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Overview

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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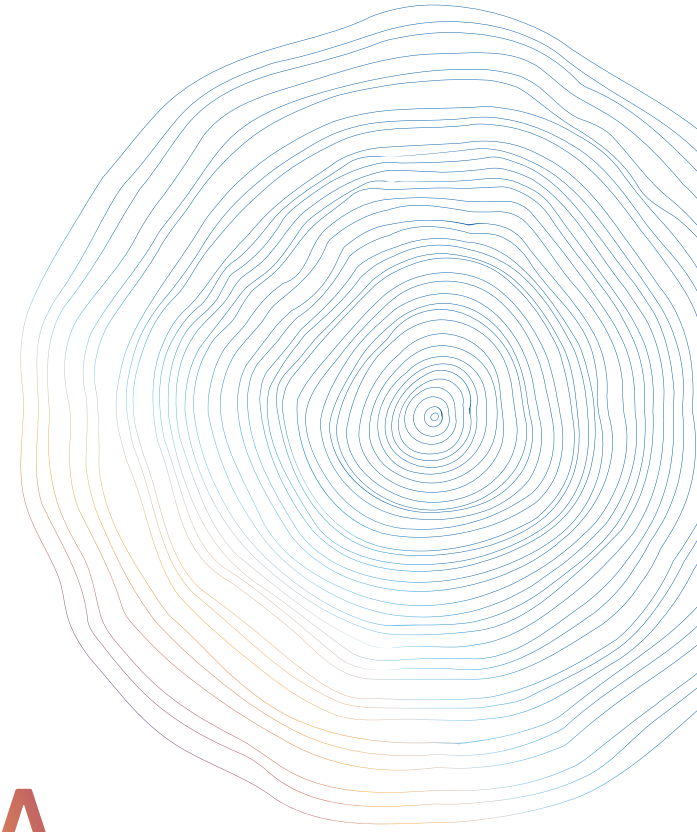

CAMBODIA

COUNTRY CLIMATE AND DEVELOPMENT REPORT

Overview

Acknowledgments

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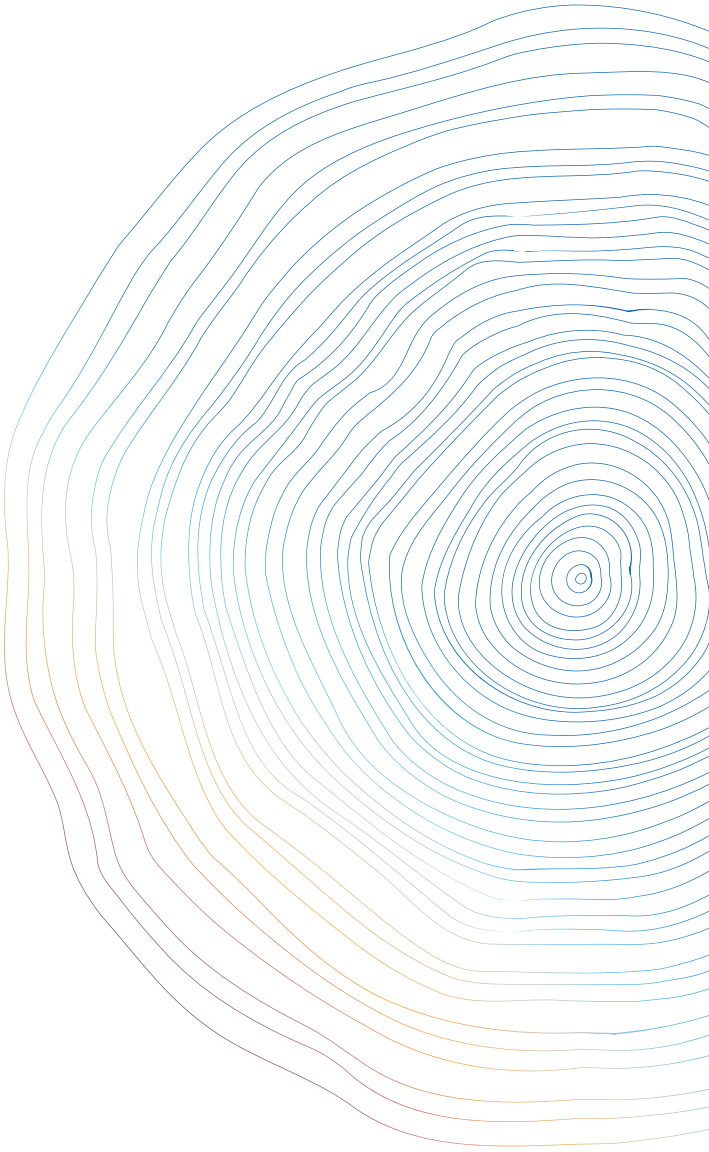


OVERVIEW

The Cambodia CCDR provides analysis and recommendations on how Cambodia can achieve sustained development while responding to climate change and the global low-carbon transition. Cambodia has an ambitious development vision to transform the economy and reach upper-middle income status by 2030 and high-income status by 2050. Climate change will have profound implications for achieving this vision, both directly and indirectly. First, climate change poses physical risks from rising temperatures and increased severity and frequency of natural disasters. As such, Cambodia faces the urgent need to *reduce* its exposure and vulnerability to growing climate change impacts by building resilience and supporting climate adaptation. Second, although Cambodia has historically been a low emitter, the country has made ambitious climate pledges in its Nationally Determined Contributions (NDC) and in its Long-term Strategy for Carbon Neutrality (LTS4CN). To meet these commitments in ways that benefit development, Cambodia has to *realign* its emissions trajectory through a targeted policy response. Third, as a highly globally integrated economy, the response to climate change globally will have ripple effects on Cambodia's trade, investment, financing, and technology costs. Cambodia will need to *reorient* its economy to seize opportunities from trade, investment, and technological progress, and avoid any transition risks. Through these three *Rs*—*reduce*, *realign*, and *reorient*—Cambodia can achieve its ambitious development vision, compatible with climate change risks and decarbonization, both globally and at home.

Five key findings

1 Climate change will have ripple effects throughout the Cambodian economy that could amplify existing development challenges if unaddressed

Building on its past track record of rapid development progress, Cambodia has an ambitious development vision but achieving this vision will require tackling existing constraints to growth and responding to new challenges. Between 1995 and 2021, Cambodia achieved average real gross domestic product (GDP) growth of 7.1 percent. This growth was accompanied by a large reduction in poverty, with the headcount ratio falling over 50 percentage points between 2009 and 2019. Despite its success, Cambodia must overcome several structural constraints to achieve continued rapid and transformative growth. The country's economy remains highly concentrated in terms of exports, markets, sectors, and financing sources, making it highly vulnerable to external shocks. The economy has relied heavily on labor-intensive but low-value-added garments and footwear manufacturing and increasingly relies on real estate and construction investments as the primary drivers of growth. In addition, the contribution of total factor productivity to growth has decreased over the past decade. Achieving sustained growth and development will require diversifying the export base, improving the enabling environment for the private sector, addressing low education and health outcomes, and improving critical infrastructure.

Climate change could exacerbate Cambodia's development challenges, as the country faces one of the world's highest levels of exposure to floods and extreme heat. Cambodia has been ranked as the world's fourth most flood-exposed country by the Inform Risk Index, with 80 percent of the country's population located in the Mekong or Tonle Sap basins. Cambodia also experiences some of the highest temperatures in the world, averaging an estimated 64 days per year when the maximum temperature exceeds 35 °C, placing it in the top 23 countries with acute exposure to extreme heat. Climate projections suggest that the increased intensity of precipitation events could significantly increase future flood risk and that heat

stress in Cambodia. The Cambodia Climate Country Risk Profile (2021) projects that, under a range of climate change scenarios, the average daily temperatures in Cambodia could rise by 0.9–1.7 percent by 2040–2059 compared with the 1986–2005 baseline.

Exposure to climate risks varies geographically across Cambodia with some of the poorest regions and communities being most vulnerable. Disaggregated spatial analysis of current climate hazards for this CCDR shows that areas along the Mekong, Tonle Sap River valley, and northwest Cambodia already have a high share of poor households exposed to compound risks from flooding, droughts, and heatwaves. The adverse impact of flooding on agriculture in poor communities is highest in the northwestern parts of the country. High poverty rates in the northern and western Cambodian provinces also coincide with significant population exposure to heat waves. Recurring drought events affect the central regions around the Mekong River and Tonle Sap. Women and people with disabilities are the most vulnerable to climate change impacts, especially those living in northeastern and southwestern rural areas. These findings highlight the importance of a spatially and socioeconomically targeted response when developing interventions to assist people living in these climate hotspots.

Without efforts to adapt, future changes in the climate could have ripple effects throughout the Cambodian economy that would affect people's lives and livelihoods in multiple ways. This CCDR quantifies some of the key impacts of climate change on Cambodia, highlighted in Table 1, although there are many other effects not included here due to data constraints and challenges in quantifying them.

Table 1. CCDR estimates of select climate change impacts

Floods are projected to increase losses to physical and economic assets. Climate change is projected to increase the frequency of high-impact floods, resulting in higher losses to physical infrastructure and assets. Average annual asset losses to factories, roads, housing, schools, and health centers from floods are projected to increase from US$0.5 billion in 2020 to US$3.3 billion in 2050 under a low climate change scenario or US$10.6 billion in 2050 under a worst-case high climate change scenario.

Floods cause disruptions to critical services and supply chains. In 2020, a 1-in-50 year flood is estimated to have reduced the percentage of people with access to a referral hospital within 60 minutes of travel time by up to 47 percent and the percentage of people with access to a high school within 30 minutes of travel time by up to 21 percent. These disruptions to education and health facilities could have cumulative and compound effects on human capital accumulation. Furthermore, a 7-day closure of key road corridors due to a 50-year flood could result in a 5 percent indirect cost increase for international trade partners.

Climate change is projected to lower yields for rice, maize, and cassava, as well as fisheries, with implications for food security. Climate change could lower average yields by 21 percent for rainfed rice under a low climate change scenario by 2030–

60 and up to 30 percent in a high climate change scenario. Dry season rice in Cambodia could also experience yield losses of 2-3 percent under the moderate climate change scenario and yields for rainfed maize could fall by 6–9 percent and rainfed cassava by 5–11 percent under the same scenario. Climate change is also projected to negatively affect livestock production and fisheries, posing challenges for food security and nutrition given that they account for about 80 percent of animal protein in household diets.

Climate change is projected to dampen tourism revenues. By 2050, tourism revenues could decline by around 8 percent in a low climate change scenario and up to 17 percent in a high scenario, relative to the baseline. Between 2041 and 2050, these impacts range from 4–11 percent for domestic and 12–33 percent for international tourism.

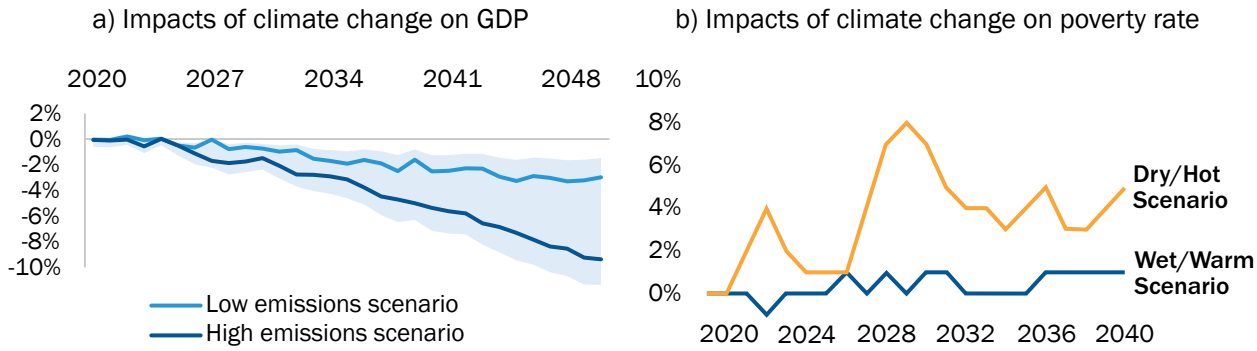
Climate change is projected to lower labor productivity. By 2050, climate change could lower labor productivity by 8 percent under a low climate change scenario or up to 20 percent under a high scenario.

Higher temperatures and more extreme rainfall adversely impact health, lowering labor supply. A shift in average daily rainfall from 5 to 20 millimeters increases diarrhea incidence by 56 percent, while a monthly temperature of 35°C instead of 28°C increases diarrhea incidence by 83 percent. Climate change is projected to increase the prevalence of some diseases and the spread of malaria, dengue, and Japanese encephalitis. Through adverse health impacts, by 2050, climate change is projected to lower the number of hours worked by each person in a year by 1.1–1.7 percent.

These impacts could have macro-critical consequences. Macroeconomic modeling for this CCDR shows that the combined impact of direct asset losses from floods, labor productivity losses, labor supply losses, and crop yield losses could jointly lower GDP by up to 9.4 percent in 2050 (see Figure 1). While these average impacts are significant, the modeling also shows that extreme events could lead to even greater losses. For example, a 1-in-10 year flood alone could lower GDP in that year by 7–11 percent through its knock-on supply chain and other multiplier effects. With climate change, the frequency and severity of floods are likely to increase considerably, meaning this type of economic impact could become more common. In addition to the direct social impacts, economic shocks of this magnitude could severely challenge macroeconomic management with impacts on fiscal and external balances, debt dynamics, and overall macroeconomic stability.

Figure 1. If unaddressed, climate change could lower GDP by up to 9 percent by 2050 and increase the poverty rate by 6 percentage points by 2040

Impacts relative to a baseline scenario without climate change (%)



Source: Panel a) CGE Box model estimates of the combined impacts of floods on asset losses, climate change on labor productivity, climate change impacts on the labor supply from health impacts and climate change impacts on crop yields, without any adaptation measures. Low emissions scenario=SSP1-1.9, high emissions scenario=SSP3-7.0. The baseline is a business-as-usual scenario without explicitly modeling climate change. Panel b) Roy et al. (2023) combines Cambodia's socioeconomic surveys with satellite-based measures from ERA, TerraClimate, and CHIRPS to estimate the impact of weather shocks, including drought, on consumption, and in turn, the impact of consumption on poverty.

Without adaptation, the economic impacts of climate change could, in turn, reverse Cambodia's progress in poverty alleviation, increasing the poverty rate by up to six percentage points by 2040. Poor households are most exposed to climate change through its impacts on agriculture, with a heightened role of droughts in causing agricultural losses. Under a high climate change scenario with an increase in dry and hot weather patterns, national poverty levels could increase by six percentage points without adaptation. Provinces along the Mekong and Tonle Sap, where poverty rates are already the highest, would bear the burden of the increase. Developing climate-resilient agriculture is essential to mitigate the adverse impacts of climate change on the poor, along with adaptive social protection and disaster risk management.

2 Recent patterns of development have exacerbated physical and transition risks

Deforestation and the loss of natural wetlands have exacerbated potential physical climate risks. Cambodia has had one of the world's highest deforestation rates, experiencing a 30 percent loss of forest cover over the past two decades, according to satellite data from Global Forest Watch (2022). Deforestation has led to the loss of valuable ecosystem services and resulted in higher soil erosion and lower water regulation, thus increasing the risk of floods and landslides. In addition to losing forest cover, Cambodia has also lost wetlands which are as crucial to building climate resilience, sequestering carbon, and providing ecosystem services. Wetlands protect against wildfires and act as sponges by storing water and releasing it slowly, which protects against floods and droughts. Despite these benefits, Phnom Penh's urban expansion alone has come at the cost of critical natural wetlands—mangroves, streams, ponds, swamps, and marshes—with the country having lost almost 45 percent of its natural wetland area.

Recent patterns of urban development that put people "in harm's way" have also increased exposure to physical climate risks. With land scarcity and limited planning controls, new urban residents are

increasingly located in flood-prone areas, such as river basins and flood plains. According to a recent World Bank study, the number of settlements defined as 'very high risk'—the highest flood risk category—increased by 251 percent between 1985 and 2015 (Rentschler et al., 2022). In the northwestern area, "very high risk" settlements expanded by 455 percent. Today, approximately 20 percent of Phnom Penh's population lives in high-risk areas, and 60 percent of people experiencing poverty are exposed to flooding. In addition, Cambodia's cities suffer from urban heat island effects, whereby high temperatures are amplified due to the built-up environment and lack of green space. A high share of schools in Cambodia remain in disaster-prone areas, while less than 40 percent of schools are estimated to be shock resistant. Phnom Penh and other major cities face further challenges, including informal settlements, deficient water supplies, wastewater treatment, solid waste management, and inadequate construction standards for buildings, all of which exacerbate climate risks.

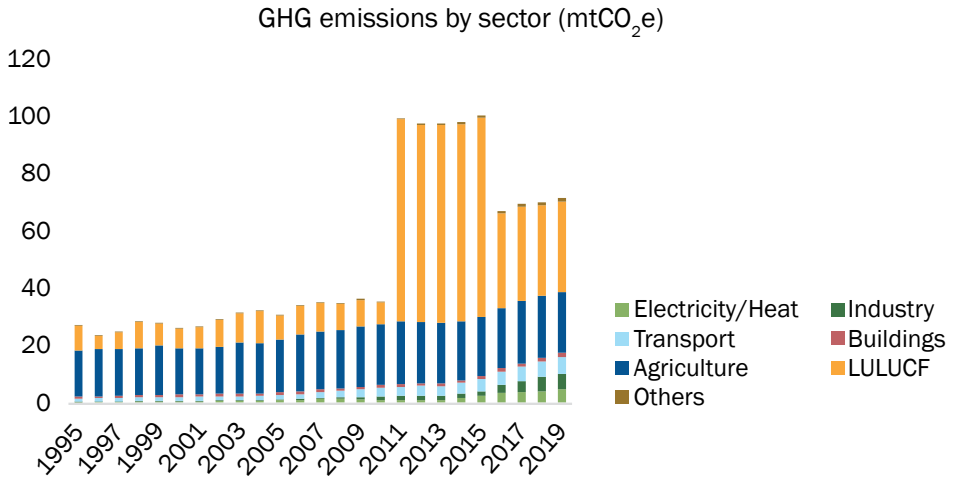
Cambodia has low per capita emissions, but its GDP is carbon-intensive, and emissions have seen the fastest growth in Southeast Asia. Cambodia's per capita GHG emissions of 4.3 tons of carbon dioxide equivalent (tCO_2e) in 2019 are under half of the OECD average of 10.8 tCO_2e, and Cambodia's share of global GHG emissions was only 0.14 percent in 2019 (Table 2). Yet GHG emissions grew at an average annual rate of 8 percent from 2010–2019, outstripping GDP growth. In addition, Cambodia's carbon intensity of GDP is over 10 times higher than the OECD average. The largest contributors to Cambodia's gross GHG emissions in 2019 were land-use, land-use change and forestry (LULUCF), which accounted for 44 percent of gross emissions, followed by agriculture at 21 percent (Figure 2). However, the fastest growing sources of GHG emissions over the past decade have been electricity and heat generation, which grew by 20 percent annually from 2010–2019, and industry, with an annual growth rate of 17 percent. This partly reflects rapid development and rising incomes, but also reflects an increasingly carbon-intensive growth model reliant on construction and real estate. Motorization and the limited expansion of public transport networks are also driving up emissions, with the number of registered vehicles in Cambodia increasing by 31 percent in 2018. Finally, urbanization is increasingly following a low-density path, with the emissions intensity of cities growing rapidly. These patterns of development are creating lock-in effects that increase transition risks, while also depleting natural capital and holding back productivity growth.

Table 2. Cambodia has low but rapidly rising GHG emissions

	GHG emissions per capita (tCO_2e per person)	Carbon intensity (tCO_2e per US$ million of GDP)	Total GHG emissions ($mtCO_2e$)	Annual emissions % growth rate (2010–2019)
United States	17.6	270	5771	-0.5
Malaysia	12.4	1081	396	0.8
OECD members	10.6	258	13797	-0.6
China	8.6	844	12055	2.2
Indonesia	7.2	1751	1960	6.3
Thailand	6.3	804	437	4.4
Lao	5.5	2104	39	3.6
Vietnam	4.5	1326	438	5.2
Myanmar	4.5	3537	243	0.5
Cambodia	**4.4**	**2649**	**72**	**8.2**
Philippines	2.2	628	237	3.5

Source: CAIT. Note: emissions are all GHG emissions and estimates for 2019. Annual emissions growth is calculated as the compound annual growth rate.

Figure 2. LULUCF is the largest contributor to Cambodia's gross GHG emissions, while electricity and heat has the highest growth rate



Sources: CAIT emissions data. Notes: The emissions data is collated as part of a government-led inventory process where inventories are published every five years, and GHG emissions are estimated by interpolations over those five-year periods and by projections.

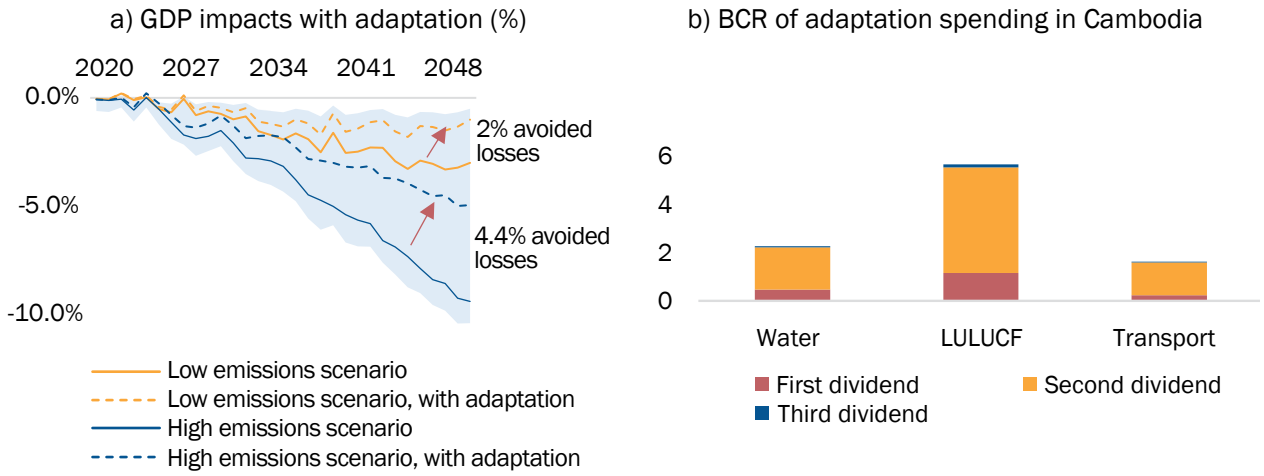
3 Adapting to climate change is a high-return opportunity for private and public investment

Measures to adapt and build resilience to climate change could lower many of the negative effects described above, with this CCDR estimating that at least half of the GDP losses from climate change could be avoided. Although adaptation measures can never fully offset the wide-ranging impacts of climate change, they can attenuate some of the negative effects. This CCDR identifies a range of measures that both the government and private entities could take to lower the impacts of climate change. Private sector adaptation actions identified, and described below, include investments in energy-efficient cooling systems, flood-resilient buildings, irrigation, clean piped water infrastructure, and climate-smart agricultural practices. Government-led adaptation actions include improving existing road networks' resilience, raising future infrastructure investments' resilience standards, risk-informed land-use planning, risk-informed public investment management, efficient water resources management, sustainable forest management, and improved early warning systems and emergency disaster management response systems. Modeling for this CCDR shows that even a few select measures have the potential to lower losses from climate change significantly. Flood-resilient infrastructure, risk-informed land-use planning, expanded irrigation, and cooling measures to protect the health of indoor workers combined could halve the impacts of climate change on GDP (see Figure 3).

In addition, some climate adaptation measures in Cambodia have high economic returns and strong induced development benefits, making them worthwhile investments even if climate risks never materialize. A "triple dividend" analysis conducted for this CCDR shows that climate-related spending can have substantial development benefits, above and beyond the benefits of avoided climate change impacts. The triple dividend of resilience approach includes a "first dividend" of resilience that measures avoided losses from climate change, a "second dividend" that includes induced economic benefits, and a "third dividend" of wider environmental or social benefits. This CCDR calculates these dividends for adaptation investment in three sectors in Cambodia: Land Use, LULUCF, water, and resilient roads (Figure 3b). In all cases, the

benefit-to-cost ratio (BCR) far exceeds 1, suggesting these are worthwhile investments, while the highest share of benefits is from the second dividend of induced economic benefits. The second and third dividends accrue whether or not the climate risk materializes and are four to six times greater than the projected avoided losses. For example, measures to upgrade and improve rural roads can lower the disruptions from flooding and increase economic activity and access to jobs in rural areas. Both improved irrigation and water management increase crop yields and agricultural productivity and lower the potential negative impacts of climate change. Improved forestry management lowers the effects of floods and droughts, benefiting rural communities through improved agricultural productivity and water resources. Benefits are particularly high for the LULUCF sector, underscoring its importance in adapting to climate change in Cambodia.

Figure 3. Adaptation measures could halve the GDP loss from climate change (left), while every US$1 of adaptation spending provides US$3 of returns from a triple dividend of avoided economic losses and development and mitigation co-benefits (right)



Source: Panel a) CGE model estimates of the combined impacts of floods on asset losses, climate change on labor productivity, climate change impacts on labor supply from health impacts, and climate change impacts on crop yields. Low emissions scenario=SSP1-1.9, high emissions scenario=SSP3-7.0. Adaptation measures include risk-informed land-use planning, resilient roads, air conditioning, and climate-smart agriculture. Panel b) World Bank analysis. First dividend refers to avoided losses from climate change, second dividend refers to induced economic benefits, and third dividend refers to environmental and social benefits.

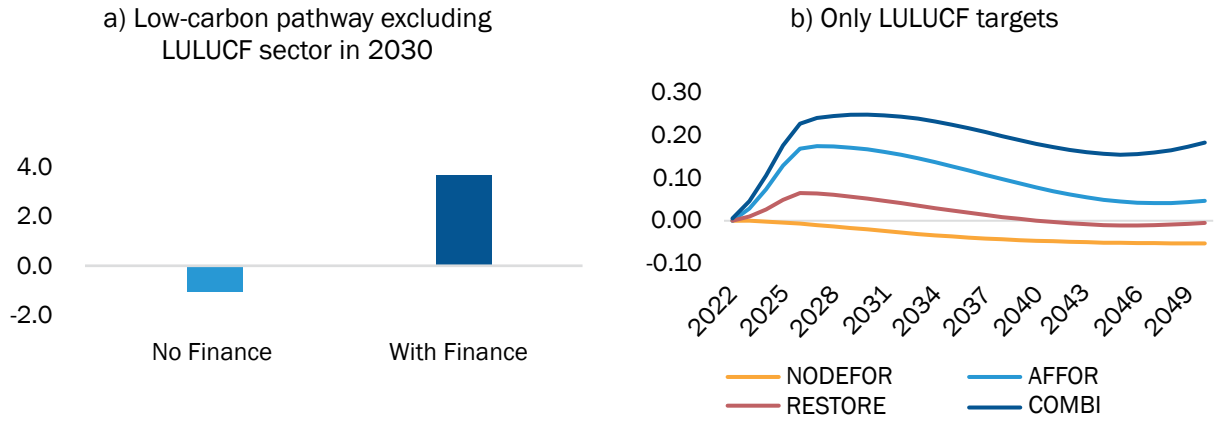
4 With a targeted policy response, achieving Cambodia's own climate mitigation goals is possible and could benefit development

Cambodia has pledged to achieve carbon neutrality by 2050, and achieving this goal will require decoupling GDP growth from emissions growth. On December 30, 2021, Cambodia submitted its LTS4CN to the Secretariat of the United Nations Framework Convention on Climate Change. The LTS4CN largely builds on existing commitments and proposes a trajectory considered to be consistent with the updated NDC from 2020, which included the target to lower emissions in 2030 by 41 percent relative to a business-as-usual scenario. Achieving Cambodia's carbon neutrality goal will require a rapid policy shift to reverse deforestation and steer the energy, transport, and industrial sectors onto a lower carbon growth path. This CCDR identifies a range of ways in which emissions growth could be lowered without compromising development outcomes. Many of these measures also generate adaptation co-benefits. The first and most central for Cambodia is through reversing deforestation, which would lower emissions, improve rural economic development,

stabilize ecosystems, and concurrently lower physical climate risks, as discussed below. Another win-win is through energy efficiency measures and technological upgrading (notably in improving the efficiency of cooling) and in agriculture, where inefficient practices lower productivity and increase emissions. A third is through a more rapid scale-up of solar energy than is currently planned in the Power Development Plan (PDP), enabled by lowering barriers to the deployment of rooftop solar and expanding the use of auctions. Finally, more compact urban development could lower emissions, boost agglomeration, and lower growth in flood risk areas, while freeing up land for wetlands and afforestation.

Modeling for this CCDR shows that achieving the LTS4CN forestry targets could have positive economic benefits, while the impacts of lowering energy-based emissions would depend on how investments are financed. The largest component of Cambodia's LTS4CN will be to reverse deforestation and increase afforestation and reforestation. Meeting these goals could also generate important adaptation co-benefits in terms of erosion mitigation, water retention, and lower flood risk. The positive benefits stem mainly from the plan to restore 1.1 million ha of degraded, unproductive forests, offsetting the adverse impacts of reduced agricultural land. Reforestation must occur in targeted locations to be effective. Modeling for this CCDR provides a potential prioritization for these areas (Figure 4b). In Cambodia's power sector, the low-carbon pathway would primarily involve meeting new demand with new solar capacity. Incremental costs are hence low, but financing will be critical due to the higher up-front capital requirements. Analysis for this CCDR shows that if financing for the electrification of transport and higher renewable energy deployment comes from the private sector or international capital flows, as has been seen recently for EV charging stations and solar auctions, then the GDP impacts in 2030 could be positive, reaching 3.7 percent by 2030. If instead investment crowds out other critical public-sector investments, the impacts on GDP could be negative, reaching 1.1 percent of GDP in 2030 (Figure 4a).

Figure 4. A low-carbon development pathway could have positive impacts on GDP if sufficient finance is available (left), while achieving Cambodia's forestry targets could have low positive GDP impacts (right)
Impacts of a low-carbon pathway on GDP, relative to a business-as-usual scenario of current policies (%)



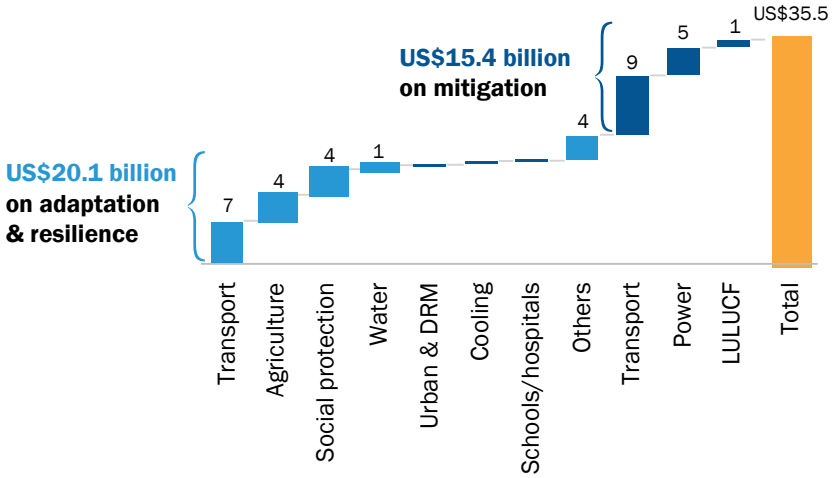
Source: Panel a) MINDSET model impacts of policy package to achieve NDC and LTS4CN targets Panel b) IEEM modeling of GDP impacts of LTS4CN LULUCF targets. NODEFOR=the target to reverse and eliminate deforestation, AFFOR= the target for afforestation, RESTORE= the target for forestry restoration, and COMBI=combination of all of these, as included in the LTS4CN

This CCDR estimates that achieving carbon neutrality by 2050 could require around an additional US$15 billion (NPV) in public and private-sector investment over the next three decades, equivalent to 0.7 percent of cumulative GDP. The largest component of this would be the electrification of transport, which could require incremental investments of around US$9 billion. However, this would depend heavily on the

extent to which global costs for EVs continue to decline relative to the costs of internal combustion engine vehicles. The second largest component would be a more rapid scale-up of variable renewable energy than is currently planned, which could require an incremental US$5 billion from now to 2050, although it would also depend heavily on the future costs of solar energy and battery storage. Despite accounting for the highest share of emissions declines, incremental needs for the LULUCF sector are estimated to be low at around US$1 billion, reflecting the high BCR of improved forestry management. The CCDR outlines various ways to spur these investments, including incentives and policies to catalyze private financing and fiscal policy instruments (Figure 5).

Figure 5. The measures outlined in this report could require US$36 billion (NPV) in incremental investment from 2023–2050 (1.7% of GDP)

Cumulative incremental investment needs 2023–2050 (US$, billions)



Source: World Bank analysis. Notes: Estimates are in NPV terms, with a 6 percent discount rate used for future investments. Investments are incremental, relative to a business-as-usual scenario of current policies or investments already in place. Estimates for adaptation measures are as described in Chapter 4.1. Estimates for mitigation measures are from the macroeconomic modeling in Chapter 2, with the exception of LULUCF, where estimates follow the REDD+ and LTS4CN investment needs.

5 The global low-carbon transition could offer economic opportunities for Cambodia, especially its private sector

The global net-zero transition offer new export and job opportunities for Cambodia, but seizing these opportunities will require conducive policies and an improved enabling environment. The global economy's low-carbon transition is driving rapid growth in demand for low-carbon goods and services, which is already being seen in Cambodia. Manufacturing clean-energy technologies and integration into supply chains for related goods and services could contribute to the goal of diversifying the export base. Spurring technological upgrading could also boost competitiveness in garment manufacturing. This CCDR finds that many multinationals sourcing from Cambodia have stringent net-zero and renewable energy targets, while Cambodian firms lag behind their peers in adopting green technologies and practices. In addition, while Cambodia is not currently highly exposed to policies like the EU's Carbon Border Adjustment Mechanism (CBAM), this could change later this decade if CBAM is expanded to a wider set of products. With Scope 2 emissions from electricity making up around half of Cambodia's production emissions, supporting firms in deploying renewable energy or using a grid with a higher renewable share could attract future investment.

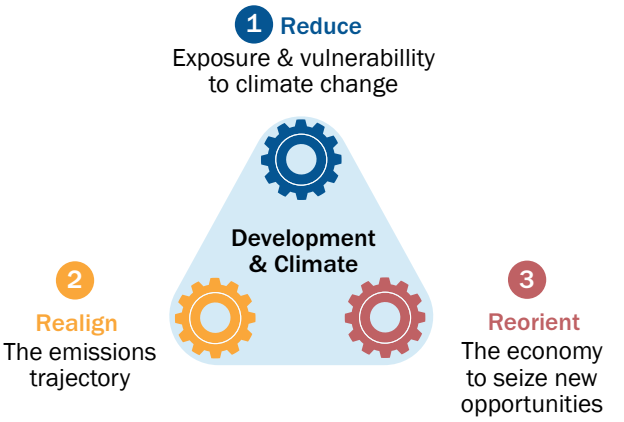
This support would capitalize on the country's natural solar endowment: Cambodia has one of Southeast Asia's highest solar irradiation levels (NREL, 2020). Despite these opportunities, this CCDR finds that barriers to trade and investment and an unconducive enabling environment are hindering competitiveness.

Rapid cost declines for clean energy technologies globally also offer new opportunities for lower-carbon growth in Cambodia. Over the past decade, the levelized cost of electricity from solar energy has more than halved in ASEAN countries (NREL, 2020). Reflecting these rapid cost declines, the share of solar in Cambodia's installed power generation capacity sharply increased from nearly zero in 2016 to 12.5 percent in 2021 (Ministry of Mines and Energy, 2022). Analysis for the new PDP in November 2022 has found that the scenario involving the greatest increase in the share of renewable energy throughout the modeling period (2022–2040) was now as affordable as one involving building new coal plants (Asian Development Bank, 2022). In addition, the most recent auction of a 60 MW solar power project in Cambodia achieved a price of less than 4 US cents/kWh. According to the Asian Development Bank, this figure was a record low for Southeast Asia and less than half the cost of the prevailing power purchase prices for coal of about 7 US cents/kWh or more. The global net-zero transition is also pushing down the cost of electrification. It is estimated that the cost for solar energy in Cambodia could decline by 31 percent between 2020 and 2040 and the cost for offshore wind could decline by 25 percent. To seize these opportunities, Cambodia will need to level the playing field by removing regulatory and financial barriers, such as fixed capacity charges penalizing rooftop solar, and spur key infrastructure investments.

Three key priorities

Cambodia will therefore need to steer the economy onto a more climate-compatible development path. This report identifies priority actions for Cambodia to achieve its ambitious development vision, compatible with climate change, a transitioning global economy, and with high climate ambitions at home (structured around the three *Rs—reduce*, *realign* and *reorient*—as outlined above (see Figure 6)). Under these priorities, the CCDR organizes key actions into five policy packages according to their levels of urgency and impact.

Figure 6. This CCDR will address three interrelated climate and development priorities for Cambodia



Priority 1: Reduce exposure and vulnerability to climate change

Policy package 1: Lower climate exposure by building resilience of critical infrastructure, disaster risk management, and risk-informed planning

Increasing the resilience of critical infrastructure assets including roads, schools, hospitals, water, and power infrastructure will be critical to avoid disruptions to supply chains, education, health services, reliable water, and energy supply. This CCDR finds that an additional US$93 million in road maintenance annually would be one of the most cost-effective measures to ensure climate resilience against flood risks. Building all-new infrastructure with higher resilience standards is also estimated to cost around US$130 million annually but could offset at least half of the future asset damage from floods. With an investment of around US$600 million, expanding Cambodia's existing rail lines and inland water corridors, which are far less exposed to riverine flooding, could also reduce disruptions from flooding and lower emissions. Increased variability in rainfall intensity and patterns caused by climate change will significantly impact the performance of urban drainage systems and water and hydropower infrastructure. Cambodia will need to increase the water storage capacity of dams, reservoirs, in-field storage, and tanks. Ensuring the resilience of health and education facilities and avoiding construction in high flood-risk zones could mitigate climate change's impact on health and human capital.

Improving disaster risk reduction and strengthening urban planning will be crucial for lowering people's and assets' exposure to climate hazards. This CCDR estimates that, by 2050, risk-informed urban land-use planning could lower the annual average asset losses from floods by 80 percent and cost only around US$4 million annually in administrative costs for urban and commune-level plans. Cambodia also ranks among the top 15 countries globally where universal access to early warning systems for natural disasters could significantly reduce climate risks. However, the coverage and effectiveness of early warning systems are currently insufficient. In addition to risk reduction, improving emergency response procedures will be important to mitigate the impacts of natural hazards. Cambodia's emergency response capacity currently faces challenges due to broadly defined responsibilities and coordination gaps, resulting in a system that cannot effectively manage the scale of future climate risks. Efficient disaster risk management will also require improved data collection and management of climate risks, which will require crossministerial collaboration. Cambodia has tried to upgrade its hydrometeorological observation network and communication systems, but more investment is needed to meet the rapidly growing needs for weather and hydrological information.

1. Align road design standards with climate risk levels of specific locations, increase the resilience standards for new transport infrastructure, and increase allocation for road maintenance by around US$94 million per year, prioritizing investments for critical rural roads, particularly in Battambang, Prey Veng, and Kampong Cham.
2. Increase budgetary allocation for repairs and maintenance of water storage infrastructure, repurpose existing reservoirs by adding additional functions (such as flood control), and increase the resilience of water storage systems to hydroclimatic conditions by updating the operational rules of reservoirs and enhancing flood and flow forecast systems.
3. Develop a comprehensive flood management strategy that combines risk-informed land-use planning, physical infrastructure improvements, and nature-based solutions.
4. Formulate and enforce building codes and standards to decrease the exposure and vulnerability of health and education facilities, leveraging existing efforts by the Cambodia Green Building Council.
5. Enhance early warning system coverage and develop an operational and effective national emergency operation center, building up the country's warehousing and logistics capabilities for emergency response.

Policy package 2: Lower climate vulnerability through climate-smart agriculture, enhanced health system resilience, and adaptive social protection

Increasing resilience in agriculture will be critical to avoid impacts of climate change on poverty and food security. The CCDR finds that upgrading irrigation infrastructure could avoid 90–95 percent of the crop yield losses for rainfed rice. For maize and cassava, yield losses due to climate change could be halved or more through increased irrigation. However, irrigation performance is currently hampered by the high costs of pumping water, inadequate irrigation canals, designs that are not adapted to changing rainfall patterns, and the low capacity of user groups for maintenance. Climate change will also impact livestock production and fisheries negatively, posing further challenges to food security. The adoption of climate-smart agriculture, livestock, and fisheries practices is a major opportunity to change production practices and attain farming efficiency, higher productivity, and higher incomes among farmers in Cambodia. Moreover, crowding-in the private sector is also crucial to enhance resilience in agricultural supply chains and distribution management, investments in sustainable agriculture solutions, and funding for agro-industrial processing to promote value addition.

Addressing climate risks to health and improving social protection will be crucial to avoid adverse impacts on human capital, protect vulnerable groups, and increase inclusion. This CCDR shows that increasing investments in WASH could have a significant impact. Investing around 5 percent more annually in WASH relative to the recent historical spending trends could significantly improve access to sanitation services and drinking water. This increased investment could nearly offset the negative impacts of climate change on the labor supply resulting from adverse health outcomes. It would also have wider development co-benefits of improving Cambodians' health, human capital, and productivity. Cambodia has shown significant progress in its capacity to use existing social protection programs to respond to shocks in the last three years, particularly in response to the 2022 floods. However, to sufficiently respond to climate change, a permanent, broad-based, social assistance cash transfer program that covers vulnerable households' main risks will be required, along with transitioning from ad hoc social assistance responses to a pre-established adaptive social protection system.

1. Develop programs and introduce incentives to expand irrigation systems, modernize existing irrigation infrastructure, and promote water-,use efficiency through crop management practices, while incentivizing farmers to adopt alternate wetting and drying (AWD) production systems for rice.
2. Promote the diversification from high-risk crops towards climate-resilient and high-value marketable crops through the provision of incentives, credit, climate information, training, and extension services.
3. Support community-level investments that improve the capacity of poorer and smallholder farmers to cope with natural disasters through shared agricultural storage facilities, rainwater harvesting facilities, or flood-protection infrastructure. Interventions could target the most climate-affected areas along the Mekong and Tonle Sap and in the Northwest.
4. Develop a climate health monitoring system to better understand and respond to climate-related health risks and increase the availability and affordability of health insurance schemes, specifically targeting climate-vulnerable populations, such as those identified in this CCDR.
5. Create a permanent adaptive social protection program by moving toward an integrated and interoperable social registry and developing a risk financing strategy that can endow the financial resources required to expand cash transfers.

Policy package 3: Accelerate reforms to achieve forestry targets, protect wetlands, and deploy nature-based solutions

Managing land use change, reversing deforestation, and harnessing nature-based solutions offer win-win-wins for climate adaptation, climate mitigation, and improved development outcomes for rural communities. As discussed above, deforestation is not only a major cause of emissions but also exacerbates the impacts of climate change. Approximately 80 percent of rural communities directly depend on forests for their livelihood. Expanding wetlands has also been shown to be one of the most cost-efficient ways to sequester carbon and lower the impacts of floods, droughts, and wildfires. It will be essential to not only rapidly expedite the reforms to achieve the LTS4CN commitments on deforestation, reforestation, and afforestation, but to also protect remaining wetlands and expand the use of nature-based solutions, particularly in urban areas. This policy package includes the following key recommendations:

1. Prioritize urgent reforms to implement rigorous monitoring and evaluation of progress against LTS4CN targets, as well as enhancing protected area management and law enforcement to eliminate illegal logging. Reforestation and afforestation should be targeted in strategic locations where ecosystem services benefits are the highest.
2. Finalize and implement the Environment and Natural Resource Code to prevent further loss of natural wetlands and explore ways to rehabilitate and expand wetland areas.
3. Create a comprehensive plan to expand public greenspaces, following the sponge cities concept, in key urban areas to reduce flooding and urban heat island effects.

Priority 2: Realign the emissions trajectory to achieve climate mitigation goals in ways that benefit development

Policy package 4: Expedite the clean energy transition, promote compact cities, and catalyze investments in energy-efficiency improvements in cooling and agriculture

Energy efficiency, scale-up of renewables, compact cities, and improved agricultural practices all offer potential ways to decouple output growth from emissions in Cambodia while also potentially benefiting development. Implementing the recent National Energy Efficiency Plan (NEEP) will be critical for lowering emissions growth. The CCDR also highlights the economic case for rapid scale-up of variable renewable energy, which could have several benefits in Cambodia, including reduced system generation costs, increased energy security, and lowered exposure to energy price volatility. However, urgent grid enhancement will be needed to meet the fast-growing demand as the existing transmission and distribution grids are outdated. It will also be important to ensure power purchase agreements for new coal plants do not include fixed "take-or-pay" clauses that result in costly lock-ins to using higher capacity than necessary and disincentivize the scale-up of renewables. The expansion of agricultural land devoted to rice production has led to high methane emissions, stemming largely from inefficient water, fertilizer, and energy use. Likewise, promoting compact urban development could offer triple wins for development, adaptation, and emissions.

1. Increase the ambition of renewable energy targets and conduct a review of power purchase agreement terms, while expanding the use of auctions.
2. Revise urban plans to promote energy-efficient compact urban development through institutional strengthening for urban planning and by incorporating geospatial systems for urban management.
3. Enhance the capacity and flexibility of transmission and distribution networks to enable renewable energy integration.

4. Scale up energy efficiency with effective implementation and enforcement of the NEEP and through implementation of the National Cooling Action Plan launched in early 2023.
5. Provide incentives in the form of subsidies/credits for switching to efficient and clean cookstoves for the residential sector.

Priority 3: Reorient the economy to seize new opportunities from trade, investment, and technological progress

Policy package 5: Adjust trade and investment policies, improve the enabling environment, and upskill the workforce

Reorienting trade, investment, and labor market policies could help Cambodia to seize opportunities from the global low-carbon transition. Cambodia's trade and investment policies have not yet kept pace with its ambitions to capitalize on the low-carbon transition to diversify exports and upgrade manufacturing. Cambodia's tariffs on environmental goods are higher than the world average and regional peers. For example, on average, renewable energy products face a 10 percent tariff in Cambodia, which is five times higher than the global average tariff applied to these products. These tariffs dampen Cambodia's competitiveness in these industries and could increase the cost of transitioning to low-carbon production relative to other countries. In addition to relatively high tariffs on final environmental goods, Cambodia levies high duties on key parts and components, undermining trade and participation in regional value chains. For example, the tariff on solar panels is 7 percent, yet critical solar installation items such as batteries, cables, fuses, breakers, and surge protectors face tariffs as high as 35 percent. These policies also keep the private sector from investing in low-carbon technologies, limiting the domestic market's growth. The low-carbon transition also provides an opportunity to create better jobs—with higher productivity and higher skill requirements —but will require improved educational outcomes and digital skills in the workforce to ensure the country can seize these opportunities.

1. Lower tariffs on environmental goods and particularly on inputs into key clean energy export products.
2. Lower barriers to adoption of rooftop solar by private companies by i) issuing permits based on applications to install rooftop solar power for any electricity consumer, ii) replacing the current fixed capacity charge with a quota scheme to have a compensation tariff for variable energy from rooftop solar, and iii) encouraging a lease-to-own model by increasing familiarity of financing structure with private sector investors.
3. Initiate a green competitiveness review to identify opportunities to increase competitiveness in low- carbon industries and support private sector engagement by making improvements to the business regulatory environment, which also has the added benefit of increasing the attractiveness of Cambodia to foreign investors.
4. Encourage private sector participation in low carbon industries through a transparent implementation of investment law and improvements in the investment climate.
5. Develop targeted skills training to facilitate the movement into green jobs and update curricular standards to consider future skills in demand from the green economy.

The way forward

Policy package 6: Align institutions and incentives

Achieving low-carbon climate resilience will also require addressing gaps in institutional planning, capacity, financial management, and accountability mechanisms. The ambitious new climate adaptation and mitigation targets are outlined in their own separate plans, and targets are not yet integrated into development plans. One harmonized, integrated framework with ownership for each ministry could improve monitoring and accountability. Currently, ministries are not required to identify climate change-related expenditures in their yearly budgets, making them reluctant to spend on climate efforts. Incorporating climate spending in Budget Strategic Plans for individual ministries could improve incentives and monitoring. In addition, monitoring of climate-related risks is also fragmented across ministries, with different approaches taken and limited information sharing. One harmonized, more systematic approach to measuring and monitoring exposure and vulnerability to granular climate hazards could help improve the efficacy of targeted interventions. A 2022 International Monetary Fund Climate Public Investment Management Appraisal noted that the guidance on project appraisal and selection for externally or domestically financed capital projects or public-private partnerships does not include requirements for considering climate-related issues. Finally, the CCDR finds that Cambodia also lags behind peers in Southeast Asia in terms of managing climate-related financial and macro-fiscal issues. The debt sustainability assessment or financial sector assessment program does not yet include climate and disaster impacts. Regulations for banks, insurers, and large investors do not yet include specific disaster and climate risk requirements.

1. Mandate the inclusion of physical climate risk assessments in public investment project appraisal and selection to avoid further public investments that are exposed to climate risks.
2. Expand the mandate of the Climate Change Technical Working Group to serve in a coordination and leadership role that initiates larger-scale programs.
3. Integrate climate targets for adaptation and mitigation into development plans for each ministry.
4. Incorporate climate change spending in individual ministry budgets and require climate spending to be included in Budget Strategic Plans.
5. Establish a more comprehensive, advanced, and standardized approach for climate risk measurement to ensure consistent data collection and risk identification across sectors.

Policy package 7: Financing the transformation

Achieving the objectives outlined in this CCDR will require catalyzing private investment domestically and internationally, increasing domestic revenue mobilization, or attracting concessional finance. This report shows that lowering barriers to private sector participation in climate-related fields and improving the investment climate could play an important role in filling the financing gap. Green finance could also play a growing role in mobilizing resources into green projects. In addition, there are various fiscal instruments that could be used to raise revenues for climate spending, including phasing out fossil fuel subsidies or applying carbon pricing with revenue recycling. The CCDR shows that a broadly applied carbon price rising to US$75 per ton of carbon by the end of this decade could raise 4 percent of GDP by 2030—nearly triple the required investment needs identified in this report. The adverse effects of carbon pricing on equity could be addressed by recycling revenues to compensate the most affected households.

1. Develop a green finance taxonomy, aligned with international standards and supported by verification and validation systems.
2. Update current legislations on disaster-related fiscal risk management to quantify, recognize, and disclose disaster-related contingent liabilities.

3. Explore options for environmental tax reform and carbon pricing instruments that incorporate revenue recycling.
4. Encourage private risk financing and the insurance sector to develop, promote, and grow micro-insurance and contingent finance solutions for key productive sectors as well as household insurance solutions.

Summary and ranking of policy recommendations

This final section ranks these top five policy recommendations from each policy package in terms of their cost, urgency and impact on climate adaptation, climate mitigation, and Cambodia's development vision. Recommendations are ranked as high, medium, or low in terms of their investment needs as outlined above, with darker blue reflecting a more favorable ranking. They are also ranked as low or high in terms of their urgency. Finally, they are ranked in terms of their impact on climate adaptation, climate mitigation, and Cambodia's development vision. This ranking considers whether policies would have positive development impacts even if climate risks do not materialize. The top ten policies identified from this ranking in terms of their overall score across these four categories are then highlighted as immediate priorities for Cambodia.

Table 3. CCDR policy recommendations
Key: +++ =high, ++ =medium, + =low,
A=adaptation, M=mitigation, D=development, top ten policy actions

Objective	Priority policy actions	Cost	Urgency	Impact		
				A	M	D
Reduce exposure and vulnerability to climate change						
Lower climate exposure through resilience of critical infrastructure, DRM, and risk-informed planning	Align road design standards with climate risk levels, increase resilience standards for future infrastructure, and increase allocation for road maintenance, prioritizing critical rural roads	High	+++	+++	+	+++
	Increase budgetary allocation for repairs and maintenance of water storage infrastructure, repurpose existing reservoirs by adding additional functions such as flood control, and increase the resilience of water storage systems to hydroclimatic conditions	High	++	+++	+	++
	Formulate and enforce building codes and standards to decrease the exposure and vulnerability of health and education facilities	Low	++	+++	+	++
	Develop a comprehensive flood management strategy that combines risk-informed planning, physical infrastructure improvements, and nature-based solutions	Medium	++	+++	++	++
	Establish a National Emergency Center and enhance early warning system coverage by improving access and reliability	Low	+++	+++	+	+
Lower climate vulnerability through climate-smart agriculture, enhanced health system resilience, and adaptive social protection	Develop programs and introduce incentives to modernize existing irrigation infrastructure and promote water use efficiency and AWD production systems	High	+++	+++	++	+++
	Introduce incentives and expand extension services to promote diversification from high-risk crops toward climate-resilient and high-value marketable crops	Low	+++	++	+	+++
	Fund community-level investments that improve the capacity of poor and smallholder farmers to cope with natural disasters	Medium	+++	+++	+	+++

Objective	Priority policy actions	Cost	Urgency	Impact		
				A	M	D
	Institute a monitoring system to better understand and respond to climate-related health risks	Medium	++	++	+	+
	Legislate and fund a permanent adaptive social protection program	High	+++	+++	++	+++
Reverse deforestation and loss of wetlands and deploy nature-based solutions	Prioritize urgent reforms to implement monitoring and evaluation of progress against LTS4CN targets and to enhance protected area management and law enforcement to eliminate illegal logging	Low	+++	+++	+++	+++
	Finalize and implement the Environment and Natural Resource Code to prevent further loss of natural wetlands	Low	+++	+++	+++	++
	Launch a program to expand public greenspaces in urban areas to reduce flooding and urban heat island effects	Medium	++	++	++	++
Realign the emissions trajectory to achieve climate mitigation goals in ways that benefit development						
Accelerate the clean energy transition, increase city density, and catalyze investments in energy-efficient technologies	Increase the ambition of renewable energy targets and conduct a review of PPA terms, while expanding the use of auctions	Medium	+++	++	+++	+++
	Revise urban plans to promote compact urban development	Low	+++	+++	+++	+++
	Enhance the capacity and flexibility of transmission and distribution networks to enable renewable energy connection and integration	Medium	+++	++	+++	+++
	Incentivize investments in energy-efficient technologies and efficient cooling systems through implementation of the NEEP and NCAP	Medium	++	+++	+++	++
	Provide incentives in the form of subsidies/credits for switching to efficient and clean cookstoves for the residential sector	Medium	+++	++	++	++
Reorient the economy to seize new opportunities from trade, investment, and technological progress						
Lower trade, investment, and skills barriers in low-carbon industries	Lower tariffs on environmental goods and particularly on inputs into key clean energy export products	Low	+++	+	+++	+++
	Lower the capacity charge on rooftop solar, remove the solar PV installation capacity limits of 50 percent, and introduce net billing, allowing time-of-use tariffs and streamlining the approval process	Low	+++	++	+++	+++
	Initiate a green competitiveness review to identify opportunities to increase competitiveness in low-carbon industries and support the private sector	Low	++	+	++	+++
	Encourage private sector participation in low-carbon industries through a transparent implementation of investment law and improvements in the investment climate	Low	+++	+	++	+++
	Develop targeted skills training programs and update curricular standards to place more focus on the skills demanded by the low-carbon economy, including digital and STEM skills	Low	++	+	++	+++
Cross-cutting priorities						
Align institutions and incentives	Mandate physical climate risk assessments in public investment project appraisal and selection	Low	+++	+++	+	+
	Expand the mandate of the Climate Change Technical Working Group to serve in a role that initiates larger-scale programs.	Low	+++	++	+++	++

Objective	Priority policy actions	Cost	Urgency	Impact		
				A	M	D
	Integrate climate targets for adaptation and mitigation into development plans for each ministry	Low	++	+++	+++	++
	Incorporate climate change spending in individual ministry budgets and require climate spending to be included in Budget Strategic Plans	Low	+++	+++	+++	++
	Establish a more comprehensive, advanced, and standardized approach for measuring and monitoring climate change risks and exposure	Low	+++	+++	+	++
Finance the transformation	Develop a green finance taxonomy and green capacity building, aligned with international standards and supported by verification and validation systems	Low	+++	++	+++	+
	Update current legislation on disaster-related fiscal risk management to quantify, recognize, and disclose disaster-related contingent liabilities	Low	++	+++	+	+
	Initiate fiscal reforms and explore options for carbon pricing instruments that incorporate revenue recycling	Medium	+++	+++	+++	++
	Provide incentives to the insurance sector to develop and expand micro-insurance and contingent finance solutions	Medium	+++	+++	+	++

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