WORLD BANK GROUP

PEOPLE IN A CHANGING CLIMATE:

FROM VULNERABILITY TO ACTION

Insights from World Bank Group Country Climate and Development Reports covering 72 economies

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Contents

Acronyms

A&R	adaptation and resilience
BCR	benefit-cost ratio
CBAM	Carbon Border Adjustment Mechanism
CCDR	Country Climate and Development Report
CSA	climate-smart agriculture
DRFI	disaster risk finance and insurance
EDGE	Excellence in Design for Greater Efficiencies
EU	European Union
EV	electric vehicle
GCP	Global Challenge Programs
GDP	gross domestic product
GHG	greenhouse gas
HCI	Human Capital Index
HIC	high-income country
IEA	International Energy Agency
IHLEG	Independent High-Level Expert Group
IMF	International Monetary Federation
LIC	low-income country
LMIC	lower-middle-income country
MDE	multi-dimensional exclusion
MIC	middle-income country
MIGA	Multilateral Investment Guarantee Agency
IFC	International Finance Corporation
NbS	nature-based solutions
ODA	official development assistance
OECS	Organisation of Eastern Caribbean States
PPP	public-private partnership
RCP	representative concentration pathway
SDG	Sustainable Development Goals
SIDS	Small Island Developing States
SLR	sea level rise
SSP	shared socioeconomic pathway
UMIC	upper-middle-income country

1. Introduction

Ending poverty on a livable planet requires all countries to enhance the resilience of their people and economies to the impacts of climate change, while also reducing greenhouse gas (GHG) emissions and other damages to nature and the environment. To identify opportunities and priorities for aligning development and climate change action and objectives at the country level, the World Bank Group introduced the Country Climate and Development Reports (CCDRs) in 2022.[1] This core diagnostic helps countries prioritize the most impactful and urgent actions to boost resilience and adaptation and reduce GHG emissions, while delivering on broader development and sustainability objectives. CCDRs are designed to guide policy priorities and decisions by public and private stakeholders, and to inform World Bank Group priorities at the country level or through its global initiatives, including the Global Challenge Programs (GCPs) (box 1).

Box 1: The role of CCDRs in informing the World Bank's new GCPs

The World Bank's GCPs are a series of country-level operations that aim to help countries address global challenges more quickly and effectively. The GCPs combine public and private sector solutions and financing to achieve results that are aligned with the Sustainable Development Goals (SDGs) and implemented with greater scale, speed, and impact. The first six GCPs, outlined here, are consistent with the priorities identified in CCDRs, which will inform delivery at country level.

- **GCP1. Fast-track water security and climate adaptation** to strengthen water security in client countries through system-level change and by scaling up more sustainable water management and disaster risk reduction solutions
- **GCP2. Energy access and transition** to increase access to affordable, reliable, sustainable, and modern energy, by scaling up clean energy and phasing down fossil fuel use
- **GCP3. Enhanced health emergency prevention, preparedness, and response** to enhance capacity to prevent and prepare for health emergencies by strengthening health systems at country, regional, and global levels
- **GCP4. Accelerating digitalization** at scale to enable innovation and adoption of technology
- **GCP5. Food and nutrition security** to help break the cycle of food and nutrition insecurity by 2030
- **GCP6. Forests for development, climate, and biodiversity** to build a sustainable forest economy in critical forest biomes

This report presents a selection of key findings from the first three years of CCDRs, with 58 reports covering 72 countries and economies published by November 2024 (figure 1). The CCDRs now cover 60 percent of the population of low- and middle-income countries (LICs and MICs) and 73 percent of their gross domestic product (GDP) (figure 2). In terms of resilience and adaptation, coverage is also improving: 67 percent of disaster losses in LICs and MICs since 2000 occurred in countries with published CCDRs, and 70 percent of LIC and MIC GHG emissions are emitted in CCDR countries. CCDRs also include two high-income countries (HICs), **Romania** and **Poland**.

The latest batch of CCDRs include several Small Island Developing States (SIDS)—the **Maldives**, four Organisation of the Eastern Caribbean (OECS) countries (**Dominica**, **Grenada**, **Saint Lucia**, and **Saint Vincent and the Grenadines**) and three Pacific atoll countries (**Kiribati**, the **Marshall Islands**, and **Tuvalu**)—offering insights into the vulnerability of these countries, and the opportunities they have to build resilience.

1 https://www.worldbank.org/en/publication/country-climate-development-reports.

Figure 1: CCDRs published by November 2024

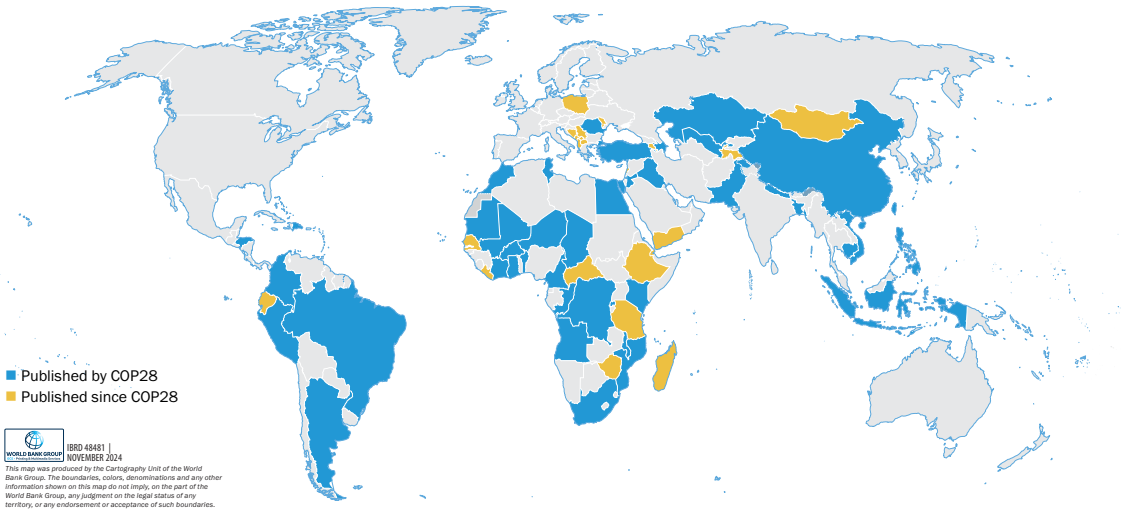
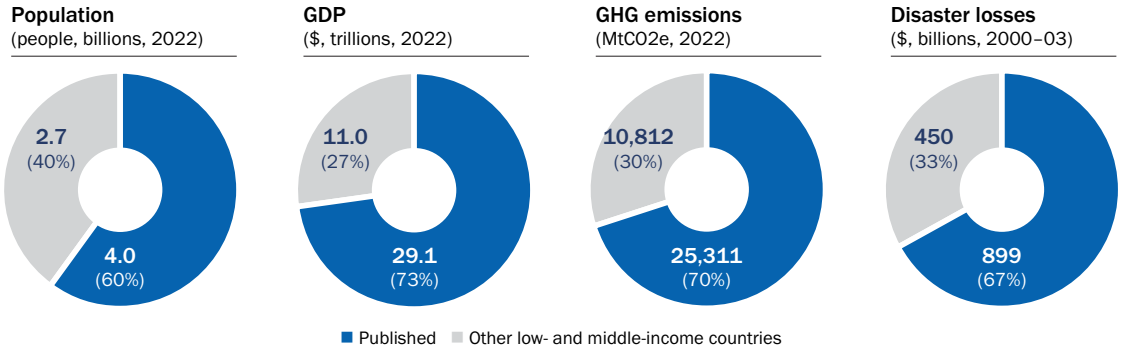


Figure 2: Share of LICs and MICs covered by CCDRs, by various metrics



This report builds on and complements the first two CCDR summary reports.[2] The first focused on the synergies and trade-offs between climate and development with an emphasis on infrastructure and economic risks and opportunities. The second focused on forestry, land-use, and nature, the role of the private sector, and macroeconomic implications.

This third summary report focuses on people, emphasizing how they are impacted by climate change, but also essential in inventing, designing, and implementing solutions to make development more resilient and to lower emissions. The first section of the report summarizes the key findings of CCDRs on climate change impacts on people, going beyond averages and aggregate metrics, such as gross domestic product (GDP). It also explores how putting people at the core of climate-development policies—including through investment in social sectors, such as education, health, and social protection—makes the policies more effective, generating larger co-benefits for people, communities, and countries.

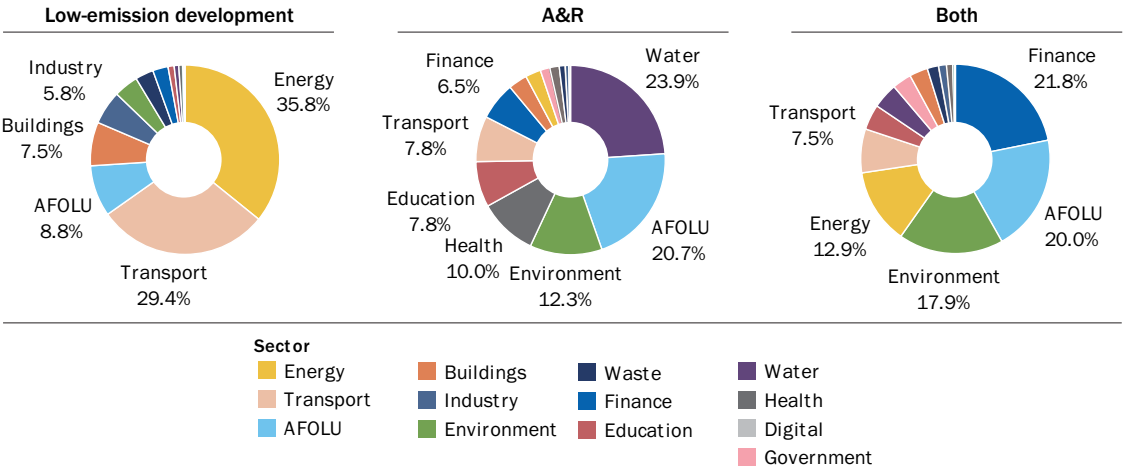
Next, it explores how people's vulnerability and ability to shift toward resilient low-emission development depend on interventions in key infrastructure systems. The number of CCDR recommendations for each sector varies (figure 3), with mitigation efforts primarily targeting energy and transport, while

2 World Bank Group. 2022. *Climate and Development: An Agenda for Action—Emerging Insights from World Bank Group 2021–22 Country Climate and Development Reports*. Washington DC: World Bank. http://hdl.handle.net/10986/38220; World Bank Group. 2023. *The Development, Climate, and Nature Crisis: Solutions to End Poverty on a Livable Planet—Insights from World Bank Country Climate and Development Reports Covering 42 Economies*. Washington DC: World Bank. http://hdl.handle.net/10986/40652.

adaptation and resilience (A&R) actions largely focus on water, agriculture, forestry, and land use. This report specifically considers water, transportation, digital technologies, and urban development, and includes an analysis of green value chains, which offer a unique opportunity for countries to create jobs and boost exports while contributing to global decarbonization efforts.

Finally, because people are also affected by macroeconomic and aggregate changes that affect their country, the last section summarizes CCDR conclusions on GDP impacts and aggregate financial challenges. Revisiting conclusions from previous CCDR summary reports, this report looks at a broader range of countries and includes a deep dive on SIDS (section 4.3), allowing the exploration of how countries' vulnerability to climate impacts depends on their socioeconomic conditions—especially their income level—but also their geography and topography. This summary highlights that poorer countries are more exposed to climate impacts through labor productivity, a consequence of the importance of agriculture in their economies and the large share of jobs involving physical outdoor work. In contrast, higher-income countries (HICs) appear more exposed to impacts through their capital stock, especially damage to buildings and infrastructure, and SIDS exhibit an extreme vulnerability to extreme events.

Figure 3: Policy recommendations by sector across the CCDRs



Notes: Labels shown only for shares greater than 5%. AFOLU = Agriculture, forestry and other land use; A&R = adaptation and resilience.

2. People are at the center of climate change risks, but also at the core of adaptation and mitigation solutions

KEY MESSAGES

- Climate change poses significant risks to people, causing long-term, irreversible, and intergenerational harm. The most vulnerable populations are often disproportionally affected as vulnerability factors, such as economic exclusion and food insecurity, frequently intersect with climate exposure.
- People are at the core of climate solutions too: investing in people—through education, reskilling, health, functioning labor markets, social protection, and so on—is crucial for building people's ability to adapt to climate change and contribute to and benefit from low-emission development.
- Placing people at the core of climate-development policies, as opposed to addressing their challenges through complementary policies, enhances policy effectiveness and can foster more inclusive growth.

Placing people at the core of climate action is critical for achieving climate and development objectives. Effective climate policies are crucial to reduce GHG emissions, aid climate adaptation and resilience, and leverage job opportunities and sustainable livelihoods in the transition to low-emission economies. The CCDRs highlight that investing in human capital—people's health, skills, and knowledge—is vital for the success of these policies. Critical investments include those that raise people's climate change awareness, develop their skills, and involve people and communities so they initiate and join climate action. Careful analysis and policy design can ensure climate policy benefits reach the most vulnerable, including women, children, the elderly, people in rural areas, informal workers, and unskilled populations. Inclusive climate policies and well-designed legal and regulatory frameworks promote people's engagement and participation, ensuring that the voices of all communities are integrated and considered in the transition to low-emission and resilient development.

Development—including accelerated progress toward achieving the SDGs—is required to make people, communities, and countries more resilient. As noted in multiple CCDRs and a recent World Bank report, targeted A&R interventions cannot make people resilient if they do not have access to basic infrastructure services (such as energy and improved water), financial instruments (such as savings accounts and borrowing), and basic services (such as health care and education).[3] Investments in people, and in their health and education, are therefore key, not just for development and poverty reduction, but also for resilience and adaptation to climate change. At the same time, increasing the resilience of social services and infrastructure, including schools and hospitals, can contribute to quicker and more inclusive development. Thanks to these synergies, recent development progress has enhanced resilience. According to the World Bank scorecard risk indicator,[4] the fraction of people at high risk from climate-related hazards has halved within a decade, dropping from 36 to 18 percent of the global population between 2010 and 2021.

3 World Bank. 2024. *Rising to the Challenge: Success Stories and Strategies for Achieving Climate Adaptation and Resilience*. Washington DC: World Bank. https://hdl.handle.net/10986/42326.

4 https://scorecard.worldbank.org/en/scorecard/home.

2.1. Climate change affects people, their economic prospects, and their well-being

Climate change is a direct threat to people and human capital. Both slow-onset climate trends and climate shocks can have long-lasting impacts on people, holding back learning and intensifying disease and malnutrition. For example, Typhoon Odette in the **Philippines** damaged nearly 30,000 schools in December 2021, interrupting learning for around 12 million students and requiring $1.2 billion in repairs, equivalent to 10 percent of the Department of Education's annual budget. Air pollution shortens average life expectancy in **Pakistan** by 4.3 years, while waterborne diseases in **Zimbabwe** are expected to increase by 57–123 percent by 2040 under different climate scenarios. GCP3 and GCP5 (box 1) are focused on these dimensions and will contribute to building people's resilience to climate change.

Climate change can also undermine people's livelihoods and food security, risking long-term, irreversible, and intergenerational harm to human capital. These impacts on people underscore the importance of rapid response and the need to manage risks and strengthen resilience in anticipation of climate threats. In **Moldova**, job losses from climate impacts could amount to 1.1 percent of total employment in 2030. These losses will not be evenly distributed across income levels; the lowest-paid 40 percent of workers would face the most significant job losses, and the top 10 percent of earners would be least affected. In the **Pacific atoll** countries, climate hazards and environmental degradation have led to loss of traditional lands, lifestyles, and community-based resource management, eroding community nutrition and health as well as informal support networks and communal bonds. In the **Sahel**, climate impacts threaten women's livelihoods and increase the likelihood of malnutrition, raising the risk of anemia during pregnancy and eventual stunting in children. In **Armenia**, climate change could increase poverty by 2.7 percentage points in 2030 compared to the baseline, due to a combination of reduced agricultural yields and productivity, and increased food prices. Disasters and climate impacts also limit how people invest in health and education for themselves and family members, and various threats can have compound effects. In the **Republic of Yemen** in 2022, 26 percent of the population was living in areas subject to the food security crisis and exposed to at least one extreme climate-related hazard. But climate change can also have positive effects: in **Sierra Leone**, the dry/hot climate scenario is projected to reduce soil erosion compared to baseline conditions, resulting in a small positive impact on crop production and a 0.7 percent increase in GDP by 2050.

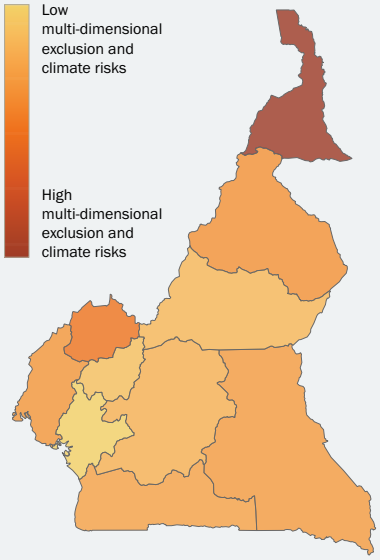
People and communities face different climate impacts, based on their exposure to hazards and vulnerability. Poor people experience disproportionate climate impacts. Multiple, often overlapping factors that influence climate impacts include where people live, their livelihoods, health, education, skills, and life stage. The **Bangladesh**, **Nepal**, and **Pakistan** CCDRs illustrate this, with maps overlaying hazard exposure with vulnerabilities that include high poverty levels and levels of socioeconomic resilience. Similarly, the urban poor in **Brazil**, especially those living in informal settlements, are particularly vulnerable to disasters. In **Poland**, areas with lower per capita GDP are disproportionately affected by flooding, which over the last 30 years has cost an estimated $10 billion in losses. The interaction between people's location, socioeconomic vulnerability, and climate risks is captured in a new World Bank Scorecard indicator, which will provide a proxy to track global progress toward reducing climate change risks.

Exclusion factors that drive vulnerability often intersect with climate exposure. These include economic inclusion, resilience, social cohesion, agency, voice, and social accountability.[5] For example, **South Africa's** Northwest and Limpopo provinces and non-white households experience greater exposure to climate shocks and have fewer coping strategies due to limited resources, low education levels,

5 While indicators vary by country due to availability, *economic inclusion* indicators usually include access to labor markets and basic and health services, and human capital level; *resilience* indicators can include asset ownership, quality of housing, food security, and water security; *social cohesion* indicators can include violence and crime, safety in the neighborhood, freedom of speech, and trust in government institutions; and *process legitimacy* indicators can include those that assess civil participation, satisfaction with democracy, government effectiveness, and corruption perceptions.

and dependence on climate-sensitive economic activities. Some CCDRs find higher risks for minority and excluded groups. In **Honduras**, areas with high numbers of Indigenous people and Afro-descendants have high levels of socioeconomic vulnerability and reduced coping capacity, and face more climate risk. The CCDR for **Romania** notes that elderly people and people living with disabilities often have lower capacity to prepare for and adapt to natural hazards due to health conditions, social and economic disadvantage, and insufficient coverage by social protection and emergency response programs. The **Cameroon** CCDR identified the Far North and Northwest regions as having high levels of both social exclusion and climate vulnerability (figure 4).

Figure 4: Cameroon's social exclusion and climate risk combined, by region



Note: This map combines the Multi-Dimensional Exclusion (MDE) Index with a climate risk index. Darker brown reflects higher values of both MDE and climate risk. MDE uses measures for levels of human capital, access to labor markets and services, levels of social cohesion and resilience against exogenous shocks, and incidence of political conflict. The climate risk index uses measures of vulnerability to floods, heat stress, and droughts.

Climate change can decrease people's productivity, harming their livelihoods. Losses in labor productivity in **Mozambique** could reach up to 12 percent in agriculture and 10 percent in industry, while in **Côte d'Ivoire**, heat stress and health-related costs could reduce domestic production by 10 percent by 2050. These declines in productivity have significantly adverse implications for livelihoods. They will also be magnified by other impacts on firms, such as damage to physical capital, infrastructure disruptions, or higher supply costs. Several CCDRs for **Middle Eastern** and **North African** countries highlight the livelihood impacts of water scarcity and extreme heat stress—for example, in **Iraq**, an estimated 20 percent reduction in water availability and higher temperature impacts on crops will reduce demand for unskilled agricultural labor by more than 11 percent and unskilled labor in other sectors by almost 5 percent in the medium term. In many countries, climate change impacts on labor demand will require people to transition to jobs in new sectors or to new, greener, and more resilient jobs or tasks in the same sector, as discussed for tourism in the **Dominican Republic** CCDR.

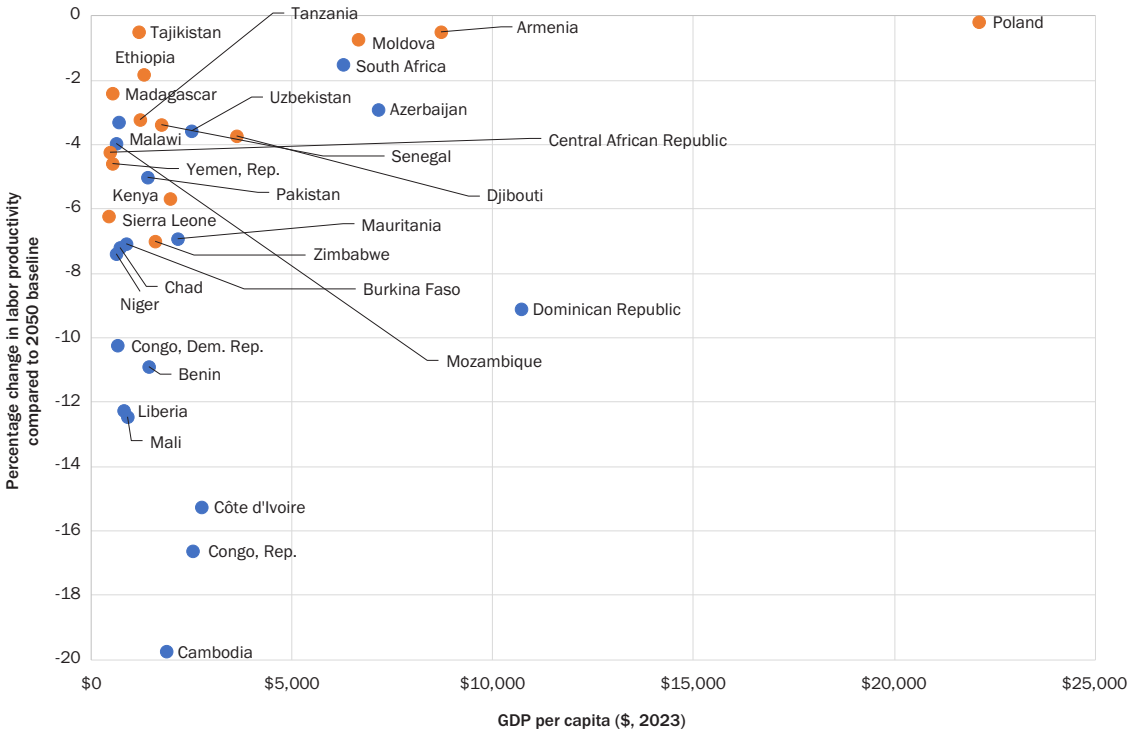
Lower-income countries tend to be more vulnerable to the impact of temperature on labor productivity. Figure 5 uses different colors to illustrate the effect of an adjustment in methodology made in the CCDRs after the first year. A change in how climate change will affect the wet-bulb global temperature—the typical metric used to assess productivity impacts—has led to lower estimated impacts on labor productivity.[6] But even taking this change into account, lower-income countries appear more vulnerable: the median loss of productivity is 6.2 percent in LICs, 5.7 percent in lower-middle-income countries (LMICs), 1.5 percent in upper-middle-income countries (UMICs), and 0.2 percent in HICs.[7] This is driven by two dimensions: the economic structure of countries, as LICs have more physical outdoor labor due to the large share of unmechanized agriculture; and the climate conditions in LICs, which are, on average, hotter and more humid than richer countries.

6 For example, the new methodology changes the impact on labor productivity in agriculture by 25% in Senegal and up to 57% in Ethiopia. Changes are even larger in industry and services, but this has less influence on the aggregate impact, as the effects outside of agriculture are smaller.

7 A simple average across countries gives similar results, with less difference between LICs and LMICs. Results are 6.4% for LICs, 7.8% for LMICs, 2.9% for UMICs, and 0.2% for HICs.

In addition to losses in labor productivity due to workplace temperature increases, climate change is projected to reduce labor supply through increased sickness, resulting in time away from work. These effects are based on projected increases in morbidity from vector-borne diseases such as malaria and dengue, waterborne infectious diseases that cause acute diarrhea, and heat-related diseases. By 2050, increasing temperatures in **Senegal** could result in a labor supply shock of around 1.2 percent in both a dry/hot and a wet/warm scenario. The **Kenya** CCDR notes that mortality and morbidity due to malaria and dengue are expected to increase by 56 and 35 percent, respectively, by 2050.

Figure 5: Labor productivity impact from heat stress by 2050, hot and dry climate scenario



Notes: This figure presents aggregated estimates for the agriculture, industry, and services sectors, weighted by the value-added share of each sector. An updated methodology for estimating changes in labor productivity, applied in orange countries, includes adjustment for solar radiation and other relevant factors. This improvement has resulted in generally lower estimates of heat stress impacts compared to the previous methodology, which was used in blue countries.

Women and men can experience different climate exposure, vulnerability, and impacts. CCDRs with in-depth analyses of the gender-differentiated impacts of climate change, such as those for **Cameroon**, **Benin**, the **Philippines**, and **Côte d'Ivoire**, illustrate that women are more vulnerable to climate change due to limited access to income opportunities, fewer productive assets and services, and lower social capital and decision-making power. In **Cameroon**, women's employment could fall by more than 10 percent when climate policies are not gender sensitive.

Climate change can also exacerbate gender differences in economic opportunities and time poverty, as women are more likely than men to have nature-based livelihoods and work in climate-vulnerable activities. In some regions of **Iraq**, drought and increased heat have forced farmers to stop growing certain crops, harming a sector that accounts for 30 percent of female employment. In the **Maldives**, women work mostly in low-growth informal sectors—such as education, social work, and manufacturing linked to the fisheries sector—all of which are susceptible to climate impacts. Male migration also increases the share of female-headed households that face the triple burden of productive, household, and care work and tend to have limited access to resources and decision-making. The **Mozambique** CCDR underscores

gender differences in labor and access to water resources. The escalating frequency of drought requires women to walk longer distances to collect water, decreasing their time available for other activities and increasing the risks of gender-based violence, sexual exploitation, and sexual harassment.

Climate change can induce people to migrate as an adaptation strategy, and these migrants, refugees, and displaced people often have reduced capacity to prepare for and respond to climate effects where they settle. The **Bangladesh** CCDR estimates that about 2.5 percent of the population has been displaced by natural hazards and that, by 2050, around 27 percent of all South Asian climate migrants will come from Bangladesh. Climate-induced migration is expected to impact women more, and migration could strain infrastructure and services in urban migration centers. In **Morocco**, climate impacts on livelihoods in rural areas may drive 1.9 million people to migrate to major coastal centers by 2050, worsening their vulnerability. Recent CCDRs for island states use innovative approaches to discuss climate-induced migration despite data constraints and propose measures that support fair, safe, and orderly migration. The **Pacific Atoll** CCDR includes migration as an adaptation option in its model, and the report discusses human and social capital measures to support potential migrants. In the **OECS**, small island states are disproportionately affected relative to their population size—Hurricane Maria displaced nearly half of **Dominica's** population. Already experiencing some of the highest global migration rates, **Caribbean** countries also face erosion of human capital and economic growth exacerbated by climate-driven migration. Emigration rates among those with tertiary education are 30 times higher than less educated groups, with medical staff among the most common category of professionals migrating.

Migrants, refugees, and displaced people may experience long-term effects on their health, education, and livelihoods from climate impacts, deepening poverty and inequality. Disparities in access to public services and limited policies to support or integrate migrants can exacerbate their vulnerability to climate change. In **Lebanon**, which has one of the world's highest concentrations of refugees per capita, refugees are highly vulnerable to climate shocks due to limited basic services and poor-quality housing. Migrants in the **Maldives** also face systemic challenges—such as a lack of medical insurance, challenging labor conditions, and difficulties accessing governmental support during emergencies—which are compounded by climate impacts.

2.2. Investing in people is a key part of making them resilient and better able to adapt

Countries can boost resilience by investing in health, education, and social protection, especially when complemented by climate adaptation to deliver these services. The **Angola** CCDR recommends investments in health and nutrition as a shield against shocks, especially for the most vulnerable and food-insecure, as well as integrating climate resilience into health plans, budgets, and programs. Countries can also build capacity to address changing disease burdens and new climate-related disease threats. The **Kenya**, **Uzbekistan**, **Nepal**, and **OECS** CCDRs highlight health management plans that focus on strengthening health systems to address the evolving threats posed by climate change. The **Pacific Atoll** CCDR recognizes that a strong educational foundation starting from early childhood helps people respond to climate impacts and shift to new jobs, and recommends incorporating new climate threats and adaptive measures into the school curriculum. The **Zimbabwe** CCDR notes that education is a core resilience strategy that requires medium- to long-term investments, underlining an urgent need to reverse declines in primary education enrolment. The **Senegal** CCDR recognizes that social protection initiatives often focus on responding to shocks and overlook potential roles in building resilience to climate change impacts before they happen. The CCDR proposes long-term investments in systems strengthening.

Box 2: Climate policies seen from a child's perspective

Children are particularly vulnerable to climate change impacts. CCDRs report severe impacts, particularly for girls, that threaten their health and access to essential services, such as education, sanitation, and clean and reliable drinking water. As a result of drought, girls in **Ethiopia** have to drop out of school to collect water, and children and youth in **Côte d'Ivoire** have to spend more time tending their family farms and less time in school. CCDRs also flag evidence that climate change-induced crop losses that lead to food insecurity can undermine children's cognitive development, impacting learning and future productivity and incomes.

Opportunities to incorporate children into climate response measures include maternal-child health care, nutritional support, shock-responsive education, and social protection programs for families with children. The **Senegal** CCDR suggests accounting for maternal, newborn, and child health care needs in climate adaptation strategies to improve access to and quality of health care services. The **Pacific Atoll Countries** CCDR recommends adapting the Early Childhood Development Conditional Cash Transfer program to include shock-responsive elements, such as prioritizing scaled-up nutrition assistance to families with young children during and after disasters.

Photo: Stephan Bachenheimer/World Bank

Investments in climate-smart agriculture (CSA) programs are an opportunity to improve livelihoods, incomes, and food security for rural poor people. Countries can combine CSA and income diversification programs in rural areas with social assistance, skills development, and coaching to foster sustainable and inclusive livelihoods, thereby reducing climate impacts on nutrition and mitigating the risk of stunting. The **Ecuador** CCDR emphasizes that CSA programs can enhance farmers' resilience and productivity while reducing the emissions intensity of agricultural exports. The **Cambodia** CCDR finds that only a quarter of farmers apply improved climate-smart technologies and practices to address climate risks, with poor households and small landholders constrained by limited capital and land. Potential responses include community-level investments that improve the collective ability to cope with natural hazards; better financial instruments and insurance products, particularly for small landholders; incentives and extension services to encourage crop diversification; and improved fisheries management, climate-resilient aquaculture, and protection of critical mangrove habitats. The **Benin** CCDR highlights the gender implications of climate impacts on agriculture and recommends gender-responsive CSA programs that incorporate greater decision-making for women in crop choices, and integrated services for women and youth.

Strengthening early warning systems and disaster preparedness and response services is pivotal to enable risk-informed decision making. Several CCDRs emphasize that hydrometeorological services and early warning systems are critical for the long-term adaptation of key sectors that contribute to jobs and economic growth, including agriculture, water, tourism, and aviation. In the **Democratic Republic of Congo**, a key CCDR recommendation is to establish improved early warning systems, with timely and accurate weather alerts, that can boost the national and subnational governments' disaster preparedness and response capacity. This should be supplemented by effective coordination with civil protection and defense agencies, as well as community engagement, training, and awareness-raising that recognize the importance of highlighting the participation of women and other disadvantaged groups in disaster preparedness and response.

Investing in public transit provides affordable and reliable mobility options, connecting low-income communities to jobs and essential services. Not only does this support economic stability; it also builds resilience to climate shocks by reducing people's reliance on more vulnerable transport modes and limiting exposure to rising fuel costs (see also section 3.3). **Pakistan's** CCDR highlights that bus rapid transit interventions in Lahore, Karachi, and Peshawar have cut travel time and costs, prompting a major shift from private to public transport and improving both affordability and accessibility for low-income commuters.

Not all risks can be avoided, so adaptive social protection programs are crucial in helping people respond to climate shocks and building community resilience to long-term climate trends. Adaptative social protection systems are an essential component of disaster risk finance and insurance (section 4.4). They address climate risks by enhancing flexibility and responsiveness, strengthening social registries, expanding coverage to include vulnerable groups, and providing emergency cash transfers or in-kind support during and after climate-induced crises. **Viet Nam** is piloting an adaptive social protection program, and its CCDR suggests scaling the program nationally and developing insurance markets. In **Niger**, an adaptive social protection program automatically dispenses cash after a drought, based on satellite data, and an early warning system linked to a safety net program helps families avoid asset losses. Many CCDR countries use the Social Protection Stress Test Tool[8] to assess social protection system readiness to respond to climate change or other shocks and to highlight policy and funding priorities (figure 6). These assessments show that lower-income counties are in greatest need for improving system readiness.

Figure 6: Social protection system readiness results for selected CCDR countries

		Programs and delivery systems	Data and information	Financing	Institutional arrangement
UPPER-MIDDLE-INCOME	Argentina	Established	Emerging	Established	Established
	Maldives	Nascent	Nascent	Emerging	Latent
	Montenegro	Established	Established	Nascent	Emerging
	Serbia	Established	Established	Emerging	Established
	Dominican Republic	Established	Established	Emerging	Established
	Brazil	Established	Established	Emerging	Established
	Bosnia and Herzegovina	Emerging	Emerging	Nascent	Emerging
	Albania	Established	Established	Nascent	Established
	North Macedonia	Established	Established	Emerging	Established
	Peru	Established	Emerging	Established	Emerging
	Colombia	Emerging	Emerging	Emerging	Emerging
	Ecuador	Emerging	Emerging	Nascent	Emerging
	Kosovo	Emerging	Emerging	Nascent	Nascent
	Indonesia	Emerging	Emerging	Emerging	Emerging
LOWER-MIDDLE-INCOME	Honduras	Emerging	Nascent	Nascent	Nascent
	Bangladesh	Emerging	Latent	Nascent	Nascent
	Mauritania	Emerging	Emerging	Nascent	Nascent
	Senegal	Emerging	Emerging	Latent	Emerging
	Pakistan	Nascent	Nascent	Emerging	Emerging
	Nepal	Nascent	Latent	Nascent	Nascent
LOW-INCOME	Mali	Nascent	Nascent	Latent	Nascent
	Burkina Faso	Nascent	Nascent	Latent	Nascent
	Chad	Nascent	Nascent	Latent	Nascent
	Niger	Nascent	Nascent	Nascent	Nascent

Note: Countries are ranked by GDP per capita. Results are based on the Social Protection Stress Test Tool.

8 World Bank Group. 2021. *Stress Testing Social Protection: A Rapid Appraisal of the Adaptability of Social Protection Systems and their Readiness to Scale-up. A Guide for Practitioners*. https://documents1.worldbank.org/curated/en/559321634917529231/pdf/Stress-Testing-Social-Protection-A-Rapid-Appraisal-of-the-Adaptability-of-Social-Protection-Systems-and-Their-Readiness-to-Scale-Up-A-Guide-for-Practitioners.pdf.

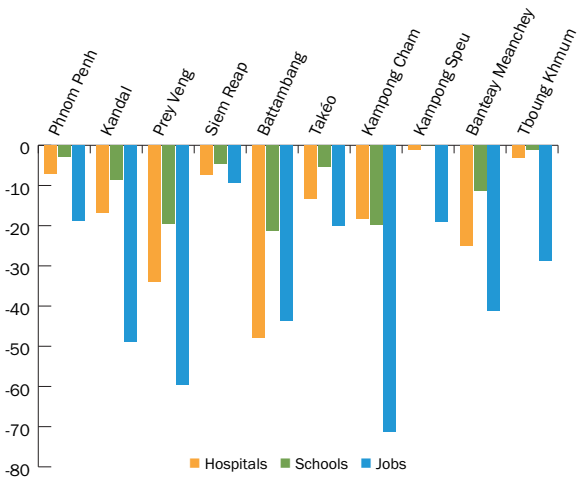
2.3. Making health care, education, and other infrastructure systems more resilient to natural hazards and climate change risks is a high priority

Adapting health and education infrastructure is a critical step for creating climate-smart institutions and services. The **Türkiye** and **Philippines** CCDRs highlight climate-resilient design features, such as situating health and education infrastructure in lower-hazard areas, building to withstand more frequent climate shocks, and adopting measures to manage rising temperatures—for example, painting roofs white and using natural building materials. Investing in green infrastructure for health and education facilities, renewable energy, and energy-efficient health systems can reduce the health care sector's large GHG emissions, which currently stand at five percent of the global total. The **Angola** CCDR mentions off-grid solar systems to keep health care facilities fully operational during regular power outages and after disasters. In the **Caribbean**, developing remote learning content, strengthening regional educational networks, and adopting remote learning strategies can help ensure continuity of education in the face of disruptions from disaster events. In **Armenia**, strengthening 60 schools and 13 hospitals exposed to severe flood risk would generate benefits 2 to 4 times higher than the costs, just from avoided damages, and much higher benefits for the users of these facilities. The **Iraq** CCDR proposes using vaccine cold chain refrigerators that are directly powered by solar energy. These findings will be part of the body of knowledge that will inform GCP3 (box 1).

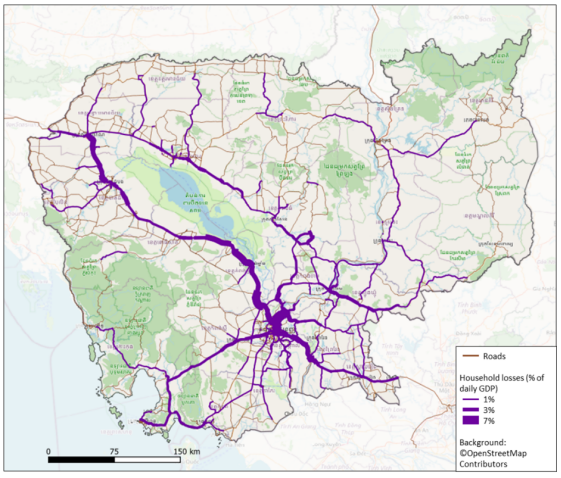
Access to affordable and sustainable public transit and infrastructure investments, such as roads, can also protect people's access to education, health care, and employment. In **Cambodia**, a 1-in-50-year flood lowers the share of people with unimpaired road access to a referral hospital within 60 minutes' travel time by more than 30 percent in two provinces, and the share of people with access to a high school within 30 minutes' travel time by 20 percent or more in three provinces (figure 7a). Building more resilient roads maintains access to critical services while reducing supply chain disruptions, generating construction and maintenance jobs, and protecting household incomes for people who depend on roads for their livelihoods (figure 7b).[9]

Figure 7: Loss of access to schools, hospitals, jobs, and income due to flooding in Cambodia

a) Accessibility loss from a 1-in-50-year flood



b) Losses from a 1-week road closure



Stronger capacity and more flexible education, health, and social protection delivery systems can mitigate climate risks to human capital. The CCDR for the **Western Balkan** countries mentions

9 On the health care system, see also Rentschler, J, Klaiber, C, Tariverdi, M, Desjonqueres, C and Mercadante, J. 2021. *Frontline: Preparing Healthcare Systems for Shocks from Disasters to Pandemics*. Washington DC: World Bank Group. http://hdl.handle.net/10986/35429.

investing in surge capacity and training for frontline workers to confront climate hazards and support people who migrate due to changing job opportunities. The **Tunisia** and **OECS** CCDRs advocate for improved response capacity for emergencies, disease surveillance, and resilient health care supply chains, as well as flexible and resilient health financing for rigid line-item historical budgets with high donor dependency. Countries can also deploy more flexible human capital delivery models for climate resilience: **Türkiye** uses digital tools for learning continuity during and after climate events.

2.4. People-centric climate policies can minimize the cost of—and maximize the benefits from—the transition toward low-emission development

Climate policies and actions that protect and invest in people can simultaneously benefit both people and the planet, fostering more inclusive growth. By identifying synergies and trade-offs early in the design of climate policies, countries can effectively combat climate change while improving people's lives and helping to address disparate climate impacts on women and other vulnerable groups. In **Lebanon**, an increasing percentage of firms report that the quality and cost of electricity supply is a major barrier to operating and growing their businesses. Replacing unreliable and costly diesel generators with solar electricity generation creates opportunities for these firms and could generate more than 20,000 jobs across multiple sectors. The **Mozambique** and **Sahel** CCDRs emphasize that clean cooking technologies can protect vulnerable populations and counteract environmental impacts from solid fuel sourcing, production, and combustion. Exposure to household air pollution affects children's learning, skills, and health, while also lowering productivity, wages, and overall quality of life. In **Mozambique**, the cost of not adopting clean cooking technologies is around $17 billion annually due to health, gender, and climate impacts. The **Western Balkan** CCDR also highlights that heavy reliance on fossil fuels has significant negative impacts on air pollution, which causes over 39,000 deaths and has an estimated welfare cost of $16 billion (15 percent of GDP) annually in the six countries covered in the analysis.

Transitioning to a low-emission economy may reshape the jobs landscape and displace some workers, but well-designed policies can generate new opportunities, foster a more inclusive economy, and minimize impacts on people. Although the transition to a low-emission economy will bring new job and livelihood opportunities, to fully realize these benefits, the workforce must be equipped with the right skills and support through the transition. For example, the "brown" sector workers most impacted by lost jobs are often ill-prepared to shift into alternative livelihoods or would struggle to relocate to regions with new opportunities without significant support. In the Mpumalanga province—home to over 80 percent of **South Africa's** coal-fired power plants and coal mines—150,000–200,000 jobs are at risk (about 18 percent of the employed provincial labor force), including about 75,000 coal miners and 15,000 transport workers. Understanding the skills of affected workers and identifying labor market programs to help them move to alternative profitable livelihoods is essential. Simulations in the **Mongolia** CCDR show that the shift to a more labor-intensive economy under the green transition could lead to slightly higher labor demand and job creation, both in 2030 and 2050, and that most of the additional jobs would be in the construction and transport sectors, and result from the large investment needed in renewable energy. In **Peru**, sustainability-related interventions could create 85,000 new jobs annually by 2050. The **Kenya** CCDR, among others, highlights the need to ensure that policies that support the transition also consider the needs of informal sector workers, who face specific threats and do not always benefit from official support.

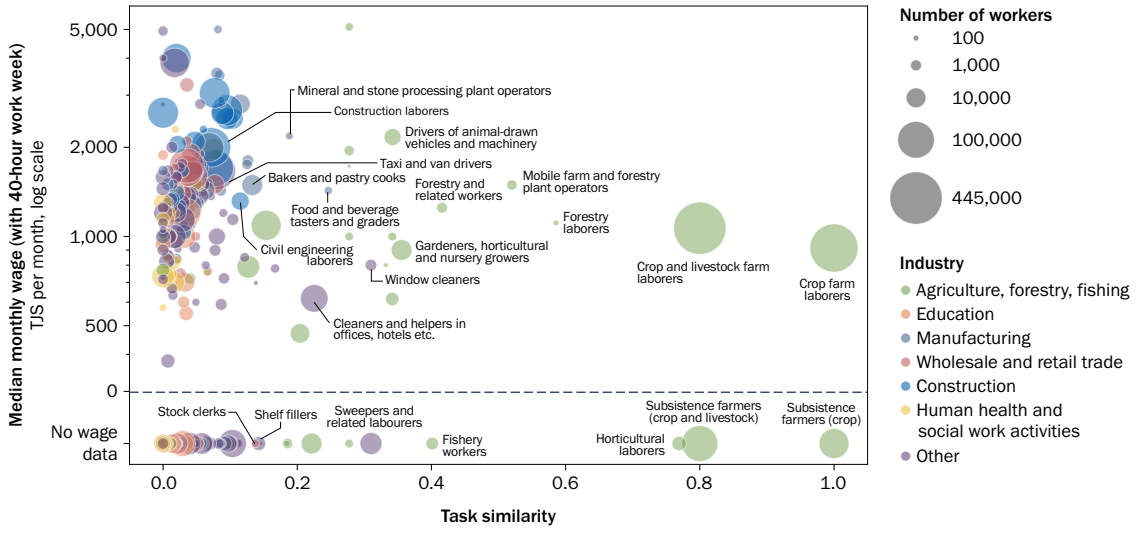
As part of making new green economies a reality and ensuring inclusive growth, countries must invest in people's skills and connect them to jobs in emerging green industries. In **Viet Nam**, recognizing that the net zero pathway is expected to boost employment by close to one million jobs

by 2040, the CCDR recommends a comprehensive national skills development program to improve labor productivity and educational and vocational training programs that address skills mismatches in green industries and help workers move across sectors. The **Madagascar** CCDR emphasizes the need for education reforms and skills development to reach disadvantaged youth and women to ensure an inclusive green transition. The **Colombia** CCDR proposes skilling and reskilling programs that align with new job demands, particularly in fields such as renewable energy and energy-efficient technologies. It also underscores the need for gender-aware training to address barriers to economic opportunities for women. In **Tajikistan**, a large portion of the labor force is employed in agriculture, in which climate impacts could lead to job losses. The low task similarity between agricultural and nonagricultural jobs (figure 8) makes it difficult for agricultural workers (green bubbles) to switch to other sectors, at least without marked loss of income. Climate-induced structural shifts will therefore need targeted policies to reskill workers in shrinking sectors.

Many CCDRs highlight that supporting the transition of the labor market—including with better labor market regulations, reskilling, and active labor policies—is essential not only to protect people and workers, but also to reduce the macroeconomic cost of the transition. The **Brazil** CCDR emphasizes the need for policy reforms that enhance flexibility and facilitate the reallocation of labor and capital across firms, sectors, and regions. In **Türkiye**, the transition toward resilient and low-emission development leads to net gains in GDP, but these are much larger under the assumption of reduced labor market friction (compared to current estimates).

Education and behavioral change interventions can help realize people's potential to reduce GHG emissions. The **Philippines** adopted education as a tool to combat climate change by mandating that schools teach green skills and integrate adaptation concepts into the health, science, and social studies curriculums. Given the mixed success to date due to weaknesses in general science education, the CCDR suggests strengthening teacher training and improving awareness of climate science among parents and communities through schools. The **Jordan** CCDR also emphasizes public education and recommends engaging the public in planning, implementing, and monitoring climate actions. Better public education and information can drive behavior change: the **Pakistan** CCDR points to policies aimed at changing behaviors and attitudes to reduce waste generation for more livable cities.

Figure 8: Job transition possibilities for crop farm laborers in Tajikistan



2.5. Community and locally led action can help address different climate vulnerabilities and exposures and improves economic inclusion

Participatory processes to develop climate policies and legal and regulatory frameworks as well as stronger links between local, regional, and national climate action can lead to more effective, sustainable, and equitable policies. Many CCDRs identify a need for institutional reforms to establish citizen engagement and participatory mechanisms that engage the population and foster the legitimacy of climate policies—a crucial way for countries to navigate the political economy of climate policy. CCDRs also point to the enabling role of legal and regulatory frameworks to support the participation of all stakeholders, increase accountability and enforcement of climate goals, and help safeguard people's rights related to climate action. Government structures and frameworks that incorporate locally led climate action and align initiatives at all governance levels increase policy effectiveness and sustainability. The **Republic of Congo** CCDR suggests fostering inclusive governance and stakeholder engagement by involving government agencies, civil society organizations, private sector actors, and local communities in decision-making and ensuring transparency and accountability.

Countries can develop systems that support local initiatives to identify more sustainable solutions. Many CCDRs, including **Nepal**, **Cameroon**, **Madagascar**, **Burundi**, and **Ecuador**, find that although subnational and local governments hold important responsibilities for climate adaptation and mitigation, they often lack resources for implementation. This challenge represents an opportunity to enhance capacity and financing for local and subnational governments, accelerating locally led approaches to climate action and resilience. While many adaptation and mitigation interventions require national and regional approaches, climate programs that address climate risks together with local vulnerabilities and needs can also help better contextualize and operationalize solutions. Noting that risks and opportunities for CSA vary by location and type of producer and crop—and therefore require local approaches—the **Ecuador** CCDR proposes a national program to support capacity building and resource transfers to subnational governments for local climate action. The **Maldives** CCDR explores options to help mainstream climate concerns into local planning processes, proposing a national climate change and disaster risk management capacity development program focused on the local level and noting that communities' granular knowledge should be leveraged for innovative climate strategies.

Integrating community socioeconomic factors into climate solutions can boost climate benefits, enhance social resilience, and strengthen economic inclusion. Climate solutions offer an opportunity to address socioeconomic drivers of climate vulnerability at the community and regional levels, such as high levels of poverty and exclusion, low levels of human capital, limited physical capital, and fragility, conflict, and violence considerations (box 3). Poverty maps and exclusion-driven risk maps can be useful to identify these socioeconomic factors. In **Moldova**, 71 percent of the Roma population live in substandard dwellings that are particularly at risk from climate shocks. Identifying and adding them and other vulnerable groups to social registries will enhance effective outreach and support as part of disaster response and adaptive social protection measures intended to buffer shocks at household level. The **Brazil** CCDR advocates for urban resilience investments that address the combined challenges of social exclusion, lagging access to infrastructure and services, and exposure and vulnerability to extreme climatic events.

Integrating Indigenous and local populations and incorporating local knowledge into agriculture, forestry, and other land use policies can strengthen community resilience and increase climate policy effectiveness. CCDRs for the Amazon countries—**Brazil**, **Colombia**, **Peru**, and **Ecuador**—underscore the role that Indigenous communities play in forest conservation and land management, with their

territories accounting for more than 30 percent of the forest area in some countries. These CCDRs also highlight policy approaches such as secure land tenure and culturally sensitive participatory mechanisms to help these populations access policy making. In **Ecuador**, improving the legislation and agreements that regulate citizen engagement could achieve better inclusion and increase the participation of Indigenous people and local communities in climate policies. In **Mongolia**, where forests and livestock areas often coincide, supporting combined forestry and pasture user groups can help foster agreement on how to restore forest areas. Effective policies involve local communities in conserving forests and mangroves through formal agreements or payment for ecosystem services, ensuring sustainable livelihoods for forest-dependent communities while reducing deforestation and degradation. GCP6 (box 1) is particularly focused on the interplay between these dimensions.

Box 3: Climate change and people affected by fragility, conflict, and violence

Among the 72 countries and economies with CCDRs published to date, 18 are classified as fragile and conflict states and their CCDRs reference the potential for climate change to act as threat multiplier for conflict, which can reduce resilience and increase environmental degradation. Agricultural dependency, low levels of economic development, and political marginalization all increase risks within the conflict and climate nexus. The **Central African Republic** CCDR finds that climate-related factors are likely to inflame conflicts over seasonal pastoralist and livestock movements, particularly in areas already facing security concerns and food insecurity, while fragility and conflict also hinder efforts in forestry management and conservation. Assessing the relationship between food insecurity and severe climate conditions, the **Ethiopia** CCDR finds that a 10-day increase in high temperature (>37 °C) in a year raises the number of food-insecure households by 3 percent on average; and an increase food insecurity is correlated with an increased likelihood of future conflicts at district level.

People-centered climate solutions can address some of the immediate impacts of climate change while also tackling key drivers of conflict, such as resource scarcity and inequality. The **Republic of Yemen** CCDR notes that addressing the country's development challenges through a climate action lens that also integrates a long-term view of post-conflict recovery requires taking advantage of opportunities to build resilience around the development-conflict-climate nexus such as sustainable water management, CSA, and renewable energy. CCDRs for countries and economies experiencing fragility, conflict, and violence recommend solutions that recognize specific challenges, such as limited government capacity and a shrinking natural resource base. The **West Bank and Gaza** CCDR recommends targeted support for service delivery and social protection among groups that are most vulnerable to the impacts of climate change, including women, children, agricultural workers, persons with disabilities, and the elderly. In the **Democratic Republic of Congo**, the government's limited financial capacities suggest a need to engage with the private sector in resource-intensive activities using a 'do no harm' conflict-sensitive approach that identifies and manages climate and fragility risks in local communities. The private sector can also help address service gaps in electricity access, which are particularly common in remote and conflict-affected communities, by investing in renewable energy, including independent power producer renewable energy, off-grid power, and solar mini-grids.

3. People's resilience and low-emission development require urgent action in key sectors

KEY MESSAGES

- People are also affected by climate change and policies through key infrastructure systems, including power, water, transport, and digital. Ensuring these are reliable, affordable, sustainable, and resilient is essential for people's resilience and well-being, but also for productivity and job creation.
- The CCDRs highlight the potential resilience benefits of enhanced access to electricity, the insufficient investments in water infrastructure, despite large benefits, and the potential gains from improved maintenance and construction standards in transport and other infrastructure sectors.
- Low-emission technologies and practices also offer important opportunities, including by expanding renewable energy, investing in public transit, and supporting the electrification of all transportation modes, the growth of green value chains, and the diffusion of digital technologies.
- Rapid urbanization provides a unique opportunity to develop resilient, low-emission cities that can drive growth; and the irreversibility of urban development makes action in this sector urgent.

People's resilience and adaptive capacity, as well as their ability to shift to greener and low-emission technologies and practices, depend on key infrastructure systems and economic sectors. Reliable and affordable infrastructure services play a key role in ensuring quality of life, job creation, and economic growth. Applying a people-centric approach to climate action in these sectors helps identify the major risks that these sectors create for people and how successful sector-level transition can create opportunities to improve incomes, health, and more broadly, quality of life.

3.1. The power sector is important for resilience and low-emission development

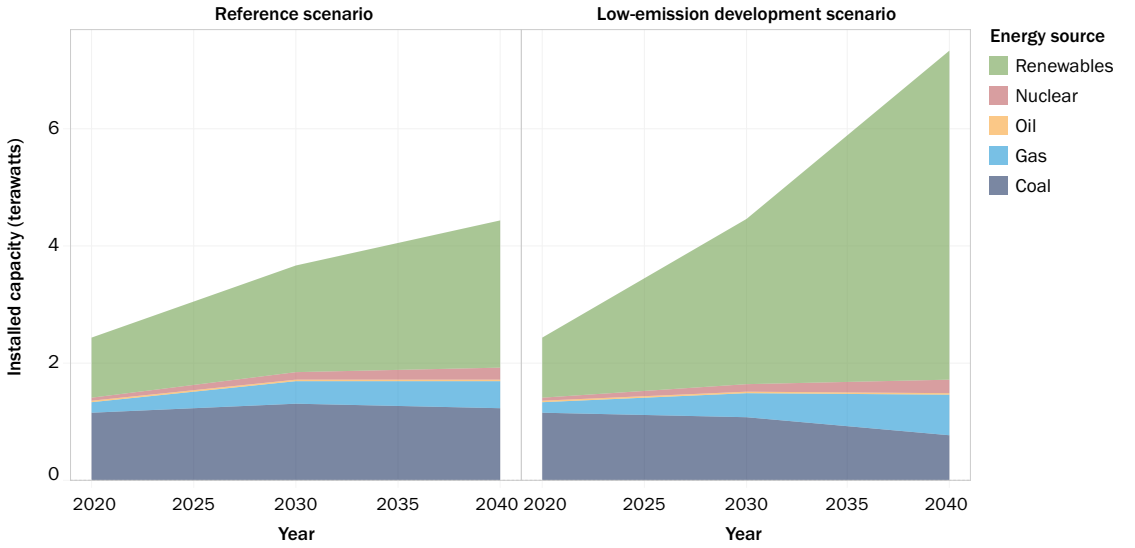
The energy and power sectors are key for the transition toward low-emission development, achieving the mitigation objectives of the Paris Agreement, and reducing future climate change impacts. Many CCDRs explore net zero scenarios in the power sector, highlighting pathways for countries to achieve significant emissions reductions while ensuring energy security. With detailed findings summarized in the first two CCDR summary reports, this report does not delve into the same level of detail.

CCDRs also emphasize the (sometimes underappreciated) role of the power and energy sectors for people's resilience, especially through access to reliable, affordable, and resilient electricity. Many highlight the higher vulnerability to extreme temperatures of people without access to electricity, as well as the need to increase access to fans, passive cooling technologies, food refrigeration, and air conditioning equipment. The **Mongolia** CCDR emphasizes the importance of reliable and affordable power, reporting that heating is one of the biggest uses of energy (35 percent of energy demand) with average ambient temperatures reaching -30°C in winter and a heating season that lasts eight months. Access to electricity is also a requisite for deploying digital technologies that enable access to risk data and information, including early warnings that can save lives and reduce the economic cost of disasters. The **Mozambique** and **Sahel** CCDRs identify clean cooking as essential for improving health (especially for children), saving time for other productive activities (especially for women), and

reducing deforestation and GHG emissions. The CCDRs discuss opportunities for deploying different technologies, including liquefied petroleum gas and induction cooking, to reduce these negative social, economic, and environmental impacts.

Renewable energy can boost resilient and low-emission development by improving energy access for the poorest and most vulnerable, meeting the growing demand for electricity at the lowest possible cost, improving energy security, and reducing GHG emissions. Power sector modeling in the CCDRs shows that solar and wind energy play a significant role in meeting the growing demand for electricity at the lowest cost to consumers (figure 9), even without considering climate objectives. When countries phase down fossil fuels and ramp up renewable energy, they are usually driven by economic considerations, rather than climate goals. When climate objectives are considered, in low-emission development pathways, renewable energy plays an even larger role and represents almost all new capacity additions. In **Moldova**, investing in renewables and energy efficiency is estimated to reduce energy import dependence from 78 percent to 40 percent by 2050, a shift that is accelerated with climate objectives, partly due to the electrification of transport, heating, and industry. In fragile or conflict countries, such as the **Republic of Yemen** or **Lebanon**, distributed solar power can build community resilience by providing power for critical facilities, such as schools and hospitals. For many **Caribbean** countries, including the **OECS** CCDR countries and the **Dominican Republic**, renewable energy is a priority as a means to reduce dependence on costly fossil fuel imports and the resulting exposure to global price volatility. In most CCDRs, this transition toward renewable energy takes place with electricity total costs that decline over time, providing a gain for households and businesses.

Figure 9: Power generation capacity in 34 CCDRs

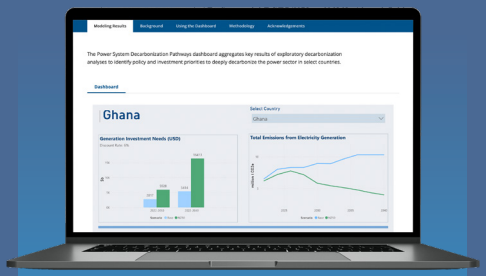


Between 2023 and 2030, renewable energy capacity in CCDR countries (except China) increases by a factor 2.5 in the reference scenarios, and by a factor 3.5 in the low-emission development pathways. When **China** is included, the increase is reduced to 44 and 80 percent, respectively. For countries excluding China, these results are consistent with the commitment made in 2023 at the 28th United Nations climate change conference to triple global renewable energy capacity by 2030. To increase transparency in these results, and facilitate their use by others, these power sector scenarios are now available on the World Bank's Power System Decarbonization Pathways Dashboard, allowing users to explore the implications of the scenarios, and the policies and interventions needed to create them (box 4). Access to electricity, building on renewable energy, is a key World Bank Group priority,

with GCP2 (box 1) dedicated to the effort and its recently approved Mission 300[10] partnership, which aims to provide access to electricity to 300 million people in Africa by 2030.

Box 4: The Power System Decarbonization Pathways Dashboard

This new dashboard consolidates the results of power system analyses led by the World Bank in collaboration with country energy teams and government counterparts. Providing key data points—from total investment needs to generation demand and emissions trajectories—the dashboard has been integral in supporting the CCDRs, as they help identify the policy and investment priorities needed to deeply decarbonize the power sector, enhance resilience, and meet broader development objectives in line with the World Bank Group's vision and mission. By making these insights publicly available, the dashboard is an invaluable resource for World Bank teams, government officials, technical organizations, and other users to compare decarbonization trajectories and analyze energy transition data across countries and scenarios. Featuring data for 14 countries, there are plans to expand the dashboard as more power system analyses are conducted for the CCDRs and to incorporate analyses performed using tools beyond the World Bank's Energy Planning Model.



LEARN MORE

Scan the QR code to visit the new dashboard.

3.2. Climate impacts on people are often mediated by water and water infrastructure[11]

Access to safe water and sanitation is a basic need, and water is critical for agriculture, food security, human development, economic growth, employment, and the environment. Unsurprisingly, these are central in CCDRs, which will inform GCP1 (box 1).

Water is crucial for development and is being affected by climate change

Climate change impacts on water affect economies through key impact channels, including water shocks on agricultural and energy production, water-related diseases impacting health and labor productivity, and water-related natural hazards and resulting infrastructure damages. Economic impacts from changes in the water sector often disproportionally affect the poor and vulnerable. Drought conditions in **Malawi** increase the probability of an individual falling below the poverty line by 14 percent. By 2040, it is estimated that hydropower generation in **Ghana** could decline by 8–30 percent compared to 2020 levels. In **Armenia**, irrigated and rainfed crop yields are expected to decline through 2050 as a result of changes in temperature (for fruit and vegetables) and precipitation (for most other crops), and reduced water availability for irrigation. In **Argentina**, annual losses in rainfed agriculture from water deficits or excesses are estimated at $2.1 billion (0.6 percent of GDP). Drought in Cape Town, **South Africa**, led to a loss of 20,000 jobs in agriculture, resulted in a decrease in tourist numbers, and had a direct economic impact of 3.4 percent of provincial GDP and 0.3 percent of national GDP in 2018. In **Lebanon**, climate change is projected to lead to an up to 9 percent reduction in water availability by 2040 and induce significant losses in agriculture (up to $250 million per year) and tourism. In **Uzbekistan**, a rising incidence of waterborne and heat-related illnesses could result in a 0.6–1.2 percent increase in mortality by 2050. By the 2040s, waterborne diseases in **Zimbabwe** are projected to increase by 57 and 123 percent for the wet/warm and hot/dry scenarios, respectively.

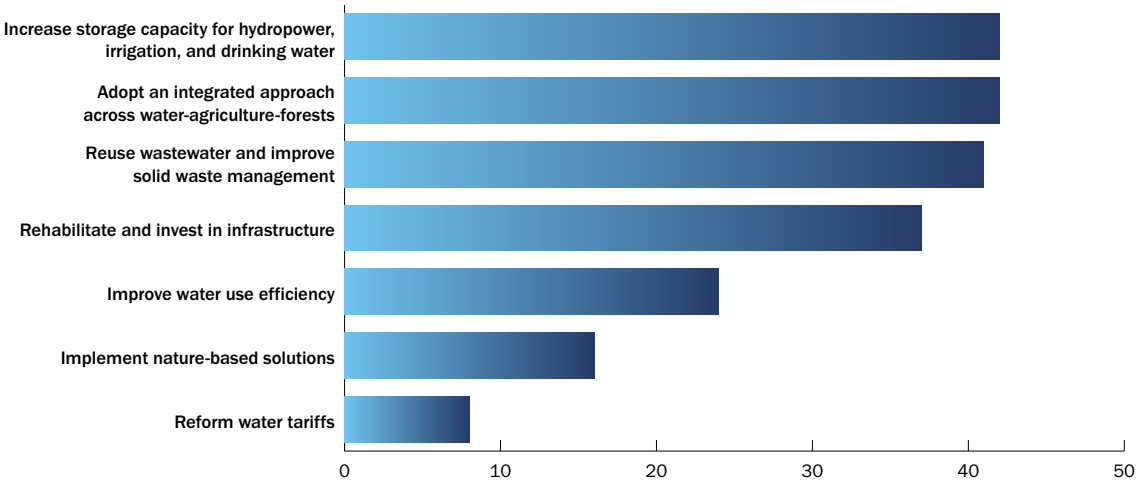
10 https://www.worldbank.org/en/programs/energizing-africa.

11 This section is based on the forthcoming companion report , World Bank. 2024. *Water Security and Climate Change: Insights from Country Climate and Development Reports*, Washington, DC: World Bank.

Water sector investments and policies are critical for improving resilience

The CCDRs identify a range of general and country-specific solutions to improve water resource management and build climate resilience, covering investments and policy, institutional, and regulatory reforms. Such measures include strengthening joint regional institutions for water operations, planning, and climate adaptation; stepping up water sector reforms to improve sector efficiency, financial sustainability, and access to finance; and strengthening work to achieve universal water, sanitation, and hygiene provision. It is worth noting that water tariff reform often faces political economy challenges, and is more likely to be recommended in countries that have already confronted water scarcity challenges accompanied by social interventions to facilitate the transition and protect the vulnerable (figure 10).

Figure 10: Most common water-related recommendations in CCDRs



Access to urban water supply and sanitation services is highly vulnerable to climate change. The lack of safe drinking water and basic sanitation undermines efforts to combat poverty and disease, so expanding and improving water supply and sanitation infrastructure in underserved areas is crucial. This has not kept pace with urban growth and is highly affected by climate change. In **Liberia**, 27 percent of the population lacks access to basic drinking water supply, 17 percent lacks access to sanitation, and over 60 percent of the urban population lives in informal settlements where improving sanitation is a challenge. Increased rainfall and flooding due to climate change are expected to disrupt water supply in both urban and rural areas, contaminate groundwater resources, and increase sanitation vulnerabilities due to the higher prevalence of water- and vector-borne diseases. The CCDR recommends small-scale interventions—including contingency planning to adopt alternative sources of drinking water supply (such as drilled piped groundwater or trucked water connected to an elevated reservoir—and onsite sanitation facilities to help communities "live with water", reducing their exposure and vulnerability.

Leveraging wastewater circularity can improve water security and reduce water resource pollution risks. Inadequate and inefficient wastewater management is leading to widespread environmental pollution. Most cities face severe sustainability and resilience risks to long-term water resource availability due to rapidly expanding populations, a heavy concentration of industrial and commercial activities, and environmentally unsustainable wastewater management practices. The **Arab Republic of Egypt** CCDR recommends that cities focus on strengthening regulatory enforcement and performance monitoring systems in wastewater treatment plants, to strengthen water quality monitoring, operational and treatment efficiency in treatment plants, and GHG mitigation. The **Mongolia** CCDR recommends

increasing the use of treated wastewater in urban industries by building decentralized cluster-based industrial wastewater treatment plants, possibly co-financed by industries, updating water quality regulations, and improving wastewater discharge. Strategic water resource management and optimization to ensure their sustainable and efficient use through wastewater recycling for industrial and agricultural use would deliver additional economic benefits from water resource circularity and reduce freshwater stresses for key economic and urban centers.

Water also underpins innovative solutions needed for the green energy transition. Many countries—including **Angola**, **Morocco**, **Nepal**, **Pakistan**, **Türkiye**, **Azerbaijan**, **Brazil**, **Colombia**, and **Romania**—have shown interest in becoming producers, users, or exporters of green hydrogen, which requires reliable access to water. In **Angola** and **Jordan**, co-locating pumped hydro and reservoirs with renewable energy sources could support renewable energy integration. In **Colombia** and **Brazil**, significantly increasing solar and wind power generation capacity, alongside high hydroelectricity use, represents the least-cost option for expanding electricity generation.

There are barriers and obstacles to mobilizing investments in the water sector

Water investments yield significant social, economic, and climate returns. The net benefits of investing $1.8 trillion globally in five areas related to adaptation in water are estimated at $7.1 trillion from 2020 to 2030.[12] In **Armenia**, an ambitious adaptation portfolio (with 15 new reservoirs) would cost $1 billion but increase efficiently irrigated land by 66 percent and bring $2.6–3 billion in direct benefits. At the macro level, these investments would increase GDP by 0.5–1 percent per year after 2030. In **Peru**, adaptation investments can increase GDP by 5 percent, mostly from co-benefits in agriculture and water. In **Jordan**, water and energy efficiency measures could significantly reduce water sector costs and achieve operational cost recovery by 2040. In **Cambodia**, increasing annual investment in water, sanitation, and hygiene by 5 percent could nearly offset negative climate change impacts on labor supply by 2050. And in **Pakistan**, improving sanitation could reduce stunting among children under 5 from 40 to 30 percent by 2030—and to 5 percent by 2050—with significant gains for quality of life and economic prospects.

In spite of these gains, investment in the water sector is insufficient. Annual spending on water in LICs and MICs amounts to approximately $165 billion, representing only about 0.5 percent of GDP.[13] The CCDRs have highlighted large investment needs in the water sector in many countries (figure 11) and an equally large financing gap. Large, coordinated flows of public, concessional, and private capital are needed to meet SDG water-related objectives, including to compensate for decades of underinvestment in the sector.

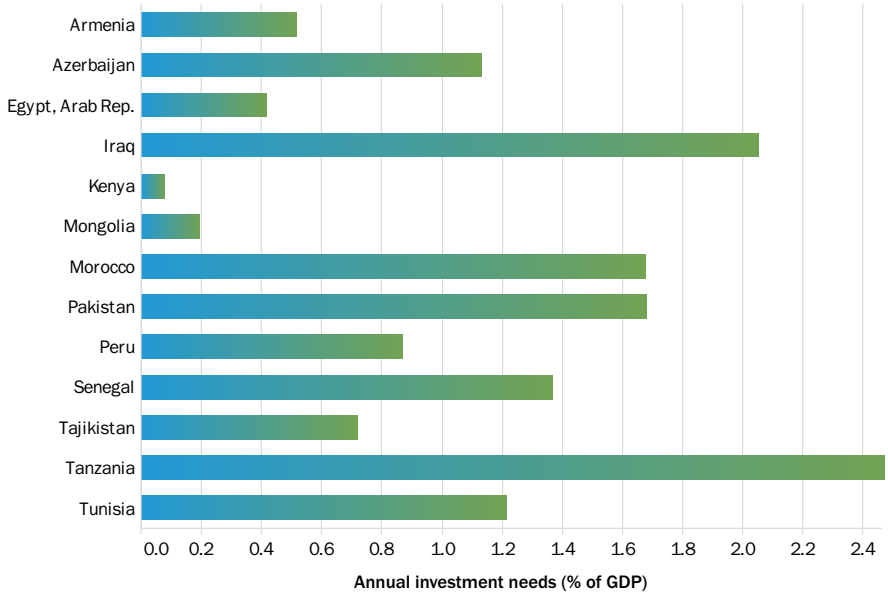
Demand-side management and improved allocation of scarce water resources are often more cost-effective than supply-side investments in reducing water supply shortages; but they face political barriers. Water demand management involves adjusting water tariffs to reflect the true value of water in overall water management (allocation and use), increasing consumer awareness, and strengthening regulations and technologies to improve water use efficiency. But water is often underpriced, leading to wasteful consumption and significant fiscal costs. In **Pakistan's** Punjab and Sindh provinces, indirect subsidies encourage lower-value production, unsustainable groundwater use, and continued GHG emissions. Even though these subsidies cost the government up to $2.7 billion per year, provide little benefit to households or farmers, and reduce the incentive to increase productivity, affordability

12 Global Commission on Adaptation (2019). *Adapt Now: A Global Call for Leadership on Climate Resilience*. https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/.

13 Joseph, G, Hoo, Y R, Wang, Q, Bahuguna, A and Andres, L A. 2024. *Funding a Water-Secure Future: An Assessment of Global Public Spending*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/099050624154572979/P172944100adb1042188ab1d289e7f2f00b.

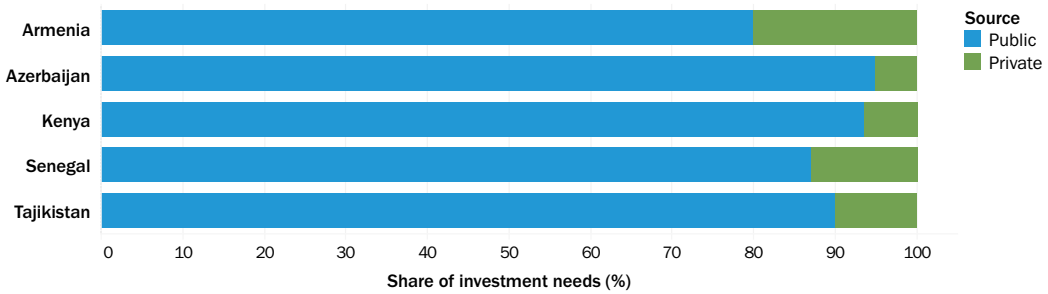
concerns make pricing reform politically sensitive. The **Jordan** CCDR highlights that demand-side measures, such as reducing demand from agriculture and non-revenue water, will be cost-efficient and improve the sector's financial viability, while supply-side demand measures—such as desalinization and water transport—will be required but are energy-intensive and expensive.

Figure 11: Water annual investment needs to 2030 in selected CCDRs, as share of GDP



With appropriate policy measures and incentives, investments in water-related urban infrastructure, sanitation, waste, and other water-related projects can be either partly or fully financed by the private sector. Estimates from the CCDRs suggest that, although the public sector will continue to play a dominant role in water sector investments, the private sector can contribute up to 20 percent (figure 12). Performance-based contracts, hybrid public-private financing models and credit enhancement mechanisms can incentivize private sector participation in niches where its know-how is particularly relevant, such as reducing methane emissions from irrigated rice. Revenue-generating subsectors, such as hydropower, which are less susceptible to operating below cost-recovery, are also well-suited to attract long-term private investment. City-level planning and regulatory instruments in the **Brazilian** cities of São Paulo, Belo Horizonte, and Porto Alegre include practical incentives for private developers to adopt climate-focused solutions, including instruments that promote rainwater infiltration and reservation. In **Azerbaijan**, performance-based public-private partnerships (PPPs) for nonrevenue water reduction and management and wastewater treatment plant operation can bring both critical private sector expertise into the sector and additional resources through the potential use of blended finance.

Figure 12: Public-private sector funding split for water investments in selected CCDRs



Governance capacity constraints limit countries' ability to integrate climate adaptation and water resource management in development planning. Effective water management requires a whole-of-government approach at national level, and regional cooperation for transboundary waters. Water-related planning, investments, and regulations are often scattered across multiple agencies, requiring close coordination and collaboration. The **Nepal** CCDR notes that constraints in financial resources are compounded by a lack of technical capacity and significant coordination gaps across three levels of government. The ability to address climate challenges is particularly limited in the world's most water-stressed regions, including the **Middle East** and **North Africa**, where some countries are also grappling with ongoing physical conflicts. Countries with low governance capacity will need significant support for efforts to improve water security and climate resilience.

3.3. Transport infrastructure is at the core of resilient and low-emission development[14]

The transport sector is highly vulnerable to natural hazards and climate change, but also a large and growing source of GHG emissions. The CCDRs explore both these dimensions and tend to include recommendations for both adaptation and mitigation (figure 13). Co-benefits, through reduced congestion or better air quality, also play a key role in this sector (box 5).

Box 5: Economic and health benefits from transport policies

Increasing the rate of motorization comes at a substantial human cost, including air pollution, congestion, and fatalities. In **Tunisia**, the number of private cars in operation rose steadily from 950,000 in 2010 to 1.8 million in 2016, creating near-permanent traffic congestion and increasing emissions and air pollution. In **Angola**, road traffic and pedestrian injuries are two of the three leading causes of disability and death due to injury, and without management of both motorization and traffic, this is likely to get worse. In **Egypt**, transport is one of the fastest-growing sectors and one of the largest air pollution emitters, with emissions in Greater Cairo among the highest of all global cities. In 2019, more than 150 per 100,000 people died prematurely in the country due to ambient air pollution. **Indonesian** cities also suffer from severe congestion, air quality issues, and increasing road accidents and fatalities. With too many motorized vehicles competing for too little road space, the increasingly intolerable congestion—along with the traffic accidents and air pollution that come with it—has a high health cost burden.

Traffic and pollution in Cairo – Kim Eun Yeul/World Bank

Transport systems can be made more resilient, reliable, and efficient

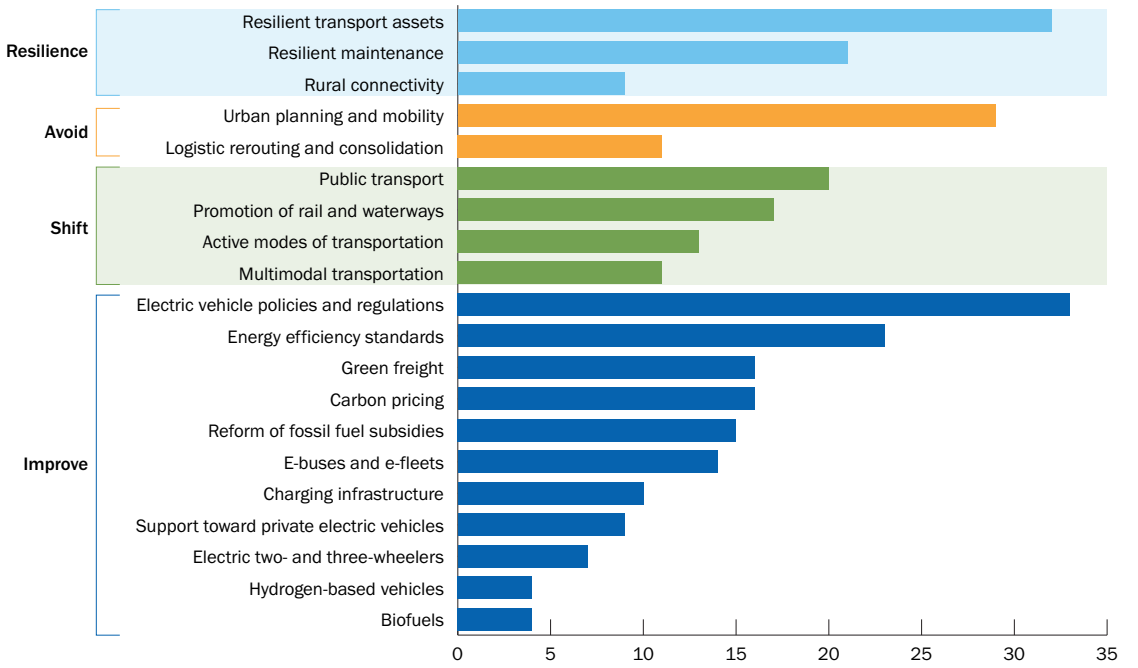
The impact of natural hazards and climate change on the transport sector is evident, and increasing the resilience of new transport infrastructure would lead to large economic gains. Many countries' design standards are outdated, not based on climate risk exposure levels, and do not incorporate flood levels to inform embankment, drainage, or pavement designs. Confirming global studies,[15] CCDR analysis shows that making all new infrastructure investments more resilient to climate change and natural hazards and increasing maintenance standards would increase upfront costs, but pay back over time, by reducing the economic impacts of climate events and the deterioration of roads. In **Brazil**,

14 This section is based on the forthcoming companion report, World Bank. 2024. *Transport and Climate Change: Insights from Country Climate and Development Reports*, Washington, DC: World Bank.

15 Hallegatte, S, Rentschler, J and Rozenberg, J. 2019. *Lifelines: The Resilient Infrastructure Opportunity. Sustainable Infrastructure*. Washington DC: World Bank. http://hdl.handle.net/10986/31805.

making roads climate resilient would cost an estimated $22 billion, but would avoid losses of around $47 billion, resulting in a benefit cost ratio (BCR) of 2.1. In **Colombia**, adapting critical primary roads for landslides, floods, and hurricanes would cost approximately $800 million and generate economic benefits that are nearly four times higher. In **Malawi**, estimated adaptation investment needs for transport infrastructure are $0.44–$1.75 billion, with a BCR of 1.7–2.7.

Figure 13: Transport sector recommendations in CCDRs



Improving maintenance is a key priority, and a high-return investment. Although maintenance comes up as a key action for increasing the resilience of the transport sector, countries are struggling to finance their infrastructure's maintenance needs. This absence of adequate maintenance funding reduces the efficiency of road transportation and can adversely affect productivity and competitiveness in all sectors. In **Madagascar**, the current lack of maintenance will make infrastructure costs increase by 50 percent in the transport sector by 2030, due to reduced lifespans. More than one-third of all CCDRs—including **Central Africa Republic**, **Comoros**, the **Democratic Republic of Congo**, **Ethiopia**, **Sahel**, **Madagascar**, **Mozambique**, and the **Republic of Congo**—make transport infrastructure periodic and routine maintenance a priority, with some, such as **Ecuador** and **Ethiopia**, also emphasizing ex-post measures via rapid response systems.

Retrofitting existing infrastructure to make it more climate resilient is expensive and should focus on the critical assets, which are most important for the transport system as a whole. Many CCDRs include criticality analyses that identify the most important transport infrastructure assets, as well as the costs and benefits of retrofitting them. In **Brazil**, economic analysis suggests that road retrofits outside of the normal replacement schedule has a BCR below 1, except for the most critical assets. These include the main corridors for soy exports, which would cost around $400 million to upgrade and bring benefits of $520 million, with a BCR of 1.3. The policy implication is that more strategic transport system management is needed, using exposure to risk and asset criticality to determine the appropriate approach. **Viet Nam's** cost-benefit analysis shows that upgrading 20 national highway sections to climate-resilient standards—which would cost around $153 million—would yield between $651 million and $3.66 billion in benefits over 35 years. The **Tajikistan** CCDR recommends that resources to strengthen infrastructure be focused on strategic corridors with high traffic volumes or critical connectivity.

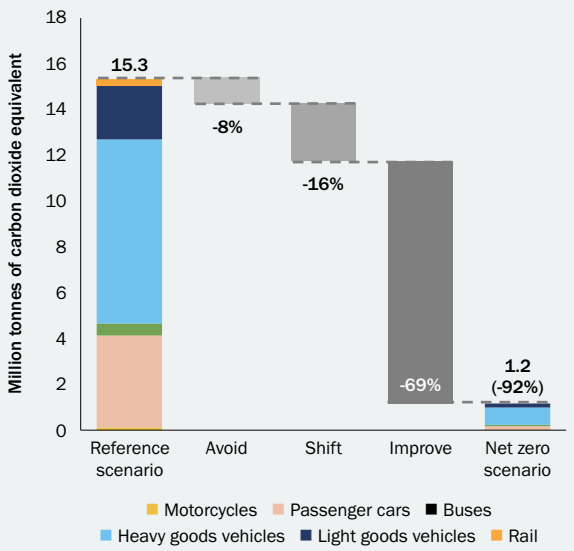
Countries can use redundancy and multimodality to increase the resilience of the transport sector while also reducing GHG emissions. Most LICs and MICs have a high reliance on road transport and road corridors. In further developing their transportation systems, they have an opportunity to integrate different networks, reducing emissions while increasing resilience and efficiency. The **Bangladesh**, **Nepal, India, Tunisia**, **Egypt**, **Cambodia**, **China**, and **Philippines** CCDRs are among those that highlight a multimodal resilient rural transport system. In SIDS, such as **Dominica** and **Grenada**, transport networks often have just one major highway, airport, and port on an island, offering limited to no redundancy, and justifying higher construction standards or early retrofitting. Similar situations are also seen in landlocked countries, such as **Rwanda**, and mountainous countries like **Nepal**.

Transport plays a key role in facilitating responses to natural hazards, whether for evacuating people before an event, or delivering goods and services in its aftermath. Improving and maintaining resilient rural roads for market and service access will keep goods moving regularly, promoting productivity, reducing food loss and the need for costly inventories, and enhancing local markets. In **Angola**, **Liberia**, and **Mozambique**, limited rural road network accessibility is considered one of the main barriers to stimulating agricultural production, and is a serious constraint for potential investors in large-scale farming, especially when transport systems are not reliable year-round. As already noted in section 2, transport infrastructure vulnerability is also an important consideration for maintaining access to education and health care, especially during rainy seasons and floods. But as discussed in the **Angola**, **Brazil**, **Liberia**, and **Mozambique** CCDRs, it is also important that connectivity is not increased at the expense of forests, which are vital for climate mitigation.

Decarbonizing the transport system can make it more efficient

CCDR coverage of transportation issues can be described through the Avoid-Shift-Improve Framework, which is widely applied in policy circles. This framework distinguishes between *avoiding* travel activity, *shifting* travel from less efficient to lower-carbon modes, and *improving* the energy efficiency of a given mode of travel. Figures 13 and 14 show that recommendations for emissions reductions in the transport sector cover the three dimensions of, and can be expressed through, this framework.

Figure 14: Avoid-Shift-Improve impact on direct inland transport emissions in Romania in 2050



Avoid

Sound city growth planning and more efficient logistics systems can help prevent the excessive movement of people and goods. Avoiding haphazard growth of populated areas and ensuring that growth is compact and resource efficient will ensure cities are not locked into costly, low-density, emissions-intensive sprawl that is hard to correct in the future. One key solution is transit-oriented development, a planning and design strategy that promotes compact, mixed-use, pedestrian- and bicycle-friendly urban development that is closely integrated with mass transit by clustering jobs, housing, services, and amenities around public transport stations. The **Cambodia, Central Africa**

Republic, Côte d'Ivoire, Ghana, Jordan, Kazakhstan, Republic of Congo, Rwanda, Senegal, and Western Balkans CCDRs all prioritize compact urban development.

Increasing efficiency in transport logistics also offers opportunities to reduce unnecessary travel, with environmental and economic benefits. In Viet Nam, this is achieved by creating economic clusters of industrial parks and economic zones around the interchanges of high-capacity, high-speed corridors, reducing the distance of supply chain traffic and avoiding freight traffic to pass through cities and move along already congested highways, further reducing emissions. Digitally improved logistics are rapidly growing, particularly in countries such as China, India, Indonesia, and Nigeria. For OECS countries and other islands, regional coordination on developing e-mobility—including vehicles, ferries, and cruise ships—and coordination on inter-island transport networks and digital logistics can help reduce transaction costs, foster economies of scale, and deepen intraregional trade and connectivity.

Shift

Investing in public transport systems and walking and cycling infrastructure is vital for shifting passenger traffic away from private motorized vehicles. Walking, cycling, scootering, e-biking, and using wheelchairs or other light devices—have the lowest emissions of all forms of transport and support an active lifestyle that brings health, social, and economic benefits. The Colombia CCDR describes the implementation of pedestrian-centric infrastructure in Bogota, which prioritizes walking and active modes of transport while reclaiming public space for neighbors and street users. Scaling up mass transit systems and enabling compact city development are key actions most countries can take to curb emissions. The Jordan CCDR stresses that improving public transport presents an important opportunity, not only to reduce air pollution from GHG emissions, but also to create equitable, inclusive, and safe mobility options. The China and Türkiye CCDRs recommend public transport investment strategies to encourage transit-oriented development as one of the main policy actions to achieve a low-carbon urban growth path.

Shifting freight from road to rail and waterways can reduce both logistic and environmental costs. It would have the added benefit of reducing socioeconomic costs from congestion (about $1.2 billion a year), air pollution, and road traffic accidents (about $15 billion a year). Türkiye's CCDR highlights opportunities from intermodality and a shift to rail transport, noting that trucks account for 72 percent of all ton-kilometers transported in the country, compared to 4 percent for rail freight, despite the distances and commodity profiles being generally favorable to rail use.

Improve

Electrifying transport offers significant environmental benefits and has a long-lasting economic impact. In Viet Nam, Kenya, and Nepal, two- and three-wheelers make up the majority of vehicle traffic, and electric versions have achieved cost parity with internal combustion engines. These vehicles should therefore be the initial focus for electrification, followed by urban buses. CCDRs often recommend reforms and regulations that create a favorable environment for electric vehicle (EV) adoption, including fossil fuel subsidy reforms, rather than focusing on direct incentives for private EV adoption. As urban settings will be the early priority for charging infrastructure, coordinating with cities' broader spatial and urban mobility plans will also be critical. For some vehicles—especially in air and maritime transport—other zero-carbon fuels, such as ammonia, hydrogen, or synthetic fuels, could also play a role; but these technologies are still far from maturity and cost-competitiveness.

3.4. Digital technologies will play an enabling role in resilience, energy efficiency, and decarbonization, but have their own vulnerability

Digital technologies can act as an enabler across sectors for both climate adaptation and mitigation activities. CCDRs mention this role in the analysis of all sectors—including agriculture, water, energy, forestry, social protection, and disaster risk management—and digital technologies are the focus of GCP4 (box 1), with expected benefits for the climate agenda. Opportunities include digital-enabled CSA via precision farming, index insurance, remote sensing, and weather forecasting, as highlighted in the **Argentina, Honduras, Indonesia** and **Tunisia** CCDRs, which help farmers increase yields during droughts and optimize water and fertilizer usage. The **Ethiopia** and **Liberia** CCDRs also emphasize the importance of digital land information systems with georeferenced registration of land rights and ownership. The **Kenya** and **Uzbekistan** CCDRs highlight the need for digital tools in forest and water resource monitoring and management to reduce carbon footprints and build greater resilience. Digital technologies can also help improve integrated weather monitoring, early warning systems, and data collection on climate hazards, land degradation, and water level management, as noted in the **Maldives**, **Viet Nam**, and **South Africa** CCDRs. Among others, the **Bangladesh**, **Cambodia**, and **Ethiopia** CCDRs emphasize the importance of digital forms of identification and payment in enabling governments to respond to climate disasters by initiating emergency cash transfers and disseminating safety information.

But the digital sector also contributes to the global carbon footprint and is susceptible to climate hazards. Multiple CCDRs—including **Nepal**, the **Democratic Republic of Congo, Benin, Ethiopia, Côte d'Ivoire, Maldives**, and **Azerbaijan**—highlight the risk of extreme weather events disrupting digital connectivity and recommend investing in climate-resilient digital infrastructure via a higher diversity of connectivity routes, early warning systems, and data backup systems, so that more people, businesses, and government actors can stay connected in the event and aftermath of climate shocks. The growing electricity consumption of digital technologies and implications for decarbonizing power systems remain to be explored.

3.5. Rapid urbanization offers a unique opportunity to build resilient, low-emission cities that contribute to more rapid growth

Urban policies are often identified as priorities in CCDRs, because of the irreversibility of urban development. The CCDR prioritization framework highlights the need to address not only the most important issues, but also the most urgent. Once cities have developed in high-risk areas, or with sprawl that makes it difficult to deploy public transit, they are hard or impossible to change. In **Poland** since 1985, urban expansion in areas with high or very high flood risks, where most vulnerable households are located, increased by more than 118 and 135 percent, respectively, far outpacing the 92 percent growth in wealthier and "safer" settlements.

Addressing urban sprawl can enhance adaptation for the urban poor and most vulnerable. The higher exposure of the urban poor to floods and landslides is well identified, and recent global analysis has found that cities are growing faster in flood zones than in safe areas.[16] CCDRs often reach similar conclusions at country level. In the **Western Balkans**, the most deprived areas[17] face higher exposure to localized flood events: compared to the top quartile, it is 11, 12, and 21 percent higher in municipalities with lowest education, lowest wages, and highest unemployment, respectively. More resilient, compact urban development implies better access to economic activity and services for a larger share of the

16 Rentschler, J, Avner, P, Marconcini, M, Su, R, Strano, E, Vousdoukas, M and Hallegatte, S. 2023. "Global Evidence of Rapid Urban Growth in Flood Zones since 1985." Nature 622(7981): 87–92. https://www.nature.com/articles/s41586-023-06468-9.

17 Local measures of deprivation are based on net earnings or wages, educational attainment, and unemployment rates.

population, including the urban poor and most vulnerable. Cities that develop in that way will be better able to attract private investment and human capital, enhancing the benefits of agglomeration.

Cities and municipalities around the world are increasingly committing to decarbonization and adaptation objectives. In **Türkiye**, **Azerbaijan**, and **Cameroon**, a growing number of cities and municipalities have joined the Global Covenant of Mayors for Climate and Energy—a global alliance of more than 11,500 cities, local governments, and city networks in 142 countries[18]—and committed to adopt local climate change mitigation and adaptation targets and prepare sectoral and city climate action plans, policies, and measures that are compatible with the Paris Agreement. **Jordan's** Greater Amman Municipality is a member of C40 Cities—a network of nearly 100 mayors who are leading on ambitious and innovative climate action[19]—and has adopted the Amman Climate Plan for 2050 and Green City Action Plan, a first in the region. The **Indonesia** CCDR reports that work is underway in Jakarta to set city-level climate targets to incentivize local authorities to mainstream climate change in cities' planning and investment prioritization.

Cities have specific climate priorities

As well as wider energy, water, and transport priorities, CCDRs identify priorities for action within cities, which require particular cross-sector coordination. These include improved and risk-informed land use, informal settlement upgrading and urban generation, affordable housing and buildings, solid waste management, and flood risk reduction, extreme heat management, and nature-based solutions (NbS).

Improved and risk-informed land use

Governments need to prioritize risk-informed land use planning and promote compact urban growth by integrating climate-smart practices in city planning systems. Analysis in the **Cambodia** CCDR demonstrates how investments in ambitious low-carbon, compact, energy-efficient urban policies and infrastructure could lead to 40 percent lower emissions, lower flood risk, and a lower share of the population exposed to urban heat. Better planning would benefit from city-level GHG inventories and climate risk assessments to improve the evidence base underpinning policy and investment decision-making. The **Brazil** CCDR notes the first-ever municipal-level mapping of GHG emissions published in March 2021, covering all the country's 5,570 municipalities from 2000 to 2018.

Informal settlement upgrading and urban generation

Action is needed to protect the most vulnerable people living in low-lying, flood prone settlements. In **South Africa**, there are still large disparities in the quality of basic infrastructure and services between poor and affluent areas as settlements continue to expand in flood-prone areas at rapid rates. The CCDR recommends taking early coordinated action to prepare the urban poor for natural hazards by upgrading buildings and infrastructure. CCDRs also recommend that cities work with low-income communities to identify and implement comprehensive upgrading interventions. In some countries, urban regeneration is a starting point to facilitate the transformation of neighborhoods. The **China** and **Romania** CCDRs recommend that climate-smart development should include the structural transformation of vacant, abandoned, or disused buildings and brownfield areas. This is in contrast to new development on the outskirts of cities and towns, which contributes to sprawl, increases congestion, impacts air quality, and results in a loss of agricultural land.

Affordable housing and buildings

Addressing the global affordable housing deficit in a climate-smart manner can have substantial mitigation co-benefits. The analysis presented in the **Türkiye** CCDR finds that immediately improving

18 https://www.globalcovenantofmayors.org/.

19 https://www.c40.org/.

energy efficiency in buildings can substantially reduce emissions and energy expenditures for households, while delaying electrification of heating until 2030 will reduce overall transition costs. The **Maldives** CCDR shows that an increased-density scenario in Hulhumalé, a reclaimed island south of North Malé Atoll, would consume one-third less water and energy than the baseline scenario and reduce infrastructure costs per housing unit eightfold. The **Kenya** CCDR discusses how changing construction materials, design, appliance and lighting use, and waste management could lower the per-unit value of embodied carbon by 10 tonnes of carbon dioxide equivalent. Finally, the **Ghana**, **Brazil**, and **Colombia** CCDRs all highlight the potential of green building certification programs—such as the International Finance Corporation's (IFC) Excellence in Design for Greater Efficiencies (EDGE) program—to improve energy and water efficiency in buildings, and lower operating and maintenance costs, thereby reducing GHG emissions.

Solid waste management

To reduce methane from the waste sector, cities can prioritize increasing waste collection, minimizing open dumping and uncontrolled landfill, managing landfill gas, and diverting organic waste from landfill. Accounting for 20 percent of the global methane stemming from human activities, and five percent of total global GHG emissions, reducing emissions from municipal waste brings environmental, economic, and health benefits. Analysis conducted for the **Nepal** CCDR estimates that significant investments in better biodegradable waste management, reduced landfilling, and improved methane capture could reduce solid waste emissions by 50–75 percent. This could be achieved alongside measures to ensure integrated sector development, including enhanced waste collection, waste minimization, increased and improved treatment, and measures to improve sector governance, especially the availability and predictability of operational financing. Beyond direct emissions from methane, GHG emissions are emitted in the process of manufacturing materials and products, which could be recycled, reused or repurposed, and more generally prevented, if the waste management system supports the capture of such materials and if products are designed and manufactured in ways that allow for reuse or recycling.

Flood risk reduction, extreme heat management, and nature-based solutions

Due to high concentrations of people, infrastructure, and economic activity, cities are particularly vulnerable to flooding and extreme heat. The CCDRs describe many approaches to reducing flood risks sustainably through a combination of hard and soft interventions, including investing in flood defenses, drainage, and stormwater systems, and non-structural measures such as risk-sensitive land use planning, community engagement, early warning systems, and emergency response systems. The **Sahel** CCDR estimates that a comprehensive, five-year flood management investment program could cost up to $2.5 billion; and a 10-year program, $3.5 billion. Integrating NbS can also help manage risks and enhance cities' adaptive capacity against climate hazards and chronic stresses such as heat, drought, floods, coastal erosion, and air pollution. NbS can be as much as five times as cost effective as engineered solutions.[20] Although the current conflict affects what is possible, the **West Bank and Gaza** CCDR discusses how spatially targeted NbS, such as permeable surfaces and adopting modular infrastructure, can help address risks and hazards in vulnerable built-up areas and expansion zones.

Cities face governance, capacity, and financing challenges

Local governments face institutional barriers in taking climate action and require technical capacity and decision-making power to plan, coordinate, and implement investments within urban areas. Most local governments have a broad legal mandate to intervene across sectors that have a high potential for climate resilience and emissions reduction within their jurisdictions. This includes land use planning and zoning, solid waste management, housing, urban transport, issuing development

20 Brill, G, Shiao, T, Kammeyer, C, Diringer, S, Vigerstol, K, Ofosu-Amaah, N, Matosich, M, Müller-Zantop, C, Larson, W and Dekker, T. 2021. *Benefit Accounting of Nature-Based Solutions for Watersheds: Guide*. United Nations CEO Water Mandate and Pacific Institute. Oakland, California. www.ceowatermandate.org/nbs/guide.

permits, and disaster risk management. But such functions are often transferred to cities without the corresponding financial, human, and technical resources. At the same time, a lack of appropriate, national-level regulatory frameworks and standards, institutional mandates that overlap with sectoral ministries, and weak coordination between national and local levels prevent local authorities from effectively performing their duty, reducing the effectiveness of infrastructure provision and service delivery. Many CCDRs note the need to clearly delineate national and local government roles and responsibilities and strengthen their local government capacity in urban and disaster risk management. In **Rwanda** and **Kenya**, where cities play a prominent role in national development, updating national urban policies would help align and coordinate them with national climate change targets, programs, and policies and integrate climate actions into urban plans. In **Indonesia**, a national urban mobility policy framework would catalyze investments in low-carbon transport and enhance energy efficiency improvements in the longer term.

Many CCDRs highlight that most cities lack financial resources and rely heavily on fiscal transfers from national governments. **Cameroon's** Municipality of Yaoundé III is a pioneer in developing climate change action plans but has found implementing these plans a challenge due to the lack of resources. In **Mozambique**, decentralization reforms have granted municipalities greater fiscal autonomy, but only 1.5 percent of national public expenditure is annually distributed to municipalities, who still rely mostly on national transfers. Mainstreaming climate adaptation and mitigation measures in urban infrastructure investments will require sustainable revenue streams via a variety of financing instruments. CCDR recommendations include enhancing own-source revenues, introducing performance indicators for allocating intergovernmental fiscal transfers, leveraging property taxes, introducing climate-informed, multiyear capital investment planning systems, and improving cost recovery for urban services. Cities will also need to adopt innovative instruments—such as credit enhancement mechanisms and guarantees, green loans and green or sustainability-linked bonds, concessional financing, carbon credit sales, and land value capture instruments—to mobilize additional resources.

Cities can explore partnerships with private sector investors and service providers for their climate initiatives. PPPs are one such mechanism, allowing risk-sharing on investments in new technologies, innovative business practices, and climate-smart performance-based contracts. In **Pakistan**, where several small, local, private companies are developing and scaling up sustainable models to curtail the waste that goes into landfills, concession contracts supported by an enabling regulatory environment could attract more private sector interest. In the buildings sector, **China, Cambodia**, and the **Republic of Congo** CCDRs discuss how tools such as EDGE are being used to incentivize private sector investment in green construction and affordable housing development as more developers understand the commercial benefits of green certified buildings.

3.6. Green value chains offer opportunities for growth, innovation, and job creation

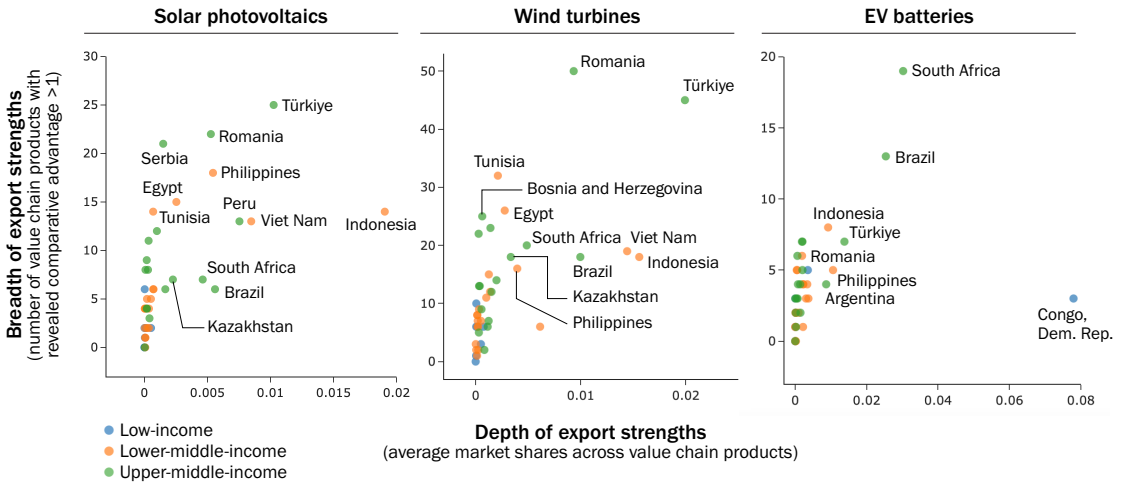
The transition to a low-carbon economy is fundamentally altering the global competitiveness landscape. With a growing number of countries introducing climate-friendly policies and taking more stringent action to decarbonize their economies, global demand is shifting away from fossil fuel-based production toward cleaner technologies and more environmentally friendly products. Key green technologies, such as solar photovoltaics, wind turbines, and EVs, are expected to see unprecedented growth over the coming decades. Nations that can strategically leverage opportunities to produce green products and participate in their global value chains could reap substantial economic rewards. Countries that can capitalize on relatively inexpensive renewable energy or other environmental or technological advantages to produce essential products and materials—such as steel, cement, and

fertilizers—in greener ways could benefit from the shifting global economy, while those that are too slow to transition away from emissions-intensive exports or production processes face greater risks. Without proactive strategies to adapt to the changing global market, these countries could face diminishing competitiveness and market relevance.

The manufacturing and mining sectors can benefit from the green transition

The CCDRs explore opportunities for countries to increase their participation in key green technology global value chains, creating new jobs while boosting incomes and exports. According to the International Energy Agency's (IEA) Net Zero Roadmap,[21] solar photovoltaic capacity is expected to increase nearly fivefold and wind capacity threefold in the next decade, while EV sales are projected to grow 18-fold by 2030. This rapid scale-up offers significant employment and income benefits for countries and industries involved in each stage of production, from mining critical minerals to assembling components. **China** is a particularly strong player in all three value chains, but the CCDRs also identify other countries that are well placed to benefit and grow their involvement further (figure 15). Owing to its strong manufacturing base, **Türkiye** occupies a strong position in all three value chains, while **Romania** has a comparative advantage in more than 25 products in the solar value chain and over 40 products in the wind value chain. **Poland** boasts an already solid standing in key clean energy value chains, including wind component manufacturing, EV end products, such as electric accumulators, primary cells, and batteries, hydrogen bus manufacturing, heat pump manufacturing, and perovskite solar cell research. With rich mineral reserves, the **Democratic Republic of Congo**, **South Africa**, and **Brazil** hold strong positions in the EV battery value chain. **Tunisia, Egypt, Viet Nam**, and **Indonesia** also show important export strengths in the solar and wind value chains, which they could leverage to further expand production of these key green technologies. Similar opportunities exist in the service sectors, such as in the digital and logistics sectors, but they have not been explored with the same depth.

Figure 15: Depth and breadth of CCDR countries export strengths across key green value chains (not including China)



Cultivating competitiveness in manufacturing technologically sophisticated products and components can spur technological upgrading, boosting people's productivity and income beyond the direct job and revenue creation. Many subcomponents associated with green technology value chains are relatively technologically sophisticated and offer important skill upgrading and knowledge spillover opportunities into other sectors.[22] Developing the capabilities to competitively produce these

21 https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach.

22 Rosenow, S and Mealy, P. 2024. *Turning Risks into Rewards: Diversifying the Global Value Chains of Decarbonization Technologies*. Washington DC: World Bank. http://documents.worldbank.org/curated/en/099936402072438837/IDU127b390ef1155014bd91aea9110575d799ce6.

products and associated components can help countries achieve greater economic growth and export diversification prospects. To promote growth and develop key manufacturing capabilities, the CCDRs emphasize the importance of: education and technical programs that can help upskill the workforce; promoting industrial clusters and special economic zones that can foster collaborative and innovative ecosystems; and measures to improve the business environment, streamline regulations, and attract foreign direct investment. Expanding green manufacturing industries could also increase service sector jobs, though the CCDRs do not explicitly focus on this dimension.

Many CCDR countries have rich reserves of critical green minerals; but their extraction and use can pose important challenges. Although green technologies require less mining than fossil fuels, the projected growth in these technologies is expected to drive a significant increase in demand for minerals such as cobalt, copper, graphite, lithium, nickel, and rare earths. Many of these are considered *critical minerals*, as they are essential inputs for key green technologies, but have uncertain supply due to geological, geopolitical, environmental, and other constraints. For example, in the **Democratic Republic of Congo**, copper mining has led to deforestation and environmental degradation due to a reliance on forest biomass for energy. Strengthening environmental regulations and promoting recycling and efficient mineral use can mitigate these negative impacts, but governance challenges such as corruption, exploitation, poor labor conditions, and a lack of transparency are prevalent in the mining sector. CCDRs recommend improving governance frameworks, increasing transparency in mining rights allocations, and enforcing labor standards to prevent exploitation and unsafe working conditions. The benefits of more sustainable mining would expand beyond green minerals. In **Brazil**, where mining activities for iron ore and manganese have caused significant deforestation, particularly in the **Amazon** region, more sustainable mining would contribute to reducing emissions and natural habitat losses.

Sound resource revenue management is crucial to ensure the benefits of mining are equitably distributed and invested, and benefit populations. Mining activities often fail to distribute benefits to local communities, particularly Indigenous groups. In **Ethiopia**, investments in transportation infrastructure for potash mining could boost export earnings and local job creation, but efforts would be needed in parallel to improve benefits for the local communities, by investing in local infrastructure and capacity building, promoting inclusive economic development, or ensuring that resource revenues are managed transparently and equitably distributed. **Liberia's** mining sector could enhance its community compensation mechanism—particularly in artisanal gold and diamond mining—by improving governance and ensuring fair distribution of mining revenues, while in **Mozambique**, better land use planning and impact assessment for graphite mining could ensure new mining projects benefit communities.

A better understanding of the potential, transparency, and accessibility of geological data could also help attract new sustainable and responsible mining investment. Mapping the world's major mineral belts shows high mineral potential in lower-income countries. But the detailed geodata available in these countries are a fraction of the data available for higher-income countries, hindering government efforts to effectively manage and leverage mineral resources in a highly competitive global industry. **Tajikistan** has substantial potential for climate-smart mining in lithium, graphite, rare earth elements for renewable energy, and platinum group metals, which could aid economic diversification and the green transition, but exploration budgets are less than a quarter of what would be expected, based on the country's global market share.

Many countries with large potential for low-cost renewable energy may also be advantaged in developing low-carbon manufacturing—for instance, in fertilizers or steel. **Brazil** and **Argentina** are notable due to their vast renewable energy resources, particularly in hydropower, wind, and solar energy, which are crucial for green hydrogen production, key element in green steelmaking. With

about 75 percent of the world's phosphate reserves, **Morocco** has become the fifth-largest exporter of fertilizers and has the ambition to become a large producer of green hydrogen and its derivatives, such as ammonia, which could make it a leader producer of green fertilizers.

Action is needed to protect people from transition risks

The CCDRs investigate the transition risks countries could face in the shift toward a resilient, low-emission economy. Countries with exports heavily dominated by fossil fuels—such as **Angola, Azerbaijan, Cameroon, Colombia, Côte d'Ivoire, Iraq**, and **Mongolia**—could face significant risks as demand for these exports decline. Over 90 percent of **Azerbaijan's** exports come from oil and gas. Such a high export concentration undermines the development of non-oil sectors, and creates a fragile economic base, where temporary revenue boosts from high fossil fuel prices often hinder economic growth. To address these challenges, the CCDRs discuss strategies for investing in renewable energy, decarbonizing existing operations, and expanding into other sectors, such as manufacturing and services, to reduce reliance on fossil fuels. Improving governance, regulatory, and enabling frameworks to support private investments in clean energy is also key. Many CCDRs also highlight the need for active labor market policies and retraining programs to help workers move from fossil fuel sectors to greener industries.

Countries are increasingly considering carbon border adjustment mechanisms (CBAMs), which would affect trade and create risks and opportunities for exporting countries. CBAMs are designed to prevent carbon leakage (when emissions-intensive activities move to jurisdictions with less stringent climate policies), maintain a level playing field in trade-exposed industries (replacing other instruments, such as tax exemptions and free emission permits), and enable more rapid emission reductions, especially those linked to consumption. From January 2026, the **European Union's** (EU) CBAM, will subject all EU importers to financial obligations linked to unpriced carbon in imported iron and steel, cement, fertilizers, aluminum, hydrogen, and electricity. This applies to direct emissions for iron, steel, and aluminum, and includes emissions from energy generation (scope 2) for the remaining sectors. The EU CBAM will be implemented in parallel with the phasing out of free emission permits in the EU Emissions Trading System. It has been implemented in stages to help manage challenges with carbon measurement and reporting and verification, which could create substantial costs for some third-country suppliers, even those with low carbon intensities, and create barriers to the EU market, especially for small- and medium-sized enterprises and in lower-capacity countries.

Modeling exercises in the CCDRs suggests that the macroeconomic impact of the EU CBAM—as currently designed—will be small, but impacts could be significant at product or sector level. For most countries, exports of CBAM-affected products constitute well below 5 percent of their total merchandise exports.[23] But others, such as **Zimbabwe** (iron and steel), **Mozambique** (aluminum), **Tunisia** (cement), and **Egypt** (fertilizer), face potential competitiveness losses under CBAM. **Morocco**, **Colombia**, and **Albania**, on the other hand, are well-positioned to gain a competitive advantage in the cement and fertilizer sectors due to their lower carbon intensities and investments toward greener production processes. In **Armenia**, the CBAM may create opportunities in downstream sectors, such as machinery and equipment or metal products. But if the EU expands its CBAM to cover more sectors, such as nonferrous metals, chemicals, and mineral products, **Armenia's** exports could be significantly affected. By investing in low-carbon alternatives, countries can improve their compliance with global regulations, such as the EU and other CBAMs, while also strengthening their competitiveness in green value chains, ensuring long-term economic and environmental sustainability.

23 With the exception of Mozambique and Ukraine, where in 2022 this share reached 18% and 7%, respectively.

4. Outcomes for people will depend on macroeconomic effects and aggregate risks and opportunities

KEY MESSAGES

- **Poorer countries are more vulnerable to climate change impacts than richer ones, are exposed to different threats, and have lower adaptation potential. Some countries, especially SIDS, have distinct geographical and socioeconomic characteristics that render them particularly vulnerable.**
- **In spite of the large potential of adaptation action, unavoidable residual risks make GHG emission reductions a priority in all countries, especially in higher-income countries and other large emitters. With well-designed policies, synergies across structural reforms, and enhanced support from HICs, resilient and low-emission development pathways can achieve similar rates of economic growth than current trends.**
- **Larger investments are required for resilient and low-emission development, especially in lower-income countries. Private investments can contribute more to these needs, but public finance will continue to play a crucial role, and more concessional resources will be required, especially in LICs.**

Macroeconomic and aggregate impacts will be critical determinants of the final impact of climate change and climate policies on people's situations and well-being. To explore the economic impacts of climate change impacts and emission reductions, CCDRs combine granular insight from sector-level analysis with consistency and general equilibrium dimensions that can only be captured through macroeconomic modeling. These analyses aim to ensure consistency across sectoral scenarios, identify positive or negative spillovers across sectors, and highlight economic trade-offs and synergies. Facing a diversity of data and model availabilities, CCDRs use different macroeconomic models and tools.[24] This section aims to summarize the key results of these analyses, bearing in mind the differences in scenarios, data availability, scope of the CCDRs, and models used.

4.1. Countries face different levels and types of climate risk, and adaptation priorities differ across countries

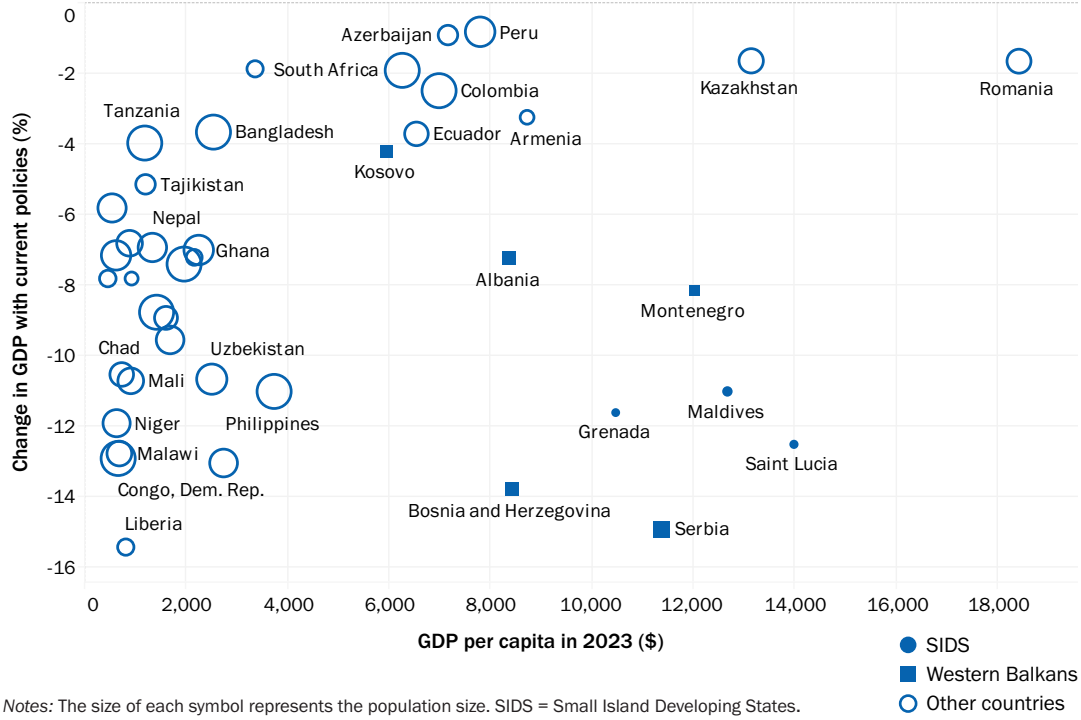
Even considering only a subset of impact categories and without exploring the larger impacts expected beyond 2050, the impact of climate change on GDP is expected to be significant. It remains out of reach to do an exhaustive assessment of all climate change impact channels, and some of the biggest risks linked to ecosystem, conflict, or economic tipping points cannot be quantified at this point. CCDRs focus on some of the most crucial impacts, including labor productivity, agricultural yields, water availability, and natural hazards. Importantly, CCDRs calculate the combined cost of climate change and natural hazards, not only the fraction of these costs due to anthropogenic GHG emissions. Figure 16 shows the estimated impacts of these channels on GDP in 2050, under a pessimistic climate scenario, which combines continued GHG emissions and a choice of climate model with higher impacts.[25] It shows that climate change impacts can have significant economywide costs by 2050, as measured against GDP. The CCDRs do not estimate impacts beyond 2050; this is an important limitation, as impacts are expected to continue increasing beyond that date, even in scenarios with rapid reductions in emissions.

24 To improve transparency and openness, the methodologies developed in the context of CCDRs—usually detailed in background notes to the CCDR—are being made available as technical papers.

25 CCDRs usually estimate climate change impacts in two climate scenarios, based on two different climate models selected to cover the range of possible climate futures in terms of temperature and precipitation change, with usually one drier and one more humid scenario. These models are usually run with an SSP3–7.0 emissions scenario, which corresponds to an expected warming of 1.7–2.6°C over 2041–60 and 2.8–4.6°C over 2081–2100.

Lower-income countries experience higher climate change impacts relative to their GDP. Analysis reveals a strong relationship between climate change vulnerability and GDP per capita, when controlling for the unique situations of **SIDS** and **Western Balkan** countries, which used a different methodology for assessing flood impacts (figure 16). Specifically, each $1000 increase in GDP per capita reduces climate change-induced GDP losses by 0.5–0.7 percentage points.

Figure 16: Estimated impacts of a pessimistic climate scenario on GDP by 2050



Notes: The size of each symbol represents the population size. SIDS = Small Island Developing States.

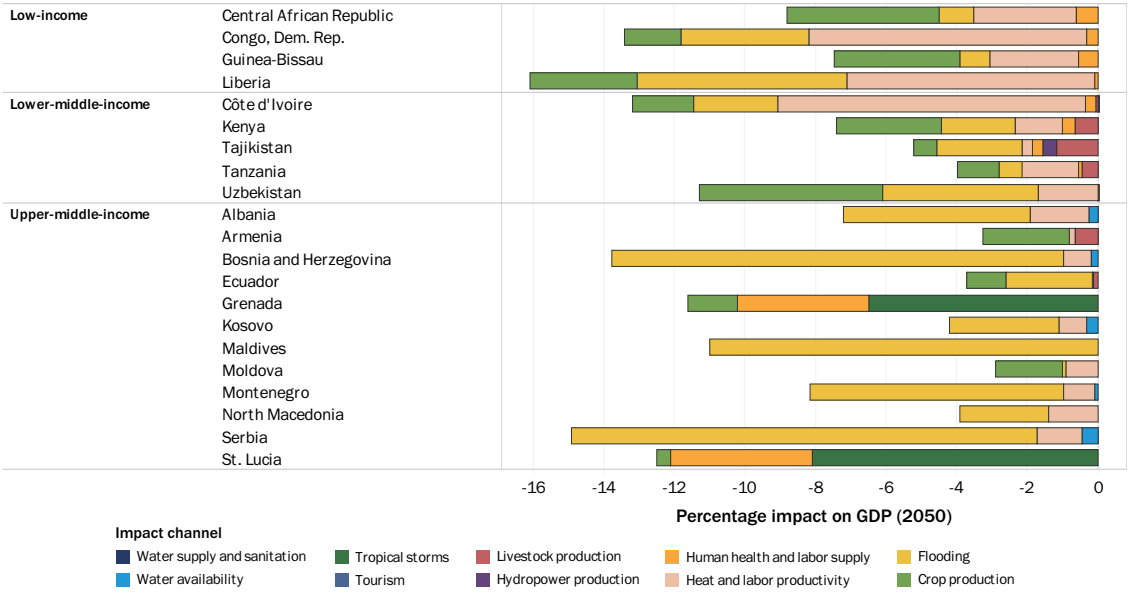
These differences can be explained by the difference in the dominant channel of impacts across countries: lower-income countries are more exposed to the effect of temperature on labor productivity, while higher-income countries are more exposed to the impacts of extreme weather events on physical capital. Figure 17 shows the disaggregation across impact channels for the CCDRs that report it—they are a subset of all CCDRs that have estimated the impacts of all channels together. For LICs with a warmer climate, a large fraction of the impact arises from the effect of heat on labor productivity (see section 2.1). For UMICs, labor productivity plays a much smaller role, with the impacts of flooding, tropical storms, and other extreme events on physical capital playing a bigger role, especially in SIDS exposed to tropical cyclones and the **Western Balkan** countries that are heavily exposed to floods. Simple regressions show that impacts on labor productivity diminish rapidly with income per capita, while impacts on physical capital increase with income per capita, probably because of these countries' higher capital-to-GDP ratio. Climate change also offers some potential gains, notably in cold countries where higher temperatures can increase—or at least do not reduce—labor productivity and improve crop yields. But in the pessimistic scenarios selected in figures 16 and 17, the impact through water availability tends to dominate the effect through temperature, and effects on crop yields are negative.[26]

The difference in the magnitude and the nature of risks across CCDRs translate directly into different priorities (and potential) for adaptation. While the impacts of floods on transport systems are often noted as a major risk, there are readily available solutions to reduce this vulnerability, by locating new transport infrastructure in safe areas or building with stronger resilience standards. In HICs, protecting

26 See individual CCDRs for results in the wetter climate scenario, in which benefits for agriculture are possible, especially if accompanied by appropriate infrastructure development (for example, see **Kenya** CCDR).

and strengthening physical assets and building the resilience of infrastructure systems is often a key priority. Impacts of higher temperatures on labor productivity for physical work outdoor are more difficult to adapt to,[27] and the solutions—structural change and inclusive development, mechanization of physical work in agriculture, and creating jobs in manufacturing and services—often depend on the broader development pathway more than on targeted adaptation interventions.

Figure 17: Selected climate change impacts of a pessimistic climate scenario on GDP



Note: Not all CCDRs have calculated the disaggregated impact of each impact channel separately.

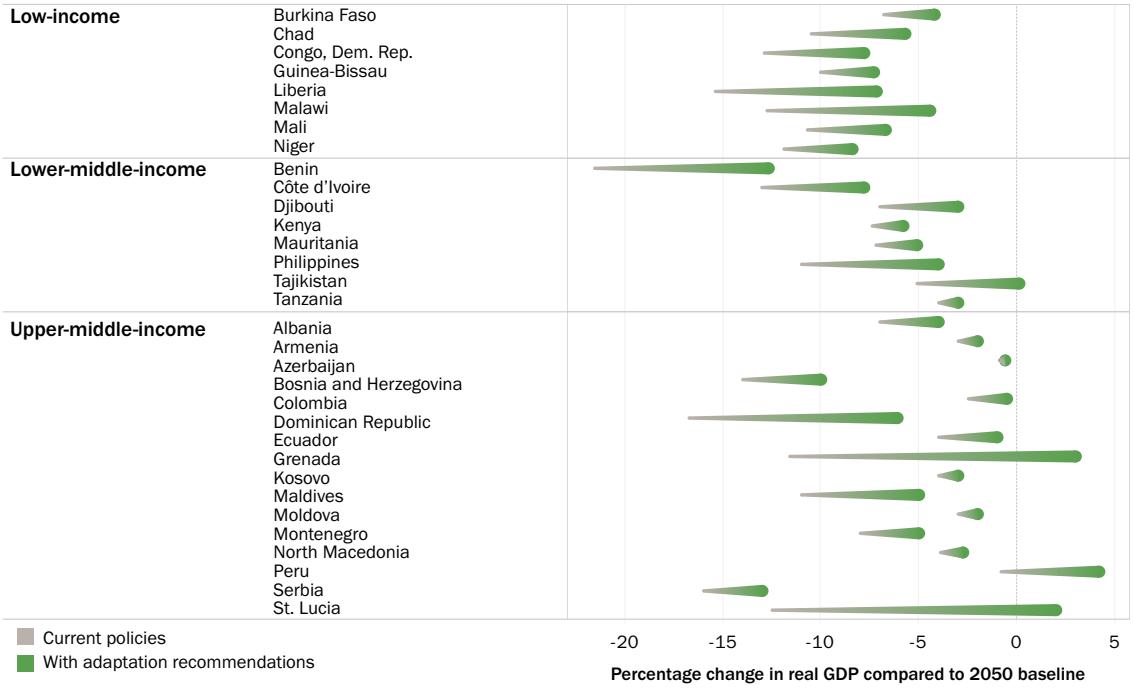
The CCDRs identify many recommendations for adaptation, estimating their impact on GDP, and often find major gains, ranging from 0.3 to 15 percentage points of GDP. Figure 18 illustrates the clear benefits of the adaptation measures recommended in a set of CCDRs. These estimates are the net effects, considering the gross benefits (such as reduced vulnerability to floods) and gross costs (such as investing in more resilient roads). The difference across countries has to be interpreted carefully: a fraction of the difference is linked to differences in vulnerability and opportunities to adapt; but they also depend on the scope of the analysis done in each CCDR.

4.2. Short-term economic growth in low-emission development scenarios can be similar to, or faster than, in the reference scenarios

Rapid acceleration of global mitigation action is urgently needed to prevent the worst impacts of climate change. Figure 18 shows that the CCDR adaptation recommendations cannot cancel all climate change impacts, and the most ambitious recommendations will reach their limit if climate change continues to increase beyond 2050. And, as illustrated by the United Nations Framework Convention on Climate Change's global stock take technical dialogue, current policies would lead to more than 2°C—and maybe as high as 3.4°C—of warming by 2100. HICs are more responsible for historical emissions and have higher per capita emissions, more capacity to develop new solutions and technologies, and more resources. As such, it is incumbent on them to accelerate their decarbonization, increase their efforts to develop greener technologies and solutions, and make them available to others, and ensure that their domestic policies do not create new obstacles for the development of lower-income countries.

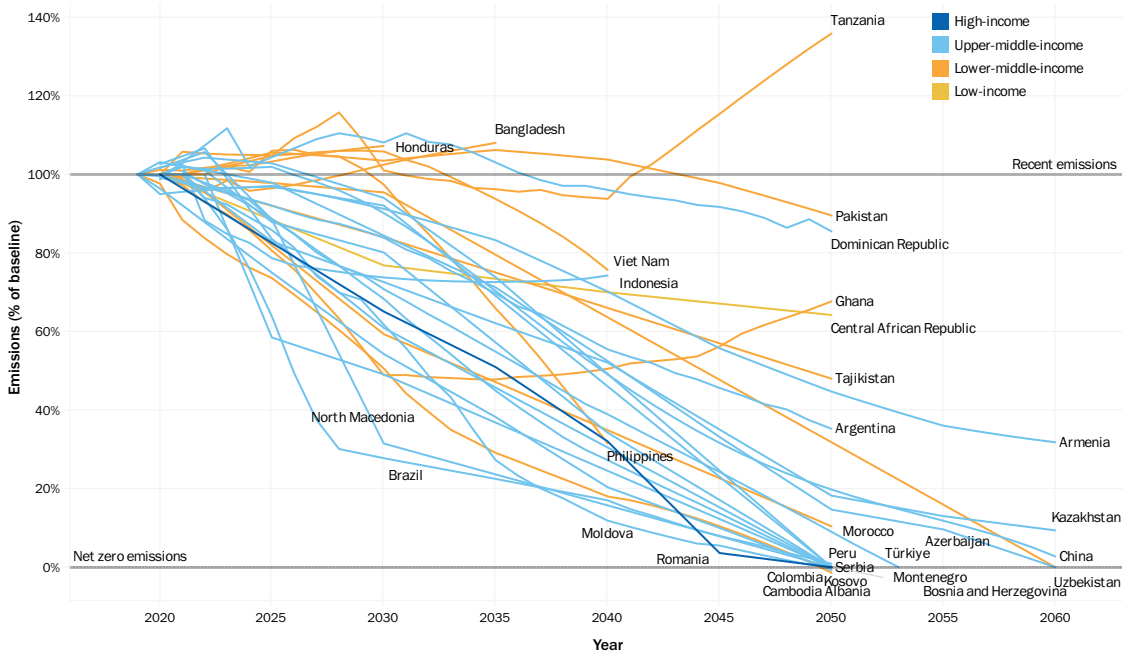
27 Counter-intuitively, impacts like labor productivity losses for outdoor workers lead to small adaptation costs, because there are few adaptation options that are cost-effective.

Figure 18: Benefits from adaptation interventions recommended in the CCDRs



Note: In countries with net gains from adaptation, the benefits of the interventions are higher than the considered climate and disasters impacts, either because they reduce disaster losses below the baseline, or because they generate other development gains.

Figure 19: Change in GHG emissions in low-emission development scenarios



To achieve global mitigation objectives, all countries have a role to play and most CCDRs explore illustrative ambitious low-emission development strategies that lead to decreasing GHG emissions (figure 19). These are not "optimal" or "least-cost" decarbonization pathways; rather, they explore the implications of plausible decarbonization scenarios that are consistent with countries' own climate targets. UMIC and HIC CCDRs systematically explore an illustrative pathway that is consistent with net zero emissions to highlight the costs, benefits, opportunities of, and barriers to, such pathways. Lower-income country CCDRs, including most LMICs, explore less ambitious scenarios, with scenario

definitions based on local context and countries' existing commitments. Since achieving the Paris Agreement's global mitigation objectives depends on global emissions, no single country trajectory can be consistent with the Paris Agreement objectives on its own.

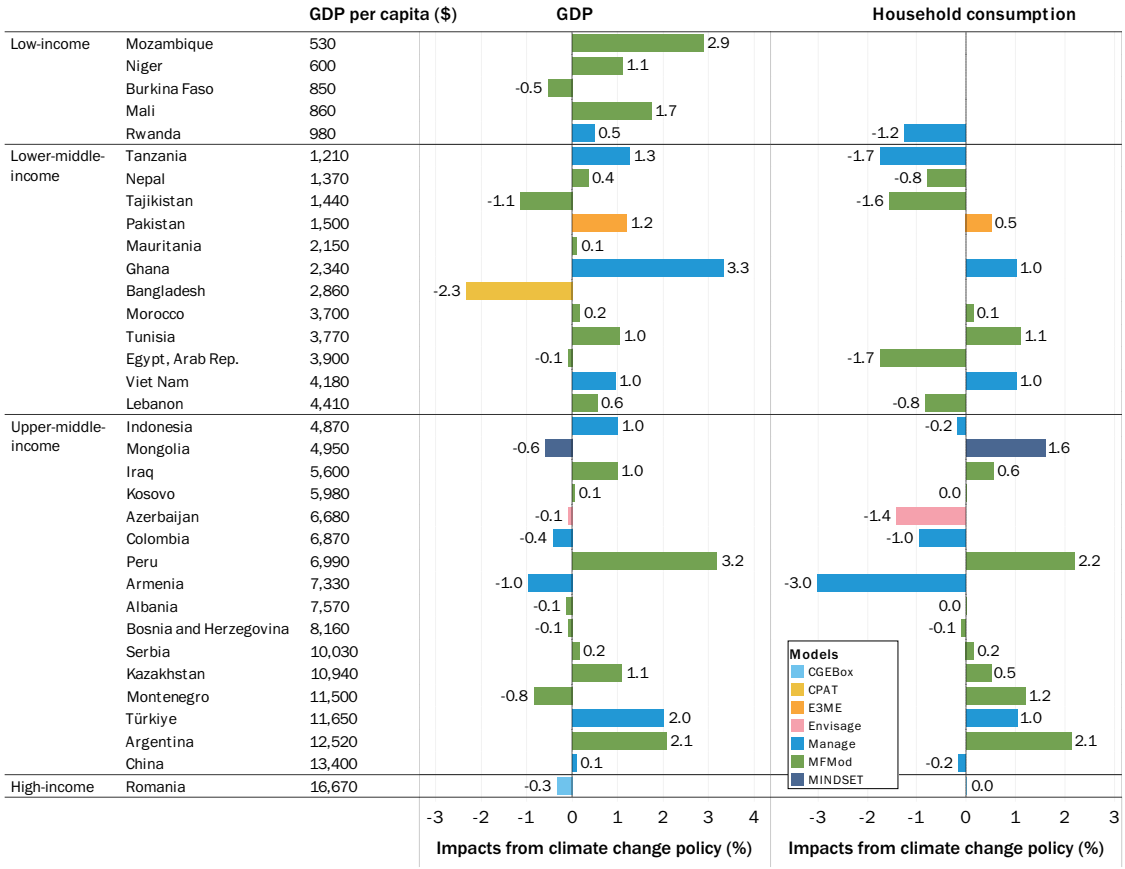
These low-emission development scenarios reduce countries' GHG emissions by 72 percent by 2050, compared to current levels. Without China, which, due to its size and current emissions, has an outsized role in total numbers, 2050 emissions in the CCDR low-emission scenarios would be reduced by 58 percent, compared to current levels. The low-emission strategies in CCDRs are often more ambitious than nationally determined contributions, emphasizing the importance of the current decade in achieving long-term climate objectives and the need to align short-term commitments with long-term pledges.

In the low-emission development scenarios, annual GHG emissions in CCDR countries could still reach more than 5.3 gigatonnes of carbon dioxide equivalent by 2050. As discussed in the first two CCDR summary reports, achieving the Paris Agreement's global mitigation objectives and reducing net global emissions to zero in or around 2050 will require enhanced ambition beyond the CCDR low-emission development pathways, including larger reductions in fossil fuel use.

More CCDRs confirm that short-term economic growth can be similar or even faster in low-emission development scenarios than in the reference scenarios, when assuming well-designed policies, synergies between structural reforms and a supportive environment. The second CCDR summary report explored in detail the macroeconomic implication of these scenarios, and the key results and explanations for these results in that report remain valid. As such, this report does not repeat the discussion. But figure 20 shows the updated results with more countries. Because low-emission development scenarios systematically require higher investments and lower operational costs, the short-term impact on household consumption is often larger than on GDP. This impact on consumption highlights the importance of the way countries mobilize financial resources, with different sources of finance creating different trade-offs, opportunities, and challenges. The impact on consumption, as well as the negative effects on some carbon-intensive sectors, means it is essential to consider appropriate compensation and social interventions to protect poor people's consumption and facilitate a just transition for workers and communities affected by climate policies. Longer-term impacts are more uncertain, as they depend on technological development, socioeconomic changes, and avoided climate change impacts.

Climate action has a more uncertain impact over the long term. While emissions reduction can lead to the early retirement of carbon-intensive capital and have a short-term impact on growth and consumption, technological change and upgrades can have a positive effect on long-term growth. For example, in **Armenia**, decarbonization has a negative impact of GDP in 2030, but growth accelerates after 2040, leading to a 2-percentage-point increase in GDP compared with the reference scenario in 2060. But long-term benefits depend on the uncertain evolution of key technologies, including those needed to achieve total decarbonization in the power sector while maintaining system stability and reliability with high penetration of renewable energy, the transport sector (notably air and maritime transport), or industry (including steel and cement).

Figure 20: Impacts of low-emission development pathways on GDP and household consumption by 2030 compared with the reference scenario, by country, income class, and per capita income



4.3. Small islands face a unique set of challenges due to climate change, exceptional levels of climate risk, and unique energy and economic contexts

SIDS possess a unique set of geographical and socioeconomic characteristics that make them particularly vulnerable to economic shocks and the impacts of climate change. They typically have relatively small populations, are remote, depend on ocean resources and imports, and have limited access to finance. For example, **Kiribati**, the **Marshall Islands**, and **Tuvalu** comprise 55 inhabited islands and numerous islets spread over 6.4 million square kilometers of the Pacific Ocean and are among the world's smallest, most dispersed, and remotest countries. The **Maldives** comprises 1,192 coral islands dispersed across 26 atolls over roughly 90,000 square kilometers with an average elevation of just 1.5 meters above sea level, making Maldivians and their assets particularly vulnerable to sea level rise (SLR) and flooding.

Economically, many SIDS are more reliant on outside assistance or have higher shares of public debt (table 1). High public spending on infrastructure investments in the **Maldives** has led to a rising debt stock (with public debt increasing from around 77 to 123 percent of GDP between 2019 and 2023) and concerns about the country's ability to service its debt. In **Dominica, Grenada, Saint Lucia**, and **Saint Vincent and the Grenadines**, overly expansive fiscal policies during economic booms led to relatively high public debt levels (80 percent on average) and limited fiscal buffers to cushion their economies during downturns. The high exposure to external macroeconomic shocks in these **OECS** countries also makes managing natural hazards and climate shocks more difficult.

Table 1: Socioeconomic characteristics of selected SIDS

Country	Population	Reliance on wage remittances (% of GDP)	Reliance on official development assistance (% of GDP)	Per capita gross national income ($)	Human Capital Index	Dependence on fishing license revenues (% of GDP)	General government gross debt (% of GDP)
Kiribati	126,614	9.7	26.3	2,888	0.48	65	17
Marshall Islands	43,550	11.8	50.1	6,570	0.40	9	22
Tuvalu	11,081	4.7	70.8	6,654	0.44	56	11
Atoll average	60,415	8.7	49.1	5,371	0.45	43	17
Other Pacific Islands average	129,276	14.9	23.5	7,942	0.51	9	42
OECS average	119,800	5.7	8.9	8,942	0.56	0	80
Maldives	523,727	0.7	2.1	10,880	0.59	6	110

Sources: World Bank Staff calculations, based on the Pacific Atoll Countries CCDR; International Monetary Federation (IMF) World Economic Outlook; IMF Article IV reports; World Development Indicators; World Bank staff estimates; and OECD Statistics.

Notes: Most data are 2018–22 average; gross official development assistance data are 2019–21 average; Human Capital Index data are only available for 2018 and 2020 and rankings are out of 177 countries, with the highest being 1; OECS average is for the four CCDR countries: Dominica, Grenada, Saint Lucia, and Saint Vincent and the Grenadines.

SIDS are particularly vulnerable to the impacts of climate change

Climate change significantly impacts SIDS, intensifying and increasing the frequency of natural hazards, with substantial economic consequences. A simple regression suggests that being a small island is associated with an additional 12-percentage point loss in GDP due to climate change by 2050, primarily driven by floods and tropical cyclones (section 4.1). And while these impacts are decades in the future, the vulnerability is already evident today: climate-related events already cause economic losses estimated at 3–4 percent of GDP in the **Marshall Islands** and **Kiribati**, and almost 7 percent in **Tuvalu**. The continuous need to rebuild infrastructure slows economic development, and the repeated impacts of flooding will make maintaining even the current capital stock a challenge. Estimates indicate that a 1-in-20-year climatic event (which has a 40 percent chance of occurring at least once before 2035) could lead to a 25–50 percent loss of GDP among the **Pacific atoll countries**. Beyond 2050, all impacts could be expected to increase as temperatures rise further and the SLR rate accelerates.

Slow-onset events, such as SLR, pose serious threats to small island communities and depend on the natural rate of island adaptation, which is highly uncertain. The physical foundation of atolls is influenced by sand produced by marine ecosystems and the relative health of coral reefs in sustaining that process of sand production. Because of this, the **Maldives** and **Pacific atoll countries** have adapted to SLR naturally in the past, but climate change impacts make their future natural adaptation potential highly uncertain. In recent decades, only 3 percent of **Maldivian** islands experienced net land loss from 2004 to 2016; 59 percent saw an increase in land area and 38 percent remained stable, owing to natural accretion and strategic land reclamation. But the degradation of coral reefs (valued at $442 million, or 8 percent of annual GDP in the **Maldives**) compromises islands' ability to produce sand and in its role in flood protection. In the **Pacific atoll countries**, infrastructure projects for both regular operations and climate change defenses rely heavily on aggregates (sand, gravel, and rock) which are highly limited, and call for a national aggregates strategy.

Even with island dynamics, the estimated impacts of SLR are substantial. This is compounded by limited institutional capacity, scarce financial resources, and a high degree of vulnerability to systemic shocks. In the **Maldives**, it is estimated that SLR impacts would cause an almost 11-percentage point reduction in GDP by 2050 under a high-emissions scenario. Rising sea levels and beach erosion may also impact tourism, which employs one-in-five workers in **Saint Lucia**. A reduction in precipitation by the turn of the century, alongside rising temperatures and lower crop yields are projected to reduce **Dominica's** GDP by

up to 3.5 percent, while increasing temperatures reduce outdoor labor productivity, with additional output losses of up to 4 percent of GDP expected for all four OECS countries by 2050. Climate impacts, which can vary significantly by island, impede adaptation efforts, which must be also locally targeted.

The CCDRs' limited time horizon—often to 2050—may hide large long-term vulnerabilities for SIDS, and therefore the existential risks they face. For example, in the **Pacific atoll countries**, the medium- and high-emissions scenarios (SSP2–4.5 and SSP5–8.5, respectively) could imply 0.5 meters of SLR between 2070 and 2110 and 1 meter between 2110 and 2150. A 0.5-meter rise could submerge up to 20 percent of South Tarawa, **Kiribati** during high tide, with floods affecting up to 70 percent of buildings. In the **Maldives**, accelerated SLR from a strong warming scenario (RCP8.5) could result in a cumulative SLR of 0.2–0.5 meters by 2050 and up to 1 meter by 2100, compared to the 1995–2014 mean. These SLR levels are likely to be an existential threat, given the country's low-lying terrain and erodible landforms. SLR could lead to frequent inundation or even submersion of islands, significantly reducing the already limited land available. SLR projections suggest that **Saint Lucia's** shorelines will retreat 22–27 meters by 2050, and 51–78 meters by the end of the century, depending on the emissions pathway (RCP4.5 or 8.5). This implies that up to 57–61 percent of Saint Lucia's current hotel accommodation will no longer be near a sandy beach by 2100, which is critical for tourist jobs and income.

Adaptation needs to evolve with changing climate change impacts

A range of adaptation actions can mitigate the impacts of increased coastal flooding and shoreline erosion due to SLR. These can be further organized around three broad categories of action—protect, accommodate, and retreat—which are not mutually exclusive and need to be adjusted according to their relative effectiveness and risks.

- **Protect options** aim to protect coastlines with different types of gray and green infrastructure, such as revetments, seawalls, or vegetated natural buffer zones, including mangroves. The latter can reduce the erosive effects of waves and help islands adapt naturally through sediment capture, but not completely block flooding.
- **Accommodate options** reduce the impacts of flooding by raising dwellings or land, or reclaiming new land from the sea.
- **Retreat options** are for when flooding becomes unacceptable and people need to move further away from the shore (behind setback lines) or to higher places, either within their own country, or in another country.

Applied to the Maldives, this approach suggests that the 11-percent negative GDP impact could be reduced to less than 6 percentage points through a combination of sustained reconstruction and adaptation investments including land reclamation and gray coastal protection infrastructure. Over time, more than three-quarters of the 188 inhabited islands have seen some form of island or sandbank widening (and in selected cases, also raising) or a seawall, breakwater, or groyne erected on its shores. The financing requirements for adapting to SLR and flooding alone range from $2 billion to $4 billion and is based on bespoke coastal protection solutions that cater to the physical characteristics of each island.[28]

In the OECS countries, the frequent nature of climate hazards and risks dictate a different approach to building a *resilient core* by either retrofitting capital assets or building back better with new infrastructure. Results show that the total discounted costs of achieving a resilient core through the

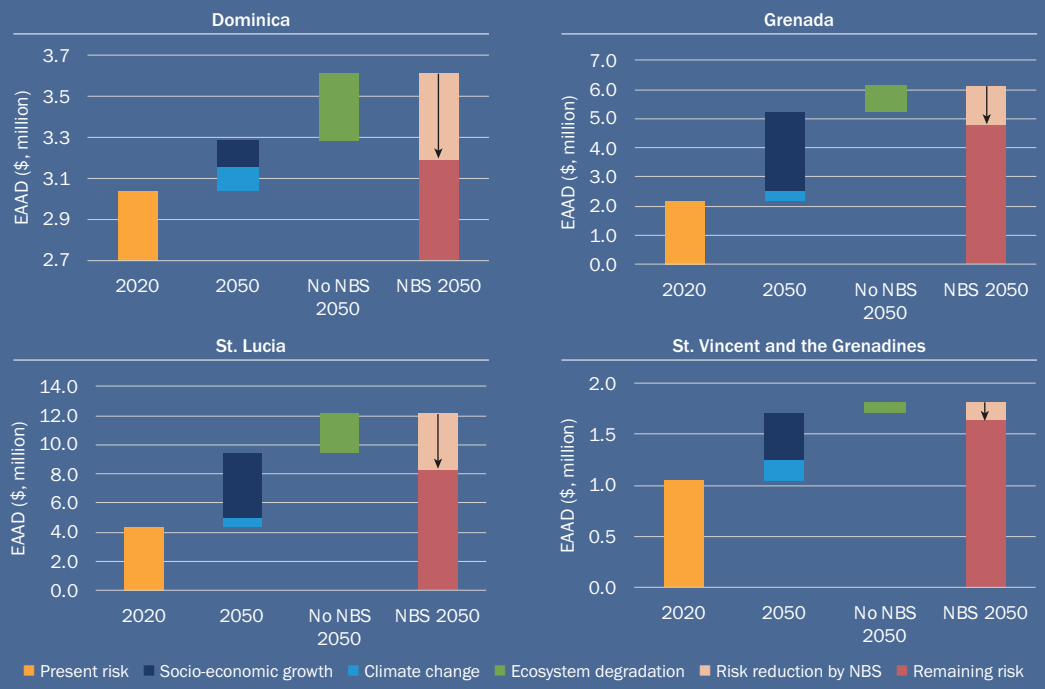
28 They do not include other adaptation costs, such as those related to ocean warming, which will significantly threaten tourism and fisheries, or the financing gap for mitigation, which has been estimated at $1 billion.

retrofit scenario—in which capital assets are retrofitted to make them resilient to a 100-year event for hurricanes and a 50-year event for flooding over a 15-year time horizon—is at least 2 percent of cumulative GDP over the period 2024–2050.[29] Under the alternative build back better scenario, there is no retrofitting, but all new investments for depreciated or destroyed capital are designed to the improved resilience standards over a 25-year horizon. This scenario enables significant cost savings compared to the retrofit scenario. But considering that resilient investments occur only when capital fully depreciates or is destroyed, this longer time horizon would also mean that residual risks remain elevated for longer and that avoided losses take longer to be realized. When selecting adaptation options, it is also important to consider land tenure implications of both impacts and measures, including the need to protect affected people's land and natural resource rights, as well as spatial and land use planning.

Box 6: Nature-based solutions: protecting corals to reduce coastal flooding in the OECS

NbS can complement other investments in coastal resilience and provide significant co-benefits. Beach, mangrove, and coral restoration are among the key NbS available in this context that can reduce the long-term impacts of climate change and ecosystem degradation (figure 21). In OECS countries, the BCR of beach restoration is mostly greater than 1, driven primarily by benefits to tourism, rather than flood mitigation. In places where mangroves are ecologically viable, mangrove restoration brings significant benefits (with a BCR of 4–5), particularly due to the benefits of enhanced carbon storage. Coral restoration, on the other hand, delivers a BCR of less than 1 unless flood mitigation benefits from corals are present. This caveat highlights the need for spatial prioritization of NbS investments to target corals that provide protection against flooding.[a]

Figure 21: Effect of NbS on expected average annual damages due to coastal flooding in OECS countries



Source: GFDRR. 2024. "Nature-based solutions for coastal resilience." Background note for the OECS CCDR. https://openknowledge.worldbank.org/bitstreams/ed18dd98-1033-4ea6-b8e7-a45bd1c6902a/download.

Notes: EAAD = Expected Average Annual Damages. The baseline risk of 2020 (including the effect of existing ecosystems) is shown in orange. This risk increases by 2050 due to climate change (SLR) shown in light blue and socioeconomic growth (which increases the value of the assets exposed to flooding), shown in navy. Ecosystem degradation reduces flood-mitigation capacity of NbS and creates additional damages, shown in green, which can be reduced by preserving and enhancing NbS. The risk reduction by NbS is shown in light pink, and the total risk with NbS by 2050 in red.

a) This analysis was prepared using the coastal NbS opportunity scan from https://naturebasedsolutions.org/.

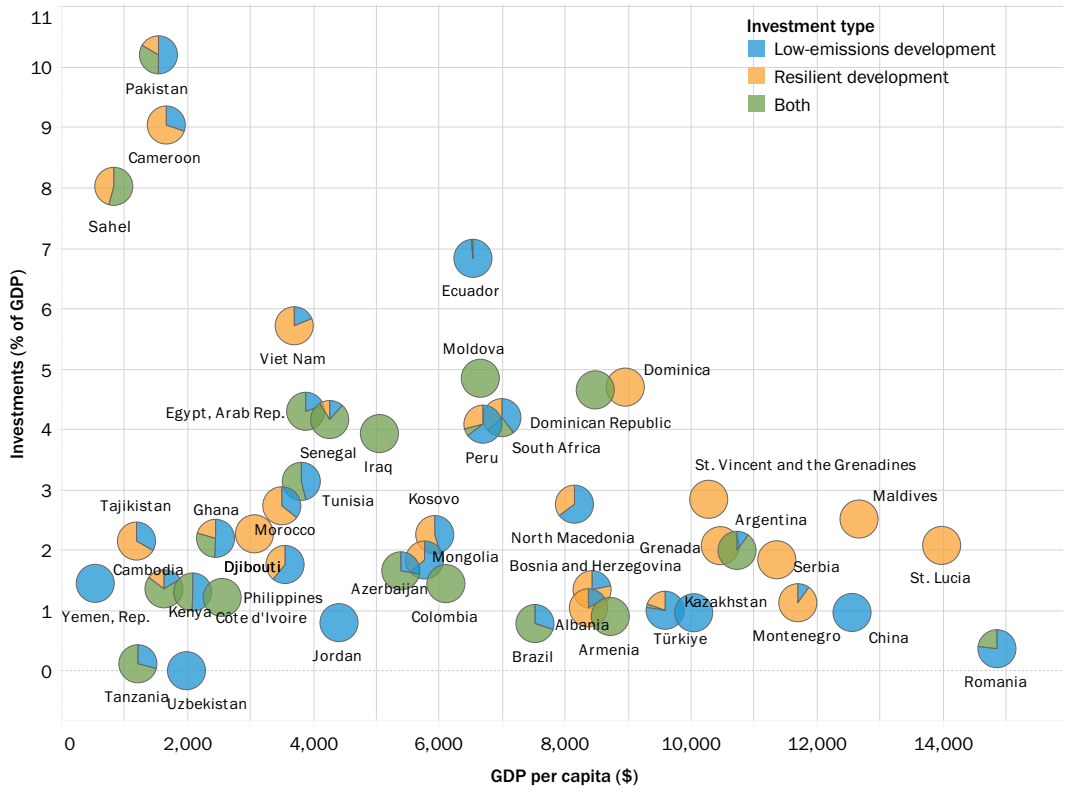
29 Values are discounted over the timeline of implementation (15 or 25 years) using a 6% discount rate.

There are tradeoffs between building resilience and debt sustainability

Some adaptation investments are high cost and could put fiscal sustainability at risk if interventions are not selective and strategically funded. While investments in adaptation can significantly reduce and even reverse potential economic losses, the fiscal costs of interventions are substantial even for adaptation investments limited to a resilient core, implying the need for selectivity and prioritization. Using alternative funding sources can also improve debt sustainability. In **OECS countries**, increasing indirect taxes will have a temporary negative impact on GDP, but could increase GDP to similar levels as debt financing, with a more modest increase in the debt-to-GDP ratio. Funding adaptive investments by reallocating public expenditure could also keep debt levels in check, but at a greater expense to long-run GDP, particularly if adaptation investments are funded by reallocating existing capital expenditures.

4.4. Investment in resilient low-emission scenarios and climate finance

Figure 22: Increase in annual investment in CCDR countries' resilient low-emission scenarios



Investments for resilient, low-emission development are larger in lower-income countries

The resilient, low-emission pathways explored in the CCDRs include investments that are, on average, 1.4 percent of GDP higher than in the reference scenarios, between now and 2030. These additional investments are higher as share of GDP for LICs (figure 22). Extrapolating CCDR results using the average incremental investments by 2030 per income group suggests that, excluding China, all LICs and MICs will need about $960 billion in additional annual climate-related investments by 2030.[30] This estimate is slightly lower than the Independent High-Level Expert Group (IHLEG) on Climate Finance[31] projections of $1.2–1.7 trillion. The discrepancy is due to differences in the timing and ambition of climate action, with

30 Total needs are estimated at $4.8 trillion (2.9% of cumulative GDP over the same period). Although CCDRs use different starting points, assuming these investments are realized over a five-year period, the annual investment requirements amount to $960 billion.

31 Songwe, V, Stern, N and Bhattacharya, A. 2022. *Finance for Climate Action: Scaling Up Investment for Climate and Development*. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. https://www.lse.ac.uk/granthaminstitute/publication/finance-for-climate-action-scaling-up-investment-for-climate-and-development/.

CCDRs, for example, considering a 72 percent reduction in GHG emissions by 2050.[32] It is also important to note that many CCDR estimates are partial. They include the sectors that cover each country's most important needs, making them good—but still conservative—proxies for total needs (box 7).

Box 7: Comparing CCDR and global estimates of investment for resilient low-emission development

There are several global estimates of investment needs. Among the most commonly used are the IHLEG on Climate Finance and the World Bank's Beyond the Gap report.[a] The IHLEG report finds that around $1 trillion per year is needed by 2025, and $2–2.8 trillion by 2030, for emerging markets and developing countries other than China (the second IHLEG report converges to $2.4 trillion by 2030).[b] These are total investments, including development and climate-related needs, while additional climate-related investments are estimated at $1.2–1.7 trillion per year by 2030 (with a similar ratio, it puts the 2025 climate-related needs at $600 billion). World Bank estimates from Beyond the Gap are $1.5 trillion by 2030 in the "preferred scenario," but vary from $640 billion to $2.7 trillion, depending on the ambition of the scenarios and assumptions on policy efficiency.

These estimates cannot be directly compared with CCDR estimates, which are not necessarily a measure of a country's total needs. The CCDRs analyze resilient, low-emission development scenarios. These bottom-up, ambitious scenarios do not necessarily achieve all country development goals by 2030, especially where significant economic, financial, or government constraints make it particularly challenging. In contrast, global estimates tend to assume that SDG and decarbonization objectives are met by 2030 in all countries. The CCDRs and global studies use different scopes, ambitions, and timing, as outlined here.

Differences in scope and baseline: Estimates from the IHLEG and Beyond the Gap reports focus on full investment costs to achieve development goals and climate objectives. The CCDRs, on the other hand, focus on the interplay between climate and development and compare different development pathways, using different baselines depending on what appears most useful and relevant in each country.

Differences in scenario ambition: The CCDRs analyze country-specific scenarios, building on countries' own priorities and commitments. As such, the ambition for development, mitigation, and adaptation differs from most global studies, which apply a more uniform, top-down approach. For example, the CCDRs do not achieve net zero emissions in 2050, and there are no universally agreed objectives for adaptation and resilience, leading to different levels of ambition across CCDRs. The differences in development scenario ambitions also have a major impact on estimated investments. Most CCDRs do not achieve all SDGs, so it is unsurprising that the identified investment are lower than in global studies that assume uniform SDG achievements.

Differences in the timing of investments: Even if studies analyze scenarios with the same target (such as net zero by 2050), there are many pathways to achieving the same end goal. To minimize short-term costs and ensure realistic implementation timelines, the CCDRs tend to delay the most expensive actions, thereby reducing short-term costs compared with global studies.

a) Rozenberg, J and Fay, M. 2019. *Beyond the Gap: How Countries Can Afford the Infrastructure They Need while Protecting the Planet*. Washington DC: World Bank. http://hdl.handle.net/10986/31291; Songwe, V, Stern, N and Bhattacharya, A. 2022. *Finance for climate action: Scaling up investment for climate and development*. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

b) Bhattacharya, A, Songwe, V, Soubeyran, E and Stern, N. 2023. *A climate finance framework: decisive action to deliver on the Paris Agreement—Summary*. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

CCDR investments represent additional investments by 2030, compared with a reference scenario, to boost resilience, finance adaptation, and enable countries to undertake low-emission development. In UMICs, additional investments are calculated as the difference between a resilient low-emission development scenario and a business-as-usual development scenario achieving the same development goals. These estimates remain moderate because they consider both the additional investments (for example, more solar power) and the investments that are no longer needed, such as coal power plants or natural gas infrastructure. On the A&R side, since these countries already have well-developed

32 World Bank. 2023. "What You Need to Know About How CCDRs Estimate Climate Finance Needs." https://www.worldbank.org/en/news/feature/2023/03/13/what-you-need-to-know-about-how-ccdrs-estimate-climate-finance-needs.

infrastructure systems, the estimates tend to include the incremental cost of building the new assets at a higher resilience standard and high-priority retrofitting needs. As a result, the net effect on investments UMICs is not very large, suggesting that, in these countries, aligning development and climate magnifies the financing challenges they face, but only moderately.

In most LICs and LMICs, the CCDR recommendations are not about reallocating investments; rather, they recommend a major increase in investments to accelerate development in a more resilient and sustainable way. To boost resilience in LICs, countries will need to quickly close development and infrastructure gaps, such as a lack of access to improved water or modern energy. The **Sahel** CCDR does not explore how to provide green, resilient energy access to the same number of people as in a business-as-usual scenario; rather, it looks at the investments needed to provide more people with access to green and resilient electricity.

In LICs and LMICS, investments in the resilient low-emission scenarios primarily depend on the scenario ambition—for example, the year when the population would have universal access to improved water and sanitation. The **Sahel** and **Pakistan** CCDRs estimate investments in very ambitious development scenarios, leading to very large investment levels. This dependency on the development objective is the reason why LIC and LMIC CCDRs exhibit a large range of estimates, from only a few percent of GDP to 5 or 10 percent, or in some cases, more. As an extreme case, the **Central African Republic** CCDR identifies total investment needs at $15.5 billion, representing more than 35 percent of annual GDP if realized by 2030. The large additional investment needs in LIC and LMIC resilience low-emission scenarios shows the size of the financial challenge these countries face to achieve their development goals in a resilient and sustainable way.

Climate finance flows are much lower than investment needs and show substantial geographic and sectoral disparities

There is no single definition of climate finance, and methodologies are not consistent across data sources, leading to varying expectations from countries. It also leads to widely varying estimates of climate finance needs and flows, depending on the underlying assumptions and methodologies used.

Data show substantial mismatches between climate finance flows and needs, across geographies and sectors. For instance, Least Developed Countries receive only 3 percent of global climate finance, while emerging markets and developing economies (excluding China) receive 15 percent.[33] One of the causes of this discrepancy is that financing is often tied to absorptive capacity rather than actual needs, leaving Least Developed Countries particularly underfunded. Adaptation finance also represents less than 5 percent of global climate finance flows, with 98 percent sourced from public funds. This imbalance is compounded by the need to ensure a just and equitable transition that does not disproportionately affect vulnerable populations or reverse development gains.

Where climate action aligns with development priorities, public finance can be allocated (or reallocated) to avoid conflict between these objectives. The **Maldives**, which is heavily dependent on imported diesel fuel for over 90 percent of its energy needs, is accelerating the shift toward renewable sources, particularly solar, to combat climate change and strengthen its energy security, and planned renewable capacity additions could help it reduce diesel fuel imports by up to 30 percent by 2040. In **Ethiopia**, the hydropower sector, which contributes about 90 percent of the country's power supply, is highly sensitive to changing rainfall patterns, hydrological cycles, and increased risks of flooding or extreme winds. So, diversifying the electricity generation mix to manage climate-induced increases in the variability of hydropower generation is crucial for the energy system's long-term sustainability.

33 Climate Policy Initiative. 2023. *Global Landscape of Climate Finance*.

Public finance and concessional capital are crucial for direct investments in resilient low-emission development, but also to address barriers to private finance

The private sector can undertake a major part of the investments and financing for climate action, if the policy and regulatory conditions and, where appropriate, blended finance opportunities are in place to provide attractive combinations of risk and return. Figure 23 shows that, in a subset of countries and sectors, the private sector could provide a large share of financing across multiple sectors, although the expected share of private sector participation varies widely between countries and sectors. In industry, most CCDRs expect the financing to come from the private sector, while in water, the public sector is expected to cover most of the needs. But in transport and energy, there are large differences across countries, due to the nature of investments—for example, there would be more public sector financing for electricity transmission and transport infrastructure, and more private sector financing for power generation and transport fleets—and country economic structures. But a general finding is that, to mobilize more private investments, countries will need to be able to make more long-term financial commitments, financially stronger utilities, more robust planning capacities, and more transparent and competitive procurement processes.

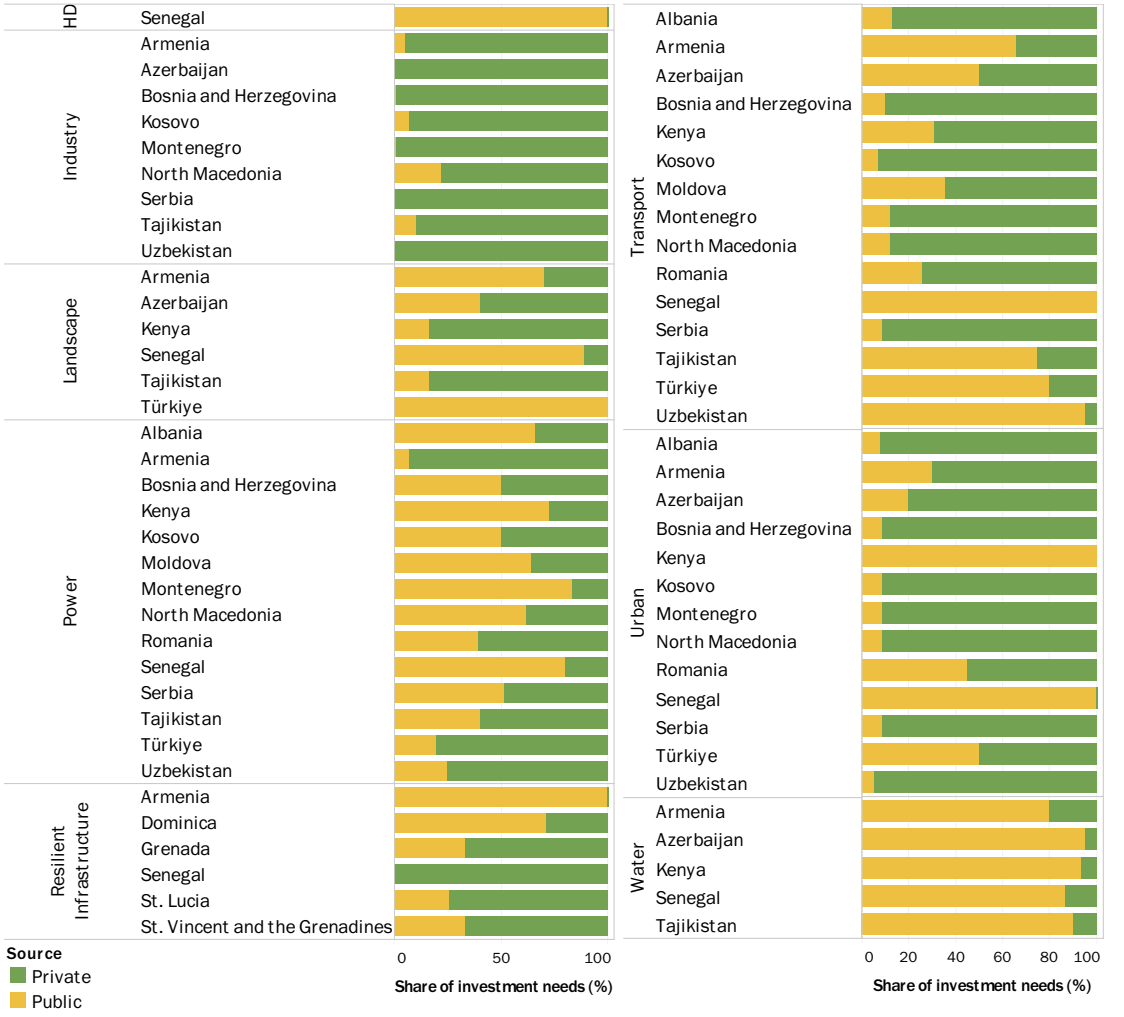
Private sector resource mobilization will also depend on the development and regulation of domestic capital markets. Key CCDR recommendations on these topics include enhancing financial sector regulators' capacity to assess climate risks in the finance sector, as seen in **Colombia**; developing a sustainable finance roadmap for the financial sector, as seen in **Türkiye**; developing supervisory guidelines on green finance and investment, and developing disclosure and reporting regulations on green or sustainable finance, including through taxonomies; and integrating green finance into financial inclusion agenda.

Public finance will play a crucial role beyond derisking private investments. About 60 percent of the investments identified in the CCDR scenarios are expected to be met by mobilizing domestic resources; and, in the near term, public finance is anticipated to continue playing a significant role. The public sector will also play a crucial role by providing investment signals through policy and regulations. For example, the use of carbon pricing instruments can drive investments toward low-carbon activities. Rigorous policy reforms, optimal allocation of limited public resources, increasing public climate expenditure, and improving the overall efficacy of public spending while also securing enhanced financial support from the international community are all crucial. **Benin** has begun integrating climate considerations into its performance-based budgeting system, developing mechanisms to assess and track climate-related expenditures. This approach includes enhancing budget planning tools, such as macroeconomic orientation and medium-term expenditure frameworks to address climate risks. Public spending can also provide an investment signal that is crucial for an orderly transition, such as repurposing fossil fuel subsidies. The **Maldives**, which spent approximately $199 billion (3 percent of GDP) on fuel and electricity subsidies for imported fossil fuels in 2023, intends to eliminate blanket subsidies on fuel and electricity starting in Q4 2024, reducing overall subsidy spending on food, fuel, and electricity by 55 percent to $99 million in 2024. This highlights the importance of ensuring public investments and spending (such as subsidies) are aligned with climate and development priorities to enhance domestic resource mobilization. This is particularly true for countries that face substantial fiscal constraints and may not be able to increase public spending on climate finance in the near-term.

Efficient, resilient infrastructure services—including energy, water, and transportation—also depends on the performance of state-owned utilities, which are often the primary providers. Recognizing this, the CCDRs emphasize the need for targeted state-owned enterprise reforms to boost efficiency and service delivery. In the water sector, this includes reducing network losses to improve resource management and access. In transportation, optimizing fleet management and infrastructure can

enhance reliability and reduce emissions. And in the energy sector, ensuring cost recovery and financial viability of utilities are crucial steps toward supporting resilient, low-carbon growth.

Figure 23: Public-private split of investment needs in CCDR low-emission development scenarios



Note: HD = human development.

The affordability of other forms of financing remains a significant challenge, and concessional resources are insufficient to support the transition, especially in LICs and LMICs. Concessional resources are scarce, and climate-related projects face various barriers in accessing affordable finance, including macro fiscal risks that limit investor willingness to enter a market; sectoral risks, such as the poor financial standing of utilities responsible for making payments; and project or program risks, such as a limited track record or lack of financially viable business models. There is also a mismatch in expectations related to the availability of dedicated sources of climate finance—such as the Green Climate Fund and Adaptation Fund—relative to their size,[34] and stakeholders often underestimate the procedural requirements associated with accreditation, meeting funding criteria, and reporting on progress, which can be time-consuming and require substantial effort. To meet needs for resilient low-emission development, access to increased amounts of concessional funding will be necessary, especially in lower-income countries, and these resources should not be at the expense of concessional development finance.

34 While capitalization cycles vary, current pledges or resource mobilization for the dedicated global climate funds for the next ~4 years amount to less than $25 billion.

Carbon markets have the potential to channel much-needed climate finance toward climate action. Many countries—including **Benin**, **Brazil**, and **Côte d'Ivoire**—are looking to access carbon markets under Article 6 of the Paris Agreement to leverage carbon finance for investments in forest production, conservation, and reducing deforestation. Others, such as **Kenya** and **Uzbekistan**, are considering the role of carbon markets in mobilizing non-debt finance for supporting energy transition. While carbon markets are unlikely to meet a large proportion of the total financing needed for climate action and will certainly not meet all needs, they provide revenues that do not need to be repaid and can be deployed flexibly to address underlying financing challenges. As part of a broader policy mix, high-impact, high-integrity carbon markets that encompass domestic carbon pricing instruments, Article 6 and voluntary carbon markets can offer important price signals and channel climate finance toward emissions reductions. Importantly, countries need to have the enabling environment and institutional and market infrastructure to participate in carbon markets, and to have fully operationalized Article 6 for markets to scale.[35]

The toolkit of climate finance instruments available to countries for mobilizing private capital toward climate mitigation and adaptation investments has significantly expanded over the years. It includes capital markets solutions, sovereign green and sustainable bonds (as issued by **Colombia, Brazil**, and the **Dominican Republic**), and green and sustainable loans (as issued by **Côte d'Ivoire** in 2023) with issuers committing funds to finance climate expenditures, as well as sustainability-linked instruments. The toolkit also includes banking instruments (risk-sharing facilities) and public-private funds, such as climate finance facilities (for example, **Rwanda's** Ireme Invest), insurance, and disaster risk sharing instruments. Market-based instruments enable institutional investors to participate in climate-related investments. But not every country can explore all these options, as each instrument has distinct preconditions and structuring challenges and is intricately linked to specific country circumstances. Each country's choice of instruments will be guided by the nature of its funding needs, macroeconomic conditions, financial sector development, availability of financial resources from different sources, and expected achievable private sector mobilization.

Many CCDRs identify disaster risk finance as a priority

Disaster risk finance and insurance (DRFI) solutions are at the core of countries' climate adaptation and disaster resilience efforts, aiming to help people, businesses, and governments to not only cope, but also prosper, in the face of climate shocks and disasters. It is impossible to eliminate all risk; so building resilience requires investments in financial preparedness, to ensure countries and communities are ready to cope with the likely costs of disasters and minimize their direct and indirect impacts. At the same time, without appropriate investments in risk reduction, risks would continue to increase, making risk finance solutions unaffordable.

To protect public finance against the contingent liabilities created by climate change and natural hazards, countries can mobilize a series of tools and instruments. Governments need DRFI strategies to strengthen crisis preparedness and ensure the delivery of essential services and reconstruction of public assets after a shock. Countries with greater financial capacity can self-insure, but for many, a comprehensive DRFI strategy with international risk transfers is essential to protect public finance, maintain government continuity, and act as reinsurers of last resort for private firms and individuals.

Comprehensive DRFI strategies often rely on a layered approach (figure 24)**.** This differentiates instruments that are more or less appropriate for different types of risk (frequent and moderate shocks

35 For a more detailed discussion on challenges and opportunities in carbon markets, please see World Bank. 2024. *State and Trends of Carbon Pricing: International Carbon Markets*. Washington DC: World Bank. http://hdl.handle.net/10986/42094.

vs. rare and high-impact shocks) or different financing needs (urgent needs to maintain government continuity vs. longer-term reconstruction needs). These instruments include:

- Sovereign contingent finance, such as the World Bank's Catastrophe Deferred Drawdown Options or Cat-DDOs, which provide rapid liquidity to address natural hazards and other shocks—**Dominica** and **Grenada** already have such lines in place, and CCDRs often recommend this instrument

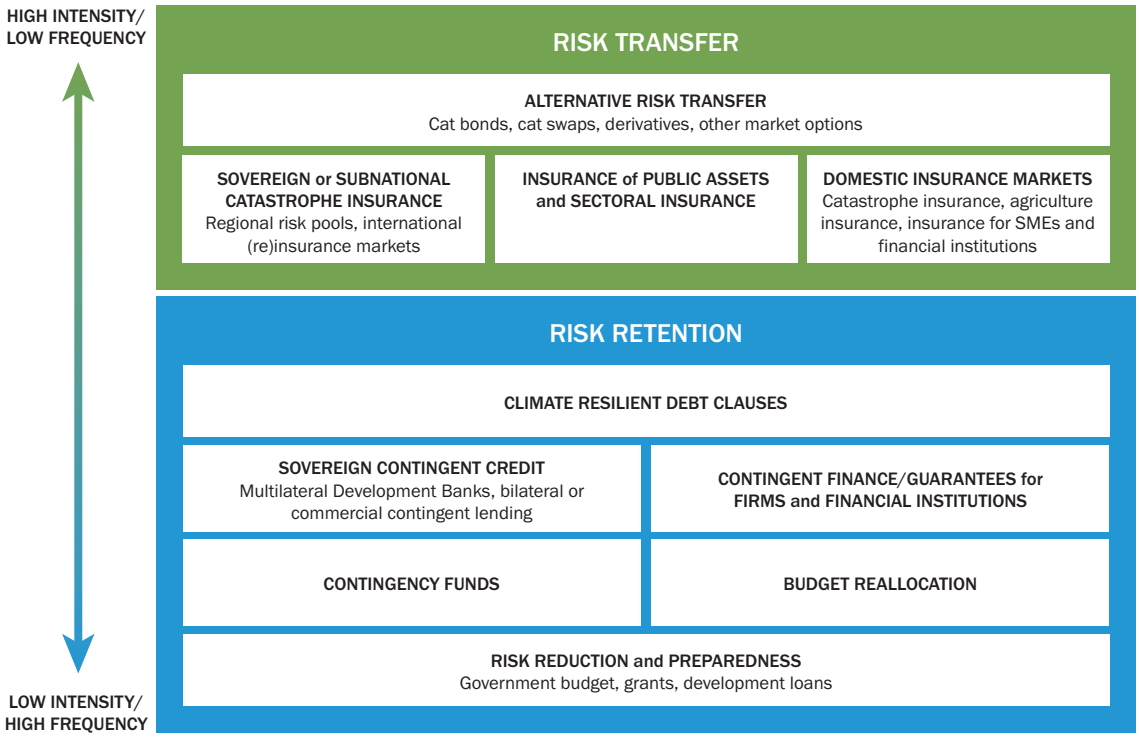
- Sovereign catastrophe risk insurance pools or regional insurance pools, such as the **Caribbean** Catastrophe Risk Insurance Facility and **African** Risk Capacity Group, which offer parametric insurance to fund post disaster responses, and provided $1.4 billion in coverage globally in 2022

- National insurance programs for public assets, such as **Indonesia's** State Assets Insurance Program, which insures thousands of public buildings, and helps restore services quickly after climate shocks, as happened after the 2020 Jakarta floods

- Sovereign alternative risk transfer instruments, which provide additional protection, such as **Jamaica's** catastrophe bond for tropical cyclone coverage, introduced in 2021.

DRFI strategies also involve ensuring financial protection for individuals and businesses, often through adaptive social protection and PPPs, for insurance. Examples include: adaptive social protection for vulnerable people (**Malawi** is adapting safety nets to provide emergency cash transfers in crises, with insurance backing larger scale-ups during severe droughts); regional disaster insurance programs for farmers (in E**thiopia, Kenya**, and **Somalia**, 1.5 million pastoralists benefit from insurance against drought, enabling access to financial services and protecting livelihoods); and national catastrophe risk insurance pools for homeowners (the governments of **Türkiye** and **Morocco** established catastrophe insurance pools to protect homeowners).

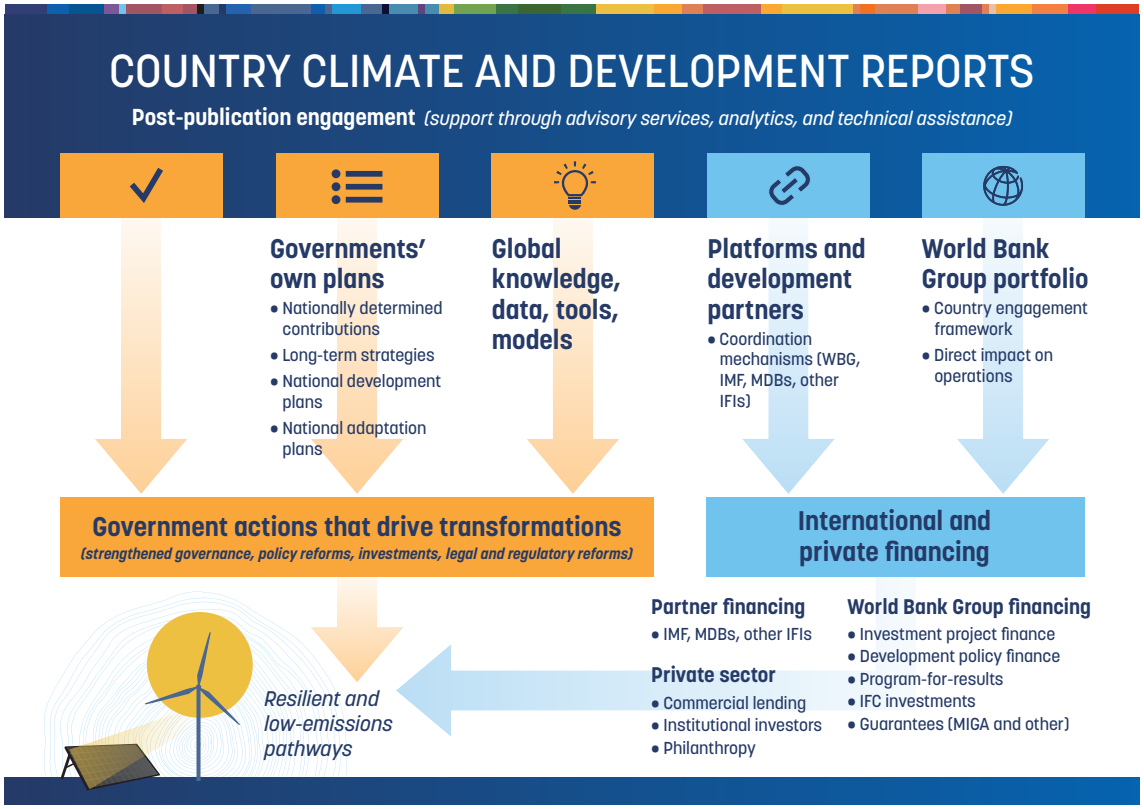
Figure 24: Illustration of a layered DRFI strategy, underpinned by targeted analytics, advisory and knowledge services



5. Conclusion and next steps

This review of three years of CCDRs demonstrates the benefits of applying a people-focused lens to climate policy design. By prioritizing the protection of, and investing in, people, countries can counteract potentially long-lasting climate change impacts on individuals and communities, lay the groundwork to foster innovative local climate solutions, accelerate climate action, and demonstrate the potential for achieving mutually reinforcing climate and development objectives. Protecting, building, and using human capital—through education, health care, and social protection systems—will not only shield the most vulnerable populations from climate impacts but also empower them to drive innovative climate solutions. And by placing people at the core of climate policy design from day one and increasing engagement with communities and stakeholders, countries can navigate a green transition that improves people's lives and makes policies and economic growth more inclusive.

Figure 25: The five modalities of CCDR operationalization



Notes: WBG = World Bank Group; IMF = International Monetary Fund; MDBs = multilateral development banks; IFIs = international financial institutions; IFC = International Finance Corporation; MIGA = Multilateral Investment Guarantee Agency

A companion report, *From Knowledge to Action: Lessons from Early Operationalization of Country Climate and Development Reports*[36], explores how the first CCDRs have been used in countries at subnational, national, or regional levels. One important finding is the diversity of operationalization modalities, illustrated in figure 25. CCDRs have had a direct influence on government policies and action, with or without World Bank Group support, through the engagement at preparation or finalization. CCDR

36 World Bank Group. 2024. *From Knowledge to Action: Lessons from Early Operationalization of Country Climate and Development Reports*. Washington DC: World Bank. http://documents.worldbank.org/curated/en/099110124091520135/P5070741b7f66e09c19dae18076d882175c

recommendations have been included in national plans, ensuring they receive the required ownership, improving coordination with other decisions and policies, and creating opportunities for further engagement with governments and stakeholders. CCDRs have also informed dedicated cooperation platforms—such as **Egypt's** Nexus of Water, Food and Energy Platform and the **Bangladesh** Climate and Development Platform—and development partner instruments, such as the IMF's Resilience and Sustainability Facility programs, which have been systematically informed by CCDRs. They are also a key input into the World Bank Group's Country Engagement Framework, including the Country Partnership Frameworks, and other World Bank, IFC, and Multilateral Investment Guarantee Agency (MIGA) operations. CCDR recommendations have been operationalized through investment project financing, development policy financing, Program-for-Results, IFC investments, MIGA guarantees, and other instruments. Finally, developing the CCDRs has contributed to the advancement of new tools and methodological approaches that are being used by **Côte d'Ivoire**, **Viet Nam**, and other countries to perform their own analyses. This diversity of operationalization modalities is driven by each country's unique needs and political context, and many countries combine multiple modalities.

This report focuses on the main conclusions and recommendations of CCDRs, with an emphasis on implications for people and households and on the differences across countries. Its findings, and the differences across countries, support the value of the CCDR approach as a bottom-up, context-specific approach that complements global analytics from other organizations. Through new analytics, CCDRs will continue to contribute foundational knowledge to global and country debates on how to align climate and development objectives, provide substantive guidance for policy makers, private sector decision-makers, civil society, and populations, to support a shift toward more resilient, lower-emission development.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