INVESTING IN INFRASTRUCTURE FOR A CHANGING CLIMATE:
RESULTS AND KEY LESSONS FROM PPCR-SUPPORTED PROJECTS

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- Ines De Seixas Duarte and James Falzon — (Tajikistan) Enhancing the Climate Resilience of the Energy Sector Project
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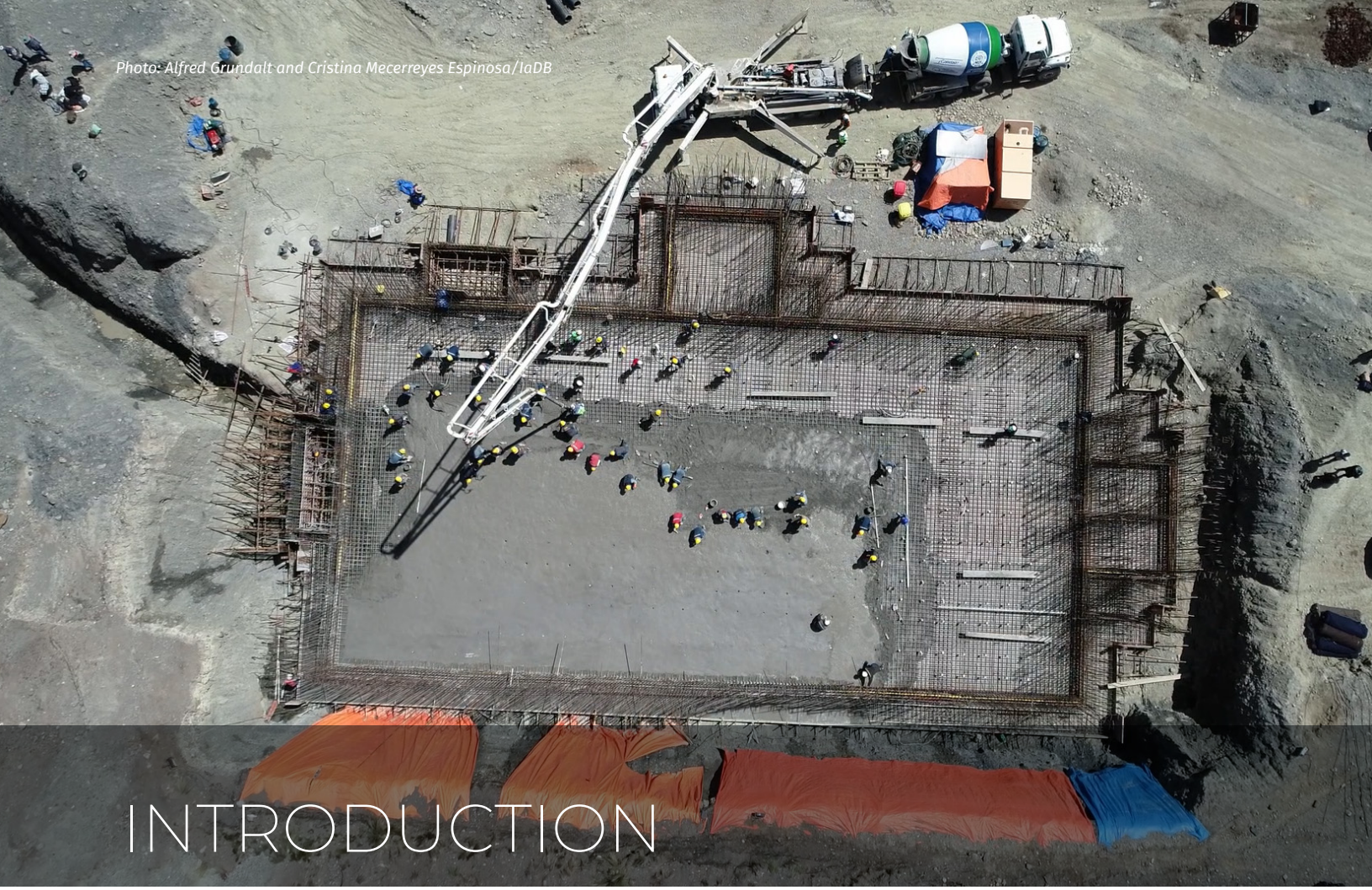

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INTRODUCTION

Accessible and functioning infrastructure is the backbone of human well-being and prospects for economic development. In low- and middle-income countries, however, chronic underinvestment makes access to critical infrastructure for water, electricity, transportation, and telecommunications a regular struggle in the best of times. As climate change accelerates, images of flooded roads, deluged airports, and parched reservoirs have come to hit the headlines on a weekly basis. They are stark reminders that the current infrastructure, much of it designed and built a long time ago, is no longer robust enough to cope with current extreme weather conditions, let alone the more frequent and severe events projected under a changing climate.

Disruptions to the infrastructure in low- and middle-income countries, through a combination of poor maintenance, mismanagement, and natural hazards aggravated by climate change, have already imposed an estimated annual cost of at least USD390 billion (Hallegatte et al. 2019).[1] Moreover, population growth and rapid urbanization are placing an ever rising demand on infrastructure. This is compounded by the damages and losses stemming from the increasingly frequent as well as more intense weather and climate extremes brought by a changing climate.

The Climate Investment Funds (CIF) fully recognizes the vital importance of investing in climate-resilient infrastructure to support developing countries in achieving sustainable and inclusive development. As shown in Figure 1, climate-resilient infrastructure can yield triple dividends. It can: (1) reduce the costs of infrastructure maintenance and repairs; (2) support the wider economy through reliable services, such as transport and power; and (3) generate societal benefits by protecting people against extreme weather events and enabling their livelihoods.

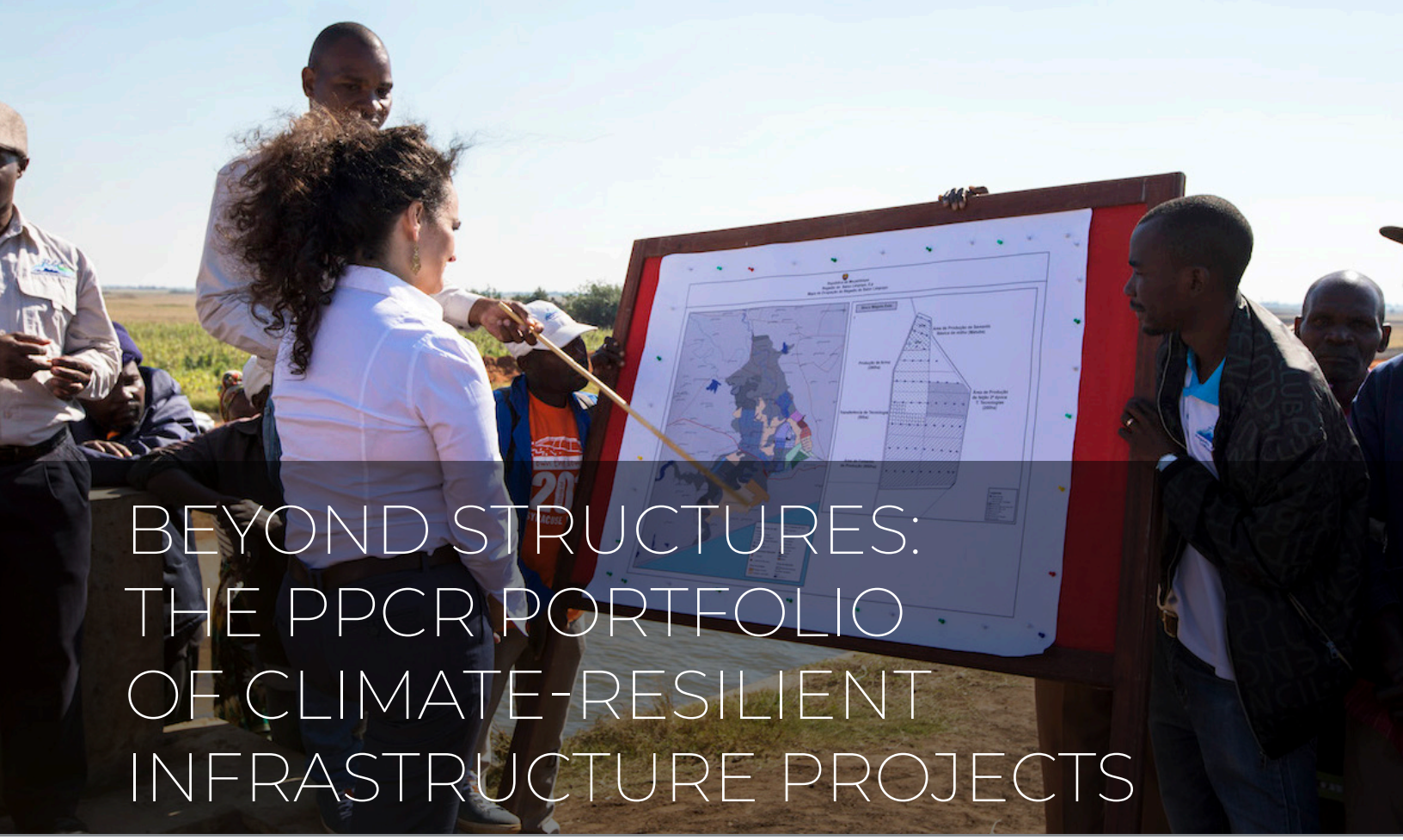
A depiction of coastal vulnerability in Bangladesh.
Photo: Swarna Kazi/World Bank

Figure 1
THE "TRIPLE DIVIDENDS" OF INVESTMENT IN CLIMATE-RESILIENT INFRASTRUCTURE

Working with multilateral development bank partners, donors, and recipient country governments, CIF's Pilot Program for Climate Resilience (PPCR) has invested more than USD700 million in 11 projects focused on infrastructure, or with infrastructure components in various countries, across Africa, Asia and the Pacific, Central Asia, along with Latin America and the Caribbean. Designed as part of the national strategic programs for climate resilience, these projects have either been completed or are at the advanced stages of implementation.

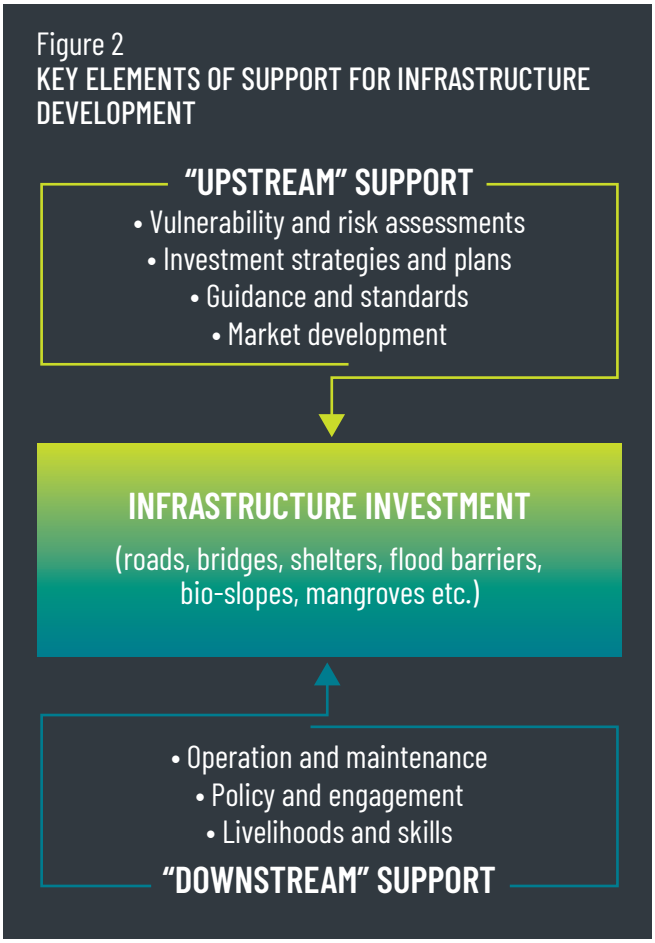
The economic and health impacts of COVID-19 have currently stretched social and physical infrastructure to the limit. As the world gradually emerges from the pandemic, governments, including those in developing countries, have designed unprecedented economic recovery packages. Since infrastructure spending has historically been a strong source of economic stimulus, the International Monetary Fund (IMF) has advised its members to boost their infrastructure stimulus spending.[2] But to have the desired and optimal effect, infrastructure investment projects need to be carefully prioritized and designed. It is, therefore, a particularly opportune moment to take stock of what could be learned from CIF-supported infrastructure projects in developing countries, with a view to contributing to the planning, design, and delivery of a new generation of infrastructure fit for the future. Through sharing key lessons and good practices, this learning brief endeavors to make a humble contribution to the world's momentous efforts to recover and restart in ways that are sustainable, inclusive, and resilient.

PPCR's diverse portfolio of infrastructure projects is discussed in the next section. The brief then highlights the major activities and progress made to date, followed by a discussion of key lessons and good practices. A series of "project snapshots" (PSs) were provided to illustrate the key features of and learning points from different projects within the portfolio. Priority areas for further supporting climate-resilient infrastructure development are outlined in the final section.



BEYOND STRUCTURES: THE PPCR PORTFOLIO OF CLIMATE-RESILIENT INFRASTRUCTURE PROJECTS

Figure 2
KEY ELEMENTS OF SUPPORT FOR INFRASTRUCTURE DEVELOPMENT



PPCR seeks to accelerate climate resilience and the transformation it brings. Accordingly, it supports projects designed to shift the ways decision-makers and other stakeholders think, plan, operate, and maintain infrastructure. To ensure the relevance, effectiveness, and sustainability of investments in infrastructure development, it is essential to complement the support of construction or rehabilitation with "upstream" and "downstream" activities (Figure 2).

As shown in Table 1, the PPCR portfolio includes structural infrastructure components. In tandem, a wide range of support activities create a broad enabling environment (upstream) and ensure that beneficiary communities make the most of the infrastructure in a sustainable fashion (downstream).

Table 1

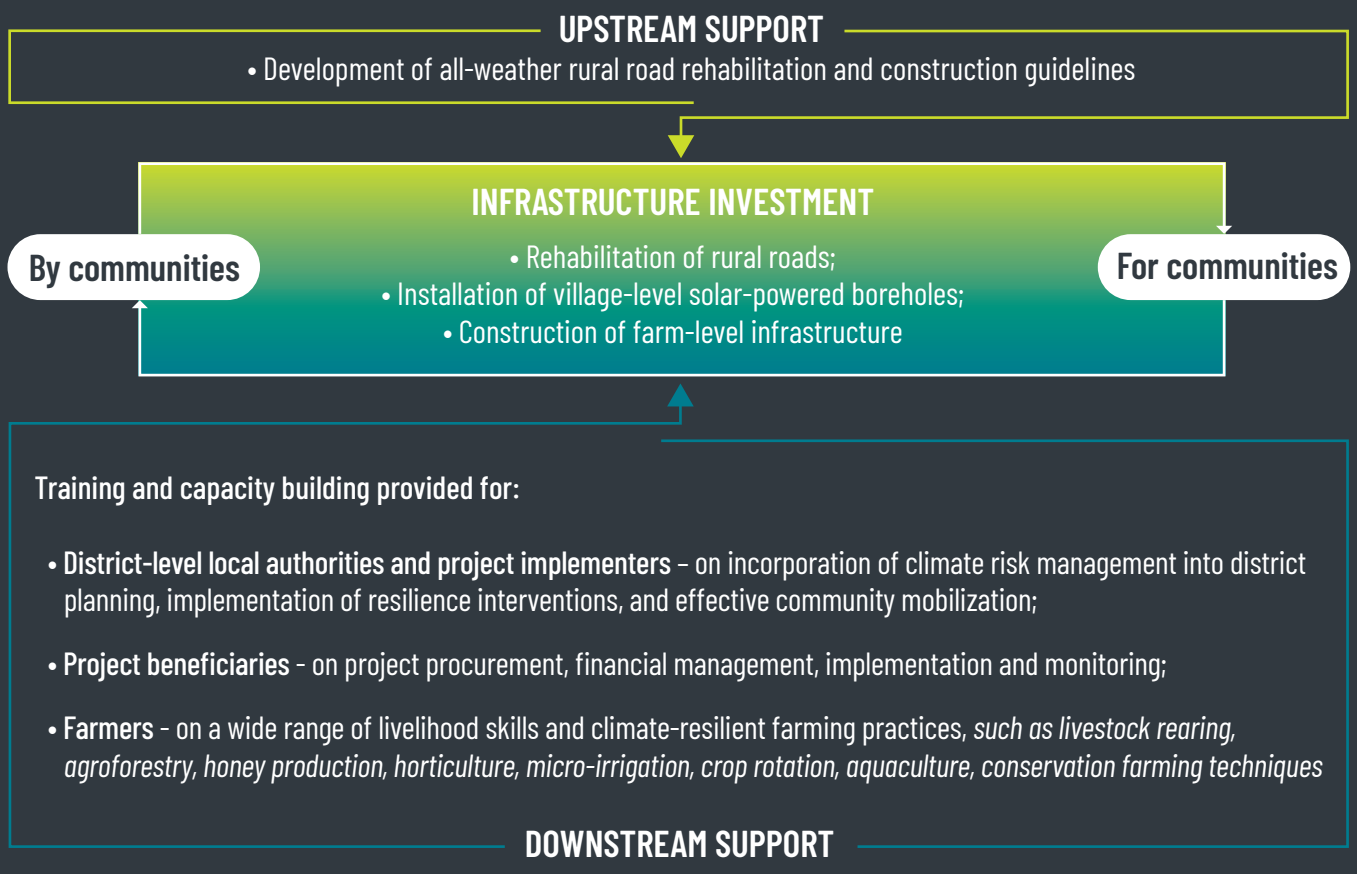
SCOPE OF PPCR-SUPPORTED INFRASTRUCTURE PROJECTS FEATURED IN THIS LEARNING BRIEF

					SCOPE OF PPCR SUPPORT										
					UPSTREAM SUPPORT					INFRASTRUCTURE INVESTMENT		DOWNSTREAM SUPPORT			
COUNTRY	PROJECT	REGION	SECTOR/ THEME	LEAD MULTILATERAL DEVELOPMENT BANK	VULNERABILITY ASSESSMENT	STRATEGIES AND PLANS	GUIDANCE AND STANDARDS	MARKET DEVELOPMENT		GREEN INFRASTRUCTURE	BUILT INFRASTRUCTURE	TRAINING ON OPERATION AND MAINTENANCE	POLICY AND ENGAGEMENT	LIVELIHOODS AND SKILLS	
Bangladesh	Coastal Embankment Improvement Project	Asia	Coastal zone management, Agriculture	International Bank for Reconstruction and Development	●	●	●			●	●	●		●	
Bolivia	Multipurpose Drinking Water and Irrigation Project	Latin America	Water resources	Inter-American Development Bank	●	●				●	●	●	●	●	
Haiti	Center and Artibonite Regional Development Project	Caribbean	Regional development, Transport	International Bank for Reconstruction and Development	●	●				●	●	●	●	●	
Mozambique	Building the Resilience of Mozambique's Power Sector through a Private Sector Investment Project	Africa	Energy	International Finance Corporation	●	●		●			●	●		●	
Mozambique	Cities and Climate Change Project	Africa	Urban development	International Bank for Reconstruction and Development	●	●				●	●	●		●	
Mozambique	Roads and Bridges Management and Maintenance Project	Africa	Transport	International Bank for Reconstruction and Development	●	●	●				●	●		●	
Niger	Niger Irrigation Program	Africa	Agriculture	International Finance Corporation	●	●		●			●	●	●	●	
Papua New Guinea	Climate Proofing the Alotau Provincial Wharf Project	Pacific	Transport	Asian Development Bank	●	●	●			●	●	●	●		
Samoa	Enhancing the Climate Resilience of the West Coast Road Project	Pacific	Transport	International Bank for Reconstruction and Development	●	●	●			●	●	●	●		
Tajikistan	Enhancing the Climate Resilience of the Energy Sector Project	Asia	Energy	European Bank for Reconstruction and Development	●	●	●	●		●	●	●		●	
Zambia	Strengthening the Climate Resilience of the Kafue Sub-basin Project	Africa	Transport, water resources, food security, local development	African Development Bank	●	●		●		●	●	●	●	●	

Figure 3 illustrates the typical scope of PPCR-supported infrastructure projects, using an example from the CIF project in Zambia - Strengthening the Climate Resilience of the Kafue Sub-basin Project (SCRiKA project).

Project beneficiaries admiring thriving vegetables as a result of borehole installation, Zambia.
Photo: Walter Odhiambo/AfDB

Figure 3
SCOPE OF ACTIVITIES OF ZAMBIA'S STRENGTHENING THE CLIMATE RESILIENCE OF THE KAFUE SUB-BASIN PROJECT



WHAT IS IT AND HOW IS IT GOING: THE SCOPE OF CIF SUPPORT AND PROGRESS TO DATE

Given the breadth of the PPCR support for infrastructure, this section presents the interventions and early results in each of the three support categories in Figure 2—namely, (1) the upstream creation of an enabling environment, (2) structural infrastructural components, and (3) the downstream delivery of benefits to people and communities.

GO UPSTREAM: CREATING ENABLING CONDITIONS

A wide variety of upstream activities feature in all the infrastructure projects. They create broad enabling conditions for planning, designing, constructing and operating climate-resilient infrastructure. Some examples in the PPCR portfolio include:

- **Implementation of sector- and community-based climate vulnerability and risk assessments** as well as feasibility studies to facilitate infrastructure development planning through the identification of risks and the prioritization of needs;
- **Development of climate-resilient infrastructure investment policies, strategies, and plans,** including land use planning and zoning, to strengthen the climate resilience of communities, livelihoods, and ecosystems that are dependent on infrastructure services;
- **Development or updating of climate-resilient infrastructure design guidance, standards, and codes** to ensure that the infrastructure delivers expected benefits under a changing climate; and
- **Market development** for climate-resilient infrastructure and associated technologies as a prerequisite for scaling up climate-resilient practices and technologies, along with establishing and connecting supply and demand, as well as finance.

PPCR-supported countries consider these activities to be pivotal to the establishment of new standards and practices for ensuring the climate resilience of their infrastructures across economic sectors. Table 2 summarizes the scope and early results of such support under a selection of projects.

Table 2
SUMMARY OF UPSTREAM SUPPORT ACTIVITIES AND PROGRESS TO DATE

Legend:

Vulnerability and risk assessments	*Development/updating of climate-resilient infrastructure planning tools, design guidance, standards, and codes*
Development of infrastructure investment strategies and plans	*Support for market development*

COUNTRY AND PROJECT	SCOPE OF SUPPORT AND PROGRESS TO DATE
Bangladesh: Coastal Embankment Improvement Project	• A comprehensive analysis was carried out to support the preparation of a framework for a polder design and investment plan. The analysis included macro- and meso-scale modeling to better understand the coastal dynamics and the potential for increasing climate resilience.
	• The project supported the identification of the next phase of the coastal resilience program. • It also improved investment planning through the use of risk-based decision support systems that are based on an enhanced understanding of the large-scale dynamics of the delta.
Bolivia: Multipurpose Drinking Water and Irrigation Project	• The project supported the establishment of a hydrological monitoring system for intervened glaciated basins.
	• Integrated Watersheds Management Plans (IWMP) were developed for the intervened basins. • A management model for Water and Sanitation Service Providers (WSSP) was designed.
	• A climate-resilient design guidance for the hydrologic analyses underpinning the dam design was developed. • Climate-resilient infrastructure planning tools were developed (for example, the Water Evaluation and Planning (WEAP) model for the entire basin, including water-agriculture elements, was created within the context of a robust decision-making methodology).
Haiti: Center and Artibonite Regional Development Project	To inform the planning of climate-resilient infrastructure in the Center and Artibonite Loop region, a series of climate-related risk and opportunity analyses were carried out, including: • A natural hazards and climate-related risk analysis; • An agriculture value chain analysis; and • An analysis of the social context of the project area.
	Support was provided to develop and adopt: • A regional road maintenance strategy; and • Climate-informed urban plans for Titanyen and Hinche.
	• A technical guide for market construction was also developed.
Mozambique: Cities and Climate Change Project	• Feasibility and detailed design studies were conducted to define the concept and design of the green urban infrastructure, including the structural components and the soft interventions. The studies included assessments on the coast, climate change, run-off, and flood modeling, along with other environmental analyses. Studies were also undertaken to identify the potential for green infrastructure development in other coastal cities in Mozambique.
Mozambique: Roads and Bridges Management and Maintenance Project	• An in-depth climate resilience analysis was carried out to define and prioritize climate-resilient road interventions in the Gaza Province. Following the analysis, pilot designs were identified and evaluated, with civil works contracted for three pilot roads.
	• The project supported a first-of-its-kind country-appropriate set of road standards to enhance climate resilience. Nine design manuals and guidelines have been adopted: the Geometric Design Manual, the Rehabilitation Design Manual, the Hydrology and Drainage Design Manual, the Site Investigations Manual, the Pavement Design Manual, the Specification for Bridge Loads, the Standard Specifications for Roads and Bridges, the Standard Details for Roads and Bridges, and the Guidelines for Performance Specifications. An online tool is now used to plan for climate resilience with regard to the most vulnerable roads.

COUNTRY AND PROJECT	SCOPE OF SUPPORT AND PROGRESS TO DATE
Niger: Niger Irrigation Program	• The project supported the establishment of a market ecosystem of key businesses that are necessary for the development and growth of the irrigation market. This ecosystem includes: an equipment supplier (Netafim); agri-distributors (Agrimex and Talbus); maintenance and training providers (Nirritech); polyvinyl chloride (PVC) suppliers (Afriplast); and a borehole drilling company (Etrafor). The project helped identify the financing avenues that would make drip technology and solar pumps accessible to smallholder farmers on a commercial or semi-commercial basis (see PS 13).
Papua New Guinea: Climate Proofing the Alotau Provincial Wharf Project	• Assessments covering climate change vulnerability and resilience as well as the boats and users of the port facilities were undertaken to inform the wharf design. Data on gender, along with the needs of vulnerable persons such as those with disabilities, were factored into the assessment.
	• The project supported the "PNG Ports Corporation Limited Climate Change Policy Situation Assessment" and related manuals as an enabling framework for advancing climate-resilient coastal infrastructure development in the country.
	• Climate-resilience building codes and design standards will be developed based on the pilot Climate Proofing the Alotau Provincial Wharf project.
Samoa: Enhancing the Climate Resilience of the West Coast Road Project	• A climate vulnerability assessment was carried out to inform the transport sector planning and the climate-resilient road design.
	• A Climate-Resilient Road Strategy was developed.
Zambia: Strengthening the Climate Resilience of the Kafue Sub-basin Project	• The project supported the revision of rural road rehabilitation and construction guidelines for providing all-weather services. Revised guidelines take into account the current and projected values of key climate parameters, such as temperature, rainfall, and wind.

BUILD FOR THE FUTURE: MAKING INFRASTRUCTURE CLIMATE RESILIENT

To help developing countries address chronic infrastructure investment gaps and meet their growing demand for services, PPCR supports the rehabilitation, upgrading, and development of infrastructure. Such support covers a range of sectors (water resources, agriculture, energy, and transport) in both rural and urban settings. It engages public and private sector partners; includes traditional structures (such as roads and power plants); as well as green and blue infrastructures (mangroves, floodplains, and wetlands).

The PPCR investments have backed a new generation of climate-resilient infrastructure, thereby expanding all-weather access to essential services, such as water and energy, transport, public health, and education. These investments in the construction and maintenance, restoration, and upgrading of critical existing infrastructure provide a lifeline for vulnerable communities and deliver immediate benefits, while building community resilience to climate change. In many cases, the PPCR investment is the first of its kind in integrating climate risk management in infrastructure development, upgrading, rehabilitation, and maintenance.

Table 3 summarizes the scope and results to date of select PPCR projects. PSs 1 to 4 further illustrate climate-resilient solutions that are integrated into infrastructure investments.

Table 3
SUMMARY OF INVESTMENTS IN CLIMATE-RESILIENT INFRASTRUCTURE AND PROGRESS TO DATE

Note: The text in green relates to investments in green and blue infrastructure.

COUNTRY AND PROJECT	SCOPE OF SUPPORT AND PROGRESS TO DATE
Bangladesh: Coastal Embankment Improvement Project	The investment aims to provide protection against tidal flooding and storm surges for approximately 724,202 people and 66,012 hectares (ha) of highly productive land. The project has carried out a wide range of works as of June 2021, including: • Upgrading 243 kilometers (km) of coastal embankments; • Replacing 42 and repairing two drainage structures; • Replacing 31 and repairing 14 flushing inlets; • Upgrading 158 km of drainage channels; • Protection works for 8.67 km of riverbanks and 18 km of slopes; and • Afforestation of 340.6 ha (PS 1). These interventions have helped Bangladesh to mitigate the impacts of cyclones and flooding, as well as improve emergency responses in the coastal region. The project has increased protection for over 390,000 people, including 195,000 women, and more than 40,600 ha of land for selected polders that are at risk of tidal flooding and storm surges.
Bolivia: Multipurpose Drinking Water and Irrigation Project	The project supported works to improve the supply and efficiency of water systems for drinking and irrigation during the dry season. Works carried out include: • Constructing, improving, and extending drinking water systems that consist of dams, intake works, reservoirs, treatment plants, water supplies, conveyance and distribution networks, along with residential connections; • Constructing new piped systems to enhance the efficiency of conveyance; • Repairing existing irrigation canals; • Repairing, expanding, and constructing water intakes; • Modernizing the irrigation system of Alto Peñas; along with • Installing distribution works and pressure reduction valves.
Haiti: Center and Artibonite Regional Development Project	The focus of the infrastructure investment has been to improve access to all-weather transport links and logistics services in order to boost the livelihoods and growth in the Center and Artibonite region (PS 2). Key interventions and results, as of August 2020, include: • Rehabilitation of 30 km of rural roads and 56 km of non-rural roads; and • Spot improvements in 64 locations along the road sections of: Titanyen to Saut d'Eau, Dessalines to St. Michel, St. Michel to St-Raphael, and Hinche to Maissade, as well as the rural road network.
Mozambique: Cities and Climate Change Project	A core element of this project (PS 3) is the green urban infrastructure development in the coastal city of Beira, including: • Rehabilitation and protection of four km of natural drainage courses; • Creation of an urban park of more than 17 ha along the Chiveve River; and • Planting and maintenance of mangroves.
Mozambique: Building the Resilience of Mozambique's Power Sector through a Private Sector Investment Project	The project supported the development of a 40-megawatt (MW) solar photovoltaic (PV) plant and associated transmission works near the town of Mocuba in north-central Mozambique. The Mocuba plant, commencing commercial operations in August 2019, is the first utility-scale solar plant in the country. The plant is helping to increase the climate resilience of the electricity sector and delivering power to the rural areas, in addition to generating a wide variety of socioeconomic benefits (PS 13).
Mozambique: Roads and Bridges Management and Maintenance Project	The project supported pilot designs for rural unclassified roads and associated hydraulic structures. Civil works increased the climate resilience of three roads, totaling 230 km in length, by improving the conditions of culverts at identified embankments, constructing new drainage structures, and raising road platforms. To effectively control soil erosion and reinforce road structures, the project introduced geocell—a high-intensity plastic webbing that more evenly distributes road stresses while reducing cracking and water seepage.
Niger: Niger Irrigation Program	To help smallholder farmers cope with worsening climate shocks (for example, drought, floods, etc.) that decrease yields and thus aggravate food insecurity, the project facilitated the installation of small- and medium-scale solar-powered drip irrigation equipment for smallholder, community, and medium-sized commercial farms, covering 68 sites across 53 ha of land (PS 14).
Papua New Guinea: Climate Proofing the Alotau Provincial Wharf Project	To maintain transport links vital to local communities and businesses, the project supported the construction of the new Alotau Provincial wharf—a climate-resilient replacement for the existing wharf. It uses an innovative method of integrating climate change adaptation and resilience elements into the wharf design through a dual approach of "climate proofing" and "climate readiness" (PS 4).

COUNTRY AND PROJECT	SCOPE OF SUPPORT AND PROGRESS TO DATE
Samoa: Enhancing the Climate Resilience of the West Coast Road Project	The project rehabilitated the eastern section of the West Coast Road from Malua to Saina (12.5 km in length) through: • Civil works such as asphalt concrete surfacing and the installation of thermoplastic line marking and rumble strips; • Installation of 17 new rainfall outfall channels to improve drainage; and • Vegetated scour protection along two km of sea walls, in line with guidance from the Ministry of Natural Resources and Environment, and with the participation of local communities.
Tajikistan: Enhancing the Climate Resilience of the Energy Sector Project	The project (PS 5) has invested in the climate-resilient rehabilitation and modernization of the Qairokkum hydropower plant through: • Supporting climate-resilient dam works; • Installing hydraulic steel components, turbines, and electromechanical equipment for the six hydropower units; along with • Installing new monitoring and safety instruments for the dam.
Zambia: Strengthening the Climate Resilience of the Kafue Sub-basin Project	Over 60 percent of the nearly 1,400 community projects help to upgrade the community and farm infrastructure, benefiting 272,850 individuals. Infrastructure supported includes: • Solar-powered boreholes; • Infrastructure for livestock, such as poultry and goat houses, piggeries, livestock service centres and drinking troughs, pond; and • Rehabilitation and construction of 247 km of roads, aimed at: strengthening climate resilience, particularly during floods; sustaining links between farmers and markets; as well as improving accessibility for farmers, traders, tourists, and service providers of education and health.

Project snapshot 1
NATURE-BASED SOLUTIONS TO COASTAL PROTECTION IN BANGLADESH

The USD400 million First Phase of the Coastal Embankment Improvement Project (CEIP-I) for Bangladesh aims to protect over 724,000 people and 66,000 hectares (ha) of vulnerable coastal areas by: (1) rehabilitating selected polder systems from tidal flooding and storm surges; and (2) enhancing agricultural productivity by reducing salinity intrusion. It involves the use of climate data and projections as well as in-depth analyses of the large-scale dynamics of the delta.

As part of an overall integrated protection program, the CEIP-I incorporates a nature-based solutions initiative through the Afforestation Component of Social Forestry. Selected mangrove and other saline tolerant species are planted to provide an additional layer of protection to embankments and the livelihoods of communities. The activity is conducted under a Memorandum of Understanding (MoU) with the Forest Department under a social afforestation model. This facilitates the engagement of local communities in the selection of tree species and ensures equitable benefit-sharing. A range of commercial wood, fruit, and other shallow-rooting tree species are carefully selected by communities and planted on the lower slopes of foreshore embankments. In addition, the social afforestation component includes efforts to increase the community's awareness of the protective and productive functions of trees. It also builds the capacities of local institutions and communities to engage in secondary maintenance schemes, foreshore and embankment afforestation, social forestry, and the protection of the embankment toe against erosion. Key lessons from past embankment afforestation projects, including participatory planning, the selection of forest types and species, the selection of beneficiaries, post-planting Operations and Management (O&M), plantation protection, the harvesting of wood and non-wood forest products, along with benefit-sharing, have been taken into account in the implementation of this component.

Social afforestation activities under CEIP-1, Bangladesh.
Photo: Swarna Kazi and Ignacio Urrutia/World Bank

The CEIP-I has helped Bangladesh to mitigate some of the large impacts of cyclones and flooding as well as improve its emergency response in the coastal region. The project has enhanced the protection of over 390,000 people (of whom 50 percent are female beneficiaries) by increasing the resilience to climate change in selected polders from tidal flooding and storm surges. Up till now, the project has protected 40,600 ha of gross area and upgraded 243 km of embankment.[3] The social afforestation activity is being closely monitored and will be evaluated to inform the wider strategy of coastal protection in Bangladesh.

Roads and Bridges Management and Maintenance Project in Chókwè, Mozambique.

Project snapshot 2

STIMULATING REGIONAL DEVELOPMENT THROUGH INVESTMENTS IN ALL-WEATHER CONNECTIVITY AND LOGISTICS SERVICES IN HAITI

A rehabilitated road section providing an all-weather river crossing under the project in Haiti.
Source: Malaika Becoulet and Jordy Chan/World Bank

Haiti's Center and the Artibonite region is considered the country's bread basket, covering over 4,632 km^2, with a population of 1.2 million. Along with other forms of infrastructure rehabilitation, the Center and Artibonite Regional Development Project took a spot improvement approach to road rehabilitation. This approach has proven particularly effective in providing all-weather accessibility to markets located on the road sections, extending from St. Michel to St. Raphael, Hinche to Maissade Titanyen to Saut-d'Eau, and along Petite Rivière Bayonnais.

A survey carried out at the closing of the project suggested that 97.5 percent of people in the area were satisfied with the infrastructure that had been financed. The most cited benefit was being able to cross rivers during the rainy season.

Another survey in the four markets showed that 96 percent of the respondents had seen positive impacts, especially on market logistics. Road improvements allowed for greater reliability and speed in obtaining supplies, with 52 percent of participants declaring that supply regularity had substantially increased and 45 percent stating that travel time was reduced by half or more. Ninety percent noted that delivery time was shortened. This translates into better-quality products according to 66 percent of participants and an overall increase in sales volume of 61 percent.

Project snapshot 3

BUILDING CLIMATE RESILIENCE AND CREATING HEALTHY URBAN SPACES THROUGH INVESTMENTS IN GREEN URBAN INFRASTRUCTURE IN MOZAMBIQUE

The coastal city of Beira in Mozambique is highly exposed and vulnerable to weather-related events and the effects of climate change, including recurrent floods from storm surges and heavy rains. About 300,000 residents (half of the city's population) live in poorly-planned settlements with inadequate housing and lack basic services, thus putting them in a particularly vulnerable situation. With co-financing from the German Development Cooperation, the PPCR finance contributed to the implementation of Beira's master plan to build long-term climate resilience, including through the creation of green infrastructure that enhances the retention of soil moisture and provides additional drainage to increase capacity at low tide and prevent flooding.

The green urban infrastructure transformed the Chiveve River margin areas into a linear urban park that offers ecosystem services (drainage and flood mitigation, biodiversity, and urban cooling), as well as economic and recreational opportunities to people in Beira. Valuable riverine and wetland ecosystems were restored while stormwater retention and drainage functions of the tidal river were protected and improved. The park incorporates, among other features, boardwalks for users to appreciate the natural habitat, bicycle paths, a botanical garden, cultural amenities, playground and sport facilities, sanitation facilities, and lighting. These measures complemented non-structural interventions, such as awareness campaigns and the mobilization of community-based organizations to plant and maintain mangroves as well as collect solid wastes along the river.

Beira now hosts the largest green urban park in Africa. Tangible benefits for residents, local communities, the environment, and the economy include:

- Enhanced protection from flooding for an estimated 50,000 people living in the catchment area of the Chiveve River Basin;
- Reduction in water-induced structural damages to buildings, owing to improvements in groundwater management;
- Boost in perception of security and decline in crime, along with a cleaner river; as well as
- Increased opportunities for businesses, recreation, and leisure activities.

"In ecological and environmental terms, green spaces in urban areas help regulate the local climate or microclimate through the capacity of plants to absorb carbon dioxide and release oxygen. They help regulate temperature, and provide protection against wind, rain, and soil erosion."

Beira Green Infrastructure Park.
Source: Michel Matera/World Bank

"These are places that bring us closer to nature and that promote our health, including our mental and emotional health."

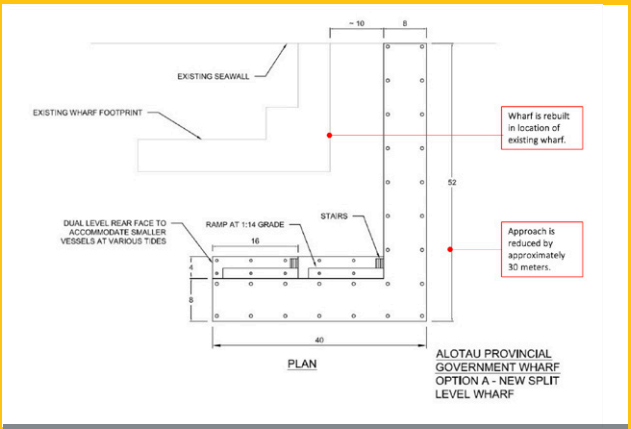
"The park is not merely an attractive leisure space but should serve as a school for education about climate change."

Filipe Nyusi,
President of the Republic of Mozambique,
19 December 2020,
on the inauguration of Beira Park —
the largest green infrastructure in Africa

Project snapshot 4
INVESTING IN CLIMATE-RESILIENT PROVINCIAL WHARF REPLACEMENT IN PAPUA NEW GUINEA

Under the Climate Proofing the Alotau Provincial Wharf Project, PPCR supported the replacement of the Alotau Provincial Wharf. Located in Milne Bay, the wharf is a key maritime transport harbor for the country. It has been particularly exposed to swells generated by cyclones and tropical storms as well as faces risks from rising sea levels, with considerable uncertainties in the frequency and severity of these phenomena moving forward. In addition, the wharf serves relatively small vessels that are highly sensitive to the height differences between the deck and sea levels. Ensuring that the wharf can provide vital services in a changing but uncertain climate requires preparing now and building in resilience for the future.

Consultations with local stakeholders determined that the wharf's deck level needs to be raised incrementally as sea levels increase over time. An adaptive design approach was devised to phase the sea-level rise into the structure, as shown in the drawing here. The replacement wharf incorporates a dropped rear face with steps and ramps that provide immediate climate proofing and allow for incremental adjustments over time. The project has served as a valuable pilot for integrating climate change and sea-level rise into other structures and services in Papua New Guinea.



Drawing of the climate-resilient wharf supported by the PPCR project.
Source: Jack Stanley/ADB

The Qairokkum hydropower plant.
Photo: Chris Booth/EBRD

Project snapshot 5
PILOTING CLIMATE-RESILIENT HYDROPOWER IN TAJIKISTAN

Tajikistan's glacial hydrology and hydropower sector makes it highly sensitive to the impacts of climate change. Through the Enhancing the Climate Resilience of the Energy Sector Project, the Climate Investment Funds (CIF), along with other financiers, is supporting the climate-resilient rehabilitation and modernization of the 60-year-old Qairokkum hydropower plant that provides electricity to 500,000 people. The investment funds the dam rehabilitation works and the installation of hydraulic steel components, turbines, and electromechanical equipment for six hydropower units. Full rehabilitation will increase the plant's installed capacity from 126 megawatts (MW) to 174 MW.

Central to the upgrade is the introduction of innovative climate resilience measures to enable the plant to cope with the expected impacts of climate change on hydrological systems. Using the rehabilitation as a pilot demonstration activity, the CIF project will also build the capacity of the Tajik hydropower operator to anticipate, assess, and manage climate-related risks based on the best international practices. In demonstrating how carefully-designed investments can make hydropower more resilient, the project aims to establish a model that can be replicated across the country and the region.

FOLLOW DOWNSTREAM: SUSTAINING AND FULLY BENEFITING FROM INFRASTRUCTURE

To ensure that the infrastructure provides sustained and comprehensive benefits to communities, it is critical to support technical and institutional capacities for ongoing operation and maintenance so as to assure continued improvements in livelihood opportunities and quality of life. PPCR-supported infrastructure projects build in downstream support activities that include:

- Training and capacity building on infrastructure operation and maintenance;
- Policy dialogues and community engagement to ensure access to essential natural resources, such as water and land, and the realization of full benefits from the infrastructure investments; along with
- Livelihood development and skills training.

The Qairokkum hydropower plant providing electricity to 500,000 people in Tajikistan.
Photo: Chris Booth/EBRD

Table 4 summarizes the downstream activities in projects featured in this learning brief. PSs 6-8 provide details on a selection of downstream support activities.

Table 4
SUMMARY OF DOWNSTREAM SUPPORT AND PROGRESS TO DATE

COUNTRY AND PROJECT	SCOPE OF SUPPORT AND PROGRESS TO DATE
Bangladesh: Coastal Embankment Improvement Project	• Over 536 person days of technical training provided to the Bangladesh Water Development Board. • Ongoing community consultations and engagement of water management organizations and afforestation groups to ensure the sustainability of the hydraulic infrastructure and afforestation works.
Bolivia: Multipurpose Drinking Water and Irrigation Project	• Comprehensive technical assistance provided to 6,663 families to manage the irrigation systems at the community level, as well as practice water-efficient and climate-resilient agriculture . • A technical commission planned to mediate the fair allocation of water among domestic and agricultural users (PS 6). • Training carried out to support community organizations on negotiations and conflict resolution.
Haiti: Center and Artibonite Regional Development Project	• Training and capacity building provided to 284 members of local communities on basic climate-resilient road maintenance skills, along with more than 100 municipal agents and members of the Board of Directors of the Communal Section on urban planning skills. • Twelve knowledge dissemination and consultation events involving government stakeholders, mayors, municipal agents, members of the Communal Section, and other stakeholders.
Mozambique: Cities and Climate Change Project	A wide variety of activities were carried out, with knowledge shared and disseminated, including on the importance and benefits of green urban infrastructure, along with good practices. They comprise: • Mozambique's Water Infrastructure and Sanitation Administration (AIAS) organized workshops on the potential of green urban infrastructure solutions to mitigate flooding and the possibilities for nature-based interventions in the municipalities of Nacala (August 2018) and Quelimane (May 2019). • In September 2019, AIAS organized a knowledge-sharing and dissemination workshop on green urban infrastructures for flood management in Maputo, with the participation of several municipalities (Nacala, Quelimane, Matola, Maputo, and Beira), along with representatives from national ministries and agencies as well as the private sector. • A report on lessons learned from the Beira green urban infrastructure experience, an assessment of the enabling institutional environment for nature-based solutions for urban flood management, urban risk assessments and the potential for nature-based solutions in Nacala and Quelimane, as well as an overall knowledge note, were developed.

COUNTRY AND PROJECT	SCOPE OF SUPPORT AND PROGRESS TO DATE
Mozambique: Building the Resilience of Mozambique's Power Sector through a Private Sector Investment Project	The project includes support for interventions to help beneficiary communities take full advantage of reliable and clean energy (PS 7) through: • Provision of formal land titles for new plots of land to 223 project-affected persons, 158 of whom were women, to ensure their continued farming beyond the project. • Construction of two new bridges near the new plots of farming land and two new drinking water boreholes. • Training on upgraded farming skills to ensure food security. • Introduction of a saving scheme and financial literacy training to members of the local community. • Non-farming skills training for individuals unable to do agriculture work. • A cyclone response program, school facility improvement initiatives, and a malaria program.
Mozambique: Roads and Bridges Management and Maintenance Project	Training and capacity building provided to local contractors and other service providers on climate-resilient road management and maintenance.
Niger: Niger Irrigation Program	To ensure the sustainability of the interventions, the project built local capacity for the delivery of irrigation services. Community field assistants and solar pump technicians were trained; they in turn provided training to 900 smallholder and medium-sized farmers, including 538 women, on how to operate drip irrigation equipment. Furthermore, 517 farmers received training on operating solar pumps, while 306 were also trained on new markets and gaining access to them (see PS 8).
Papua New Guinea: Climate Proofing the Alotau Provincial Wharf Project	• Capacity building for the Milne Bay provincial government staff on the incorporation of climate change risks in coastal port and jetty operations. • Online training (instead of in-person, due to COVID-19) about climate change vulnerability assessments and engineering design standards for coastal infrastructure and assets delivered to: the Climate Change and Development Authority; the ports operator—PNG Ports Corporation Limited (PPCL); the Department of Transport; and academic institutions.
Samoa: Enhancing the Climate Resilience of the West Coast Road Project	Training provided to strengthen the government capacity for planning and constructing climate-resilient infrastructure, including: • Training of the Land Transport Authority staff on updating the Vulnerability Assessment and Climate Resilient Road Strategy. • Training of new staff and staff from other relevant agencies (by the Land Transport Authority personnel) on the tools for assessing the vulnerability of the road network.
Tajikistan: Enhancing the Climate Resilience of the Energy Sector Project	• Training and public outreach sessions for relevant personnel from Barqi Tojik (a state-owned power company) and Tajik Hydromet covered, among other issues: › Climate, hydrological, and reservoir data management (data quality assurance, along with access to open source data and their use). › Hydropower equipment planning and design, with a focus on the incorporation of inflows that vary with seasonality and climate change into the planning and design of new equipment, or the refurbishment of existing installations. › Dam safety. › Hydrological modeling for climate change impacts assessment, dam safety, infrastructure vulnerability and climate change, along with examples of best practices in adaptation worldwide › Public awareness of climate change and links to energy security. › Outreach activities to improve climate risk management among private hydropower plant operators. • A study tour to Quebec helped the staff from Barki Tojik and Tajik Hydromet to gain firsthand experience in managing climate risks for hydropower plant operations.
Zambia: Strengthening the Climate Resilience of the Kafue Sub-basin Project	Training and capacity building provided to local authorities, communities, and farmers, including: • Basic training for project beneficiaries on project procurement, financial management, implementation, and monitoring. • Building the capacity of local authorities and project implementers at the district level to mainstream climate risk management into district planning, implement climate-resilient interventions, and effectively mobilize communities. • Training of communities on climate risk assessments and planning for risk management. • Training of communities and farmers on a wide range of livelihood skills and climate-resilient farming practices, such as community goat rearing; household free-range chicken rearing; piggery; agroforestry; honey production; moringa production and value addition; horticulture; micro-irrigation; crop rotation; intercropping; crop diversification; aquaculture; conservation farming techniques such as zero tillage; as well as the use of animal manure for soil enrichment and retention of water.

Members of the community engaged in the Multipurpose Drinking Water and Irrigation Project in Bolivia.
Photo: Alfred Grunwaldt and Cristina Mecerreyes Espinosa/IaDB

Project snapshot 6
ENGAGING COMMUNITIES AND ADDRESSING WATER GOVERNANCE CHALLENGES IN BOLIVIA

In Bolivia, the Multipurpose Drinking Water and Irrigation Project has sustained progress on construction works during the COVID-19 pandemic, including the recognition and proactive tackling of potential risks from relatively weak water governance. At the national level, there is not yet a comprehensive water law or a clear mechanism for allocating water rights among different users, particularly in times of water stress. Although this has hampered progress, the project team has worked with stakeholders to overcome the challenge. Safeguard specialists from the Inter-American Development Bank have closely monitored the situation and worked with the project execution unit to identify potential risks and carry out remedial actions so that water allocation is managed in a fair and timely manner.

Further, and more importantly, the project budget also covers a technical commission—envisioned as a high-level body that the Minister of Water will "enable" to facilitate dialogues among different water user groups on water rights and governance. With the broad participation of relevant interest groups, the commission aims to ensure equitable and efficient water allocation, particularly in times of scarcity. Its creation, in addition to the construction of vitally important water and irrigation infrastructure, will help accelerate the transformation of water resources management, including towards long-term climate resilience.

Project snapshot 7
SUPPORTING COMMUNITIES BY LOOKING BEYOND INFRASTRUCTURE IN MOZAMBIQUE

A bridge, built near new plots for farming, also benefits the wider community.
Photo: Alforce Mudzi/IFC

To ensure improved livelihoods for target beneficiaries, the Building the Resilience of Mozambique's Power Sector through a Private Sector Investment Project went above and beyond a typical infrastructure initiative. It helped secure formal land titles, so that 223 individuals—158 of whom were women—gained new plots of land that are now used for climate-resilient small-scale farming. The allocation of land titles, which the individuals did not previously have, provides security of tenure and increases the value of the land. The project also constructed two new drinking water boreholes, made improvements to the road, and built two new bridges near the plots to benefit the farmers and the broader community. Early evidence shows that since the start of the project, many households have improved their livelihoods through upgraded farming skills, which have led to improved crop yields. They have also enhanced their business skills and financial literacy.

Woman tending farmland under the Niger Irrigation Program in Niger.

Project snapshot 8
COMMUNITY ENGAGEMENT TO SAFEGUARD THE BENEFITS OF INFRASTRUCTURE INVESTMENTS FOR WOMEN IN NIGER

Niger's mostly rain-fed agriculture makes the dry season a time of low productivity and peak labor: farmers spend much of their time fetching water with buckets from wells. This has led men in particular to seek off-farm income-generating opportunities, while women are left to tend the community farming land.

With PPCR-supported drip irrigation installed, women farmers now generate much more income through higher yields and the ability to produce crops not typically farmed during the dry season, which garner higher market value. Moreover, with the time saved from not needing to fetch water from the wells, some women are able to engage in other income-generating activities, such as purchasing livestock and tending them. As the men began recognizing the opportunities created by the drip irrigation and started returning to their villages for the dry season, the project team worked with community leaders to make sure that land would not be taken away from women. Of the 900 project beneficiaries to date, 538 are women. Another benefit of having access to drip irrigation that is particularly important for women in fragile and conflict-riven environments like Niger is the increased personal safety, because the need for frequent travel to the well is eliminated by having an on-farm irrigation system with a localized water source. Seventy-eight percent of the surveyed farmers reported increased safety due to the provision of a local water source.

Photo: Robert Kay/ADB

WHAT HAVE WE LEARNED?

From diverse PPCR-supported infrastructure projects implemented to date, a set of early lessons can be derived on the factors for success and challenges. These can be broadly categorized as related to the engagement of key stakeholders, knowledge and analytics, financing, and a holistic approach to climate resilience.

STAKEHOLDER ENGAGEMENT MATTERS IN ENSURING RELEVANCE, EFFECTIVENESS, AND LASTING BENEFITS

In contrast to climate mitigation measures, where required actions are fairly similar across the world, building climate resilience through adaptation is highly context-specific, that is, dependent on the policies and plans that are shaped by local needs and capacities. A toolkit used on the Florida coastline to adapt to coastal erosion will not be of much use for sub-Saharan communities at risk of intense droughts threatening their food supply. For investments in building climate resilience, an inclusive and participatory process helps ground interventions on the best available information as well as the needs and values of beneficiaries. The engagement of key project stakeholders can also reduce the risks of future conflict, avoid negative unintended consequences, identify a strong pool of options, increase support for the measures chosen, and ensure the sustainability of project outcomes.

Guided by a country-driven, participatory approach that is one of the central features of the CIF business model, all PPCR-supported projects have emphasized the strong engagement of key stakeholders. This is reflected throughout the investment cycle that includes upstream and downstream activities as integral complements to the development and

rehabilitation of structures. Key stakeholders have ensured that infrastructure projects are relevant, effective, efficient, and sustainable by:

- **Identifying climate risks and priorities for resilience through community-based risk assessment and mapping as well as climate-resilient investment planning.** One example involves selecting pilot project sites based on the vulnerability or suitability of local agroclimatic conditions. This is a prominent feature in the projects in Bangladesh, Samoa (PS 9), Papua New Guinea, and Zambia (PS 10).
- **Carrying out pilot adaptation activities within investment projects and allowing for design flexibility.** Examples of such activities include: the rehabilitation of the existing (community) infrastructure that comprises roads and coastal embankments; river restoration (for example, in Bangladesh, Bolivia, Haiti, Mozambique, Samoa, and Zambia); along with the installation of climate-resilient infrastructure, such as drip irrigation in Niger and farm-level structures in Zambia.
- **Facilitating project interventions through the identification of potential barriers and/or solutions.** These interventions involve: resolving issues related to the legal rights of way in Samoa (PS 9); the obtaining of consent from local leaders to install solar-powered drip irrigation; physical security and safety while accessing project sites; measures to prevent land from being taken away from women in Niger; or performance-based contracts for the upgrade and maintenance of rural roads, for instance, in Zambia.
- **Ensuring the long-term sustainability of project outcomes through ongoing maintenance work.** Examples consist of: the engagement of water management organizations and afforestation groups to maintain the hydraulic infrastructure and afforestation works in Bangladesh; the ongoing community maintenance of trees planted for scour protection in Samoa (PS 9); the active participation of local climate resilience adaptation facilitators in Zambia (PS 10); the continued dialogues among key water users in Bolivia (PS 6); and the engagement with internal stakeholders to identify innovative and sustainable irrigation financing solutions in Niger.

Project snapshot 9

A PARTICIPATORY APPROACH TO BUILDING THE CLIMATE RESILIENCE OF THE WEST COASTAL ROAD IN SAMOA

The PPCR-supported project aims to improve the road's climate resilience while boosting local skills that can help Samoa develop a more climate-resilient road network overall. The project entails sealing road shoulders; implementing drainage works and vegetated scour protection measures; along with conducting vulnerability assessments as well as knowledge management, training, and capacity-building interventions. A participatory approach is a central feature of the entire process, with the project bringing together all key stakeholders: relevant governmental agencies working on transport, natural resources, and the environment; non-governmental organizations; and communities situated along the road.

As part of the efforts to build resilience, coastal trees were carefully selected and provided by the Ministry of Natural Resources and Environment to communities living along the road. They have not only been given the trees to plant on the seawall for scour protection, but also been entrusted to maintain them regularly. The Samoan government greatly appreciates this close engagement of the communities and local stewardship, and plans to actively promote similar approaches in future road transport projects.

Trees planted and maintained by local communities along the seawall for scour protection.
Photo: Rodrigo Archondo-Callao/World Bank

Project snapshot 10

BY THE COMMUNITY, FOR THE COMMUNITY: COMMUNITY ACTIONS IN THE KAFUE SUB-BASIN PROJECT IN ZAMBIA

Growing high value tomatoes made possible through borehole installation under the Project in Zambia.
Photo: Walter Odhiambo/AfDB

Communities are at the heart of the project in Zambia. With the support of local authorities and community-based organizations, the project comprises nearly 1,350 subprojects for the community as well as farm infrastructure upgrades or construction. The project also supported a total of 35 matching grant investments within the communities.

Working initially through government structures proved to be key to the mainstreaming of climate change into district development planning; however, implementation was hampered by the high staff turnover. To address this challenge, the project engaged a group of climate resilience adaptation facilitators from non-governmental organizations active in supported communities prior to the project. They worked with the communities to mobilize and sensitize them on concepts, such as climate change impacts, adaptation, and resilience. Their involvement quickly inspired community trust and confidence, paving the way for the smooth implementation of the subprojects.

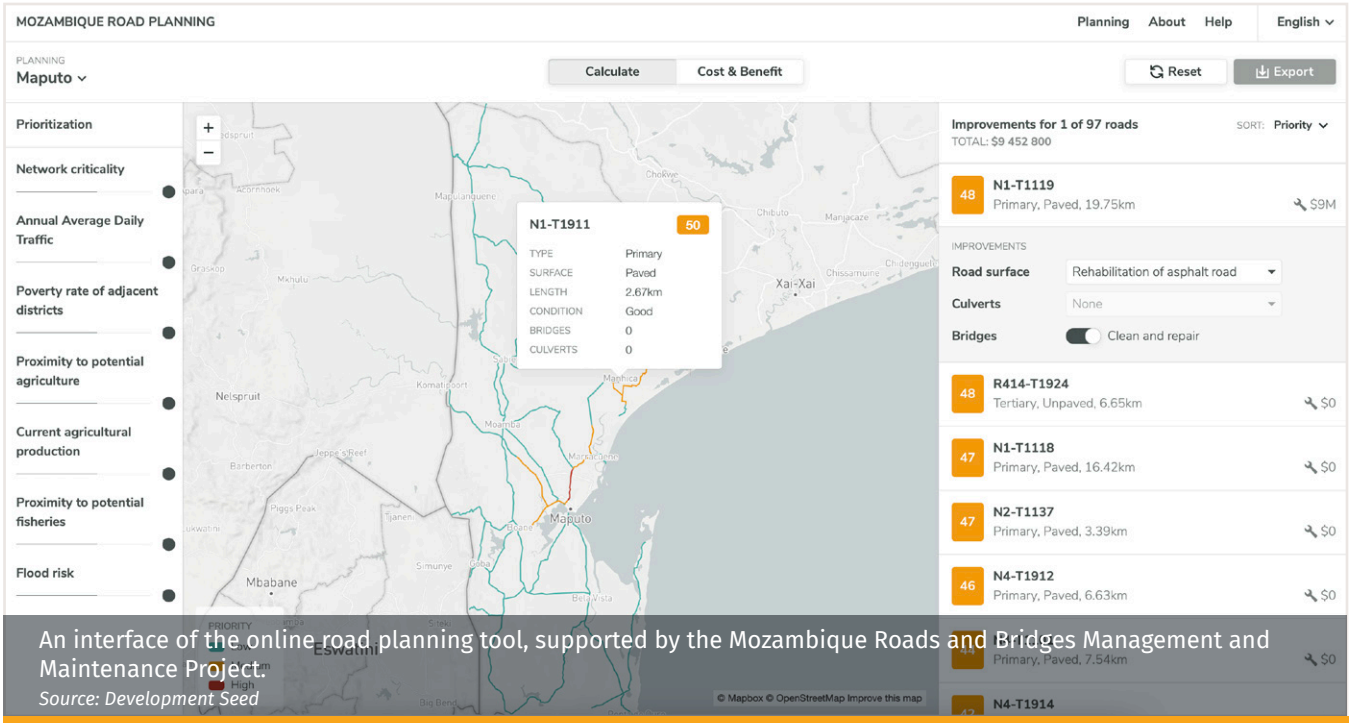
With the support of the local authorities and the climate resilience adaptation facilitators, and the provision of basic training on procurement, financial management, project implementation, and monitoring, the communities have taken the driver's seat in planning, designing, and implementing the community subprojects such that they are accountable for their projects' outcomes. Since the communities are directly involved in the entire project cycle, they feel a sense of ownership towards the subprojects and the responsibility for ensuring that the resilience practices continue beyond the PPCR project.

DATA AND RISK ANALYTICS ARE FOUNDATIONS FOR SOUND PROJECT PLANNING, DESIGN, AND DELIVERY

For people around the world, the ongoing COVID-19 pandemic has made clear the fundamental importance of data and science. They shape our understanding of the nature and evolution of the disease as well as underpin the solutions to treat and prevent it. Similarly, planning, designing, constructing, along with operating and maintaining infrastructure and other assets to support life and livelihoods amid a changing climate, require critical data, science, and analytics. PPCR-supported projects have invariably included upstream analyses of climate vulnerability hotspots, analytical tools, in-depth feasibility studies, and market analyses for promoting resilience solutions.

Under the **Bangladesh** Coastal Embankment Improvement Project, a comprehensive analysis helped in: informing decision-making about coastal erosion and dynamics; steering choices around optimal solutions; and developing a systematic investment roadmap. In **Haiti**, the assessment of flood, landslide, drought, and seismic risks, including mapping at commune and city levels, was useful to the infrastructure planning and the setting of technical norms for guiding the standardization of the market infrastructure to ensure conformity. The online planning tool developed under the **Mozambique** Roads and Bridges Management and Maintenance Project provides a highly user-friendly aid for climate-resilient road works planning (PS 11), while improved hydromet data and forecasts have guided safer and more efficient hydropower operations in **Tajikistan** (PS 12).

The **Mozambique** Cities and Climate Change Project team observed that municipalities, in many cases, should improve data management, with "base data" sets for their own use as well as for consultants working on projects in their jurisdictions. This would reduce the costs and time of data collection, as well as increase the quality and compatibility of outputs. Important project outcomes, such as the geographic information system (GIS)-based maps of utility systems, should be fully backed up so they can offer evidence-based infrastructure investment decision support as needed.



An interface of the online road planning tool, supported by the Mozambique Roads and Bridges Management and Maintenance Project.
Source: Development Seed

Project snapshot 11
POWERING CLIMATE-RESILIENT ROAD PLANNING WITH DATA ANALYTICS IN MOZAMBIQUE

The Roads and Bridges Management and Maintenance Project in Mozambique helped develop an online tool to plan for climate-resilient road works (an interface is shown above).[4] The tool leverages a wide range of geospatial data related to road network criticality, traffic volume, poverty, agricultural productivity, fisheries, and flood events. Drawing on data and analytics related to the annual flood damage stemming from a wide range of flood events (with return periods from 1-in-5 to 1-in-1,000) under current climate scenarios and three future plausible ones, the tool assesses, among others, the flood vulnerability of the roads network.

Road agency staff and other users can use the tool to identify the roads that are the most vulnerable to climate impacts, those that add to redundancy in the network, and those that are more critical than others, in terms of their impacts on poverty, agriculture, or fishery production. Estimates of the costs and benefits of interventions allow the Road Administration or agencies in charge of investment planning to most efficiently use their resources to improve resilience.

For Engineer Moises Nunes, in charge of the road administration delegation in Zambezia, the tool provided the first opportunity to interact with a live geospatial version of the road network he manages.

The Quairokkum hydropower plant being rehabilitated and made climate-resilient, Tajikistan.
Photo: Chris Booth/EBRD

Project snapshot 12
SUPPORTING CLIMATE-RESILIENT HYDROPOWER OPERATIONS THROUGH IMPROVED DATA PROVISION IN TAJIKISTAN

Fully recognizing the importance of timely and accurate hydromet data and forecast analytics for the safe and efficient operation of hydropower plants, the PPCR-supported project in Tajikistan helped develop procedures for using hydrometeorological information and forecasts in dam operations and flood management plans. Tajik Hydromet has applied new techniques to provide more targeted information to Barqi Tojik, while the latter offers additional hydrological data to the former to further improve forecasts. The power of data and analytics was evident when Tajik Hydromet gave the advance warning of a dry year to Barqi Tojik, which enabled the company to plan ahead with the precious time afforded.

BLENDED FINANCE HOLDS THE KEY TO SCALING UP PRIVATE SECTOR ENGAGEMENT

With an annual infrastructure finance gap of many trillions of dollars in the middle- and low-income countries,[5] it is essential to mobilize private sector financing for climate-resilient infrastructure. But meaningful private sector engagement is not yet occurring in many developing countries, due to a host of well-documented challenges. Among others, key barriers include a perception of high risks from investing in uncertain and challenging markets. By strategically deploying blended concessional finance, PPCR, through its implementing partner, the International Finance Corporation (IFC), has supported a number of interventions to create conditions that enable private sector engagement.

Contrary to many developed markets where private sector involvement typically relates to the deployment of technology, efforts to develop market value chains and business models are often pivotal in developing countries. PSs 13 and 14 show how, through blended finance, projects jumpstarted the introduction of new climate-resilient technologies, while creating market value chains that link manufacturers, local distributors, customers, and technical services teams, and unlocking affordable financing. With relatively modest finance, these projects catalyzed growing and potentially long-standing private sector involvement. They provided much-needed expertise and investments in climate-resilient infrastructure development while securing livelihoods for millions of vulnerable people in a changing climate.

Project snapshot 13

ENHANCING THE CLIMATE RESILIENCE OF THE POWER SECTOR THROUGH SCALING UP OF PRIVATE SECTOR INVESTMENT IN MOZAMBIQUE

Mozambique's power sector is extremely vulnerable to climate change. Over 50 percent of its current capacity comes from one hydropower plant located in a drought-affected river basin. Further, the country's power system depends on a single long-distance power transmission system that is vulnerable to interruptions from severe floods and storms. The Climate Investment Funds (CIF)-supported Building the Resilience of Mozambique's Power Sector through a Private Sector Investment Project had the twin goals of diversifying power generation sources and helping to decentralize the power system through localized generation capacity in the Zambezia region. It has backed the country's first utility-scale private solar photovoltaic (PV) project—the 40-megawatt (MW) Mocuba solar plant.

By blending USD19 million in CIF concessional finance[6] with its own commercial funds and funds mobilized from private-sector lenders, the International Finance Corporation (IFC) helped to make solar power generation in Mozambique more affordable and climate-resilient. Without this blended finance, project tariffs would not have achieved competitive levels, thus rendering the project unattractive for the government and energy users. Operational since 2019, the Mocuba plant is demonstrating the viability and attractiveness of utility-scale solar PV in Mozambique, particularly in remote regions, and establishing a track record for future investments. The plant that provides secure, reliable, and clean energy for over 173,000 households in a remote part of north-central Mozambique has improved the livelihoods for those living in the vulnerable Zambezia region.

The Mocuba solar plant been providing reliable and clean energy for over 173,000 households since 2019, Mozambique.
Photo: Alfonce Mudzi/IFC

A solar-powered drip irrigation installed under the Niger Irrigation Program.
Photo: Amel El Abed/CIF

Project snapshot 14
WORKING WITH THE PRIVATE SECTOR TO PROMOTE EFFICIENT IRRIGATION TECHNOLOGY AND REDUCE POVERTY IN NIGER

Under the PPCR-supported Niger Irrigation Program (NIP), the International Finance Corporation (IFC) partnered with Netafim—a global leader in irrigation technology— to expand access to drip irrigation across the country, thus improving livelihoods for poverty-struck smallholder farmers. Drip irrigation is a sustainable agricultural practice and climate-resilient solution for dealing with recurring and severe droughts. It can increase yields, boost incomes, and make beneficiary communities more resilient to climate impacts.

With the support from IFC, Netafim designs and installs drip irrigation systems for land parcels, ranging in size from 250m^2 to 2,500m^2. It provides expertise and training, makes links to microfinance, and signs commercial contracts with local distribution companies for the sales of solar pumps and irrigation equipment. It is also developing a cadre of technicians who travel on motorbikes to provide advice to underserved farmers in remote areas.

NIP completed installation and training activities in December 2020. To date, 53 hectares have been drip irrigated as a result of the program, boosting yields by 46 percent, farmer incomes by 71 percent, and water savings by 56 percent. For Netafim, sales that have amounted to USD133,000 are rising. For agriculture in Niger, a well-functioning irrigation market ecosystem, comprising local agri-distributors, solar pump providers, post-sale service companies, borehole drilling companies, and polyvinyl chloride (PVC) material suppliers, is emerging. This network of market players is essential for scaling up irrigation. There is evidence of growing demand for drip technology that is being met by Nirritech—the company that has been launched as a result of NIP, as well as two competing service providers that emerged after the project's completion. The project has also demonstrated tangible social and economic benefits for the farming community. For families involved in the project, these results have translated into better food security, dietary diversity, stronger climate change resilience, and shifts in social dynamics that are easing gender gaps, since women were among the many early adopters of the new systems. Improved livelihoods also convince young people to stay in their community, instead of drifting away and even creating security challenges in some cases.

" Capacity is a huge challenge. We worked hard on building the capacity of farmers to finance equipment and keep it in repair and operating, so they can grow their operations, supply food markets, and employ others."

Seyni Ganda, Netafim's representative in Niger

Project snapshot 15

A LITTLE FLEXIBILITY IN PROJECT IMPLEMENTATION YIELDS SIGNIFICANT RESILIENCE RESULTS IN MOZAMBIQUE

Under the Roads and Bridges Management and Maintenance Project in Mozambique, the original plan was to improve selected road sections so that three roads would be passable with minimal repairs after major rainfall events. But it soon became apparent that to achieve climate resilience and deliver real benefits to local communities, it was not sufficient to only work on the selected road sections. The work was then expanded to additional sections to ensure that the roads remain resilient to severe weather conditions, such as floods. As a result of this pragmatic approach, local communities have cut travel times in half, in some cases, and gained greatly-improved access to health facilities, schools, and markets, which is the ultimate objective of the project.

FLEXIBILITY HELPS AS A RESPONSE TO THE UNEXPECTED AND DELIVERS RESULTS

CIF programs, including PPCR, afford partners a degree of flexibility in project scope and implementation arrangements. Guided by the ultimate goal of building the climate resilience of beneficiary communities, project adjustments have included: adding civil works to improve project effectiveness in **Mozambique** (PS 15) and **Haiti**; extending the building or upgrading of major roads to improve minor feeder roads to connect villages to markets; along with providing livelihood skills and entrepreneurship training in **Zambia** (PS 16). In other cases, to fully realize climate resilience benefits in communities, PPCR-supported infrastructure projects help reduce structural inequalities faced by women and other marginalized groups, such as through efforts to resolve issues around land ownership in **Niger** and access to water in times of water stress in **Bolivia**. Solutions to unexpected issues arising during project implementation have included managing mosquitos, insects, and waste in newly-developed urban areas in **Mozambique**.

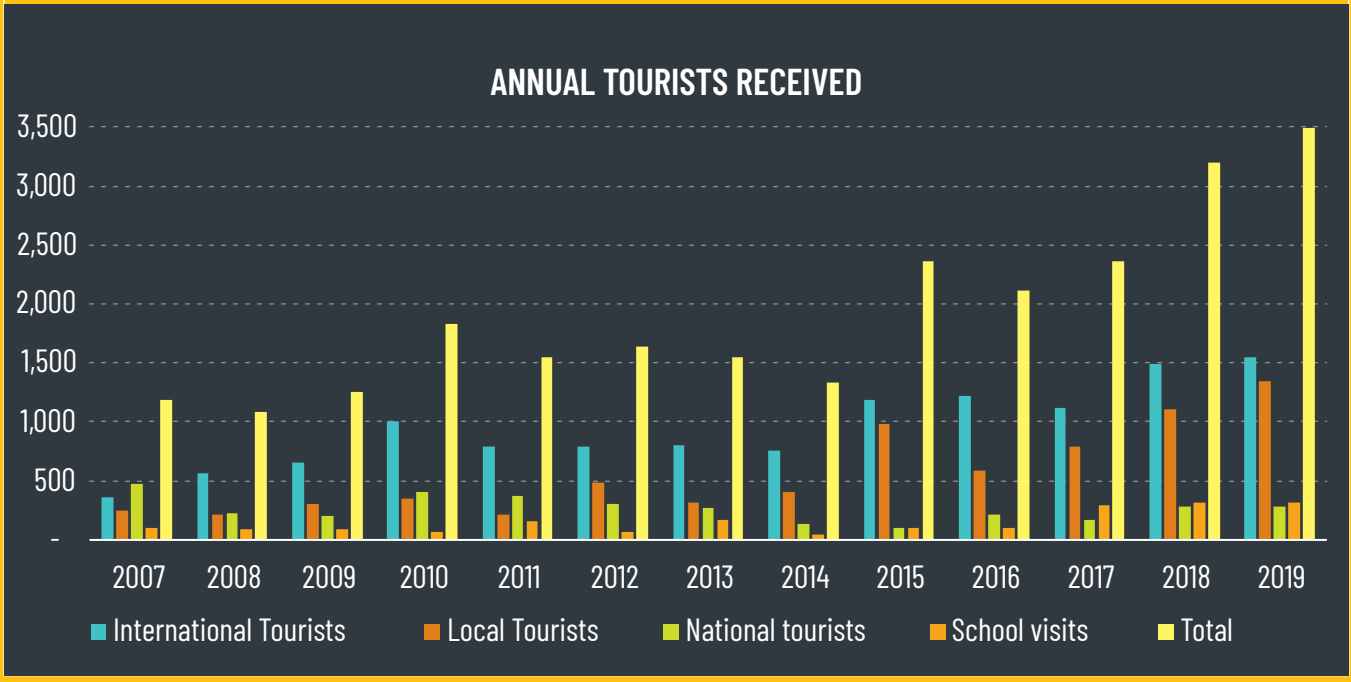
Flexibility in project implementation helps deliver results on the ground. In **Niger**, the private sector partner, Netafim, had initially planned to work on two plots of land with an area of 60 hectares each. However, land of that size is hard to come by in Niger; so the project shifted to working with small- and medium-sized farmers directly, thus enabling the installation of small-scale, solar-powered drip irrigation schemes.

Result of community and farm-level infrastructure rehabilitation subprojects, Zambia.

Project snapshot 16

BRIDGING THE "LAST MILE" IN THE DELIVERY OF PROJECT BENEFITS IN ZAMBIA

The Zambia project is decidedly community-centered. All the project interventions have been selected, designed, and implemented by the communities, based on their needs, and toward the goal of improving their lives and livelihoods. To ensure that the infrastructure investments (rural roads and solar-powered boreholes) deliver full benefits to the target communities, the scope of the project was expanded to provide training to farmers on a wide range of livelihood skills (see table 4) and to 35 matching grant enterprises aimed at adding value to products supplied by local communities. These measures have spurred a notable increase in incomes and livelihoods (see PS 10). As shown in the figure below, the combined investments in infrastructure and ancillary support (for example, facility management) has stimulated local tourism and the economy, especially around the Kafue National Park-South.



MOVING FORWARD

ADOPTING A HUMAN-CENTRIC, INTEGRATED APPROACH

With a vast amount of investments in infrastructure expected in developing countries over the next decades, such investments must be made in a sustainable manner to ensure success. This imperative has become even more apparent during the pandemic, where precious resources must deliver social, economic, and environmental dividends in the short and long terms. Notable gaps remain in integrating these multiple dimensions into infrastructure development, however. The most persistent barriers to an integrated approach are the human ones that are related to planning, inclusive and effective public participation, along with transparency.[7]

As illustrated in this learning brief, a holistic, people-centered approach is needed to build the climate resilience of infrastructure, and more critically, that of intended beneficiary communities. Such an approach entails:

- Placing discrete pieces of infrastructure within a wider system of institutional processes, sectoral or territorial development plans, service delivery, and socioeconomic processes;
- Conducting and using data analytics and participatory climate risk assessments to inform the early-stage planning of infrastructure, provide strategic investment coherence, identify viable project pipelines, foster stakeholder support, and lay the groundwork for effective and efficient delivery;
- Complementing traditional structural components with green and blue infrastructure; and
- Considering the integration of “soft” elements, such as design standards and good practices related to infrastructure planning, construction, along with operations and maintenance, to deliver more enduring infrastructure services.

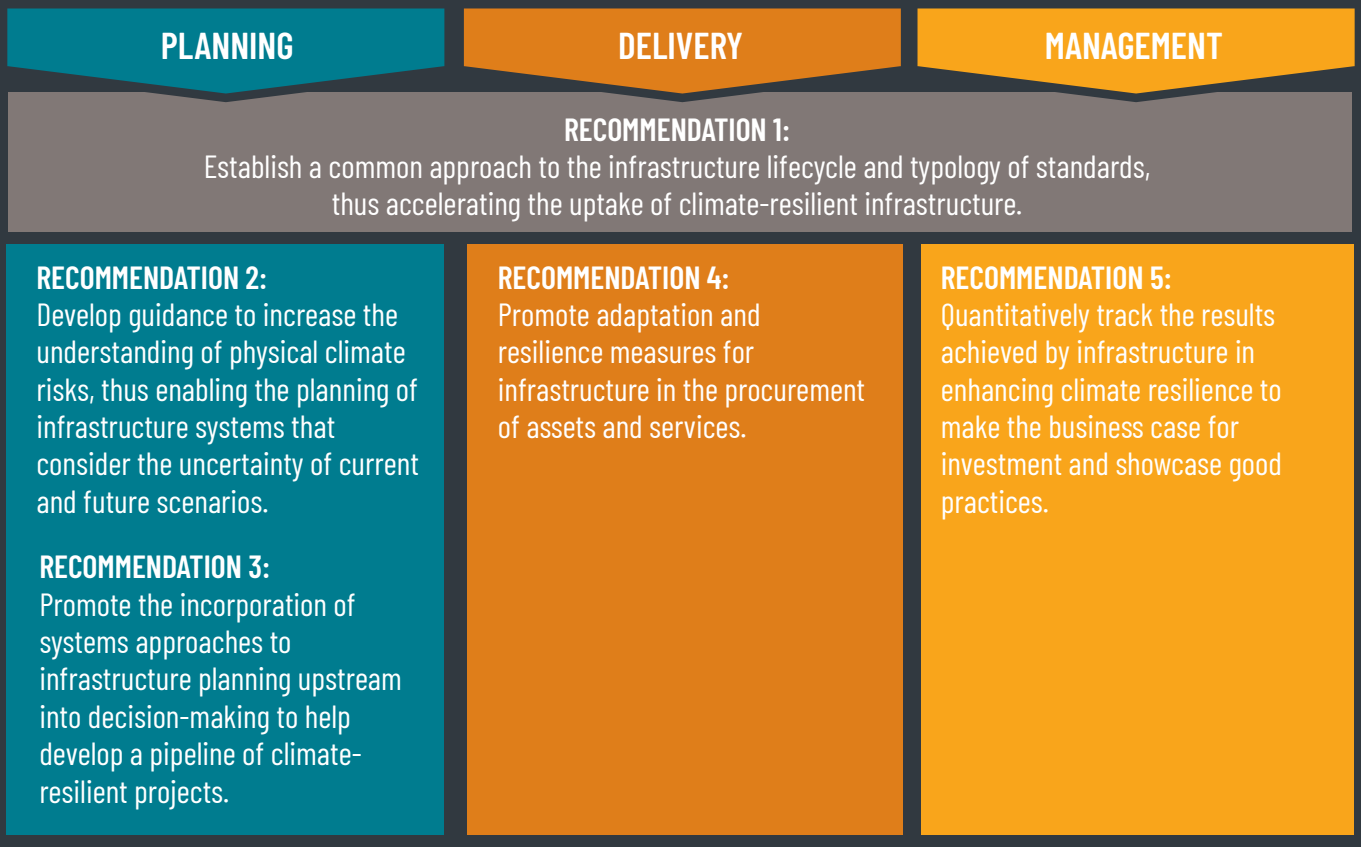
DEVELOPING AND MAINSTREAMING CLIMATE RESILIENCE STANDARDS

As underlined by the development and pilot application of climate-resilient infrastructure manuals and guidance under the PPCR projects, consistent climate resilience standards underpin efforts to make infrastructure resilient to climate change. Such standards will also help mobilize capital where it is needed most. Currently, for example, not all public sector procurement processes recognize the importance of the infrastructure lifecycle cost analysis in evaluating bids for new assets.[8] This can result in higher-cost bids, with greater climate resilience being outbid and opportunities for building resilience lost.

A recent review of existing standards suggests that the majority of existing standards focus on the delivery phase, but do not address the link to: upstream decision-making (planning phase), follow-up over time (management phase), or feedback into planning.[9] The review advocates for the adoption of a long-term perspective and the inclusion of specifications to procure infrastructure that accounts for risks from climate change and promotes resilience. To make climate-resilient infrastructure a norm, the review provides five recommendations for the different stages of the infrastructure lifecycle (Figure 4).

Building on these recommendations, efforts are underway to develop practical guidance to internalize climate resilience in the entire infrastructure development lifecycle. Infrastructure Pathways is an example of such efforts to provide practical insights, references, and tools to enable stakeholders to better navigate key decision points and responsibilities, in order to enhance and retain climate resilience values from conception to service delivery.[10]

Figure 4
RECOMMENDATIONS FOR MAKING CLIMATE-RESILIENT INFRASTRUCTURE THE NORM



Source: adapted from Cançado and Mullan (2020) (see details in Endnote 9)

STRENGTHENING THE KNOWLEDGE BASE AND TECHNICAL EXPERTISE AMONG ALL STAKEHOLDERS

As demonstrated across PPCR-supported projects, knowledge and technical expertise are crucial. All stakeholders, from policy makers, planners, and investors to engineers, standard developers, and community members, need such capacities to make and implement better infrastructure decisions in the face of a changing and uncertain climate.

"I also encourage our educational institutions to dutifully examine the provisions of both the NRDS and the CRRP for the purpose of guiding students into careers and professions which respond to the areas of greatest national needs."

Prime Minister of the Commonwealth of Dominica, Honorable Roosevelt Skerrit[11]

Building technical capacity around climate-resilient infrastructure is particularly challenging in developing countries where financial resources and cutting-edge expertise may be limited. Strategies are needed to build capacity more effectively and faster. Training under several PPCR-supported projects has shown encouraging new ways of learning by doing and peer learning. To speed up and scale up technical capacity building, however, formal educational systems need to be engaged. This entails the development of appropriate curricula and modules for training professionals at different levels of qualifications, as called for by the Prime Minister of the Commonwealth of Dominica (see quotation). Addressing more immediate needs requires training climate resilience professionals. The Global Center on Adaptation and the World Bank have initiated a knowledge module on how to incorporate climate resilience into public-private infrastructure partnerships. The module certifies practitioners as climate-resilient infrastructure officers.[12] Many more such initiatives will be required to meet the considerable demand in the years to come.

SCALING UP INVESTMENT

The COVID-19 crisis has put public finances under enormous strain, particularly in low- and middle-income countries. Governments and businesses face an unprecedented challenge in repairing severely-scarred economic systems; any post-crisis investment needs to count. But the pandemic recovery also presents a unique opportunity for scaling up investments from the public and private sectors in green and climate-resilient infrastructure.

From the public side, trillion-dollar stimulus packages have been announced by governments. Planned and executed well, they can help create jobs and regenerate businesses in the near term and build the long-term resilience of businesses and society. Investments in green and resilient physical infrastructure have been recognized as an area where stimulus finance could generate triple dividends for people, economies, and the environment.[13]

For the private sector, there is currently a capital market paradox. A large amount of capital is parked in high-income countries with negative interest, while developing countries struggle to access funds to develop essential infrastructure. To tap into the resources of the private capital market, barriers to private capital flow need to be overcome, such as through de-risking projects and demonstrating the economic value of building resilience, including through nature-based solutions. International development and climate finance institutions have an important role to play by strategically deploying grants and concessional finance to:

- De-risk through the provision of support for the development and pilot testing of products and services that advance resilience in developing country markets;
- Create enabling conditions through market research and data analytics, policy reforms, upstream planning and project preparation, climate-resilient value chain development, along with capacity building and training; and
- Develop and pilot innovative financing instruments, such as green and climate resilience bonds.

ENDNOTES

1 Stephane Hallegatte, Jun Rentschler, and Julie Rozenberg, 2019, *Lifelines: The Resilient Infrastructure Opportunity. Sustainable Infrastructure,* Washington, DC: World Bank, https://openknowledge.worldbank.org/handle/10986/31805.

2 The IMF blog on public investment for recovery can be found at https://blogs.imf.org/2020/10/05/public-investment-for-the-recovery/.

3 The figures are as of June 2021.

4 Details on the tool are available at: https://road-planning.devseed.com/en/about.

5 See a World Bank blog on closing the infrastructure financing gap at: https://blogs.worldbank.org/ppps/simple-way-close-multi-trillion-dollar-infrastructure-financing-gap.

6 Including USD9 million from the CIF Clean Technology Fund and USD10 million from PPCR.

7 See UN Environment, 2019, Integrated Approaches To Sustainable Infrastructure, Nairobi: UN Environment.

8 Blair Chalmers and Lawrence Slade, 2020, "Building Climate-Resilient Infrastructure in the Post-Pandemic World," GreenBiz, September 11, 2020, https://www.greenbiz.com/article/building-climate-resilient-infrastructure-post-pandemic-world.

9 Danilo Cançado and Michael Mullan, 2020, "Stocktake of Climate-Resilient Infrastructure Standards," Working Paper of the Global Center on Adaptation, https://gca.org/wp-content/uploads/2021/01/Stocktake-of-Climate-resilient-Infrastructure-Standards.pdf.

10 Infrastructure Pathways is a multistakeholder initiative of the International Coalition for Sustainable Infrastructure. It aims to bring together existing guidance to provide a line of sight across the entire infrastructure project lifecycle to embed climate resilience and deliver safe, sustainable and resilient infrastructure for all. For more on the initiative, see https://www.resilienceshift.org/infrastructure-pathways/.

11 NRDS stands for National Resilience Development Strategy. CRRP stands for Dominica Resilience and Recovery Plan. Excerpt from the Foreword by the Prime Minister for Dominica Climate Resilience and Recovery Plan 2020-2030.

12 For more on the knowledge module, see https://gca.org/programs-infrastructure-and-nbs-knowledge-module-ppp/.

13 The Oxford Smith School of Enterprise and the Environment in 2020 carried out a survey of 231 central bank officials, finance ministry officials, and other economic experts from G20 countries on the relative performance of 25 major fiscal recovery archetypes across four dimensions: speed of implementation, economic multiplier, climate impact potential, and overall desirability. Five policies with high potential on both economic multiplier and climate impact metrics were identified: clean physical infrastructure, building efficiency retrofits, investment in education and training, natural capital investment, and clean R&D. See https://www.smithschool.ox.ac.uk/publications/wpapers/workingpaper20-02.pdf.

THE CLIMATE INVESTMENT FUNDS

The Climate Investment Funds (CIF) was established in 2008 to mobilize resources and trigger investments for low carbon, climate resilient development in select middle and low income countries. 14 contributor countries have pledged over US$8.5 billion to the funds. To date CIF committed capital has generated an additional US$61 billion in co-financing for mitigation and adaptation interventions at an unprecedented scale in 72 recipient countries. CIF's large-scale, low-cost, long-term financing lowers the risk and cost of climate financing. It tests new business models, builds track records in unproven markets, and boosts investor confidence to unlock additional sources of finance. The CIF is one of the largest active climate finance mechanisms in the world.

CIF
CLIMATE INVESTMENT FUNDS

www.climateinvestmentfunds.org

Photo: Alfred Grundalt and Cristina Mecerreyes Espinosa/IaDB