WESTERN AND
CENTRAL AFRICA

Benin

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Abbreviations and Acronyms

BCEAO	Central Bank of the West African States
BC-WAMU	West African Monetary Union
Capex	Capital expenditure
CCDR	Country Climate and Development Report
CGE	Computable General Equilibrium model
CNE	National Water Council
CSA	Climate smart agriculture
DALY	Disability-adjusted life year
DRF	Disaster risk financing
DRM	Disaster risk management
EHCVM	Harmonized Survey of Household Living Conditions (*Enquête Harmonisée sur les Conditions de Vie des Ménages)*
FONCAT	Fond Catastrophe
GDP	Gross domestic product
GHG	Greenhouse gas
GWh	Gigawatt hours
Ha	Hectare
ICT	Information and communication technology
IEc	Industrial Economics
IPP	Independent power producer
LMIC	Lower-middle income country
LULUCF	Land use, land-use change and forestry
MANAGE	Mitigation, Adaptation and New Technologies Applied General Equilibrium
MASM	Ministry of Social Affairs and Micro-Finance
MCVT	Ministry of Environment and Transport in charge of Sustainable Development (*Ministère du Cadre de Vie et du Transport chargée du Développement Durable)*
MoEF	Ministry of Environment and Forests
MoH	Ministry of Health
MRV	Measurement, reporting and verification
MWh	Megawatt hours
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NDP	National Development Plan
NPL	Non-performing loan
PAG	Government Action Plan
PANGIRE	National Action Plan for Integrated Water Resources Management
PONADER	Renewable Energy Policy
PONAME	Energy Efficiency Policy
RCP	Representative Concentration Pathway emissions scenario
SBEE	Beninese Electrical Energy Society (*Société Béninoise d'Energie Electrique)*
SLR	Sea-level rise
SME	Small and medium-sized enterprise
SNE	National Electrification Strategy
SOE	State-owned enterprise
SSA	Sub-Saharan Africa
SSP	Shared Socioeconomic Pathway emissions scenario
TFP	Total factor productivity
USR	Unique Social Registry
WAEMU	West African Economic and Monetary Union
WASH	Water, sanitation and hygiene

Content

Executive Summary

Executive Summary

Benin's socioeconomic development will increasingly depend on climate action

High growth over the last decade has helped Benin reduce poverty, but gains need to be sustained. Benin – a small open economy in West Africa – achieved lower middle-income status in 2020 thanks to above-average growth over the last decade. The poverty incidence (share of population under the national poverty line) has declined steadily – from 47 percent in 2010 to 38.5 percent in 2018/19. But it remains high and gaps in human capital and infrastructure create significant financing needs, challenging the growth momentum required to achieve the country's Vision 2060 goal of reaching upper-middle income status.

Worsening climate change impacts will make it harder to improve living standards equitably and sustainably. Despite having amongst the lowest greenhouse gas (GHG) emissions globally – at only 0.05 percent of global emissions – Benin is one of the most vulnerable countries to climate change, ranking 152 out of 181 countries for extreme climate vulnerability. While its GHG emissions are expected to increase with development, Benin's main challenge is its vulnerability to climatic shocks. Future dry and wet periods are likely to become more extreme, with more droughts and a higher risk of floods. Under a 2.7°C global warming scenario (i.e., business as usual), by 2070 98 percent of Benin's territory is expected to be exposed to extreme temperatures – one of the most exposed countries by percentage of landmass worldwide. Natural wealth has also declined in recent decades, with deforestation amplifying the negative effects of climate change.

This Country Climate and Development Report (CCDR) proposes that Benin focuses on building a resilient economy, with investment and policy options primarily targeted at adapting to climate change risks. The dependence of Benin's economic structure on agriculture and informal employment makes its development path highly vulnerable to climate change in the absence of proper adaptation. The government and the private sector need to be better prepared to deal with climate change – building adequate institutions and governance structures will be crucial. While all sectors will have to become more resilient, this is especially urgent for agriculture and land use, urban and network infrastructure, and human development (education, health). Mitigation efforts should focus on avoiding carbon lock-ins and reducing deforestation. Investing in renewable energy whilst expanding the population's access to electricity should be a priority for Benin. A higher share of renewable energy can bring about co-benefits for other sectors (agriculture, water, transport, and forestry). To maintain its growth trajectory, Benin needs to pay special attention to its most vulnerable people, including women. To protect the poor and vulnerable the just transition should focus on reconciling development and climate goals while addressing inequality (income and gender related), and spatial exclusion.

The CCDR uses modelling to explore the impacts of a range of climate change scenarios (see box), helping to identify specific recommendations for policy and investment action. These actions are listed in detail at the end of each thematic chapter, with a summary table of priority actions presented below. The report also identifies the potential avenues for financing the action required.

Modelling Benin's climate scenarios

The impact of climate change on Benin's economy and people has been modelled for this report. The modelling used a recursive dynamic Computable General Equilibrium (CGE) model and microsimulation tools. A baseline scenario has been calibrated and modelled using two alternative climate scenarios:

- **The baseline growth pathway to 2050:** assumes that current development ambitions are met by increasing historical productivity growth rates, thanks to a gradual transformation of the economy in line with the Vision 2060 and national development strategies.
- **A dry/hot scenario**: high mean temperature changes are paired with low mean precipitation changes.
- **A wet/warm scenario**: high mean precipitation changes are coupled with relatively low mean temperature changes.

Private and public institutions still need to mainstream climate action

Benin has established its climate change commitments and strategic objectives. The country's commitments to climate action are set out in its Nationally Determined Contributions (NDC), updated in 2021. It has also made important efforts to establish a climate change legal and policy framework that supports NDC implementation. The Law on Climate Change was enacted in 2018, the National Adaptation Plan (NAP, 2022) outlines key adaptation measures, and the National Climate Change Management Policy (PNGCC, 2021-2030) aims to guide Benin towards becoming a climate-resilient country with sufficient adaptive capacity and mechanisms to respond to climate risks and ensure low-carbon growth.

However, institutional arrangements for adaptation, risk management and mitigation need to be more joined up. Reflecting the cross-cutting nature of climate change, multiple institutions are engaged in climate change matters. While sectoral ministries have translated the strategic orientations into their planning documents, from agriculture to health, some governance structures need to be reinforced given their key role for climate resilience. For example, water management is too fragmented to support climate change adaptation and mitigation. Benin has a repository of instruments developed for coastal management and sustainable marine development, but the interactions among, and hierarchy of, the different laws and regulations are not always clear; and urban planning needs to prioritize climate in a new urban code.

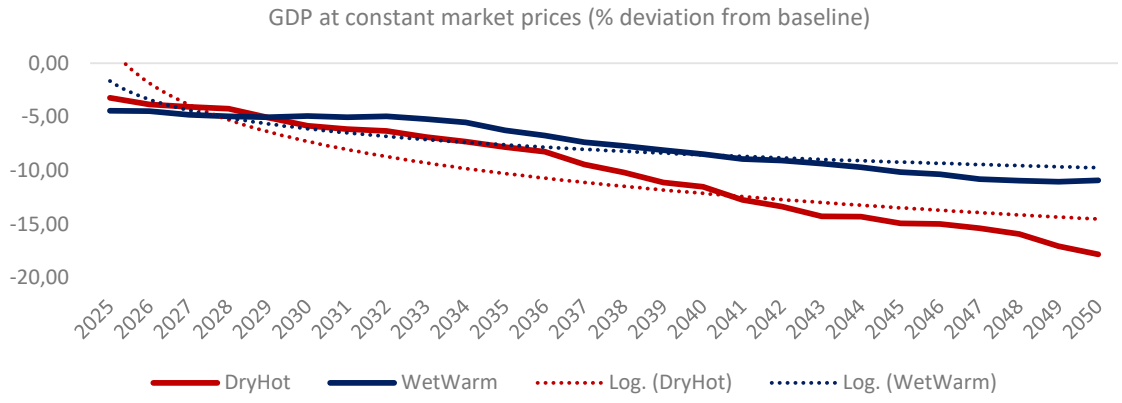
Private firms and financial institutions are mostly aware of the need to prepare for a changing climate, but need to take more action. Close to three in four Beninese firms face significant risks from climate change. While firms of all sizes indicate facing environmental risks, smaller businesses are more concerned about overall climatic volatility, whereas larger firms view input supply as a key challenge. While almost all agricultural firms fear exposure to environmental risks – especially changing temperatures and water scarcity – manufacturing and services firms display less concern. Only one in two Beninese firms indicate already having invested in adaptation measures, highlighting the elevated need for the private sector to bolster climate resilience. Firms' investments in mitigation measures appear to be less widespread, and primarily focus on reducing waste or chemical use.

The financial sector has yet to incorporate measures to manage the high exposure to climate-related risks. Climate shocks have the potential to translate into significant financial risks for the Beninese financial sector, especially the banking sector. To date, there is no mandate to systematically integrate climate-related risk analysis into the supervisory activities of key financial oversight agencies. The Regional Council for Public Savings and Financial Markets (AMF-UMOA), the regulatory and supervisory authority for capital markets in WAEMU, has not yet introduced climate risk disclosure guidelines for corporates. The Central Bank of the West African States (BCEAO) is not yet exploring the potential of greening the central bank's operations, including monetary policy. However, awareness is growing amongst the regional authorities. In 2020, the Banking Commission of the West African Monetary Union (BC-WAMU) released a guide on environmental and social risk management for banks and financial institutions which includes a section on climate risk. The guide provides recommendations on how banks can identify and assess climate risks, as well as how they can develop appropriate risk management.

Adapting to climate change requires a resilient growth model

Without any additional adaptation effort, modelling for this report estimates that average annual GDP losses will increase over time and could reach up to 19 percent of GDP by 2050. The estimated loss of real GDP due to climate change increases from an average range of 7-9 percent in the 2030s to 11-19 percent by 2050 compared to the baseline and across both climate scenarios. This entails an equivalent loss in real per capita income. In the hot/dry scenario, GDP per capita is projected to be over 18 percent lower by 2050.

Figure E1 – The cost of inaction increases over time and could reduce GDP by 19 percent by 2050



Source: MANAGE simulations. Notes: Deviations from the baseline; 5-year moving average.

Climate change affects the Beninese economy principally through changes to labor productivity. Effects of higher average temperatures on labor heat stress, human health, and availability of water supply and sanitation all reduce labor productivity, with productivity losses from labor heat stress the main driver of economic losses. Negative shocks to output through damage to physical capital stock are much less pronounced, likely owing to the low capital stock at baseline. At

the sectoral level, agriculture stands to be significantly impacted. Modelling for this report shows that by 2050 under the dry/hot mean scenario, crop yields would be reduced by 16 percent relative to the baseline.

Building a resilient economy will require investing in key sectors and a resilient labor demand and supply. Investing in a resilient agricultural sector, reversing deforestation and improving water management, while supporting the development of agribusiness, will be the cornerstones of sustained economic growth despite climate change uncertainty. Resilient labor demand will mean adapting infrastructure, networks and cities to climate change to allow a thriving private sector to develop, including through higher value-added services. Infrastructure and cities that are resilient to flooding and coastal erosion will be able to meet their economic potential and will help boost tourism – Benin's second-largest generator of foreign exchange earnings (after cotton). Building a resilient labor supply means ensuring that the accumulation of human capital is not hampered by climatic events. This will require resilient health and education systems. Benin can take advantage of its demographic transition to increase productivity and growth as long as the economic and human development policies that accompany it ensure that healthier and better educated young people enter expanding labor markets. However, the gaps are large: a child born today in Benin will be 40 percent less productive as an adult than if they had been fully educated and healthy. Preventing any further deterioration due to climate change should be a priority.

Summary of adaptation actions

- **Adapt agricultural approaches and techniques**. Benin's drive to diversify agricultural exports offers synergies to adapt to changing climatic conditions. Invest in sustainable food production models by: (1) implementing appropriate climate-smart agricultural techniques such as conservation tillage and using drought-resistant crops, in line with the Ministry of Agriculture, Livestock, and Fisheries (MAEP) strategy on sustainable agriculture; (2) promoting efficient irrigation systems and water harvesting infrastructure; and (3) investing in agricultural mechanization.
- **Restore and protect forests.** Enable the regeneration of 300,000 hectares of forest cover to restore degraded lands; strengthen early warning systems and fire risk monitoring; promote agroforestry systems in 15% of all classified forests; and strengthen land tenure security.
- **Invest in water resource management.** Increase supply through the construction of hydraulic structures and allow for multifunctional use to meet the needs of various sectors (agriculture, livestock farming, water supply, etc.). This means (i) protecting catchment areas; (ii) conserving knowledge, monitoring and securing of recharge areas; and (iii) implementing specific schemes to facilitate preferential water infiltration through secured aquifer recharge areas, such as establishing protection perimeters with regulated zones and zones declared non-constructible.
- **Plan for sustainable cities and coastal management.** Build resilience to urban flooding through effective land-use and urban planning. Consider more sustainable funding mechanisms for local governments, earmarked for climate resilience investments. Integrate water management and sanitation into expansion plans for cities and peri-urban areas to reduce sanitation risks caused by frequent flooding. Protect coastal areas through a combination of hard and soft interventions, including nature-based solutions.
- **Protect network infrastructure to keep people and markets connected**. Adopt multimodal transport for a more resilient and greener transport sector. Incorporate climate-resilient design parameters systematically into transport infrastructure. Conduct a thorough criticality analysis of the road network to ensure that climate-related events do not disrupt links essential to agriculture and other economic activities. Protect digital networks to allow them to increase connectivity in rural areas and boost people's access to climate finance, insurance, and early warning systems.
- **Strengthen the resilience of health service delivery and reinforce emergency preparedness.** Build the capacity of health personnel to diagnose, treat and manage climate-sensitive diseases; increase community-level preparedness and response plans; develop surveillance, an early warning system, information and research on climate-sensitive diseases and an appropriate response; install a financing mechanism for climate change-related health interventions; and adapt health infrastructure, equipment, products, and services.
- **Ramp up efforts for a more climate-resilient education system**. Accelerate the development of resilient school buildings; strengthen capacity in the Ministry of Education and mainstream climate change within the education sector's policies and plans.

Mitigation can avoid carbon lock-in and create opportunities for inclusive growth

The energy transition is an opportunity to embrace a less carbon-intensive development path. Most emerging and developing economies need to find the right balance between development needs and a lower carbon path. With more than half the population lacking access to electricity, achieving universal access to electricity by 2030 is Benin's main priority. The Benin Least-cost Electrification Master Plan (2021) expects that by 2030, 76 percent of the population will be connected to the electricity grid. To achieve this, the government plans to progressively increase the share of renewable energy (RE) in the energy mix as it expands production. The target is to reach between 20-30 percent RE penetration in the energy mix by 2035 and 33 percent by 2045. Overall, production expansion plans for 2045 will require financing of around US$2.6 billion (or 15 percent of 2022 GDP).

Co-benefits from the use of renewable energy could be sizeable, especially in telecoms, water management, and transport. A greener energy grid can reduce the emissions from ICT expansion. Benin is performing well at a regional level but there is still room for improvement as 20 to 40 percent of mobile sites do not have access to a reliable grid. Digital technologies could in turn support climate change mitigation in the energy sector by facilitating the transition to RE, enhancing energy efficiency, and enabling demand-side flexibility. Co-benefits could also exist from decarbonizing the transport sector to reduce negative externalities. Road transport's GHG emissions multiplied by six between 2000 and 2021. Even though in comparison with regional peers the current level of per capita transport emissions remains extremely low, they are increasing and will continue to rise as urbanization progresses.

Mitigation can also bring about new opportunities for forests and land use. To reduce carbon emissions from land use, deforestation rates will need to slow in the short term and stop altogether in the long term, with continued investment in sustainable forest management. Developing carbon financing opportunities for forest production and conservation offers a high-value opportunity for increasing and conserving carbon stocks, and reversing deforestation. To support this, in the context of Article 6 of the Paris Agreement, Benin adopted two decrees in December 2022 to enable projects to access carbon credits managed under the Ministry of Environment and Transport in charge of Sustainable Development (MCVT), and the Ministry of Environment and Forests (MoEF). To help meet energy demands, the government aims to improve fuelwood production, while expanding the use of clean fuels and efficient technologies. Much of the forested area is used for fuelwood and charcoal production, which support 46 percent of the national energy consumption.

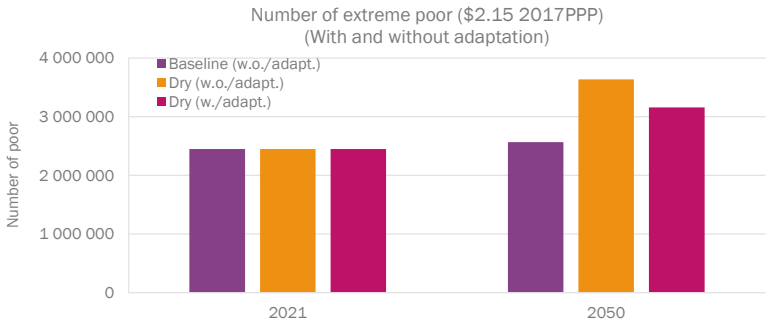
Summary of mitigation actions

- **Deepen the energy transition.** Implement the energy sector least-cost plan; respect generation planning and competitive procurement principles and ensure regular updates with a focus on reaching universal access by 2030. Create a favorable investment climate for investment in renewable energy.
- **Take advantage of co-benefits in key economic sectors.** In the transport sector for example, develop a clean mobility strategy for the country; encourage e-mobility private investments through a friendly framework; analyze financing possibilities and schemes; and rehabilitate and modernize public road transportation (light public transportation).
- **Seize mitigation opportunities for forests and land use.** Ensure the large-scale reforestation aims indicated in the government's Forest Policy (2023-2032) are accompanied by an investment plan and sustainable fuelwood strategy; expand and develop rural fuelwood markets in the most important areas of uncontrolled exploitation; introduce a system of labeling, and testing standards and protocols, to ensure adequate stove and fuel performance and provide targeted incentives to promote a localized supply chain; and create and manage new national parks, marine protected areas, and biodiversity reserves through community-based approaches.

Protecting the poor and vulnerable, especially women, is key to sustaining the transformation

Benin's vulnerable populations and households face disproportionate risks from climate change, potentially delaying a sustained economic transformation. The negative impact on human capital – particularly in outdoor sectors such as agriculture – could be large if no action is taken. Between half a million to 1 million additional people would remain in poverty by 2050 in the absence of adaptation action. Women and unskilled workers stand to be the most affected. Rural areas display higher poverty incidence rates than urban ones: 20 percent vs. 17 percent, respectively. Regional disparities in the poverty incidence are also noticeable. While regions in the south (such as Littoral and Ouémé) are expected to maintain low poverty rates by 2050, simulations suggest that in other regions, such as Collines (in the Center), reducing poverty will be very difficult in the absence of adaptation.

Figure E2 – Extreme poverty could increase by up to 1 million in the absence of climate change action



Source: Microsimulations. Notes: Deviations from the baseline under hot/dry climate impact with and without adaptation.

Actions to reduce the negative impact of climate change through resilience and adaptation would help mitigate this effect. Simulations for this report suggest that if Benin invests in certain resilience and adaptation measures in the coming decades, poverty rates would be lower than without any climate action. Almost half a million fewer people would be living under the poverty line by the end of the projection period compared to a scenario without any policy interventions.

Social assistance and labor market programs have an important role to play in addressing household vulnerability to shocks and facilitating a 'just transition'. Benin can:

- **Expand the productive and adaptative social protection program to reach vulnerable groups affected by climate change, especially women.** Currently, government spending on social protection programs is low, at less than 1 percent of GDP. The government's Productive Social Safety Net Program (PSSNP) will expand the national Gbessoke safety net program, focusing on support to poor households during shocks. The program aims to reach at least 150,000 individuals, representing 61 percent of extremely poor households in the social registry.
- **Build the resilience to climate shocks of women and female-headed households**. This could involve building female agency on climate change-related issues, targeted social protection programs, cash transfers, safety net projects, greater financial inclusion, supporting livelihood diversification, and support to develop the skills needed to succeed in the green economy.

How to fund and finance climate action?

Climate interventions involve significant investments, but the benefits outweigh the costs. In this CCDR we estimate that strict additional financing needs[1] in Benin amount to an annual investment of 0.1 percent of GDP to 2030, rising to 0.3 percent of GDP to 2040 and 0.8 percent of GDP in 2050. This would be an annual average of 0.3 percent of GDP over the entire period and would cost US$2.7bn by 2032. This calculation assumes higher levels of public investment as a share of GDP, averaging 8 percent for the 30-year period, compared to historical averages of 5 percent of GDP between 2012-2023, most of which will require financing and will involve both adaptation and mitigation action. Indeed, adaptation costs can be hard to separate from other development needs, as development and adaptation are self-reinforcing. The costs of climate adaptation identified in other strategic documents are all encompassing. The NDC estimated investment needs for mitigation at about US$8.6 billion, with US$5.1 billion coming from the government and the private sector, and the remaining US$3.5 billion expected to be mobilized from the international community. Investment needs for adaptation were estimated in the NDC at approximately US$1.8 billion, of which US$ 578 million (32 percent) would be public funding and US$1.2 billion would require international support (68 percent). Meanwhile, the NAP estimates investment needs for adaptation of about US$4.2 billion over a 10-year horizon.

There are at least three potential avenues for financing climate action as described in this CCDR:

(1) **Increase revenue (such as through a carbon tax) and make public spending more efficient to create fiscal space for adaptation.** There is growing consensus that carbon taxation can reduce global carbon emissions effectively and replace less effective carbon regulations. The analysis here finds that a well-designed carbon tax could raise significant revenue and reduce the distortions introduced by current tax instruments. Similarly, Benin stands to gain from making the public financial management (PFM) system climate responsive and seizing opportunities to foster more climate-smart public investment management.

1 Defined by a strict additionality definition, i.e., the difference between optimal investment levels in a scenario without climate change (baseline) and one with climate change.

(2) **Tap into concessional and blended finance and disaster risk financing.** Benin is already using innovative financial instruments to finance its development agenda. In this context, the country should maximize the full range of concessional and semi-concessional financing available, including new sources of climate funds. Several new financial institutions are expanding the scope of their activities to Africa, creating the potential for new blended financing. One example is the recent launch of the European Investment Bank (EIB) Global in January 2022. In addition, Benin can explore deploying more innovative financial structures from these concessional and semi-concessional resources, including thematic bonds and sustainability-linked bonds using its ESG framework. Disaster risk financing is also an attractive option for Benin and involves proactive planning to better manage the cost of disasters and ultimately mitigate long-term fiscal impacts.

(3) **Leverage corporate investment.** Crowding in private sector financing will require deepening the financial sector. While bank credit accounts for 82 percent of total private domestic funding, the credit structure has remained broadly the same over the years, with most credit focusing on short- and medium-term financing. Relatively little progress has been made in private sector financing on capital markets in general, and green financing in particular, at the WAEMU level. In this context, to enable private financing to flow, while continuing to support the deepening of financial markets, public resources are also required to de-risk projects, provide concessional credit, and backstop against certain shocks. Public-private partnerships also provide a critical tool to advance private sector involvement and technology transfers for mitigation projects and more resilient infrastructure. The authorities promoted PPPs as a mean of financing for 61 percent of planned investment in the first Government Action Program (2016–21) and have set the target at 52 percent for the second Government Action Program (2021–26). Strengthening the PPP framework, creating a knowledge-sharing mechanism to improve capacity to mobilize the private sector, and establishing a pipeline of potential PPPs, are all important next steps.

Key policy actions are identified to maximize synergies and unlock potential gains

Given the limited resources and complex interactions of the different policy and investment actions laid out in the chapters of this report, the table below attempts to prioritize the most pressing interventions. The most urgent actions with greatest co-benefits and impact (in no particular order) are presented in the left-upper quadrant of the table. The top right quadrant contains actions that require more preparation and timing; although they remain critical, the cost of inaction is considered to be more moderate. The lower-left quadrant presents urgent actions that require consensus building and should be designed considering the political economy, complexity, financing mechanism, among others.

	Game changers - critical actions (actions which if delayed will have systemic consequences and increase costs)		**Tier 2 critical actions** (actions which if delayed will have systemic consequences but more moderate costs)	
	Sector	***Action***	***Sector***	***Action***
Synergies (actions that facilitate other objectives)	Agriculture (AG2)	Finalize rural land titling reform by reinforcing institutions at the Ministry of Agriculture in charge of the reform.		
	Urban management (UM2)	Promulgate the new building code, adopt the secondary legislation, and increase enforcement capacity of building codes/land use under consideration of gender equality principles; and protect the coast from erosion and flooding.	DRM (DRM1)	Develop a multi-risk mapping, early warning systems and the further use of digital information and tools with the aim to reach all social groups, including women, rural residents, and vulnerable populations.
	Energy (E2)	Ensure that the resilience to climate change of electricity generation, transmission and distribution infrastructures is analyzed at the design stage and that the measures identified are considered when the work is carried out; and vulnerable sites protected.	Transport (TR1)	Develop a road asset management system for a more strategic allocation of resources towards maintenance and modernization interventions; and a thorough criticality analysis of the road network to ensure that climate-related events do not disrupt links essential to agriculture and other economic activities.
	Gender (GG1)	To benefit from the demographic dividend, ensure women are represented in climate action decision-making, increase the representation of women across all relevant decision-making bodies (e.g. ensure participation of women and girls in consultation processes on urban planning /DRM/ climate change adaptation policies).	Transport (TR2)	Incorporate climate-resilient design parameters into future transport infrastructure. Pilot low-cost nature-based solutions to increase resilience and reduce erosion.

	Sector	Action	Sector	Action
Synergies (actions that facilitate other objectives)	Governance (PFM)	Strengthen budget planning instruments by systematically considering climate risks. Develop a standard methodology for climate change impact assessments in the PIM by including climatic risks and more climate-sensitive project selection criteria.	Water	Continue investments in urban sanitation and storm water management to effectively address flooding risks and ensure proper management of sewage sludge.
	Forests (FO2)	Restore/reforest 0.45 million ha of degraded land (to restore forest cover to 2015 level) and strengthen forest governance by adopting a new forestry code.		
Actions that require building consensus (due to high costs, political economy complexity, among others)	**Sector**	**Action**	**Sector**	**Action**
	Water (WA2)	Operationalize the user-payer principle for commercial use of water resources to mobilize financial resources, following the adoption of a ministerial order that defines this principle across all water subsectors.	Education and Health	Develop a strategy for the health and education sectors that integrates climate change and ensure resilient buildings/ institutions (e.g safe schools).
	Water/ Agriculture	Remove financial and regulatory hurdles for the implementation of the hydro-land management in rural areas for agriculture use.	Macro	Incorporate an effective green taxation system including carbon taxation.
	Energy	Invest in network infrastructure, including digitizing and compliance of the grid's operating network to reduce the amount of unserved energy and the related losses in economic productivity.	Energy/ Forests	Implement the *National Strategy on Clean Cooking* to achieve universal access.
	Social protection	Continue building an adaptive social protection system by (1) updating data for populations at risk of flooding, relying on mobile payment transfers for faster delivery of benefits in case of a shock, and (2) using the social registry to scale up interventions as needed, including adding new beneficiaries (horizontal expansion) and/or increasing the cash transfer amount (vertical expansion).	Financial sector	Regional level action: (1) The BCEAO should conduct stress testing on the largest banks in Benin to assess the impact of climate change on the financial sector; (2) BCEAO should integrate climate risks into its supervisory framework (e.g., AMF-UMOA has not yet introduced the climate risk disclosure guidelines for corporates).
	Coastal management	Harmonize the regulatory framework on coastal management, including the interactions and hierarchy between the different laws and regulations, especially with regard to territorial planning, (equal access in property ownership, and other environmental issues (pollution and biodiversity), and the use of natural resources.		

Chapter 1.

Development and climate challenges are intertwined

Chapter 1: Development and climate challenges are intertwined

1.1. Immense socioeconomic development challenges are heightened by rising uncertainty

Benin – a small open economy in West Africa – has recently transitioned to lower middle-income status thanks to above-average growth during the last decade. Despite growth volatility over the last decade, Benin's performance has been above average for sub-Saharan Africa (SSA). Real gross domestic product (GDP) growth averaged 5.2 percent over 2011-22, making it one of the region's most dynamic economies (Figure 1). The services sector has risen to prominence partly thanks to the country's increasing role as a local trade and transit hub with Nigeria. The continued scale-up of cotton production has also consolidated its position as the lead cotton producer in West Africa for three consecutive years (2019-21). On the demand side, private consumption has remained the largest contributor to growth, and the contribution of investment – which has historically been marginal – has surged, driven by private investment (Figure 2). Private investment increased fourfold, from 3.6 percent of GDP (2000-10 average) to 16.4 percent over 2011-21. Growth performance has also been supported by prudent macroeconomic policies and political stability. In 2020, Benin officially transitioned from a low-income to a lower-middle income country (LMIC).

Poverty over this period has gradually declined, but it remains high. The poverty incidence (share of population under the national poverty line) declined steadily – from 47 percent in 2010 to 42 percent in 2015, falling to 38.5 percent in 2018/19.[2] However, high population growth (with one of the highest total fertility rates in the world, at 4.8 births per woman) and low levels of labor productivity have prevented the high growth trajectory from being translated into higher income per capita gains. The average per capita growth rate of 2.4 percent between 2011 and 2021 remains lower than peers.[3] The poverty incidence also varies across the country, with marked differences between rural and urban areas, and northern and southern regions. The urban-rural gap in poverty incidence stood at 12.8 percentage points (ppts) in 2018/19, with the poverty incidence averaging 44.2 percent in rural areas, versus 31.4 percent in urban areas. Regional disparities are even larger, ranging from a poverty incidence of 60.6 percent in Atacora (in the northwest bordering Burkina Faso) to 18.2 percent in Ouémé (Figure 3).

The road ahead is challenging as Benin needs to find ways to sustain its growth momentum and drive the structural transformation outlined in its Vision 2060 in a context of rising uncertainty and vulnerabilities. Benin's Vision 2060[4] aims to achieve upper-middle income status, halve poverty and increase living standards across the board. This will require sustained high growth levels, driven by higher productivity growth and continued physical and human capital accumulation. Productivity growth has been stagnant since the 1990s.[5] Benin has one of the lowest Human Development Index (HDI) scores, ranking 166 of 180 countries in 2021. While investment in infrastructure has picked up over the last five years, access to key infrastructure (and services) remains low, with only 35 percent of the population connected to the electricity grid overall, with the share falling to less than 20 percent for the rural population. Challenges to socioeconomic development are still immense in a context of rising uncertainty, with increasingly large threats from insecurity in the Sahel and Nigeria's northern borders; tightening global financial conditions putting strains on public finances and drying up sources of development financing; and increasing climatic vulnerability worldwide.

Rising global vulnerabilities are increasing the tensions between short-term and long-term development challenges. The generalized rapid normalization of monetary policy that followed the onset of the war in Ukraine in 2022 resulted in tightening financing conditions for developing and emerging economies. At the same time, increasing fiscal deficits and negative terms of trade for oil-importing economies such as Benin have led to a worsening of external accounts, emphasizing macroeconomic imbalances in developing economies. Debt levels in SSA are at their highest since the Heavily Indebted Poor Countries (HIPC) Initiative, as countries exiting the COVID-19 crisis with expanded fiscal balance sheets and limited domestic resource mobilization have seen their borrowing capacity contained. Against that backdrop, financing development needs, while increasingly having to deal with climate change shocks and fragile bordering countries, has become all the more challenging.

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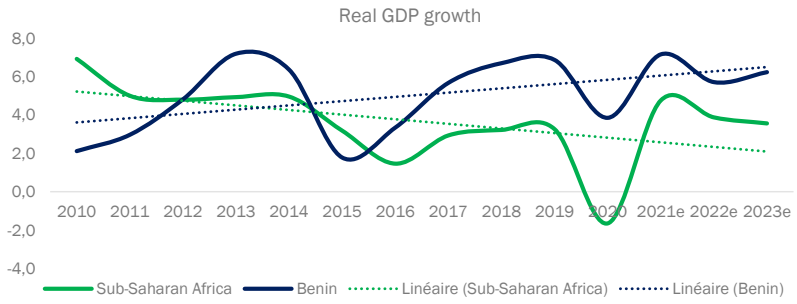
2 The World Bank has addressed the 2018 data non-comparability with the 2010 and 2015 household surveys through the SWIFT (Survey of Well-being via Instant and Frequent Tracking) approach of the survey-to-survey technique (World Bank, 2022a, Benin Poverty Assessment).

3 In the same period, it was 2.7 percent in Togo, and 3.8 percent in Rwanda (World Bank, 2022b, Benin Country Economic Memorandum).

4 Vision 2060 is under preparation and sets the country's vision to be achieved 100 years after independence.

5 Between 2001 and 2018, Benin's output per worker grew at an average rate of 1.2% a year. As a result, by 2018 the average worker in Benin produced only 16.2% more real output than in 2001, compared to 50.4% for a worker in Rwanda, and 56.5% in Sri Lanka. Despite an uptick in the most recent decade, output per worker still grew at an annual average of 2.0% over 2011-2018, slightly lower than other WAEMU peers like Senegal and Côte d'Ivoire. Growth accounting also suggests that capital accumulation has been one of the main drivers of growth over 2011-2018, with TFP contributing marginally and declining since the 1990s (World Bank 2022b).

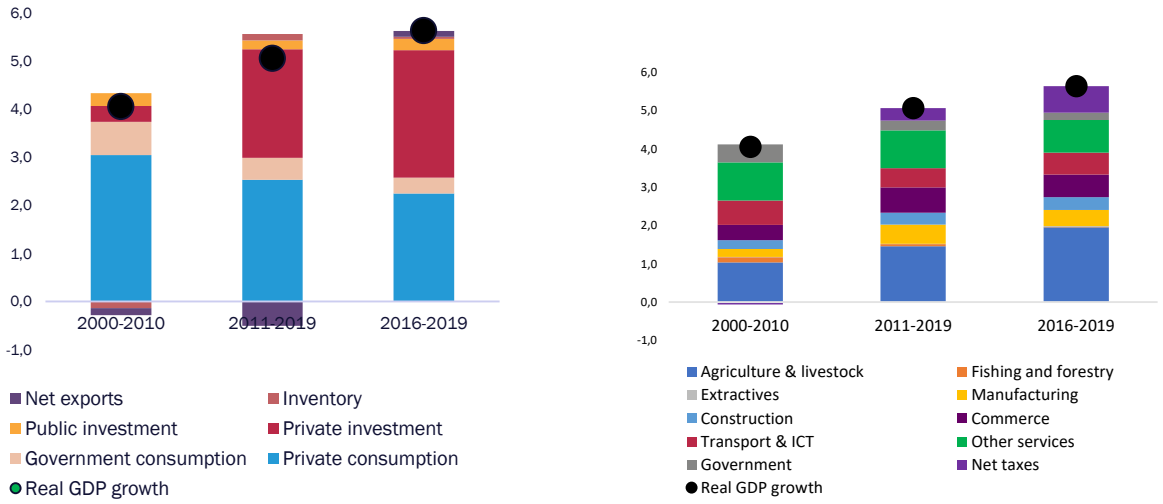
Figure 1 – Benin's real GDP growth remains above the SSA average



Source: IMF (2022). World Economic Outlook.

Figure 2 – Private investment is the main driver of growth.

Demand-side growth decomposition (graph on left) and supply-side growth decomposition (graph on right)



Source: World Bank Group (2021), Benin Country Economic Memorandum.

The country needs to create more jobs in the formal economy and deepen the process of structural transformation to lift people out of poverty. So far, the expansion of services has offered a wider path to jobs outside agriculture, but services remain dominated by low-productivity non-tradable commerce and informal activities. Underemployment stands at 72 percent, with more than 90 percent of rural women and people under 25 declared to be underemployed. Over 90 percent of the labor force is employed in the informal economy, and two-fifths of the population are still engaged in informal rural activities, predominantly smallholder agriculture often associated with high rates of poverty.[6] In 2022, 27 percent of value-added was still in agriculture, mostly cotton and a few other export crops (cashew, pineapple), but the sector remains dominated by smallholder farming. Tourism, transport, and logistics services offer significant potential to expand the services sectors.[7] Manufacturing remains limited, but the government is investing in the transformation of raw materials with the opening of the industrial park of *Glo Djibé* in 2021. Improving market competition, reducing the cost of doing business (by investing in infrastructure and upstream sectors such as energy, transport, digital technologies, financial services), and reducing frictions in markets through stronger institutions and regulations will continue to be crucial for developing a dynamic private sector that can deepen the structural transformation of the economy and create better jobs.[8]

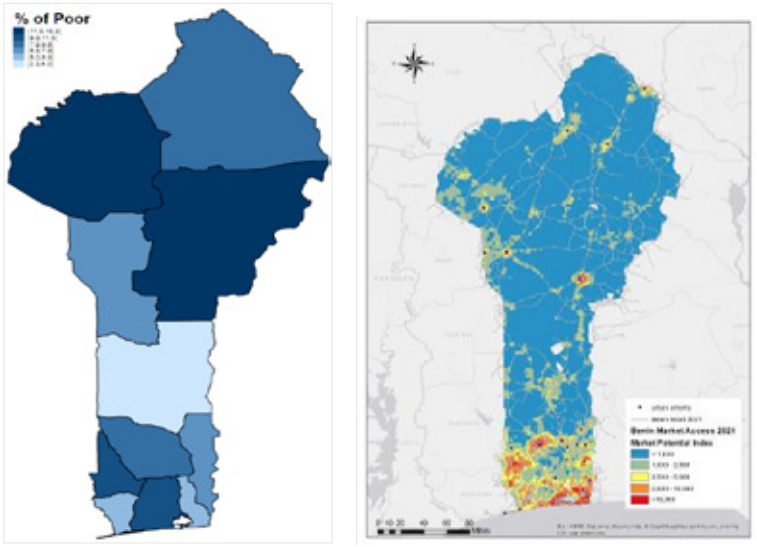
6 World Bank (2022). Benin Poverty Assessment.

7 World Bank Group (2023), Country Private Sector Diagnostic.

8 World Bank (2022). Benin Poverty Assessment.

The quality of the labor supply also needs to improve, especially by empowering women and girls. Currently, at 4.8 births per woman, Benin's fertility rate is slightly above the SSA average of 4.6 births per woman[9] and substantially higher than many SSA countries that are already further along their demographic transition (especially those in Southern Africa). Benin's rapidly growing population – it has risen from 2.4 million in 1960 to close to 12 million in 2020 – makes it a "pre-dividend" country. This offers the potential to take advantage of its young labor force to increase productivity and growth per capita, but doing so will require healthier and better educated young people to enter expanding labor markets.[10] According to the Human Capital Index (HCI), a child born in Benin in 2020 is expected to be only 40 percent as productive when they grow up as they could have been if they had enjoyed complete education and full health.[11] Improving the quality of the labor supply will also mean accelerating the fertility decline, tackling the wide gender gaps in access to education and formal jobs, and expanding access to sexual and reproductive health.[12]

Figure 3 – The prevalence of poverty is higher in the north (left), where there are fewer people and markets (right)



Source: World Bank (2022), Benin Poverty Assessment; World Bank (2022), Benin Country Economic Memorandum. Notes: poverty incidence based on ECHVM 2018/19.

Rapid urbanization as the country grows is expected to have significant spatial implications. About 50 percent of Benin's population lives in urban areas. Four agglomerations (cities which exceed the 10,000-inhabitant threshold) contain about half of the total urban population: Cotonou (1.5 million inhabitants), Porto-Novo (572,000), Parakou (260,000), and Abomey (257,000).[13] Unlike in other parts of the world, this level of urbanization has been reached without significant changes to the structure of the economy, which limits the potential offered by agglomeration economies.[14] By 2050 the urban population is expected to reach 60 percent (UN population projections), making building cities' resilience and urban infrastructure crucial for development going forward. Cotonou dominates the urban hierarchy and is 2.7 times larger than the second largest city, Porto Novo. However, these two agglomerations are so close to each other that they are likely to merge soon. Taken together, the combined agglomeration will be home to 20 percent of Benin's population. Climatic pressures are set to aggravate spatial imbalances and geographical disparities between rural/urban areas and northern/southern provinces, further amplifying the fragility caused by insecurity in the northern region and provoking more displacements (including in-migration from Sahelian countries).

9 World Bank (2021). World Development Indicators. https://datatopics.worldbank.org/world-development-indicators/

10 World Bank (2022). Benin Country Economic Memorandum.

11 The Human Capital Index (HCI) measures the consequences of neglecting investments in human capital in terms of the lost productivity of the next generation of workers (World Bank, 2018, World Development Report 2019).

12 World Bank (2022). Benin Country Economic Memorandum.

13 See https://africapolis.org/en/country-report/Benin.

14 "Lall, S.V., Henderson, J. V. and Venables, A.J. (2017). Africa's Cities: Opening Doors to the World. World Bank

1.2. Worsening climate change impacts will make it harder to improve living standards equitably

Despite its low contributions to greenhouse gas (GHG) emissions, Benin is one of the most vulnerable countries to climate change. Benin's per capita emissions are among the lowest in the world. It contributes only 0.05 percent of global GHG emissions and is ranked 149 out of 188 countries for its per capita emissions. In 2021, its GHG emissions were 5 percent of South Africa's, and the second lowest of all West Africa Economic and Monetary Union (WAEMU) countries.[15] While GHG emissions are expected to increase as the country develops (Box 1), and mitigation measures should be considered in order to avoid carbon lock-ins, Benin's main challenge is its vulnerability to climatic shocks. The country ranks 152 out of 181 countries for extreme climate vulnerability (181 being the most vulnerable).[16] Climate change is therefore set to have a significant impact on Benin's most vulnerable populations and key economic sectors in the coming decades.

The impacts of climate change are already visible and are expected to worsen over time with increased temperatures, greater weather variability, and more extreme weather events.[17] Under a 2.7°C global warming scenario (i.e. under current policies), by 2070 Benin is expected to have one of the largest exposures to the most extreme temperatures by percentage of landmass, with 98 percent of its territory expected to be impacted.[18] Future dry and wet periods are likely to become more extreme, with more droughts and a higher risk of floods expected. Floods are already becoming increasingly severe and more destructive: recurrent floods in urban areas such as Cotonou, Porto Novo, and Parakou pose significant challenges to the inadequate and insufficient water supply, sanitation, and waste collection systems. Droughts will continue to affect Benin, with impacts felt in the agriculture and water resources sectors. The country's coast already has one of the highest rates of coastal erosion in the Gulf of Guinea.[19]

Climate change impacts are magnified by high levels of poverty and inequality. Climate change impacts are asymmetric: poor households are generally more exposed to air, water, and soil pollution and to rising temperatures, uneven rainfall, and other extreme weather events. In addition, poor households rely on low-quality public health services and have fewer financial resources to cope with damage. High exposure to shocks poses serious challenges for poverty reduction, with negative spillover effects on labor productivity and the well-being of households. Increasing temperatures and floods will also have an impact on the spread of infectious diseases, such as malaria. Social safety nets are still nascent in Benin and do not yet account for the climate dimension, while most of the health and education infrastructure is vulnerable to climatic shocks.

Climate change impacts are not gender neutral. The vulnerability of poor households to climate shocks also depends on their demographic composition and on the characteristics of their members. For instance, female-headed households often fare worse in adapting to climate shocks than male-headed households due to persistent gender disparities in the labor market and asset ownership, and a higher total dependency ratio. Beninese women are particularly vulnerable to climate-induced shocks due to pre-existing gender inequalities that prevent them from accessing basic services, participating in the labor market and quality employment, owning and controlling land and assets, and exercising their decision-making role in the household and in public life in the same way as men.[20] Women are also more likely than men to be overrepresented in climate-vulnerable sectors and to bear the burden of the care and domestic work, further limiting their capacity to prevent and mitigate climate shocks.[21]

15 Benin is part of the WAEMU together with Burkina Faso, Côte D'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo.

16 See ND-GAIN Country Index (University of Notre Dame Global Adaptation Index) (dashboard), University of Notre Dame, Notre Dame, IN, https://gain.nd.edu/our-work/country-index/.

17 This report uses the World Bank guidance for the selection of global climate scenarios for CCDR analyses. These include SSP2-4.5, SSP3-7.0 for adaptation; and SSP3-7.0 GCMs and SSP1-1.9 GCMs for mitigation (see Annex 2).

18 Lenton, T.M., Xu, C., Abrams, J.F. *et al.* (2023). "Quantifying the human cost of global warming". *Nat Sustain*, 6: 1237–1247.

19 Note that potential catastrophic impacts and tipping points that are not easily captured through existing estimates may pose the biggest future threats. One example is the West African Monsoon (See Annex 1: Selecting climate change scenarios).

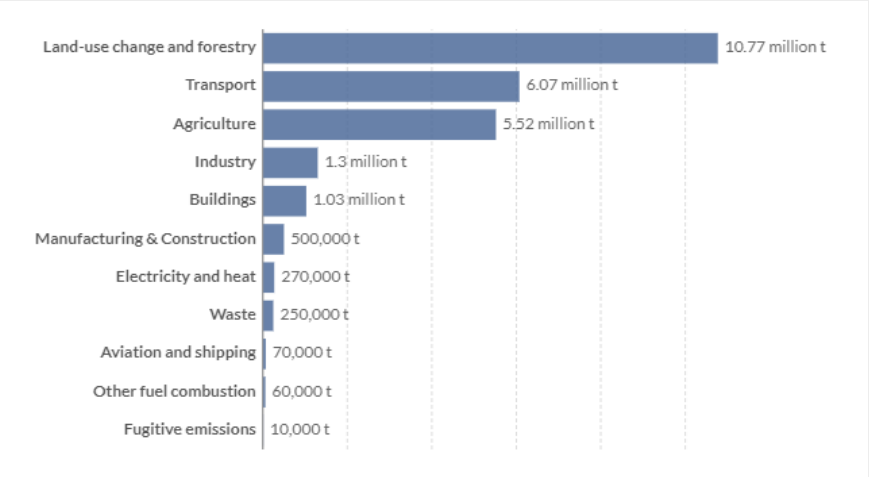
20 Harris-Fry et al. (2020); UNICEF 2023.

21 Deininger et al. 2023l; UN Women 2020; WBG Climate Group 2017; WHO 2014).

Box 1 – GHG emissions in Benin

Benin's total GHG emissions are very small on a global scale, at approximately 32.6 million tons of carbon dioxide equivalent (CO_2e), or 1 ton of CO_2e per capita in 2021. Its GHG emissions are below the SSA average, which is estimated at 3.27 tCO_2e per capita. The agriculture, forestry and other land use (AFOLU) sector is the single most important contributor to GHG emissions, accounting for 41.76 percent (Figure 4). Emissions are mainly driven by the uncontrolled expansion and conversion of forests to agriculture, but forest degradation caused by illegal and unsustainable logging and over-extraction of wood for timber, and fuelwood and charcoal production to meet energy needs, are other leading sources. Traditional fuelwood and charcoal continue to be the dominant sources of energy, as access to energy in rural areas is limited. Urbanization and infrastructure developments also cause deforestation, including coastal mangrove forests which are capable of storing more carbon than other ecosystems. Benin's methane emissions are mainly from agriculture (2.4 $mtCO_2e$), waste (0.1 $mtCO_2e$) and land use change and forestry (0.3 $mtCO_2e$). Emissions from agriculture doubled between 1990 and 2015 mainly due to enteric fermentation and cultivation of soils. However, their overall contribution declined from 69 percent of total to 41 percent over the same period. Agriculture is the largest contributor to both methane and nitrous oxide emissions. The energy sector emits 0.24 kilograms of CO_2 per kilowatt-hour, which is higher than Côte d'Ivoire (0.17) and Ghana (0.19), but comparable to Togo (0.23). The transport sector is the second contributor to total emissions and has seen the highest increase in GHG emissions (a six-fold growth since the 2000).

Figure 4– Annual GHG emissions are mostly from land use change and forestry, with transport and agriculture both growing sources



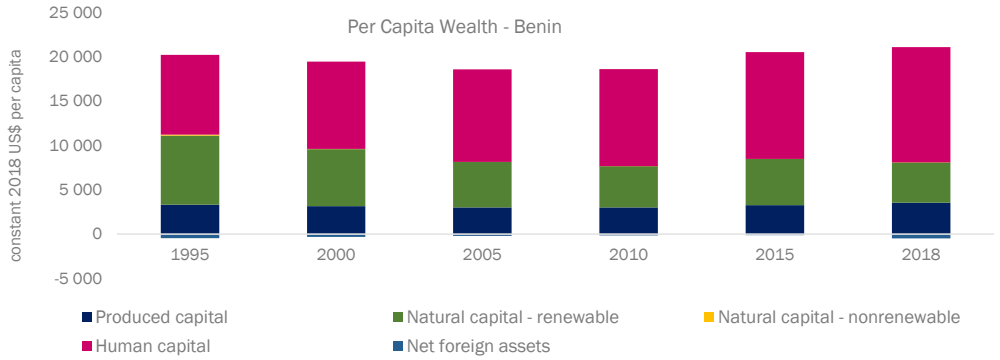
Source: Our World in Data (2019); Note: Emissions are measured in carbon dioxide equivalents (CO_2eq). This means non-CO_2 gases are weighted by the amount of warming they cause over a 100-year timescale.

Natural wealth per capita has declined over recent decades, with deforestation amplifying the negative effects of climate change.[22] For lower income countries that are often scarce in human and produced capital, natural capital offers an opportunity to generate additional revenue for capital accumulation in the process of economic development. As growth proceeds, this might imply a reduction in the share of natural capital in total wealth, but it should not imply a reduction in natural capital per capita (e.g., Chile has grown without depleting its natural capital per capita). Building wealth without depleting per capita natural capital is critical for sustained wealth accumulation. However, between 1995 and 2018 Benin increased its per capita human and produced capital at the expense of its per capita renewable natural capital (Figure 5), which declined by more than 30 percent (driven by the degradation of protected areas and sub-soil assets). This has resulted in stagnant wealth per capita growth and slower GDP growth than countries where natural per capita wealth

22 Although GDP is an important indicator of economic progress, it is a flow measure that doesn't reflect changes in the underlying asset base. For instance, it does not reflect depreciation, depletion, or degradation of assets; nor does it not indicate whether accumulation of wealth is keeping pace with population growth, or whether the mix of different assets will support a country's development goals. Sustained economic growth over the long term requires building and managing a broad portfolio of assets: produced, human, and natural capital (renewable and non-renewable). The World Bank has established a program for measuring national wealth to monitor long-term economic well-being and guide the development process seen through the lens of a country's assets. World Bank (2021). The Changing Wealth of Nations 2021: Managing Assets for the Future.

has increased or remained constant, like Cambodia and Azerbaijan.[23] In return, the degradation of protected areas and increased deforestation further exacerbate climate change, thus impacting capital accumulation in the future.

Figure 5 – Natural wealth per capita has declined in recent decades



Source: World Bank (2021). *The Changing Wealth of Nations 2021: Managing Assets for the Future.*

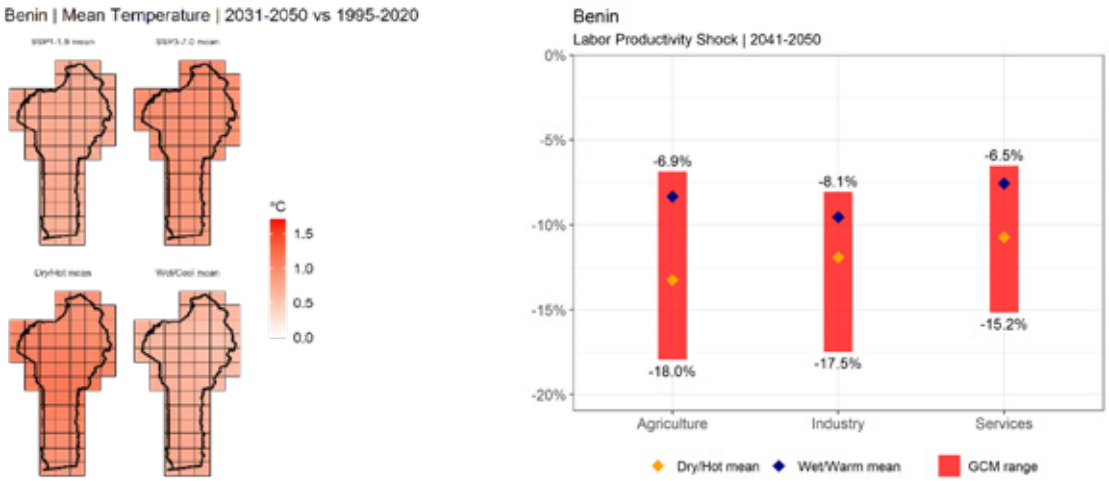
1.3. Modelling in this report helps understand the costs of inaction and the benefits of action

The economic impacts of climate change will depend on the interaction between the climate change transmission channels, the underlying socioeconomic structure of a country, and its trajectory. The impact of climate change on the economy and people has been modelled for this Country Climate and Development Report (CCDR). The macroeconomic modelling used a recursive dynamic computable general equilibrium (CGE) model (Box 2). Microsimulation tools were used to complement macroeconomic modelling and simulate the impact of shocks on welfare at the household level (see Annex 3 for details). The baseline macroeconomic framework is calibrated to the CGE, while modelling of the impact of climate change is done using two alternative climate scenarios. Results presented throughout the report compare deviations from the baseline across climate shock channels with and without additional adaptation and mitigation efforts (see Annex 6). The key assumptions are below:

- **The baseline growth pathway to 2050** assumes that current development ambitions are met by increasing historical productivity growth rates over the medium term, thanks to a gradual transformation of the economy in line with the Vision 2060 and national development strategies described in Chapter 2. Under the baseline, growth meets its potential, stabilizing at 5 percent by 2050. We assume an annual rate of deforestation of 1.6 percent per year between 2015-20. We also model two energy mixes: a baseline that follows the least-cost energy development plan, and an alternative scenario with a more ambitious renewable energy (RE) mix. For details see Annex 2.
- **Two alternative climate scenarios (hot/dry and warm/wet) are used due to the uncertainty related to climate change.** These represent qualitative differences in the nature of climate shifts: (i) the dry/hot scenario (dry) incorporates cases in which high mean temperature changes are paired with low mean precipitation changes; whereas (ii) the wet/warm scenario (warm) incorporates cases in which high mean precipitation changes are coupled with relatively low mean temperature changes. To incorporate these impacts in the CGE model, the analysis considers the main impact channels that will cause shocks to the country's economy. These shocks have been estimated using a biophysical model developed by Industrial Economics (IEc). The impact channels can be grouped into three categories: (i) productivity and human capital; (ii) agriculture and natural resources; and (iii) infrastructure and services. For an example, see Figure 6 (and see Box 2, and Annex 5 for a fuller description).

23 World Bank (2021). The Changing Wealth of Nations 2021: Managing Assets for the Future.

Figure 6– Temperature increases could significantly impact labor productivity in the absence of adequate adaptation measures, with the most severe impacts under the dry/hot scenario



Source: IEc Benin CCDR report (2022). Notes: Left graph shows the distributions of mean temperature changes in 2031-2050 compared to 1995-2020; the right graph shows the average labor productivity shock for three key sectors from rising temperatures for 2041-2050 under the dry/hot and wet/warm scenarios.

Box 2 – Modelling the impact of climate change using the MANAGE model

The World Bank's Mitigation, Adaptation and New Technologies Applied General Equilibrium (MANAGE) model has been used in this analysis as a macro-simulation model. MANAGE is a single-country recursive dynamic computable general equilibrium (CGE) model, designed to focus on energy, emissions, and climate change. Climate change is likely to have direct and indirect effects on the Beninese economy. The former are introduced in the macro and micro models through damage vectors (i.e., channels such as sectoral and labor productivity, labor and capital supplies) estimated using a biophysical model (IEc, 2022). Indirect effects accrue from various channels, such as production linkages, factor substitution and intersectoral mobility, the fiscal framework, and trade. MANAGE is sufficiently flexible and detailed to deal with a wide range of transmission channels for climate shocks and can capture the effects along several dimensions. These include national accounts (GDP, consumption, and investment); the fiscal framework (government revenue, deficits, and debt); the external account (trade, foreign investment, and the current account); as well as the distributional impact across industries, factors of production, and households (identifying those likely to be most adversely affected). Climate action is introduced via adaptation and mitigation policy scenarios capturing the effects of various financing options and identifying trade-offs. A detailed analysis of energy supply and demand has also been incorporated, taking into consideration various sources of electricity generation and the corresponding energy mix. Finally, the model is set up to include and track the evolution of GHG emissions by type and source. The analysis has also, as much as possible, looked at differentiated impacts of climate change on various social and vulnerable groups using microsimulations.

To measure the impact of climate change we use selected vectors and extreme weather events (see Annex 2). They are not exhaustive and only capture some key impacts on the economy. Impact channels rely on stylized biophysical models that are capable of incorporating climate information and projections, and simulate changes in biophysical variables (e.g., streamflow or infrastructure conditions) and/or socioeconomic (e.g., labor supply hours). These variables are then translated into inputs to the macroeconomic model and the microsimulation tool.

1.4. Benin needs to build a resilient economy by focusing investment and policies on adapting to climate change

In the next 30 years Benin will need to build a strong private sector-led economy – based on greater human and physical capital and labor productivity growth – that is resilient to climate change and avoids carbon lock-ins. Both labor supply and labor demand will need to change to achieve the country's development objectives. This will imply a change in the structure of economic output and employment, and subsequently in the distribution of people and markets across space. In addition, this shift will need to happen under increasing vulnerability to climate change. It will also require making sure that policy choices balance risks of carbon lock-in given greater global commitment towards low-carbon pathways. Currently, the world is facing the dual challenges of the COVID-19 crisis and the impact of Russia's invasion of Ukraine, both of which are limiting sovereign financing resources and creating macroeconomic vulnerabilities. Benin is also dealing with growing regional security concerns in the Sahel, coupled with climatic stress. This CCDR sets out to understand these challenges in the medium and longer term, as well as synergies and opportunities, and to make recommendations for how Benin can attain higher per capita income levels despite the challenging context.

This CCDR proposes that Benin focuses on building a resilient economy with investment and policy options primarily focused on adapting to climate change risks. The dependence of Benin's economic structure on agriculture and informal employment makes its development path highly vulnerable to climate change in the absence of proper adaptation. The readiness of government and the private sector to deal with climate change is mixed – building adequate institutions and governance structures will be crucial (Chapter 2). While all sectors will have to become more resilient, this is especially urgent for agriculture and land use, urban and network infrastructure, and human development (education, health) (Chapter 3). Mitigation efforts should focus on avoiding carbon lock-ins and reducing deforestation (Chapter 4). Investing in renewable energy whilst ensuring expanding access to electricity should be a priority for Benin and will involve gas in the energy mix in the medium term. A higher share of renewable energy can bring about co-benefits for other sectors (agriculture, water, transport). Meanwhile, mitigation through reversing deforestation can provide new growth opportunities.

It is also crucial for Benin to set out measures to build a more resilient society (Chapter 5). Benin needs to pay special attention to its most vulnerable people, including women. To protect the poor and vulnerable the just transition should focus on reconciling development and climate goals while addressing inequality (income and gender related), and spatial exclusion.

The CCDR identifies actions that are particularly urgent and most likely to create synergies between development and environmental objectives. In combination, these actions lead to priority policies that should produce the greatest impacts if properly implemented within the next three to five years (Chapter 6). Given the government's limited fiscal space and the global public good dimension of climate change, special attention is given to both the domestic private sector and external financing (Chapter 6).

Chapter 2.

Preparing institutions for climate change

Chapter 2: Preparing institutions for climate change

2.1. The public sector needs to turn plans into coordinated actions

2.1.1. Climate change commitments and strategic objectives have been set

Benin has established the country's commitments to climate action in its Nationally Determined Contribution (NDC), updated in 2021. [24] The NDC sets a target of reducing GHG emissions by 20 percent by 2030 compared to business as usual. To achieve this, it includes several mitigation measures for the agriculture, energy, land use, land-use change and forestry (LULUCF) and waste sectors (Table 1). The investment needed to achieve these mitigation objectives was estimated at about US$8.6 billion, with a contribution of US$5.1 billion from the government and the private sector, and the remaining US$3.5 billion expected to be mobilized from the international community. These contributions amount to a total of 5.2 percent of 2030 GDP in our baseline growth pathway.

Table 1. Summary of mitigation measures and objectives in the updated NDC

Sector	Mitigation measures and objectives
Agriculture	Improve the productivity and production of crops, animal and fish products through low carbon and resilient gender-responsive practices in agricultural sectors, including soil fertility management techniques, water harvesting, and irrigation.
Energy	Develop the production of electricity from natural gas and renewable sources; expand access to lighting in the residential sector; promote efficient consumption of electricity in the residential and services sectors; ensure sustainable management of wood energy; reduce losses in electricity transmission and distribution; and promote energy efficiency in the transport sector.
LULUCF	Increase the carbon sequestration capacity of forest ecosystems through the implementation of sustainable management of natural forests, strengthening reforestation efforts and promoting agroforestry measures.
Waste	Improve management of household waste by setting up a facility for energy recovery from the Ouèssè landfill.

Source: Government of Benin (2021). Nationally Determined Contribution. Benin's Updated Contribution to the Paris Agreement.

The NDC highlights adaptation as a priority given Benin's vulnerability and development objectives. The NDC considers eight sectors for adaptation (agriculture, water resources, forestry, coastal areas, tourism, energy, health, urban planning and infrastructure) and indicates key objectives for 2025, 2030 and 2050 (Table 2). Investment needs up to 2030 were estimated at approximately US$ 1,796 million, of which US$ 578 million (32 percent) would be provided by the government and the remaining US$ 1,217 from international support (68 percent).[25]

Table 2. Sectoral adaptation objectives established in the NDC

Sectors	Key adaptation objectives	Horizon		
		2025	2030	2050
All sectors	- Vulnerability assessment and decision support tools for the integration of climate change adaptation into planning and management instruments of national and regional institutions. - Strengthen the capacity to adapt to climate change in all sectors. - Mobilize the necessary resources to finance adaptation.			
Agriculture	- Improve agricultural performance to ensure food sovereignty, to contribute to the country's economic and social development of women and men and to achieve the Sustainable Development Goals (SDGs). - Ensure, monitor and evaluate the involvement of women farmers in the implementation of actions promoting sustainable land management techniques.			
Energy	- Promote access to small-scale cooking equipment by setting up a mechanism to facilitate access to credit for small-scale operators and ensure that women have equal opportunities in access to the aforementioned equipment.			

24 Government of Benin (2021). Nationally Determined Contribution. Benin's Updated Contribution to the Paris Agreement.

25 Government of Benin (2021). Nationally Determined Contribution. Benin's Updated Contribution to the Paris Agreement

Water resources	- Reduce the vulnerability to water stress, flooding, and degradation of water quality. - Strengthen knowledge of the climate system and tools for generating information and forecasting of climate hazards. - Promote water management and good governance.			
Forestry	- Reduce the vulnerability of communities to forest degradation. - Promote agroforestry. - Develop mangrove ecosystems. - Ensure women's participation in the protection and conservation of natural forests through designated programs.			
Coastal areas	- Reduce the vulnerability of coastal human settlements and resources to sea level rise. - Ensure continued protection of marine and lagoon ecosystems.			
Health	- Improve the health and well-being of all people through the reduction of vulnerabilities and increasing adaptive capacities and climate resilience. - Improve food security of people vulnerable to malnutrition, particularly women of reproductive age and young children.			
Tourism	- Contribute to the reduction of negative impacts by promoting water and energy efficient consumption patterns and increase the added value for communities and the various actors of the sector.			

Source: Government of Benin (2021). Nationally Determined Contribution. Benin's Updated Contribution to the Paris Agreement.

At the national and strategic levels, Benin has made important efforts to establish a climate change legal and policy framework that supports NDC implementation:

1) **The Law on Climate Change was enacted in 2018.** It aims to combat climate change and its negative effects and consequences, and to increase the resilience of living communities (Article 4). It also aims to enable effective response, adaptation and mitigation measures to be taken by setting precise objectives for sustainable economic and social development, energy security and efficiency, in accordance with the specific provisions of national and international legal instruments related to climate change. The law also mandates the integration of climate change measures into national development programs and projects.

2) **The Low Carbon and Climate Resilient Development Strategy** (2016-2025)[26] aims to address the adverse effects of climate change through adaptation measures, while also responding to the country's desire to contribute to global mitigation efforts. The overall objective of the strategy is to contribute to Benin's sustainable development by integrating climate considerations into the country's strategic sectoral plans. Specific goals are to: (i) strengthen the resilience of communities and production systems by increasing the level of food security, the share of agriculture in Benin's GDP, and the degree of climate resilience of local communities; (ii) reduce GHG emissions and enhance the carbon sequestration potential of forest areas, in line with the commitments made in the NDCs; and (iii) protect communities, especially those most vulnerable to natural disasters (women, girls, children, minorities). This objective seeks to reduce flood-related risks by at least 60 percent in urban and peri-urban areas, with a positive impact on GDP, as well as a decrease in the prevalence of climate- sensitive diseases among the populations in at-risk and in disadvantaged areas.

3) **The National Climate Change Management Policy** (PNGCC, 2021-2030)[27] aims to guide Benin towards becoming a climate-resilient country with sufficient adaptive capacity and appropriate mechanisms to respond to climate risks and ensure low carbon growth, and whose institutions, organizations, businesses and citizens adopt climate-sensitive practices and behaviors. The PNGCC is organized around three strategic guidelines: (i) strengthening institutional, individual and material capacities to deal effectively with climate change; (ii) promoting low-carbon, climate-resilient development in all development sectors; and (iii) promoting climate change governance for optimized management and coherent coordination of interventions. The PNGCC also commits to promoting women's leadership in building community resilience and strengthening gender-sensitive national and international climate policies. Moreover, it aims at facilitating access to microfinance services for the most vulnerable, in particular women, young people and people with disabilities.

4) **The National Adaptation Plan (2022) outlines key adaptation measures for the country.** The NAP includes eight key priority sectors which are considered most vulnerable to climate change: (i) water resources, (ii) agriculture, (iii) health, (iv) energy, (v) forest ecosystems, (vi) coastal zones, (vii) infrastructure and urban management, and (viii) tourism. It presents priority adaptation measures for each target sector. Its vision is to achieve resilient and

26 Government of Benin (2016). Low Carbon and Climate Resilient Development Strategy 2016-2025.

27 Government of Benin (2020). National Climate Change Management Policy

decarbonized economic development and growth by 2030, with adaptive capacity and early warning systems in place, and institutions, organizations, the private sector, and citizens adopting climate-sensitive approaches and behavior. The total cost of adaptation options for the eight targeted sectors is estimated at US$4,240 million over the 10-year horizon, equivalent to 4 percent of 2023 GDP. The NAP widely acknowledges women's gender-specific vulnerabilities to climate change and lists a number of gender-responsive measures as part of its core objectives in all key areas. These include: ensuring women's participation in the development, implementation and monitoring of health services disaster prevention programs; training for women to use improved seeds and climate-resilient crop varieties; promoting access to technical information and training for women farmers in the transition to new income-generating activities that are not dependent on climatic hazards; and facilitating women's access to land in the event of internal displacement resulting from climate change, with the aim of strengthening their financial empowerment.

Despite these plans, Benin still faces challenges to the effective integration of climate change considerations into development policies. The Government Action Program (PAG II) 2021-26 is the main strategic guidepost for socioeconomic development. The PAG II builds on the achievement of the first phase (PAG 2016-21) and maintains its focus on accelerating economic and social development through a three-pronged approach: (i) consolidation of democracy, rule of law, and good governance; (ii) structural transformation of the economy; and (iii) improvement of social wellbeing. These objectives will be achieved through reforms and ambitious investments in infrastructure (transport, logistics, agriculture, tourism), resource mobilization (both public and private) and innovative mechanisms for implementation, monitoring and evaluation. Climate change is not included as a cross-cutting element but is considered as one of the priority actions of Axis 7, which seeks to strengthen environmental conservation and build resilience to climate change. However, while climate change has been considered in some sectoral policies, this integration is often not supported by budgetary allocations or a monitoring framework.[28] There is also the need to strengthen institutions' technical capacity for the more effective integration and policy implementation of climate change in various sectors, as well as to enhance capacity at national, regional and local level to handle and build climate change data.

2.1.2. Institutional arrangements for adaptation, risk management and mitigation need to be more joined up

Institutional responsibility for the climate change agenda is spread across multiple public sector institutions; better coordination is needed. Reflecting the cross-cutting nature of climate change, multiple institutions are engaged in climate change matters in Benin. The Ministry of Environment and Transport in charge of Sustainable Development (*Ministère du Cadre de Vie et du Transport chargée du Développement Durable* – MCVT) is responsible for leading the climate change agenda with support from other ministries, including the Ministry of Economy and Finance (MoEF) and the Ministry of Planning and Development (MPD). The MCVT, through its Environment and Climate Department (*Direction Générale de l'Environnement et du Climat* – DGEC), oversees the processes for preparing national communications on climate change, Biennial Update Reports (BURs) and Nationally Determined Contributions (NDCs), in close collaboration or synergy with other structures. Inter-institutional coordination is fostered mainly through the National Committee on Climate Change (CNCC) established in 2003 (Decree No. 2003-142). The CNCC aims to inform and raise awareness on climate change, monitor the implementation of international climate change frameworks and support the preparation of climate-related projects. Despite its establishment more than a decade ago, more needs to be done to strengthen coordination across various ministries and departments in order to ensure greater synergies, coherence, and impact of activities. Clarifying the respective roles of the CNCC and the recently created National Committee on Sustainable Development (CBDD)[29] would also be important. The CBDD is responsible for promoting low-carbon development through implementing carbon credits and acts as a catalyst for the regulation of the carbon market regulation.

Benin has established inter-institutional arrangements for implementing adaptation and risk management measures. A Technical Commission has been put in charge of the National Adaptation Plan (*Comite technique du PNA*, CTPNA). Its goal is to integrate climate change adaptation into policies, development planning strategies and programs in all sectors of activity at both national and local levels, and to ensure the implementation, monitoring, evaluation and updating of the NAP. Inter-institutional coordination of climate change adaptation is also fostered by the National Platform for Disaster Risk Reduction and Climate Change Adaptation (Decree No. 2011-834), an intersectoral body for strategic and operational coordination of disaster risk reduction actions. The government has also established a Commission for Economic Modelling of Impacts of Integration of Climate Change into the General State Budget (Decree No. 2014-359) based in the Ministry of Planning and Development. This is responsible for developing a national economic model incorporating sectoral assessments of the impacts of climate change. While sectoral ministries have translated the strategic orientations into their planning documents, from agriculture to health, some governance structures need to be reinforced given their key role in climate resilience. These are discussed in Annex 7.

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28 CABRI, IIED, IBP and UNDP (2021). The integration of climate change into budgeting and finance. Key note paper.

29 Created by Decree No. 2022-274.

2.2. Private firms and financial institutions are partially prepared

Climate challenges require a collective response in which the private sector is expected to play a central role. Businesses will invest in new technologies, while banks should help finance climate-related projects. Both will also see their operations impacted by exposure to climatic shocks.

2.2.1. Climate readiness varies among Beninese firms

Close to three in four Beninese firms face significant risks from climate change. The SME Competitiveness Survey (Box 3) identifies eight specific climate change risks, ranging from changing sea levels and water scarcity to floods and decreased quality of inputs. Overall, 73 percent of businesses surveyed indicated being concerned by climatic risks and feeling significantly exposed to at least one of these risks.

While firms of all sizes indicate facing environmental risks, smaller businesses are more concerned about overall climatic volatility, whereas larger firms view input supply as a key challenge. Respectively 76 percent and 79 percent of micro enterprises (1-4 full time employees, FTEs) and large firms (>100 FTEs) note being exposed to significant risks, versus only 64 percent of medium-sized companies. Looking at the specific risks cited, micro firms primarily refer to climatic shocks such as changing temperatures, floods, or more severe and frequent storms. Larger businesses, on the other hand, are less worried, suggesting stronger capacity to manage and prepare for environmental volatility. They primarily identify the sourcing of inputs, including water, as a key risk for their activities, likely related to having more complex production processes in place which depend on multiple sourcing chains.

Box 3 – Measuring private sector readiness

The International Trade Center (ITC) conducted an SME Competitiveness Survey in Benin in 2019, in partnership with the local Chamber of Commerce and Industry. The SME Competitiveness Survey has been implemented in over 40 countries and has covered more than 17,900 firms thus far. Its primary aim is to gauge the sentiment of the private sector on doing business, trade, and competitiveness, as well as to obtain perceptions on issues related to climate change and sustainability. For the exercise in Benin, 502 firms from six economic regions were interviewed, covering the agriculture, manufacturing, and services sectors. The sustainability questions ranged from general enquiries into firm awareness of climate issues, such as whether companies had already identified specific climate risks and opportunities, to specific questions focused on the implementation of mitigation and adaptation measures.

Firm characteristics are used to assess whether the attitude and awareness of firms differs depending on their resources or activities. The survey indicators allow for a mapping of firms' sustainability awareness across different dimensions, including size, geographical location, sector, and ownership. The table in Annex 4 gives an overview of the operationalization of the variables used for the analysis. An important caveat is that around 80 percent of firms interviewed indicated being officially registered, which does not reflect Benin's economic structure, which is dominated by informality. As a result, the survey primarily reflects the attitudes of formal firms. In alignment with the focus of this Benin CCDR, we examine firm awareness of overall climate change risks and opportunities, and measures undertaken to bolster resilience and adaptation. The survey questions were categorized using the key themes of the CCDR.

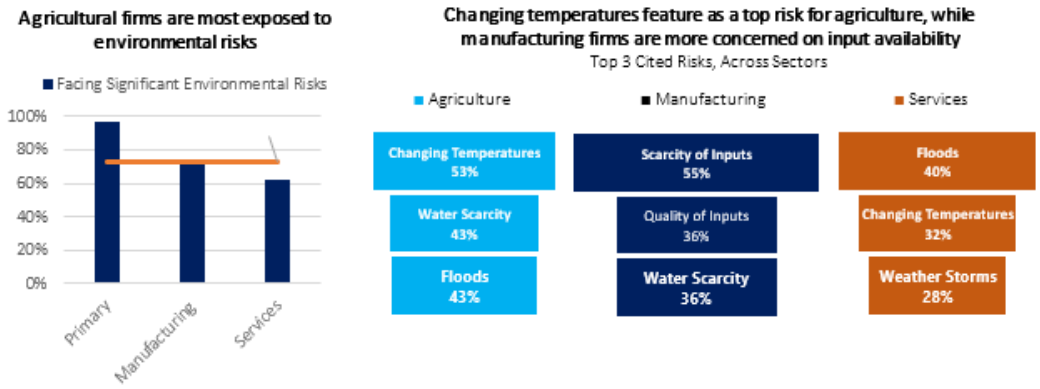
While almost all agricultural firms fear exposure to environmental risks – especially changing temperatures and water scarcity – manufacturing and services firms display less concern. Close to 97 percent of firms active in agriculture[30] indicated their exposure to at least one climate change risk, versus 75 percent and 62 percent for manufacturing and services, respectively (Figure 8). The risks identified vary significantly across sectors. Manufacturing firms primarily express concerns about the availability of inputs, while for agricultural firms the perceived risks revolve mainly around changing climatic conditions, with the top three risks cited being temperature increases (53 percent), water scarcity (43 percent), and floods (43 percent). The manufacturing sector, on the other hand, highlights the scarcity of inputs (55 percent), deteriorating input quality (36 percent), and water scarcity (36 percent). For services, the key risk is flooding (40 percent).

Perceptions of environmental risk exposure are highest for firms in Benin's center. All 51 firms interviewed around Abomey, situated in the middle zone, reported facing environmental risks ranging from input shortages (75 percent) to water scarcity (84 percent), and changing temperatures (71 percent). Firms in the northern regions also reported risks, but with less elevated levels. Major concerns here were flooding (55 percent), likely due to exposure to the annual rainy

30 The agricultural sector has a dual structure. On the one hand, commercial farmers on relatively large single-product farms produce cotton or cashews, or both, for export markets. On the other hand, a large number of small mixed-crop farms produce agricultural products for their own consumption or for sale in the domestic market. Almost all farms grow cereals, and 6 out of 10 farms grow roots and tubers (CPSD).

season. Lastly, risk perceptions in the southern regions appear to be more dispersed, and few firms feel threatened by the rising sea level (10 percent in Cotonou), despite proximity to the coast.

Figure 8 – Environmental risks vary by firm size and sector, with agricultural firms most exposed

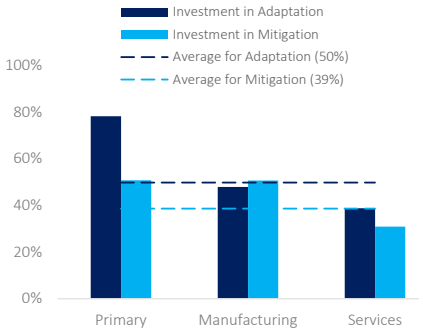


Note: Respondents were asked: 'Which of the following environmental risks are significant for your business?' and 'Please choose the 2-digit ISIC code that best applies to this establishment's main sector of activity.' Source: IFC calculation based on ITC (2019). SME Competitiveness Survey.

Only one in two Beninese firms indicate already having invested in adaptation measures, highlighting the elevated need for the private sector to bolster climate resilience. The measures respond to Benin's climate change threats and range from irrigation systems to flood prevention systems and temperature controls (see Annex 4 for details). On average, close to half of surveyed firms confirmed having invested in at least one such measure already (Figure 9). For firms that have made these types of investments, the top three consisted of temperature controls (30 percent), soil management practices (23 percent), and more resilient transportation means (23 percent). Medium-sized firms lag behind both large and micro-sized firms for investments in adaptation measures, with theirs focusing primarily on temperature controls and resilient soil management. The share of agricultural firms investing in climate adaptation is almost twice as high as services firms. Around 78 percent of firms in the primary sector confirmed having invested in measures to reduce sustainability risks (Figure 9).

Firms' investments in mitigation measures appear to be less widespread than in adaptation measures, and primarily focus on waste or chemical reduction. Close to 40 percent of firms confirm having invested in one mitigation measure (see Annex 4 for details), with the three leading measures being waste management systems (36 percent), reducing chemical use (34 percent), and sustainable/recycling packaging (26 percent). Both large and micro-firms display the highest levels of investment in mitigation measures, with the former focusing more on energy.

Figure 9 – Close to 80% of agricultural firms have invested in adaptation measures versus 30% of services firms



	Top 3 adaptation measures		*Top 3 mitigation measures*	
	Large firms	***Micro firms***	***Large firms***	***Micro firms***
1.	*Soil management (40%)*	*Power generation (32%)*	*Waste management (31%)*	*Reduction chemical use (39%)*
2.	*Water purification (33%)*	*Temperature controls (23%)*	*Renewable energy (31%)*	*Waste management (33%)*
3.	*Temperature controls (27%)*	*Soil management (15%)*	*Energy efficient tech (31%)*	*Sustainable packaging (15%)*

Source: IFC calculations based on ITC (2019). SME Competitiveness Survey. Note: Respondents were asked: 'In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing?' and 'In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment?'

2.2.2. The financial sector has yet to acknowledge its high exposure to climate-related risks

Climate shocks have the potential to translate into significant financial risks for the Beninese financial sector, especially the banking sector. In the financial sector, climate risks could affect at least three of the traditional financial risk categories:

(i) Credit risk: natural catastrophes such as floods could impact the banking sector directly through increased non-performing loans (NPLs) in key sectors (e.g., agriculture, hydropower, etc.). They could reduce borrowers' ability to repay and service debt, and undermine banks' ability to fully recover the value of a loan in the event of default, including through direct damage to physical assets. This could in turn undermine profitability and capital adequacy for highly exposed banks (e.g. those with risk concentrated in agricultural sector and rural areas, including microfinance institutions, MFIs).

(ii) Market risk: this could result from a reduction in the values of real or financial assets, leading to downward price shocks and an increase in market volatility in traded assets.

(iii) Liquidity risk: linked to banks' reduced capacity to access stable sources of funding if climate risk drivers cause banks' counterparties to draw down deposits and credit lines.

Physical risks could also indirectly affect the banking sector through impacts on GDP, government debt, inflation, risk-free interest rates and exchange rates, which could contribute to NPLs in several sectors and affect the value of banks' investment portfolios.

This isdespite the Central Bank of the West African States (BCEAO) and the Banking Commission of the West African Monetary Union (BC-WAMU) recognizing the importance of climate risks and their potential impact on the financial sector. The BCEAO has not conducted stress testing on the largest banks in Benin to assess the impact of climate change on the financial sector. It has also not yet taken steps to integrate climate risks into its supervisory framework. The Regional Council for Public Savings and Financial Markets (AMF-UMOA), the regulatory and supervisory authority for capital markets in WAEMU, has not yet introduced climate risk disclosure guidelines for corporates. Yet these could provide the data needed to enhance the financial sector's understanding and management of climate risks. The issuance of such disclosure guidelines could be complemented by the implementation of a green taxonomy, which would not only facilitate the identification of environmentally sustainable investments, but also their associated climate risks.

Internationally, there is growing interest in greening central banks' activities and operations (mostly in advanced economies). However, the thinking on these issues is still in the very early stages, and many of the options are still under review by the international central bank community. Examples of greening central bank operations include the adoption of sustainable and responsible investment practices in central banks' portfolio management, central banks' climate-related disclosure, and greening monetary policies (e.g., credit operations, collateral policies, and asset purchases).

In 2020, the BC-WAMU released a guide on environmental and social risk management for banks and financial institutions which includes a section on climate risk. The guide provides recommendations on how banks can identify and assess climate risks, as well as how they can develop appropriate risk management. The BCEAO and the BC-WAMU are members of the NGFS, an international network of central banks and financial regulators working together to promote the integration of climate and environmental risks into financial stability supervision. In this capacity, they serve on the regional working groups for micro-prudential supervision and the macro-financial impact of climate change.

2.3. Key policy options for institutional strengthening

Table 3 summarizes key policy options identified in this chapter for strengthening policy coordination, institutions, and private sector preparedness for climate change.[31] The actions are organized by sector, and by whether they are policy actions – which are regulatory/institutional in nature – or investment actions, which require hard investment (e.g., construction, an operational budget, etc). Complexity levels for each action were defined together with government counterparts through an inclusive consultation process that considered feasibility, presence in government strategic documents, budget plans, and political economy. Costs are only reported when available.[32] "Expected financing source" indicates the most likely source of financing.

31 Chapter 6 conducts a prioritization exercise and identifies top policy actions and investments in the medium term across all sectors.

32 The cost of action includes cost of capex of investment needs over 5-10 years for project development, but most of the time excludes variable costs (operation/maintenance). They are indicative based on the most recent available information and from exchanges with government counterparts. Missing costs denote areas where the exercise has not yet been carried out. When costing was available in EUR or CFAF, the conversion was done using October 2023 exchange rates.

Table 3: Summary of key policy options and investment actions for governance and institutional strengthening

Area	Action	Complexity	Fixed cost (capital investment)	Expected financing sources
Governance (G)	**Policy action G1:** Develop a reliable data collection and monitoring system for environmental data (e.g., projects' GHG emissions) to improve the quality of impact reports (particularly for sovereign thematic issuances).	High	-	Public budget / concessional resources (PB/CR)
G	**Policy action G2:** (1) Strengthen inter-ministerial coordination at the central level (especially by updating and strengthening the role of the CNCC to assess/weigh in on policy and investment with respect to climate); (2) ensure systematic alignment between the different strategic documents (NDCs, NAP, PAG2, Public Investment Program, and sector strategies).	Low	-	PB/CR
G	**Policy action G3:** (1) Develop audit tools of the Supreme Audit Institution for the assessment of plans or policies specifically related to climate change or risk management; (2) enhance citizens' participation and civil society organizations' engagement in monitoring of climate change action through formal mechanism for consultation, collection and response to concerns expressed by citizens on climate actions.	Low	-	PB/CR
Gender (GG)	**Policy action GG1:** Strengthen climate leadership of Beninese women and enhance their participation in decision making at local and national levels.	Medium	-	PB/CR
Water (WA)	**Policy action WA1:** (1) Operationalize the CNE by adopting a new decree updating the CNE so that it can play its full role in improving governance of the sector; (2) increase the coordination between the water sector and other key sectors (industry, agriculture, forests).	Low	-	PB/CR
WA	**Policy action WA2:** Operationalize the user-payer principle for commercial use of water resources to mobilize financial resources, following the adoption of a ministerial order that defines this principle across all water subsectors. This will have three phases: (1) sensitization; (2) e-services for the collection of the non-tax revenue; and (3) implementation at the local level.	Medium	-	
WA	**Policy action WA3:** Strengthen the roll out of "the water police" who grant permits for the exploitation of water resources.	Medium	-	PB/CR
WA	**Policy action WA4:** Adopt the Water Sector Vision 2050.	Low	-	PB/CR
Coastal management (CM)	**Policy action CM1:** Harmonize the regulatory framework on coastal management, including the interactions and hierarchy between the different laws and regulations, especially with regard to territorial planning, (equal access in property ownership, and other environmental issues (pollution and biodiversity), and the use of natural resources.	High	-	PB/CR
Urban and municipal planning (UM)	**Policy action UM1:** Strengthen coordination with the local level to ensure effective implementation of NDC and other commitments, particularly on urban planning (city planning and management, capital investment planning at local level) and reinforce institutions responsible for land titling and property transfer through: 1) Strengthening the national system of data collection and monitoring of urban indicators; 2) Developing and adopting a national policy for urban development; 3) Supporting municipalities to develop/implement the land governance framework.	High	-	PB/CR

Disaster Risk Management (DRM)	**Policy action DRM1:** (1) Adopt DRM Law and accompanying Low Carbon and Climate Resilient Development and implementing decrees; (2) align risk assessment methodologies, design a national framework for risk mapping, and strengthen the National Platform for Disaster Risk Reduction and Climate Change Adaptation; and (3) ensure operational coordination with local authorities for adequate preparedness for disasters.	Medium	-	PB/CR
Forestry (FO)	**Policy action F01:** (1) Finalize the national forestry policy (2023-2032) strategic plan and programmatic framework, including budget planning for its implementation; and (2) finalize the fuelwood strategy, including strategic plan and programmatic framework.	Medium	CFAF 55 billion or 0.46% of 2023 GDP	PB/CR
FO	**Policy action F02:** Improve forest governance in terms of legislation, regulations and financing, through the adoption of a new forestry code.	Medium	-	PB/CR
FO	**Policy action F03:** Review and adopt the new institutional framework of the forest sector in line with the National Forestry Policy (including resources) to strengthen its administration, reduce conflicts of attributions, and improve coordination of the various actors involved in the sector, including decentralized level.	Medium	-	PB/CR
Forestry	**Investment action F01:** Strengthen forest surveillance and security monitoring	High	CFAF 50 billion or 0.42% of 2023 GDP	PB/CR
Energy (E)	**Policy action: E1:** (1) Put in place an outreach strategy for the regulatory framework for private sector participation in energy production, particularly RE; (2) strengthen the capacity, regulatory framework, and financial situation of the relevant institutions (DPEERR, SBEE, CEB, SBPE), for example by publishing financial statements; (3) adopt the *Fond National Electrification Rurale et des Energies Renouvelables; and* (4) finalize the adoption of the secondary legislation of the Electricity Code.	Medium (2) High	-	PB/CR
Agriculture (AG)	**Policy action: AG1:** Adopt the nutrition-oriented national agriculture strategy**.**	Medium	CFAF 33 billion or 0.28% of 2023 GDP	PB/CR
National Meteorological Agency (Meteo)	**Policy action: Meteo1:** Update and then adopt the implementing decrees of the (1) National Framework for Climate Services (NFCS); and (2) National Strategic Development Plan of Meteorology (NSDPM)	Low	-	PB/CR
Financial sector (Fin)/ Regional level action	**Policy action Fin1:** Regional level action: (1) The BCEAO should conduct stress testing of the largest banks in Benin to assess the impact of climate change on the financial sector; (2) BCEAO should integrate climate risks into its supervisory framework (e.g., AMF-UMOA has not yet introduced the climate risk disclosure guidelines for corporates).	Medium	-	
Fin/Regional level action	**Policy action Fin2:** AMF-UMOA should introduce a green taxonomy.	Medium	-	

Chapter 3.

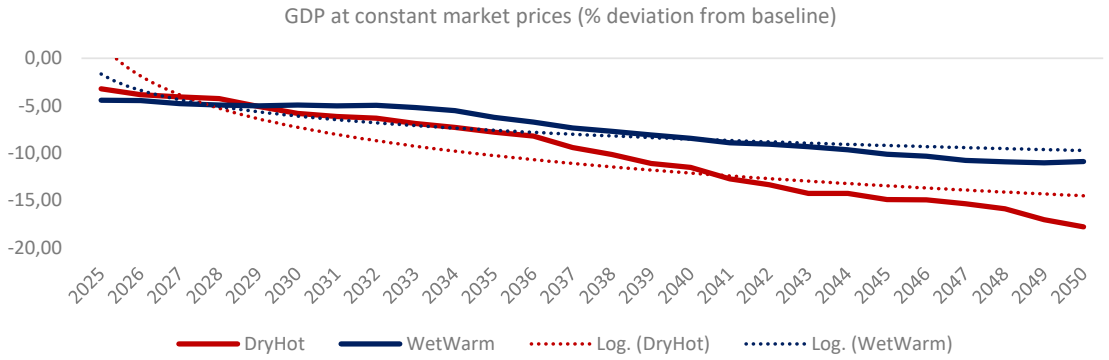
Adapting to climate change requires a resilient growth model

Chapter 3: Adapting to climate change requires a resilient growth model

3.1. The macroeconomic cost of inaction is high and will increase over time[33]

In the absence of additional adaptation efforts, average annual GDP losses are projected to increase over time to reach up to 19 percent of GDP by 2050. The modelling done for this report estimates that loss of real GDP due to climate change impacts will increase from an average of 7 percent in the 2030s to 11 percent by 2050 compared to the baseline under the wet/warm climate scenario; and from an average of 9 percent in the 2030s to 19 percent by 2050 in the more pessimistic dry/hot climate scenarios[34] (Figure 10, and see Annex 5 for key impact channels). Productivity loss from labor heat stress is the driving source of economic losses from climate change: GDP per capita is projected to be over 18 percent lower than the baseline by 2050 in the hot/dry scenario.

Figure 10 – The cost of inaction increases over time and could reduce GDP by 19 percent by 2050



Source: MANAGE simulations. Notes: Deviations from the baseline; 5-year moving average.

Climate change principally affects the Beninese economy through reductions in labor productivity. These derive from the impacts of higher average temperatures on labor through heat stress, human health more generally, as well as reduced availability of water supply and sanitation. Overall, under higher temperatures, the negative labor productivity[35] shock to GDP is expected to average 11.9 percent by 2050 under a hot/dry scenario, and 8.26 percent under a warm/wet scenario (Figure 11). Labor heat stress is expected to reduce labor productivity in all sectors, but especially in agriculture and industry. The overall productivity loss across the sectors (primary, secondary and tertiary) could potentially range from 6.5 to 18 percent in 2041-50, with the mildest impacts expected in services (loss of 6.5-15.2 percent). The prevalence of informal employment in Benin (the third highest in SSA) explains this significant impact. Overall, decreased labor productivity from the combined impacts of heat stress and other health issues[36] could reduce domestic production by between 8 percent (under the wet/warm scenario) and 12 percent (dry/hot scenario) by 2050.

33 This chapter summarizes the results from the CGE simulations (Annexes 1 and 2 for details).

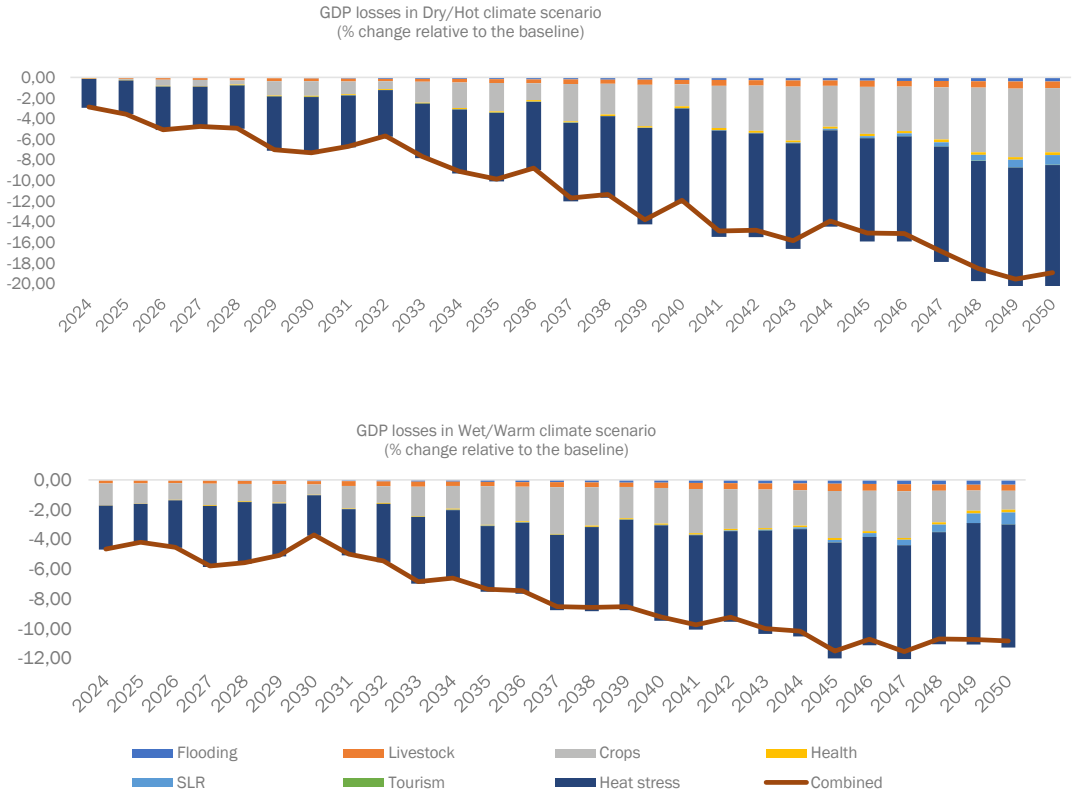
34 A baseline (business as usual) macroeconomic framework was calibrated to simulate the growth path in the absence of climate change. See Chapter 1 for details.

35 Following the methodology applied by the ILO 2019, labor productivity losses are calculated based on worker occupations, daily workday temperatures, and mean monthly humidity levels, adjusting for the proportion of workers located inside and assumed use of temperature-controlled environments based on mean household incomes.

36 Over 2041-2050, labor supply shocks are expected to be highest from heat-related diseases, followed by water-borne and vector-borne diseases. We use IEc estimates that apply different biophysical and statistical relationships between climate variables and the incidence of or transmissibility for each disease, with changes in disease incidence and death rates then used to estimate the number of hours of labor supply lost (see Section 3.2).

Figure 11 – Heat stress will have the largest impact on GDP

Cumulative impact on GDP of damage channels for dry/hot scenario (top graph) and wet/warm scenario (bottom graph)



Source: MANAGE simulations. Notes: Deviations from the baseline – legend refers to different damage vectors (Annex 2).

Increased costs of capital repair and renewal will be another important climate impact on Benin's economy. Inland flooding, sea-level rise, and storm water surge directly impact the use and availability of capital goods. Additional annual capital losses from increased inland flooding[37] are estimated at between 0.16 and 0.22 percent in 2041-50. Rising mean sea levels and temporary flooding from surge events also threaten coastal infrastructure and land. Overall, impacts to the capital stock from sea-level rise and surge events increase consistently through 2050 relative to baseline conditions, with surges accounting for the greatest impact. By 2050, impacts from surge events result in a 0.3 percent loss of capital stock (i.e., an incremental loss of 0.3 percent of capital relative to the baseline). Large exogenous shocks have the potential to be more damaging. For example, under 50-year flooding events, the capital loss is expected to range from 4.9-6.5 percent of the capital stock by 2050, depending on the climate scenario. Figure 12 simulates the consequent losses on GDP.

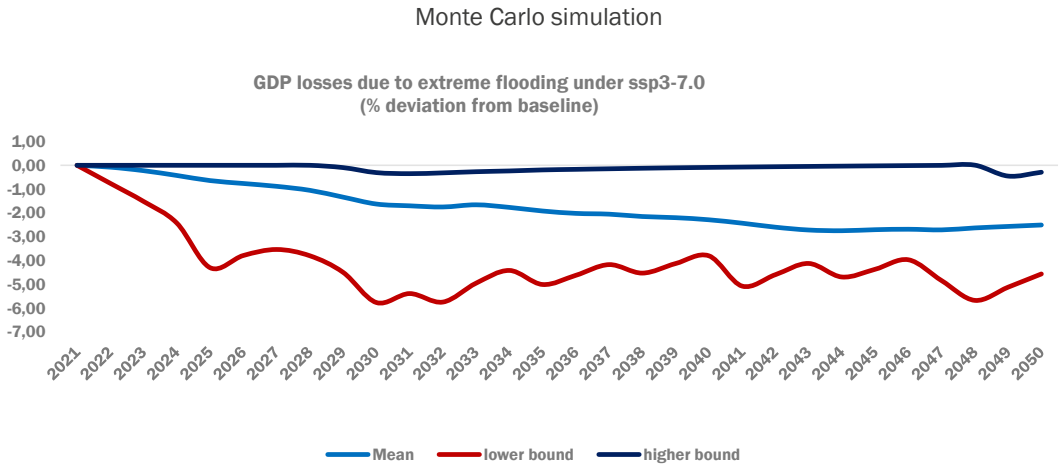
Negative shocks to output from damage to physical capital stock are much less pronounced than from labor productivity. This is likely to be because of the low capital stock at baseline and the fact that the direct impact on capital levels would not directly affect the marginal productivity of capital. Overall, the projected GDP shock through the capital stock because of flooding, sea-level rise and water surge is in the order of close to 1 percent of GDP by 2050 (in both the dry/hot and warm/wet scenarios, Figure 11). Extreme events would be much more damaging and could translate into annual losses of up to 7 percent of GDP by 2050. The impact on physical capital is likely to be under-estimated and could be significant if future capital stock does not incorporate resilience standards. Indirectly, productivity growth is likely to be dampened by significant losses to capital stock.

At the sectoral level, agriculture stands to be significantly impacted through lower crop yields (discussed further in Section 3.2.1 below). Under climate change, crop yields have the potential to be affected by changes in rainfall patterns/ irrigation water availability, increasing evaporative demands, extreme heat as temperatures rise, and land erosion. Livestock productivity is also estimated to be damaged by climate change. In the absence of adaptation measures, by 2050

37 Climate change may exacerbate flooding by increasing the frequency, intensity and duration of storm events. This analysis relies on projected changes in the return interval of precipitation events from the World Bank's Climate Knowledge Portal. Flood hazard maps are developed to determine areas with a certain probability of flooding for a given baseline and climate change projected return period.

agriculture's contribution to GDP is likely to decrease by between 0.5 and 1 percentage point compared to the baseline (Figure 11). The effect on poverty from such a shock is likely to be pronounced, with the most vulnerable subsistence farmers directly affected (Chapter 5).

Figure 12 – The impact of extreme flooding on capital costs could reduce GDP by 6% by 2050



Source: MANAGE simulations. Notes: Deviations from the baseline; this shows simulations of the impact on GDP of extreme flooding events based on their probability using Monte Carlo simulations. For example, the 5-year RP has a 20% probability, and the 25 yr RP has a 4% probability. SSP3-7.0: Scenario in which warming reaches 4 °C by 2100, due to lax climate policies or a reduction in ability of ecosystems and oceans to capture carbon.

3.2. A resilient growth pathway depends on decisive action across key economic sectors

Building a resilient economy will require investing in resilient labor – both demand and supply. Investing in a resilient agricultural sector, reversing deforestation, and improving water management, while supporting the development of agribusiness, will be the cornerstones for sustaining economic growth despite climate change uncertainty. As the structural transformation process pushes people into cities, a resilient labor demand will also depend on adapting infrastructure, networks, and cities to climate change, allowing a thriving private sector to develop including through higher value-added services such as tourism. Building a resilient labor supply means ensuring that human capital accumulation is not hampered by climatic events (and by ensuring adequate safety nets – see Chapter 5). The next section discusses the impacts on and investments required for each of these key sectors.

Building a resilient labor demand

3.2.1. Agriculture can maintain growth by investing in adaptation, sustainable water management and forest protection

Agriculture contributes significantly to Benin's GDP (27 percent in 2022) and employed about 40 percent of the population in 2019.[38] The national economy relies heavily on cotton production, which contributes the most to agricultural GDP, and represents one-third of exports.[39] Most of the agricultural land is dedicated to maize and cotton, covering 40 percent and 19 percent respectively. Cassava accounted for around 38 percent of total production from 2016–20, and yams for nearly 29 percent. However, crop productivity is low, including for cotton.[40] Agricultural systems remain fragmented and dominated by small-scale farming. Only 51 percent of farms at the national level apply mineral fertilizers, while less than one-third of farmers use organic fertilizers (28.4 percent), improved seeds and seedlings (28.6 percent), or phytosanitary products. The average rate of machinery use for working the soil stands at 12.4 percent.[41] Most agriculture is rainfed, with

38 World Bank (2022), *Benin Country Economic Memorandum 2.0: Accelerating the Growth Momentum and Creating Better Jobs*. Chapter 1.

39 According to customs data, cotton amounted to 30% of all exports in 2017-19 as the country became the number one cotton producer in West Africa. World Bank (2022). Benin Country Economic Memorandum 2.0 (Vol. 4): Increasing Diversification and Integration for Economic Transformation - Chapter 4 (English).

40 At 483 kg/ha, cotton yields are low in comparison to other countries, such as China and Turkey (2000 kg/ha).

41 World Bank (2022). Country Private Sector Diagnostic: Creating Markets in Benin - Leveraging Private Investment for Inclusive Growth, (English).

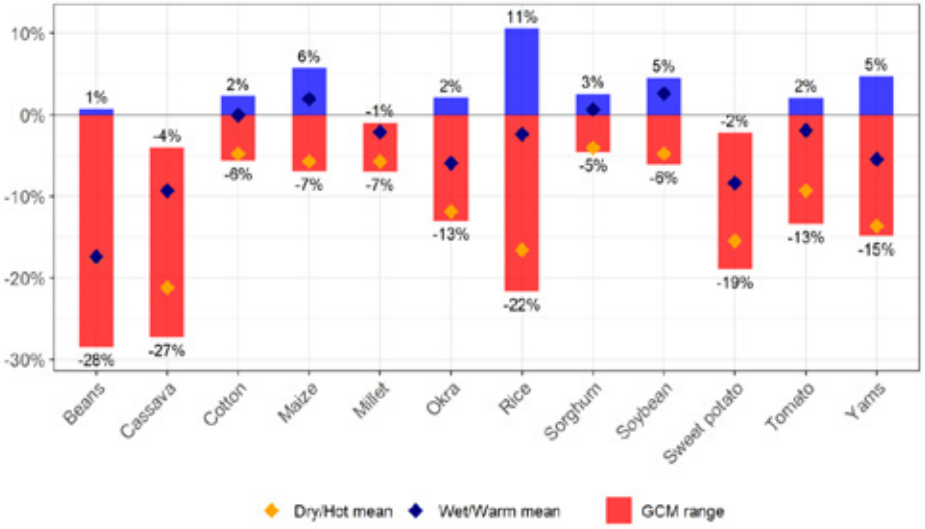
only 3.4 percent of producers using irrigation techniques.[42] Farming systems are either single-product farms of cotton or cashews (or both) for export, or small mixed-crop farms for sale in the domestic market or own consumption.[43]

Crop yields could decline by up to one-third by 2050 if no sufficient action is taken to invest in resilient agriculture. Temperature increases are likely to reduce the suitability and productivity of crops, pastures, and livestock, while changes in precipitation patterns could reduce water resources, with extreme rainfall events increasing erosion, with additional impacts downstream. We explored the impact of climate change on irrigated and rainfed crop production by modeling changes in water availability and extreme heat (see Annex 5). By 2050, climate change may result in yield reductions ranging from +3 percent to -21 percent, with the figure depending on the crop concerned (Figure 13). Over 2041-50, negative impacts on crop production are highest from the dry/hot mean scenario, which is expected to reduce crop yields by 16 percent by 2050 relative to the baseline. The wet/warm mean scenario is anticipated to result in smaller production shocks, with yields reduced by around 2.5 percent by mid-century. The impact will be largest on beans and cassava under both dry and wet scenarios, while the impact on cotton production is much smaller.[44] Erosion is also expected to have important implications for crop production within the country, although these are smaller in range.

Livestock – one of the key mechanisms for rural populations to accrue wealth – will also be severely harmed by increased temperatures. Climate change poses risks to livestock production both directly – from increasing heat stress on animals – and indirectly, through the availability of feed sources.[45] We estimate that by 2050, increasing temperatures may reduce livestock production by between -3 percent and -12 percent in the dry/hot scenario.

Figure 13 – Agriculture is dominated by rainfed crops, all vulnerable to climate change to some extent

Average annual rainfed crop yields, as a deviation from the baseline (2041–2050)



Source: IEc Benin CCDR background report (2023), see Annex 5. Notes: GCM range refers to a general circulation model (GCM), a type of climate model.

Water capacity – key for agriculture, livestock and domestic use – is expected to come under intense stress. By 2050, climate projections show a tendency towards longer and more accentuated dry periods on the one hand, and rainy events on the other, impacting water availability. Benin has abundant water capacity, with estimated groundwater potential of about 1.87 billion m^3, and surface water of about 13 billion m^3 per year.[46] However, local seasonal water supply shortages are common during dry seasons, and surface water volume is expected to be reduced under warmer and drier climate conditions (including the shares initially available for groundwater recharge). This will increase competition for surface

42 MAEP (2021). Projet d'Appui Scientifique aux processus de Plans Nationaux d'Adaptation (PAS-PNA), Etude de Vulnérabilité Sectorielle face aux changements climatiques au Bénin. Extension au Pôle de Développement Agricole III (PDA III, Atacora-Ouest, Secteur : Agriculture

43 World Bank (2022). Country Private Sector Diagnostic: Creating Markets in Benin - Leveraging Private Investment for Inclusive Growth, (English).

44 The NAP (2022) estimates that average maize yields will decline by 15 percent in 2030 and up to 29 percent in 2050, whereas for cotton the estimates are 0.9 percent in 2030 to 6.3 percent in 2050. Cashew nuts will see drops of about 26 percent by 2030 and 2050.

45 We measure these losses by combining animal and product-specific equations that link a daily temperature-humidity index (THI) with animal-specific tolerance thresholds for livestock with results obtained from the crop production channel to the corresponding portion of the domestically produced feed.

46 Government of Benin, National Adaptation Plan 2022

water among domestic use, agriculture, and livestock production. The current drinking water coverage rate is 70 percent in rural areas and 72 percent in urban areas. To fill the access gap, Benin relies on mobilizing groundwater resources. However, this resource is poorly assessed, both in terms of quantity and quality, as well as geographical distribution and recharge capacity. In addition, other development sectors, such as industry, use groundwater to meet their water needs. The increasing pressure on groundwater will therefore worsen over time.

Deforestation and land degradation are principally driven by agriculture expansion. The national forest cover continues to be highly exposed to deforestation and degradation. Despite efforts to sustainably manage forest resources, deforestation rates remain high – with an average rate of forest degradation of 50,000 hectares (ha) per year, or 1.6 percent (Figure 14, for GDP value). In 2021, forests covered 5.8 million ha of the territory, down from 7.89 million ha in 2005 – a 26 percent reduction over 16 years. Deforestation trends are driven by several factors (Box 4), mainly anthropogenic, including direct factors such as the uncontrolled expansion of agricultural land, fuelwood extraction to meet energy demands, illegal timber extraction, and urban sprawl. Indirect drivers include high population pressure, poverty, and weak land governance.

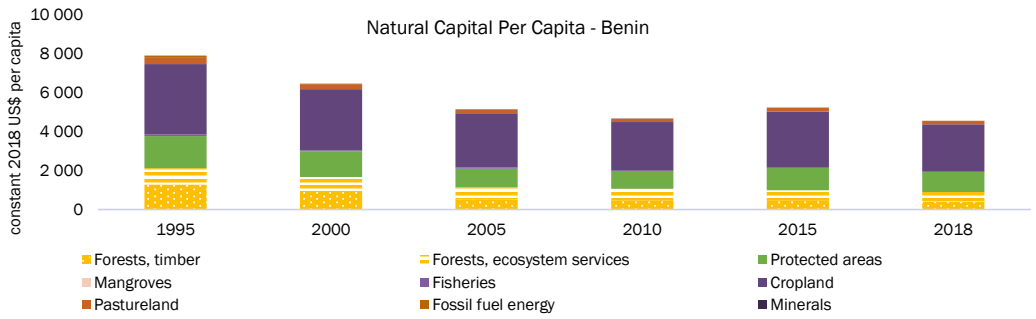
Box 4. Forests are mainly threatened by agriculture and fuelwood production

The uncontrolled expansion of subsistence agriculture, driven by the lack of investments in improving land management, has been a predominant cause of deforestation. Under these conditions, cultivated soils become quickly degraded leading to further deforestation in search of new fertile land to attain high crop yields. In the last 16 years, forest cover has decreased by over 2 million ha, while agricultural land has increased by 1.9 million ha.[47] Pervasive cotton cultivation causes encroachment on forests, mainly in the northern region, encouraged by the subsidies for fertilizers and pesticides available for cotton production. The loss of tree cover significantly impacts soil erosion, water regulation and groundwater recharge.

About 80 percent of the population depend on firewood and charcoal for cooking and heating purposes, which constitutes the second primary source of pressure on natural forests near cities and villages. Firewood and charcoal value chains provide employment, mainly informal, but consequences for forest degradation are immense. Charcoal production is also inefficient, with low carbonization methods. Finally, the use of fuelwood and charcoal for cooking is also linked to health risks associated with indoor air pollution.

Deforestation is expected to be amplified by climate change. Climate change can increase tree mortality, either through increased droughts, or indirectly by increasing wildfires and insect pests.[48] Benin is prone to frequent forest fires, mostly due to anthropogenic pressure from slash-and-burn agriculture. However, predicted hotter and drier climate conditions, in combination with poor land management, are expected to trigger more frequent, larger, and more intense wildfires, leading to higher tree cover loss, loss of biodiversity and essential ecosystem services, and further GHG emissions into the atmosphere. Globally, wildfires account for up to one-third of annual average ecosystem carbon emissions, while major fire seasons can emit up to two-thirds of global ecosystem carbon.[49] An increase in the frequency, severity and duration of wildfires and droughts could cause irreversible changes to the ecosystem. Meanwhile, Benin lacks a reliable early warning system for forest fires.

Figure 14– Forests per capita have declined significantly since 1995



Source: World Bank (2021). The Changing Wealth of Nations.

47 (DGEFC, 2022)

48 IPCC (2023). IPCC AR6 Synthesis Report: Climate Change 2023.

49 IPCC (2023). IPCC AR6 Synthesis Report: Climate Change 2023.

The way forward: adapt agricultural practices, restore and protect forests, and invest in water resource management

Benin's drive to diversify agricultural exports offers synergies for adapting to changing climatic conditions. Cotton represented 53.4 percent of export revenues in 2021, despite the government's efforts to diversify. The country has access to excellent natural endowments for diversifying its agricultural base, and many products with high yields and export potential (pineapples, soybeans, shea nuts, and oil palm fruits) provide significant opportunities for rapid value generation.[50] Some crops are expected to be more resilient than others to the effects of climate change, such as sorghum. Better availability and affordability of crop-specific inputs, such as improved seed varieties, seedlings, fertilizers, and phytosanitary products, in combination with improved agriculture practices, are needed to diversify into more resilient crops.

Beyond diversification efforts, vulnerabilities could be mitigated through adopting sustainable food production models and implementing appropriate climate-smart agricultural techniques. In this context, the Ministry of Agriculture, Livestock, and Fisheries (MAEP) has prepared and adopted a strategy on climate-smart agriculture. Communities have often initiated their own local strategies, including staggered planting, use of short cycle varieties, integrated use of fertilizers, and diversification of sources of income. However, the implementation of these strategies in practice is fragmented and has only small-scale impacts because of limited financial resources.[51] To reduce the carbon footprint of the agriculture sector and avoid further deforestation, as well as to increase the resilience of the sector, it will be essential to enforce land regulations, and to invest in sustainable intensification and climate-resilient technologies. For example, agroforestry, which integrates trees and shrubs in crop and animal production, makes it possible to improve agricultural yields and ensure the recovery of degraded forest cover while improving soil fertility and carbon storage. To mitigate the risks of decreased water in the agriculture sector, upscaling water harvesting infrastructure and developing efficient irrigation systems (e.g., drip irrigation systems) will also be critical.

Restoring and protecting forests reduces communities' vulnerability to climate change and maintains natural capital. The forestry sector has benefitted from at least US$85 million from development partners over a period of 10 years (2010-19) to strengthen the sector and improve forest management. Reforestation works have been conducted by the Forestry Administration, the National Wood Company (SONAB), and municipalities through participatory approaches, with the aim of supporting livelihoods through job creation.[52] Timber and fuelwood production offer opportunities for long-term investment, contributing to national GDP and strengthening livelihoods. Other forest products can also help generate valuable sources of income for rural communities. For example, shea is already an important export product and offers positive employment opportunities for women and youth, who dominate the workforce in the value chain.[53], [54], [55] Finally, preserving mangrove forests not only protects against flooding and coastal erosion, but also creates ecotourism opportunities (with positive spill-over effects for women's economic empowerment), and boosts food security.

Strengthening land tenure security can be an effective way to reduce deforestation. Land tenure in Benin is mainly governed by customary tenure systems, where inheritance is the dominant tenure arrangement. As well as defined laws and codes to ensure communities' equitable access to land,[56] some innovative tools have been implemented since 2009 to strengthen land tenure security. These include the scale-up of the land registration program, known as *Plans Fonciers Ruraux* (PFR), with the objective of improving agricultural production and protecting natural resources. The PFR led to the delimitation of landholdings within villages, documented usage rights, and created institutions to facilitate conflict resolution. Most of the demarcated landholdings included agricultural plots, but forested areas were also demarcated. One study shows that implementing the program in 80 selected villages reduced forest loss by 20 percent and fires by 5 percent.[57] The National Plan for Agricultural Investment and Food and Nutritional Security (*Plan National d'Investissements Agricoles et de Sécurité alimentaire et Nutritionnelle* - PNISAN) 2017-2021 included the securitization and management of access to land as one strategic component. Its activities focused on implementing the PFR at national level and raising awareness of land rights. It also updated the Master Plan for the Development of Municipalities (*Schema directeur d'amémagement des communes* - SDAC) to integrate the preservation and securing of agricultural and pastoral lands.

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50 World Bank (2022). Country Private Sector Diagnostic: Creating Markets in Benin - Leveraging Private Investment for Inclusive Growth, (English).

51 Ibid.

52 For example, the World Bank-financed Gazetted Forests Management project established 22,000 ha of forest plantations for timber and fuelwood production on degraded lands in 11 Classified Forests. It aims to preserve at least 40 percent of the areas for conservation and ecosystem restoration in targeted habitats conducive to increased biodiversity. Around US$18 million have been injected into the local economy, involving over 33,000 direct beneficiaries in the reforestation works. The project is estimated to have benefitted over 185,500 people (based on an average household size of 5.5 persons according to the National Institute of Statistics and Economic Analysis in Benin). Source: World Bank (2018). Gazetted Forests Management Project.

53 Research from Burkina Faso and Ghana shows that investments in shea production are associated with positive outcomes for the economic and food security of women farmers, who are often disproportionally vulnerable to climate change and poverty. (Irandu, E. M., & Shah 2014 ; Kunjurman, V., & Hussin 2014.)

54 Agúndez et al. 2020; Honfo et al. 2012.

55 Chen 2017

56 Law n° 2013-01 of 14 August 2013.

57 Wren-Lewis, L. Becerra-Valbuena, L. and K. Houngbedji (2020). "Formalizing land rights can reduce forest loss: Experimental evidence from Benin". *Sci. Adv.* 6 (26).

Strengthening due diligence and promoting certification schemes for agricultural commodities can increase awareness of deforestation risks along supply chains. A stronger due diligence approach is needed for responsible production and sourcing of key commodities, e.g., cotton, cashew, and wood products. This will require stronger sustainability policies for reducing deforestation, and integrating them better into national development and sectorial plans, as well as into forestry policies and strategies, including agriculture, urban and infrastructure plans. A first step could be the creation of new policies targeting zero deforestation, or zero illegal deforestation commitment goals for commodities, which would require compliance by the private sector. Several tools are also needed to ensure the effectiveness of commitments, such as increased third-party deforestation monitoring; reliable geospatial forest monitoring systems; traceability systems; strengthened regulatory, political, and financing conditions; certification schemes, etc.

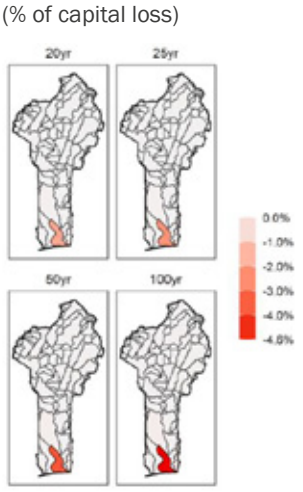
Adequate water resource management requires increasing supply through the construction of hydraulic structures and allowing for multifunctional use to meet the needs of various sectors (agriculture, livestock farming, water supply, etc.). These include investments in multifunctional hydraulic infrastructures and integrated water resource management, for example. The continued implementation of the National Action Plan for Integrated Water Resources Management, 2011-25 (PANGIRE) is essential to support climate change adaptation and mitigation. The following measures are particularly important: strengthening the water-food-energy security nexus, which is essential for community survival and economic development; and maintaining a minimum volume of water in aquifers to preserve ecosystems that depend on it resource for their survival. This means (i) protecting catchment areas; (ii) conserving knowledge, monitoring and securing of recharge areas; and (iii) implementing specific schemes to facilitate preferential water infiltration through secured aquifer recharge areas, such as establishing protection perimeters with regulated zones and zones declared non-constructible. Finally, programs will be needed to extend access to and manage demand for drinking water in urban and rural areas, and to integrate demand and supply in the coming decades, taking into account the impact of climate change on the resource.

3.2.2. Sustainable cities and coastal management are key for urban adaptation and tourism

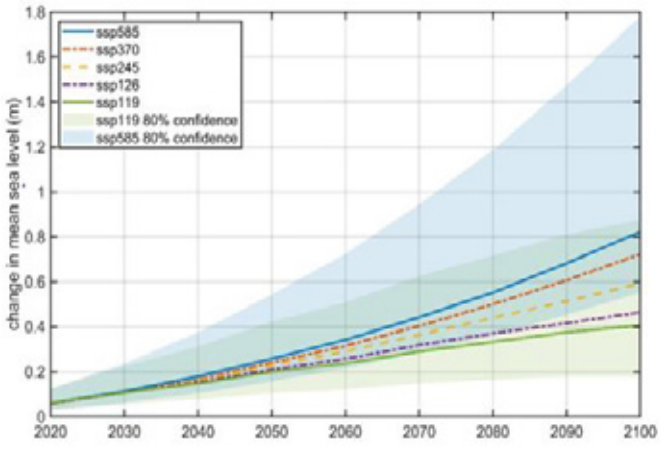
Rapid and unplanned urbanization, especially in the south, increases the country's already high vulnerability to disasters and climate-related shocks. Benin is characterized by a sparsely populated north and a densely populated south. Urban growth began to accelerate in the 2000s, largely driven by rural-urban flows, particularly to the coastal zone and the central region (the city of Parakou).[58] By 2050, the urban population will almost triple, with 65 percent of the population projected to live in urban areas (about 15.6 million people) compared to about 49 percent in 2021 (6.10 million). Unplanned urban development is of particular concern in Cotonou and the other southern coastal agglomerations where most of the population resides, as they are highly vulnerable to erosion, sea-level rise, increasing temperatures, and flooding. In contrast, secondary cities in the north and center will grapple with extreme heat. Desertification has accelerated and is projected to continue as droughts and extreme winds become more constant.[59]

Figure 15 – Benin's coastal agglomerations are highly vulnerable to flooding and sea-level rise

A) Historical inland flood damage of 20-100-year events is concentrated in the south (1990-2018)



B) Sea level is expected to rise significantly from 2050



Source: IEc Benin CCDR background report (2023). Notes: The analysis used a Geographic Information System to estimate the share of assets (i.e., capital and land) inundated under various sea-level rise scenarios. We use a "bathtub" approach to estimate the impacts of rising sea levels, whereby land grid cells become inundated as the total water level increases based on the projected sea level rise (IEc).

58 Rigaud, K. et al. (2021). *Groundswell Africa: Internal Climate Migration in West African Countries*. World Bank.

59 Ibid.

Densely populated cities in the south will be significantly impacted by heavy rainfall and floods, with implications for urban sanitation. The south, where most of the urban population and economic activities are concentrated, is prone to heavy rainfall and floods. An assessment of historical disasters reported between 1990 and 2018 points to a significant impact of adverse natural events (Figure 15A). Recurrent natural shocks have seen Benin suffer average annual losses of 0.26 percent of GDP (relative to 2019 GDP) and reduced consumption of 0.53 percent of national GDP.[60] Vulnerability to flooding is even more pronounced with the increase in informal settlements and unregulated development in disaster-prone areas, such as along riverbanks or in flood plains. This has also led to major sanitation challenges. Following past floods, surface and groundwater have been contaminated by a mix of rainfall runoff and flooded latrines, septic tanks and municipal wastes, exposing the population to health risks, notably cholera.

Sea-level rise is posing serious threats to Benin's coastline, which has one of the highest rates of coastal erosion in the Gulf of Guinea. Sea-level rise is projected to exacerbate shoreline recession, inundate low-lying coastal areas, and increase the salinity of estuaries and aquifers (Figure 15B and Box 5). Coastal erosion is partially caused by natural factors, but aggravated by anthropogenic pressure. About 65 percent of the coast is subject to an average erosion of nearly 4 meters per year (compared with Togo at 2.4 meters/year and Côte d'Ivoire at 1.4 meters/year).[61] Over the last 40 years, the national coast has recorded over 400 meters of erosion in certain areas, causing severe damage to the environment, and engulfing and sweeping away homes and infrastructure. Coastal erosion also damages roads and connectivity, ports, and cropland, and affects livelihoods.[62] The increase of flooding in low and coastal areas will also severely impact marine ecosystems and biodiversity.

Urban transport connectivity is increasingly hampered by its vulnerability to sea-level rise, flooding and poor transport services. Climate-related events hinder circulation on the cities' main thoroughfares, disrupt urban mobility and aggravate impacts to an unprepared urban sector. Almost 4,000 kilometers (or 12 percent) of all urban road networks would be directly exposed to some level of flooding in a 1-in-100-year flood scenario (see Figure 15 and Section 3.2.3 for more details). Urban transport services are mainly provided by the paratransit sector (e.g., *zemidjans and tôkpa-tôkpas*) comprising aging fleets of highly polluting vehicles. This is due to the lack of a reliable formal public transport system, and the weak enforcement of the passenger transportation regulatory framework. The under-provision of formal public transport services has led to market dominance by these informal transport operators, who are unable to provide an efficient, resilient or reliable service to meet the increasing demand. Weak sector governance and unregulated operations provide little incentive for transport providers to replace aging polluting vehicles with cleaner ones.

Box 5 – Sea-level rise is already costly

Sea levels are projected to rise by 38 cm by 2060 and 58 cm by 2080 (Figure 15B). The most exposed areas at greatest risk of erosion are found in eastern Cotonou, at Donatin, a district to the east of the outlet of Lake Nakoué, with an erosion rate of around 9 meters per year. The Mono and Couffo lagoons and the eastern area of Cotonou, comprising 12.9 km^2, suffer from high erosion and could disappear by 2100. Impacts of coastal inundation will be felt most in the western region around Mono and Couffo lagoons, but also in the east of Porto-Novo. In 2017, coastal erosion cost the country US$117 million, or 1.3 percent of GDP, and coastal floods caused US$29 million in damage to assets, economic production, and human life. Aggravated effects of coastal degradation and erosion will continue to have significant socio-economic implications, affecting coastal populations in both urban and rural areas, agricultural land and infrastructure, and jeopardizing economic activities. Without effective measures, these impacts are likely to lead to population migration, increased poverty, declining agricultural yields, death of livestock, displacement of tourism activities, and slower national economic growth.

The Autonomous Port of Cotonou (*Port Autonome de Cotonou,* PAC) is highly vulnerable to coastal erosion. While no strategic plan has been developed by the government yet to tackle the issue, greening the port is becoming of strategic importance. The PAC plans to extend the dikes to reduce coastal exposure to erosion and inundation. The port should also consider developing an adaptation plan to counter coastal erosion risks downstream of its dikes. A second deep seaport in Sèmè is planned in the coming decades, depending on trade growth. Considering the moderate erosion risk to Benin's east coast near the Nigerian border, a system for by-passing sediments from west to east must be considered and budgeted for as part of the port construction. Construction of the sediment bypass is expected to cost around US$20 million (0.1 percent of 2023 GDP) and maintenance is likely to be about US$800,000/year. This type of investment could be carried out by the private sector.

60 The estimate is based on a probabilistic evaluation of disaster risks in Benin led by the World Bank in 2019.

61 Croitoru, L., Miranda, J.J and Sarraf, M. (2019). The Cost of Coastal Zone Degradation in West Africa: Benin, Côte d'Ivoire, Senegal and Togo. World Bank.

62 https://climateknowledgeportal.worldbank.org/country/benin/impacts-sea-level-rise

The way forward: Build resilience to urban flooding, improve land and urban planning, invest in WASH and protect coastal areas

Building cities' resilience to flooding will increase their economic potential. According to the NAP, flooding is the natural hazard the most likely to occur. Urban flooding is exacerbated by the destruction of natural absorption sinks (e.g. wetlands), and widespread impervious surfaces that prevent ground absorption, paired with poor drainage infrastructure. While climate change is a key driver of floods, so are local planning decisions. Outdated building codes and weak capacity to enforce them, unregulated land use leading to urban sprawl, lack of maintenance, and scarce municipal resources have all resulted in infrastructure and building stock prone to damage by natural disasters. Only 35 of Benin's 77 municipalities have developed their City Master Plan[63] and a large share of these 35 plans need to be updated. An unclear approval process for City Master Plans has led to lack of standardization and poor compliance with the territorial planning law, and inadequate planning both in urban and rural areas, resulting in uncontrolled development and informal settlements. The limited funding at the city level translates into four major challenges for operating and maintaining urban assets: (i) sporadic and limited maintenance; (ii) inadequate and/or obsolete equipment; (iii) inability to conclude multi-year contracts with service providers; and (iv) inability to pay the private sector for various activities.

Urban planning documents and zoning regulations need to be urgently updated to take into consideration climate risks, given the rapid population growth and urbanization rate. These documents are some of the most effective tools for responding to climate change. Compact and coordinated urban development is associated with lower emissions, lower long-term infrastructure costs, more green spaces, and the protection of agricultural and forest land.[64] Spatial development is largely irreversible; therefore, time is of the essence. Given the growth rates, the next 5-10 years could be crucial for determining the productivity, resilience and sustainability of Benin's cities over the very long term. Once a city has sprawled, it is almost impossible to transform it into a compact safe city, meaning that natural risks are locked in. Resettling people living in high-risk flood zones is difficult – much better to avoid settlements there in the first place. Climate-smart urban planning can keep settlements out of flood zones and can also yield more compact, efficient and lower-emission cities. More sustainable funding mechanisms for local governments, increasing transfers and potentially including the use of performance-based capital block grants — earmarked for climate resilience investments[65] — should be considered.

Creating a Grand Nokoué metropolitan area (encompassing Cotonou, Porto Novo, Abomey-Calavi et Sèmè-Podji) could bring efficiency gains and improve coordination. The management of this area is challenging due to the historical administrative boundaries and governing structures. A dedicated metropolitan authority would be better positioned to develop a sustainable urban mobility strategy to: (i) promote a sustainable compact form; (ii) integrate climate-resilient standards into construction and maintenance guidelines; (iii) improve urban mobility through an public transport system integrated with planning and land-use management; (iv) invest in high-capacity public transportation and interconnectivity; and (v) enhance the financial base by diversifying funding sources, promoting private capital mobilization, and making the tax system more efficient.

Water management and sanitation need to be fully integrated into cities' and peri-urban areas' expansion plans. To reduce sanitation risks from frequent flooding, stormwater drainage and sludge management are also needed. The government has prioritized urban sanitation to address flooding risks effectively and ensure proper management of sewage sludge, at a cost of US$1.18 billion. Nevertheless, it will be necessary to accelerate access to basic sanitation in rural areas to preserve the quality of water resources throughout the country.

Coastal erosion can be addressed more sustainably through a combination of hard and soft interventions, including nature-based solutions. To date, the government has invested in 53 km of coastal protection, targeting 42 percent of the coast (in the center-eastern and western parts of the country) with protection works involving grey infrastructure. For example, a breakwater has been constructed in Fidjrossè – along the port of Cotonou section. More recently (2023), the World Bank-financed West Africa Coastal Areas Resilience Investment Project has implemented transboundary works between Togo and Benin comprising 23 km of coastline protection in Benin. While protective infrastructure can be highly effective, building such structures is costly, and maintenance costs are also high.[66] About 72 km of hotspots have been identified that remain to be protected.[67] In recent years, emergency protection works to stabilize the south bank of the

63 National Agency for Land Use Planning. January 2019.

64 Worldwide, nature-based solutions through urban agriculture and forestry and river restoration have increasingly been applied in urban areas as an adaptation response, reducing adaptation costs and contributing to flood control, sanitation, water resources management, landslide prevention and coastal protection.

65 Earmarked grants can finance important prevention measures such as flood control systems, safe schools/shelter construction, and solid waste management including methane capture.

66 If infrastructure is not well designed and is not regularly maintained, it can result in accelerated erosion on adjacent coastlines, as recorded in Avlékété in the center-western region, and in the center-eastern area in Siafato. To avoid detrimental effects from hard engineering interventions, a strong design, and regular monitoring and maintenance is needed. World Bank (2022). Coastal Management Practices in West Africa.

67 Discussions have taken place regarding the development of a deep port at Sèmè-Podji. If realized it could likely lead to aggravated erosion in the eastern part, which is already vulnerable. In the Krakè area bordering Nigeria, investments in hard infrastructure should be avoided to avoid shifting erosion to Nigeria. Instead, a large natural ''buffer'' zone should be created.

Mono River have also been carried out. Moving forward, a combination of hard and soft interventions, including nature-based solutions, will ensure more sustainable results for the remaining coast. Nature-based solutions are already being applied to improve Benin's coastal management while having less impact on the environment. These include investment in restoring Benin's low-cost blue carbon ecosystems (mangroves and wetlands). To date, about 100 ha of mangroves around coastal lagoons have been restored, along with 200 ha of wetlands. The government also aims to continue restoring 420 ha of mangroves in Ramsar site 1017. The NAP outlines the adoption of several coastal climate resilient actions, to cost around US$757 million. These include establishing participatory early warning systems, soft interventions, resilient infrastructure, and implementation of coastal management plans, among others.

Sustainable cities and resilient infrastructure will help develop the tourism sector. Tourism is a high-priority sector for Benin and the country's second-largest generator of foreign exchange earnings (after cotton). Incorporating climate resilience into tourism will be critical to ensure a sustainable future for the sector. International tourism receipts amounted to an estimated US$241 million in 2019, accounting for almost half of the country's services exports. The authorities are keen to tap into the sector's potential, with Benin's comparative advantage stemming from its location, political stability, international openness, and strength of endogenous natural and cultural assets.[68] However increasingly severe and more destructive floods, especially in the coastal region, threaten many of the country's tourism facilities. Recurrent floods in urban areas such as Cotonou, Porto Novo, and Parakou, pose significant challenges to the already inadequate and insufficient water supply, sanitation, and waste collection systems, which in turn hamper the development of tourism activities. Coastal erosion also deters private investment in tourism as it puts infrastructure at risk.

To realize tourism's development impact, the sector needs to be structured, developed, and managed in a green, inclusive, resilient, and competitive manner. To date, however, few environmental sustainability measures have been implemented or prioritized in the sector. Outside of protected areas, sustainability and greening are not yet priorities for the private sector or the government, in part because their mostly business-heavy clientele does not place a premium on sustainable measures. In addition, investors have limited knowledge of and expertise in cost-saving environmental measures. As tourism has the unique potential to drive growth in Benin and serve as a robust entry point for formal employment, more needs to be done to make the sector more climate resilient.

3.2.3. Resilient transport and digital infrastructure will keep people and markets connected

Despite efforts to improve the country's road network, connectivity remains a challenge – especially in rural areas subject to climate-related events. Benin's share of dirt roads is one the largest in the sub-region (54 percent, compared to 20 percent in Senegal and 35 percent in Ghana). Despite efforts to improve rural connectivity, only 23 percent of the rural population has access to an all-weather road – a small improvement on the 18.1 percent recorded in 2009.[69] Benin's national Rural Access Index (RAI) is much lower than that of its neighbors (20 percent in Benin, compared to 34 percent on average) and is even lower in the northern regions.

Climatic events can severely affect the primary road network and hinder connectivity to agricultural areas. Heavy rainfall can cause flash floods and landslides which can instantly destroy, block, or cause significant and recurrent damage to both paved and dirt roads. According to the NAP, paved roads in Borgou and Atacora and dirt roads in Alibori, Atacora, Borgou and Donga appear to be the most vulnerable to extreme rainfall. Our evaluation shows that almost 4,000 kilometers (or 12 percent) of urban road networks would be directly exposed to some level of flooding in a 1-in-100-year flood scenario (Figure 16A). More than 3,000 kilometers of all roads experience flooding deeper than 30 cm. For more intense flood scenarios, the extent of the exposed road network increases systematically. Extreme heat can alter bitumen, leading to short-term deformation and potential traffic disruption. It can also induce long-term damage, especially if it alternates with heavy rainfall. Three National Interstate Roads (RNIEs) are vulnerable to extreme temperatures: RNIE 3 (in Atacora), RNIE 2 (in the south, in Borgou and Donga), and RNIE 1 (in the south). All Benin's major cities (Abomey-Calavi, Bohicon, Cotonou, Parakou and Porto Novo) are also vulnerable to climate extremes. Prolonged drought also increases the risk of wildfires along key inter-urban roads. The resilience of economic activities in such areas is therefore tightly linked to the ability of the road network to withstand adverse climatic conditions.

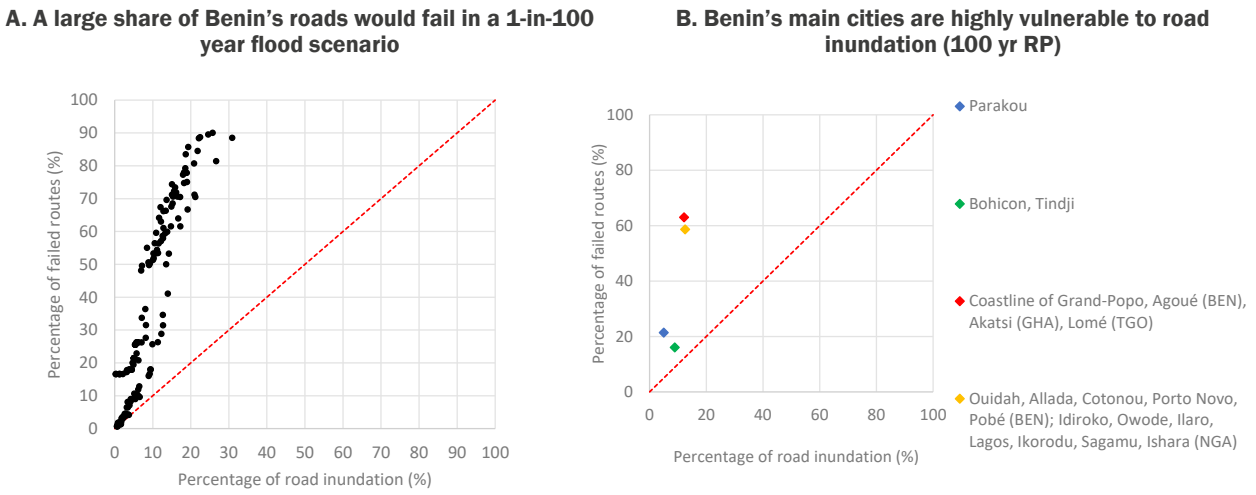
The lack of resilience planning for the primary and rural road networks is a major challenge. Climate data and risks are not systematically included in the planning of construction or maintenance interventions on the transport network. The country's exposure to climate-related disasters is thus aggravated by the lack of an adequate road asset management strategy/system. Flood scenarios occurring once every five years in Benin do not substantially affect most of the selected regions – with the exception of Parakou (see below) – as road failure remains below four percent. However, more intense

68 CPSD Benin, WBG.

69 World Bank (2021). Benin Country Economic Memorandum – Transport Sector.

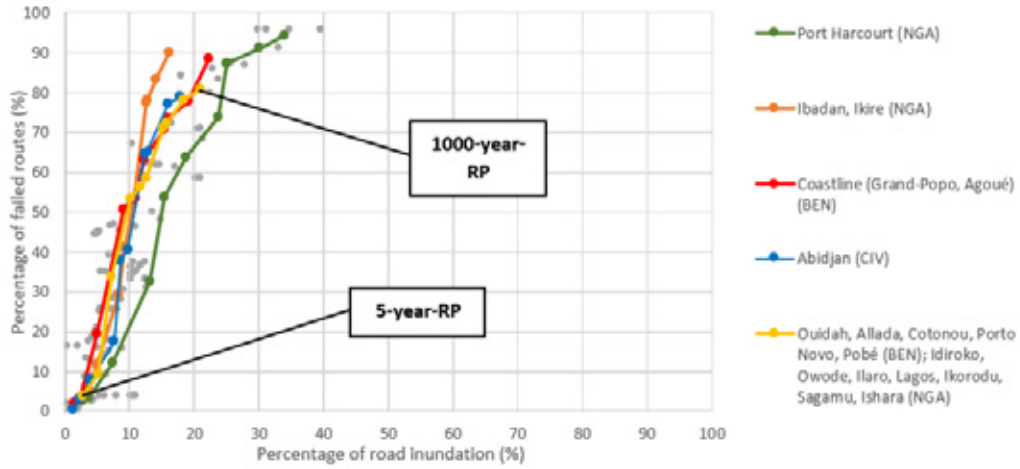
floods (1-in-100-year return period, RP) would see disproportionally high shares of route failure in all the selected regions – in particular the cities of Ouidah, Allada, Cotonou, Porto Novo and Pobé, as well as along the coastline of Grand-Popo and Agoué (Figure 16B). Parakou is one of the most vulnerable cities in West Africa to floods with a 5-year return period, while other regions in Benin display average vulnerability. Higher flood return periods would see vulnerability in the southern regions of Benin increase rapidly (Figure 17). Compared to a 5-year RP, the share of failed routes as a result of flooding increases only by four percent under a 100-year RP in Parakou. However, Benin's western coastline – including Grand-Popo and Agoué (Region c), as well as the region covering the cities of Ouidah, Allada, Cotonou, Porto Novo and Pobé (Region d) – faces high vulnerability increases under higher flood return periods.

Figure 16 –Transport infrastructure is highly vulnerable to flooding



Source: *Vulnerability towards floods with a 100-year return period in selected Western African cities* (Benin CCDR Background Note 2023). Note: Figure shows road network inundation and associated mobility disruptions.

Figure 17– Route failure under more severe flooding events would be higher across West Africa



Source: *Vulnerability towards floods with a 100-year return period in selected Western African cities* (Benin CCDR Background Note). Note: Figure shows road network inundation and associated mobility disruptions.

Benin has considerable potential for developing its digital economy, but increasing coverage remains a challenge, as does protecting digital infrastructure from climate shocks. With a new legal framework updated in 2018 and recent access to three international submarine cables (Africa Coast to Europe, Maroc Telecom West Africa, South Atlantic Telephony-3/West African Submarine Cable), Benin is progressing towards digital inclusion. At least 85 percent[70] of the population benefits from mobile network coverage. However, mobile broadband penetration (measured by the number of unique subscribers) remains low, at 18.7 percent in January 2023.[71] Despite the launch of 4G services in 2015, remote areas remain underserved, and the gender gap is large, with 38 percent of men having access to the Internet compared to 14 percent of women.[72] Developing digital infrastructure is crucial for economic activity, people's resilience and access to public services,[73] but vulnerability to climatic shocks needs to be built in. Figure 18 shows how weather shocks can impact several types of digital infrastructure, such as submarine and terrestrial fiber optic cables, landing stations, terrestrial cables, data centers and mobile antennas. Sea-level rise and intense rainfall could damage submarine cable landing stations, potentially disconnecting international capacity and the country's internet.

Figure 18: Telecommunications infrastructure is vulnerable to many natural hazards.

Infrastructure/climate event	Inland/ coastal floods	Earthquake	Tsunami	Sea-level rise	High temp	Water scarcity	High winds/ storms
Submarine cable (deep sea)							
Submarine cable (near shore)							
Landing station							
Terrestrial cables (underground)							
Terrestrial cables (overland)							
Data centers							
Antennas							

Source: World Bank (2019). "No broken link – The vulnerability of Telecommunication Infrastructure to Natural Hazards". adapted from: GSA (2014), UK DRO (2018), Fu et al (2016), and Dept. of Homeland Security (2017).

Data centers, telecommunication towers and electrical networks are all vulnerable to climatic events. The Beninese data center market is growing,[74] but the centers may be subject to failure or malfunction caused by an intense heat wave, drought, or increased humidity. Digital infrastructure such as telecommunication towers and electrical networks can also be damaged by flooding caused by heavy rains and overflowing rivers. In 2022 there were around 1,800 telecom towers in Benin.[75] Mobile network infrastructure, and especially mobile base stations (which host mobile antennas), located in high-risk areas are particularly vulnerable. The mobile access network is the most critical segment of the network to which most mobile users are exposed. Disruptions at this level have an immediate impact on consumers' quality of service and can cause distress in an emergency.

70 World Bank (2020). Benin Digital Economy Diagnostic Report.

71 GSMA Mobile Broadband Capable Connections (January 2023) / GSMA SIMs Per Unique Subscriber (January 2023) / United Nations Population (January 2023)

72 Gallup World Survey. (2020). *Question: "Do you have access to the Internet on a cell phone, computer or any other device?"*

73 Digital infrastructure is at the heart of the country's most critical infrastructure – such as energy, operated by the Beninese Electric Energy Company (*Société Béninoise d'Energie Electrique* – SBEE) and the management and distribution of water to households by the Benin National Water Company (*Société Nationale des Eaux du Bénin* – SONEB). The stability, availability and security of these critical systems depend on the accompanying digital infrastructure.

74 The operator MTN-Benin launched its data center in 2019 and the Tier 3 national data center in Abomey-Calavi was commissioned in 2021 and is operated by SBIN (Celtiis).

75 IFC, Altai. (2022). The number of telecom towers is based on data collected during fieldwork in Benin.

The way forward: Invest in multimodal transport networks, asset management and planning, climate-resilient digital infrastructure and digital solutions

Adopting a multimodal approach, where possible and relevant, will enable a more resilient, greener strategy for the transport sector. The Beninese government's transport development strategy is heavily focused on the road sector, considering that roads account for transportation of 93 percent of passengers and 73 percent of freight.[76] However, a more systematic consideration of the potential contribution of other modes of transport, such as rail and inland waterways, will enable a more holistic approach to the many challenges that lie ahead. For example, developing inland waterways transport could help address the urban mobility adaptation and mitigation challenges in Cotonou and the Grand Nokoué region. In addition, investing in railroads between the PAC and the dry port of Allada, located 60 km away, would help reduce the impact of trucks on the physical road infrastructure and improve traffic conditions and air pollution in central Cotonou.[77]

Benin's ambitions to improve access to sustainable and quality road infrastructure will require important reforms and massive investment in the coming decades. Building resilient transport infrastructure is not only a necessity to ensure market connectivity, but will also enable the urban transport system to keep up with the impact of rapid urbanization. High-capacity transport modes, such as light rail and bus rapid transit systems, rely on dedicated infrastructure which needs to be climate-resilient. Better coordination is also needed between infrastructure planning and the transport services industry. As the transport sector modernizes it needs to shift towards a more people-centered and network-level approach to planning to maximize benefits for people and supply chains. This will require: (i) better planning of transport systems and urban planning with investment prioritization at the network level of critical vulnerable links; (ii) climate-resilient construction and climate-smart maintenance; and (iii) stronger institutional capacity, coordination and financial capability. It is also important to (i) improve data availability and data/transport planning systems; and (ii) increase the capacity of relevant stakeholders to use and maintain these systems.

Digital technologies play a significant role in adapting to climate change. While Benin's National Meteorological Agency makes a considerable effort, there are significant gaps in the coverage and quality of their data. The use of digital technologies such as satellite imagery, remote sensing, and depth sensors can help fill these gaps and provide more accurate and detailed climate data. The government is making remarkable efforts to develop the information and communication technology (ICT) infrastructure and increase digital adoption. However, it is necessary to work with local private players to generate and transform climate data into sector-specific information and knowledge products, and to operationalize the national climate services framework to make climate information available and reliable. Platforms such as geographic information systems could also be used in the design and maintenance of climate-resilient infrastructure. A National Geographic Information Council (CNIG) is being established to coordinate and harmonize geospatial and thematic data on geodesy, habitat and infrastructure, hydrography, land use, orography, and road and energy networks. These data are made available to the public free of charge by the National Geographic Institute.[78]

The rise of digital technologies and the increasing expansion of connectivity in rural areas could also help increase access to climate finance, insurance, and early warning systems. Mobile insurance products can provide affordable and accessible insurance coverage to smallholder farmers, who do not always have access to traditional insurance products. The expansion of the digital economy can also present important gains for women in terms of financial inclusion, employment opportunities, and access to services. However, considering pre-existing gender vulnerabilities in e-inclusion in Benin (women's limited access to assets and finance, low literacy rate and enrolment in technical fields of studies, lack of awareness about and use of mobile banking, etc.), it is important to implement gender-specific policies and concrete programs to increase women's access to and use of digital services. Resilient rural connectivity will also ensure the continued functioning and deployment of early warning systems (EWS)[79] and the roll-out of digital public services in line with the government's e-services strategy.

Ensuring access to digital technologies will also mean making them resilient. The government, private operators, and investors should consider all potential climate risks in the design and deployment of digital infrastructure. This will require relevant technical actions: replacing copper cables with fiber optic cables (depending on feasibility), defining climate-friendly standards for underground ducts to prevent cable cuts, and enforcing the use of climate risk management (CRM) systems and green IT equipment for enterprises. The regulatory framework for infrastructure construction and civil works should be strengthened for greater resilience and adaptation.

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76 InfraSAP Benin (2023). Benin's classified national road network is approximately 6,000 km long and revolves around four major service corridors.

77 This project must of course be seen in the broader context of prospects for rail development along the Cotonou-Niamey-Ouagadougou corridor, considering the commissioning of the dry port of Parakou, 400 km north of Cotonou, scheduled for October 2023.

78 www.geobenin.bj

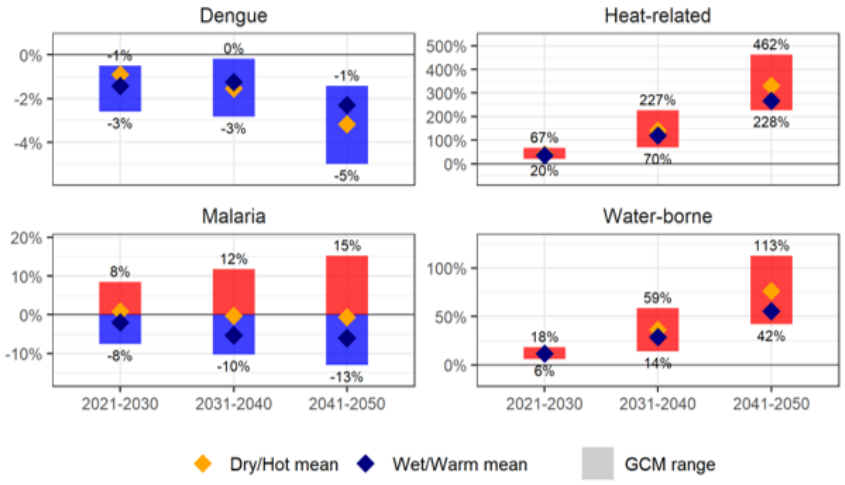
79 Through the National Strategy for Climate Risk Reduction 2019-2030, the Government of Benin has committed to focus its efforts on the EWS for disasters related to hydro-climatic hazards. The 2010 floods prompted the creation of an EWS, known as "SAP-Benin" (*Système d'Alerte Précoce – Bénin*), launched in 2014.

3.2.4. Human capital needs to be climate-proofed

Resilient health and education systems are required to ensure continued human capital accumulation. As a pre-dividend country, Benin can take advantage of its growing young population to increase productivity and growth per capita. The speed at which its demographic transition takes place and the economic and human development policies that accompany it can power the next wave of economic growth, depends on healthier and better educated young people entering expanding labor markets.[80] The gaps are however large: a child born today in Benin will be 40 percent less productive as an adult than they could have been if they had been fully educated and healthy.[81] Preventing any further deterioration due to climate change should be a priority.

Benin is highly vulnerable to health conditions that could be worsened by climate change. Although the burden of communicable diseases has decreased, malaria, neonatal infections, lower respiratory tract infections and diarrheal diseases remain the four leading causes of death in the country.[82] Benin is also exposed to a very high risk of epidemics of infectious diseases, especially those of animal origin (zoonotic diseases), and has experienced several epidemics in recent years.[83] In addition, the rate of chronic malnutrition among children under five[84] remains high, at 32 percent.[85] In terms of geographical distribution, infant mortality is highest in the north-eastern and western regions. Nationally, 32.2 out of every 100 children are stunted, increasing the risk of cognitive and physical limitations that impact overall development, academic achievement, and productivity/wages in adulthood.

Figure 19: Climate change is likely to increase the human impacts of heat stress, malaria, and water-borne diseases



Sources: IEc (Benin CCDR). Notes: The figure shows how the mortality and morbidity of the different diseases are expected to change relative to the baseline when considering the impacts of climate change.

Climate change will aggravate health risks and put strain on the health system. Rising temperatures and more frequent heat waves, which are expected to be more pronounced in the north, will lead to more cases of vector-borne diseases.[86] Malaria is already one of the main causes of death. Heat stress is also leading to an increase in non-communicable diseases.[87] In addition, climate change presents unique challenges for women's maternal, sexual and reproductive health.[88] In areas with more pronounced droughts, cases of dehydration will increase, which can be fatal in the elderly and

80 World Bank (2021). Country Economic Memorandum.
81 World Bank (2020). Human Capital Project.
82 Institute for Health Metrics Evaluation, 2019
83 Cholera (2014, 2016, 2020, but now considered endemic), measles (201-4-2020), Lassa fever (2016-2019) and meningitis (2016, 2020)
84 UNICEF, WHO, World Bank (2018). Joint estimates of child malnutrition (JME).
85 World Food Program (2022). Benin - Country profile.
86 DGEC (2022). National Adaptation Plan Benin.
87 These include stroke, ischemic heart disease and diabetes.
88 Davis et al. 2010; Rylander et al. 2013.

children, as will malnutrition and other conditions[89] (due to loss of crop yields). Our modelling predicts that heat-related diseases are expected to be impacted the most by climate change, with increases in mortality and morbidity of more than 400 percent by 2050. Meanwhile, mortality and morbidity linked to water-borne diseases would increase by 113 percent, and malaria by 15 percent, while those linked to dengue fever could decrease by -5 percent (Figure 19). Human health impacts are also likely to dampen the economy, by accounting for an estimated decrease in the effective labor supply of roughly 0.24 percent by 2050 in the hot/dry climate scenario.

Several risk factors increase the population's vulnerability to disease: the prevalence of waterborne and foodborne diseases, food and water shortages, air pollution, and lack of sanitation and hygiene (WASH). The central and southern regions, which will be most affected by changes in rainfall patterns, flooding and rising sea levels, will be most impacted by contamination of drinking water, marine water and agricultural land. Contaminated water and poor sanitation are linked to the transmission of several diseases such as cholera and diarrhea, among others.[90] Higher mortality and reduced ability to work due to illness or caring for ill relatives will further stress entire communities. Climate events can also damage transport infrastructure, affecting accessibility and emergency response. The average time to access a health center is 3 hours, but can be as much as 7 hours in some regions, such as Malanville.[91]

Moreover, climate change is an added threat to the delivery of healthcare services through its impacts on health infrastructure and staff. The country currently has a shortage of health workers able to deal with climate-sensitive diseases. The health infrastructure is also not well prepared for climate change and the expected increases in certain diseases (such as malaria in the southwestern region). However, the government has commissioned national studies to analyze the impact of climate change on the health sector and has begun planning for what is needed to reduce risks and enhance climate resilience.[92] A key factor is to ensure climate adaptation measures are integrated into the rehabilitation of health centers as well as any new constructions, particularly in the most vulnerable and remote communities.

A few government projects aim to address some of the challenges related to climate change, but the lack of funding in the sector makes it difficult to scale up such interventions. Two projects are supporting adaptation to climate change in the health sector: (i) the Programme to Support Reproductive Health Activities (PAASR), which aims to improve the quality and accessibility of maternal and child health services; and (ii) the National Programme for the Rehabilitation and Construction of Hospitals (PNRCCH), which aims to contribute to improving the quality and accessibility of health care and health services.

Climate change is also affecting the education system. The growing incidence of extreme weather events is disrupting both the supply and demand aspects of education, with girls likely to bear the brunt of the impact:

1) The delivery of educational services. Floods and storms are already damaging and destroying schools. The rehabilitation costs following a natural disaster absorb a large part of the national budget, diverting resources away from improvements to the education sector. Climatic hazards and environmental degradation provoke displacement and migration, and school closures, hampering children's access to education and teachers' ability to deliver quality education.
2) School performance and demand. Prolonged excessive heat, especially in the north, is compromising children's ability to go to school or learn while in school. In some places, classes are already scheduled at late (non-regulatory) hours to avoid exposure to excessive heat.
3) Adolescent girls' drop-out rates: girls' ability to return to school after climate-induced shocks is particularly low due to their increased domestic workload. They also face heightened risks of early and child marriage as a mechanism to cope with financial and food insecurity.[93]

The way forward: strengthen the resilience of service delivery in health and education to protect human capital formation

Improving the resilience of the health system to climate change is an opportunity to address key underlying vulnerabilities. On the supply side, the country needs to increase (i) capacity among health personnel to diagnose, treat and manage climate-sensitive diseases; (ii) community-level preparedness and response plans to commission medicines and other important products and to raise community awareness; (iii) surveillance, early warning systems, information

89 Malnutrition can also lead to other conditions such as meningitis and measles among vulnerable populations (children under five).

90 These include amoebic dysentery, hepatitis A and typhoid and paratyphoid fevers.

91 More than 50% of the poorest women between the ages of 15 and 49 indicate that difficulty in accessing health centers is a barrier to access to treatment. World Bank (2022). Benin Country Economic Memorandum 2.0.

92 Tye, S. and Waslander, J. (2021). "Mainstreaming climate adaptation planning and action into health systems in Fiji, Ghana and Benin". World Resources Institute, Working Paper, January 2021.

93 Corno, H. and Voena (2021); UN Women (2022a).

and research on climate-sensitive diseases and an appropriate response; (iv) financing mechanisms for climate change-related health interventions; and (v) adapted health infrastructure, equipment, products and services. Affordability is a challenge on the demand-side. Direct healthcare expenditures account for around half of total financing, with public healthcare spending accounting for just 23 percent of total healthcare expenditure.

Reinforcing emergency preparedness remains crucial. Benin is ranked 171/195 on the Global Health Security Index (GHSI) for emergency preparedness in the health sector. It had an overall score of 25.4 in 2019, lower than that of Senegal (37.9), Nigeria (37.8), Côte d'Ivoire (35.5), Ghana (35.5) and Liberia (35.1).[94] During COVID-19, service provision in hospitals and health centers was moderately disrupted as a result, with community level facilities being the most affected. Benin has begun to implement WHO-recommended strategies to mitigate service disruption, such as triage to identify priorities and the deployment of telemedicine to replace face-to-face consultations. Finally, some institutions are dedicated to effective surveillance and preparedness for health emergencies and natural disasters that may impact the health sector, but they need reinforcement. At the national level, the Public Health Emergency Operations Centre (PHOC) monitors the situation and has a mechanism for detecting and reporting events. An effort to strengthen the capacity of rapid response teams for the response to public health emergencies has been made at central, intermediate and local levels as part of the response to the COVID-19 pandemic.

WASH interventions and improving access to drinking water will mitigate against the risk of certain diseases. Benin's greatest sanitation challenge is in urban areas, where measures need to be reinforced to mitigate and adapt to flooding through stormwater drainage and sludge management. This has been a key focus of recent government action. In contrast, while there is a national strategy for the promotion of hygiene and basic sanitation in rural areas for 2018-2030, lack of resources mean implementation is falling behind. The government is making progress towards achieving universal access to drinking water for all Beninese by 2026, with current coverage at 76.7 percent in rural areas and 70 percent in urban areas. To bridge the remaining access gap, Benin is counting on the mobilization of groundwater resources. However, this resource is poorly assessed, not only in terms of quantity and quality, but also geographical distribution and regenerative and recharge capacity. In addition, other development sectors such as agriculture and industry also rely on groundwater to meet their water needs. Climate change will add to the growing pressure on groundwater. A plan for the sustainable management of water resources is needed, including appropriate adaptation and mitigation measures to ensure sustainable access to water.

More urgent measures to make the education system more resilient are needed, especially for infrastructure. There are already actions taking place to increase the climate resilience of the education system. These include introducing climate change concepts into the education and training curriculum; reforestation campaigns in schools and colleges; environmental awareness campaigns; and policies for building schools resilient to floods, storms, and excessive heat. However, some measures – such as developing resilient school buildings – should be accelerated. Other key priority actions include capacity strengthening in the Ministry of Education; mainstreaming climate change within the education sector's policies and plans; incorporating modules on agriculture, farming and green economy in the school curriculum; strengthening collaboration and partnerships between sectors; developing financing mechanisms targeting children, schools and regions most affected by the climate crisis; and enabling girls to pursue education through tackling gender-specific barriers in access to schooling.

3.3. Key policy options for a more resilient growth pathway

Tables 4a and 4b summarize the key policy and investment options identified in this chapter for strengthening the resilience of labor demand and labor supply. The actions are organized by sector, and by whether they are policy actions – which are regulatory/institutional in nature – or investment actions, which require hard investment (e.g., construction, an operational budget, etc). Complexity levels for each action were defined together with government counterparts through an inclusive consultation process that considered feasibility, presence in government strategic documents, budget plans, and political economy.[95] Costs are only reported when available. "Expected financing source" indicates the most likely source of financing.

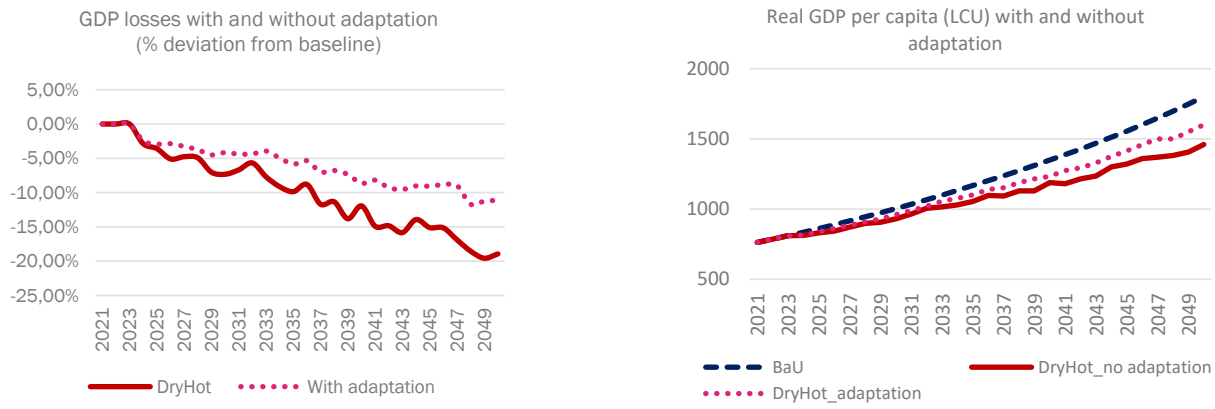
The early adoption of adaptation measures in the National Adaptation Plan and the recommendations in Table 4 are crucial for Benin's sustainable and inclusive economic development. A modelling exercise shows that implementing certain adaptation measures (those listed in Table A7 in Annex 6) would halve projected losses from the most extreme scenario (Dry/Hot mean), with GDP only reduced by 11 percent by 2050 compared to the baseline (Figure 20). Some

94 NTI and Johns Hopkins Bloomberg School of Public Health (2019). Global Health Security Index, Building Collective Action and Responsibility.

95 Costs of action include costs of capex of investment needs over 5-10 years for project development, but most of the time excludes variable costs (operation/maintenance). They are indicative based on the most recent available information and from exchanges with government counterparts. Where costs are missing, the exercise has not yet been carried out.

adaptation measures could bring about gains greater than the losses avoided (for example, for the rainfed crop yields channel, adaptation through expanding irrigation leads to an improvement in output).

Figure 20: Investing in resilience and adaptation measures early could halve losses from climate change



Source: MANAGE simulations. Notes: Deviations from the baseline; 5-year moving average.

Table 4a: Summary of key policy options and investment actions for a resilient labor demand

Area	Action	Complexity	Fixed cost (capital investment)	Expected financing sources
Adapt agricultural practices, restore and protect forests, and invest in water resource management				
Agriculture (AG)	**Policy action AG1:** Reinforce the mechanism presided over by MAEP for the securitization of rural land titling.	High	-	Public budget (PB)/concessional resources (CR)
AG	**Policy action AG2:** Strengthen the operational efficiency of FNDA (National Fund for Agricultural Development) to better target farmers and effectively channel financing to a larger pool of agricultural actors and small and medium enterprises, with a focus on adaptation and mitigation measures: through (1) adequate subscription provisions; (2) greater flexibility of refinancing conditions; (3) higher financial education of actors; (4) development of the decentralized financing system; (5) development of an insurance scheme.	Medium	-	PB/CR Private sector participation possible
AG	**Policy action AG3:** Conduct feasibility study to understand financial and regulatory hurdles for the implementation of the hydro-land management in rural areas for agriculture use.	High	-	PB/CR
Agriculture (AG)	**Investment action AG1:** Operationalize the national strategy on sustainable agriculture (*biologique et ecologique*).	Medium	US$20 million (5 years)	PB/CR Private sector participation possible (10%)
AG	**Investment action AG2:** Invest in sustainable food production models by: (1) implementing appropriate climate-smart agricultural techniques in line with MAEP strategy on sustainable agriculture; (2) Invest/upscale efficient irrigation systems and water harvesting infrastructure in line with the strategy under preparation; (3) invest in agricultural mechanization.	High	(1) CFAF 1200 billion over 5 years (or 10% of 2023 GDP) (2) CFAF 500 billion over 5 years (or 4.8% of 2023 GDP)	PB/CR Private sector participation is required.
AG	**Investment action AG3:** Upscale agro-forestry on rural land, including through farmer-assisted natural regeneration.	Medium	-	PB/CR Private sector participation possible

AG	**Investment action AG54:** Promote value-addition through equitable structuring of value-chains, strengthening food safety and nutrition, and the quality and sanitary system of food.	Medium	CFAF 82 billion over 5 years (or 0.68% of 2023 GDP)	PB/CR Private sector participation possible
Water (W)	**Policy action WA1** – Conduct strategic assessment of groundwater resources including quantity and quality, geographical distribution and recharge capacity, and develop an action plan for exploitation.	High	-	PB/CR
W	**Investment action WA1:** Develop and operationalize a monitoring system for the use of water resources.	Medium	-	PB/CR
W	**Investment action WA2:** Invest in developing multifunctional hydraulic infrastructure and integrated water resource management through the continued implementation of the *Plan d'Action National de Gestion Intégrée des Resources en Eau* (PANGIRE); and construct 11 multipurpose dams in the Ouémé basin	High	US$646 million; US$60 million	PB/CR Private sector participation possible
W	**Investment action WA3:** (1) Protect catchment areas; (2) monitor and secure recharge areas; (3) implement specific schemes to facilitate preferential water infiltration through secured aquifer recharge areas, and the establishment of protection perimeters with regulated zones and zones declared non-constructible.	High	US$1182 million	PB/CR
Forest (FO)	**Investment action FO1: Resilient forest systems.** (1) Promote regeneration of 300,000 ha of forest cover to restore degraded lands; (2) strengthen early warning systems and fire risk monitoring; (3) promote agroforestry systems in 15% of all classified forests. Agroforestry systems are based on food crops, timber, fuelwood, native tree species or fruit trees, enhancing synergies with the agriculture sector to support food security, and livelihood improvement; (4) promote high economic interest sources of income from non-timber forest products (mushrooms, honey, shea, baobab) including with gender-specific angle.	Medium	(1) CFAF 450 billion (10 years) (2) CFAF 30 billion (10 years) (3): CFAF 20 billion (10 years) (4): CFAF 70 billion (10 years)	PB/CR Private sector participation is required
Build resilience to urban flooding, improve land and urban planning, invest in WASH and protect coastal areas				
Urban management (UM)	**Policy action UM1:** Promulgate the new building code, adopt the secondary legislation, and increase enforcement capacity of building codes/land use under consideration of gender equality principles.	Medium	-	PB/CR
UM	**Policy action UM2:** (1) Develop city master plans aligned with climate resilience standards in all municipalities (only 35/77 have one and some of these 35 plans need to be updated); (2) review the approval process for city master plans; (3) review the urban assets maintenance process, legislation and responsibilities; (4) ensure the representation of women across all relevant decision-making bodies and participation in consultation processes for developing city master plans.	Medium	-	PB/CR
UM	**Policy action UM3:** Develop a more sustainable funding mechanism for local governments, increasing transfers and potentially scaling-up the use of performance-based capital block grants — earmarked for climate resilience investments.	Medium	-	PB/CR
UM	**Policy action UM4:** Institutionalize a Metropolitan Area of Grand Nokoué.	High	-	PB/CR
FO	**Investment action FO1:** Expand program of urban reforestation.	Medium	-	PB/CR

Water (W)	**Investment action WA4:** Continue investments in urban sanitation and storm water management to effectively address flooding risks and ensure proper management of sewage sludge. These include investing in the following: - Cotonou rainwater sanitation - Storm drainage in secondary cities - Sanitation, management, and economic development of lakes and lagoons - Modernization of septage and wastewater management.	Low	US$ 1182 million (5 years)	PB/CR Private sector participation possible
Coastal management (CM)	**Investment action CM1:** Ensure 100% of the coast is protected against coastal erosion and flooding. (1) Establish national coastal early warning system (2) Periodically maintain (every 5 years) existing coastal protection works (3) Reinforce and maintain groins to the east of Cotonou (4) Protect the central coast at Avlékété (5) Establish other groins to protect identified hotspots, in response to the principle that erosion is transferred from west to east (6) Restore 2000 ha of mangroves in Ramsar sites 1017 and 1018 (7) Create an artificial breach in the mouth of the Mono river (8) Create a natural buffer zone in the extreme eastern part of the coast.	Medium/ High	(1) CFAF 1.8 billion (10 years) (2) CFAF 24 billion (10 years) (3) CFAF 53.2 billion (30 years) (4) CFAF 50 billion (30 years) (5) CFAF 50 billion (10 years) (6) CFAF 5 billion FCFA (10 years) (7) CFAF 10.9 billion (10 years) (8) CFAF 80 billion (10 years)	PB/CR
DRM	**Investment action DRM1:** Develop multi-risk mapping, early warning systems and the further use of digital information and tools with the aim of reaching all social groups, including women, rural residents and vulnerable populations.	Medium	-	PB/CR
Tourism (T)	**Policy action T1: Tourism**. Incorporate climate resilience into tourism through standards for constructing new projects.	Low	-	PB/CR
Invest in multimodal transport networks, asset management and planning, climate-resilient digital infrastructure and digital solutions				
Transport (TR)	**Policy action TR1:** Enhance planning of transport systems and include multimodal transport systems	High	-	PB/CR
TR	**Policy action TR2:** Incorporate climate-resilient design parameters systematically into the design of transport infrastructure. Pilot the implementation of nature-based solutions to increase resilience and reduce erosion.	Low	-	PB/CR
TR	**Policy action TR3:** Improve data availability and data/ transport planning systems and increase the capacity of relevant stakeholders to use and maintain these systems.	Medium	-	PB/CR
TR	**Policy action TR4:** The PAC and the other future ports should adopt a strategy to reduce coastal risks (erosion and inundation) and maintain the systems developed (dykes, spins, etc.).	High	-	PB/CR Private sector participation possible
TR	**Investment action TR1**: Develop a road asset management system for the more strategic allocation of resources to maintenance and modernization interventions. Benin should also develop a thorough criticality analysis of the road network to ensure that climate-related events do not disrupt links essential to agriculture and other economic activities.	Medium	US$2 million over 5 years	PB/CR
TR	**Investment action TR2:** Implement innovative grey infrastructure and nature-based solutions to increase resilience and reduce erosion, especially in critical areas such as the coast and port areas.	High	CFAF 70 billion (over 5 years)	PB/CR

Digital development (DD)	**Policy action DD1**: Install climate-proof ducts and civil works to protect digital infrastructure from climate shocks. This could be done by (1) strengthening construction norms and standards to make telecommunications infrastructure more resilient; and (2) defining policies and guidelines for a green digital infrastructure.	Low	-	PB/CR
DD	**Investment action: DD1**: Extend digital connectivity coupled with a better adoption of digital technologies	Medium	-	
Energy (E)	**Policy action E1:** (1) Ensure that the resilience to climate change of electricity generation, transmission and distribution infrastructures is analyzed at the design stage and that the measures identified are considered when the work is carried out; (2) and protect vulnerable sites.	High	-	PB/CR
E	**Investment action E1:** Improve the quality of electricity supply: invest in network infrastructure, including digitizing and compliance of the grid's operating network, to reduce the amount of unserved energy and the related losses in economic productivity. Investments in the distribution grid should include climate-resilience measures based on climate vulnerability assessments to protect against climate hazards.	Medium	US$ 650 million for grid electrification (transmission/ distribution). NB: this costing is larger than rehabilitation	PB/CR
Meteo	**Investment action: Meteo1:** Implement (1) the National Framework for Climate Services; and (2) the National Strategic Development Plan of Meteorology.	High	CFAF 10 billion; CFAF 8 billion (both 5 years)	PB/CR
Meteo	**Investment action: Meteo2:** Reinforce the resilience of local communities and local agricultural production systems through the delivery/communication/increased access of meteorological services at the local level.	Medium	CFAF 4 billion.	PB/CR

Table 4b: Summary of key policy options and investment actions for a resilient labor supply

Area	Action	Complexity*	Fixed cost (capital investment)	Expected financing sources
Strengthen the resilience of service delivery in health and education to protect human capital formation				
Education (EDU)	**Policy action: EDU1:** Strengthen climate change concepts in the education and training curricula; run environmental awareness campaigns, including planning schemes from elementary to tertiary schools; and implement policies for building schools resilient to floods, storms, and excessive heat	Medium	-	PB/CR
EDU	**Policy action: EDU2:** Strengthen collaboration and partnerships between sectors of education; and develop financing mechanisms targeting children, schools and regions most affected by the climate crisis.	Medium	-	PB/CR
EDU	**Policy action: EDU3:** Incorporate modules on agriculture, farming and the green economy in school curricula; enable girls to pursue education by tackling gender-specific barriers in access to schooling.	Medium	-	PB/CR
EDU	**Policy action EDU4:** Adopt a strategy for the education sector (primary, secondary and tertiary) that incorporates climate change considerations at all levels.	Medium	-	PB/CR
EDU/GG	**Policy action GG1:** Develop vocational training programs to encourage climate smart agriculture and green jobs and provide incentives for women to participate; support women to move into sustainable employment (e.g., in the honey and shea value chain).	Medium	-	PB/CR

EDU	**Investment action EDU1:** Accelerate development of resilient school and tertiary education buildings.	Low	-	PB/CR
Health (H)	**Policy action H1:** Develop a strategy for the health sector that integrates climate change.	Medium	-	PB/CR
H	**Investment action: H1**: Improve the resilience of the health system to climate change by building capacity of health personnel to diagnose, treat and manage climate-sensitive diseases.	Medium	-	PB/CR
H	**Investment action: H2**: Ensure the adaptation of health infrastructure, equipment, products and services: (1) increase surveillance and an early warning system, information and research on climate-sensitive diseases and an appropriate response; (2) put in place better financing mechanism for climate change-related health interventions; and (3) improve community-level preparedness and response plans to commission medicines and other important products and to raise community awareness.	Medium	-	PB/CR
H	**Investment action: H3**: Expand availability and accessibility of maternal, sexual and reproductive healthcare services for women and adolescent girls during and in the aftermath of climate-induced shocks.	High	-	PB/CR
H	**Investment action H5:** Reinforce gender-sensitive emergency preparedness. At the national level, the Public Health Emergency Operations Centre (PHOC) monitors the situation and has a mechanism for detecting and reporting events. An effort to strengthen the capacity of rapid response teams to respond to public health emergencies has been made at central, intermediate and local levels as part of the response to the COVID-19 pandemic.	Medium	-	PB/CR
Water (WA)	**Investment action WA1:** Implement WASH interventions and improve access to drinking water through the following programs: - Universal Rural Water Access Program - Universal Urban Water Supply Program	Medium	USD 1.6 billion	PB/CR
WA	**Investment action WA2**: Operationalize the WASH national strategy particularly by focusing on reducing open defecation.	High	-	PB/CR

Chapter 4.

Mitigation can avoid carbon lock-in and create opportunities for inclusive growth

Chapter 4: Mitigation can avoid carbon lock-in and create opportunities for inclusive growth

4.1. The energy transition presents an opportunity for a less carbon-intensive development path

Most emerging and developing economies need to find the right balance between development needs and a lower carbon path. Benin emits only 0.05 percent of global GHG emissions. With a growing population, rising GDP per capita levels, and the expansion of progressively more energy-consuming economic activities, such as manufacturing and higher-value added services (e.g., data centers), the energy transition remains nonetheless a key question for Benin. How much should fossil fuels drive energy expansion? What are the costs of investing earlier in renewable energy? What are the potential co-benefits of the energy transition?

4.1.1. Achieving universal access to electricity is the primary goal of Benin's energy sector

In 2022, the government established a National Electrification Strategy (SNE) which aims to achieve universal access to electricity by 2030. More than half of the population lacks access to electricity, limiting the capacity of both firms and households to invest in human capital, improve wellbeing and participate in productive activities. In 2021, the national electrification rate was only 36.5 percent,[96] but this hides wide disparities between access rates in urban (59.2 percent) and rural areas (6.5 percent). Poor transmission and distribution infrastructure, and high costs of supply to remote areas, are among the biggest hurdles for extending grid-based electricity.

Benin's electricity sector needs ambitious growth to achieve universal access. Demand is expected to grow at an annual rate of 6.4 percent, reaching 4,199 gigawatt hours (GWh) in 2030 and 7,930 GWh by 2045 (from 2,010 GWh in 2021).[97] This will more than double the total demand on the SBEE (*Société Béninoise d'Energie Electrique*) network (x2.2). For the period 2021-2030, the annual growth rate is predicted to be 9.2 percent due to the ambitious electrification campaign and the increase in the SBEE customer base. Strong growth in demand is expected outside the major urban areas as rural areas electrify and increase their share of total demand from 5 percent in 2020 to 19 percent in 2045. Most of the increase will be on the low and medium voltage network serving households and administrative buildings.[98] Peak annual demand in 2045 is expected to be 1,331 megawatts (MW), adding to the need for electricity generation during evening peak hours.

4.1.2. Generation expansion is expected to increasingly rely on renewable energy

Major investment in generation infrastructure will be required to ensure that the power sector is able to meet the country's growing demand for electricity. The Benin Least-cost Electrification Master Plan (2021) which supports the SNE expects that by 2030, 76 percent of the population will be connected to the SBEE electricity grid, 15 percent connected via mini-grids and 9 percent via solar home kits. Achieving the objectives of the SNE will require a total investment of around US$1.1 billion over the ten-year period (or 5 percent of 2022 GDP), including US$650 million for grid electrification (investment in transmission and distribution), US$340 million for mini-grids and US$60 million for solar home systems.

Benin has the advantage of starting with a relatively low-emissions power sector. It is crucial that the sector progressively reduces the need to use fuels like coal and heavy fuel oil in the future, as they have high emissions and are potentially expensive. In 2021 the electricity mix shifted to 53 percent from domestic generation (100 percent thermal generation from natural gas) and 47 percent from imports – from Communaute Electrique du Benin (CEB), Ghana and Nigeria. With the Maria-Gléta natural gas power plant reaching full capacity in 2021, the government has successfully completed the phase-out of high-emission fuels such as heavy fuel oil. The domestic generation mix will change in the short-term, with 225 MW of solar photo-voltaic (PV) in the process of progressively coming online. In 2021, the sector emitted 1.155 kTon of CO_2, with an average emission factor of 0.575 kTon CO_2eq/GWh. Renewable energies accounted for just 2 percent of the energy mix.

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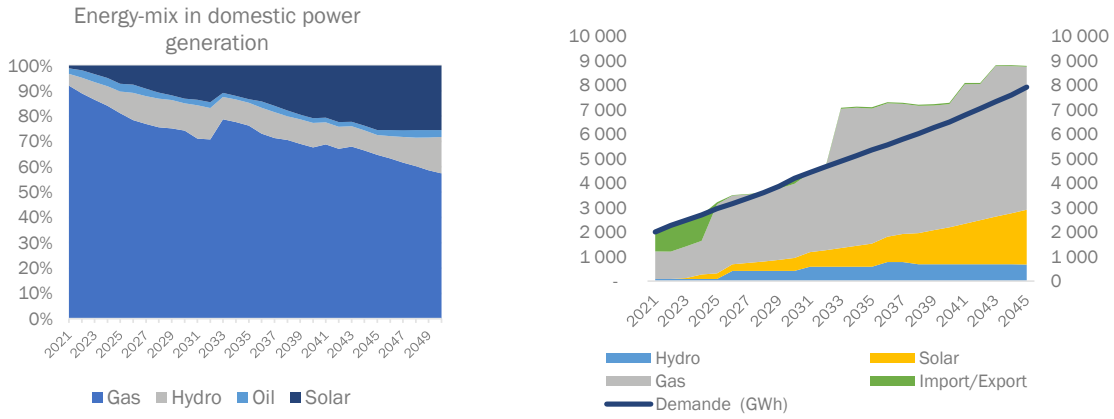
96 ESMAP monitored statistics place access at 42 percent in 2018 but we will use annually produced statistics by the Ministry of Energy – *Rapport du Système d'Information Energetique du Benin 2021*.

97 According to the reference scenario of the Electricity Sector Master Plan, approved by the government in December 2021.

98 The high-voltage network, which serves heavy industry, should see more limited growth, accounting for just 5% of demand in 2045. Power plants, which are expected to fall to 16%, account for the remainder of total demand.

To meet demand the government expects to progressively increase the share of renewable energy in the energy mix as it expands production (Figure 21). The target established in the Renewable Energy Policy (PONADER) is to reach between 20-30 percent of renewable energy penetration in the energy mix by 2035 and achieve a 7.8 percent reduction in CO_2 emissions by 2045. Renewable energy development is expected to come from the construction of a series of hydroelectric dams as well as photovoltaic solar power. This plan will increase renewables to 33 percent of the energy mix by 2045, with total system emissions of 3,210 kTon CO_2. The system's emission factor will decrease to 0.365 kTon CO2eq/GWh.

Figure 21– Renewables will make up a growing share of domestic power generation (left graph), and including import/export (right graph)



Sources: Authors' calculations based on the SNE and Energy Master Plan.
Notes: left figure depicts the energy mix used in the baseline for the CGE model.

Achieving this expansion in renewable energies will require significant investment. Overall, production expansion plans for 2045 will require financing of around US$2.6 billion (or 15 percent of 2022 GDP). Major hydroelectric projects are scheduled for 2026 (Dogo-Bis, 128 MW), 2031 (Vossa, 60 MW) and 2036 (Bétérou, 19 MW). Dogo-Bis is currently planned as mixed financing. The track record of private investment in hydropower in Africa indicates that this will be a challenge, requiring careful planning. Vossa and Bétérou could follow the same financing concept if successful. Additionally, hydropower requires thinking about resilience to climatic risks (Box 5). The planned hydroelectric plants alone will not be sufficient to meet PONADER's renewable energy target. Solar energy is expected to be the fastest-growing source of generation in Benin, with a baseline of 1.4 GW of solar installations and US$1.1 billion of investment required. There are currently only four solar projects in the pipeline (Defissol, Kandi and the Millennium Challenge Account, or MCA, plant). Only the MCA plant is financed as an independent power producer (IPP). The absorption capacity and stability of the power grid will be crucial elements to consider.

Only falling costs of solar photovoltaics can accelerate the deployment of solar power, which will require improving the quality of the distribution network. The Least-cost Master Plan also envisions a scenario with a faster acceleration of solar power. In this scenario, renewables would achieve 44 percent of the energy mix (excluding hydropower) by 2030. The balance between supply and demand is ensured until 2028 by a high use of thermal power, which is gradually reduced until it becomes non-existent by 2045 when all thermal power plants reach the end of their service life. In this scenario, by 2040, solar power could provide 100 percent of the midday electricity mix, and any additional generation beyond that would be available for export to the West Africa Power Pipeline (WAPP) grid.[99] However, this would require even more significant investments – not only in PV energy, but also in improving the quality of the distribution network as existing electricity grids do not allow for the injection of more than 30 percent of peak demand into the grid. Investment costs would increase substantially, from EUR 2.8 billion to between EUR 4.3 and 6.2 billion, depending on whether a storage option is also included. This scenario would reduce emissions from gas-based power generation by 30 percent on average compared to the baseline. Higher investment costs however would have a very small but negative impact on GDP until 2035. They would also require crowding out other sectoral investments.

99 https://www.ecowapp.org/

Box 5 – Climate change risks to infrastructure could hinder universal access

Hydro dams are significantly vulnerable to climate change. Preliminary feasibility studies show that in dry years over the period 2026-2030, the Dogo-Bis dam can expect its production to fall from an average of 399 GWh/year (a capacity factor of 32%) to 42 GWh per year (a capacity factor of 4%). As the Vossa and Bétérou dams are to be built further upstream, improved water management would increase the dry-year capacity factor to 16% in 2040. Nevertheless, significant variability in hydroelectric reservoirs and production can be expected, and climate-induced drought could increase this risk, which will also affect the agriculture and water and sanitation sectors.

The SBEE network is also vulnerable to climatic hazards. A climate vulnerability and resilience study revealed that flooding, extreme temperatures and forest fires present the main climate risks for the distribution infrastructure. Mapping of forest fire and extreme temperature risks shows that, on average, 510 km of medium-voltage distribution lines will be vulnerable to the projected average risk of forest fire. The risk of forest fires and extreme heat also increases the cost of maintaining distribution lines and reduces their efficiency. Flood risk can disrupt service quality, with flood-risk mapping showing that, on average, 588 km of medium-voltage lines will be affected by average climate-related flood risks.

4.1.3. The co-benefits of renewable energy use could be sizeable

Co-benefits from a greener energy mix would mostly accrue in three sectors: telecoms, agriculture and water management, and transport. Each is outlined below.

Telecommunication sector: Digital technologies can help boost the use of renewables

A greener energy grid could reduce the negative externalities of ICT expansion. The rapid increase in ICT penetration in recent years is often associated with greater dependence on fossil fuels for electricity and has thus implied greater energy consumption and GHG emissions. Benin performs well on a regional level as the bulk of its sites are greenfield and are connected to the grid. Between 60 to 82 percent of each Mobile Network Operator's sites (MNO) are greenfield and between 60 to 80 percent of all sites have access to the grid. However, there is still room for improvement, as 20 to 40 percent of mobile sites do not have access to a reliable grid. Energy consumption is higher for mobile than fixed technologies due to the power requirements of radio links, but the introduction of innovative technologies could increase energy efficiency. According to the World Bank's "Green Telco" report, the adoption of modern technologies such as 5G and fiber optic could increase the energy efficiency ratio of previous technologies such as 3G and copper-based networks by a factor of 10. To decrease emissions from the sector, the government could implement new regulatory measures. This could be done by evaluating the energy consumption rates and optimal methods for telecommunication networks and equipment, and then setting (i) restrictions on their energy consumption; and (ii) guidelines to promote the use of green energy in the sector.

Digital technologies could support climate change mitigation in the energy sector by facilitating the transition to RE, enhancing energy efficiency, and enabling demand-side flexibility. Digital technologies are at the core of smart grids and allow various electrical network equipment to exchange information with each other in real time, thus maximizing the efficiency of the network. Smart grids enable the reduction of GHG emissions by (i) reducing power losses; (ii) introducing renewable energies on a large scale and promoting their efficient use; and (iii) allowing grid users to become producers by reselling the excess of green energy produced.

Agriculture and water management will benefit from multifunctional hydro power and e-agriculture

Multifunctional hydropower dams can have a significant impact on agriculture and water resources management. The three dams mentioned above are planned as a cascade system on the Ouémé River and will be multifunctional, supporting irrigation, and water and sanitation activities in addition to power generation. Around half of the net economic benefits are expected to be for agricultural activities, with the remaining 40 percent and 10 percent from power generation and the water and sanitation sector, respectively.

Greening the energy mix would also support the use of digital technologies for agriculture. A report by the Goblal e-Sustainability Initiative (GeSI) suggests that at the global level, smart agriculture could boost yields by 30 percent and make farming more sustainable by lessening reliance on water and reducing deforestation.[100] Smart agriculture makes farming more efficient through techniques like geographic mapping, sensors, machine to machine (M2M) connectivity, data

100 [45] Global e-Sustainability Initiative (2015). #SMARTer 2030, ICT Solutions for 21st Century Challenges.

analytics and smart information platforms. The government could promote the use and expansion of these technologies. Technologies vary depending on the size of the farm, from obtaining basic weather information with a mobile phone to deploying smart sensors and data analytics platforms to monitor and automatically adjust the provision of water or crop inputs or prevent and monitor crop diseases.

Decarbonizing the transport sector would reduce negative externalities

Transport emissions are increasing, driven by growing urbanization. GHG emissions from road transport in Benin multiplied by six between 2000 and 2021. While Benin's per capita transport emissions remain well below the regional average, they are increasing. Relatively low taxation and parafiscal levies on individual transport, unsuitable and poorly maintained infrastructure and the small share of asphalted roads (14 percent in Cotonou in 2019), have pushed people towards individual motorized transport, in particular two-wheeled motorized vehicles that are privately owned, or operated as informal and poorly regulated cab services. Nearly 73 percent of Cotonou's vehicle fleet is made up of two- and three-wheelers. This situation contributes to a high number of accidents, as well as to air pollution, aggravated by poor fuel quality (85 percent of fuel is imported informally from Nigeria). Past attempts to create regular urban public transport services have failed, among other reasons, due to high fares, unreliable and infrequent services, excessive and highly variable journey times, the absence of well-organized stops to promote intermodal travel, and the sprawl of Benin's conurbations in general and Greater Cotonou in particular (Abomey-Calavi, Ouidah, Sèmè-Podji and Porto-Novo).

Modernizing the public transport system is a key step to reduce urban transport GHG emissions and improve air quality. The modernization of the public transport system, involving high-capacity transport modes and better organization of the paratransit sector, is key to mitigate the negative environmental impact of urban transport such as GHG emissions and air pollution. The government has endeavored to reform the public transport sector, but significant challenges lie ahead. The NDC prioritizes three projects to promote the energy efficiency for the transport sector: (i) the development of road infrastructure to reduce congestion; (ii) the creation and implementation of a strategy and action plan to improve mobility in the medium and long term in the greater Cotonou region and neighboring localities; and (iii) the development of river-lagoon transport with the establishment of a service between Calavi and Cotonou, followed by Cotonou and Porto-Novo.[101] Improving urban mobility in the Greater Nokoué is also planned through establishing a formal public transport system, and converting the *zemidjans* fleet to electric vehicles. This would help mitigate emissions from the transport sector, but depends on having a green energy grid. The benefits of an integrated public transport network (potentially utilizing high-capacity bus systems) in the Grand Nokoué region are currently being assessed. An action plan has also been established to deploy a diesel-electric light train network for interurban transport. Another opportunity lies in the development of a motorization management plan to manage motor vehicle flows throughout their lifecycle to support the economy in a sustainable concern.[102]

Promoting public transport, e-mobility, low-emission transport systems and innovation will help mitigate the direct impact of greater demand for mobility. Urban transport could benefit from mass transit (including the use of inland waterways, intercity rail and high-capacity bus systems) and improved shared mobility for the last mile connectivity. The development of an e-mobility-friendly framework to encourage private investment in the e-mobility industry will accelerate the penetration of electric vehicles in Benin – both for private vehicles and public transportation. It is critical to put policy and financial incentives in place to promote the transition to electric mobility and encourage the shift to cleaner fleets. Promoting and facilitating the development of e-mobility start-ups will help innovative solutions to emerge. For example, an agreement has been signed with the Government of Benin to produce electric vehicles in the Glo-Djigbé industrial zone, near Abomey-Calavi. In 2021, an Indian company established its electric mobility business in Africa, notably in Togo and Benin. In May 2022, the first two models of electric bicycles adapted to the African market were launched.

101 A study of the feasibility of waterways public transport was conducted in 2008 and updated in 2013 in line with the PAG I. The estimated cost of this technology is CFAF 60,857 million over a 7-year period. The study forecasted the deployment of a fleet of 20 boats with a capacity of 217 passengers/ride to reach 7,923,000 passengers/year on the two lines (3,657,000 passengers on the Cotonou-Porto Novo line and 4,266,000 passengers on the Calavi-Cotonou line). A reduction of 8,074 tCO_2eq/year was projected.

102 World Bank Group (2021). Motorization Management and the Trade of Used Vehicles.

4.2. Mitigation can bring about new opportunities for forests and land use

To reduce carbon emissions from land use, deforestation rates will need to slow in the short term and stop entirely in the long term, driven by continued investment in sustainable forest management. Reforestation on previously forested land, and conservation of protected areas, are some of the most practical and cost-effective ways of sequestering and storing carbon. According to Benin's updated NDC (2021),[103] reducing deforestation by at least 58 percent[104] while investing in reforesting 15,000 ha per year would help achieve 60 percent of the country's national emissions reductions up to 2030 (24.53 Mt CO_2-eq). The government aims to reforest at least 150,000 ha of degraded lands through natural forests, as well as timber and fuelwood plantations on degraded forest lands. High biodiversity areas, particularly in protected areas, are essential carbon sinks, helping reduce the magnitude of climate change. Protected savanna ecosystems have the highest total carbon stocks stored of all other land uses.

A proactive policy is needed for the use of firewood to meet the energy needs of the population. Much of the forested area is used for fuelwood and charcoal production, which together support 46 percent of national energy consumption. The total quantity of fuelwood harvested amounted to over 3 million tons in 2020, but annual wood energy production subject to tax and royalty collection was only around 85,000 tons of charcoal and 40,000 steres of firewood, indicating significant governance challenges. The transfer to clean fuels (see below) will only be gradual, and with increasing population pressure fuelwood and charcoal will remain a source of energy for several years to come. Meanwhile, demand for wood will continue to grow, increasing pressure on forest resources. Based on the natural potential of fuelwood species, about 18,000 hectares of fuelwood plantations could meet 30 percent of the wood-energy demand from the eight main urban centers.[105] The fuelwood and charcoal value chains will need to adopt more efficient carbonization methods, and highly degraded forest areas restored with fuelwood plantations, among other measures.

The large-scale reforestation aims included in the Government's Forest policy (2023-2032) will need to be accompanied by a sustainable fuelwood strategy. Given the reliance on fuelwood in the coming years, the national forest policy includes large-scale reforestation targets for fuelwood production. However, the development of a fuelwood strategy can help the sector to further strengthen its gaps and increase synergies with other sectors for efficient and sustainable production. The Energy Ministry's PONADER strategy also aims to increase efficiency through the promotion of dedicated technologies, developing fuelwood plantations, and improving institutional cross-sectoral coordination among relevant ministries involved in the sub-sector. The strategy also takes into account the ECOWAS Energy Efficiency Policy (PECC) for universal access to safe, clean, affordable, efficient and sustainable cooking by 2030. Similarly, there are several other strategies which promote sustainable and efficient frameworks for the use of renewable energies and biomass. These include the National Action Plan on Renewable Energy (*Plan d'Action National sur les Énergies Renouvelables*, or PANSER) 2015-2020/2030;[106] the National Strategy for Sustainable Biomass Energy (*Stratégie Nationale pour une Biomasse Énergétique Durable* - SNBED);[107] and the National Energy Efficiency Action Plan (PONAME) 2015-2020/2030.[108] The PONAME and PONADER also include standardization and labeling for energy equipment, including clean cookstoves, to meet ECOWAS and international standards.

A transition to clean cooking is needed to improve indoor air quality, take the pressure off forests and improve women and girls' well-being. Only 4.6 percent of Benin's population has access to clean cooking fuels and technologies;[109] the rate being 7.7 percent in urban areas[110] and 1.4 percent in rural areas. The use of clean fuels and modern technologies is essential to reduce household air pollution, protect public health, and benefit women and girls, who perform most of the housework, and spend more hours than men within the home.[111] The health impact of household air pollution is estimated at US$8.3 billion from deaths and disability adjusted life years (DALYS).[112] Household air pollution from cooking smoke is responsible for around 9,890 premature deaths and 562,100 DALYs every year.[113] The gender impact associated with the time spent performing cooking-related tasks, such as collecting fuel, cooking, and cleaning stoves, as well as lost productivity, is estimated at US$2.6 billion. To improve fuelwood production and reduce household dependency in

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103 Government of Benin (2021). Nationally Determined Contribution. Benin's Updated Contribution to the Paris Agreement.

104 From 60,000 ha to 35,000 ha per year according to Benin's NDC (2021)

105 Cotonou- Abomey-Calavi, Porto-Novo, Lokossa, Bohicon-Abomey, Parakou Djougou, Natitingou and Malanville.

106 Ministry for Energy (2015). Plan d'Action National des Énergies Renouvelables (PANER), Période 2015-2020/2030 {National Renewable Energy Action Plan].

107 Ministry for Energy (2020). Plan d'Action National de la Bioénergie du Benin 2020-2030 [Benin's National Bioenergy Action Plan].

108 Ministry for Energy (2015). Plan d'Action National d'Efficacité Energétique (PANEE) [National Energy Efficiency Action Plan].

109 Tracking SDG 7 (2023). Benin Country Report. Retrieved 5 July,2023 from: https://trackingsdg7.esmap.org/country/benin

110 World Bank (2021). Access to clean fuels and technologies for cooking, urban (% of urban population), Benin.

111 Regional evidence shows that the use of clean cookstoves is associated with a lower number of smoke-related health issues for women, reduced women's time spent on domestic work and increased women's participation in the waged work outside home (Khatiwada, 2009).

112 The total cost of inaction on Benin's clean cooking agenda has been estimated at US$11 billion, or about 63% of its annual GDP, based on the negative externalities for health, women, and climate.

113 Health Effects Institute (2020). State of Global Air 2020. Data Source: Global Burden of Disease Study 2019.

the short term, the government aims to distribute improved cookstoves to around 800,000 new households; promote access by 275,000 new households to cooking equipment using domestic gas; and provide subsidies for domestic gas consumption to meet at least 30 percent of the cost of refilling.

Achieving universal access to modern energy cooking services (MECS) by 2030 would require significant investment, but co-benefits would be large. Investments would include the expansion of modern fuels like liquified petroleum gas (LPG), biogas and solar energy which are considered clean, efficient, convenient, safe, reliable, and affordable. The universal adoption of MECS would in turn bring about significant estimated co-benefits.[114]

Developing carbon financing infrastructure for forest production and conservation offers a high-value opportunity to increase and conserve carbon stocks, and reverse deforestation. A key measure to achieve and fund climate-resilient and climate-neutral development is to increase access to climate finance, including international carbon markets. To support this, in the context of Article 6 of the Paris Agreement, Benin adopted two decrees in December 2022 on the modalities for registering projects to access carbon credits managed under the MCVT and the Ministry of Environment and Forests (MoEF). These key regulatory building blocks will ensure the country's participation in international carbon markets and help to support a low-carbon economy. The forestry sector offers a high-value opportunity to obtain carbon credits, which would help to create jobs and grow the national economy, while also increasing and conserving carbon stocks. This would also be an entry point for the private sector to support climate investments in the country. Furthermore, with co-management structures in place, it lays the groundwork for REDD+ programs and other carbon voluntary markets (Box 6). However, the technical and institutional capacities of the authorities and stakeholders involved will need to be strengthened to enable Benin to reap the benefits of carbon markets. For example, national measurement, reporting and verification (MRV) systems would need to be improved for its GHG inventories and mitigation assessments, and forest reference levels would need to be established and forest monitoring strengthened.

Box 6 – Benin's high-value agroecological and forestry services

The total value of agroecological services for building resilience in forest reserves was estimated to vary between $2,229 million and $5,155 million, covering 1.29 million hectares.[115] Based on the total forest area and investment actions planned in the classified forests and protected estate domain by 2030, at least 177 million tons CO_2-eq will be sequestered for the forestry sector alone by 2050. An assessment of agroecosystem services estimated a value of $3,700 per ha in subequatorial regions, which showed to be 2–3 times of greater value than for the same services estimated in tropical regions in the country ($1,600 per ha).[116] With Benin's improved landscape management approaches, including sustainable agricultural practices, agroforestry and forestry systems have the potential to receive future performance-based carbon payments. Examples from elsewhere in SSA include Mozambique and Ghana under the REDD+ program, supported by the World Bank Forest Carbon Partnership Facility. Mozambique's Zambezia Emission Reduction Program received its first payment of US$6.4 million in November 2021 for reducing 1.28 million tons of carbon emissions since 2019. More recently, Ghana received its first payment in January 2023, totaling US$4.8 million, for reducing nearly 1 million tons of carbon emissions through sustainable cocoa forest landscape approaches. Both countries are set to receive four planned payments of up to US$50 million each for reducing 10 million tons of carbon emissions through 2024.

4.3. Key policy options for mitigation action

Table 5 summarizes the key policy and investment options for benefitting from the opportunities offered by a lower-carbon path identified in this chapter. The actions are organized by sector, and by whether they are policy actions – which are regulatory/institutional in nature – or investment actions, which require hard investment (e.g. construction, an operational budget, etc). Complexity levels were defined together with government counterparts through an inclusive consultation process, considering the feasibility, presence in government strategic documents, budget plans, and political economy. Cost of action includes cost of capex of investment needs over 5-10 years for project development, but most of the time excludes variable costs (operation/maintenance). They are indicative based on the most recent available information and from exchanges with government counterparts. "Expected financing source" indicates the most likely source of financing.

114 Across three impact areas: health (S$1.1 billion), gender (US$6 million) and climate (US$1 million).

115 World Bank (2023).

116 Djihouessi et al. (2022).

Table 5: Summary of key policy options and investment actions for mitigation and co-benefits

Area	Action	Complexity	Fixed cost (capital investment)	Expected financing sources
The energy transition presents an opportunity for a less carbon-intensive development path				
Energy (E)	**Policy action E1:** Implement the least-cost plan through generation planning principles and competitive procurement and ensure regular updates.	Low	USD 1.1 billion in generation investment or 0.01 percent of 2023 GDP	Public budget (PB)/concessional resources (CR) Private sector participation for implementation is a requirement
E	**Policy action: E2:** PONAME implementation: Develop investment plans or technical assessments for each of PONAME's programs.	Medium	-	PB/CR
E	**Policy action: E3**: Strengthen support for productive use of electricity by (1) developing a lending policy framework and capacity to finance productive use appliances and equipment that will help boost electricity consumption and productivity, including in the agriculture sectors; (2) subsidizing clean cooking appliances in large cities.	Medium	(2) US$ 5 million or 0.08 percent of GDP 2023 (NDC)	PB/CR
E	**Investment action E1:** Continue to implement the connection charge policy.	Low	-	PB/CR
E	**Investment action: E2:** Create a favorable investment climate by preparing the SBEE to manage the technical challenges of VRE and BESS integration. This could also include developing a feed-in-tariff study for distributed solar PV.	Low	-	PB/CR
E	**Investment action: E3:** Realize the investments required under the 2022 National Electrification Strategy to achieve universal electrification by 2030.	Low (Medium for financing needs)	Over the next 10 years: US$ 650 million for grid electrification (transmission and distribution investments), US$ 340 million for mini-grid systems and US$ 60 million for solar home systems	IPPs/PPPs PB/CR Private sector participation is a requirement
E	**Investment action: E4:** Implement the National Strategy on Clean Cooking to achieve universal access.	Medium	CFAF 9.2 billion for 5 years or 0.8 percent of GDP 2023	PB/CR
Transport (TR)	**Policy action TR1:** Develop a clean mobility strategy for the country	Low	-	PB/CR
TR	**Policy action TR2**: Increase regulation and control of imported vehicles, standards for vehicles on the roads (adopt decrees and laws, WAEMU standards and increase controls on highly frequented roads)	Low	-	PB/CR
TR	**Policy action TR3:** Encourage e-mobility private investments through a friendly framework, analyze financing possibilities and schemes.	Low	-	PB/CR
TR	**Investment action TR1:** Rehabilitate and modernize public road transportation (light public transportation)	Low	Public road transportation in Grand Nokoué area~US$250million) Develop waterways transport: CFAF 60,857 million Interurban railway network: 85,284 million CFAF Period of 10 yrs	PB/CR Public sector participation is a requirement

Mitigation opportunities for forests and land use				
Forest (FO)	**Investment action FO1: Resilient forest systems.** Reforest 150,000 ha of degraded forest lands through timber and fuelwood plantations, supporting 60 percent of the country's reduced GHG emissions.	Medium	CFAF 250 billion or 2 percent of 2023 GDP (over 10 years)	PB/CR Private sector participation is possible
FO	**Policy action FO1:** Develop and implement participatory forest management plans in all classified forests and forests in the protected estate domain.	High	-	PB/CR Private sector participation is a requirement
FO	**Policy action FO2:** (1) Create and manage new national parks, marine protected areas, and biodiversity reserves through community-based approaches; (2) strengthen the management of national parks comprising an area of 830,000 ha.	Medium	(2) CFAF 50 billion (10 years)	PB/CR Private sector participation is possible
FO/FIN	**Policy action FO3:** (1) strengthen forest MRV data, establishing reference levels to support enabling environment for participation in carbon markets; (2) adopt sharing guidelines for carbon sequestration benefits; (3) reinforce institutional capacity of actors in the sector.	Medium	CFAF 10 billion (10 years)	PB/CR
FO	**Policy action FO4:** (1) Expand and develop rural fuelwood markets in the most important areas of uncontrolled exploitation; (2) develop alternative sources of biomass; (3) develop systems of high-return carbonization.	Medium	(1) CFAF 10 billion (10 years)	PB/CR Private sector participation is a requirement
FO	**Policy action FO5:** Introduce a system of labeling and testing standards and protocols to ensure adequate stove and fuel performance and provide targeted incentives to promote a localized supply chain.	Low	-	PB/CR

Chapter 5.

Protecting the poor and vulnerable

Chapter 5: Protecting the poor and vulnerable

Benin's vulnerable populations and households will face disproportionate risks from climate change, potentially delaying a sustained economic transformation. The negative impact on human capital accumulation and labor productivity – particular in outdoor sectors such as agriculture – could be large if no action is taken, with significant potential implications for sustaining Benin's growth path and structural transformation of the economy. Building a resilient labor supply requires adequate safety nets to ensure that all segments of the population can participate actively in quality labor markets.

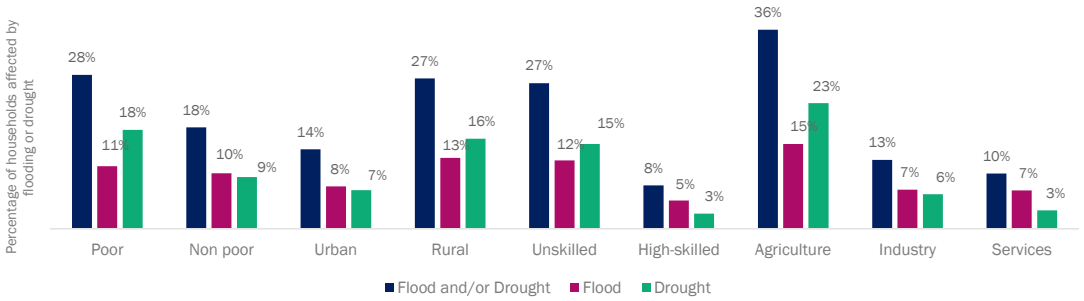
5.1. The poor, rural dwellers, and women will be worst affected by climate change

5.1.1. Climate-induced shocks are already impacting vulnerable households

Climate-induced shocks are already affecting households in Benin. Overall, over one-fifth of households (21.4 percent) reported being affected by a climate-induced shock over the previous three years, with about 10.5 percent of households reporting being affected by floods, and 12 percent of households impacted by droughts (EHCVM 2018/19).

Poor, rural, agriculture-reliant households are most vulnerable to climate-induced shocks. Poor households are most likely to report being affected by drought. Households reliant on agriculture are also more likely to be affected by drought (22.8 percent) than by floods (15.4 percent). Over 36 percent of households reliant on agriculture reported being affected by a flood and/or drought, which is well above the share of the overall population affected by these shocks (21 percent). Finally, rural households reported being affected more than urban households by both flooding and drought (Figure 22). Households in different regions tend to be affected by different types of climate shock. For instance, floods are more prevalent in Alibori, Littoral, and Mono, whereas droughts are more common in Atacora, Couffo, Plateau and Zou.

Figure 22 – Poor, rural, agricultural-reliant households are already affected by climate shocks



Source: ECHVM 2018/19. Notes: Calculations done at the household level using household level weights. Sociodemographic categories such as skill level and employment sector pertain to household head.

The structure of the labor market explains the vulnerability of Beninese households to shocks, as formal jobs account for less than 10 percent of employment. As in many lower-income countries, both women and men are predominantly employed in the informal sector, although in Benin the proportion of women working informally is higher: 95 percent vs 86 percent of men.[117] Similarly, the informal sector is more important in rural areas than in urban areas (a 10-percentage point difference). The prevalence of informal employment creates significant vulnerability for workers in times of shocks. The dependence of Benin's economic structure on agriculture and informal employment makes its development pathway particularly vulnerable to climate change in the absence of proper adaptation.

Agriculture contributes up to 85 percent of rural households' income, increasing their vulnerability to climatic shocks. Approximately 44 percent of Benin's population is engaged in agriculture, which constitutes the main source of livelihoods for poor, rural households (ECHVM 2018/19). Over 77 percent of rural households belonging to the lowest wealth quintile participate in agricultural activities, compared to 38 percent from the highest wealth group.[118] Rural agricultural production is heavily oriented towards own consumption (more than 80 percent of total). Even so, agriculture contributes up to 85 percent of rural households' income.

117 World Bank (2022). Benin Country Economic Memorandum 2.0.

118 World Bank (2022). Benin Poverty Assessment: Pathways to Better Well-Being.

Agricultural households, and particularly women farmers, face several constraints which reduce their resilience to shocks. Limited access to markets, productive assets, land ownership, and poor road infrastructure are among the main constraints faced by agricultural households.[119] Only six percent of rural households report receiving credit for agricultural activities. Formal agricultural land ownership is also low, with a 22-percentage points gender gap. Overall, only 3.9 percent of women claim agricultural land ownership, compared to 25.9 percent of men. The gender gap is particularly pronounced among individuals from the bottom two quintiles (37.8 percent of men compared to 5.3 percent of women) (EHCVM 2018/19). Women also have lower access to quality employment: 94 percent of women are engaged in self-employment compared to 83 percent of men.[120] Moreover, women are less protected from a shock which affects their livelihood, and more likely to lose their livelihood as a result.[121] Women working in agriculture are likely to be among those most negatively impacted by climate change.

The two main mechanisms used by households in response to climate shocks are accessing savings and relying on social networks. Almost half of the households exposed to climate change shocks relied on their own savings to cope with the negative effects (Table 6). Other coping strategies include help from relatives or friends, changing consumption habits, and buying cheaper food. Compared to flood-affected households, drought-affected households are more likely to turn to selling livestock, obtaining credit, selling food stores, selling agricultural assets, or seeking additional employment. Climate-induced shocks can also have important consequences for adolescent girls, such as increased risks of child marriage and related early pregnancy, school drop-out and intensive involvement in paid and unpaid work activities.[122]

Climate change threatens to reinforce gender inequalities. Coping mechanisms in response to shocks often penalize girls more: parents who have experienced loss of livelihoods and incomes due to climatic hazards and environmental degradation often expect their children to contribute to the family income and/or take on more household chores, thus forgoing their children's education. Families are likely to resort to early marriage and child labor, which contribute to school drop-out, especially by girls. Women also typically have fewer coping strategies in the face of a shock than men. This is due to several factors, including a lack of assets, higher poverty incidence, perceived gender roles, weaker engagement in civil society leading to lower social capital, and greater employment vulnerability. A study of the gender-specific responses to climate variability in Benin[123] finds that male and female farmers share similar perceptions of climate change and adopt similar immediate response strategies to increase agricultural production. Women, however, are highly vulnerable as men are the primary decision makers in the household and often migrate away from it in the event of a shock, leaving women with an increased burden of agricultural and household responsibilities. Other studies have found that women are more likely than men to be forced to adopt negative coping strategies, such as skipping meals, in response to a shock.[124] In addition, children with disabilities and special needs are at greater risk in humanitarian emergencies and are more likely to suffer discrimination, with girls with disabilities particularly vulnerable to exploitation.

Table 6. Drawing on savings is the most common strategy for coping with climatic shocks in Benin

	All households	Drought-affected	Flood-affected
Use of savings	49.3 %	37.3 %	36.4 %
Help from relatives or friends	27.6 %	10.2 %	19.8 %
No strategy	22.1 %	22.3 %	18.8 %
Buy cheaper food	11.9 %	6.5 %	6.5 %
Changing consumption habits (number of meals, quantity consumed, etc.)	11.9 %	6.7 %	8.6 %
Livestock sale	8.2 %	6.7 %	3.8 %
Obtaining credit	6.9 %	5.1 %	2.4 %
Sale of food stock	5.9 %	4.5 %	3.2 %
Reduced health/education spending	2.7 %	1.3 %	1.6 %
Sale of agricultural assets	2.2 %	2.0 %	1.1 %
Government/state aid	1.6 %	0.1 %	1.8 %
Practice of off-season cultivation	1.3 %	2.5 %	2.7 %
Active hh. members seek additional employment	1.2 %	3.4 %	1.3 %
Migration of household members	1.2 %	0.8 %	2.5 %

Source: ECHVM 2018/19.
Notes: *Please note columns do not add up to 100 percent as respondents could select more than one coping option.

119 World Bank (2022). Benin Poverty Assessment: Pathways to Better Well-Being..

120 World Bank (2019). World Development Indicators. https://datatopics.worldbank.org/world-development-indicators/

121 Erman et al., 2021.

122 Abebe 2014; Asadullah, Islam & Wahhaj 2021 ; Figueroa et al. 2020; Mburu, Kung'u & Muriuki 2015 ; Pope et al. 2022.

123 Dah-Gbeto and Villamor 2016

124 Erman et al., 2021.

Climate shocks increase food insecurity among the most vulnerable households, with implications for human capital development. Prior to the COVID-19 pandemic, 9.6 percent of Benin's population was considered food insecure, and chronic malnutrition affected 32 percent of young children. Furthermore, the percentage of households with children under 5 affected by drought and/or flooding is slightly higher than that of the overall population (22.6 percent compared to 21.4 percent). The health and well-being of schoolchildren are increasingly affected by extreme weather events and climate change-related illnesses, while lack of food at home and/or at school reduces pupils' ability to attend and learn. As a result, climate change threatens to reinforce pre-existing poverty and human capital traps, increase poverty levels, and deepen inequalities.

5.1.2. The poverty impact is expected to worsen if no action is taken

The pace of poverty reduction is expected to slow down due to the estimated economic losses from climate shocks if no adaptation or mitigation measures are adopted. Under the baseline growth pathway,[125] the poverty headcount (share of population below the international extreme poverty line of US$2.15 per day and per capita in 2017 PPP) is expected to decline by almost half (from an estimated 18.8 percent in 2021 to 9.5 percent in 2050).[126] This is due to an increase in economic activity (real GDP) that would translate into a significant alleviation of extreme poverty by the end of the projection period (Figure 23). However, failure to address climate change would disrupt this downward trajectory over the long run, slowing down the pace of poverty reduction under both climate scenarios. In the dry/hot scenario, poverty is expected to remain almost 4 percentage points above the baseline projection in 2050, reaching 13.4 percent. Under the wet/warm scenario it would also be higher than in the baseline scenario by almost 2 ppts (11.3 percent) by 2050. Productivity losses from labor heat stress are predicted to be the largest climate change driver of poverty, followed by negative effects on crops. In addition, the path of poverty reduction under the dry/hot climate scenario and under the baseline appear to diverge over time, suggesting that the poverty reduction slowdown would worsen (in contrast, under the wet/warm climate scenario, this difference appears to stabilize after 2040).

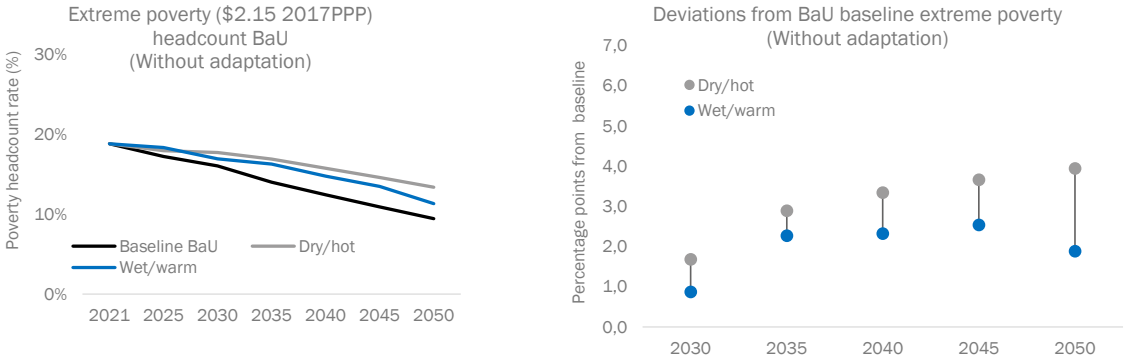
Between half a million to one million additional people would remain in poverty under the more negative climate scenario, if no action is taken. Overall, the differences in the pace of poverty reduction would translate into 510,000 additional people living below the poverty line by 2050 in the wet/warm scenario, and 1 million in the dry/hot scenario (Figure 23). Women and unskilled workers are likely to be the worst affected (Figure 24). The urban-rural gap in poverty incidence would stand at 3.2 percentage points, with rural areas displaying higher poverty rates than urban areas: 20.2 percent vs. 17.0 percent. The regional disparities in the poverty incidence are also noticeable (Figure 25). While under the hot/dry scenario the regions in the south of the country (such as Littoral and Ouémé) are expected to continue showing low poverty rates by 2050, the simulation suggests that poverty reduction in other regions, such as Collines, will lag behind the rest of the country and could be more severely affected by a lack of adaptation action.

Actions to adapt and build resilience to climate change would help mitigate this effect. The results from the microsimulation model suggest that selected resilience and adaptation measures would be associated with poverty rates up to 2 percentage points lower than those predicted for the dry/hot climate scenario by 2050 in the absence of any action (11.6 percent versus 13.4 percent under BAU and dry/hot climate scenario). This would translate into almost half a million fewer people (476,000) living under the poverty line by the end of the projection period. The biggest impact is through resilience investments that preserve labor productivity, in particular those that mitigate some of the productivity losses expected from labor heat stress (see Annex 6).

125 To analyze the potential impacts of climate change on long-term poverty and inequality, we use growth projections from a recursive dynamic Computable General Equilibrium (CGE) model calibrated to 2050 that produces a baseline growth pathway, and pair it with two alternative representative climate scenarios illustrating qualitative differences in climate shifts: the dry/hot scenario (dry/pessimistic) and the wet/warm scenario (warm/optimistic). The baseline growth pathway assumes that current development ambitions are met by increasing historical productivity growth rates over the medium term, due to the gradual transformation of the economy in line with the Vision 2060 and national development strategies (described in Chapter 2). See Annexes 2 and 3 for details.

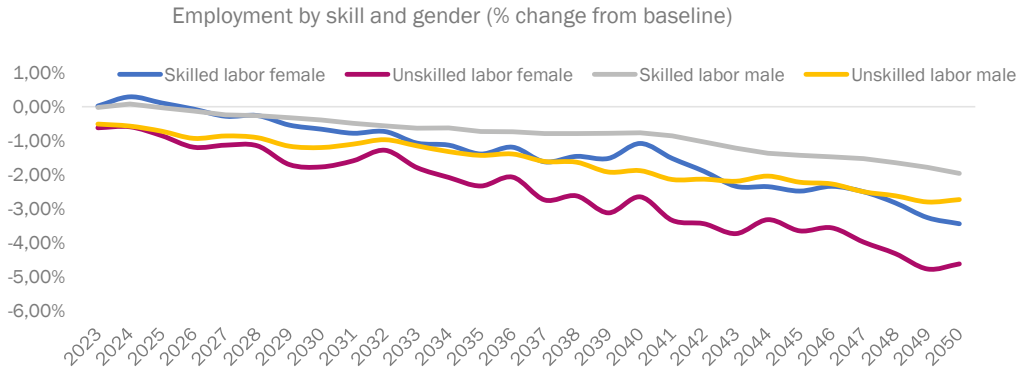
126 The international lower-middle income poverty line of US$3.65 (PPP2017) per capita per day in Benin was equivalent to 803.4 CFA francs in 2018 and translated into a 53.2 percent poverty headcount rate (2018).

Figure 23 – The number of people living below the poverty line could be higher by up to 1 million compared to the baseline in the absence of climate change action



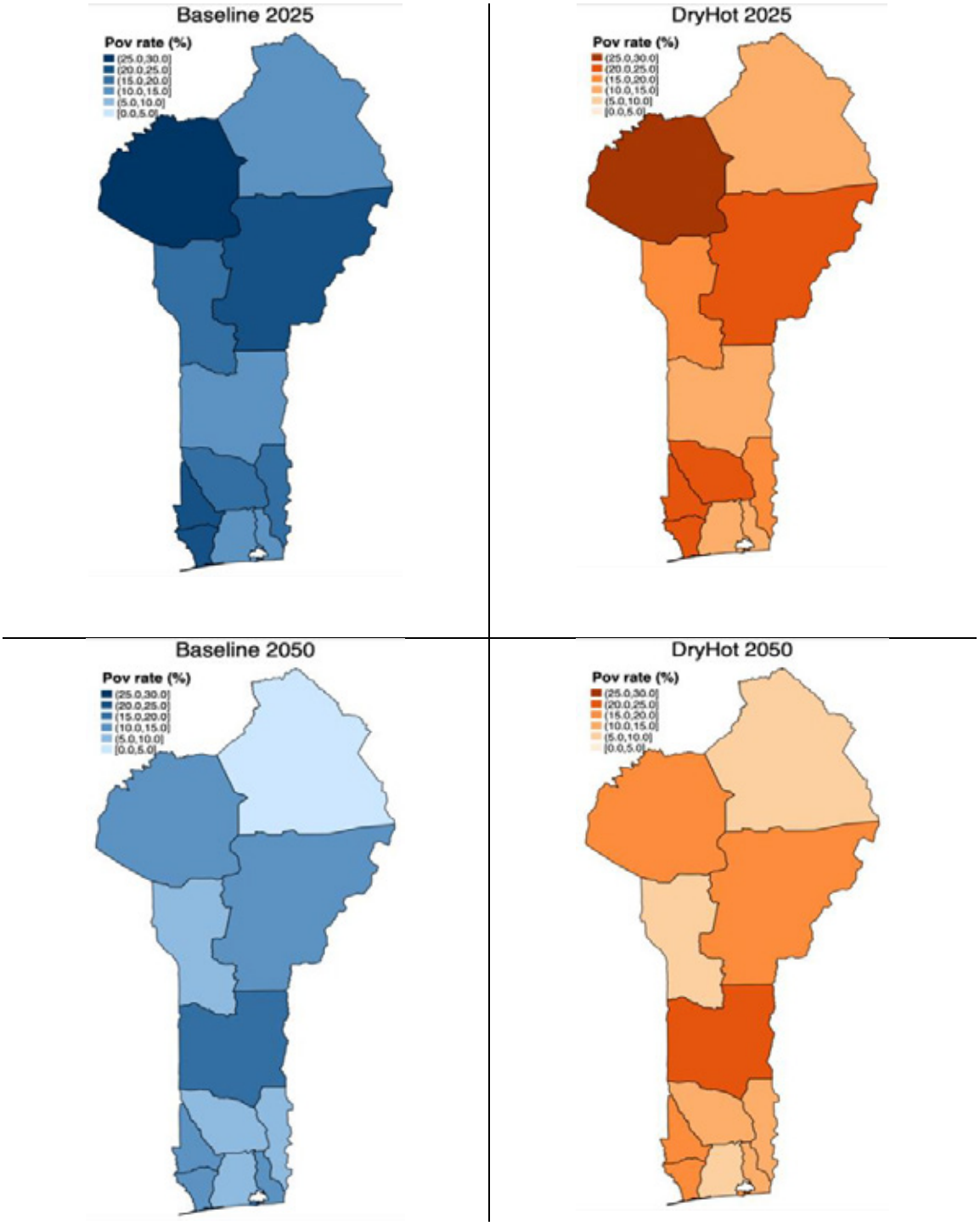
Note: Poverty microsimulations based on household level data from the EHCVM 2018/19 and using macroeconomic projections from a recursive dynamic Computable General Equilibrium (CGE) model for the 2021-2050 period. See Annex 3 for details.

Figure 24 – Unskilled workers and women would see employment rates plummet (hot/dry scenario)



Source: Macroeconomic projections from MANAGE for the 2021-2050 period. Note: Skill refers to secondary and above.

Figure 25– Poverty levels in poorer regions will be the worst affected by climate change



Note: Poverty microsimulations based on household level data from the EHCVM 2018/19 and using macroeconomic projections from a recursive dynamic Computable General Equilibrium (CGE) model for the 2021-2050 period. See Annex 3 for details.

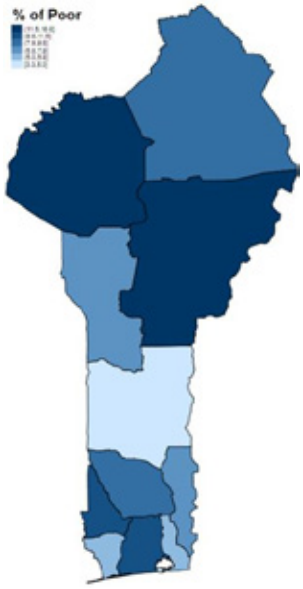
5.2. Building a resilient society will require a stronger social protection system and reducing gender gaps

5.2.1. A strong social protection system is needed to reach households affected by climate change

At less than 1 percent of GDP, government spending on social protection programs is low relative to Benin's income per capita and compared to peer countries. Most social protection spending – 84 percent on average – is allocated to the public pension fund, which mostly covers civil servants (formal sector employees). Social assistance programs tend to be externally financed, making up 0.05 percent of GDP, and reached approximately 187,400 beneficiaries between 2012 and 2022.[127] These low levels of social protection financing and coverage persist within a context of high poverty and vulnerability to climate shocks, with almost 40 percent of the population living below the national poverty line. As shown in the geospatial analysis below (Figure 26), areas with a higher prevalence of poverty tend to be at greater risk of flooding. Southern regions (except Alibori) tend to be the most at risk of flooding (Zou, Atlantique Ouémé, Mono and Plateau) and concentrate 37.2 percent of all poor households in the country.

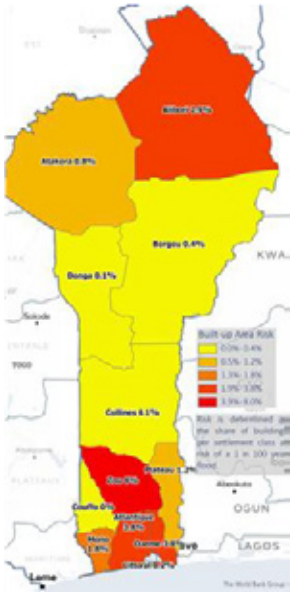
Figure 26 – Many of the poorest households also live in areas at greater risk of flooding

Poverty rate (darker=poorer)



Source: Concentration of poor by region, EHCVM 2018/19

Risk of flooding (darker=higher risk)



Source: Built-up Area Risk by region, latest available year

In recent years, the government has made progress in establishing a more inclusive and effective social protection system. The government has recently invested in core elements of an adaptive social protection system, including establishing a Unique Social Registry (USR) and developing a new flagship productive social safety net ("*Gbessoke*"). The USR will improve transparency and accuracy of targeting efforts to ensure that programs reach the most vulnerable, including in response to shocks, and allow for rapid implementation of emergency programs based on available household information. New human development programs will rely on the USR to improve efficiency of programming. The *Gbessoke* program also marks an important step towards strengthening adaptive and productive social protection in Benin. In particular, it targets extremely vulnerable individuals (primarily women) to receive support to develop their income-generating activities and supports the development of a nationwide network of local one-stop-shops (the *Guichets Uniques de la Protection Sociale*, or GUPS) to provide services to vulnerable populations.

127 World Bank (2023). Benin Public Finance Review: Creating fiscal space to build human capital.

Targeting is a key element in the adaptive social protection delivery chain, and will need to be continuously improved in the future to maximize the efficiency of all interventions. Innovations are needed to strengthen the USR and make it dynamic, for instance by developing on-demand household registration and update procedures to ensure that all data can be always relied on, in particular during an emergency. Expanding the definition of vulnerability to include vulnerability to climate change is critical. This vulnerability can be defined in terms of the hazards households are exposed to, as well as the characteristics which make households more vulnerable to climate change, for instance reliance on climate-vulnerable types of agriculture. Broadening the definition of vulnerability implies an expansion of the coverage of the USR, in particular to cover all populations in areas prone to floods. Georeferenced information from the USR can be paired with hazard data to produce more precise hazard maps to observe household exposure to shocks. Improving the USR to be dynamic and capturing vulnerability to climate change is thus key to inform disaster risk response planning, including financing and modalities of shock response, and therefore improve decision-making prior to shocks occurring.

Social assistance and labor market programs have an important role to play in addressing household vulnerability to shocks and facilitating a 'just transition'. Targeted cash transfers can help households prepare for, respond to, and recover from shocks. Building resilience to unpredictable weather patterns through cash transfers has proven to be an effective way to increase household access to food security and nutrition.[128] Complementing cash transfers with accompanying measures can also build household resilience to climate-related-shocks and worsening livelihood conditions by diversifying livelihoods, building savings, and avoiding the need to resort to negative coping strategies. For example, public works programs can help establish a more resilient natural and physical asset base for communities and households. In different contexts, public works programs have been shown to enhance landscape management through reforestation efforts, agroforestry promotion, soil and water management, and crop diversification (in Ethiopia, China, Indonesia, to name just a few examples). Furthermore, initiatives such as grants, job training, housing subsidies, and improving access to information can support labor mobility and safe migration for people seeking quality employment. When seen as complementary to a system of adaptive social protection (described below), these interventions are all potential options for addressing vulnerability.

Social assistance interventions can be delivered alongside investments in climate smart agriculture (CSA) and renewable energy, which has the potential to increase food security and resilience and reduce emissions. For example, evidence shows that a cash transfer program for women in Mexico increased land use, livestock ownership, crop production and agricultural expenditures.[129] Four priority areas for CSA in Benin include (i) land restoration and agroforestry systems; (ii) crop diversification; (iii) markets, value chains and microfinance; and (iv) integrated soil fertility and management.[130] In addition, to achieve landscape or community-level changes, investments in CSA can be combined with public works programs focusing for example on mangrove restoration or reforestation. Awareness raising, skills development, targeted programs and policy support can all help manage potential risks that households may face and boost the adoption of climate smart agricultural practices. Renewable energy investments can also support productive livelihoods. When supported by labor market policies, small loans and job training, electricity access can for instance provide the opportunity for off-farm economic activities in rural areas, as well as improving agricultural productivity, thereby contributing to more and better jobs.

In addition, greater financial inclusion and increasing household savings can help households cope better with shocks and to rebuild livelihoods afterwards. Savings schemes and microcredit can also increase access to cleaner technologies. Combining interventions that foster savings with targeted cash transfers to the households most vulnerable to climate shocks can help strengthen household resilience and productive inclusion to better cope with and recover from shocks. Regional evidence shows that participation in savings groups brings substantial benefits for women's financial inclusion, access to credit, increase in savings, and improved decision-making power within the household and the community.[131] Beyond financial inclusion, informal women's savings groups could also be leveraged to support skill-building, knowledge dissemination and social capital acquisition among women – all of which will build their resilience to climate shocks.

Supporting livelihood diversification is another way to build household resilience. In addition to their agricultural activities, rural households on average conduct one non-farming activity. Both poor (54 percent) and non-poor (39 percent) households are active in trade, although poor households are more constrained by seasonality, lack of customers, high levels of competition, and challenges accessing credit or in supply of raw materials. Rural non-farm activities are more likely to be self-funded or financed by loans from other households, rather than formal finance, and markets for rural non-farm enterprises consist largely of other households for both buying and selling.[132] Targeted SME support for improved access to finance, markets, and business development services to develop non-farm enterprises can help households adapt to climate shocks that may affect agricultural production.

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128 Asfaw and Davis 2018

129 Todd et al. 2010; Gertler et al. 2012

130 Assogbadjo AE et al., 2022.

131 Karlan et al. 2017.

132 World Bank (2022). *Benin Poverty Assessment: Pathways to Better Well-Being*.

While supporting productive inclusion to increase resilience, vulnerable households should also receive support to develop the skills needed to succeed in the green economy. Households and individuals most vulnerable to climate shocks tend to have lower levels of formal education. For example, Beninese women are significantly more likely than men to be illiterate and lack formal education. According to EHCVM 2018, only 29.6 percent of Beninese women are literate, compared to 63.1 percent of men. Skills development plays a crucial role across the African continent in creating sustainable, decent and green livelihoods. Skills development efforts will need to be accompanied by employment and macroeconomic policies that contribute to green job creation and enterprise growth, especially in the sectors that are expected to see growth in Benin's low-carbon transition.

A productive and adaptive social safety net program is a good step forward

The upcoming implementation of a productive and adaptive social safety net program (Box 7) marks an important step towards increased resilience for the most vulnerable Beninese households. The national *Gbessoke* safety net program aims to reach at least 150,000 individuals (or which at least 80% will be women), representing 61 percent of extremely poor households in the unique social registry, to support them through a package of productive inclusion measures. The program additionally supports the development of one-stop-shops to improve overall delivery of human development programs, including microcredit, health insurance and social assistance. Elements of the program include a focus on updating data for populations at risk of flooding, relying on mobile payment transfers for faster delivery of benefits in case of a shock, and using the social registry to scale up interventions as needed, including adding new beneficiaries (horizontal expansion) and/or increasing the cash transfer amount (vertical expansion).

Box 7 – Adaptive social protection systems

Adaptive social protection (ASP) aims to build the resilience of poor and vulnerable households by supporting them to prepare for, cope with, and adapt to shocks. With the growing frequency and intensity of climate shocks due to climate change, investments in ASPs are particularly urgent. Shocks impact poorer households disproportionately, and especially women, children, the disabled, and the elderly, who have less capacity to prepare, cope, and adapt. Shocks can also push vulnerable, non-poor households into poverty. Therefore, when appropriately designed and managed, ASPs can protect the wellbeing of vulnerable households and ensure they do not fall into, or fall deeper into, poverty due to a shock.

Adaptive social protection systems consist of four main building blocks: (i) programs that enhance resilience outcomes; (ii) financing to allow for timely responses; (iv) data and information to understand sources of risk and vulnerability; and (iv) institutional arrangements and partnerships to support coordination across sectors. The adaptive approach integrates social protection interventions with disaster risk management and climate change adaptation to better anticipate and respond to shocks.

Adaptive social protection can also help to facilitate a 'just transition', ensuring that vulnerable households and women are not left behind during the shift to a low-carbon economy. Special attention should be paid to female-only households, which appear to be disproportionately affected by poverty and vulnerability. According to EHCVM 2018, individuals from households with only one adult female display a strikingly higher poverty incidence (30.3 percent) than male-headed households (13.5 percent). The incidence of poverty is even higher among female-headed households with children (48.4 percent), than households with one male adult with children (31.1 percent). Productive inclusion measures can target those most at risk of being negatively affected by the transition to a low-carbon economy, notably women and young people in rural and agriculture-reliant areas, supporting them with resources and skills development.

5.2.2. Avoiding widening gender gaps

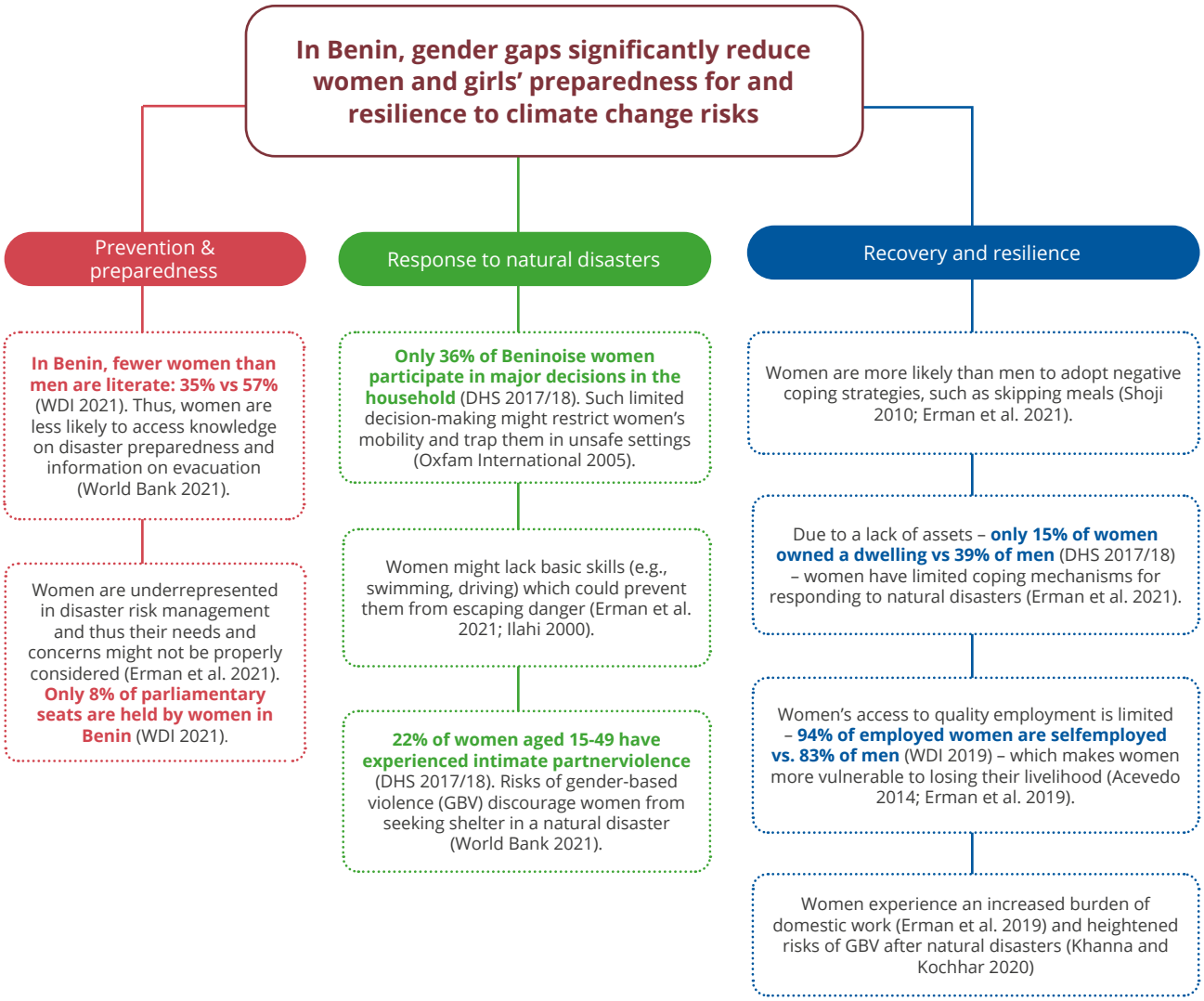
Understanding the differing nature of women and men's climate change vulnerabilities, concerns and priorities is crucial to mitigate the impacts and avoid widening gender gaps. Figure 27 illustrates women's greater vulnerability to climate change. Global and regional evidence shows that building the resilience of women and female-headed households (e.g., through social protection programs and safety net projects) strongly enhances their human capital outcomes, increases their financial security and hence creates a pathway out of poverty.[133] Targeting women as the main beneficiaries of social protection programs is also directly linked to their improved bargaining power within the household and better investments in children's education, health and nutrition.[134] Addressing both the underlying structural barriers to women and girls'

133 Asfaw et al., 2014; Barce et al. 2015 ; Covarrubias, et al., 2012 ; Daidone et al., 2015 ; Seidenfeld et al., 2013.

134 Adato, et al., 2000; Attanasio and Lechene, 2002; Handa et al., 2009; Doss, 2013; Wasilkowska, 2012; World Bank, 2014.

agency, as well as specifically reinforcing their capacity to respond to climatic-shocks, will mean considering their needs across all sectoral interventions, institutions and regulations. This will mean increasing the representation of women in all relevant decision-making bodies, ensuring their active participation in consultation processes, and strengthening their preventive and adaptive capacity by investing in their human capital, economic empowerment and basic human rights.

Figure 27 – Gender gaps in Benin significantly reduce women and girls' resilience to climate change



Source: Authors, based on expanded literature review and ECVHM 2018. Acevedo (2014); Erman, A. et al. (2021). *Gender Dimensions of Disaster Risk and Resilience: Existing Evidence.* World Bank, Washington, DC; Khanna and Kochhar (2020); Ilahi (2000; Oxfam International (2005); Shoji (2010); WDI (2021); World Bank (2021).

5.3. Key policy options for building a resilient society

Table 7 summarizes the key policy and investment options required for building a more inclusive and resilient society in the face of climate change. The actions are organized by sector, and by whether they are policy actions – which are regulatory/institutional in nature – or investment actions, which require hard investment (e.g. construction, an operational budget, etc). Complexity levels were defined together with government counterparts in an inclusive consultation process that considered feasibility, presence in government strategic documents, budget plans, and political economy. "Expected financing source" indicates the most likely source of financing.

Table 7: Summary of key policy options and investment actions for building a resilient society

Area	Action	Complexity	Fixed costs	Expected financing sources
A strong social protection system is needed to reach households affected by climate change				
Social protection (SP)	**Investment action SP1:** Continue building an adaptive social protection system by (1) improving the USR to be dynamic and capturing vulnerability to climate change, and (2) ensuring the USR is used by all human development programs to maximize efficiency, and used for emergency responses	Low	- (2) CFAF 500 million (6 months)	Public budget (PB) / concessional resources (CR)
EDU/SP	**Investment action EDU/SP2:** Strengthen the school feeding program in more vulnerable areas through school gardens, small farms and water management systems; and including fuelwood plantations.	Medium	CFAF 75 million (5 years).	PB/CR Smallholder farmers
SP	**Policy + investment action: SP3:** Strengthen the social protection system to increase readiness to climatic shocks and preparedness by: (1) adopting a strategy of emergency response cash transfer using the USR; (2) expanding productive cash transfers to help households prepare and respond to shocks including through diversified livelihoods; (3) developing public works focused on improving community resilience to climate change, including through mangrove restoration or reforestation; (4) developing livelihoods programs focused on 'green livelihoods' such as sustainable agriculture, forestry, or renewable energy. Social assistance interventions can be delivered alongside investments in climate smart agriculture (CSA) and renewable energy. Four priority areas for CSA in Benin include land restoration and agroforestry systems, crop diversification, market, value chain and microfinance, and integrated soil fertility and management.	High	-	PB/CR
SP/Gender (GG)	**Policy action SP4/GG1:** Increase financial inclusion by supporting the development of saving schemes and access to microcredit, especially for women.	Low	-	PB/CR
SP/ Finance (FIN)	**Policy action SP5:** Provide targeted SME support through improved access to finance, markets, and business development services to develop non-farm enterprises to help households adapt to climate shocks that may affect agricultural production. These efforts might include financial incentives or business development support to help shift micro and SMEs to function within a greener economy, including through the production and delivery of greener products and services.	Medium		PB/CR
Transport (TR)	**Policy action TR1:** Ensure connectivity of rural populations. Rehabilitate and develop a maintenance scheme for the strategic non-paved and paved network (to increase RAI index). Improve public and private sector capacities and develop a structured plan for maintenance programs.	Medium	--	PB/CR
Avoiding widening gender gaps				
Gender (GG)	**Policy action GG3:** Institutions and regulations: (1) increase the representation of women across all relevant decision-making bodies; (2) ensure the participation of women and girls in consultation processes on urban planning and design/DRM/climate change adaptation policies, etc.; (3) introduce a quota for women in forest committees and in ecosystem-based adaptation measures and address barriers limiting their participation.	Medium	--	PB/CR
GG	**Policy action GG4:** Strengthen preventive and adaptive capacity by (1) developing training in DRM for women and strengthen their adaptive capacities through informal training and peer-to-peer learning by targeting women-headed households; (2) ensure accessibility and outreach of early warning systems in all parts of the country, and in particular for women.	Medium	--	PB/CR
GG	**Policy action GG5:** Develop gender responsive climate-smart agriculture programs by training women in adopting climate-resilient crop varieties or water sustainability; empower women to exercise decision-making in crop choices to increase food security; institute a gender-responsive forest management certification scheme to increase sustainably sourced firewood and restore riparian forests such as mangroves.	Medium	--	PB/CR

Chapter 6.

Making it happen: financing and policies for resilience

Chapter 6: Making it happen: financing and policies for resilience

The investment required by Benin to maintain its growth path in the face of climate change is significant compared with the country's economy and fiscal capacities. Against that backdrop, this chapter identifies possible financing sources for climate investment.

6.1. Investing in climate action requires significant funds and innovative financing sources

Climate interventions involve significant investments, but the benefits outweigh the costs. In this CCDR we estimate that strict additional financing needs[135] in Benin amount to an annual investment of 0.1 percent of GDP to 2030, rising to 0.3 percent of GDP to 2040 and 0.8 percent of GDP in 2050. This would be an annual average of 0.3 percent of GDP over the entire period and would cost US$2.7bn by 2030-32 (Table 8). This calculation assumes higher levels of public investment as a share of GDP, averaging 8 percent for the 30-year period, compared to historical averages of 5 percent of GDP between 2012-2023 (Annex 2), most of which will require financing and will involve adaptation and mitigation action. Indeed, adaptation costs can be hard to separate from other development needs, as development and adaptation are self-reinforcing. The costs of climate adaptation identified in other strategic documents are all encompassing. The NDC estimated investment needs for mitigation at about US$8.6 billion, with US$5.1 billion coming from the government and the private sector, and the remaining US$3.5 billion expected to be mobilized from the international community. This amounts to a total of 5.2 percent of 2030 GDP in our baseline growth pathway. Investment needs for adaptation were estimated in the NDC at approximately US$1.8 billion, of which US$ 578 million (32 percent) would be public funding and US$1.2 billion would require international support (68 percent). Meanwhile, the NAP estimates an investment need for adaptation of about US$4.2 billion over a 10-year horizon.

Table 8 - Estimates of investment needs differ as development and climate action are intertwined

Averages	By 2032	%public	% foreign aid
CCDR strict additionality estimates	US$2.7 bn		
NDC mitigation	US$8.6 bn	30%	41%
NDC adaptation	US$1.8 bn	32%	68%
NAP	US$4.2 bn		

Source: Authors' estimates based on MANAGE, NDC and NAP. Notes: Exchange rates are approximate.

Whatever the definition, the investment required in the short term is significant compared with the country's economy and fiscal capacities. While Benin is at moderate risk of external and overall debt distress, the space to absorb shocks remains limited.[136] In that context, efforts to mobilize revenue are one of Benin's most pressing policy priorities given the country's large development needs, regardless of the investments required to increase climate resilience. At 11.5 percent in 2022, Benin's tax-to-GDP ratio is below WAEMU peers and below the country's tax potential. Assuming convergence with the WAEMU fiscal rule, the CCDR macroeconomic baseline already assumes significant increases to domestic mobilization capacity – of up to 7 percentage points of GDP by 2050. While private sector investment has increased significantly in the last decade, a substantial jump will also be required for the economy to continue its structural transformation while adapting to climate change and avoiding carbon lock-ins. Continued efforts to maximize concessional external borrowing are also crucial.

At least three potential avenues exist for financing the climate action outlined in this CCDR:

(1) Increase public financing by raising additional revenue (for example, through a carbon tax), and achieve efficiency gains in spending through improved public investment and financial management. The government's borrowing capacity will be constrained in the future due to its revenue mobilization capacity and relatively high debt levels

135 Defined by a strict additionality definition, i.e., the difference between optimal investment levels in a scenario without climate change (baseline) and with climate change.

136 IMF and World Bank (2023). Joint Debt Sustainability Analysis. The high debt service-to-revenue ratio continues to leave debt vulnerable to revenue underperformance or shifts in market sentiment that could increase rollover costs.

in a context of tightening financing across the world. As part of the WAEMU, Benin needs to comply with the convergence criteria, including the fiscal rule, which is assumed to remain constant until 2050.

(2) Garner more resources from multilateral and bilateral development partners and disaster risk financing. Many interventions that are efficient and essential to reduce GHG emissions or to build climate resilience would not meet private sector investment criteria and would require concessional resources and/or grants from the international community.

(3) Leverage corporate investment. This will require (i) using pricing instruments (through taxation and subsidization) to shift the allocation of capital toward climate-related projects; (ii) greening the financial sector (for example, taxonomy and disclosure); and (iii) developing market-based instruments and de-risking tools (such as insurance products) to better share the burden of risk between the public and private sector. To further mobilize private savings, the government could also prepare a list of bankable green infrastructure transactions (including through PPPs).

Innovative solutions will be needed to mobilize these sources of finance. This section focuses on these three potential options and the key regulatory changes required to enable them.

6.1.1. Increase revenue and make public spending more efficient to create fiscal space for adaptation

Use more effective environmental taxation to increase revenue

There is growing consensus that carbon taxation can reduce global carbon emissions effectively and replace less effective carbon regulations (Box 8).[137] If designed properly, a carbon tax could bring positive macro-economic and distributional benefits to Benin. An analysis carried out by the World Bank in 2021[138] found that Benin already had a number of environmental fiscal instruments: in 2019, green tax revenues amounted to CFAF 18.3 billion, and increased significantly to CFAF 40.8 billion in 2020, resulting in a net tax burden of CFAF 10 billion when tax expenditures were considered. However, the analysis highlighted the inefficiency of Benin's diverse tax instruments, which often include earmarked taxes and overlapping fiscal instruments with conflicting incentives (e.g., tax exemptions and excise taxes). Using a range of carbon prices for sensitivity, progressive introduction mechanisms and different sectoral coverage (Table 9), the analysis found that if properly designed, and considering certain parameters, a carbon tax could be beneficial for Benin and could reduce the distortions introduced by current tax instruments. The negative impact on GDP would be less than 1 percent relative to the baseline, and up to 4 percent in the two scenarios with higher carbon pricing. However, this can be mitigated through reinvesting the revenue generated, which is only partially modelled. Further, the revenue raised could be significant, offering a good route for financing mitigation/adaptation needs. For example: up to US$140-150 million a year could be raised with a carbon price of US$7.50 if agricultural emissions are included; a total of US$1,138 million could be raised by 2030 with a US$10 carbon tax.

A carbon tax would also help reduce the environmental damage of economic activity and encourage behavioral changes. Recent World Bank studies of Côte d'Ivoire suggest that a carbon tax would reduce the environmental footprint of activities like transport and agriculture and decrease air pollution.[139] These studies recommend a feebate type of tax incentive, whereby positive "abate" incentives are granted to production methods with low environmental impact, while negative "fees" are levied on production methods with high carbon intensity. The returns are likely to be similar in Benin.

137 World Bank (2021). Status and Trends in Carbon Pricing 2021.

138 Technical Assistance to the MoEF on MANAGE and Environmental fiscal taxations.

139 See the CCDR for Côte d'Ivoire (2023).

Table 9: A range of carbon taxation scenarios have been modelled

Carbon price	Average annual revenue generated by 2030 (US$ millions)	Progressive introduction	Coverage of consumption-based emissions	Land use and livestock emissions	Emitting sectors					Program coverage		
					Agriculture	Transport	Energy	Households	Other	CO_2	N_2O	CH_4
2.5 $	59	No	Full	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5 $	109	No	Full	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7.5$	147	No	Full	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15 $	147	Yes	Full	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
30 $	258	Yes	Partial	No	No	Yes	Yes	Yes	No	Partial	Partial	Partial
60 $	147	Yes	Partial	No	No	Partial	Yes	Yes	No	Partial	Partial	Partial

	Low carbon price and broad coverage
	With a higher carbon price, exemptions may be needed
	Phasing in a higher carbon price with exempted sectors
	Phasing in a higher carbon price with partial coverage of emissions.
	High carbon price, narrow coverage, targeted decarbonization of sectors

Source: Authors' calculations based on MANAGE simulations.

Box 8 – An upstream carbon tax is the most efficient tax for emission reductions

Environmental taxation offers a range of fiscal options and entry points to address the negative impact of GHG emissions:

- adapting existing taxes, including excise taxes, on the consumption of products or services that contribute to high GHG emissions
- rationalizing the portfolio of tax expenditures (customs, VAT) to correct expenditures that contribute to high GHG emissions
- implementing carbon pricing, preferably collected upstream at the time of extraction or import
- introducing a variety of instruments that link emitting behavior with payment for the full costs of that behavior, such as through road pricing systems.

In practice, countries apply a combination of instruments, integrating a 'carbon price' system into the existing tax system. However, this tends to result in overlapping taxes, which are not mutually exclusive. Replacing burdensome regulations and a complex taxation system with a simple price signal – such as an upstream carbon tax – will promote economic growth and give companies the regulatory certainty they need to invest in clean energy alternatives over the long term. A carbon tax will also promote more inclusive economic growth and make the economy more efficient by eliminating distortions and reducing less efficient taxes. Implementing upstream carbon taxes on fossil fuels would ensure that prices accurately reflect the true costs of using those fuels, thus helping to mitigate climate change. At the same time, the smart use of the revenues generated would benefit the economy in general and increase social welfare. Carbon taxes have other advantages: they have low administrative costs, are easier to collect and monitor than direct taxes, offer few opportunities for evasion, and would cover the country's large informal segment of the economy. It is important to design the carbon tax instrument adequately for the country context. For example, the price of carbon varies from less than a dollar per ton of CO2 (in Poland) to 137 dollars (in Sweden, 2020). A high carbon tax does not guarantee high revenues, however. For example, South Africa had a carbon tax of US$9.2 which generated US$43 million in 2020, whereas the US$0.4 carbon tax in Ukraine generated US$31 million that same year.

Strengthen public financial management systems to support climate action

Making the public financial management (PFM) system climate responsive would require reforms on various fronts. In February 2020, the government adopted a methodological guide for developing sectoral policies and strategies for adapting to climate change.[140] It presents the overall approach to integrating climate change into policies, strategies and plans, as well as into national, sectoral and communal budgets. Benin started to move to climate-informed performance-based budgeting[141] (PBB) in 2022, which would require it to develop a formalized mechanism to assess the climate relevance of programs and sub-programs and ensure that tagging is correctly applied. There is a need to integrate climate change concerns into the budget circular and to tag and track adaptation and mitigation expenditures during the preparation and execution of the budget. Budget planning instruments, such as the macroeconomic orientation and forecasting and the medium-term expenditure framework (MTEF), could be strengthened by systematically considering climate risks. More systematic monitoring and evaluation is also critical to move from planning to effective implementation. The consolidation of a monitoring, reporting and verification (MRV) system, as stated in the updated NDC, will be critical to support these efforts. These recommendations are aligned with the findings of the 2023 C-PIMA evaluation.[142]

Seize opportunities to foster more climate smart public investment management. In 2018 a new law on public investment management (PIM) was adopted, requiring the integration of climate into environmental impact assessments (EIAs). However, in practice there is still no guidance or standard methodology. Climate smart PIM represents a significant opportunity, and would require reforms to (i) develop a standard methodology for climate change impact assessments by integrating the systematic assessment of climatic risks and including more climate-sensitive project selection criteria; (ii) take into account the impact of climate change in the methodologies for maintaining public assets; and (iii) more systematically estimating and tracking the contributions of public investments to GHG emissions and adaptation objectives.[143]

Require state-owned enterprises (SOEs) to report on climate change action. Given SOEs' large portfolio, the central government – through its regulatory powers and financial relationship with these entities – has a key role in ensuring their full commitment by systematically aligning SOE investments with NDC and climate change objectives and promoting climate reporting, which could potentially also lay the foundation for accessing green finance.

Integrate funds from the National Fund for the Environment and Climate into the budget process. Benin established the National Fund for the Environment and Climate (FNEC) in 2017 to help finance climate change measures.[144] The fund is accredited by the Green Climate Fund (GCF) and aims to finance programs and projects aimed at protecting and managing the environment, combating the adverse effects of climate change, and promoting sustainable development in Benin. However, the funds are not integrated into the budget process, which creates fragmentation in climate action.

Strengthen planning at the local level to incorporate climate change. Benin's local government system includes a decentralized administration comprised of 77 municipalities divided into 12 departments. The legal framework includes a list of specifically assigned and shared areas of authority for all municipalities for infrastructure and services in certain areas. Appropriations provided by the central government to the local government units consist of earmarked and non-earmarked transfers through the Municipality Development Support Fund (FADEC). The municipalities prepare their municipal development plan and annual investment plan and submit the list of projects to be included in the public investment program (PIP). Since 2018, the law requires that all local governments integrate climate vulnerability aspects in their local development plans. While the MCVDT supports the municipalities in developing municipal development plans sensitive to climate change, there is a need to ensure that climate change aspects are integrated into the overall planning and budgeting process at local level.[145]

6.1.2. Tap into concessional and blended finance and disaster risk financing

Benin already uses innovative financial instruments to finance its development agenda. Since 2019, the government has issued three Eurobonds, including the longest Eurobond maturity ever received by a WAEMU country (31 years); and a Sustainable Development Goals (SDG) Eurobond of €500 million in July 2021 – the first African sovereign nation to do so. The use of innovative financing instruments is at the heart of Benin's debt management strategy. Over the last three years the country has consistently ranked top amongst sub-Saharan African countries on the World Bank Country Policy and

140 Government of Benin. (2020). National Adaptation Plan.

141 A preliminary analysis of climate change integration into the budget cycle was prepared in October 2022.

142 Wendling, C., von Thadden-Kostopoulos, S., Lonné, P. Roumegas, P. Traoré, S. and M-C Ugue (2023). Évaluation de la gestion des investissements publics PIMA et PIMA Changement climatique. International Monetary Fund.

143 These are aligned with the preliminary findings of the C-PIMA 2023 conducted by the IMF, which were shared during the exit meeting with the development partners.

144 Decree 2017-128.

145 October 2022 Millenium Development Corporation guide on "démarche d'élaboration des plans de développement communaux ».

Institutional Arrangement (CPIA) for its debt management and debt policy. In October 2022, Benin also secured a partial credit guarantee from the African Development Fund, the concessional lending arm of the African Development Bank Group, to raise funds in foreign currency from international investors for expenditures to meet SDG targets on agriculture and agro-industry, water and sanitation, health, affordable housing, education, and renewable energy. Taking advantage of its strong institutional framework, Benin should consider a range of instruments to finance climate action and climate-preparedness while optimizing public resources.

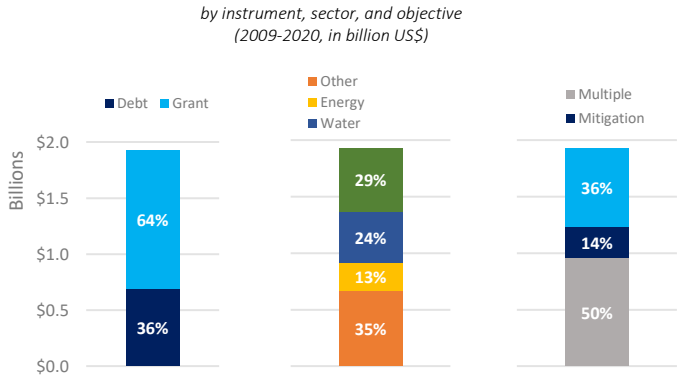
Be creative in the use of concessional and blended financing

Explore the full range of concessional and semi-concessional financing, including new sources of climate funds. It is critical to find sources of financing to enable refinancing, extend maturities and bring in cheaper funding to meet the volume of climate investment needs. Over the period 2009-20, Benin received around US$1.93 billion in climate financing commitments[146] from international partners, the majority of which (64 percent) was provided in concessional funding through grants (Figure 28). However, Benin became a gap country in 2020, which means the available grants are progressively reducing. The debt agency (CAA) and the MCVT – the implementing agency for the NDCs – should explore all possible sources of concessional and semi-concessional funding from various financiers, particularly development banks and bilateral lenders. Concessional and blended finance from donors or multilateral development banks represents one of the most significant potential sources of financing for the country's climate action.

Despite their relatively small size, international climate funds are strategically important for Benin. International climate funds attract private investment by enabling national development banks and multilateral development banks to develop risk-sharing instruments, technical capacity to deliver climate-resilient investment, and foster learning. Some of the most relevant funds, such as the Green Climate Fund (GCF), Climate Investment Funds (CIF), and Global Environment Facility (GEF), have already provided financing for initiatives in Benin. Benin's National Fund for Environment and Climate (*Fonds National pour l'Environnement et le Climat* - FNEC) has been GCF-accredited since 2019. Benin has a current GCF allocation of US$66.8 million and there are eight projects ongoing (including regional projects). Low capacity is however deterring access to these funds, and project preparation can last several years. To date, Benin has only received US$9.6 million in financing from GEF7, but stands to receive US$12.6 million from GEF8 to finance investments in biodiversity, climate change, and land degradation (not yet allocated).

Several new financial institutions are expanding the scope of their activities to Africa, creating the potential for new blended financing. One example is the recent launch of the European Investment Bank (EIB) Global in January 2022, EIB's arm to support climate action, economic growth, and development beyond the European Union. Such blended finance facilities can be developed for new investment focus areas in Benin, including nature and biodiversity conservation and climate-resilient infrastructure, transportation, and agriculture. The funding for this facility could blend IDA grants and credits and funding and guarantees from other multilateral development banks, development institutions, and public sector funds. New tools to measure and model risk components of the downstream projects could be deployed to identify the critical risks that require public-sector financing to enable private-sector investment. This would allow for more pinpointed financing and efficient use of scarce public sector financing.

Figure 28 – Most concessional financing to Benin's climate-action agenda over the last 10 years has been grants which are now mostly unavailable



Source: OECD (2023). OECD DAC External Development Finance Statistics. Notes: Climate funding in Benin from bilateral, multilateral, and philanthropic sources

146 It's important to note that this data captures the overall commitments made by bilateral, multilateral, and philanthropic sources. Actual disbursements might have been lower.

Benin could also explore deploying more innovative financial structures from these concessional and semi-concessional resources. These sources of financing can be used creatively in a variety of ways, such as liquidity backstops for climate-focused projects (for example, to create a price floor under a power purchase agreement for renewable energy projects) to incentivize private sector investments. The environmental and social safeguards that are applied would also give added comfort to investors on the quality and transparency of projects. The main options include:

(1) **Issuing thematic bonds.** There is considerable potential for Benin to become a regional leader in sustainable finance. Apart from the Government of Benin, only two other issuers in the WAEMU have issued thematic Eurobonds to date: the West African Development Bank (BOAD) and Ecobank Transnational – a pan-African retail banking group headquartered in Togo. Green and other thematic bonds have shown positive outcomes for issuers, including investor diversification, positive signaling on commitments to sustainability, and transparency in the use of proceeds. To take full advantage of thematic bonds, Benin could consider issuing on the regional market. The Luxembourg Stock Exchange and the BRVM (the regional securities exchange) signed a memorandum of understanding (MoU) in September 2022 committing them to exploring the creation of a bond market dedicated to green, social, sustainability, and sustainability-linked bonds at BRVM, and analyzing opportunities for the dual-listing of sustainable securities. In addition, the two institutions committed to collaborate on offering sustainable finance training programs as part of the BRVM Academy.

(2) **Issuing sustainability-linked bonds.** SLBs are a relatively new form of sustainable bond. They tie the financial performance of the bond to the achievement of pre-established and agreed key performance indicators (KPIs) in the area of emissions. Lack of progress toward achieving the KPIs can result in an increase in the instrument's coupon, while exceeding the KPIs can result in the lowering of the coupon. However, despite being issued in order to attain a specific KPI, they are general-purpose bonds, and the funds are not tied to a particular use of proceeds allocation. SLBs have been predominantly used in the corporate space, but they are increasingly being explored by sovereign entities due to their versatile nature and the capacity of the issuer to set suitable KPIs as well as to raise investors' interest. The first sovereign SLB was issued by Uruguay. This approach may be very interesting for Benin as a potential follow-on to a sovereign green bond (for which all aspects are already prepared) as it can build on the framework already in place but will not require the use of proceeds to be allocated. In addition, it might achieve a significant coupon step down if KPIs are met, which will provide a strong financial incentive and benefit to the government.

(3) **Issuing impact bonds.** Impact bonds are an innovative debt instrument in which the influx of funds from investors is used to cover the upfront costs of a project, with the ultimate return to the investor based on the project achieving its outcomes. In recent years, the World Bank has supported several such transactions, such as the Wildlife Conservation Bond in 2022 and the Emission Reduction-Linked Bond in 2023.

Develop disaster risk financing

Disaster risk financing (DRF) involves proactive planning to better manage the cost of disasters and ultimately mitigate long-term fiscal impacts. A range of DRF instruments are available for countries and are set according to the frequency of occurrence and the severity of a shock. Retention instruments allow governments to assume and manage disaster losses using budgetary resources – for example budgetary reserves, budgetary reallocations, or post-disaster loans – whereas with transfer instruments, the government transfers potential losses from disasters to the financial or insurance markets at a premium. The combination of these two types of instruments, in addition to disaster risk reduction interventions, could provide effective and comprehensive protection from recurring events through to more rare events. This instrument is typically used for large structural assets in the transport sector.

Benin has a framework for accessing contingent finance in case of an emergency, but it could be strengthened. Benin's national budget includes 'unallocated resources' which can be used for disaster response in cases of 'immediate need and national interest'. These unallocated resources amount to just under 10 percent of the budget but are not earmarked for disaster response. Since 2020, the government has set up a dedicated disaster risk fund (*FONCAT*) to respond to higher-frequency, lower-severity losses (CFAF 5 billion for 2023 or 0.42% of 2023 GDP).

Catastrophic risk transfer instruments are not available in Benin, either at the sovereign or micro (sectoral) level. Insurance penetration in Benin is low, at 0.8 percent in 2021, and below the WAEMU average (1 percent that same year). It is mostly driven by the auto insurance branches. At sovereign level, even though Benin has signed the ARC treaty, the country does not have coverage via the risk pool. Despite the importance and exposure of agriculture to climate shocks, agricultural insurance is non-existent. In fact, the agriculture insurance company (AMAB) closed in 2020 due to poor performance.

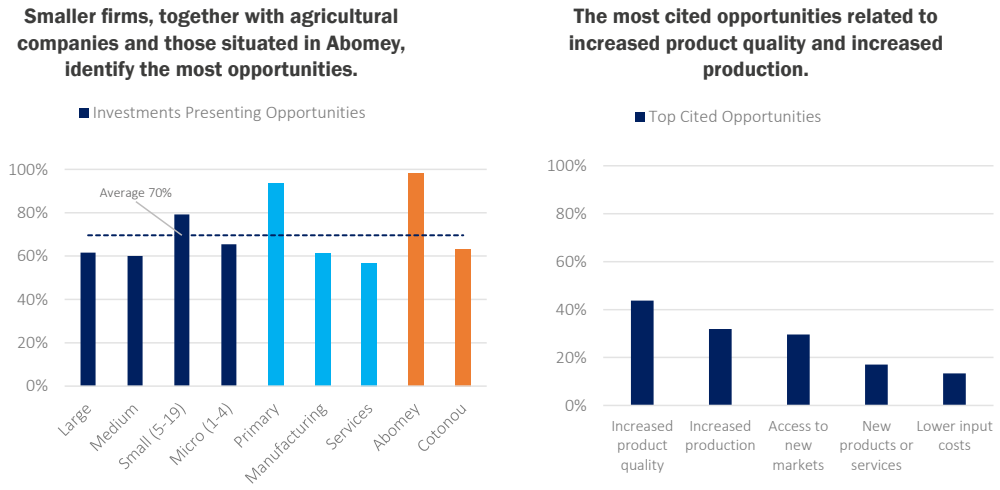
Savings from the various potential risk-layering instruments could be significant in Benin. Simulations and a cost benefit analysis (CBA) of the various DRF instruments were developed for this CCDR.[147] The objective was to simulate strategies to understand the savings that could be achieved from different potential risk-layering instruments. DRF finance instruments vary in their levels of cost-effectiveness for covering disasters of different frequency and severity. Typically, it is most cost-effective to use a combination of instruments for financial coverage against disaster risk using a risk-layering approach. To make the CBA more useful for Benin, the analysis examined the benefit of having a World Bank catastrophe-draw-down option (DDO) in addition to the FONCAT. This was found to secure savings of 40 percent compared to the baseline for a 1-in-10-year flood loss. As losses get larger it would be even more cost effective to consider using risk transfer mechanisms to fund losses. Risk transfer mechanisms could be explored as Benin is exposed to both climate and non-climate related disasters and would benefit from other forms of ex-ante financial protection.

Benin should consider exploring risk transfer instruments that can cover high-impact, low-probability events. Options to explore include issuing parametric catastrophe bonds or insurance that transfers catastrophe risk from a sponsor to bond investors. Cat bonds are similar to insurance, as sponsors receive a payout when a disaster event meets certain pre-defined criteria, with no obligation to repay it. Cat bonds are fully funded transactions and investors stand to lose some or all of the principal. The risk coverage period is typically two to five years and cat bonds can provide quick payouts when designed with parametric or modeled loss triggers. More in-depth exploration of the approach would be needed, but such risk transfer instruments could be a key part of Benin's overall risk mitigation approach to dealing with unforeseen climate shocks.

6.1.3. Leverage corporate investment

Private sector participation is urgently needed to help Benin adopt low-carbon and climate-resilient growth pathways; private firms' readiness to engage suggests large untapped potential. Beninese firms are positive about the opportunities stemming from climate change action (see Section 2.2 for details and Annex 4). Around 94 percent of firms in the primary sector and two-thirds of manufacturing and services firms see opportunities emerging from investing in either adaptation or mitigation (Figure 29). The most common opportunities perceived from action are in output quality and production, with less focus on new products or input resilience. Of the companies which have already invested in climate measures, around 40 percent cited increased product quality as the main benefit. Increased production came second (32 percent), followed by access to new markets (30 percent). Services firms primarily consider access to new markets and new services as the key opportunities stemming from climate investments, while for agricultural and manufacturing firms product quality features highest. Companies which identified sustainability risks and opportunities invested significantly more in climate measures. This suggests that increasing the awareness of climate change risks could yield material benefits and increase investment. At the same time, it is crucial that the enabling environment is in place to crowd-in private investment.

Figure 29– Nearly all agricultural firms, and two-thirds of manufacturing and services firms, perceive opportunities from climate action



Note: Respondents were asked: 'Did these investments present any of the following opportunities for your business?
Source: IFC calculation based on ITC SME Competitiveness Survey.

147 CCDR background note for financing sector.

Crowd-in private sector financing by deepening the financial sector

The long-term financing instruments that are key for climate change adaptation are still too shallow. Bank credit accounts for 82 percent of total private domestic funding in Benin. The credit structure has remained broadly the same over the years, with most credit focusing on short- and medium-term financing. Long-term credit, which is generally used for the types of structural investments particularly needed for the green transition and resilience, is poorly financed and represented only 4 percent of the overall bank lending portfolio in 2021. Other long-term financing instruments, such as equity finance and capital markets, remain shallow and do not yet offer a material alternative to bank financing.

Relatively little progress has been made on private sector financing in capital markets in general and green financing in particular at the WAEMU level. No corporate green bond had been issued in Benin as of mid-2023, and overall uptake in the WAEMU also remains negligible.[148] The market for corporate green bonds is nascent, especially compared to other countries across SSA. For example, as of March 2023, Nigeria and South African companies respectively registered around US$200 million and US$1.3 billion in outstanding green bonds.[149] Overall, capital markets in WAEMU are shallow. In 2020, the market capitalization and the amount of resources raised across the WAEMU stood at CFAF 10.42 billion and CFAF 2,018 billion respectively. The market is dominated by bond issuance (97 percent of issuance), with equity representing only 3 percent. The shares of private and regional organizations (2.7%) and foreign investors (0.03%) are low. Government bond issuance constitutes 95 percent of total securities in the WAEMU market. The strong presence of sovereign financing throughout the WAEMU financial sector can crowd out the private sector by disincentivizing investors from considering other types of assets and discouraging private issuers. As of January 2020, there were 46 listed firms, 2 rating agencies and 22 fund managers for OPCVM (*Organisms de placement collectif de valeurs mobilière*s). A dedicated SME window has also been created, but no companies have listed yet. The market lacks the necessary critical mass, participation (issuers, investors, etc.) and product diversity. The WAEMU authorities (the Regional Council for Public Savings and Financial Markets/*Conseil Regional De l'Epargne Publique et des Marches Financiers,* CREPMF) have acknowledged this gap and adopted a guide for the issuance of green, social and sustainable bonds on the regional financial market in March 2020.[150] In addition to this guide, the authorities are exploring measures to tackle existing regulatory bottlenecks.

The financial sector in Benin is dominated by the banking sector, which is profitable but has difficulties serving the private sector – challenges which are even more pronounced when it comes to climate financing. The profitability of the banking sector has improved.[151] However, firms still cite access to finance as their main constraint to business development.[152] Fewer than one in four firms has access to bank credit or a line of credit, and only 12 percent of all enterprises use a bank to finance their investments, compared with an average of 19 percent in SSA.[153] When SMEs are able to access bank financing, they must pledge a significant guarantee value (i.e. on average 231.3 percent of the loan amount, compared to 203.7 in SSA). At the end of 2021, the top five banks accounted for more than 75 percent of the banking sector's assets and loans, and the three largest MFIs accounted for 57.8 percent of microfinance loans. The ability of a bank to finance firms is limited by (i) a high exposure to state-owned enterprises; (ii) a high historic stock of bad loans and levels of NPLs above the regional average (11.5 percent); and (iii) competition from government securities.[154] The lack of adequate collateral is another obstacle, while the lack of credit information on firms elevates the risk premium. This also explains the limited uptake of debt instruments and hampers the development of more vibrant capital markets and corporate green bonds.

Climate financing remains nascent. Commercial banks are not funding climate projects at present, and authorities have not yet introduced formal labels for green lending products and banks' financing flows for climate and environmental projects. More financing mechanisms for green technology adoption at the firm level, for example, would be welcome.

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148 The sustainable debt monitor is based on Bloomberg data and has a coverage of 141 emerging and frontier markets. More information can be found here: https://www.iif.com/Products/Sustainable-Debt-Monitor.

149 It is important to note is that these figures only encompass the issuances captured by Bloomberg data. As a result, the actual level of green financing might be higher. For example, the green bond issued by a commercial property developer in Côte d'Ivoire is not registered in the data. Next to this, measuring the value of green finance remains a common challenge, as the absence of consistent standards or certification makes it difficult to pinpoint the global "ESG"-asset size, with estimations going from $3 trillion (J.P. Morgan 2019) to $31 trillion (Global Sustainable Investment Alliance 2019).

150 This guide to green, social, and sustainable bond issues aims to: (i) broaden the base of potential investors; (ii) improve the conditions for financing ambitious projects, by targeting investors who are sensitive to the objectives and commitments announced; (iii) be part of the sustainable development objectives and demonstrate the commitment of the union authorities to achieving these objectives. It is aligned with the standards of the ICMA (International Capital Markets Association). In addition, OHADA accounting standards have been reformed to bring them closer to IFRS standards.

151 Measured by the improved ROE and ROA compared to 2020, which stood at 13.8% and 1% respectively, as well as the quality of lending portfolio (NPL) which was at 12.5% against 16.2% in 2020.

152 World Bank (2023). Country Private Sector Diagnostic for Benin.

153 World Bank (2023). Findex Database.

154 World Bank (2023). CPSD Benin.

De-risk investments and public-private partnerships

While continuing to support the deepening of financial markets, public resources are still required to de-risk projects, provide concessional credit, and backstop against certain shocks. The government should explore a range of options to not only crowd-in new sources of finance, but also to leverage the more concessional financing to incentivize private sector investment. The focus should be on maximizing concessional and semi-concessional sources of financing, deploying them to de-risking and blended structures that crowd-in private sector funds, and exploring ways to raise additional public funds through instruments that may be financially efficient, such as credit-enhanced sustainable or green loans, sustainability-linked bonds, and others.

Mobilizing concessional funding to de-risk investments, combined with targeted facilities set up by Beninese authorities, could help stimulate finance for adaptation measures. The nature of adaptation projects, specifically their long horizon for realizing returns and the relatively challenging calculation to determine their benefits, is a major impediment to their financing.[155] Private sector climate financing continues to be constrained by perceptions of high risk because of uncertainties over future climate policies, technological costs, and the economic effects of climate impacts, while high upfront costs still often result in insufficient returns for the existing risks.[156] For example, improving irrigation or updating production processes require large up-front investment and it is often difficult to know when exactly the financial returns or enhanced competitiveness will materialize. Governments can mitigate this through implementing a pipeline of NDC adaptation projects.[157] De-risking such projects, through targeted public investments, could unlock greater private sector participation and have positive replication effects. In other markets, climate-related insurance schemes have provided an alternative to mitigate firms' climate vulnerability. However, the relatively underdeveloped insurance market in Benin means this is likely to be a longer-term solution which requires capacity building from national and international stakeholders.

Channeling resources from multilateral development banks and international financial institutions, through, for example, credit guarantees, securitized products, hedging- or risk sharing arrangements, could help tackle these challenges. Scaling these instruments targeted at climate measures could help to tap into new domestic and international financing sources and help to grow the overall level of private sector investment in Benin. For example, finance from climate funds could be targeted at the NDC to implement risk-sharing arrangements with private financiers.

Public-private partnerships (PPPs) are another critical tool for advancing private sector involvement and technology transfers for both mitigation projects and more resilient infrastructure. The authorities promoted PPPs as a means of financing 61 percent of planned investment in the first Government Action Plan (2016–21) and have set the target at 52 percent for the second Government Action Program (2021–26). Strengthening the PPP framework, creating a knowledge-sharing mechanism to improve capacity to mobilize the private sector, and establishing a pipeline of potential PPPs is required. For example, the legal framework still has shortcomings in comparison with international best practice, including the lack of specific budgetary control during execution, and a lack of rules regulating unsolicited proposals. Because funding is limited, a strong institutional/regulatory framework and a careful investment-pipeline evaluation based on economic returns are paramount.

The following key sectors should be prioritized for private sector participation:

(1) **Energy:** Benin is endowed with vast potential for renewable energy, which could form a stepping stone towards kickstarting the development of green financing instruments to meet the country's mitigation targets. The implementation of ongoing reforms in the energy sector has provided significant opportunities for greater private sector participation, in both on-grid and off-grid areas.[158] These measures have been instrumental for the development of renewable energy projects, notably solar IPPs. More recently, the government has been implementing both public and private solar projects to be connected to the grid, as well as installing mini-grid solar plants and distributing solar home systems. These developments create a tremendous demand for sustainable infrastructure projects and private sector solutions, the combination of which should provide a solid pipeline of sustainable projects.

(2) **Transport:** The government is actively seeking to mobilize private capital to finance public transport, the electrification of motorbikes, and resilient roads, among others. Specifically, in order to finance transport infrastructure, the government should : (i) assess the benefits of optimizing its toll system (existing and potential new ones); (ii) consider an increase or optimization of its taxes levied by SIRAT (the road infrastructure and land use planning society); (iii) consider an increase or optimization of its taxes levied by customs (49 percent of current maintenance funds come

155 IMF (2022). Mobilizing Private Climate Financing in Emerging Markets and Developing Economies.

156 Ibid.

157 Ministry of Foreign Affairs of the Netherlands (2018). Climate Change Profile Benin.

158 In January 2020, Benin adopted a new Electricity Code and related regulatory measures. Importantly, the code stipulates different regimes (concession, authorization) for private participation in both on-grid and off-grid areas. In February 2020, the government also adopted a decree to implement the code, specifying how private partners can invest in the energy sector.

from road taxes levied by customs on imported goods, hydrocarbon tax revenues, and heavy vehicle traffic tax revenues – of CFAF5,000/vehicle). In 2021, an Indian electric mobility company was launched in Africa, in Togo and Benin. An agreement has been signed with the Government of Benin to produce electric vehicles in the Glo-Djigbé industrial zone near Abomey-Calavi. Battery recharging stations have been installed in Cotonou. In May 2022, the first two electric bicycle models adapted to the African market were launched. However, the lack of a clear and supportive regulatory framework could prevent the e-mobility market from taking off. Strengthening institutional capacity, coordination and financial capability between agencies concerned with the resilience of the sector is necessary to crowd-in private investment, as is improving data availability and data/transport planning systems. Finally, the resilience and sustainability of the transport sector will also require greater involvement by the private sector and private companies from the agricultural or mining sectors (as has been initiated in Cameroon or the DRC), given existing financial constraints.

(3) **Water:** The water supply sector is undergoing an ambitious reform consisting of ensuring state control of the water supply assets and entrusting their management to regional operators through PPP delegation contracts throughout the country. A similar reform is underway for urban water supply, which aims to reproduce the management model for water supply services delegated to an operator. This presents significant opportunities for private financing of the sector, provided an adequate institutional framework is in place.

(4) **Housing:** Increased private sector participation is much needed to upgrade Benin's degraded housing stock, which remains particularly vulnerable to climate risks. Most houses in Benin were built between 30 and 50 years ago. The bulk of the housing stock has significantly degraded since then due to a lack of proper maintenance and the insufficient development of new construction projects. To fill this gap, the government has announced a flagship project for building 20,000 housing units as part of the *Programme d'Actions du Gouvernement* (PAG). The large number of newly constructed housing units, especially the new city of Ouèdo, is an opportunity to make buildings more energy efficient. Ensuring that stricter adaptation requirements are incorporated in new construction projects, for example through the building code, will be critical to enhance the population's climate resilience.

6.2. Key policy actions for financing climate action

Table 10 summarizes the key policy and investment options for financing climate action**.** The actions are organized by sector, and by whether they are policy actions – which are regulatory/institutional in nature – or investment actions, which require hard investment (e.g., construction, an operational budget, etc). Complexity levels were defined together with government counterparts through an inclusive consultation process which considered feasibility, presence in government strategic documents, budget plans, and political economy. "Expected financing source" indicates the most likely source of financing.

Table 10: Summary of key policy options and investment actions for expanding financing options

Area	Action	Complexity	Fixed cost	Expected financing sources
Macro	**Policy action Macro1:** Conduct an assessment of environmental taxation and incorporate an effective green taxation system, including carbon taxation.	High	-	Public budget (PB)/ Concessional resources (CR)
Macro	**Policy action Macro2:** Strengthen the institutional capacity of the SDG Bonds Monitoring Unit on the functioning of bond markets, and for choosing targets for sustainability-linked bonds as well as SDG impact standards.	Low	-	PB/CR
G/Public financial management (PFM)	**Policy action G1:** (i) strengthen budget planning instruments by systematically considering the climate risks; (ii) develop a standard methodology for climate change impact assessments by integrating the systematic assessment of climatic risks and including more climate-sensitive project selection criteria; (iii) take into account the impact of climate change in the methodologies for maintenance needs of public assets; (iv) estimate and track more systematically the contributions of public investments to GHG emissions and adaptation objectives; (v) ensure SOEs report on climate change action; (vi) strengthen the coordination of climate actions with central government, especially the planning tools and capacities related to planning, budgeting and monitoring of climate actions.	High	-	PB/CR

Area	Action	Complexity	Fixed cost	Expected financing sources
FIN	**Investment action FIN1:** Reinforce the institutional capacity of the debt management office to support the issuance of thematic ESG-linked bonds.	Medium	-	PB/CR
FIN	**Policy action FIN2:** Institutionalize the collection of data on economic damage and losses, as well as on expenditures related to all types and severities of natural disasters, centralized by MoEF (DGE and INStaD).	Medium	-	PB/CR
FIN	**Policy action FIN3:** Expand the strategic scope of the *Caisse des Depots et Consignations (*CDC) to develop financing instruments suitable to the MSME market. The *Cadre National de Financement Intégré* (CNFI) has identified the need for a specialized SME bank. Beyond direct financing, the CDC could also explore options to implement risk-sharing arrangements with private financiers and to deploy equity solutions.	Medium	-	PB/CR
FIN	**Policy action FIN4:** Increase the number of bankable projects by (i) building the capacity of more established corporates to develop key adaptation or mitigation projects in order to create a demonstration and replication effect; (ii) promoting issuances by local banks by providing support on portfolio construction and eligibility guidance; and (iii) promoting guarantees from the state or international financial institutions to lower the risk premium.	High	-	PB/CR
FIN	**Policy action FIN5**: Support the development of solutions and platforms, possibly private, that can fill information gaps in areas such as climate variability, agricultural productivity, input management, market access, market linkages, and supply chain management after harvest.	Medium	-	PB/CR
FIN	**Policy action FIN6:** Boost blended finance in infrastructure, and the development of PPPs: (i) establish a pipeline of potential PPPs to leverage private expertise and capital; (2) adopt the implementing decrees of the PPP Law.	Medium	-	PB/CR

6.3. Priority actions for a more resilient pathway across all sectors

Given Benin's limited resources, and the complex interactions among the different policy and investment actions laid out in the chapters of this report, the table below attempts to prioritize the most pressing interventions. The most urgent actions with greatest co-benefits and impact (in no particular order) are presented in the left-upper quadrant of the table. The top right quadrant contains actions that require more preparation and timing; although they remain critical, the cost of inaction is considered to be more moderate. The lower-left quadrant presents urgent actions that require consensus building and should be designed considering the political economy, complexity, financing mechanism, among others.

Table 11. Maximize synergies and unlock potential gain

	Game changers - critical actions (actions which if delayed will have systemic consequences and increase costs)		**Tier 2 critical actions** (actions which if delayed will have systemic consequences but more moderate costs)	
	Sector	***Action***	***Sector***	***Action***
Synergies (actions that facilitate other objectives)	Agriculture (AG2)	Finalize rural land titling reform by reinforcing institutions at the Ministry of Agriculture in charge of the reform.		
	Urban management (UM2)	Promulgate the new building code, adopt the secondary legislation, and increase enforcement capacity of building codes/land use under consideration of gender equality principles; and protect the coast from erosion and flooding.	DRM (DRM1)	Develop a multi-risk mapping, early warning systems and the further use of digital information and tools with the aim to reach all social groups, including women, rural residents, and vulnerable populations.
	Energy (E2)	Ensure that the resilience to climate change of electricity generation, transmission and distribution infrastructures is analyzed at the design stage and that the measures identified are considered when the work is carried out; and vulnerable sites protected.	Transport (TR1)	Develop a road asset management system for a more strategic allocation of resources towards maintenance and modernization interventions; and a thorough criticality analysis of the road network to ensure that climate-related events do not disrupt links essential to agriculture and other economic activities.
	Gender (GG1)	To benefit from the demographic dividend, ensure women are represented in climate action decision-making, increase the representation of women across all relevant decision-making bodies (e.g. ensure participation of women and girls in consultation processes on urban planning /DRM/ climate change adaptation policies).	Transport (TR2)	Incorporate climate-resilient design parameters into future transport infrastructure. Pilot low-cost nature-based solutions to increase resilience and reduce erosion. .
	Governance (PFM)	Strengthen budget planning instruments by systematically considering climate risks. Develop a standard methodology for climate change impact assessments in the PIM by including climatic risks and more climate-sensitive project selection criteria.	Water	Continue investments in urban sanitation and storm water management to effectively address flooding risks and ensure proper management of sewage sludge.
	Forests (FO2)	Restore/reforest 0.45 million ha of degraded land (to restore forest cover to 2015 level) and strengthen forest governance by adopting a new forestry code.		

	Sector	Action	Sector	Action
Actions that require building consensus (due to high costs, political economy complexity, among others)	Water (WA2)	Operationalize the user-payer principle for commercial use of water resources to mobilize financial resources, following the adoption of a ministerial order that defines this principle across all water subsectors.	Education and Health	Develop a strategy for the health and education sectors that integrates climate change and ensure resilient buildings/institutions (e.g safe schools).
	Water/Agriculture	Remove financial and regulatory hurdles for the implementation of the hydro-land management in rural areas for agriculture use.	Macro	Incorporate an effective green taxation system including carbon taxation.
	Energy	Invest in network infrastructure, including digitizing and compliance of the grid's operating network to reduce the amount of unserved energy and the related losses in economic productivity.	Energy/Forests	Implement the *National Strategy on Clean Cooking* to achieve universal access.
	Social protection	Continue building an adaptive social protection system by (1) updating data for populations at risk of flooding, relying on mobile payment transfers for faster delivery of benefits in case of a shock, and (2) using the social registry to scale up interventions as needed, including adding new beneficiaries (horizontal expansion) and/or increasing the cash transfer amount (vertical expansion).	Financial sector	Regional level action: (1) The BCEAO should conduct stress testing on the largest banks in Benin to assess the impact of climate change on the financial sector; (2) BCEAO should integrate climate risks into its supervisory framework (e.g., AMF-UMOA has not yet introduced the climate risk disclosure guidelines for corporates).
	Coastal management	Harmonize the regulatory framework on coastal management, including the interactions and hierarchy between the different laws and regulations, especially with regard to territorial planning, (equal access in property ownership, and other environmental issues (pollution and biodiversity), and the use of natural resources.		

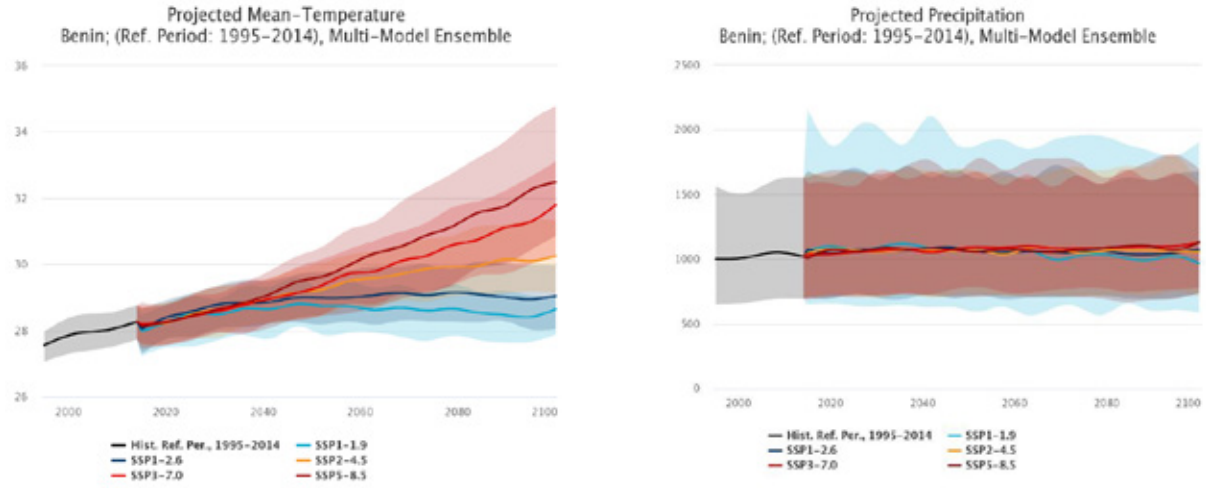
Annexes

Annex 1: Selecting climate change scenarios

To address climate uncertainty in the macroeconomic analysis, a total of ten climate scenarios were selected, two of which focus on emissions uncertainty, and eight of which capture uncertainty across climate models. The climate scenarios were provided by the World Bank's Climate Change Knowledge Portal (CCKP) for 29 General Circulation Models (GCMs) from the Coupled Model Intercomparison Project 6 (CMIP6) suite of IPCC model outputs. On the CCKP, each GCM has up to five combinations of Shared Socioeconomic Pathway (SSP) and Representative Concentration Pathway (RCP) emissions scenario runs. For each GCM-SSP combination, CCKP provided a modeled history from 1995 to 2014 and projections from 2015 to 2100 for monthly mean temperature and precipitation and 1x1 degree grid resolution.

Given that GCMs are biased relative to observed climate conditions, we applied the bias-correction and spatial disaggregation (BCSD) technique to disaggregate the projections to 0.5 x 0.5 degree grid cells and then bias correct these projections using the observed historical dataset from 1995 to 2000 from the CRU TS4.0 dataset of the University of East Anglia (Harris et al. 2020). Then, we interpolated monthly data to a daily timestep using a daily historical hindcast from the Terrestrial Hydrology Research Group from Princeton University (Li, Sheffield, and Wood 2010).

Figure A1 - Climate variables across a range of SSP-RCPs for Benin



Source: World Bank CCKP.

Figure A1 shows the CCKP projected mean temperature (left-hand graph) and precipitation (right-hand graph) for Benin to 2100. The bold lines are averages across GCM projections for each of four RCPs, and the shaded zones surrounding those lines are the full range of GCM projections within an RCP. As can be seen, projected precipitation varies widely across GCMs, but GCM ensemble averages (the bold lines) do not change significantly relative to the baseline. For this reason, it is important to select a set of climate futures that captures a wide range of possible conditions.

Following the World Bank guidance from February 3, 2022, "Global scenarios for CCDR analyses", two scenarios were selected to allow for comparisons across emissions scenarios. These are referred to as mitigation scenarios:

1) Ensemble average of SSP3-7.0 GCMs: Pessimistic Case. Scenario in which warming reaches 4 °C by 2100, due to lax climate policies or a reduction in ecosystems and oceans' ability to capture carbon.

2) Ensemble average of SSP1-1.9 GCMs: Optimistic Case. Represents reductions in GHG emissions in line with limited 1.5 °C of warming by 2100.

A second goal was to select scenarios that capture the broadest range of climate change effects across GCMs to assess the vulnerability of the economy and the performance of adaptation options under possible wet vs dry and hot vs warm GCM outcomes. We selected the following set of scenarios for Benin, based on changes from the baseline climate through 2031 and 2050:

3) Dry/hot future scenarios: Three scenarios around the 10th percentile of mean precipitation changes and the 90th percentile in mean temperature changes, across SSP2-4.5 and SSP3-7.0 GCMs, as well as a mean across those three scenarios.

4) Wet/warm future scenario: Three scenarios around the 90th percentile of mean precipitation changes and the 10th percentile in mean temperature changes, across SSP2-4.5 and SSP3-7.0 GCMs, as well as a mean across those three scenarios.

The selected SSP and GCM scenarios are presented in Table A1.

Table A1 - Climate scenarios used for the CCDR analysis

Type	Scenario
Dry / hot future	SSP3-7.0 KACE-1-0-G
	SSP2-4.5 CNRM-ESM2-1
	SSP2-4.5 GFDL-ESM4
	Dry/hot mean
Wet / warm future	SSP3-7.0 INM-CM4-8
	SSP2-4.5 MIROC-ES2L
	SSP2-4.5 INM-CM5-0
	Wet/warm mean

Sources: IEc Report 2023, CCKM.

Annex 2: Macro-modelling using MANAGE: the baseline scenario and key assumptions

A macroeconomic model has been developed to integrate climate scenarios, adaptation and mitigation choices, financing options and their impact on key macroeconomic aggregates. This model – the World Bank's Mitigation, Adaptation and New Technologies Applied General Equilibrium (MANAGE) model – is a single-country, recursive, dynamic computable general equilibrium (CGE) model, designed to focus on energy, emissions, and climate change. Climate change is likely to have direct and indirect effects on the Benin economy. The former – in the form of water supply, land use and erosion, extreme events like flooding, sea-level rise and human health – are introduced in the macro and micro models through damage vectors (i.e., channels such as sectoral and labor productivities, labor and capital supplies) estimated by a biophysical model (Annex 5). Indirect effects accrue from various channels such as production linkages, factor substitution and intersectoral mobility, the fiscal framework, and trade. MANAGE is sufficiently flexible and detailed to deal with a wide range of climate shock transmission channels, and captures the effects along several dimensions. These include national accounts (GDP, consumption, and investment), the fiscal framework (government revenue, deficits, and debt), the external account (trade, foreign investment, and the current account), as well as the distributional impact across industries, factors of production, and households, identifying those likely to be most adversely affected. Climate action is introduced via adaptation and mitigation policy scenarios capturing the effects of a various financing options, thereby identifying trade-offs. When available, a detailed analysis of energy supply and demand can be incorporated, taking into consideration various sources of electricity generation and the corresponding energy mix. Finally, the model is set up to include and track the evolution of GHG emissions by type and source.

The baseline

For the CCDR exercise, a growth pathway was calibrated to 2050 to form the baseline for analyzing the impact of climate change on long-term economic development.[159] It assumes that current development ambitions are met by sustaining historical productivity growth rates over the medium term, and increasing from 2040 onwards, with potential growth converging to 5 percent by 2050. This path is underpinned by investment in human and physical capital and improvements in the business environment that raise the efficiency of factor allocation, as envisaged in the Vision 2060. We assume an annual rate of deforestation of 1.6 percent per year between 2015-20. We model two energy mixes: (i) one at baseline that follows the Least-cost Energy Development Plan; and (ii) an alternative scenario with a more ambitious renewable energy (RE) mix. Progressive urbanization and the process of economic transformation would suggest Benin reaches 70 percent urbanization levels by 2050. Demographic trends modelled follow high demographic transition UN population scenarios that foresee population growth remaining just above 2 percent in 2050 (this compares to below 2 percent in the median population scenario, which is unlikely). The baseline assumes compliance with the WAEMU convergence criteria on the fiscal accounts starting in 2025 and remaining constant thereafter. It does not assume actions to increase adaptation to or mitigation of climate change beyond those already planned in existing government development strategies. Results presented throughout the report will include deviations from the baseline across climate shock channels, with and without additional adaptation and mitigation efforts. Table A.2 summarizes key macroeconomic aggregates over the modelling period.

The modeling has been undertaken in a context of high uncertainties about future climate outcomes, technologies, policies, and development paths. It quantifies results using a large set of assumptions in order to help assess the challenges and trade-offs. However, the answers are not definitive and specific numbers should be used cautiously. The key modeling caveats and limitations are summarized below:

Missing channels and pathways: There are a large number of potential impact channels; however, for this report only ten channels have been modeled, so estimates of GDP impacts are not comprehensive. Some important channels are difficult to model, for example, the impact of climate change on nutrition and educational attainment, which have life-long consequences for individuals' health, learning, productivity, and earnings.

Magnifying effects: The macroeconomic modeling stops at 2050 and does not include potential magnifying factors in the region such as intensified conflicts over resources (for example, water), the possibility of ecosystem collapse, and the acceleration of climate-induced outmigration. The risks of these magnifying factors being realized are considerable, especially beyond 2050 if global emissions do not drop rapidly. They would make total GDP and poverty impacts much larger than those estimated in this report.

159 To model uncertainty with respect to climate change and to economic trajectories the modelling is based on two sets of results combining two different climate scenarios.

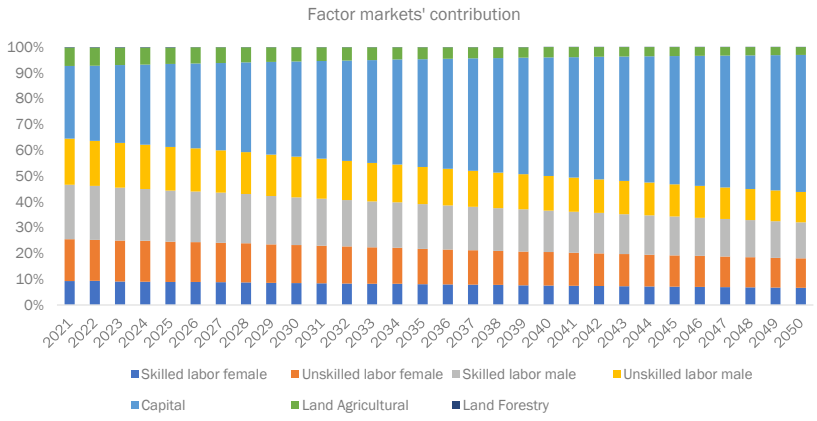
Not fully capturing the positive effect of inclusive development on reducing the impacts of climate change: The modeling only marginally accounts for how higher incomes, better access to infrastructure (such as power for fans, improved water and sanitation, and improved access to health care) and financial support (such as access to finance and insurance, and strong social protection) will enable adaptation responses by households and firms to reduce the impacts of climate shocks.

Table A2 - Key macroeconomic variables: Baseline scenario

	Baseline			
	2021	**2030**	**2040**	**2050**
National income (constant 2020)				
Real GDP (CFAF billions)	9,910	16,719	29,057	48,909
Real GDP (US$ billions)	17.8	30.1	52.3	88.0
Real GDP per capita (US$)	1,372	1,805	2,429	3,242
Real household consumption per capita (US$)	969	1,091	1,374	1,767
Average annual growth, % [(1)]				
Real GDP	5.2	6.0	5.7	5.3
Real GDP per capita	2.5	3.1	3.0	2.9
Shares in GDP (% of GDP)				
Private consumption	67.3	60.4	56.6	54.5
Government consumption	10.1	11.5	12.0	12.0
Private investment	21.1	22.0	22.8	22.9
Government investment	6.0	6.0	7.6	7.7
Net exports	-6.2	-5.2	-2.9	-0.7
Sectoral shares in GDP (% of GDP)				
Agriculture	28.5	28.1	24.4	22.8
Industry	16.5	18.5	20.2	21.6
Services	45.9	53.3	55.3	55.6
Fiscal aggregates (% of GDP)				
Tax revenue	11.0	15.2	17.5	18.0
Fiscal expenditure	16.7	19.0	22.6	22.4
Borrowing requirement	-6.6	-6.7	-6.5	-6.1
Public debt	50.3	46.9	43.4	44.2
- o/w External public debt	36.8	25.2	21.5	21.5
Population and employment				
Total population (millions)	13.0	16.7	21.5	27.2
Total population growth rate (%)	2.8	2.7	2.4	2.2

Source: World Bank staff estimations, MANAGE outputs. Notes: National income variables are presented as level results. [(1)] Average annual growth since preceding period (2012 for the first column)

Figure A2 – Factor markets over simulation period



Source: World Bank staff estimations, MANAGE outputs

Annex 3: Microsimulations: impacts on poverty and equality

The microsimulations were used to forecast the impacts of climate change and climate policies on poverty, inequality, and the overall income distribution, and identify potential winners and losers. More precisely, in this section when we talk about the "distributional impact of climate" we will be referring to a "microsimulation model linking macro model outputs produced for the CCDR to household level outputs".

Data

Two main types of data are required for this analysis: macro-level inputs that feed the CGE model and micro-level information collected from a household survey.

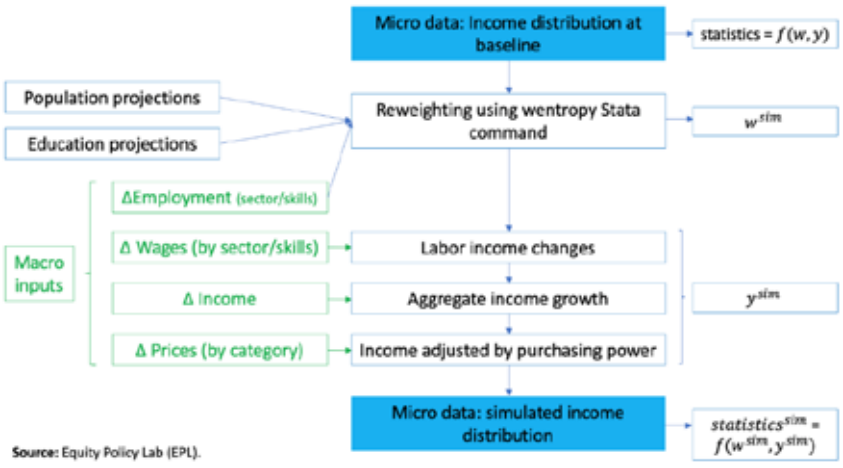
The Harmonized Survey of Household Living Conditions (*Enquête Harmonisée sur les Conditions de Vie des Ménages*) or EHCVM 2018/19 is a nationally representative household survey implemented within the West Africa Economic Monetary Union (WAEMU) with the goal of producing household survey data in Benin, Burkina Faso, Chad, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal, and Togo. For Benin, the survey collects information from approximately 8,000 households across all geographic regions of the country. The survey was implemented in two waves to account for the seasonal patterns of consumption. Across these waves, the survey collected comprehensive household-level information covering a spectrum of areas, including education, healthcare, employment, sources of non-employment income, savings and credit patterns, food consumption, food security, nonfood expenditure, nonagricultural business ventures, housing, household assets, financial transfers, encountered shocks, survival strategies, agricultural pursuits, etc.

Methodology

The approach used for simulating the micro-impacts of climate change in Benin follows a microsimulation based on a CGE reweighting approach. This method involves three stages. Figure A3 illustrates the different stages involved.

The first stage of the microsimulation involves preparing the household data and the main variables required for this analysis. The two key variables in the top blue panel are the vector of welfare "y", and the vector of weights "w". For the baseline, both variables are typically obtained from the household survey. The weights allow us to compute statistics in our sample that are representative of the entire population (i.e., assuming the household survey followed a standard representative sampling design). In Benin, the household survey we rely on is the EHCVM 2018/19. Using the welfare and weights vectors is sufficient to create a welfare vector that allow us to estimate poverty, inequality, and other distributional statistics.

Figure A3. CGE approach



The second stage of this procedure consists of simulating the vectors of welfare y^sim and weights w^sim in future periods, starting from the base welfare (y) and weight (w) vectors. These new vectors will be used to produce simulated poverty and inequality statistics from 2021 to 2050. This analysis requires using three main inputs: population projections, education projections, and projections of macroeconomic inputs such as the share of employment by sector and skill level. These inputs are used to perform the reweighting procedure that allows us to match the population projections under a set of constraints.

Population projections: since the objective of the simulation is to produce long-term projections, we need information on the future size and profile of the population (e.g., for instance, gender, age cohort group, and/or location). We rely on United Nations (UN) projections (by 5-year age group).

Education projections: In practice, the microsimulation model does not require the specific years of education but uses education attainment to classify the population by skill level for the purposes of the labor market (e.g., alternative classifications include skilled/unskilled, or low-skill/mid-skilled/high-skilled).

Changes in employment by gender and skill level: The CGE model will produce employment allocations across different economic sectors based on the classification available on the social accounting matrix (SAM) available for Benin.

Then, we use linkage variables to obtain the new simulated welfare vector. These variables include the change in prices, the change in wage by sector and education levels, and the change in aggregate income.

Next, it is necessary to rescale and recenter wages and then income/consumption to account for changes in the wage/income structure by sector and type of worker (when possible) between baseline and target years. To improve the estimates of consumption, we also use pass-throughs that reflect how changes in income translate into changes in consumption. These improved estimates of the sensitivity of consumption to changes in income would also allow us to produce a more nuanced projection of the evolution of poverty and inequality in the long run.

Baseline welfare, labor, and non-labor income

To simulate the long-term impacts of climate change on poverty and inequality, it is necessary to define a measure of welfare. The measure of welfare in this analysis is the per capita household income aggregate, defined as the sum of labor income and non-labor income. Labor earnings are aggregated across all household members in all sectors of activities. Non-labor earnings can come from transfers, remittances as well as transfers from the government. Labor income might present a challenge in many instances if either individual labor earnings are not available or if this variable is missing for many households. Solutions employed in the literature generally include either the imputation of missing values using the observed ones or the assignment of an "assumed" labor income, which is defined as the gap between household consumption (expenditure) and the income from non-labor household sources.

To obtain the subnational population projections for Benin for the years 2025–2050, we followed these steps:

1. First, we extracted the population estimates in 2020, 2025 and 2030 from a spatial raster, using the shapefiles from administrative regions of Benin (i.e., **GHS Population Grid Multitemporal**[160]).
2. Then, we computed population growth rates, from 2025 to 2030, specific to each administrative region.
3. Next, we applied the growth rate for 2030 to estimate population totals in each administrative region in 2035, 2040, 2045 and 2050.
4. Finally, we adjusted the aggregated population estimates in each year to make them consistent with the national population projections used in the CGE model.

Below, we elaborate on each of these steps:

1. Extract population projections from the spatial dataset

- The input for the population projections was **the GHS Population Grid Multitemporal**, a spatial raster that depicts the distribution of residential population across the world, expressed as the number of people per cell. It contains population estimates between 1975 and 2020 in 5-year intervals and projections to 2025 and 2030 derived from CIESIN GPWv4.11 at the grid level. We used the version of the dataset with 1 km grid resolution.
- Then, we used shapefiles for Benin's administrative regions (at the adm2 level) to extract the population living in each administrative region in 2020, 2025 and 2030.
- We used the QGIS software to perform this step.

2. Compute population growth rates

- We exported the population projections to Stata and computed the population growth rates for each administrative region.
- We used the following formula (for example, for the 2020-2025 period):
  Growth 2025 = (Population in 2025 – Population in 2020) / Population in 2020

160 https://ghsl.jrc.ec.europa.eu/ghs_pop2023.php

3. Estimate population projections for 2035-2050:

   - We then used the population projections for 2030 and the growth rate for each administrative region between 2025 and 2030 to calculate population projections for the 2035–2050 period.

4. Rescale aggregate subnational population projections to match the national population projections:

   - In the last step, we adjusted the subnational population projections using the national population projections used in the CGE model.
   - To do this, we first computed the sum of the population projections in all subnational regions for a given year.
   - Then, we followed the formula, for example in 2035:
     *Adjusted Pop in 2035 = Pop in 2035 * (Sum of subnational pop in 2035 / National population in 2035 used in CGE model)*
   - This was done for the population estimates and projections for 2025–2050. The adjusted population is the variable used for the microsimulation model.

The next step is to produce estimates of the size of the population by age group and by education level (or by skill level). Typically, the CCDRs use United Nations population projections (by 5-year age group) or projections from national statistics office (when available). A novel approach in this exercise is that we augment the UN population projections with spatially disaggregated population projections. Long-term projections of populations by education level are generally not available. To work around this, we make two assumptions following the GIDD model (Bourguignon & Bussolo 2013).

The first assumption is that the young cohort in current years will keep their level of education in the future. The second assumption is that the young cohort in the future does not improve its level of education vis-à-vis the young cohort of the present.

Reweighting and micro-simulations

The next step in the microsimulation approach is to construct new weights for each household over the projection period. The reweighting involves the use of age-sex composition, human capital accumulation, and changes in the employment structure. This procedure is achieved through the following steps.

Bringing UN population projections and aggregating cohorts

This step amounts to importing UN population projections and aggregating them by age and sex. The resulting population dataset will include as many rows as age groups and as many columns as gender by year groups. In the case of these microsimulations, this dataset would include 21 rows and 60 variables (30 years * 2 genders).

Generating target matrices based on education and cohorts

The next step is to create target matrices that incorporate the different constraints that the reweighting process faces. Two main sets of target matrices are important here. The first includes the target employment shares. These matrices include for each scenario and projected year the share of people employed by industry and skill level. In the case of this CCDR, we have 9 industries and two skill levels. The second set of matrices includes for each projection year the share of the population in each region. Benin has 12 regions, therefore each of these matrices includes 12 rows and one column. These target matrices, along with the age-sex population projections, define the constraints that the reweighting process will follow.

Reweighting

The final step of this process involves an exercise of optimization under constraints. Essentially, the optimization problem changes the distribution of certain variables (linkage variables) as it chooses new weights. Practically, we need to find an N-vector that optimizes an objective function Z(w^',w); a function that evaluates the distance between the newly computed weights w^', and the old survey weights w under a set of constraints (Agénor et al. 2003).

Rescaling and recentering

The outcome of the reweighting process is a new vector of weights for all households, but we also have newly generated linkage variables. Since the distribution of these variables has been altered, it is necessary to recenter these variables to align them with the macro-inputs for the CGE model.

Calculating growth rates and using pass-throughs.

We rescale our per-capita consumption growth rates using pass-throughs to incorporate the sensitivity of consumption to changes in income. To calculate the pass-through rates, we run the following regression: Consumption_h^pc = α+β·Income_h^pc+ε_h

Estimating this equation yields a coefficient of 0.81 which we use to rescale per capita consumption growth rates as follows: Cons_(pc,gr)^passthrough (t) = β ̇·Cons_(pc,gr)^((t))

Where Cons_(pc,gr)^passthrough (t) is the per capita consumption growth rate in year t using a passthrough of 0.81. Cons_(pc,gr)^((t)) is the growth rate of per capita consumption in year t relative to the baseline year.

Re-scaling total per capita income (since it includes non-labor income) using projected per capita GDP/consumption growth – between baseline and target year.

Adjust welfare for changes in relative consumption prices, typically for food and non-food but this can be extended to include other items (e.g., carbon-intensive goods).

Projecting measures of poverty

Now that we have both a vector of welfare (y^sim) and of weights (w^sim), the final step is to compute indicators of poverty and inequality across the projection years. We use international poverty lines to define the poor and estimate inequality using the Gini inequality index.

Annex 4: Private sector analysis - firm-level dataset

The International Trade Center (ITC) organized an SME Competitiveness Survey in Benin in 2019, in partnership with the local Chamber of Commerce and Industry. The SME Competitiveness Survey has been implemented in over 40 countries and has covered more than 17,900 firms thus far. The primary aim of the tool is to gauge the sentiment of the private sector on doing business, trade, and competitiveness, as well as to obtain perceptions on issues related to climate change and sustainability. For the exercise in Benin, 502 firms from six economic regions were interviewed, covering the agriculture, manufacturing, and services sectors. The sustainability questions ranged from general enquiries into firm awareness of climate issues, such as whether companies had already identified specific climate risks and opportunities, to specific questions focused on the implementation of mitigation and adaptation measures.

Table A3: Variable operationalization

FIRM CHARACTERISTIC	VARIABLE OF SURVEY	CATEGORIZATION
SIZE	Number of employees	Micro: 1-5 employees Small: 5-19 employees Medium: 20-99 employees Large: 100+ employees
REGION	Main location of firm at time of survey	Parakou, Natitingou, Abomey, Lokossa, Porto-Novo and Cotonou
SECTOR	Main activity of firm at time of survey	Primary Sector, Manufacturing, or Services
OWNERSHIP	Ownership type	Majority-Foreign Owned by private foreign individuals, companies, or organizations
EXPORTER	Share of sales being direct exports	Exporter: at least 10% of sales being direct exports Non-Exporter: less than 10% of sales being direct exports
WOMEN-LED	Female management and ownership	Top manager is a woman, and at least 30 percent is owned by women
REGISTRATION STATUS	Registered National Authority	Registered with or licensed by a national authority

Table A4: Environmental Risks Listed in Survey

FIRM CHARACTERISTIC	FORMULATION OF QUESTIONS
CHANGING TEMPERATURES	Which of the following environmental risks are significant for your business? Changing temperatures
CHANGING SEA LEVELS	Which of the following environmental risks are significant for your business? Changing sea levels
WATER SCARCITY	Which of the following environmental risks are significant for your business? Water scarcity
FLOODS	Which of the following environmental risks are significant for your business? Floods
DECREASED AIR QUALITY	Which of the following environmental risks are significant for your business? Decreased air quality (e.g. air pollution)
MORE SEVERE AND FREQUENT STORMS	Which of the following environmental risks are significant for your business? More severe and frequent storms
DECREASED QUALITY OF INPUTS	Which of the following environmental risks are significant for your business? Decreased quality of inputs (e.g. natural resources)
SCARCITY OF INPUTS	Which of the following environmental risks are significant for your business? Scarcity of inputs (e.g. natural resources)
OTHER	Which of the following environmental risks are significant for your business? Other environmental risk not listed
NONE	Which of the following environmental risks are significant for your business? None

Table A5: Adaptation Measures Listed in Survey

FIRM CHARACTERISTIC	FORMULATION OF QUESTIONS
IRRIGATION SYSTEMS	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Irrigation systems
WATER PURIFICATION SYSTEMS	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Water purification systems
FLOOD PREVENTION SYSTEMS	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Flood prevention systems
POWER GENERATION SYSTEMS	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Power generation systems
SOIL MANAGEMENT PRACTICES	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Soil management practices
TRANSPORTATION MEANS	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Transportation means
AIR POLLUTION CONTROLS	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Air pollution controls
TEMPERATURE CONTROLS	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Temperature controls
OTHER	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? Other measures to reduce environmentally related risks
NONE	In the last three years, did your company invest in any of the following measures to reduce the environmental risks that your company is facing? None

FIRM CHARACTERISTIC	FORMULATION OF QUESTIONS
RENEWABLE ENERGY SOURCES	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? Renewable energy sources
ENERGY-EFFICIENT TECHNOLOGIES	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? More energy-efficient technologies
WATER EFFICIENT TECHNOLOGIES	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? More water-efficient technologies
REDUCTION IN THE USE OF CHEMICALS	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? Reduction of the use of chemicals
WASTE MANAGEMENT SYSTEMS	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? Waste management systems
AIR POLLUTION CONTROLS	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? Air pollution controls
SUSTAINABLE/RECYCLABLE PACKAGING	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? Sustainable/recyclable packaging
OTHER MEASURES	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? Other measures
NONE	In the last three years, did your company invest in any of the following measures to reduce its negative impact on the environment? None

Annex 5: Impact channels

The analysis considers impact channels that will bring about shocks to the country's macroeconomy. These shocks have been estimated by Industrial Economics (IEc). They can be grouped into three categories: (i) human capital, (ii) agriculture and natural resources, and (iii) infrastructure and services.

Developing impact channels involves four stages: (i) obtaining gridded historical and projected climate data for a set of climate scenarios; (ii) selecting, tailoring, and/or developing biophysical models that convert changes in climate data into biophysical shocks (e.g., changes in crop yields); (iii) aggregating grid-level biophysical shocks to national and/or sectoral scales using high-resolution geospatial data; and (iv) producing shocks to be fed into the country's macroeconomic model. Results are aggregated either to national scale inputs (e.g., capital or labor) or to economic sectors (e.g., agriculture) to match the model resolution. For this analysis, we consider 10 channels of impact. Table A6 provides a high-level description of each channel broken down by category. Shocks from each channel are calculated based on changes in climate variables (e.g., monthly precipitation or daily max temperature) for the 30-year period from 2021 to 2050, which is the period covered in the CCDR, relative to a climate baseline from 1995 to 2020. These shocks will then be inputted to the country macroeconomic model.

In addition to shocks for the macroeconomic model, climate change shocks have been generated for estimating poverty impacts. The calculation of poverty shocks follows the same approach as the macroeconomic shock, i.e., the same models, inputs, and assumptions, but results are not aggregated to national scale. Instead, they are provided at higher resolutions to match available poverty microdata. When possible, poverty microdata will also be used to inform the inputs and assumptions of the general channel modeling. The following impact channels will consider poverty outputs: labor heat stress, human health, rainfed crops, and livestock.

Impact channels rely on stylized biophysical models that are capable of incorporating climate information and projections, and simulate changes in biophysical (e.g., streamflow or infrastructure conditions) and/or socioeconomic (e.g., labor supply hours) variables. These variables are then translated into inputs to the macroeconomic model. As mentioned, the biophysical models will be customized to the country context. This is achieved by using country-specific inputs, obtaining key assumptions from country experts and available literature, and calibrating outputs using local data. Alternative scenarios that consider policy decisions and investments (for the purpose of climate change adaptation or general development of the country) have also been included in the modeling by modifying these inputs and assumptions (Annex 6).

Table A6 - The 10 impact channels

CHANNEL OF IMPACT		DESCRIPTION
HUMAN CAPITAL		
1	**Labor heat stress**	Shock to labor productivity from daily heat stress to indoor and outdoor workers. Considers occupation-specific work ability curves from the International Labour Organization (ILO).
2	**Human health**	Shock to labor supply from changes in the incidence and mortality of vector-borne (malaria and dengue), water-borne (i.e., diarrheal), and temperature-related diseases.
3	**Water, sanitation, and hygiene**	Shock to labor supply from changes in diarrheal incidence and mortality due to investments in water supply and sanitation coverage.
4	**Clean cooking**	Shock to labor supply from indoor air pollution, including the effect of changes in cooking services and co-benefits in fuelwood use reduction.
AGRICULTURE AND NATURAL RESOURCES		
5	**Rainfed crops**	Shock to crop revenues through changes in yields. Based on FAO crop-specific yield response functions to rainfall availability and heat stress.
6	**Erosion**	Shock to crops from topsoil erosion and flooding due to vegetation conditions. Impacts on erosivity from changes in rainfall based on the RUSLE model.

7	**Livestock**	Shock to livestock revenues through changes in productivity by animal and product type. Considers extreme heat and feed availability effects through animal-specific curves.
	INFRASTRUCTURE AND SERVICES	
8	**Inland flooding**	Shock to capital from changes in the recurrence of peak precipitation events that result in fluvial (riverine) flooding. Considers modeling of stream flows and floodplains, and damage estimate through depth-damage curves.
9	**Sea-level rise and storm surge**	Shock to coastal capital from changes in mean sea level and storm surge, using a bathtub approach.
10	**Tourism**	Shock to tourism sector revenues due to changes in climate variables, which produce changes in tourism potential.

Sources: IEc Report 2023.

Annex 6: Adaptation action

The CCDR models the benefits (in terms of reduced GDP losses) and costs of high potential adaptation interventions to four of the impact channels (described in detail in Table A7 below):

1. **Heat adaptation** considers the increased use of cooling technology for the indoor workforce as the economic structure shifts toward greater formal employment in services and manufacturing, and agriculture becomes less labor-intensive. Heat stress is also likely to push vulnerable groups out of agriculture and toward urban areas. The scenario modelled considers an increase from 5 percent usage across sectors at baseline to up to 25 percent by 2050. Overall, the impact of heat stress on labor productivity is mitigated by about half in services and manufacturing.
2. **Rainfed crops adaptation** measures include the development of new irrigation infrastructure to address water stress for priority crops (maize, rice, yams, cassava, and cocoa); and crop switching to increase the production share of climate-resilient crops (cashew nuts and cotton) and the share of heat-tolerant crop varieties (maize, rice, yams, cassava, and cocoa).
3. **Crop production erosion adaptation** considers a high adoption rate of up to 20 percent by 2050 of a combination of actions that include implementing: (i) conservation tillage,[161] and (ii) shifting to a cover crop planted in the off season (the analysis is based on the use of velvet beans). These options all focus on four key crops (cassava, rice, yams, and maize).
4. **Coastal flooding adaption** assumes that new infrastructure is built at a higher elevation starting in 2025[162] relative to the historical mean sea level. This new elevation is above the projected sea-level rise of 1 meter by 2050 for SSP3-70. Two additional types of adaptation are included – building new infrastructure away from the most hazardous areas (i.e., outside of the historical 20-year floodplain), and protecting existing infrastructure.

These measures should be complemented by targeted actions on climate-related investment, including:

- Conducting periodic risk assessments of public assets and contingent liabilities owned by general government institutions and developing the use of markets and insurance instruments.
- Improving the efficiency of climate-resilient public investments by: (i) systematically tagging and monitoring that expenditure in the budgets of the national and local authorities; and (ii) evaluating projects using a social welfare-equivalent discount rate (in contrast to a market-based discount rate) to enhance rapid interventions.
- Adopting green public procurement procedures such as construction standards or land-use regulations that explicitly account for climate risks (including for state-owned enterprises).
- Enhancing the public-private partnerships (PPP) legal framework to create incentives for greater private-sector participation in climate resilient-infrastructure projects by allowing risk-sharing on investments in new technologies, innovative business practices, and climate-smart performance-based contracts.
- Considering tax incentives to stimulate private operators to spend more on improving the resilience of their own assets or to expand their investments for the well-being of the community through corporate social responsibility measures.

161 Conservation tillage, or minimum tillage, is a broadly defined practice that includes no-till, strip till, ridge till, and mulch till systems. These techniques maintain plant residues on at least 30 percent of the soil surface after tillage activities.

162 As reported by the UN World Urbanization Prospects in 2018.

Table A7 - Modeling adaptation to climate change for four key impact channels

Impact channel	Adaptation measure	Hypotheses	Costs
Heat stress	Increased air conditioning coverage for the indoor workforce	25% increase in the number of air-conditioning units by 2050	Capital cost of the new air conditioning units required by the 2040-2050 (CAPEX) + annual energy consumption costs (OPEX). CAPEX considers a low-end and high-end value. Low end corresponds to a standard window unit, high-end to a split system.
Rainfed crop yields	Measures considered are ambitious and include combined investments in: (1) the development of new irrigation infrastructure to address water stress; (2) Crop switching to more climate-resilient crops (e.g., cotton, soybeans, and sorghum) (3) Increasing the share of heat-tolerant crop varieties of maize, rice, beans, and cassava	(1) Five-fold Increase in total irrigated area in the country (i.e., an additional 134 000 hectares) by 2050; (2) Two-fold increase in production share of climate-resilient crops (i.e., 100% increase) by 2050; (3) 20% of current production of selected crops substituted by a heat-tolerant variety by 2050.	1. Capital costs of developing new irrigated hectares by 2041-2050 (CAPEX) + annual operation and maintenance costs (OPEX). CAPEX considers a low-end and high-end values, corresponding to simple and improved flooding irrigation respectively. 2. Not considered. 3. Not considered. Reference R&D cost of developing a new variety = US$ 60,000 (Porch *et al*. 2007).
Crop production erosion	Measures considered are ambitious and include combined investments in: conservation tillage, and adoption of practice of leaving crop residue in fields.	(1) increase conservation tillage to achieve an adoption rate of 10% by 2050; (2) increase conservation tillage to achieve an adoption rate of 20% by 2050; (3) increase the practice of leaving crop residue on fields to 10% by 2050; (4) increase the practice of leaving crop residue on fields to 20% by 2050.	Conservation tillage is assumed to be cost-neutral to farmers since labor and/or tractor use decline, while this intervention may increase the need for pesticides or other inputs.
Coastal flooding (Sea level rise and water surge)	New infrastructure built at a higher elevation, above the projected sea level by 2050 under the SSP3-7.0 climate scenario. Sea walls are built to protect the structures with the highest annual expected damage under SSP3-7.0 by 2050.	This protects new infrastructure from the additional damage of storm surge caused by sea level rise. This adaptation assumes new infrastructure is built outside the historical 20-year floodplain. This adaptation starts in 2025. The rate of new infrastructure constructed is assumed to follow the population growth rate of Cotonou, as reported by the UN World Urbanization Prospects 2018. The building of sea walls is assumed to cost 15 percent of a structure's value and reduce vulnerability by 80 percent. Adaptation is applied using a benefit-cost test, where benefits equal mean expected avoided damages over a 20-year planning horizon and costs equal the value of a structure as a share of national capital stock. Two adaptation levels are considered: high adaptation wherein adaptation is applied when the benefit-cost ratio exceeds 1 and medium adaptation wherein adaptation is applied only when the benefit-cost ratio exceeds 4. There are two types of adaptation included. New infrastructure built away from most hazardous areas + Protection of existing infrastructure.	There are two levels of adaptation: (i) medium: 100 buildings are protected by 2050, with a total capital cost of US$1.5 million; and (ii) high: 170 buildings are protected by 2050, with a total capital cost of US$2.5 million. Costs are based on Hecht and Kirshen (2018), at US$50 per square meter. Annual maintenance costs are negligible.

Source: IEc report for Benin CCDR, 2023

Annex 7: Sectoral institutional arrangements that need reinforcement

Water management is too fragmented to support climate change adaptation and mitigation

Reducing fragmentation is required for the adequate implementation of the National Action Plan for Integrated Water Resources Management (PANGIRE). The PANGIRE covers a period of 15 years divided into three phases: 2011-2016; 2016-2020 and 2020-2025. The implementation of the third phase of the plan (PANGIRE 3) is essential to support climate change adaptation and mitigation measures in NDC priority sectors, including: (i) the identification and prevention of risks and disasters related to climate change, such as floods and droughts; (ii) the strengthening of the water-food security-energy nexus; and (iii) the maintenance of a minimum volume of water resources in aquifers for the preservation of the ecosystems that depend on it for their survival. Implementation of PANGIRE 3 will benefit from addressing the challenges identified in the assessment of phases 1 and 2, which included the complexity of the process, the diversity of stakeholders, and a relatively precarious match between objectives, resources and deadlines.

The water sector is subdivided into three sub-sectors: Integrated Water Resources Management (GIRE), Drinking Water Supply (AEP) and Sanitation. The sector has undergone major reforms aimed at improving the legal and institutional framework for better governance and the achievement of sustainable development objectives. A law on water management was adopted in 2010 and determines the conditions for integrated water resource management to ensure balanced use, equitable distribution, and sustainable exploitation of the available resource. The National Water Council (CNE) was established the following year to contribute to decision-making on water resource management, and an Interministerial Water Commission (CIE) was created in 2015. However, while the legal and policy framework promotes integrated water management, the institutional framework is lagging behind, with the CNE and CIE struggling to become operational. A decree updating the CNE is in the process of being signed and will allow this body to play its full role in improving governance of the sector. Institutionally, the sector is also fragmented. GIRE is currently entrusted to the General Water Directorate of the Ministry of Energy, Water and Mines. The National Water Institute (*Institut National de l'Eau*) carries out research and data collection on water resources and provides training and further training for students in the water and sanitation sectors. Sanitation is the responsibility of the MCVT, in collaboration with the Ministry of Health, which is more specifically in charge of hygiene and sanitation.

Coastal management is institutionally complex

Benin has a repository of instruments developed for coastal management and sustainable marine development. However, the interactions among them, and the hierarchy of the various laws and regulations, are not always clear. Legal and policy instruments include the Integrated Coastal Zone Management (ICZM) plan, Marine Protected Areas (MPAs), Marine Areas of Ecological and/or Biological Importance (EBSAs), and biosphere reserves, including community protected areas, among others. A Multi-Sector Investment Plan (MSIP) for coastal resilience was developed in 2018. The 2022 updated Master Plan for Coastal Development (*Schéma Directeur d'Aménagement du Littoral* – SDAL)[163] is the most recent strategic instrument and aims to implement integrated coastal management. It is aligned with the PAG. New texts for implementing the coastal law, including managing and strengthening the protection of the coastal zone,[164] are to be adopted by the Council of Ministers in 2023. These include 12 draft decrees and 7 draft interministerial orders, and the establishment of a National Coastal Management Unit (*Cellule Nationale de Gestion du Littoral*). The unit will be responsible for coordinating actions linked to coastal management and protection, and to promote sub-regional cooperation for coastal protection. These complex institutional arrangements demand more harmonized laws and regulations. This is especially true for territorial planning, property ownership, and other environmental issues (pollution and biodiversity), and the use of natural resources (mining, fisheries and agriculture). SDAL could play a central role in harmonizing laws and regulations.[165]

Urban planning needs to put climate front and center

A new urban code is soon to be adopted that incorporates climate risks and strengthens the resilience of cities to disaster and climate-related risks. The new code clarifies the process for preparing, validating, and implementing urban planning instruments to enforce the new principles established in the code. Climate considerations need to be front and center in future city planning and management in Benin (covering spatial, land-use, infrastructure, economic development and investment/financial management dimensions). While city development plans are available and

163 MCVT (2022). Actualisation du Schémas Directeur d'Amenagement du littoral Beninois

164 Number 2018-10 of July 02, 2018 on the protection, development and enhancement of the coastal zone in the Republic of Benin.

165 Multisectoral Investment Plan for Adaptation to Coastal Risks 2017.

developed using participatory approaches, limited decision making takes place at the local level and these plans seldom take into consideration the city's climate risk profile. Capital investment planning at the city level needs to be coupled with climate planning and should be implemented in synergy with relevant sectors from a spatial/regional/national perspective. Reforms that strengthen formal institutions for titling and property transfer, along with flexible and effective urban planning that is properly coordinated with investments in infrastructure, can ensure that cities are not locked into suboptimal physical forms and investments.

Disaster risk management could be better aligned with climate change

Benin has developed a Strategy for the Reduction of Risks and Natural Disasters for the period 2019-30 and is currently working on a plan of action for implementing it. The strategy was developed and validated through a broad consultation process, highlighting the close links needed between the different entities mandated for disaster risk management (DRM), urban planning, and local development, as well as the need to strengthen urban resilience. The country is also in the process of adopting a DRM Law to strengthen the national system for disaster risk reduction, preparedness, financing and response. Adopting and operationalizing these two key documents is critical for the comprehensive management of existing and future disaster risks — both on the institutional framework and funding arrangements fronts. The DRM strategy and the Low Carbon and Climate Resilient Development Strategy include activities that could overlap (e.g., data collection on disasters and climate change for the agriculture sector, capacity building and early warning systems), and cover common sectors such as agriculture, land management and infrastructure. These overlaps can create entry points to increase synergies for their implementation.[166] However, detailed action plans assigning clear roles and responsibilities will be needed to avoid duplicated effort, as currently climate change adaptation is implemented by the MCVT, while DRM activities are the responsibility of the National Civil Protection Agency (NCPA).

There are additional entry points to foster coherence between DRM and climate change adaptation. These include aligning risk assessment methodologies, designing a national framework for risk mapping, and strengthening the National Platform for Disaster Risk Reduction and Climate Change Adaptation, which is currently mainly focused on coordinating DRM issues.[167] There is also a need to strengthen capacity at national and local level for climate-smart actions, for example by (i) creating the institutional arrangements for mainstreaming DRM and climate resilience in key sectors of the economy as well as in development processes and programs.; (ii) by having a distinct official declaration of state of emergency for natural catastrophes; and (iii) improving funding, and operational coordination with local authorities for adequate preparedness for disasters.

Forestry institutions face institutional constraints

Benin's national forest policy (2023-2032) was adopted in February 2023. The forest policy aims to promote the participatory management of forest resources to ensure production of goods and services for sustainable development and the public good. It recognizes that investing in sustainable forest management will contribute to the enhancement of carbon stocks and reducing GHG emissions. The policy will be accompanied by a program of priority actions and an Environmental Action Plan aiming to make the sustainable management of forest resources one of the major priorities of public action. However, the forest sector's institutional framework is hampered by several constraints. These include frequent institutional changes in the forest administration, weak coordination of the various actors involved in the sector, and challenges related to monitoring of compliance and performance. In addition, support to the forestry sector is fragmented, with one third of resources coming from the national budget and two-thirds from external financing.

Mitigation is confined to the emission reduction targets in the energy sector

Mitigation policies are mostly conducted at the sectoral levels, such as the energy sector. In 2021, the government adopted the Renewable Energy Policy (PONADER) and subsequent regulatory instruments. In 2022, it established a National Electrification Strategy (NES) with the goal of achieving universal electricity access by 2030. PONADER seeks to guide the country's sustainable energy development through the provision of energy services based on renewable energy that is accessible to the greatest number of people at the lowest possible cost, while promoting socio-economic activities in rural areas. Benin has established a goal of 20-30 percent renewable energy penetration in the energy mix by 2035,[168] as well as a 7.8 percent reduction of CO_2 emissions by 2045. The Energy Efficiency Policy (PONAME) was adopted in 2022 to promote the sustainable use of energy and improve efficiency.

166 United Nations Office for Disaster Risk Reduction (2022). Benin: Policy coherence between disaster risk reduction and climate change adaptation.

167 Ibid.

168 Government of Benin (2020). Politique Nationale de Developppment des Energies Renouvelabes (PONADER).

The important role of local governments and accountability mechanisms could be leveraged more systematically

The impact of climate change is local and often affects the poorest and most vulnerable communities the most. It is therefore critical to involve local stakeholders in activities ranging from protecting available resources and reducing emissions to enhancing local planning, adaptation, and resilience. It is of paramount importance to ensure participation and representation of women in the local decision-making bodies. Studies show that women's political participation leads to more stringent climate change policies.[169] Women's and girls' limited preparedness and resilience prior and during natural disasters in Benin also need to be reflected in implementation measures. For instance, women's participation in local forest committees has been found to positively affect forest regeneration[170] and women's participation in the decision-making on climate risk management is positively correlated with the improved disaster responses, environmental governance, and reduce carbon emissions.[171] The NDC, which envisages adaptation financing at the local level by strengthening local governance on planning and budgeting processes, could be "localized" to ensure effective implementation on the ground and maximize the resulting positive impact for local communities.

More recently, decentralized structures have become involved in creating climate development strategies. The Annual Investment Plans (*Plan Annuel d'Investissements,* PAI) are drawn up and implemented with the support of development projects and inter-communal associations. In addition, the participation of representatives of decentralized structures such as communal representatives in the sessions of the Conference of the Parties, especially since the adoption of the Paris Agreement, has generated enthusiasm and awareness of the need for socio-economic development resilient to climate change.

Accountability mechanisms and parliamentary oversight for climate action could be developed further. In February 2021, the Supreme Audit Institution (*La Cour des Comptes*) was created by an Organic Law (No. 2020-38). As a newly established institution, the audit tools in place are not yet designed for assessing plans or policies specifically related to climate change or risk management. The government has organized multi-stakeholder consultations on the climate transition. These included governmental, regional, and non-governmental parties, including representatives from the private sector and civil society. Ensuring the continued involvement of all these actors across the implementation phase will be critical to achieve the NDC's objectives. In addition, there is significant space to enhance citizens' participation and civil society organizations' engagement in monitoring climate change action. For instance, a formal mechanism could be established for consultation, collection and response to concerns expressed by citizens on climate actions, as well as requests for information, complaints, emergency alerts.

169 Mavisakalyan & Tarverdi 2019

170 Agarwal 2009; World Bank 2011, 2010, 2005

171 Foa 2009.

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