° × 1.00° (100 km × 100 km) data resolution.

but decrease –11.27 mm (–158.81 mm, 192.51 mm) over 2040–2059. Southern and eastern provinces are projected to experience the greatest increases in annual precipitation over 2020–2039, while northern divisions are projected to experience the greatest decreases in annual precipitation by midcentury. **Table 4** details the distinct regional and monthly projected precipitation medians for 2020–2039 and 2040–2059 compared to the reference period.

The greatest annual precipitation increase of 27.68 mm (–105.33 mm, 142.29 mm) from the reference period over 2020–2039 occurs in Kratie (eastern highlands), followed by Ratanak Kiri (eastern highlands), Preah Sihanouk (southwest coast), and Takeo (southern plains). The largest monthly increase of 20.39 mm (–28.86 mm, 52.50 mm) occurred in Preah Sihanouk (southwest coast) in October at the end of the wet monsoon season, followed by Koh Kong and Kampot (both southwest coast) during the same month. However, these provinces also expected nearly equivalent monthly decreases in the month of May, for example, by –20.27 mm (–59.95 mm, 19.01 mm) in Preah Sihanouk. As **Table 4** illustrates, the nationwide pattern of greatest monthly decreases around the onset of the wet monsoon season and the greatest monthly increases at the end of the wet monsoon season potentially signal a later shift in the timing of the rainy season. Whereas monthly precipitation increases during the fall months outweighed monthly decreases primarily during the spring months over 2020–2039, this trend reverses over 2040–2059 under SSP3-7.0. Northern provinces are expected to experience the greatest annual precipitation decreases by midcentury. The largest decrease from the reference period of –30.30 mm (–181.98 mm, 200.83 mm) annually is projected for Preah Vihear, followed by Kratie (eastern highlands), Kampong Thom (northern plains), and Stung Treng (eastern highlands). The largest monthly precipitation decrease of –21.50 mm (–56.31 mm, 13.12 mm) occurred in Koh Kong (southwest coast and highlands) in April at the end of the spring dry season, followed by Ratanak Kiri (eastern highlands) in May and Preah Sihanouk (southwest coast) in April. By contrast, the greatest monthly precipitation increases over 2040–2059 occurred in Preah Sihanouk and Koh Kong in August followed by Ratanak Kiri in September. Only in several southern provinces did annual precipitation over 2040–2059 increase, led by the capital Phnom Penh with an increase of 16.27 mm (–78.94 mm, 149.83 mm), roughly the same median anomaly as over 2020–2039. The trend of greater monthly decreases during dry spring months tend to outweigh monthly increases in fall months for most provinces. However, while SSP3-7.0 predicts drier annual precipitation nationally compared to the historical reference period, SSP1-2.6 and SSP2-4.5 predict wetter annual precipitation by the end of the century (see Annex for more detail). Both possibilities would likely affect Cambodia's agricultural production and food security.

Cambodia's future precipitation intensities, measured by average largest 5-day cumulative anomalies, generally increase the most during the end of the wet monsoon season in the northern provinces and generally decrease the most during the dry season months in the southern provinces, with the most extreme illustrative trends in the western provinces. For example, by midcentury under SSP3-7.0, precipitation intensities decrease –18.16 mm (–39.21 mm, 27.78 mm) during the dry season month of March and increase 19.83 mm (–35.98 mm, 69.07 mm) in the early wet season month of June in Kep (southwest coast, **see Figure 6a**). By comparison, in Koh Kong (southwest coast and highlands, **see Figure 6b**), intensities decrease less in March by a median of approximately –10 mm, increase 17.26 mm (–41.17 mm, 51.85 mm) in July, and increase 31.65 mm (–56.30 mm, 93.36 mm) at the end of the wet season in October, the most nationally. In the northeast, Ratanak Kiri's intensity increases 21.35 mm (–48.86 mm, 97.65 mm) at the end of the wet monsoon season in October. However, this late season increase in intensity is more uncertain in the northwest. In Pailin (**see Figure 6c**), precipitation anomalies do not exceed 10 mm in any month by midcentury but possess a larger range of uncertainty during the end of the wet monsoon season, including a median increase of 6.01 mm in September but a >150 mm probability range (–80.46 mm, 71.53 mm). These trends in sum reflect the pattern of drier dry seasons and wetter wet seasons with regional variations.

TABLE 4. Projected Annual and Monthly Median Precipitation (mm) for 2020–2039 and 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0

2020–2039													
Province	**Annual**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Cambodia	1772.56 (1496.81, 2004.72)	10.31 (6.82, 13.62)	20.30 (12.77, 27.22)	54.18 (39.42, 70.84)	109.86 (93.14, 126.64)	195.79 (154.10, 217.21)	224.09 (195.08, 249.35)	249.30 (221.92, 283.70)	267.69 (232.18, 297.74)	309.08 (279.14, 339.04)	227.41 (188.07, 252.71)	88.80 (63.77, 104.30)	15.74 (10.41, 22.35)
Pailin	1670.38 (1418.34, 1899.85)	15.68 (9.82, 20.19)	39.29 (24.56, 52.11)	82.07 (67.16, 104.65)	126.81 (115.34, 148.69)	184.89 (148.14, 203.00)	192.75 (164.77, 216.57)	216.78 (193.82, 249.27)	238.31 (209.90, 265.12)	287.57 (263.97, 318.04)	213.09 (173.62, 237.08)	70.07 (45.73, 79.30)	3.09 (1.52, 5.83)
Battambang	1347.19 (1126.26, 1528.59)	11.17 (7.12, 14.83)	27.62 (16.13, 36.14)	62.58 (49.10, 82.27)	106.25 (93.28, 124.08)	148.52 (115.80, 163.38)	134.44 (117.94, 150.41)	142.24 (126.87, 162.65)	169.15 (147.45, 188.14)	245.83 (224.34, 272.70)	210.42 (167.48, 230.24)	81.90 (56.07, 91.48)	7.07 (4.67, 12.28)
Pursat	1786.24 (1503.30, 2015.81)	17.54 (12.10, 22.89)	38.66 (23.11, 49.38)	84.67 (64.35, 109.94)	137.31 (122.53, 157.77)	197.21 (156.15, 216.11)	193.34 (170.58, 212.76)	208.36 (185.96, 236.18)	231.94 (205.17, 259.81)	294.19 (268.61, 321.31)	254.64 (204.09, 277.82)	106.71 (76.74, 119.76)	21.65 (13.91, 32.08)
Koh Kong	2789.41 (2426.47, 3134.29)	33.52 (25.18, 42.07)	63.75 (42.10, 83.07)	119.07 (95.98, 151.61)	177.18 (158.51, 195.35)	283.85 (238.47, 320.08)	368.14 (328.91, 397.18)	428.63 (381.75, 483.20)	433.35 (395.00, 486.90)	421.41 (387.08, 459.04)	315.64 (272.01, 343.36)	116.07 (84.17, 133.07)	28.81 (17.31, 39.35)
Kampong Speu	1476.92 (1265.05, 1661.80)	13.87 (9.17, 17.67)	22.28 (14.09, 29.82)	54.44 (38.21, 72.61)	102.47 (90.08, 115.14)	156.42 (128.24, 173.41)	161.76 (141.96, 175.93)	167.96 (151.09, 187.49)	188.09 (167.85, 213.61)	250.10 (231.59, 272.20)	235.40 (202.98, 254.36)	100.59 (74.34, 119.21)	23.55 (15.45, 30.34)
Preah Sihanouk	**2801.73** (2446.98, 3125.82)	34.51 (25.94, 42.01)	49.18 (34.71, 64.55)	92.66 (69.40, 114.78)	155.32 (134.60, 177.71)	283.43 (244.50, 317.77)	382.70 (340.76, 403.25)	426.48 (376.15, 469.33)	433.45 (394.31, 493.19)	421.12 (391.59, 455.33)	**336.09** (302.43, 366.62)	144.26 (103.69, 166.39)	42.62 (28.90, 54.88)
Kampot	1805.97 (1571.91, 2037.24)	22.98 (16.49, 27.92)	30.43 (22.56, 41.26)	68.81 (47.27, 85.59)	117.16 (101.68, 138.79)	189.74 (165.50, 213.60)	216.91 (192.43, 234.28)	224.86 (199.42, 246.53)	232.27 (212.38, 266.34)	274.32 (255.76, 300.88)	265.78 (240.62, 288.24)	127.58 (93.65, 148.49)	35.13 (24.14, 45.31)
Kep	1825.69 (1593.30, 2048.02)	24.93 (17.69, 29.77)	29.10 (22.62, 38.84)	61.12 (41.77, 74.12)	112.06 (96.42, 130.83)	204.72 (179.92, 232.59)	242.09 (216.71, 261.34)	246.73 (216.22, 269.49)	243.12 (222.42, 275.72)	263.48 (247.88, 283.41)	244.55 (220.65, 267.95)	120.00 (87.90, 139.86)	33.78 (23.10, 44.10)
Banteay Meanchey	1258.13 (1057.52, 1437.95)	7.81 (5.01, 10.68)	18.20 (11.53, 25.31)	47.28 (36.30, 62.30)	91.97 (77.13, 103.86)	143.30 (111.25, 159.93)	135.48 (120.53, 150.88)	143.07 (129.78, 169.52)	177.53 (150.47, 194.69)	252.59 (229.91, 291.28)	183.17 (146.70, 201.74)	57.06 (38.52, 65.60)	0.66 (0.38, 2.16)
Otdar Meanchey	1287.75 (1068.54, 1470.63)	5.33 (3.36, 7.73)	14.30 (9.51, 18.61)	40.82 (30.52, 52.74)	82.58 (68.28, 94.68)	144.23 (112.52, 166.16)	154.13 (136.63, 170.00)	166.72 (151.24, 203.46)	201.56 (166.09, 222.27)	265.21 (231.43, 297.86)	164.40 (127.13, 181.27)	48.18 (31.68, 54.77)	0.30 (0.13, 1.06)

2020–2039													
Province	**Annual**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Siem Reap	1499.40 (1234.75, 1705.22)	8.52 (5.38, 11.17)	21.37 (13.44, 27.33)	56.87 (41.83, 74.31)	108.16 (91.59, 126.05)	172.66 (131.60, 193.39)	167.61 (143.92, 186.22)	173.79 (156.34, 207.99)	208.62 (174.01, 231.34)	290.23 (258.96, 320.77)	**212.38** (162.42, 232.85)	74.62 (52.13, 85.56)	4.56 (3.12, 8.23)
Kampong Chhnang	1537.19 (1292.14, 1723.40)	10.39 (6.32, 14.07)	17.30 (10.29, 23.93)	45.47 (30.04, 59.52)	94.54 (82.05, 108.08)	164.70 (129.71, 178.33)	176.04 (153.13, 191.61)	190.98 (170.30, 215.20)	213.50 (182.82, 234.66)	272.41 (249.87, 296.55)	230.07 (190.42, 254.78)	99.08 (72.00, 115.93)	22.70 (15.19, 30.73)
Kampong Thom	1677.17 (1386.90, 1902.41)	6.12 (3.41, 8.15)	17.30 (10.83, 24.53)	53.68 (35.80, 69.35)	107.46 (90.39, 125.81)	183.37 (140.13, 201.32)	202.42 (169.04, 225.92)	224.35 (197.88, 254.28)	247.08 (210.28, 273.76)	309.33 (276.04, 339.77)	225.37 (180.11, 255.50)	88.27 (63.83, 105.39)	12.41 (9.17, 18.64)
Kampong Cham	1549.79 (1307.80, 1755.98)	9.06 (5.69, 12.46)	13.68 (8.13, 20.23)	41.27 (25.71, 54.47)	91.00 (77.70, 105.40)	163.46 (129.33, 181.99)	181.98 (157.28, 203.94)	203.10 (178.39, 228.89)	226.97 (193.66, 251.49)	284.51 (262.24, 310.77)	226.10 (191.61, 254.21)	90.79 (66.24, 108.33)	17.87 (11.83, 23.81)
Kandal	1452.60 (1243.68, 1623.92)	14.10 (8.61, 17.55)	14.29 (9.48, 20.41)	35.10 (22.63, 47.28)	80.96 (70.51, 92.86)	149.72 (123.16, 167.83)	162.79 (140.37, 177.41)	163.16 (148.91, 185.29)	188.10 (165.64, 207.85)	260.55 (238.95, 281.13)	247.22 (217.22, 264.94)	109.61 (80.04, 127.83)	27.02 (18.14, 33.55)
Phnom Penh	1389.87 (1180.65, 1555.09)	12.75 (7.57, 15.99)	14.74 (9.44, 20.42)	36.84 (23.83, 50.41)	83.61 (72.45, 93.21)	146.31 (118.73, 162.95)	151.04 (130.75, 165.42)	147.26 (134.62, 168.27)	172.52 (150.58, 191.86)	249.63 (228.63, 269.20)	242.85 (209.23, 259.80)	107.42 (78.15, 126.36)	24.92 (16.66, 31.20)
Takeo	**1533.12** (1328.68, 1730.18)	17.62 (11.92, 21.04)	18.11 (13.28, 25.97)	43.97 (29.23, 56.32)	89.21 (78.96, 107.06)	156.14 (135.18, 177.98)	170.16 (143.49, 185.67)	167.34 (151.90, 187.90)	185.22 (168.42, 210.18)	255.96 (236.98, 278.24)	264.56 (239.88, 283.51)	128.99 (95.47, 150.80)	35.87 (23.99, 45.52)
Prey Veng	1563.15 (1345.64, 1747.38)	14.32 (8.99, 18.59)	13.00 (8.47, 19.09)	34.14 (21.64, 46.43)	81.87 (70.00, 96.17)	160.76 (132.20, 180.62)	183.74 (160.17, 199.49)	192.48 (174.10, 215.22)	214.03 (188.80, 235.19)	278.24 (254.77, 298.06)	250.24 (223.48, 271.03)	111.00 (83.35, 130.82)	29.34 (19.68, 36.64)
Svay Rieng	1756.15 (1529.34, 1950.07)	15.39 (10.22, 20.80)	11.73 (7.55, 17.61)	30.56 (20.33, 41.54)	77.73 (65.26, 95.78)	175.51 (146.27, 197.78)	221.23 (195.66, 238.22)	240.23 (217.03, 265.13)	254.54 (228.08, 277.65)	307.62 (278.64, 324.20)	267.44 (242.91, 286.06)	119.41 (93.74, 141.71)	34.75 (23.65, 43.60)
Tboung Khmum	1736.33 (1489.19, 1963.31)	9.71 (6.66, 14.44)	13.96 (8.14, 19.73)	42.22 (27.20, 58.47)	96.69 (82.78, 114.08)	186.00 (147.08, 208.98)	217.87 (192.35, 243.43)	245.15 (216.72, 270.78)	260.13 (230.37, 284.48)	305.78 (282.08, 331.95)	239.66 (207.43, 269.18)	96.63 (73.64, 117.84)	22.53 (14.74, 29.94)
Preah Vihear	1712.81 (1411.08, 1944.50)	3.42 (1.62, 4.73)	15.05 (10.10, 19.62)	49.44 (37.35, 63.63)	105.47 (87.46, 121.87)	194.16 (149.84, 216.32)	227.91 (190.10, 260.19)	256.09 (228.85, 294.97)	277.46 (231.63, 308.36)	315.39 (275.46, 348.11)	**193.22** (149.00, 216.38)	69.49 (45.39, 80.15)	5.71 (4.27, 10.18)
Stung Treng	2112.32 (1773.19, 2399.98)	0.43 (0.18, 0.77)	8.52 (4.89, 11.86)	39.53 (28.21, 50.89)	108.56 (86.61, 123.23)	242.38 (185.94, 263.28)	315.70 (271.07, 361.68)	366.22 (329.36, 425.72)	375.10 (317.40, 419.31)	365.52 (322.80, 398.02)	205.48 (168.47, 237.15)	75.75 (52.02, 92.20)	9.13 (6.24, 15.86)
Ratanak Kiri	2191.63 (1851.66, 2486.34)	2.01 (0.76, 3.55)	5.14 (3.05, 7.70)	32.98 (23.37, 43.77)	108.08 (84.86, 122.00)	256.32 (198.12, 281.51)	334.50 (297.49, 379.01)	391.19 (345.61, 447.77)	387.89 (332.32, 438.42)	371.95 (330.12, 407.14)	212.03 (169.72, 243.15)	77.62 (58.07, 94.56)	11.91 (8.16, 17.77)

(*continues*)

TABLE 4. Projected Annual and Monthly Median Precipitation (mm) for 2020–2039 and 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0 (*Continued*)

2020–2039													
Province	**Annual**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mondul Kiri	1825.18 (1533.58, 2066.29)	5.75 (3.11, 8.90)	5.83 (2.79, 8.74)	38.55 (26.05, 54.03)	109.03 (87.92, 128.01)	219.58 (164.27, 242.41)	247.05 (216.59, 277.23)	278.34 (244.43, 309.96)	293.97 (253.69, 320.17)	316.19 (286.88, 349.11)	211.99 (177.67, 242.97)	80.92 (59.20, 99.60)	17.98 (10.98, 25.15)
Kratie	**1817.49** (1529.38, 2059.31)	3.68 (2.11, 5.85)	10.38 (5.52, 14.34)	41.36 (27.32, 56.26)	103.97 (85.45, 122.76)	203.37 (153.38, 225.89)	244.94 (211.39, 275.50)	280.91 (246.26, 315.22)	291.77 (254.82, 318.47)	320.19 (290.37, 351.20)	219.66 (182.58, 250.88)	84.21 (61.42, 102.82)	13.08 (8.77, 20.12)
2040–2059													
Province	**Annual**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Cambodia	1747.00 (1446.73, 2058.18)	10.57 (7.07, 14.64)	17.65 (13.09, 24.54)	49.04 (36.28, 76.43)	99.95 (76.37, 119.55)	186.39 (147.09, 215.52)	224.67 (182.83, 253.71)	249.64 (218.86, 294.02)	266.45 (231.80, 310.45)	310.40 (279.86, 347.19)	228.49 (176.73, 267.77)	86.80 (65.26, 105.21)	16.95 (11.47, 29.16)
Pailin	1651.00 (1379.56, 1912.75)	15.39 (11.65, 22.81)	34.89 (26.35, 45.77)	81.26 (62.42, 114.88)	116.36 (97.29, 141.09)	182.75 (144.95, 199.36)	196.07 (165.34, 215.49)	223.42 (191.33, 250.78)	233.42 (212.24, 262.37)	286.63 (250.49, 316.27)	209.38 (161.99, 254.82)	67.76 (53.55, 80.39)	3.66 (1.97, 8.73)
Battambang	1325.90 (1090.39, 1561.64)	10.99 (8.08, 16.82)	23.91 (18.09, 32.23)	60.28 (46.42, 88.69)	98.51 (81.46, 119.80)	145.30 (112.99, 160.56)	136.38 (112.15, 151.83)	143.63 (124.83, 165.21)	166.94 (149.19, 191.07)	245.92 (214.41, 273.27)	207.10 (157.14, 251.31)	78.82 (60.56, 94.12)	8.12 (5.07, 16.73)
Pursat	**1761.91** (1464.31, 2044.07)	18.14 (13.36, 25.07)	33.56 (25.60, 44.63)	79.22 (64.10, 112.35)	128.79 (101.05, 152.25)	190.81 (146.35, 213.67)	194.78 (161.51, 216.16)	212.64 (189.56, 239.95)	230.51 (209.91, 259.33)	294.33 (263.48, 326.00)	251.45 (193.47, 295.23)	103.93 (80.48, 120.69)	23.75 (15.44, 38.75)
Koh Kong	2794.54 (2359.81, 3180.93)	35.14 (24.25, 43.84)	57.00 (44.08, 71.80)	113.31 (92.63, 154.99)	165.90 (125.24, 195.38)	288.44 (218.23, 317.20)	376.66 (316.22, 413.85)	439.78 (394.01, 493.05)	436.09 (391.83, 480.81)	421.42 (384.84, 468.86)	313.91 (253.50, 363.79)	115.82 (94.67, 133.16)	31.06 (20.29, 44.20)
Kampong Speu	1467.88 (1219.01, 1709.01)	15.26 (9.78, 19.27)	20.42 (14.10, 27.10)	48.87 (38.02, 77.71)	93.45 (68.26, 114.20)	152.39 (118.76, 174.34)	161.96 (137.69, 182.69)	171.96 (153.50, 193.77)	191.62 (170.28, 213.47)	251.92 (226.89, 279.86)	234.41 (186.33, 271.65)	100.48 (79.43, 116.57)	25.14 (15.97, 38.37)
Preah Sihanouk	2796.63 (2337.91, 3249.72)	36.37 (23.51, 45.04)	44.25 (34.39, 55.82)	82.68 (60.83, 125.73)	141.18 (103.37, 172.75)	287.16 (211.53, 321.74)	385.44 (326.91, 444.91)	439.58 (383.54, 498.27)	**437.61** (382.38, 487.90)	427.28 (383.56, 485.19)	329.27 (278.94, 380.67)	141.14 (118.54, 164.99)	44.66 (30.43, 66.69)
Kampot	1800.98 (1498.95, 2119.25)	23.79 (14.93, 30.46)	27.42 (21.08, 37.90)	60.66 (42.52, 93.86)	107.80 (76.55, 136.26)	194.19 (147.17, 219.60)	217.80 (187.99, 259.24)	233.00 (202.18, 260.00)	235.40 (205.34, 262.15)	278.60 (249.67, 315.59)	259.40 (223.23, 299.23)	126.04 (102.41, 147.68)	36.88 (25.87, 57.28)
Kep	1820.41 (1521.45, 2145.10)	25.12 (15.89, 32.36)	26.41 (20.02, 35.94)	53.38 (37.42, 80.94)	103.97 (73.82, 131.08)	211.03 (156.78, 239.90)	241.54 (212.17, 289.27)	256.02 (217.75, 284.62)	244.13 (213.30, 275.54)	267.97 (239.91, 308.09)	238.54 (212.69, 274.34)	117.41 (96.13, 138.78)	34.88 (25.57, 54.23)

2040–2059													
Province	**Annual**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Banteay Meanchey	1241.24 (1028.69, 1484.05)	7.44 (5.57, 12.71)	16.30 (12.79, 21.43)	46.46 (33.76, 66.26)	85.68 (70.57, 102.99)	140.52 (109.50, 160.46)	135.08 (112.67, 154.84)	144.12 (125.65, 175.55)	174.15 (154.99, 212.18)	253.55 (223.18, 280.30)	183.50 (138.70, 227.04)	53.59 (40.97, 67.69)	0.85 (0.33, 2.61)
Otdar Meanchey	1258.65 (1044.42, 1537.51)	5.14 (3.61, 8.24)	12.74 (10.16, 16.78)	39.65 (27.30, 56.22)	75.93 (64.19, 90.31)	137.51 (105.75, 158.30)	153.29 (121.35, 176.73)	164.94 (147.81, 215.34)	198.41 (173.62, 242.98)	261.70 (236.42, 309.98)	164.18 (120.47, 203.85)	44.84 (33.62, 57.02)	0.33 (0.13, 1.76)
Siem Reap	1457.48 (1198.49, 1757.70)	8.21 (5.62, 12.86)	18.49 (14.40, 25.21)	52.14 (38.37, 79.81)	98.82 (81.66, 116.86)	163.99 (125.15, 185.96)	166.38 (130.97, 191.26)	170.04 (153.57, 213.57)	204.23 (180.62, 245.08)	287.81 (256.12, 334.71)	210.09 (155.24, 252.04)	72.03 (53.39, 88.11)	5.25 (3.38, 12.21)
Kampong Chhnang	1510.16 (1252.63, 1758.40)	10.98 (7.10, 14.78)	15.07 (10.32, 21.22)	37.81 (28.90, 64.56)	85.90 (64.84, 101.66)	155.77 (121.89, 180.31)	174.74 (144.24, 193.79)	190.28 (174.66, 219.14)	213.31 (191.58, 242.88)	272.97 (244.50, 304.15)	231.01 (175.83, 264.42)	97.90 (73.07, 111.77)	24.41 (15.71, 39.72)
Kampong Thom	**1641.79** (1345.74, 1962.72)	6.10 (4.11, 9.14)	14.45 (10.49, 21.60)	44.95 (32.49, 79.72)	**97.60** (73.54, 117.10)	172.38 (135.15, 198.02)	200.09 (157.40, 230.46)	219.97 (197.25, 269.50)	244.42 (213.58, 290.94)	309.34 (278.46, 348.43)	229.86 (170.97, 265.96)	88.81 (62.58, 103.96)	13.82 (9.72, 27.89)
Kampong Cham	1537.78 (1273.12, 1787.94)	9.55 (6.01, 13.14)	11.62 (7.41, 17.68)	34.88 (22.95, 63.98)	83.12 (60.15, 99.06)	155.39 (125.32, 181.44)	184.75 (149.24, 203.63)	201.53 (184.04, 232.32)	227.44 (203.53, 262.41)	289.67 (259.90, 315.26)	229.47 (174.78, 262.23)	91.58 (66.52, 103.55)	18.79 (13.26, 33.23)
Kandal	1439.95 (1201.48, 1671.49)	14.37 (9.11, 18.61)	12.65 (8.47, 20.73)	31.09 (20.42, 51.30)	72.66 (51.56, 94.96)	144.79 (117.06, 170.57)	162.41 (139.10, 185.85)	167.02 (150.64, 184.06)	190.34 (169.10, 209.84)	263.34 (236.09, 286.52)	244.21 (195.32, 279.61)	109.15 (85.04, 124.66)	27.92 (19.57, 44.79)
Phnom Penh	1375.12 (1140.62, 1600.30)	13.32 (8.04, 16.98)	13.11 (8.62, 20.65)	33.11 (22.02, 55.19)	74.57 (54.16, 96.07)	139.60 (112.55, 164.41)	151.26 (128.65, 171.64)	151.01 (137.21, 167.38)	174.77 (155.68, 192.81)	252.89 (226.31, 275.51)	239.19 (187.37, 276.34)	106.50 (82.86, 121.64)	25.78 (17.15, 41.68)
Takeo	1526.02 (1281.47, 1790.96)	17.47 (11.43, 23.52)	16.24 (11.90, 25.59)	38.20 (26.55, 60.66)	81.81 (55.88, 107.14)	158.50 (124.55, 185.24)	168.94 (149.50, 200.97)	171.91 (152.34, 190.10)	188.29 (164.68, 205.43)	257.38 (234.15, 286.78)	261.03 (221.19, 295.27)	128.93 (103.00, 151.52)	37.32 (26.29, 58.73)
Prey Veng	1554.82 (1301.70, 1789.24)	14.51 (9.63, 18.95)	11.21 (7.38, 19.55)	30.04 (18.61, 49.37)	73.32 (51.87, 97.53)	155.09 (127.17, 183.55)	183.81 (155.90, 203.51)	194.91 (175.31, 216.64)	218.77 (193.95, 239.82)	280.93 (252.91, 302.50)	249.86 (200.46, 281.98)	111.99 (85.84, 127.10)	30.38 (22.67, 48.74)
Svay Rieng	1747.36 (1480.77, 1989.10)	15.53 (11.09, 20.30)	10.03 (6.68, 18.80)	26.86 (16.78, 43.74)	68.69 (49.01, 96.08)	170.83 (138.18, 201.59)	222.57 (188.70, 240.74)	242.91 (216.45, 267.07)	258.77 (228.36, 280.17)	308.14 (279.14, 329.72)	266.60 (225.05, 294.36)	120.81 (93.73, 139.76)	35.62 (27.58, 56.76)
Tboung Khmum	1730.70 (1436.24, 1989.01)	9.95 (6.75, 13.87)	11.24 (6.74, 18.91)	36.76 (21.93, 62.97)	87.15 (61.55, 107.11)	176.16 (146.11, 207.66)	222.71 (180.97, 241.68)	247.02 (217.47, 276.87)	264.73 (237.14, 298.64)	311.60 (283.07, 333.18)	243.11 (186.49, 274.99)	97.18 (70.76, 113.12)	23.10 (17.25, 40.01)

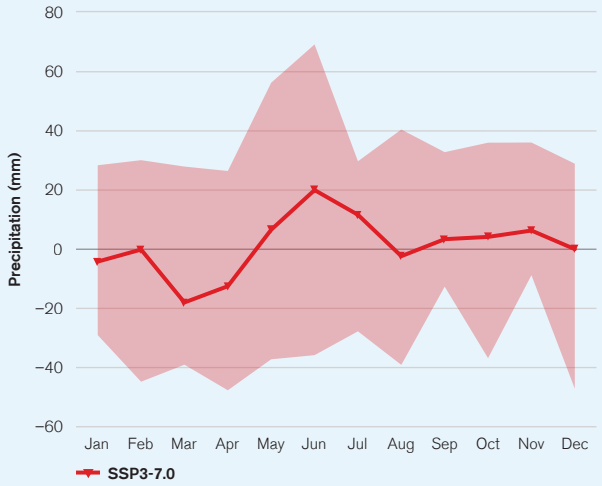
(*continues*)

TABLE 4. Projected Annual and Monthly Median Precipitation (mm) for 2020–2039 and 2040–2059 (Ref. Period 1995-2014) Under SSP3-7.0 (*Continued*)

2040–2059													
Province	**Annual**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Preah Vihear	**1665.08** (1373.87, 2013.59)	3.27 (1.75, 5.03)	12.47 (9.75, 17.97)	43.73 (31.51, 69.75)	95.15 (76.09, 109.98)	181.33 (141.49, 210.39)	226.09 (173.98, 265.88)	249.50 (218.96, 314.30)	273.29 (234.75, 323.19)	313.37 (286.71, 364.78)	194.26 (145.32, 232.38)	66.00 (49.35, 84.48)	6.63 (4.21, 15.46)
Stung Treng	2076.27 (1696.10, 2486.78)	0.44 (0.22, 0.93)	7.40 (4.87, 10.81)	33.30 (24.52, 57.22)	96.81 (75.16, 113.39)	221.63 (175.61, 263.43)	317.48 (245.26, 367.51)	365.62 (304.90, 440.78)	371.55 (306.53, 442.41)	369.22 (337.02, 417.90)	211.56 (164.37, 254.90)	70.78 (50.86, 96.71)	10.47 (6.77, 20.80)
Ratanak Kiri	2154.81 (1777.77, 2551.38)	2.06 (0.79, 3.97)	4.48 (3.19, 6.56)	29.43 (21.61, 47.23)	95.08 (72.75, 110.56)	**234.11** (192.63, 280.32)	333.37 (272.46, 372.55)	388.57 (328.20, 465.67)	387.50 (320.69, 462.13)	376.94 (336.87, 420.96)	217.35 (168.91, 259.83)	73.20 (51.54, 100.11)	12.71 (8.14, 21.48)
Mondul Kiri	1787.04 (1473.44, 2110.71)	5.99 (3.31, 9.30)	4.62 (2.93, 8.19)	34.52 (22.84, 58.20)	96.70 (68.16, 112.00)	199.43 (166.23, 240.85)	246.71 (203.11, 271.09)	276.57 (241.61, 324.78)	288.89 (245.19, 350.80)	318.42 (289.98, 349.20)	218.27 (163.85, 250.28)	77.95 (53.31, 102.68)	18.94 (12.93, 33.33)
Kratie	1787.49 (1470.48, 2119.45)	3.83 (2.37, 5.76)	8.21 (5.26, 13.49)	35.19 (23.17, 65.24)	92.26 (67.22, 109.68)	187.92 (153.35, 224.05)	244.81 (195.86, 274.15)	278.28 (241.20, 329.99)	289.01 (248.48, 351.31)	323.76 (295.46, 353.59)	226.15 (169.19, 261.06)	83.45 (58.73, 101.77)	14.63 (10.19, 29.35)

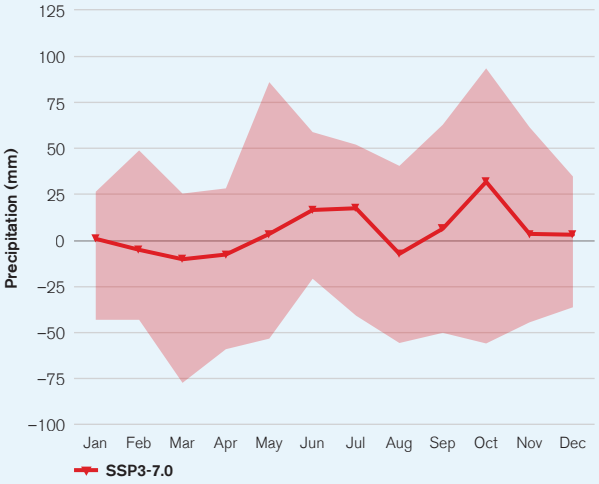
10th percentile and 90th percentile values are shown in parentheses. Medians bolded in black indicate the greatest changes from the historical reference period per region. Medians bolded in red indicate negative anomalies from the reference period. Medians shaded gray indicate minimal change from the reference period (anomalies <5 mm). Note the slight annual increases nationally for 2020–2039 with positive late-monsoon season increases, but annual decreases nationally for 2040–2059 peaking over the spring months. See text for interpretation.

FIGURE 6A. Kep's (Southwest Coast) Projected Average Largest 5-Day Cumulative Precipitation Anomaly for 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0



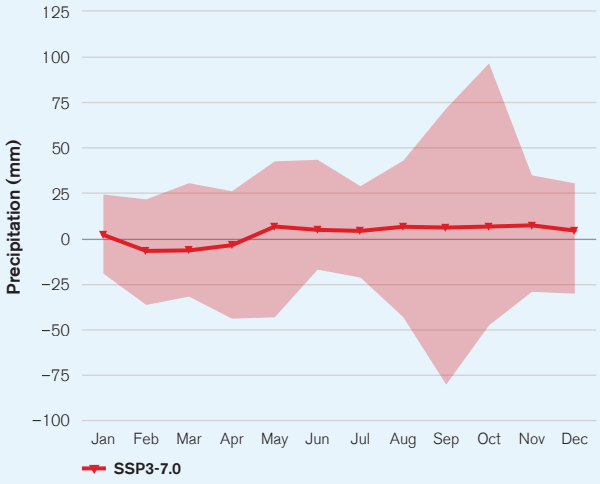
Note the anomalous monthly decrease in intensity <10 mm from March to April and anomalous monthly increase in intensity >10 mm from June to July.

FIGURE 6B. Koh Kong's (Southwest Coast and Highlands) Projected Average Largest 5-Day Cumulative Precipitation Anomaly for 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0



Note the anomalous monthly decrease in intensity <10 mm in March, increase in intensity >10 mm from June to July, and even larger increase >30 mm in October. Also note wider y-axis range compared to Kep.

FIGURE 6C. Pailin's (Northwest Highlands) Projected Average Largest 5-Day Cumulative Precipitation Anomaly for 2040–2059 (Ref. Period 1995–2014) Under SSP3-7.0

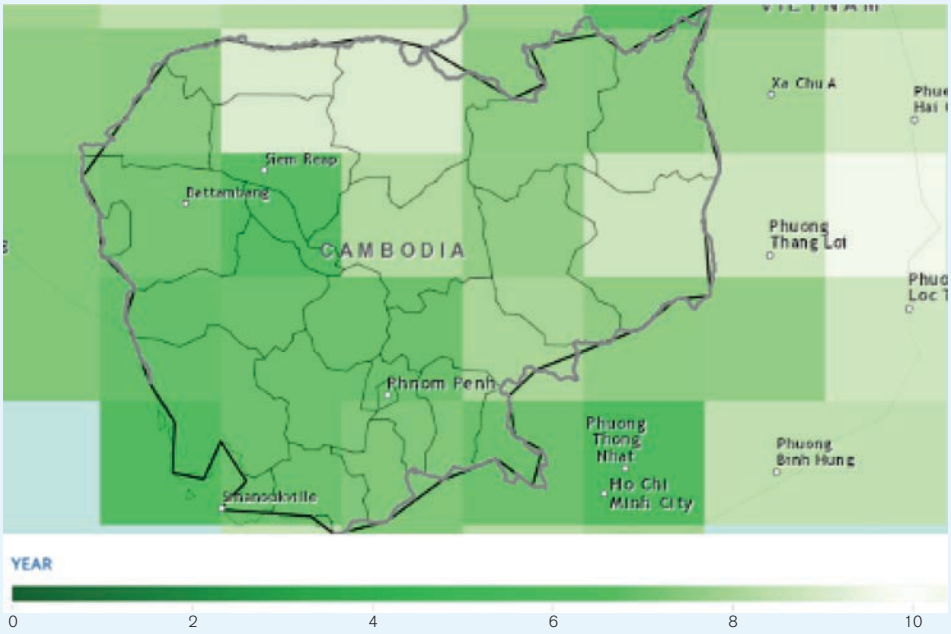


Note minimal seasonal anomalies but large amount of uncertainty during fall months. The y-axis range is the same as Koh Kong's.

Extreme Precipitation Events

By midcentury, Cambodia is likely to more frequently experience extreme precipitation event occurrence. For the projected period of 2035–2064, the largest 5-day precipitation amounts associated with 100-year historical return periods will be nearly two times more likely to occur in the western highland provinces (**see Figure 7b**). The greatest change in future return periods is projected for Pursat (48.90 years) followed by Koh Kong (51.51 years), while the least change is projected for Kep in the south (76.12 years). However, the rate of change is lower for 25-year and 10-year events nationwide. The projected future return periods for 10-year events shift for the same regions (6.67 years for Koh Kong), with the future return periods for Kep changing the least (8.56 years) by midcentury (**see Figure 7a**). SSP1-2.6 forecasts roughly similar frequencies across return periods for the same time period, however SSP2-4.5 forecasts much higher frequencies. These include 100-year return periods more than two times likelier across provinces in the central plains and 50-year return periods roughly two times likelier in the southern plains. More frequently occurring extreme precipitation events underscore future health risks related to flood impacts, agricultural yields, disease ranges, and critical infrastructure, including for water, sanitation, and hygiene.

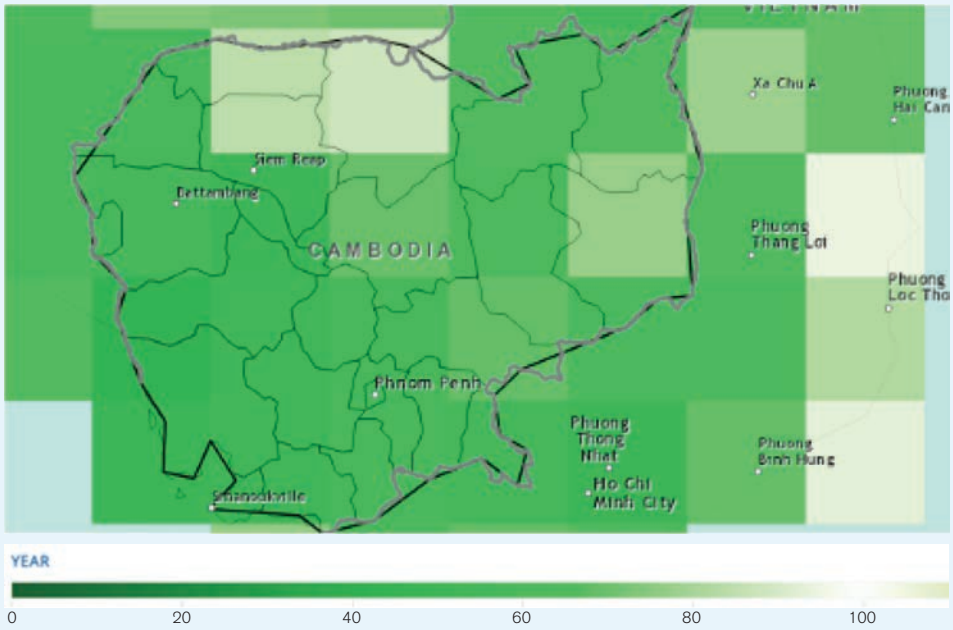
FIGURE 7A. Future Return Period of Largest 5-Day Precipitation, 10-Year Event Under SSP3-7.0 (2035–2064, Center 2050)



Note the greatest change in future return periods projected for the western highlands.[17]

[17] For extreme event projections at this resolution, data for the province of Tboung Khmum is combined with data for the province of Kampong Cham.

FIGURE 7B. Future Return Period of Largest 5-Day Precipitation, 100-Year Event Under SSP3-7.0 (2035–2064, Center 2050)



Note the greatest change in future return periods for the same provinces.

CLIMATE-RELATED NATURAL HAZARDS

Cambodia has among the highest physical exposure to river floods in the world and faces a series of other climate-related hazards such as drought, extreme heat, wildfire, and sea level rise.[18] Between 1987 and 2007, 12 major flood events and a roughly similar number of droughts caused widespread impacts across Cambodia's provinces and will likely become more common in the future, depending in part on the presence of ENSO.[19] Flooding by midcentury could produce between US$3.3–$10.6 billion in damage without future flood risk planning and increases the risks of other hazards such as landslides.[20] Provinces with the most productive agricultural activities also face the greatest future climate hazard risks from droughts, which affected millions over the last several decades and continue to pose challenges for water resource management. Extreme heat, wildfires, and sea level rise additionally threaten biodiversity and human health. Past and future impacts associated with each of Cambodia's notable hazards are discussed below.

[18] European Commission (2023). INFORM Index for Risk Management. Cambodia Country Profile. URL: https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

[19] Ministry of Environment (2022). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/20220921_Third%20National%20Communication_Cambodia.pdf

[20] World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf

Sea Level Rise and Sea Surface Temperature

Cambodia's observed sea surface temperatures have increased over the last few decades. Mean annual sea surface temperature in the Gulf of Thailand is 28.5°C, peaking in April before the onset of the wet monsoon. However, from November to January, a warm pool in the northeast gulf with temperatures 0.5°C–0.8°C warmer than the surrounding water forms, tied to the effect of the Cardamom Mountains shielding the coast from northeasterly winter monsoon winds.[21] Sea surface temperatures between 1981 and 2011 in the Gulf of Thailand rose by 0.003–0.089°C per year, which poses risks for more extensive coral bleaching events in the future.[22] Interannual patterns of sea surface temperature off of Cambodia fluctuate according to ENSO.

Sea level rise and coastal inundation will increasingly threaten Cambodia's 17,237 km² of coastal zone. Sea level rise across Cambodia's four coastal provinces (grid 10°N, 103°E) is projected to increase 0.21 m (0.07 m, 0.36 m) by 2050 and 0.69 m (0.36 m, 1.07 m) by 2100 under SSP3-7.0 with a historical baseline of 1995–2014.[23] Permanent coastal inundation from one meter of sea level rise, the approximate upper probable threshold by the end of the century, would affect roughly 25,000 hectares of land with the greatest proportion of threatened area located in Koh Kong.[24] Sea level rise would result in a loss of mangrove forests and marine ecosystems across coastal provinces, salinization of agricultural land and seawater intrusion particularly in Kampot and Kep, and deleterious impacts to critical infrastructure and coastal tourism activities in Preah Sihanouk and Kampot.[25]

Sea level rise along Cambodia's coast exhibit discernible differences under different scenarios depending on the rate of local land subsidence.[26] Under SSP3-7.0, sea level rise is projected to increase 0.50 meters above the historical baseline near Preah Sihanouk after 2080 (**see Figure 8**). However, this rate of change is slower under SSP2-4.5 and SSP1-2.6, as sea level rise does not reach this threshold until around 2090 under the former scenario and after 2100 for the latter, both with high uncertainty. Compared to SSP3-7.0 which rises 0.69 m (0.36 m, 1.07 m) by 2100, SSP2-4.5 rises 0.57 m (0.25 m, 0.94 m) while SSP1-2.6 rises 0.45 m (0.13 m, 0.80 m) over the same timeframe. Much of the uncertainty in local sea level projections comes from potential land subsidence or vertical land motion, with a median of –0.03 m attributed to land motion across all scenarios by 2100, but a wide probability range (–0.25 m, 0.20 m).

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[21] Li, J., Zhang, R., Ling, Z., Bo, W., and Liu, Y. (2014). Effects of Cardamom Mountains on the formation of the winter warm pool in the Gulf of Thailand. Continental Shelf Research, 91, 211–219. DOI: https://doi.org/10.1016/j.csr.2014.10.001

[22] Koad, P., Jaroensutasinee, M., and Jaroensutasinee, K. (2012). Sea surface temperature trends in the Gulf of Thailand and the Andaman Sea. 2012 Oceans-Yeosu (1-8). Institute of Electrical and Electronics Engineers. DOI: https://doi.org/10.1109/OCEANS-Yeosu.2012.6263509

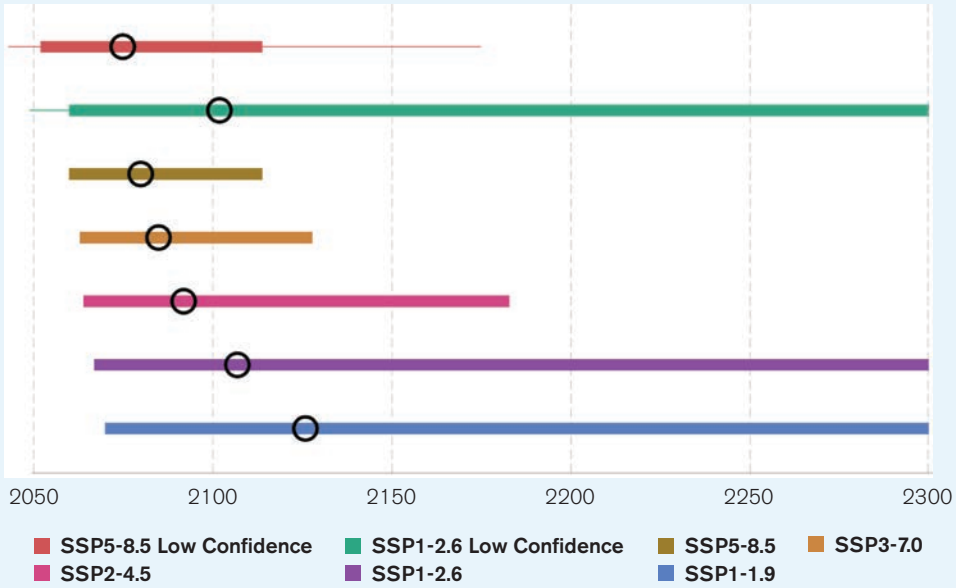
[23] NASA (2023). Sea Level Projection Tool. URL: https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool; note the figures inside parentheses represent 17th and 83rd percentiles, respectively.

[24] Ministry of Environment (2015). Second National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/khmnc2.pdf

[25] Ministry of Environment (2022). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/20220921_Third%20National%20Communication_Cambodia.pdf

[26] NASA (2023). Sea Level Projection Tool. URL: https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool

FIGURE 8. Projected Timing of 0.5-Meter Sea Level Rise Along Cambodia's Coast Under Various Scenarios (Ref. Period 1995–2014)[27]



Thick bars show 17th–83rd percentile ranges, and black circles show median value. Thin bars also show 5th–95th percentile ranges for SSP1-2.6 Low Confidence and SSP5-8.5 Low Confidence scenarios. Data reflects grid at 10°N, 103°E.

Flood and Drought Risk

Incidents of both flooding and drought in Cambodia will likely occur with greater intensity and frequency in the future, influenced by ENSO. Flooding in Cambodia is the most recurrent hazard, with major flood events transpiring every five years on average, and the frequency of major floods over the last few decades has increased.[28] This includes urban flooding in areas such as Phnom Penh, riparian flooding along the Mekong River Valley and Tonle Sap floodplains (where more than three-quarters of the population live), as well as flash flooding during the wet monsoon season and tropical cyclone events. The national government notes that extreme flooding with widespread impacts occurred during the following monsoon seasons: 2000, which affected roughly 3.5 million people and killed nearly 350; 2001 and 2002, which affected more than 3 million people and killed nearly 100 total; and 2011 and 2013, which affected more than 2 million people, killed more than 400 total, and resulted in US$451 million and US$356 million in estimated damages, respectively.[29]

[27] NASA (2023). Sea Level Projection Tool. URL: https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool
[28] World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf
[29] Ministry of Environment (2022). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/20220921_Third%20National%20Communication_Cambodia.pdf

Tropical cyclones with the potential to cause flooding and wind damage affect Cambodia an average of six times a year between April and November.[30] Tropical cyclone activity affecting the Mekong River Basin decreased between 1981–2005, as indicated by reduced sediment loads.[31] However, the frequency and intensity of most extreme tropical cyclones may become more frequent in the future. As an example, the country felt particularly widespread impacts from Typhoon Ketsana in 2009, which killed several dozen and left damages estimated at US$132 million.[32] Elevated risks from tropical cyclone hazards (a 20% probability of potentially damaging winds in the next 10 years) apply to nearly all of Cambodia's provinces according to the World Bank's Global Facility for Disaster Risk Reduction (GFDRR).[33] Prolonged heavy rainfall, including from tropical cyclones, also increases the likelihood of landslide risks, which concern human safety and critical infrastructure especially in populated areas of the western provinces (Koh Kong, Pursat, Battambang, and Kampong Chhnang).[34] These areas possess porous soil, relatively steep slopes, and land use cover subject to heavy precipitation.

The population exposed to flooding across the country by midcentury, according to one World Bank study, could increase by nearly 20%.[35] However, it is important to note that future flood projections display a range of uncertainty due to upstream hydropower developments along the Mekong River and its tributaries. More frequent flooding in these basins would lead to more food and water insecurity, interruption to critical infrastructure, transmission of waterborne diseases, habitat loss, and the potential for human displacement. As **Figure 9a** indicates, Cambodia's Lower Mekong River Valley (including Kratie, Tboung Khmum, Kampong Cham, Prey Veng, and Svay Rieng) and Tonle Sap Basin (encompassing provinces in the central plains plus eastern portions of Battambang and Pursat) experience the greatest exposure to flood hazards and subsequent agricultural losses that also intersect with low-income households. Currently, agricultural losses are estimated at $100–170 million per year.[36] During La Niña years, these risks increase because as much as one-fifth of total cultivated rice plots encounter extended periods of flooding.[37]

[30] World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf

[31] Darby, S.E., Hackney, C.R., Leyland, J., Kummu, M., Lauri, H., Parsons, D.R., Best, J.L., Nicholas, A.P. and Aalto, R. (2016). Fluvial sediment supply to a mega-delta reduced by shifting tropical-cyclone activity. Nature, 539(7628), 276–279. DOI: https://doi.org/10.1038/nature19809

[32] Ministry of Environment (2022). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/20220921_Third%20National%20Communication_Cambodia.pdf

[33] Global Facility for Disaster Risk Reduction (2020). Cambodia. URL: https://thinkhazard.org/en/report/44-cambodia/

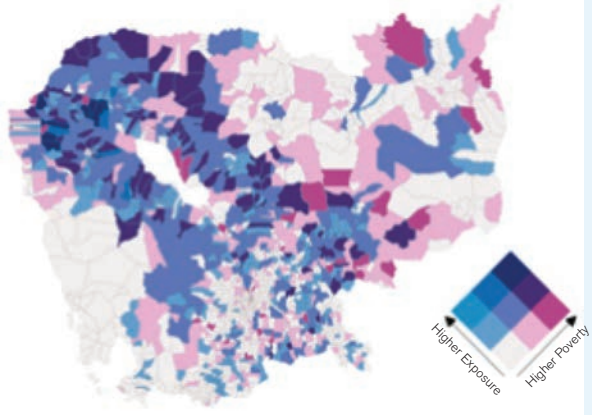
[34] World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf

[35] Winsemius, H. C., Jongman, B., Veldkamp, T. I. E., Hallegatte, S., Bangalore, M., and Ward, P. J. (2015). Disaster risk, climate change, and poverty: assessing the global exposure of poor people to floods and droughts. Policy Research Working Paper WPS 7480. World Bank Group. URL: http://documents.worldbank.org/curated/en/965831468189531165/pdf/WPS7480.pdf

[36] USAID (2019). Climate Risk Profile: Cambodia. URL: https://www.climatelinks.org/sites/default/files/asset/document/2019_USAID_Cambodia%20CRP.pdf

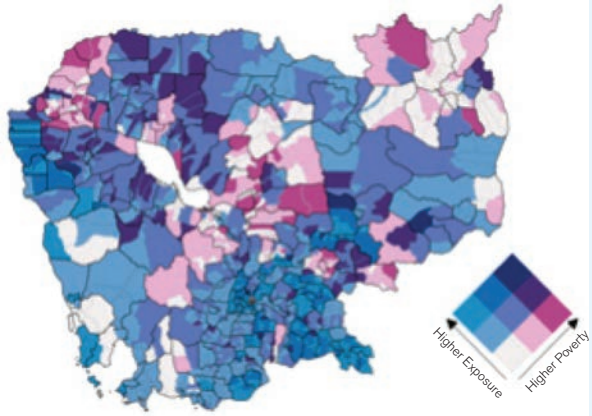
[37] Ministry of Environment (2015). Second National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/khmnc2.pdf

FIGURE 9A. Exposure of Poor Households to Agricultural Losses from Floods[38]



Note the highest exposure in the southern provinces of the Mekong River Valley and Tonle Sap Basin in the northwest.

FIGURE 9B. Exposure of Poor Households to Agricultural Losses from Droughts



Note the high exposure throughout much of the country, including Phnom Penh.

As **Figure 9b** illustrates, nearly the entire country faces high exposure to agricultural losses due to drought. Cambodia's annual median probability of severe meteorological drought is around 4% according to the standardized precipitation evaporation index (SPEI), with provinces in the southern plains (e.g., Phnom Penh, Svay Rieng, and Prey Veng) severely affected every five or six years.[39] Most severe droughts have widespread extents – droughts during the years 1995, 1996, and 2002 affected approximately 2.5 million people, droughts during 2004 and 2005 impacted 30% of the country's agricultural land and resulted in a 14% drop in rice yields, and a drought in 2015–2016 affected another 2.5 million people across 18 provinces.[40] Because only 20% of Cambodia's rice fields feature irrigation, poorer farmers depending on rainfed cropping systems are particularly vulnerable to more frequent and intense precipitation decreases or longer dry seasons.[41] This is what **Figure 10** underscores, providing insight into the projected number of consecutive dry days nationally by midcentury (i.e., greater increases during winter months in the northwest), as well as according to different climate scenarios relative to the geographic distribution of hydropower sources by end-of-century. El Niño events correlated with drought episodes further magnify cumulative impacts. These include, for example in 2016, lower water levels in Tonle Sap, reduced agricultural yields, and 640,000 hectares of forest affected by wildfires, which are only expected to continue increasing in frequency and intensity across the eastern plains.[42] Since drier dry seasons decrease freshwater fish stocks in Tonle Sap and may make it more difficult for

[38] World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf

[39] World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf

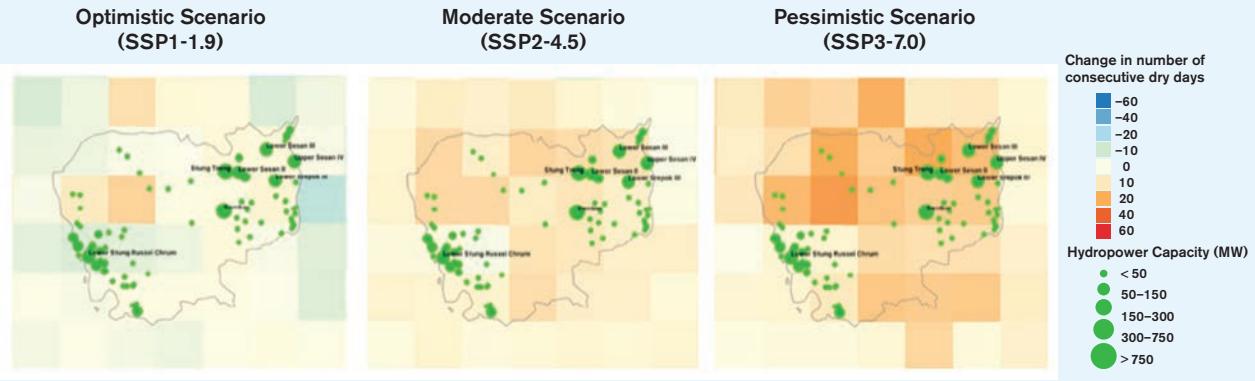
[40] Ministry of Environment (2022). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/20220921_Third%20National%20Communication_Cambodia.pdf; World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf

[41] USAID (2019). Climate Risk Profile: Cambodia. URL: https://www.climatelinks.org/sites/default/files/asset/document/2019_USAID_Cambodia%20CRP.pdf

[42] Frappart, F., Biancamaria, S., Normandin, C., Blarel, F., Bourrel, L., Aumont, M., Azemar, P., Vu, P.L., Le Toan, T., Lubac, B. and Darrozes, J. (2018). Influence of recent climatic events on the surface water storage of the Tonle Sap Lake. Science of the Total Environment, 636, 1520–1533. URL: https://hal.science/hal-02272424; Chhinh, N., and Millington, A. (2015). Drought monitoring for rice production in Cambodia. Climate, 3(4), 792–811. DOI: https://doi.org/10.3390/cli3040792; USAID (2019). Climate Risk Profile: Cambodia. URL: https://www.climatelinks.org/sites/default/files/asset/document/2019_USAID_Cambodia%20CRP.pdf

such fisheries to adapt – despite the projected benefits of wetter wet seasons – adaptation measures will be essential for maintaining the region's food security and economic livelihoods.[43]

FIGURE 10. Hydropower Capacity Exposed to Change in Number of Consecutive Dry Days by 2100 (Ref. Period 1995–2014)[44]



Note greatest increase in number of consecutive dry days in the northern provinces under SSP3-7.0, which would reduce hydropower capacity everywhere except for the southwest.

KEY NATIONAL DOCUMENTS

- Country Climate and Development Report (CCDR) (2023)
- Third National Communication to the UNFCCC (NC3) (2022)
- Long-Term Strategy for Carbon Neutrality (LTS4CN) (2021)
- Updated Nationally Determined Contribution (NDC) (2020)
- First Biennial Update Report (BUR1) (2020)
- National Adaptation Plan Communication Process (2018)
- Intended Nationally Determined Contribution (INDC) (2017)
- National Adaptation Plan Process in Cambodia (2017)
- Second National Communication to the UNFCCC (NC2) (2015)
- Technology Needs Assessment and Technology Action Plans for Climate Change Adaptation (2013)
- Climate Change Strategic Plan 2014–2023 (CCCSP) (2013)
- Strategic National Action Plan for Disaster Risk Reduction (2008)
- National Adaptation Programme of Action (NAPA) (2006)
- Initial National Communication to the UNFCCC (2002)

[43] USAID (2019). Climate Risk Profile: Cambodia. URL: https://www.climatelinks.org/sites/default/files/asset/document/2019_USAID_Cambodia%20CRP.pdf

[44] World Bank (2023). Cambodia Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099092823045083987/pdf/P17887106c6c2d0e909aa1090f3e10505c1.pdf

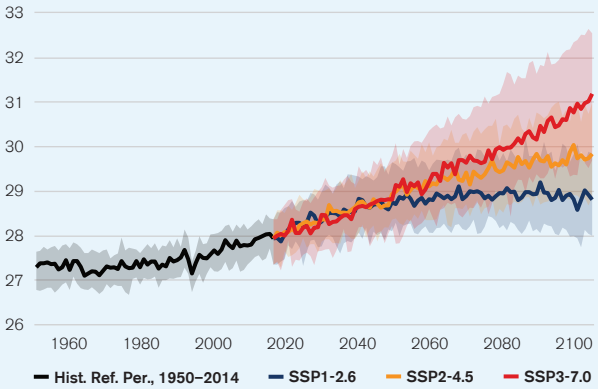
Compared to SSP3-7.0, which results in the greatest temperature and precipitation shifts nationally across all key metrics by the end of the century (see Table 5), SSP1-2.6 and SSP2-4.5 demonstrate Cambodia's different rates of change and severity of climate impacts as a result of carbon emission reductions. The differences between projected temperatures under the three scenarios are particularly pronounced (**see Figure 11a**). SSP1-2.6 has the lowest annual mean temperature increase – an anomaly above 1°C by 2080–2099. Mean temperature rises by an anomaly of approximately 2°C by end-of-century under SSP2-4.5 and greater than 2.5°C by end-of-century under SSP3-7.0. The number of tropical nights (T-min >26°C) experienced nationally by the end of the century under SSP1-2.6 (an increase of more than two

TABLE 5. Key National-Level Projected Anomalies Through End-of-Century (Ref. Period 1995–2014) Under SSP1-2.6, SSP2-4.5, and SSP3-7.0 Scenarios

	SSP1-2.6 Projection		
Metric	**2020–2039**	**2040–2059**	**2080–2099**
Annual Mean Temperature	0.68°C (0.29°C, 1.14°C)	0.98°C (0.50°C, 1.57°C)	1.16°C (0.46°C, 1.99°C)
Tropical Nights (No. Nights T-min >26°C) Annually	42.94 (15.65, 73.05)	63.02 (28.36, 110.38)	70.67 (27.41, 135.13)
Annual Precipitation (mm)	25.64 (–65.62, 138.03)	39.84 (–58.15, 192.66)	**66.75** (–33.80, 173.42)
Average Largest 5-Day Cumulative Precipitation (mm) Annually	10.42 (–43.78, 57.55)	12.01 (–39.22, 69.76)	15.78 (–32.93, 60.91)
	SSP2-4.5 Projection		
Metric	**2020–2039**	**2040–2059**	**2080–2099**
Annual Mean Temperature	0.67°C (0.35°C, 1.10°C)	1.19°C (0.71°C, 1.73°C)	**2.00°C** (1.10°C, 2.74°C)
Tropical Nights (No. Nights T-min >26°C) Annually	44.30 (20.56, 72.47)	82.81 (46.28, 126.95)	**142.66** (83.80, 193.10)
Annual Precipitation (mm)	31.60 (–78.60, 103.11)	49.95 (–44.88, 149.48)	47.41 (–88.05, 279.91)
Average Largest 5-Day Cumulative Precipitation (mm) Annually	9.77 (–41.74, 60.01)	16.19 (–32.65, 60.97)	14.69 (–37.85, 60.50)
	SSP3-7.0 Projection		
Metric	**2020–2039**	**2040–2059**	**2080–2099**
Annual Mean Temperature	0.57°C (0.31°C, 1.09°C)	1.24°C (0.70°C, 1.95°C)	**2.84°C** (1.80°C, 4.06°C)
Tropical Nights (No. Nights T-min >26°C) Annually	38.30 (18.18, 77.45)	87.32 (50.15, 146.27)	**191.06** (142.03, 246.61)
Annual Precipitation (mm)	14.48 (–106.38, 128.27)	**–11.27** (–158.81, 192.51)	**–16.84** (–214.51, 336.63)
Average Largest 5-Day Cumulative Precipitation (mm) Annually	12.96 (–55.15, 77.27)	8.91 (–62.44, 72.27)	**28.68** (–49.28, 90.02)

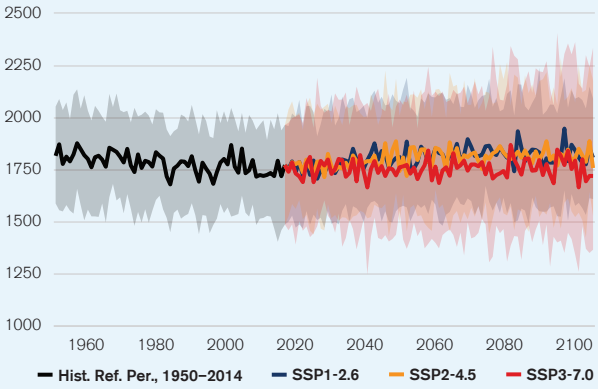
10th percentile and 90th percentile values are shown in parentheses. Key values or shifts over time are shaded orange and bolded. See text for interpretation.

FIGURE 11A. Projected Average Mean Temperature in Degrees Celsius Nationwide (Ref. Period 1995–2014) Under Various Scenarios



Shaded areas indicate ranges of 10th–90th percentiles. Note clearly higher increase of SSP3-7.0 starting midcentury.

FIGURE 11B. Projected Precipitation in Millimeters Nationwide (Ref. Period 1995–2014) Under Various Scenarios



Shaded areas indicate ranges of 10th–90th percentiles. Note the greatest uncertainty and precipitation decrease compared to the historical period by the end of the century under SSP3-7.0, but precipitation increases over the same time period under SSP1-2.6 and SSP2-4.5. Probability ranges for all scenarios extend above and below the historical reference period, indicating a potential likelihood for precipitation decreases or increases.

months above the reference period annually) contrasts those of the other two scenarios. SSP2-4.5 projects an increase in number of tropical nights of nearly five months above the historical reference annually by the end of the century, while SSP3-7.0 projects the greatest increase of more than six months annually for this metric over the same time period. Most of the change in tropical nights is concentrated in the central plains by the end of the century. The anomalous annual number of high Heat Index days above the reference period for 2080–2099 likewise increases the most under SSP3-7.0 nationally by more than six months. Whereas by the end of the century, high Heat Index days increase roughly five months under SSP2-4.5 and roughly three months under SSP1-2.6.

The projected precipitation patterns countrywide under the three scenarios produce noticeable variation by the end of the century (**see Figure 11b**). Whereas the annual precipitation forecasted by SSP1-2.6 rises steadily across the century, precipitation under SSP2-4.5 increases but stagnates between midcentury and the end of the century. On the other hand, annual precipitation under SSP3-7.0 decreases from midcentury to the end of the century by an anomaly of –16.84 mm (–214.51 mm, 336.63 mm) from the reference period. SSP3-7.0 also displays the largest range of uncertainty (>500 m) though the other two scenarios still project the potential for experiencing negative anomalies by the end of the century. Precipitation intensity, as measured by the average largest 5-day cumulative precipitation annually, increases the most from the reference period by the end of the century (>20 mm) under SSP3-7.0. Northern provinces tend to experience the greatest increases in intensity under all scenarios by the end of the century.

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