NIGER

Country Environmental Analysis

WORLD BANK GROUP

1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

Cover design: Will Kemp, Global Corporate Solutions, World Bank Group.

Contents

Boxes

Figures

Maps

Tables

Photo: Andrea Borgarello / World Bank Group

Acronyms

3N	Nigeriens Nourish Nigeriens
ABN	Niger River Basin Authority (*Autorité du Bassin du Fleuve Niger*)
AFOLU	Agriculture, Forestry, and Other Land Use
ANEB	National Association of Wood Harvesters (*Association Nationale des Exploitants de Bois*)
ANGA	National Association of Professionals of Arabic Gum (*Association Nationale des Professionnels de la Gomme Arabique*)
AREN	Association for the Revitalization of Livestock in Niger (*Association pour la Redynamisation de l'Élevage au Niger*)
BEEEI	Environmental Assessment and Impact Studies Bureau (*Bureau National d'Évaluation Environnementale Et des Etudes d'Impact*)
CAP	Community Action Program
CEA	Country Environmental Analysis
CNEDD	National Council for Environment and Sustainable Development (*Conseil National de l'Environnement et du Développement Durable*)
CNSEE	National Center for Ecological and Environmental Monitoring (*Centre National de Surveillance Écologique et Environnementale*)
CNSF	National Center for Forest Seeds (*Centre National de Semences Forestières*)
DGEDD	General Directorate for the Environment and Sustainable Development (*Direction Générale de l'Environnement et du Développement Durable*)
DGEF	General Directorate for Water and Forests (*Directorate General des Eaux et Forests*)
ECOWAS	Economic Community of West African States
EPI	Environmental Performance Index
ESA	European Space Agency
ESDS	Economic and Social Development Strategy (*Plan de Développement Economic et Social*)
FAO	Food and Agriculture Organization
FCV	Fragility, Conflict, and Violence
FMNR	Farmer-Managed Natural Regeneration
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GoN	Government of Niger

ICDP	Integrated Community Development Plan
ISFM	Integrated Soil Fertility Management
LPG	Liquefied Petroleum Gas
MP	*Maison du Paysan*
NASA	National Aeronautics and Space Administration
NDC	Nationally Determined Contribution
NEPAD	New Partnership for Africa's Development
NGO	Nongovernmental Organization
NTFP	Non-Timber Forest Product
PANGIRE	National Action Plan for the Integrated Management of Water resources (*Plan d'Action National de Gestion Intégrée des Ressources en Eau*)
PDC	Communal Development Plan (*Plan de Développement Communal*)
PDSI	Palmer Drought Severity Index
PIK	Potsdam Institute for Climate Impact Research
PNCC	National Policy on Climate Change (*Politique Nationale en matière de Changements Climatiques*
PNEDD	National Plan for the Environment and Sustainable Development (*Plan National pour l'Environnement et le Développement Durable*)
RCP	Representative Concentration Pathway
SDDCI	Sustainable Development and Inclusive Growth Strategy (*Stratégie de Développement Durable et de Croissance Inclusive*)
SDDEL	Sustainable Livestock Development Strategy (*Stratégie de Développement Durable de l'Élevage*)
SDGs	Sustainable Development Goals
SNPA-CVC	National Strategy and Plan of Action for Climate Change and Variability (*Stratégie Nationale et Plan d'Action/Climat et Variabilité Climatique*)
SPN2A	National Strategy and Plan for Agricultural Adaptation to Climate Change (*Stratégie et Plan National de l'Adaptation de l'Agriculture*)
TLU	Tropical Livestock Unit
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization

Acknowledgments

The preparation of this report was led by Yasmina Oodally (World Bank Task Team Leader and Environmental Specialist). The report was prepared by the World Bank Africa West Environment, Natural Resources, and Blue Economy Global Practice (AFW ENB GP), in coordination with the Government of Niger (GoN). The report was co-authored by Jose Diego Hopkins Alfaro, Herbert Francisco Curry Arceo, Lelia Croitoru, Nour Masri, and Sanne Agnete Tikjoeb (World Bank consultants). This publication was produced under the guidance of Maria Sarraf, World Bank Practice Manager.

Key contributors included Caroline Plançon, Moctar Sacande (FAO consultants), Ousmane Laminou Manzo, Sitou Lawali, and Abdoulaye Diouf (University of Niamey consultants). The World Bank peer reviewers Dorothea Hilhorst (Senior Land Governance Specialist) and Aimee Marie Ange Mpambara (Senior Agriculture Economist), as well as internal unit reviewers Ellysar Baroudy (Lead Natural Resources Management Specialist) and Mirko Serkovic (Senior Environmental Specialist) graciously agreed to review the draft reports, and this final version benefits from their contributions. Special thanks to Lelia Croitoru and Grazia Atanasio (Senior Communication Consultant) for support on the stakeholders' consultation and communication aspects. We would like to thank the World Bank Country Office colleagues in Niamey: Aissatou Dicko (Country Manager), Ibrah Hachimou (Environmental Specialist), Mouslim Sidi Mohamed (Communication Specialist), and Hadidia Djimba (Program Assistant) and extended country team for their operational and administrative support in organizing the stakeholders' consultation workshop.

The World Bank acknowledges support received from officials of the *Ministère de l'Environnement et de la Lutte Contre la Désertification* and *Ministere du Plan.* These officials include Seybou Yacouba (*Direction Générale des Eaux et Forêts*) and Sanoussi Garba (*Direction Générale de la Programmation du Développement*). The report also benefited from advice and comments of colleagues in the Nigerien Government, academia and civil society, as well as of the international development community: Ministry of Environment, Ministry of Agriculture, *Institut Nationale de recherches Agronomiques du Niger, Secrétariat Exécutif du Conseil National de l'environnement pour un Développement Durable,* UNDP, and more.

We would also like to thank the following participants at the consultation workshop held in Niamey on May 12, 2022: Abdou Kader Soumaila Sina, Aboubakar Almou Mani, Adam Issoufou, Awaiss Aboubacar, Ayouba Djibo, Barmo Soukouradji, Boubacar Bako, Boukari Elh Abdoulaye, Hambali Ali, Harouna Ramatou Abba Kiari, Hassana Babacar, Ibrahim Miko Abdel Nasser, Ismael Tinno, Kanta Aissa Amadou, Mahamadou Amadou, Mahamane M. Lawali, Maman Zanguina Sanouchi, Massatatchi Mahaman Sani, Massaoudou Moussa, Moutari Ousmane, Rabiou Mahamadou, and Seyni Souley.

Photo: Andrea Borgarello / World Bank Group

Executive Summary

With a gross domestic product (GDP) of US$568 per capita (World Bank 2020), Niger is one of the poorest countries in the world. It has a population of about 24 million, half of which are children under 15 years of age. The society depends heavily on its natural capital, particularly croplands, pasturelands, and protected areas (World Bank 2021). Agropastoralism is the economy's backbone, contributing 40 percent of the GDP and employing more than 80 percent of the workforce. Nonrenewable assets, such as uranium and oil, are significant contributors to the country's exports and government revenues.

Despite its endowment with natural resources, Niger faces significant challenges: extreme poverty affects more than 40 percent of the population; insecurity associated with fragility, conflict, and violence (FCV) marks particularly the regions of Tillaberi, Diffa, and Tahoua; low access to basic services, such as health care, safe drinking water, and sanitation, affects a large share of population. In addition, Niger is **the world's 7th most vulnerable country to climate change,** according to the Notre Dame Global Adaptation Initiative country index (ND-GAIN 2019). In this fragile context, the country's rapidly growing population—3.8 percent, one of the highest in the world—puts severe pressure on its natural resources.

Aware of these problems, the Government of Niger (GoN) made impressive efforts to improve natural resource management, through policies and investments aimed at restoring degraded lands, expanding protected areas, and enhancing the value of forest products, for example, Arabic gum, moringa leaves. However, scaling up land restoration and improving food security are yet to be achieved. Moreover, the COVID-19 crisis has recently worsened the economic situation, increased gender inequality, and added even more pressure on the country's natural resources. Nowadays, Niger's environmental situation is concerning: it ranks 152 out of 180 countries according to Yale's Environmental Performance Index (EPI).[1] **Key environmental challenges** include the following:

- **Land degradation.** Rapid population growth led to doubling the cultivated area in the past two decades.[2] At the same time, inappropriate agricultural practices, poor water management, and hotter and irregular weather patterns reduced agricultural yields in many areas and silted fertile basins. Given that one-third of the Nigerien population is already at risk of food insecurity,[3] the losses due to land degradation are likely to heighten this risk in the future.

1 Environmental Performance Index, 2020.

2 The cultivated areas increased from 12.6 percent to 24.5 percent of the country's land during 1975–2013 (CILSS 2016).

3 According to the National Statistical Institute, in 2018, about 29 percent of the population was at risk of food insecurity, while 12 percent was affected by severe and moderate insecurity.

- **Deforestation and forest degradation.** Forests are a pillar for Nigeriens' livelihoods in terms of biomass production (67 percent of the country's energy), non-wood forest products, and ecosystem services. Yet, current deforestation and intensive degradation lead to future losses for local communities (for example, fodder and non-wood forest products), national society (for example, erosion control), and global community (for example, carbon and biodiversity).
- **Climate change.** In the past decades, Niger has witnessed increasing temperatures, and multi-year droughts, floods, and storms. These problems are expected to intensify in the future, leading to harmful impacts on health (for example, mortality), natural resources (for example, damages due to floods), and nutrition (for example, loss of food due to droughts). As the country is highly dependent on rainfed agriculture, anticipating and managing the effects of climate change is critical to support food security and livelihoods in the future.

Objective and Scope

The objective of this Country Environmental Analysis (CEA) is to analyze critical environmental challenges that threaten sustainable economic growth in Niger and to propose actions to address them. It focuses on three government priorities that require in-depth analysis and immediate response: land degradation,[4] deforestation and forest degradation, and climate change. Due to time and resource constraints, this report does not cover other significant topics, such as mining and air pollution.

As the first CEA ever conducted for Niger, its results are expected to broaden the dialogue with the Government, to inform the updated Systematic Country Diagnostic and to provide concrete recommendations for stakeholders to effectively address environmental sustainability and natural resource management. The report relies on a wide range of publications, including official documents, scientific literature, and lessons learned from international best practices.

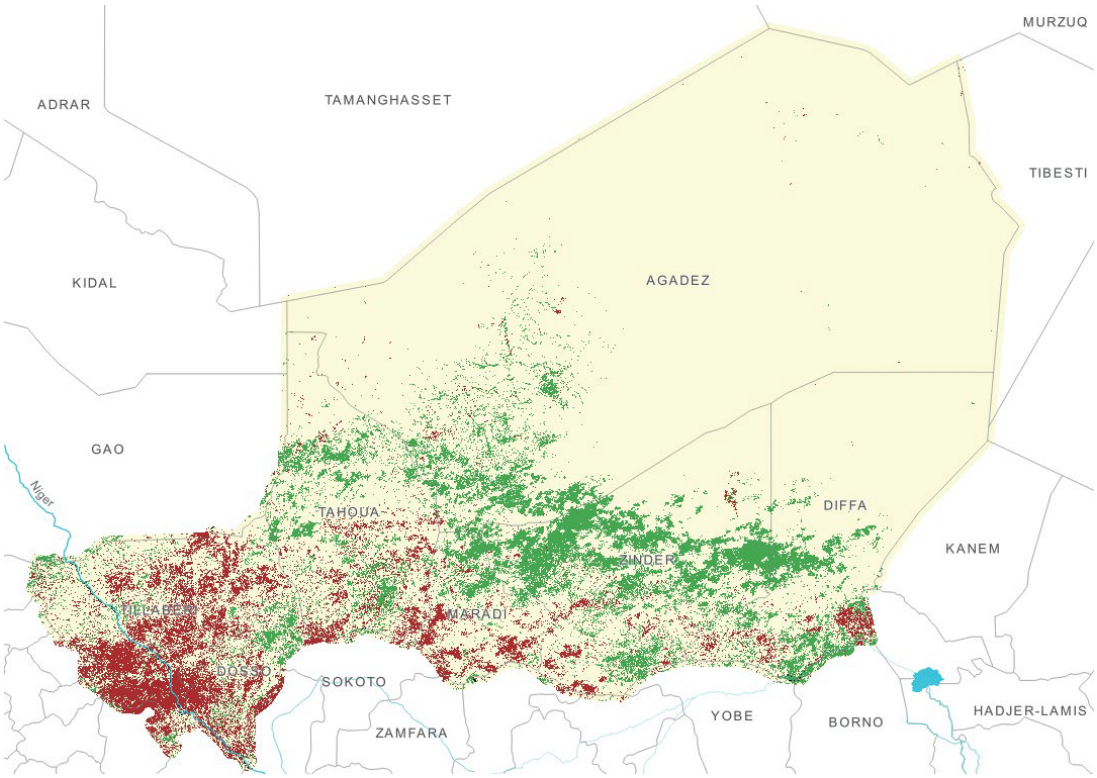
It should be noted that the pandemic and the security situation restricted the team's ability to collect local information in several cases (for example, the extent of forest degradation). Despite these constraints, this CEA identifies the main challenges and opportunities to mitigate the environmental risks faced by the three priority areas of analysis.

Land Degradation

Since the 1980s, Niger took steps toward land rehabilitation through the adoption of assisted natural regeneration, crop improvement practices, and water capture techniques. These efforts led to improved soil and vegetation, especially in the regions of Maradi, Zinder, and Tahoua (Map 1, in green). Despite these achievements, more than **6 percent of the country's area has suffered degradation** during 2001–2015. This is mostly concentrated along the Niger River Valley in the southwest and along the south-central border (Map 1, in red). In

4 In this report, the analysis of *land degradation* focuses only on the problems related to croplands and rangelands. The forest-related issues are discussed in the chapter of *deforestation and forest degradation.*

MAP 1. Land degradation in Niger between 2001 and 2015



Source: Trends.Earth, 2016.

Note: red = degraded, yellow = stable, green = improved, black = no data. About 70 percent of the country's land is desert.

these areas, the degradation translated into a decline of agricultural yields, soil stability, and natural biodiversity.

There are multiple **drivers of land degradation** in Niger, including (a) *natural factors*, such as increase of mean annual temperature by 0.6–0.8°C between 1970 and 2010; rise in the frequency and severity of extreme rainfall events, contributing to water erosion; and increased intensity of sand winds, particularly during the harmattan season, causing wind erosion (b) *anthropogenic factors*, such as rapid population growth, which increased the demand for food and prompted agricultural expansion, particularly in the Tillaberi region; inappropriate farming practices, for example, cultivating fallow land and conversion of pastoral land to cropland; overgrazing due to higher livestock population feeding on limited grassland areas; and overexploitation of woody vegetation to meet energy demands of local communities.

Land degradation led to several impacts on the Nigerien society, for example, on-site effects, such as yield losses of croplands and rangelands, and off-site effects, such as soil erosion and reduced water quality. It also generated impacts on the global community, for example, carbon emissions and reduced biodiversity in areas where vegetation was lost. An in-depth analysis estimated the **cost of land degradation at US$646 million or 5 percent of the country's GDP** in 2019.[5] Tillaberi is the most affected region, bearing more than 40 percent of

5 This is a conservative estimate, as it focuses only on the *on-site effects on croplands,* without including the off-site effects, and not the costs related to the degradation of other land uses (for example, grasslands and forests).

FIGURE 1. Cost of land degradation by region

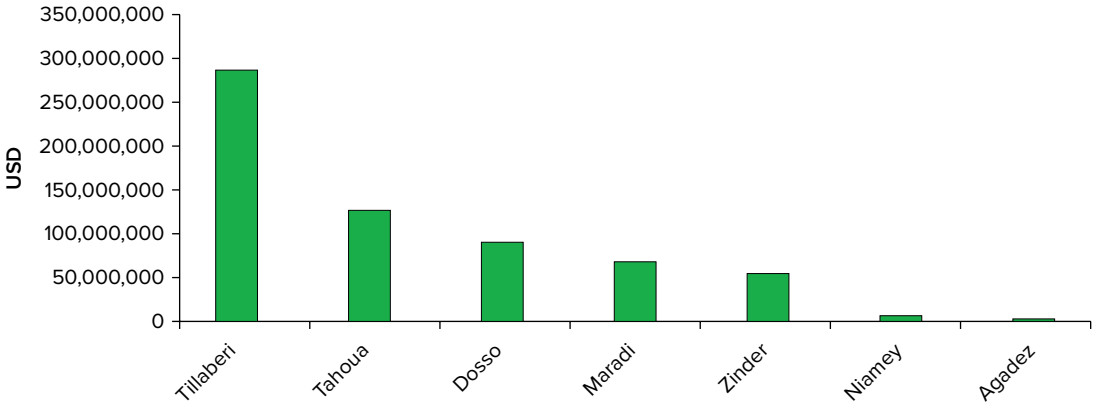
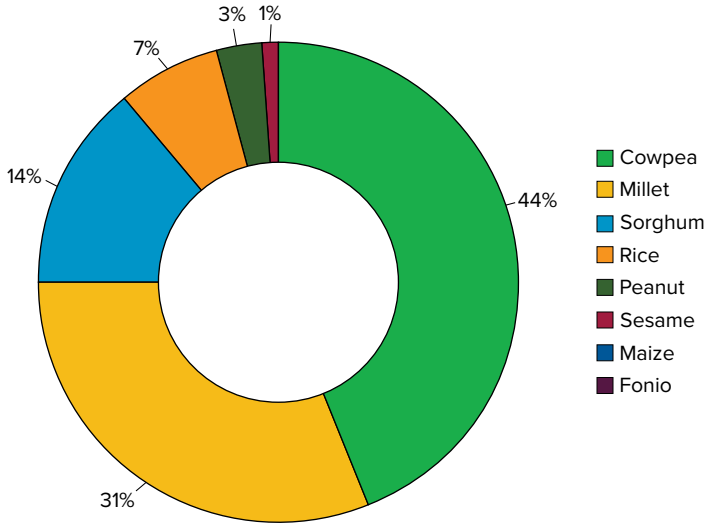


FIGURE 2. Cost of land degradation by crop (%)



Source: Data from the GoN, analyzed by the World Bank.

the cost (Figure 1). This is primarily due to the high demographic growth, agricultural intensification, and extremely dry climate in the western part of the region. The cost of land degradation is notably lower in Maradi and Zinder, where large-scale land restoration projects have been implemented since the 1980s. Overall, cowpeas and millet accounted for most of the yield loss in Niger (Figure 2).

Without remedial action, land degradation can contribute to **long-lasting impacts** on several fronts:

- **Food security.** Food insecure population concentrate mostly in Agadez, Diffa, Tillaberi, and Tahoua. Moreover, in the northern parts of Tillaberi and Tahoua, at the border with Mali, food insecurity is increasingly prevalent and humanitarian assistance covers the needs of only 8–12 percent of households. Land degradation is likely to amplify the severity of food insecurity within and across these regions.

- **Malnutrition.** Food insecurity is a major cause of malnutrition in Niger. The highest levels of malnutrition occur in remote areas (such as in Diffa region) and in areas highly dependent on subsistence farming (Maradi, Tahoua, and Zinder). In this context, yield losses due to land degradation can worsen people's nutrition and health in the long run.
- **Food trade.** The value chains of dry cereals, such as millet and sorghum, are the basis of food consumption in Niger. Given that local production is already insufficient to meet domestic food demand, land degradation can further worsen the country's food trade balance, that is, increasing food imports to cover cereal deficits and decreasing earnings from livestock exports.
- **Livelihoods.** Niger covers thirteen livelihood zones, three of which are at high risk of irregular rainfall and frequent droughts: the agropastoral belt zone; the rainfed millet and sorghum belt zone; and the cropping, herding, and work migration zone (Map 2.5 from Chapter 2). As the residents of these areas depend highly on climate for food and income, the problem of land degradation may exacerbate food deficits and income security in the long run.
- **Migration.** As most of the agriculture is rainfed, many Nigeriens migrate during the dry season to work as laborers in Southern Niger or other parts of West Africa. In addition, the increasing insecurity and conflicts from neighboring countries result in incoming migration, which affects the already limited access to food. In this fragile context, yield loss due to land degradation will likely aggravate the outmigration of Nigeriens for better opportunities.
- **FCV.** Land degradation and climate change are likely to exacerbate current conflicts, for example, between farmers and pastoralists over land use, with negative implications on the country's fragility.

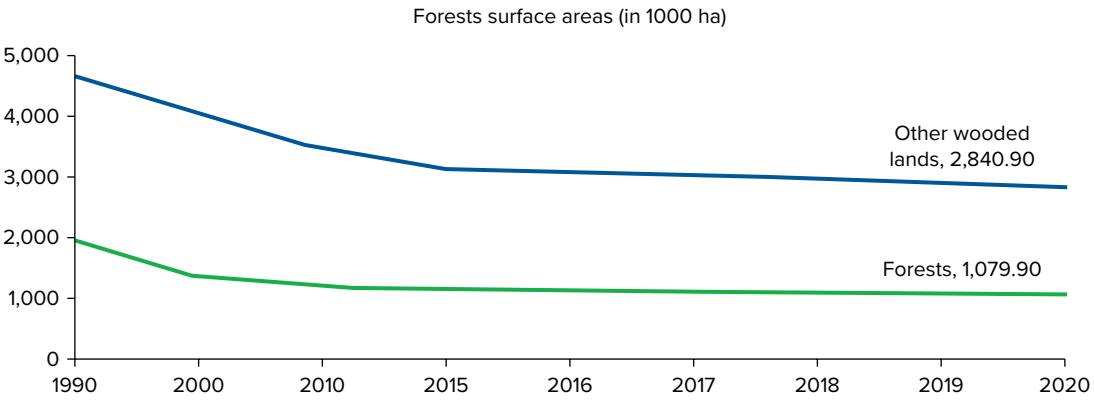
Deforestation and Forest Degradation

Forests are an important source of wood, non-timber forest products (NTFPs) (moringa leaves and so on), and ecosystem services for the Nigerien population. According to the Food and Agriculture Organization (FAO), Nigerien forests cover about **1.1 million ha**. Nearly 90 percent of these forests are naturally regenerated and include the primary forests of the W national park of Niger, while the remaining are plantations. Moreover, other wooded lands extend on an additional **2.8 million ha**. An analysis of forest-related problems was conducted based on international datasets (FAO, European Space Agency [ESA]), in the absence of updated information from national sources.[6]

Deforestation and forest degradation. During 1990–2000, the *deforestation* rate in Niger was high, about 3.7 percent (Figure 3). Although it fell to 1.1 percent in the past decade, it is nearly twice the average deforestation rate for the Sub-Saharan Africa (FAO 2020a; World Bank 2020). Since 2000, the Government has conducted impressive reforestation efforts;

6 For example, the latest State of the Environment reports 1991 data on forest area in Niger of 16 million ha (CNEDD 2021). As this information dates back 30 years, the team preferred to rely on more updated information, which is derived from international sources.

FIGURE 3. Trends in forest area and other wooded lands



Source: FAO 2020b.

however, they followed a much slower rate (2,500 ha per year) than the deforestation phenomena (14,920 ha per year). Data on the extent of *forest degradation* are not available, yet the forests known as '*forêts classes*' have been severely degraded and more than 50 percent of them have lost their regeneration potential (CNEDD 2021). The natural expansion of forests is unlikely due to the ever-increasing pressure on land for other land uses, such as cropping and livestock grazing.

There are several **drivers of deforestation and forest degradation** in Niger, including (a) expansion of cultivated areas into forests due to food needs associated with population growth; (b) wood harvesting at unsustainable rates; (c) overexploitation of non-wood forest products and unsustainable sampling of roots, bark, leaves, and fruits of several forest species; and (d) intensive exploitation of agroforest parks for fodder, particularly during the lean season.

The **impact of deforestation** particularly affects specific local species:

- *Acacia Senegal*: Many Arabic gum stands are deteriorated due to aging, bushfires, overgrazing, and a proliferation of invasive species in most gum plantations.
- *Moringa tree*: The sustainable development of this species is hampered by a defoliator pest for which farmers lack practical management approaches and by overharvesting of leaves.
- *Doum palm*: Droughts, intensive harvesting of leaves, and early collection of the green fruits are threatening the regeneration of this species.

Social cost of carbon. Niger is a low greenhouse gas (GHG) emitting country. Agriculture, forestry, and land use (AFOLU) change is the top contributor, accounting for 88 percent of Niger's GHG emissions (République du Niger 2021a). The economic value of carbon associated with forest loss between 2015 and 2020 was estimated at more than **US$205 million**. While these are costs to the global community, deforestation and forest degradation entail significant impacts on the Nigerien society, such as losses of wood, non-wood forest products, and ecosystem services. Conducting an economic valuation of the impacts of deforestation and forest degradation would be important to gain a better understanding of the real magnitude of current losses and the needs for future restoration in Niger.

Climate Change

Since 1968, Niger has suffered from increasingly frequent droughts, storms, and floods. These phenomena caused significant damages to agriculture, food security, and livelihoods.[7] Climate change is expected to increase the average temperature by up to **6°C by 2100,** depending on the scenario (Figure 4). Higher temperature extremes are projected for the country's southwest (Röhrig et al. 2022). In terms of GHG, past emissions have been low—about 0.1 tons carbon dioxide equivalent (CO_{2e}) per capita in 2018—and originated from the AFOLU sector (Figure 5).

FIGURE 4. Projected mean temperature in Niger

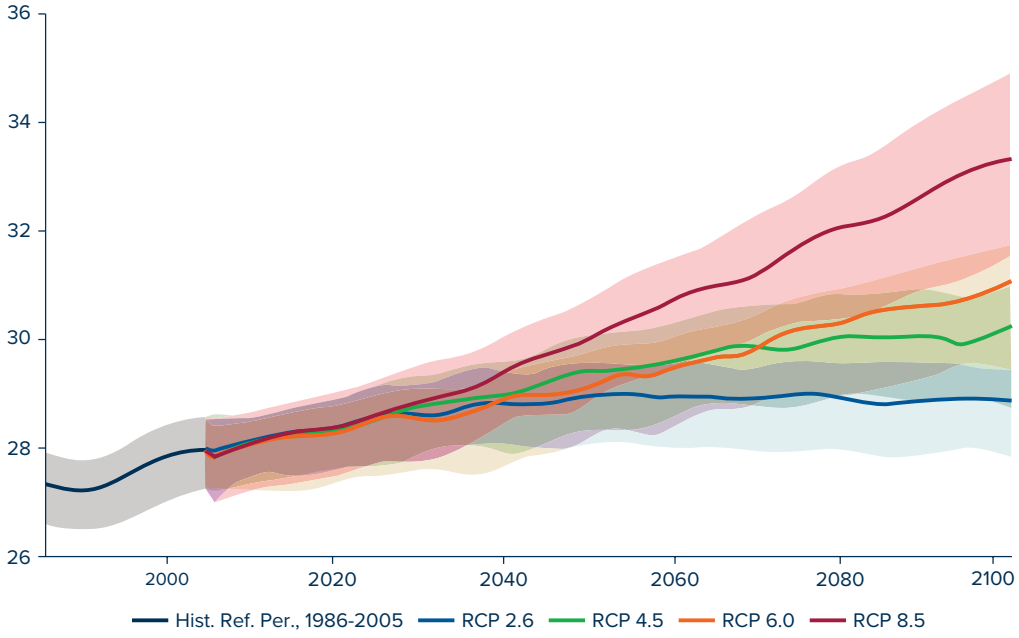
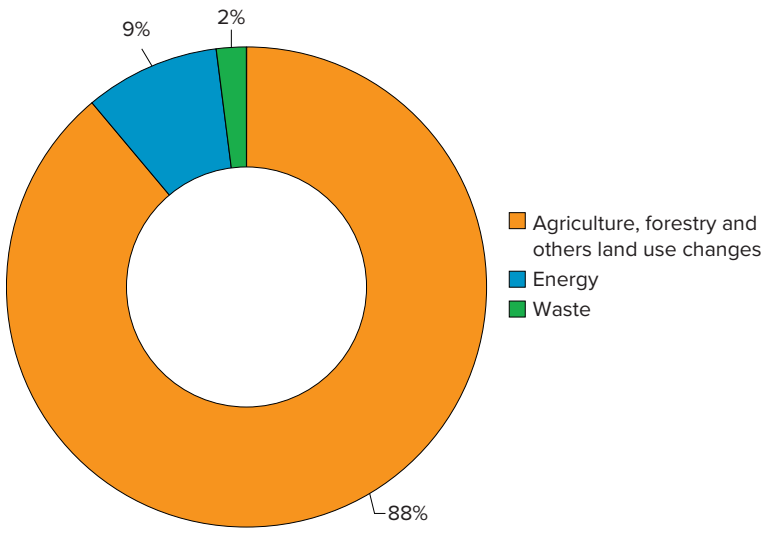


FIGURE 5. Niger's emissions profile



Sources: World Bank Group Climate Change Knowledge Portal for figure 4, and *CNEDD & AFDB*. (2020) for figure 5.

7 They affected over 3 million people in 2000 and 2001 and over 7 million people in 2002.

Under a *business-as-usual* scenario, this sector is expected **to quadruple its emissions during 2014–2030.**[8] However, the GoN has made a firm commitment through its Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC), to move the country's development pathway toward a green economy. The document aims for unconditional reductions from AFOLU by 13 percent compared to the *business-as-usual* scenario for the same year and conditional reductions by about 23 percent.[9]

In the absence of remedial actions, the above projections can bring severe impacts in Niger. Results of a model developed by the University of Stanford show that by 2100, climate change will likely reduce Niger's GDP per capita by 80 percent.[10] Other studies addressed the effects of climate change in specific sectors:

- **Agriculture.** Results of available studies indicate that Niger could potentially lose its entire rainfed agriculture by 2100 (USAID 2017); a potential increase in mean annual precipitation throughout the century could translate in improved suitability of millet (Röhrig et al. 2022); yields of heat- and drought-sensitive crops are projected to decline, while yields of less sensitive crops are projected to increase, for example, cowpeas by 54 percent and groundnuts by 52 percent (2080 versus 2000; Tomalka et al. 2021). Noting the uncertainties of the models used above, these results call for adaptation strategies based on a cautionary approach, with the overall goal of improving food security in the future.
- **Water.** Most of the region's water supply is unevenly distributed, is poorly accessible due to undeveloped hydraulic supply systems, and originates from neighboring countries. The Fouta Djallon Highlands in Guinea, West Africa's 'water tower', are expected to experience rainfall reductions of up to 26 percent by 2100, affecting basins such as that of Niger River. In addition, the expected increases in temperature and more frequent droughts in Niger will likely contribute to future declines in water supply. This situation highlights the urgency to invest in water saving measures and technologies for future water consumption.
- **Health.** Climate change is expected to induce several impacts: *heatwave*-related mortality is predicted to increase threefold by 2080 compared to 2000; in addition, the cases of *malaria, meningitis,* and *malnutrition* will likely rise due to changes in temperatures, rainfall patterns, floods (particularly in Southern Niger), and more frequent droughts.

8 They are projected to increase from 24,000 $ktCO_{2e}$ in 2014 to 107,296 $ktCO_2e$ in 2030, according to the country's NDC.

9 There is a level of uncertainty about future emissions, particularly beyond 2020. Predictions are based on varied assumptions of economic growth and the anticipated capacity and technical support from development partners.

10 Based on Burke, Hsiang, and Miguel (2015); https://web.stanford.edu/~mburke/climate/map.php.

Recommendations

This CEA demonstrated that environmental degradation is worrisome in Niger. *Land degradation* is a priority problem: losses in crop yields affect particularly Tillaberi, Tahoua, and Dosso regions, with potential future impacts on food security, livelihoods, and migration. *Deforestation* rates are nearly double the Sub-Saharan average, and *forest degradation* threatens the health of local species that are important for economic diversification (Acacia Senegal, Moringa tree, Doum palm). Moreover, *climate change* is likely to have negative implications on agriculture, water resources, and people's health. Addressing these requires integrated efforts to tackle issues needing urgent attention as well as long-term solutions of persistent problems. In this light, implementing activities with the participation of youth and women can highly contribute to improving the society's welfare. Table 1 provides a summary of the **key recommendations** aimed to address the environmental sustainability, poverty, and fragility in Niger. A detailed description of the recommendations can be found in chapter 5.

TABLE 1. Key recommendations for Niger

Categories	Recommendations
Enhancing operations	• Promote farmers' access to financing and to Farmers' Field Schools linked to the implementation of Sustainable Land Management (SLM) techniques (e.g., startup capital, knowledge exchange) • Support smart agricultural technologies, such as the farmer managed natural regeneration (FMNR) • Scale up water harvesting techniques to fight cropland degradation (e.g., contour stone bunds) • Introduce improved and climate resilient crop varieties to increase production (e.g., HKP millet variety) • Develop and implement a food storage system across regions • Link smallholder farmers to local markets to creates incentives for adopting SLM and move beyond subsistence farming • Encourage rural youth employment through vocational training and as a means to modernize agriculture • Expand value chains by promoting Niger's industrial capacity to transform agricultural products into food products (e.g., local processing and sales of animal products) • Invest in the promotion and development of the Arabic gum industry (including expansion and rehabilitation of existing stands) • Upgrade the wood energy subsector (e.g., promote participatory forest management, expand the planted area, improve the transport and marketing of wood, test models of improved household cookstoves)
Supporting policy reform	• Enhance local governance structures in planning and managing natural resources • Institute participatory land use planning as it is an important policy tool for long-term sustainable development • Support the implementation of the National Nutritional Security Policy (PNSN) with explicit attention to climate change vulnerability • Improve country's capacity to sustainably use its stock of natural capital to achieve the objectives of the Niger 2035 Sustainable Development and Inclusive Growth Strategy • Develop regulations, including monitoring and enforcement provisions in preparation for increased demand on forest resources (including fodder) • Promote integrated landscape management and landscape resilience in restoration strategies • Implement the new land policy and SLM action plans, including required regulatory and institutional reforms to help prevent conflicts linked to land and natural resource management
Building knowledge	• Develop natural accounts for agricultural land, water, and forests to address the five strategic axes noted in Economic and Social Development Strategy (ESDS) 2017–2021. • Assess and monitor forest resources to drive sector growth (for example, conduct forest inventory and economic studies to estimate forests' contribution to the national economy). • Promote dedicated technical entities for climate data collection and dissemination (for example, improved meteorological data to enhance the population's response to droughts).

Photo: Andrea Borgarello / World Bank Group

1

Photo: Andrea Borgarello / World Bank Group

Photo: World Bank Group

1 Introduction

1.1. Overall environmental situation

Niger is a fragile country, marked by a poorly diversified economy and extreme poverty. The country has a population of 24.2 million and a gross domestic product (GDP) per capita significantly below the Sub-Saharan average (US$568 versus US$1,500).[11] Its economy is dominated by the agropastoral sector, which contributes nearly 40 percent to the country's GDP and employs more than 80 percent of the workforce (World Bank 2017a). The country's demographic growth is among the fastest in the world (3.8 percent[12]), and half of the population is under 15 years of age (United Nations, Department of Economic and Social Affairs, Population Division 2019). In 2021, extreme poverty affected 42 percent of the population (World Bank 2022a), mostly due to losses in income from COVID-related job layoffs and lower remittances. Poverty affects especially girls and women and is most prevalent in Dosso, Zinder, and Maradi regions. In addition, an estimated 2 million people are chronically food insecure, while 4.5 million people are at risk of food insecurity (Government of Niger 2017). Niger currently experiences medium intensity conflict and low access to basic services.

Climate change, rapid demographic growth, and weak governance are major threats to Niger's growth. Niger is the world's 7th most vulnerable country to climate change, according to the Notre Dame Global Adaptation Initiative (ND-GAIN 2019). In the past two decades, the country faced shifting climate patterns, including rainfall variability, temperature increases, and extreme events such as heatwaves. These changes have led to human losses, decreased soil productivity, and increased competition for access to resources. Moreover, many rural communities have grappled with a land tenure system with often unclear and overlapping rights, a lack of land use classification and registry, and an absence of monitoring and enforcing by local institutions. It is important to note that the rapid population growth and the recent COVID pandemic have put additional pressure on food security and natural resources. Nowadays, the environmental situation in Niger is concerning: it ranks **152 out of 180 countries, according to the 2020 Environmental Performance Index (EPI)** (Wendling, Emerson, and Sherbinin 2020).

The above challenges are heightened by the dominance of natural assets relative to human and produced capital. Natural capital comprises 38 percent of Niger's total wealth (World Bank 2021). This is substantially higher than the Sub-Saharan average, where natural capital represents 19 percent and human capital is some 60 percent of the total wealth. Niger's resilience depends on its ability to transform its natural capital into human or produced capital at rates sufficient to meet its demographic growth. The following sections provide a brief overview of the country's natural capital, the Government's efforts to judiciously manage these assets, and the objective and scope of this Country Environmental Analysis (CEA).

11 Data refer to 2020. World Bank, "World Bank Open Data," 2022. https://data.worldbank.org.

12 Idem.

1.2. Niger's natural capital

Natural capital is crucial for the Nigeriens' livelihoods and food security. Croplands, pasturelands, and protected areas account for most of Niger's natural capital. Although their total value has increased over time (Figure 1.1), their per capita value has declined since 2010 because of high demographic growth (Figure 1.2). The following paragraphs summarize four components of Niger's assets: agricultural land, forests, water, and uranium and oil.

AGRICULTURAL LAND

Agriculture is the most important source of income in each of Niger's seven regions. When considered together, livestock and farming generate between 40 percent and 53 percent of the regions' income (Figure 1.3). The sector is dominated by food crops, particularly rainfed cereals such as millet, cowpea, sorghum, maize, and rice. Over 1975–2013, cultivated areas increased from about 13 percent to 25 percent of the country's land, primarily due to the rapid

FIGURE 1.1. Natural capital in Niger

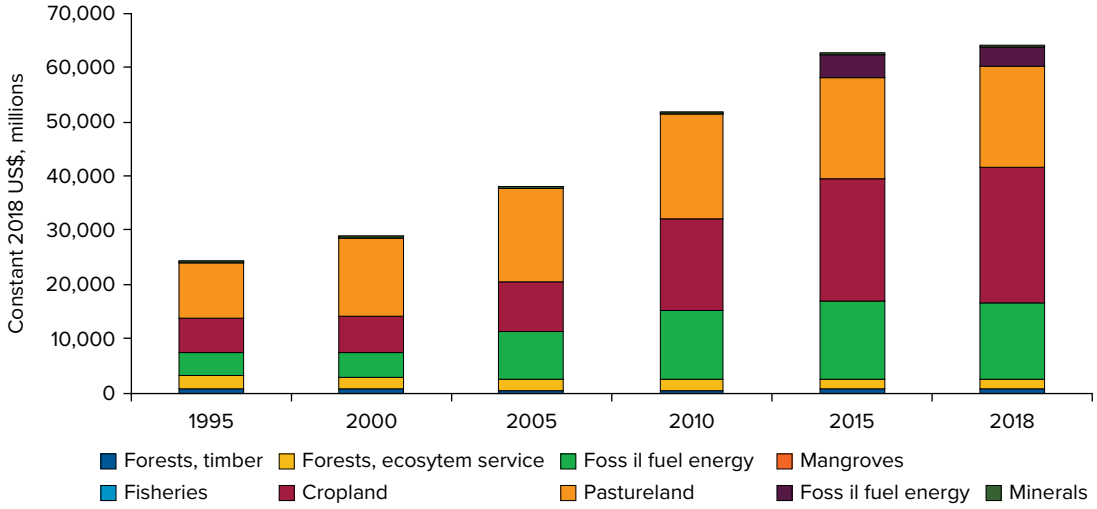
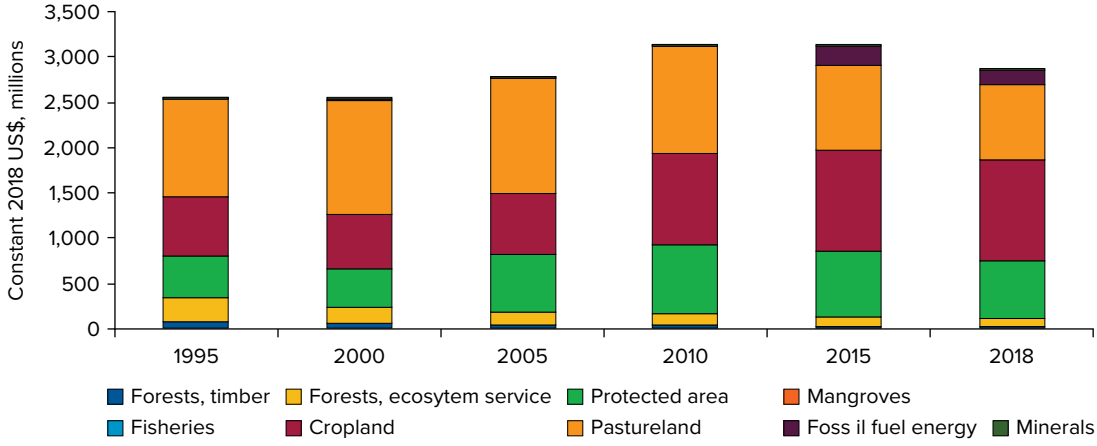
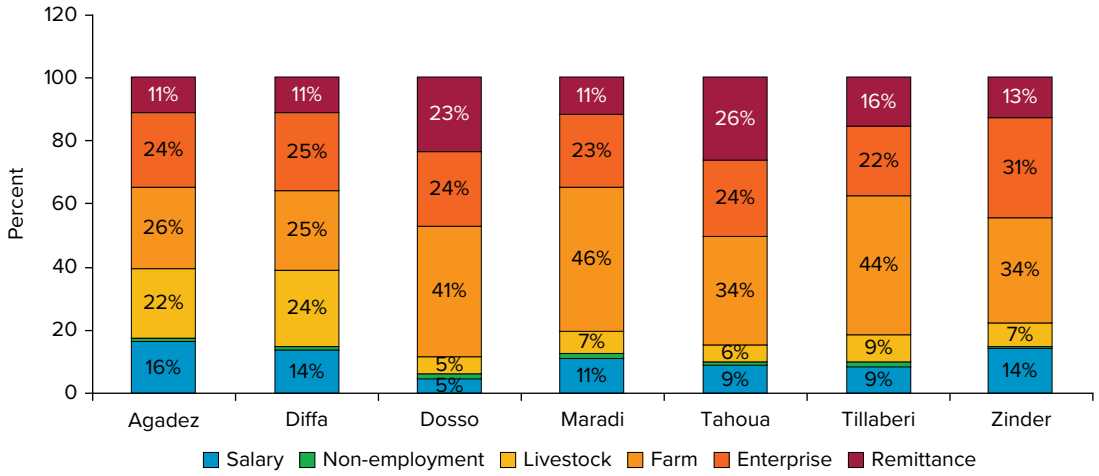


FIGURE 1.2. Natural capital per capita in Niger



Source: World Bank 2021.

FIGURE 1.3. Share of income from different sources, per region



Source: World Bank 2021.

population growth and the increasing demand for food. Nowadays, approximately 6.5 million ha are cultivated in the rainy season and a further 73,000 ha are used for intensive horticulture production in the dry season (Ministere du Developpement Agricole et Ministere des Ressources Animales 2017). Irrigation covers about 87,870 ha out of an economically irrigable land potential of more than 270,000 ha (FAO 2018).[13]

Degradation of cropland and pastureland is a key problem in Niger. Since the 1970s, croplands have expanded eastward into suitable soils and encroached traditional pastoral areas. However, inappropriate agricultural practices, poor water management, and hotter and irregular weather patterns reduced crop yields in many areas and silted fertile basins. Moreover, the livestock population has increased consistently, exerting higher pressure on the remaining pastoral land, likely contributing to reduced productivity. Given that one-third of the Nigerien population is already at risk of food insecurity,[14] the losses of yields and other ecosystem services due to land degradation are likely to heighten this risk in the future. Without remedial action, this situation can worsen in the future—especially in a context where gender inequality can leave women-led households with little choice but to adopt environmentally unsustainable coping mechanisms and land degradation can force farmers to migrate on new lands, thus adding further pressure on natural resources.

FORESTS

Nigerien forests provide a wide range of goods and services for local communities and national society. According to the Food and Agriculture Organization (FAO), Niger's forests cover about 1.1 million ha, while other wooded lands extend on an additional 2.8 million ha. These areas provide a variety of benefits: wood, covering 67 percent of the country's energy production (Ministère de l'Energie 2019); non-timber forest products (NTFPs), some of which could be integrated in value chains, for example, Gum Arabic (Ministere de l'Environnement de la Salubrite Urbaine et du Developpement Durable 2016); forest fodder, which contributes about 30 percent of fodder needs for Niger's Sahelian livestock (Ministère de l'Hydraulique et de l'Environnement and FAO 2012); and ecosystem services such as erosion

13 More than 52 percent of the total is located around the Niger River (FAO Aquastat database, 2018).

14 According to the National Statistical Institute, in 2018, about 29 percent of the population was at risk of food insecurity, while 12 percent was affected by severe and moderate insecurity.

control. These benefits are particularly important for local communities as coping mechanisms during times of drought, when agricultural yields may decline. Forests are also a critical component of the country's strategy to reduce poverty and enhance resilience to climate change (Ministere de l'Environnement de la Salubrite Urbaine et du Developpement Durable 2016).

Despite their importance, Niger's forests are being depleted at unsustainable rates. A recent forest resource assessment indicates that between 2015 and 2020, Niger lost approximately 62,100 ha or 5.4 percent of its 2015 forest cover. Cropland expansion accounted for about 57 percent of deforestation, followed by grassland expansion. An earlier study estimated that the on-site cost of land degradation was nearly 9 percent of the country's GDP in 2015; additionally, land degradation in woodlands and grasslands accounted for more than 95 percent of this cost (Nkonya, Ru, and Edward 2018). Climate change, population growth, and human encroachment are exacerbating the unsustainable depletion of Niger's forest cover and pose significant risks to its ecosystem services and biodiversity.

WATER

The agricultural and pastoral lands are dependent on rainfall, which varies across the country's five climatic zones. In Niger, the desertic Sahara Zone receives less than 150 mm per year, and vegetation is concentrated in the valleys and oases of Aïr and Kawar. The Saharan-Sahelian, characterized by nomadic breeding, receives on average 200–300 mm annually. Higher rainfalls occur in the other zones: the Sahelian Zone (300–500 mm), the Sudano-Sahelian Zone (500–600 mm), and the Sudanese Zone (600–800 mm) (Ministère de l'Hydraulique et de l'Assainissement 2017). Over time, per capita water availability in Niger has dropped considerably, from 2,300 m^3 per year in 2004 to 1,360 m^3 per year today.[15]

The national river network is divided into two major systems: the Niger River Basin and the Lake Chad. The Niger River Basin covers the western part of the country and is managed by the Niger Basin Authority, based in Niamey. The river is an important source of water for agriculture, drinking, and hydroelectricity. However, the rainfall variability has led to changes in the Niger River system: water table levels have dropped considerably in humid regions, leading to further declines in flows (Mahé and Paturel 2009), while in Sahelian regions, runoff coefficients are increasing (Mahé and Paturel 2009).

Lake Chad covers the eastern part of Niger and is one of the largest sedimentary hydrogeological basins in Africa. Annual rainfall varies significantly across the basin from 1,500 mm per year in the south to less than 100 mm per year in the north. Due to high temperatures throughout the year, potential evapotranspiration exceeds 2,000 mm per year in the center of the basin (CNEDD 2021). Groundwater is the main source of water supply for the agriculture and for the population living in the basin.

Renewable groundwater resources are estimated at 2.5 billion cubic meters. The long-term viability of this water source will be affected by the recharge rates, which depend on the rainfalls patterns and climate variability. Moreover, demographic pressure and increased conversion of land to agricultural use also pose risks to water availability. Nonrenewable groundwater resources are estimated at 2,000 billion cubic meters (Ministère de l'Hydraulique et de l'Assainissement 2017).

15 According to the Water Stress Index, absolute water scarcity is defined as less than 500 m^3/capita/year, water scarcity is less than 1,000 m^3/capita/year, water stress is less than 1,700 m^3/year, and more than 1,700 m^3/capita/year is no water stress.

URANIUM AND OIL

Niger's extractive industries contribute 42 percent of total exports and generate 7 percent of government revenues (ITIE Niger 2021). The country is the world's fifth largest producer of *uranium* (ITIE Niger 2021). A recent positive development was the readmission of Niger as an Extractive Industries Transparency Initiative implementing country in February 2020. This should facilitate the institutional reform needed to recover earlier gains and the resolution of key issues such as the environmental impact of mining and local communities' appropriate share of mining revenues collected by the Government. In July 2020, Niger adopted the National Mining Policy 2020–2035 that aims to diversify mining beyond uranium and improve the contribution of the mining sector to the national economy which has varied over the past three decades (République du Niger 2020a).

The country is also an important producer of *crude oil*. Recent investments portend increased exports as infrastructure becomes operational. However, the economic and social benefits of future oil windfalls will hinge on the transparent and efficient governance of these resources to benefit the entire population and future generations (World Bank 2022b). Furthermore, the variability of commodity prices and sector productivity will continue to accentuate volatility in government revenues and investments, as weak earnings are likely to reduce government revenues in the near term. In addition, increased oil production is expected to create a demand shock that will raise domestic prices and potentially put other economic sectors at a competitive disadvantage. Given the volatility of commodity prices, increasing agricultural productivity and fostering the development of the private sector are critical conditions for Niger's sustainable growth.

1.3. Government efforts on sustainable natural resources management

The Government of Niger (GoN) recognizes the importance of maintaining a balance of its fragile ecosystems and their services for the socio-economic development of the country. Niger's vision was enshrined in a key pillar of the country's Economic and Social Development Strategy (ESDS) for 2017–2021. The strategy recognizes that Niger is facing a precarious environmental situation due to the severity of soil degradation, low preservation of biodiversity, obstacles to the sustainable development of land and water resources, and limited ability to deal with the climate crisis. In addition, the Renaissance Program 2 (2016–2021) identified the restoration and sustainable management of land as one of the main priorities to ensure food and nutrition security through the 'Nigeriens Nourish Nigeriens' (3N) Initiative. These documents included ambitious targets to restore 1.065 million ha of land and extend protected areas[16] as well as increase the contribution of NTFPs to households by accelerating production of Arabic gum and moringa (République du Niger 2016a). More recently, the Strategic Framework for Sustainable Land Management for 2015–2029 aims at restoring **3.2 million ha** of land by 2029. Niger has expressed these commitments internationally, for example, through its Nationally Determined Contribution (NDC) to the UN Paris Agreement on Climate Change and through the Bonn Challenge.[17]

In 1991, Niger embarked on a vast institutional, legal, and administrative reform to transfer competencies and executive powers to local authorities. This decentralization process has had a major impact on the governance of natural resources, promoting dynamic engagement at the grassroots level to support and complement the efforts of the

16 During 2011–2015, Niger reported having restored 218,000 ha of land against a target of 150,000 has and doubling the area of protected areas.

17 A global platform launched by the Government of Germany, involving 61 countries to date.

central state through sectoral policies. Despite these advances, various challenges remain, in particular relating to sustainable financing, efficient and transparent management of communities and regions, and the provision of qualified staff. The development of a transfer mechanism creates further challenges. This mechanism is intended to simplify the allocation of subsidies, enable investment, and share out finances equitably among communities. However, communities and regions are not yet able to provide efficient public services or offer citizen-centric administration, while local people and communities are not sufficiently involved in municipal decision-making and the development processes taking place within the context of the decentralization reforms (GIZ GmbH, n.d.).

1.4. Objective and structure of the CEA

The objective of this CEA is to analyze critical environmental and natural resource issues threatening sustainable economic growth in Niger and propose policy actions and investments to address them. The results of the analysis aim to broaden the dialogue with the GoN and its engagement with the public on improving environment and natural resource management. The CEA aims to effectively analyze and communicate the links between good environmental and natural resource stewardship in Niger, economic growth and poverty reduction, and improved livelihoods, to galvanize investment in environmental management, land conservation and restoration, policy and regulatory reform, institutional strengthening, and capacity building. Ultimately, the CEA will inform the upcoming update to Niger's Systematic Country Diagnostic and allow the Government, the World Bank, development partners, and other stakeholders to effectively address environmental sustainability and natural resource management questions that affect Niger's future.

The report is structured around three thematic areas:

- Land degradation
- Deforestation and forest degradation
- Climate change.

These areas are in line with the high priorities identified by the GoN, given their significance to the country's economy and the intricate links between them. Other important themes such as pollution and mining go beyond the scope of this report and require their own separate analysis.

This CEA leverages existing data and research to contextualize the environmental challenges to Niger's sustainable development and brings in new analysis on the cost of land degradation and loss of forest carbon. To better understand the extent of the environmental degradation, Chapter 2 presents an in-depth analysis of land degradation, in terms of key drivers, economic cost, and potentially long-lasting impacts on the society. Further, the problem of deforestation and forest degradation is examined in Chapter 3, focusing on trends of forest areas, degradation drivers, and the economic cost of carbon loss. Given the country's vulnerability to climate-related risks, Chapter 4 provides an overview of the climate change projections and likely effects on specific sectors in Niger. Finally, concrete recommendations addressing Niger's environmental sustainability, poverty, and fragility are discussed in Chapter 5.

Photo: Andrea Borgarello / World Bank Group

2

Photo: Andrea Borgarello / World Bank Group

2 Land degradation

2.1. Overview

Land degradation[18] is particularly visible in areas that have experienced explosive population growth and intensification of agricultural activities. These areas cover the Niger River Valley in the southwestern corner and along the south-central border (Map 2.1). The impact of climate change and anthropogenic activities on the Nigerien land resulted in extensive degradation of natural resources, leading to silting-up of fertile basins and dwellings, cereal deficit, and a reduction of forest and grazing areas. This situation is affecting the country's food security, conflict, and fragility, with potential impacts on the entire Nigerien population.

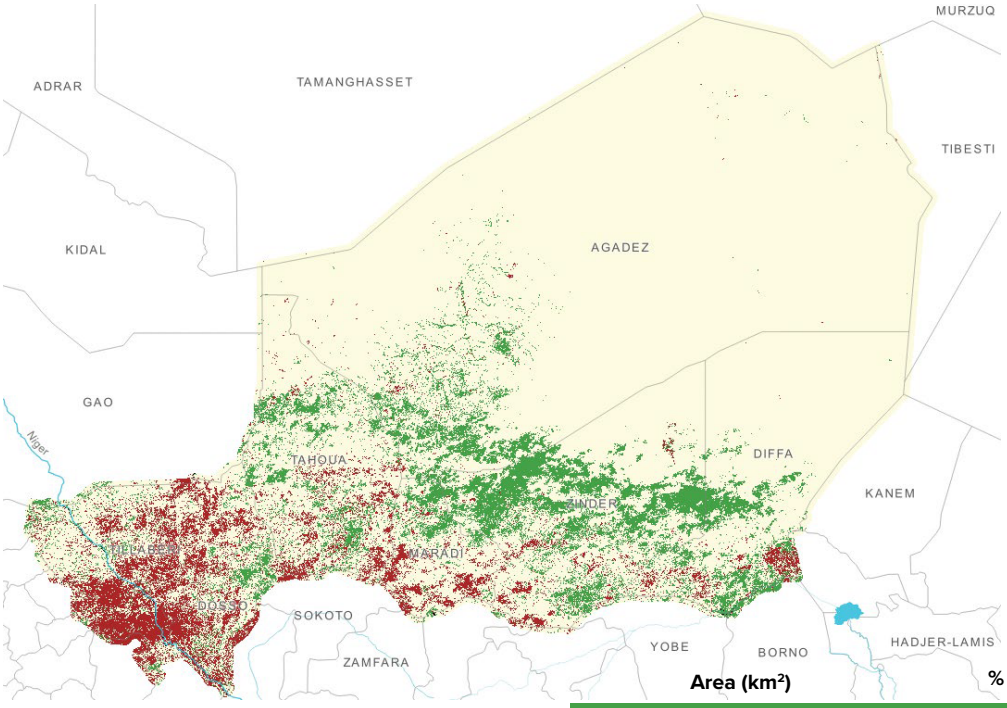
Between 2001 and 2015, more than 6 percent of Niger's overall territory suffered degradation. Today, this degradation affects millions of farmers. The combined pressure of unsustainable land management practices, growing insecurity in Tillaberi and Dosso region, demographic changes and migration, and climate change and variability is causing severe environmental and economic damages. Considering that more than 70 percent of the country is desert, the land degradation indicators showed that 85 percent of the land is stable, meaning that it neither deteriorated nor improved between 2001 and 2015. Box 2.1 presents methodological details related to Map 2.1.

Niger has taken successful steps toward land rehabilitation in areas threatened by desertification. Since the 1980s, Niger has gained significant experience in assisted natural regeneration through farmer-led initiatives to restore the tree cover on croplands, increase cereal yields, and improve water capture. Farmers from Maradi, Zinder, and Tahoua have widely adopted sustainable land and water management practices and added approximately 10 million trees with limited donor support (1985–2005). The impact is noticeable: the areas with improved soil and vegetation are visible as a belt against the desert along the Great Green Wall (Map 2.1).

This chapter is based on new economic analysis of the cost of land degradation. It is outlined as follows: first, it addresses the drivers of land degradation, including historical climate and human-induced factors. Further, the chapter presents the results of an economic analysis of the cost of land degradation, based on FAO data and other local information. Then, it examines the potential impacts on food security, malnutrition, food trade, local livelihoods, migration, and fragility. Finally, it presents an overview of current efforts to address land degradation, followed by conclusive remarks.

18 This chapter focuses on the degradation of croplands and rangelands. The deforestation and forest degradation are discussed in the following chapter.

MAP 2.1. Map of land degradation 2001–2015—Sustainable Development Goal (SDG) 15.3 target indicator



	Area (km²)	% of total land area
Land area improved:	109,038	8.8
Land area stable:	1,048,628	84.9
Land area degraded:	78,133	6.3
Land area with no data:	100	0.0
Total Niger:	1,235,898	100

Source: Trends.Earth 2016.

BOX 2.1. Land degradation methodology

Methodology: Land degradation maps were produced using Trends.Earth, which is a platform for monitoring land change based on earth observations. The Trends.Earth platform, formerly the Land Degradation Monitoring Toolbox, tracks three sub-indicators for monitoring achievement of SDG target 15.3, Land Degradation Neutrality: productivity, land cover change, and soil organic carbon. The datapoints are combined using a 'one out, all out' principle, meaning that a decline in any of the three indicators at a particular pixel causes that pixel to be mapped as 'degraded'. The database allows users to plot time series of key indicators of land change (including degradation and improvement) to produce maps and graphics that can support monitoring and reporting and to track the impact of sustainable land management. The tool supports countries in analyzing data to prepare for their reporting commitments to the United Nations Convention to Combat Desertification (UNCCD). Trends.Earth was produced by a partnership of Conservation International, Lund University, and the National Aeronautics and Space Administration (NASA), with the support of the Global Environment Facility (GEF). Additional information about the methodology behind the land degradation maps can be found at Trends.Earth.

2.2. Drivers of land degradation

Climate change and variability combined with anthropogenic activities resulted in extensive degradation of natural resources. Rising temperature, irregular and heavy rain, and frequent and often strong winds produce water and wind erosion, the main climate-related drivers of land degradation (UNCCD 2017). Moreover, anthropogenic drivers of land degradation in Niger are most common in areas with high population density and include overgrazing, clearing forest land for agricultural purposes, uncontrolled exploitation of forests to satisfy energy needs, and bushfires (CNEDD 2018).

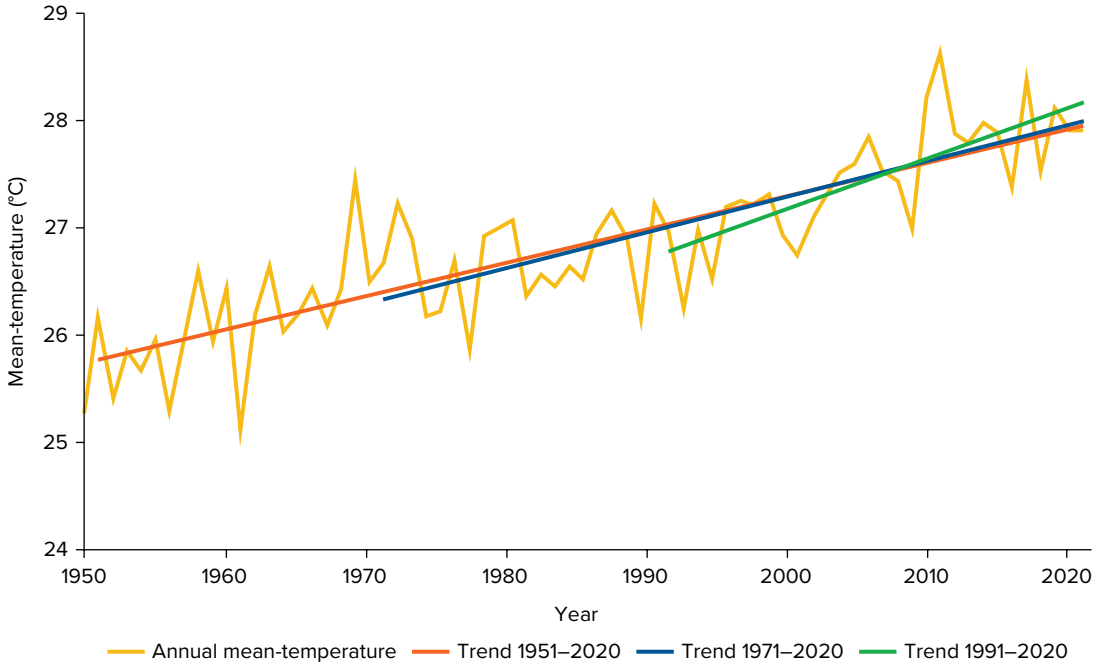
CLIMATE DRIVERS

Mean annual temperature increased by 0.6–0.8°C between 1970 and 2010, according to observed historical data produced by the Climatic Research Unit of the University of East Anglia (Figure 2.1). This is slightly higher than the global average, and there has been an increase in the number of warm days/nights and a decrease in the number of cold days/nights.

A change in dryness in key regions of Niger has been observed since 1980. According to the Palmer Drought Severity Index (PDSI), which is a standardized index based on a simplified calculation of the soil moisture balance from precipitation and temperature data, it is possible to observe a significant change in the annual dryness in regions such as Tahoua, Maradi, Agadez, and Diffa of Niger, though the PDSI remains relatively stable in parts of Tillaberi, Zinder, and Dosso (see Map 2.2).

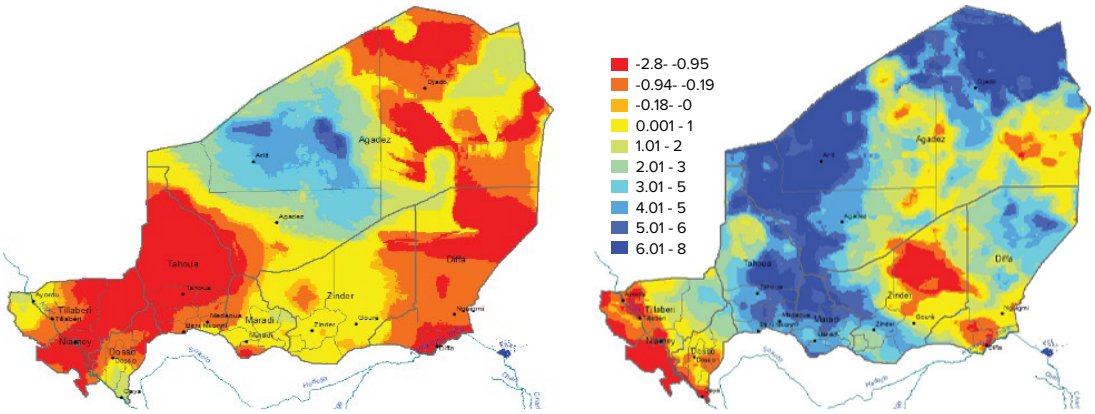
The magnitude of PDSI indicates the severity of departure from normal conditions. The average annual PDSI for Niger between 1981 and 2020 registers moderate to extreme drought between 1983 and 1987, turning to very wet to extremely wet conditions from 2016 to 2020 (Figure 2.2). Overall, 47 percent of the years are near normal or

FIGURE 2.1. Niger mean temperature annual trends



Source: World Bank Group Climate Change Knowledge Portal.

MAP 2.2. PDSI for Nigerien regions in 1980 and 2020

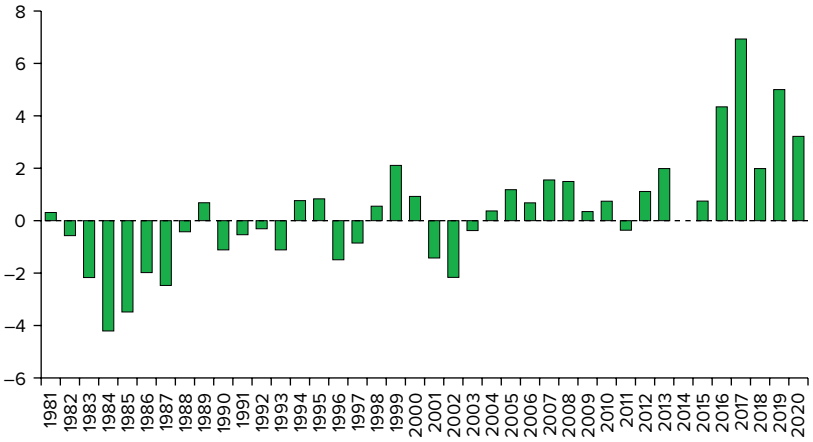


Annual PDSI, 1981 Annual PDSI, 2020

Source: Data retrieved from TerraClimate 2021, and analysis completed by the World Bank team.

FIGURE 2.2. Average Annual PDSI for Niger

Index	PDSI class
4.0 or more	extremely wet
3.0 to 3.99	very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	slightly wet
0.5 to 0.99	incipient wet spell
0.49 to–0.49	near normal
–0.5 to–0.99	incipient dry spell
–1.0 to–1.99	mild drought
–2.0 to–2.99	moderate drought
–3.0 to–3.99	severe drought
–4.0 or less	extreme drought



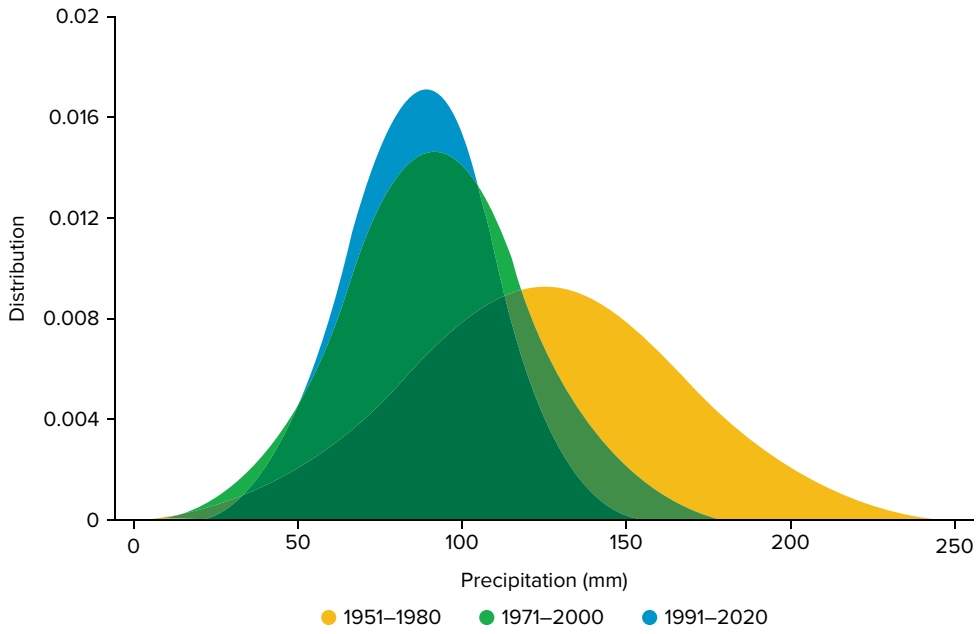
Source: Data retrieved from TerraClimate 2021, and analysis completed by World Bank team.

almost normal, 25 percent are in the drought group, and 28 percent are in the wet group of years, mostly in the last 15 years.

Precipitation has increased, but rainfall events in Niger appear to be less frequent and of shorter duration with greater intensity (Figure 2.3). The precipitation trend between 1981 to 2020 indicates an average increment of almost 1 mm of rainfall per year though cumulative precipitation has not returned to pre-1960s levels and certain characteristics have changed. An increase in the frequency and severity of extreme rainfall events and flooding has been observed (World Bank Climate Change Knowledge Portal, n.d.). The close relationship between rainfall and water erosion (Mohamadi and Kavian 2015) worsens land degradation in Niger.

Dust and sand wind affect agricultural and pastoral lands and surface watercourses. The effect is particularly harmful in the harmattan season from November to March with a hot and dry wind that ranges in speed from 5 to 10 m/s. During the monsoon season, wind speed is generally low (2 to 8 m/s) but can reach instantaneous maximum intensity winds with speed of more than 40 m/s (CNEDD 2019).

FIGURE 2.3. Change in distribution of precipitation in Niger



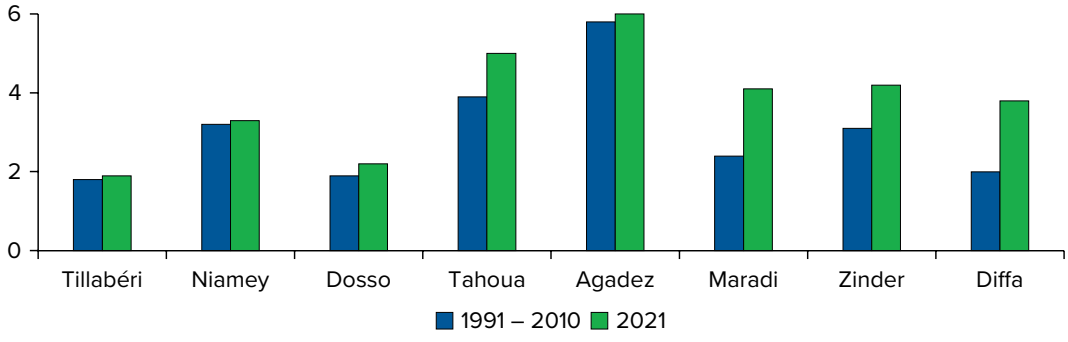
Source: World Bank Group Climate Change Knowledge Portal.

The increasing intensity of winds produces wind erosion, affecting land productivity in Niger (CNEDD 2014). Wind speed varies across regions, and changes in the speed also affect each region differently (Figure 2.4). Wind speed is greater in Agadez, Tahoua, and Niamey, but changes in wind speed for December 2021 are more extreme in Diffa, Maradi, and Zinder regions. Wind and water erosion are the main drivers of land degradation in Niger, but the impact at the regional level varies across the country.

ANTHROPOGENIC DRIVERS

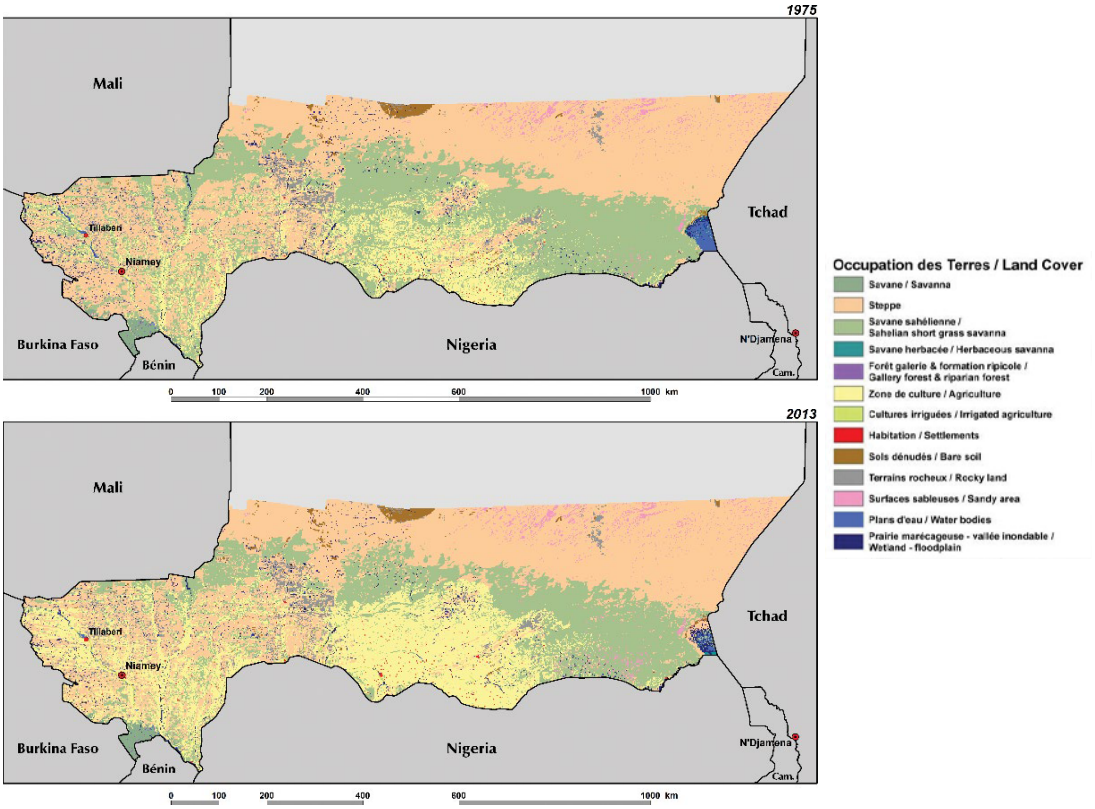
Driven by rapid population growth and the increasing demand for food, agricultural expansion is the most dramatic change in Niger's landscape over the past four decades. Over 1975–2013, cultivated areas have increased from 12.6 percent in 1975 to 18.1 percent in 2000 and 24.5 percent in 2013 (Map 2.3). Agriculture expansion mostly occurred on the productive sandy soils of the valleys in the Tillaberi region, where cropland is now encroaching on

FIGURE 2.4. Wind speed in Niger (m/s)



Source: Direction de la Météorologie Nationale du Niger (DMN)—Division Changement Climatique et Développement (DCCD) 2021.

MAP 2.3. Land use and land cover time series, 1975 and 2013



Source: CILSS 2016.

traditional pastoral lands. In this region, an increase of 50 percent in irrigated agriculture is observed along the Niger River. The south-central region, already heavily cultivated in 1975, is now a homogeneous agricultural landscape, and agriculture is still expanding eastward on the remaining short grass Sahelian savannas. In parallel, average yields of major crops have not seen a significant increase and since the 1980s, per capita food production has remained stagnant (Ministère de l'Environnement de la Salubrité Urbaine et du Développement Durable 2014).

Land degradation is an important factor contributing to low agricultural productivity, poverty, and other environmental problems. Natural vegetation suffered a sharp decline, reducing natural biodiversity and exposing the soil to wind and water erosion. In turn, sandy areas have increased by 24.8 percent since 1975. This trend, which appears to have become more acute since 2000, is a major concern because it indicates a decrease in soil stability and a loss of vegetation cover.

Although grassland areas remained relatively stable in recent years, the livestock population has increased consistently (Figure 2.5). Therefore, more pressure is exerted in the remaining pastoral areas where intensive production practices such as overgrazing occurs, increasing the risk of land degradation. Livestock is widely developed in Zinder, Tahoua, Tillaberi, and Maradi regions, in which Tropical Livestock Units[19] (TLUs) surpassed 3 million in 2019 (Figure 2.6). In addition, wood overharvest for energy and bushfires contributed heavily to land degradation, particularly in forested areas, as presented in Chapter 3.

19 Tropical Livestock Units (TLUs) are livestock numbers converted to a common unit. Camels with an average weight of 250 kg. were defined as 1 TLU. Further conversion factors: Cattle = 0.8 TLU, Sheep and Goats = 0.15 TLU, Equines = 1 TLU, and Mules = 0.5 TLU.

FIGURE 2.5. Evolution of TLUs in Niger between 2005 and 2019

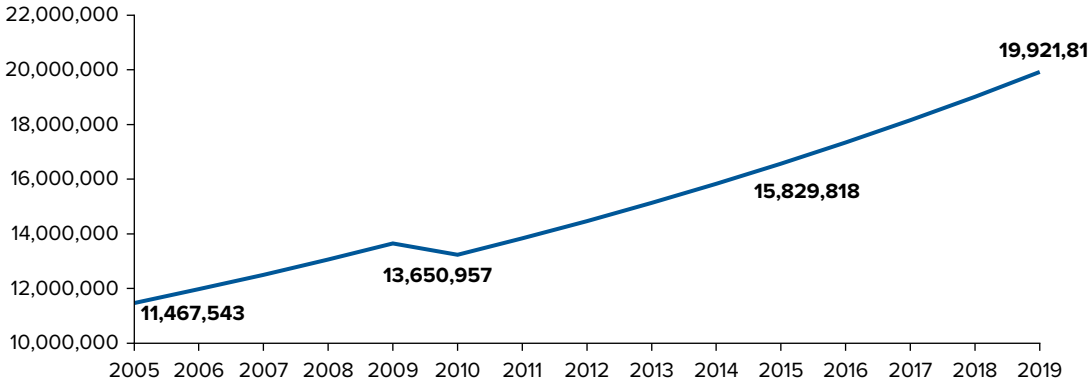
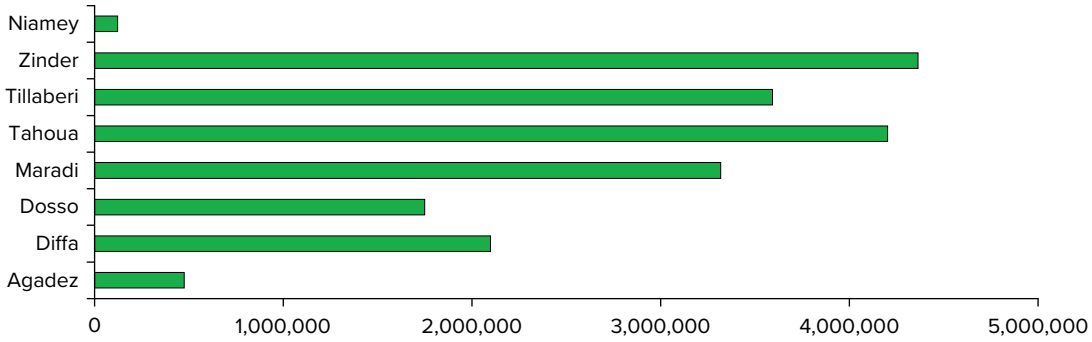


FIGURE 2.6. TLUs per region in 2019



Source: Ministry of Agriculture and Livestock, GoN.

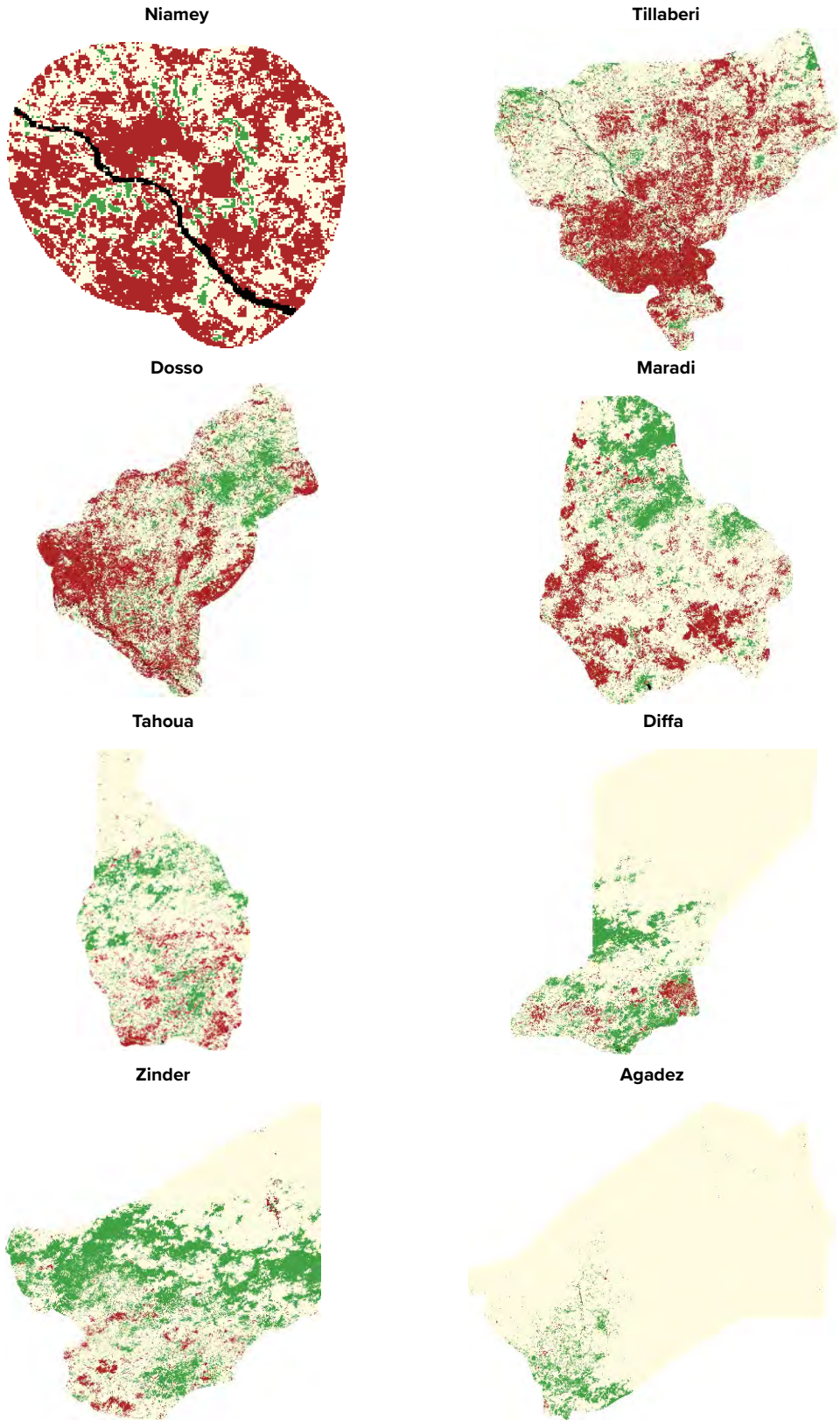
In summary, climate change and variability, coupled with strong demographic growth and cropland expansion, poor land and water management practices, and uncontrolled exploitation of forests to meet fuelwood and other needs, led to excessive exploitation of land and considerable loss of productive potential.

2.3. Cost of land degradation

There is wide disparity in the extent of land degradation across the eight regions of Niger. To obtain more accurate results of land degradation at the local level, Figure 2.7 presents land degradation maps for each of Niger's regions, based on Map 2.1. The results show that in relative terms, degradation primarily affected Niamey (52 percent of the region's area), Dosso (34 percent), and Tillaberi (34 percent). Maradi registered 17 percent of its area under the process of land degradation, while the degraded land in Tahoua represented about 9 percent of its territory. Only a small proportion of Zinder and Diffa's areas were affected by degradation (3 percent in each).

The economic cost due to land degradation was estimated at US$646 million, or 5 percent of Niger's GDP in 2019. This corresponds to about 12 percent of the agricultural GDP in the same year. The analysis focuses on the on-site economic losses on croplands, that is, agricultural productivity. Since it does not cover off-site costs related to cropland degradation such as loss of water availability due to erosion, and any cost related to pastureland degradation such as loss in fodder yields, it represents a conservative estimate. The

MAP 2.4. Regional land degradation maps



Source: Trends.Earth 2016.

FIGURE 2.7. Cost of land degradation by region (US$)

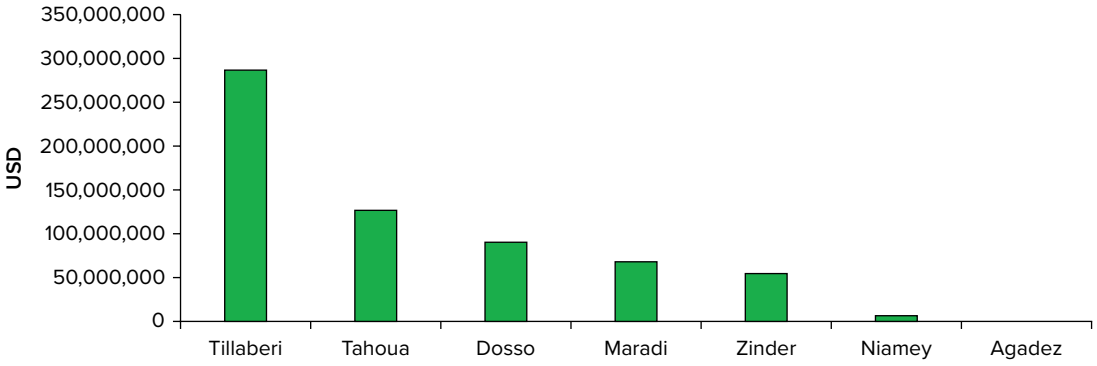
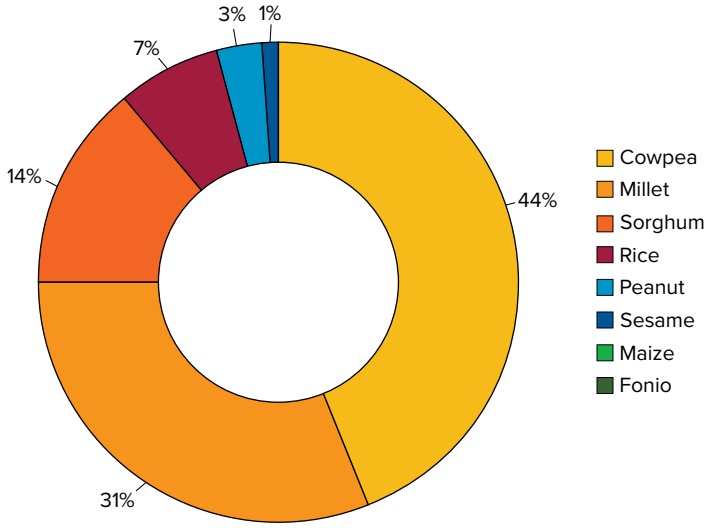


FIGURE 2.8. Cost of land degradation by crop (%)

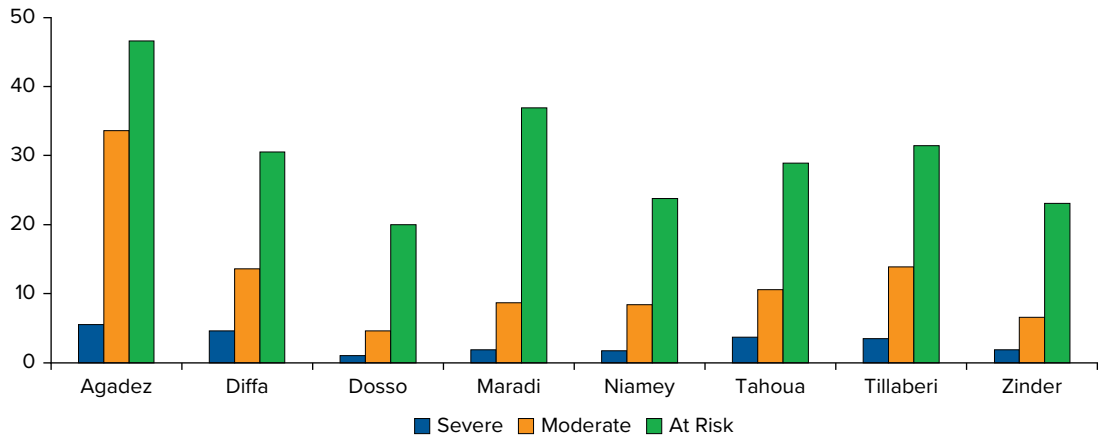


Source: Raw data retrieved from GoN and analyzed by World Bank task team.

crops selected for this study were cowpea, millet, sorghum, rice, peanut, sesame, maize, and fonio, which together account for more than 97 percent of the total crops produced in Niger. The valuation represents a broad estimate based on an average percent yield loss derived from the literature and does not consider different levels of land degradation severity in Niger (see Annex 2 for the detailed methodology and estimates).

The region of Tillaberi alone bears nearly half the cost of land degradation in Niger. In 2019, yield loss in Tillaberi reached US$287 million, or 44 percent of the total cost of land degradation in Niger. Looking at the drivers of land degradation, it is noticeable that agricultural land has expanded (Figure 2.7), encroaching onto the pastoral land, which itself has witnessed an immense intensification in terms of heads of livestock. Compounding the impact of these trends, the region has been affected by extreme drought, as indicated by the PDSI (Figure 2.2), and is often marked by violent conflict. The high cost of land degradation in Tillaberi can be explained by the production of high-value crops, such as cowpeas and rice, which combined account for 60 percent of the foregone crop yield loss in the region.

FIGURE 2.9. Food insecurity in rural areas by region, Niger



Source: Institut National de la Statistique. 2018. Tableau de bord social.

The cost of land degradation in Maradi and Zinder, where large-scale land restoration projects have been implemented since the 1980s, is notably lower. Considered the breadbasket of Niger, the regions are central to the millet and sorghum belt running horizontally across Niger (see Map 2.5) and each yields 20 percent of millet production and 30 percent of sorghum production nationally. Those areas have seen an increase in crop production, since the 1980s, of an additional 500,000 tons of cereal per year due to farmer-managed natural regeneration (FMNR, Box 2.1), which may in part explain the lower yield losses in those regions.

2.4. The impact on food security and malnutrition

FOOD SECURITY

Food insecurity is a significant threat in several Nigerien regions. The number of Nigeriens affected by moderate and severe food insecurity in rural areas in 2018 accounted for 9.8 and 2.6 percent, respectively, while the percentage of people at risk was 29.1 percent at the national level (Figure 2.9). Regional data show that Agadez, Diffa, and Tillaberi are the regions most affected by moderate food insecurity. These regions and Tahoua are the most affected by severe food insecurity.

Food security is in crisis particularly in the northern parts of Tillaberi and Tahoua. Food assistance allows the majority of people in Niger to cover their food needs. However, in the border regions of Tillaberi and Tahoua, humanitarian assistance only covers 8–12 percent of households due to difficulty of access caused by conflict and insecurity (FEWS NET 2021).

MALNUTRITION

Food insecurity is a major cause of malnutrition in Niger (République du Niger 2016b). As in much of Western Africa, food availability does not satisfy the daily per capita minimum intake as recommended by the World Health Organization (WHO) (Ministère du Plan 2021). Consumption patterns in Niger show that food intake of most types of nutrition is insufficient (see Figure 2.11). However, the nutrition deficit is partly compensated for through legumes, such as cowpeas, majorly produced by Niger.

Malnutrition is particularly high in remote areas and in areas highly dependent on subsistence farming. The prevalence of acute malnutrition,

BOX 2.2. Improved livelihoods through FMNR in Maradi and Zinder

In Maradi and Zinder, years of land restoration and expansion of agricultural activities to combat land degradation and desertification have proved that it is possible to improve local livelihoods through enhanced ecosystem health and function. Specifically, FMNR has effectively addressed key drivers of land degradation, including low soil fertility, drought, destructive winds, low yields, periodic crop failure, and fuelwood shortage.

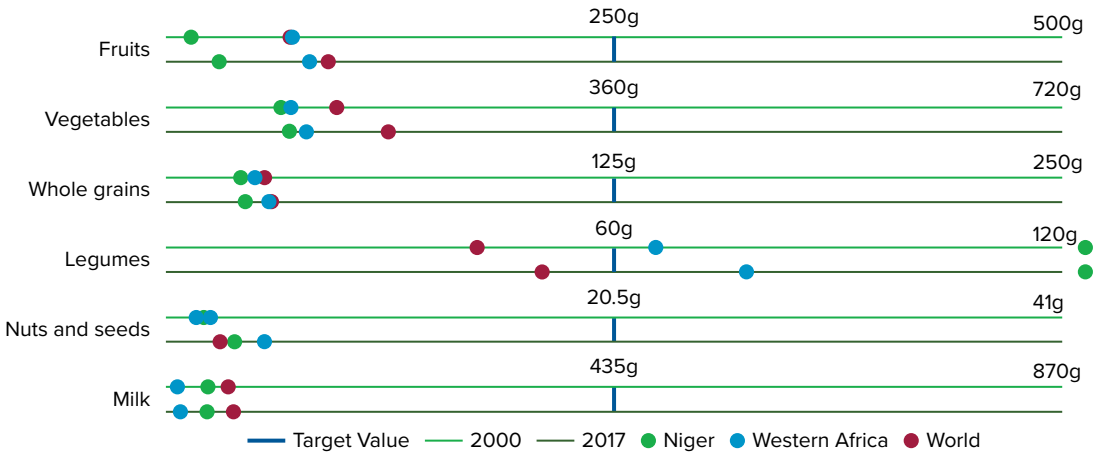
Using traditional and small-scale water capture structures, such as stone bunds, zaï pits, and half-moon planting techniques, farmers in Maradi and Zinder have been able to increase cereal yields by 40 to 100 percent in rainfed agriculture. As a result of these sustainable land and water management practices, these areas of Niger are producing an additional 500,000 tons of cereal crops annually, resulting in 2.5 million people being more food secure. In the Aguie district, Niger, farmland that was virtually treeless in the early 1980s now sports 103–122 to trees per ha and sustainably harvested fuelwood is sold locally and across the border to Nigeria. Furthermore, gross income in Maradi has grown by US$17–21 million, equal to an additional US$1,000 per household per year.

FIGURE 2.10. Regreening using Zai pits and half-moon water harvesting techniques

The social benefits of FMNR to local livelihoods have also been well documented. Because FMNR contributes to lifting yields and income, it has a positive effect on livelihoods, food security, resilience, and risk reduction. There are documented reports of reduced impact of drought and reduced incidence of flooding. Women and children's burdens become lighter as fuelwood is easier to gather and is closer at hand. Women have more time to pursue economic and other activities, and their status in the community is often lifted as they participate in decision-making group activities and sometimes leadership. Children are more likely to go to school.

Source: UN SDGs. https://sustainabledevelopment.un.org/partnership/?p=30735.

FIGURE 2.11. Estimated per capita intake in grams per day of fruits, vegetables, whole grains, legumes, nuts and seeds, and milk, 2000–2017

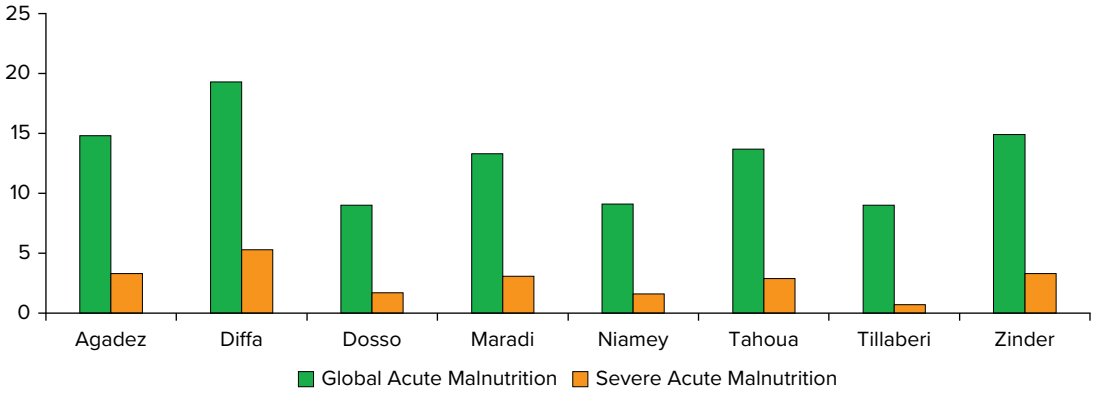


Source: Global Burden of Disease.

both global and severe, is above the high threshold level for public health at 12.7 percent and 2.6 percent, respectively (Figure 2.12). In the context of Niger, malnutrition is highest in remote areas, such as in Diffa region, where one in five children under six years suffers from acute malnutrition at twice the WHO's high threshold level for both global and severe acute malnutrition. In Maradi, Tahoua, and Zinder, where many rural households are dependent on subsistence farming for their livelihood and therefore are vulnerable to weather-related shocks, malnutrition rates are all above the high threshold of 10 percent. Interestingly, malnutrition rates are lowest in some of the areas with the highest land degradation rates, such as Tillaberi and Dosso. This is likely due to the proximity to nearby urban areas around Niamey, where rural, food-insecure families have better access to basic food staples and essential services.

Overall, in the absence of remedial actions, **land degradation and high population growth are likely to worsen the food security situation and the nutritional outcomes in Niger** in the long term. Moreover, growing pressure on the capacity of

FIGURE 2.12. Prevalence of acute malnutrition (global/severe) in children 6–59 months by region in 2020



Source: Institut National de la Statistique. 2018. Tableau de bord social.

institutional systems to meet food needs will continue. As increasing population density in agropastoral areas reduces land availability and hastens soil degradation, the evolution of food systems, agricultural production, and institutional safety nets becomes a major concern.

2.5. The impact on food trade

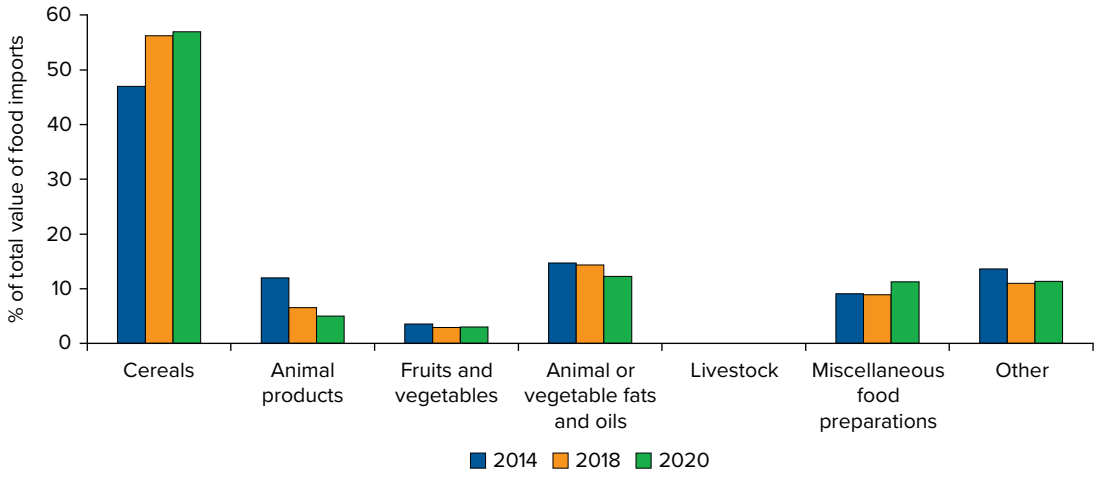
Niger produces about one-third of the minimum daily per capita food demand recommended by the WHO. Processed fruits and vegetables are mainly provided by commercial imports. The value chains of dry cereals, including millet and sorghum, are the basis of food in Niger and represent important economic opportunities for producers (République du Niger 2021b). In this context, an annual yield loss due to land degradation of about 13 percent for millet and 11 percent for sorghum significantly increases the risk of food insecurity while straining development opportunities for Niger going forward.

A worsening negative food trade balance is observed in Niger. Food imports increased fivefold between 1997 and 2017, from US$106 million to US$520 million. Food exports also increased over this period, but more modestly, tripling from US$51 million to US$171 million (FAO 2021a). Considering that local production is largely insufficient to meet domestic demand, particularly in urban areas, as most producers are smallholder subsistence farmers, land degradation poses a threat to the food trade balance in Niger.

Imports of cereals are growing relative to other food categories (Figure 2.13). Approximately 20 percent of Niger's cereal needs are met through imports, primarily from Nigeria. In an average year, 50 percent of imports cover cereal deficits. Demand for millet exceeds production, even in a good year. The quantities of staple foods (primarily cereals) that are produced and traded both internally and across borders are small scale, resulting in a thin market system that is vulnerable to even minor shocks. Cereal imports increased from 47 to 57 percent of the value of food imports during 2014–2020. In comparison, the imports of animal products showed a decreasing trend, from 12 percent to 5 percent of the total imports during the same period.

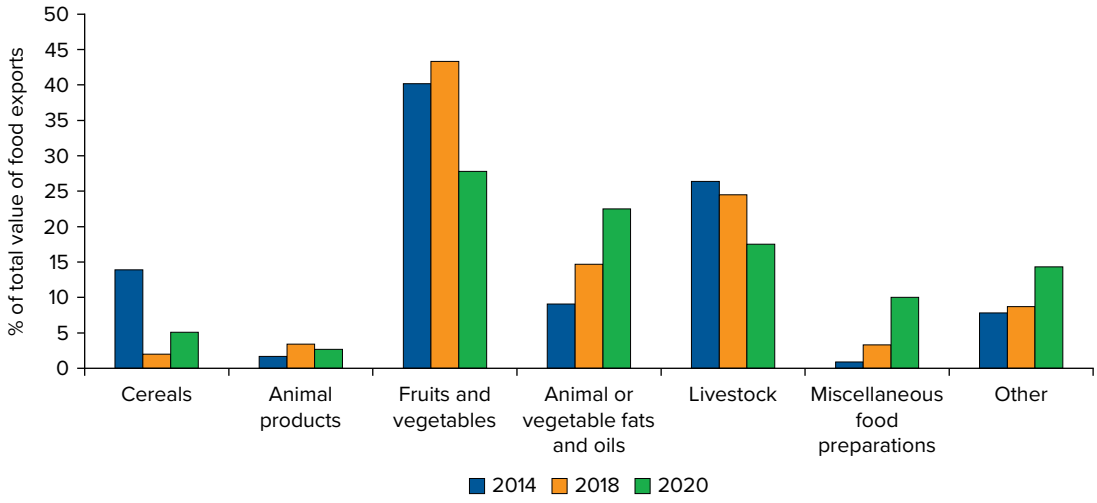
Land degradation is expected to affect future export earnings of agricultural products and livestock. Niger is a major producer and exporter of live cattle. While the country has a sufficient quantity of live animals of the bovine species to

FIGURE 2.13. Food imports in Niger—2014, 2018, and 2020 (%)



Source: Ministry of Planning 2021.

FIGURE 2.14. Food exports in Niger—2014, 2018, and 2020 (%)



Source: Ministry of Planning 2021.

satisfy the population's demand for meat and milk (Ministère du Plan 2021), land degradation is likely to reduce the future potential for export of livestock. This trend can already be observed as export of livestock has been decreasing during 2014–2020 (Figure 2.14). Similarly, the impact of land degradation on the primary food export source of Niger—fruits and vegetables—could generate a negative food trade balance and make Niger more dependent on food imports.

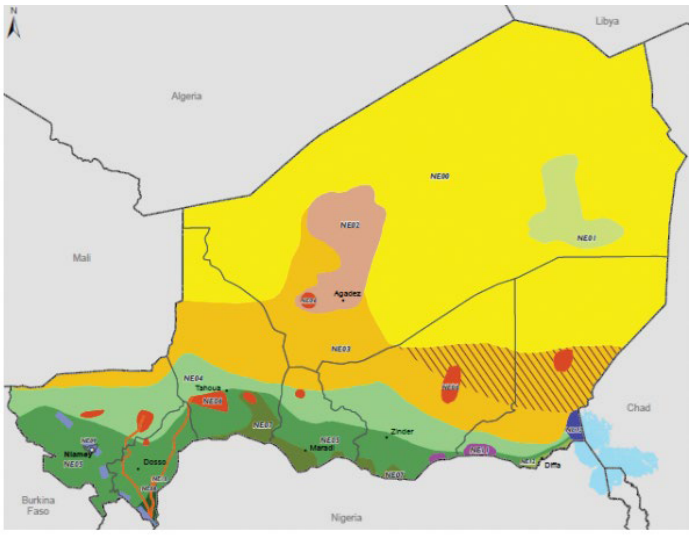
2.6. The impact on livelihoods

Niger includes three livelihood zones at high risk of irregular rainfalls and frequent droughts. The country is divided into 13 livelihoods zones, illustrated in Map 2.5. Three of them are at high risk of irregular rainfalls and frequent drought: the agropastoral belt zone (NE04); the rainfed millet and sorghum belt zone (NE05); and the cropping, herding, and work outmigration zone (NE06), which includes most of Zinder, Maradi, Tillaberi, Dosso, and Tahoua regions—they are among the most densely populated areas of the country. Among the three zones, the second one (NE05) consistently faces acute food insecurity due to its vulnerability to climate, along with population overcrowding and reduced household plot size.

Land resources play a critical role in shaping rural livelihoods as local communities are highly reliant on livestock and rainfed subsistence farming for food and income. Formally, the agricultural sector employs three out of four Nigeriens, and land cultivation and breeding are the main sources of livelihoods in Niger. However, the sector is affected by an economy unable to absorb the growing labor force, resulting in a growing share of the workforce engaged informally in the sector (FAO 2021b). At the household level, 97 percent of rural households' own livestock with an average herd size range from 13 to 16 heads for cattle and sheep, respectively (Table 2.1).

The lack of appropriate irrigation technology prevents farmers from tapping into the underutilized groundwater aquifers and reducing their dependence on traditional rainfed farming methods. This is a critical problem, particularly during the prolonged dry season that spans seven to eight months of the year. Women, most of whom do not own land, are disproportionately affected by the lack of rainwater for agriculture and often rely on sinks, a labor- and time-intensive method. Small and medium farmers are also affected by financing

MAP 2.5. Livelihood zones in Niger



- NE01 - Northeast Oases: Dates, Salt and Trade
- NE02 - Air Massif Irrigated Gardening
- NE03 - Transhumant and Nomad Pastoralism
- NE03 - Transhumant and Nomad Pastoralism—Camels
- NE04 - Agropastoral Belt
- NE05 - Rainfed Millet and Sorghum Belt
- NE06 - Cropping/Herding with High Work Outmigration
- NE07 - Southern Irrigated Cash Crops
- NE08 - Southwestern Cereals with Fan-Palm Products
- NE09 - Niger River Irrigated Rice
- NE10 - *Dallols*—Seasonal Water-Course Irrigated Crops
- NE11 - Southeastern Natron Salt and Small Basin Irrigated Dates
- NE12 - Komadougou Irrigated Peppers
- NE13 - Lake Chad Flood-Retreat Cultivation with Fishing
- Not Zoned (Desert)

Source: FEWS NET 2011.

TABLE 2.1. Characteristics of rural livelihoods in Niger, 2012

Household characteristics	Statistics
Own livestock (%)	97
Milk production per day per cow (liters), 3 months after calving	1.4
Practice rotational grazing (%)	2.24
Household production systems (% of households)	
Crop production only	37
Agropastoral	38
Pastoral	26
Households using improved pasture management (%)[a]	4
Average herd size (number)	
Shoats (goats and sheep) herd size	16
Cattle herd size (number of heads)	13

Source: National Statistical Institute 2012.

Note: a. Includes rotational grazing and managed natural regeneration. No farmer reported planted pasture.

problems, such as limited access to credit for the purchase of efficient agricultural inputs and equipment, including irrigation.

High dependence on rainfed agriculture makes rural livelihoods particularly vulnerable to land degradation. Frequent shocks, decreasing landholding sizes, underutilized water resources, overcrowding, poor natural resource management, inefficient yields, and limited use of modern technologies and inputs are constraints to production from year to year. Poor households often sell agricultural labor, engage in contract herding, and market cash crops to access food.

Land degradation can lead to cereal production deficits,[20] subsequent shocks to food prices, and poorly regenerated pastures, and the most vulnerable livelihood zones are likely to be most affected. When land degradation affects agricultural productivity and the availability of fodder for livestock, it likely worsens food and income security. In a vicious circle, degraded land often forces farmers to adopt increasingly unsustainable land and water management practices, such as overgrazing and cultivating fallow land. In turn, this may increase food insecurity, destroy local livelihoods, and deepen poverty.

2.7. The impact on migration and fragility

Seasonal migration is a traditional coping mechanism with unfavorable climatic conditions, such as erratic rainfall and droughts. During the dry season, many Nigeriens migrate to Southern Niger or other parts of West Africa to seek work as laborers (Funk et al. 2019). For example, in 2015, one-third of the total Nigerien migrants moved to other rural areas of the country, while two-thirds migrated to other African destinations, mainly to neighboring countries.

Moreover, Niger suffers from spillover due to conflicts induced by non-state groups in neighboring countries (WFP 2019). The deteriorating security situation in the border areas with Nigeria, Mali, and Burkina Faso displaced 567,000 people in 2020—compared to 187,000 in 2019 and 158,000 in 2018 (FEWS NET 2021). A considerable proportion of these people arrived in Tillaberi, Tahoua, and Diffa. The influx of foreign migrants increases the reliance on humanitarian assistance, decreases food availability, and raises prices, especially in local communities unable to absorb new populations (FEWS NET 2021).

The above migration patterns often exacerbate existing conflicts in Niger. In Diffa, the intensity of migration influx varies according to the level of security (FAO 2021b). For instance, in some areas with growing insecurity, resident livestock farmers migrate to safer areas, adding pressure to those pastures. Cross-border transhumance circuits and trade routes for livestock between Diffa region and Chad are modified to bypass areas that are beset by insecurity. This challenges the sustainable management of transhumance corridors and grazing areas and often leads to conflict between pastoral farmers and migrant transhumant herders over access rights for natural resources. In this fragile context, land degradation is likely to aggravate the outmigration of Nigeriens for better opportunities as well as the current conflicts between farmers and pastoralists.

2.8. Current efforts to address land degradation

In September 2021, Niger adopted a new Land Policy with a historic land tenure reform. Informed by the key principles related to Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests, the Land Policy included a noteworthy participatory process known as the 'États généraux du foncier rural'.

20 Commercialization rates of crops are small in Niger. Millet, which represents 65 percent of the total cultivated area (Ministry of Environment, Urban Sanitation, and Sustainable Development 2020), and sorghum, registering a commercialization rate of only 1 percent, are mainly subsistence crops (World Bank 2017a).

BOX 2.3. Overview of institutional actors engaged in sustainable land management

The Presidency of the Republic: This comprehends various specialized support-advice departments, including the Water and Environment and Sustainable Development unit, but also other structures that stand out for the promotion of sustainable development, in particular the High Commission to the 'Nigeriens Nourish Nigeriens' (3N) Initiative and the High Commission for the Development of the Niger Valley.

The National Assembly: This institution is the representation of national elected officials who vote on all laws submitted by the Government, including those concerning the sustainable management of natural resources as defined by the constitution.

The Cabinet of the Prime Minister: Within the framework of the coordination of government action, in addition to the Executive Secretariat, the Cabinet has specialized structures in promoting sustainable development, including the following:

- The National Mechanism for the Prevention and Management of Crises and Food Disasters which carries out sustainable land management actions, in the form of cash and or food for work, in collaboration with local actors to mitigate various crises at the local level and improve resilience climatic.
- The National Environmental Council for Sustainable Development: National focal point for post-Rio Conventions, which is the national body for coordinating and monitoring activities relating to these conventions and their protocols as well as any other convention that Niger may ratify in this area.
- The Ministry of Planning, Regional Planning and Community Development: It is in charge of intersectoral coordination, dialogue with technical and financial partners, mobilization of external resources, and monitoring of development programs and projects. It coordinates the exercise of integrating sustainable land management actions into the national strategies adopted by the Government.
- The Ministry of the Environment and Sustainable Development: It develops and implements policies, plans, programs, and projects relating to the preservation of the environment and the management of natural resources. The ministry has two general directorates: The General Directorate for the Environment and Sustainable Development (*Direction Générale de l'Environnement et du Développement Durable,* DGEDD) and the General Directorate for Water and Forests (*Directorate General des Eaux et Forests,* DGEF). In addition, the ministry has supported directorates including the Office of Environmental and Impact Studies and Assessment (*Bureau National d'Évaluation Environnementale Et des Etudes d'Impact,* BEEEI), the National Center for Ecological and Environmental Monitoring (*Centre National de Surveillance Écologique et Environnementale,* CNSEE), and the National Center for Forest Seeds (*Centre National de Semences Forestières,* CNSF).
- The Ministry of Agriculture and Livestock: It ensures the supervision of rural producers, acts in sustainable development through the fight against poverty in rural areas, promotes agricultural and pastoral production and the fight against food insecurity, develops ecosystems, and secures the living conditions of rural populations. It manages the bases of agropastoral production.
- The Ministry of Hydraulics and Sanitation, the Ministries in charge of Finance, Foreign Affairs, Cooperation for African Integration and Nigeriens Abroad play a decisive role in the search for partnership, negotiation, and mobilization of financial resources for the implementation of sustainable land management practices.

Local authorities: They are represented by municipalities (266) and regions (8). Each commune has a development planning tool, the Communal Development Plan (*Plan de Développement Communal,* PDC) with a strong sustainable land management component.

Higher education and research institutions: They have operational units for the conservation of collected seeds and constitute places for testing sustainable land management innovations and techniques to be applied in rural areas.

Civil society organizations: They are represented by around a hundred nongovernmental organizations (NGOs) and associations working in the environment field, which have enabled increased accountability of the population in the implementation of natural resources management activities.

This process was highly participatory, involving all the actors of the various sectors and regions of the country during regional preparatory workshops, allowing in-depth discussions on the land tenure situation in the country. It culminated in a high-level forum in 2018 with multi-stakeholder platforms and mechanisms that were able to build consensus around a strong and inclusive tenure reform. The process also had a positive effect on the establishment of national and regional transhumance committees in Niger. The preparation of the Land Policy has been accompanied by an action plan for the effective implementation of the newly adopted policy.

Niger has a long tradition for participatory farmer-managed efforts to counteract the trend in land degradation. Supported by policy changes, Niger has successfully begun restoring agroforestry parklands on the heavily populated, agricultural plains of south-central Niger. In 2017, FMNR was conducted on an estimated 7 million ha—a scale and longevity that attests to the economic viability of the approach (Wouterse and Badiane 2018). Niger has also implemented several sustainable land management projects and has engaged in restoration and rehabilitation initiatives such as the Great Green Wall. A wide number of institutional actors are actively engaged in sustainable land management (Box 3.3).

The GoN is placing significant importance on the rehabilitation and development of irrigated systems as a means to increase production, improve food security, and increase resilience toward climate change. With the adoption of a Strategy for Small-Scale Irrigation in Niger in 2015, the country has focused on the development of small-scale irrigation to produce vegetables such as onions, tomatoes, sweet pepper, maize, and out-of-season wheat. This form of irrigation has a real development potential. Notwithstanding the arid nature of the country, Niger has an estimated irrigation potential of 270,000 ha, with some 140,000 ha located in the Niger River Valley. In 2015, only about 30 percent of that potential was used (FAO, n.d.).

Despite progress in land restoration, Niger still faces great financial barriers to scale up successful approaches and embrace a comprehensive effort of new land rehabilitation and sustainable management projects. Based on the *Cadre Stratégique de la Gestion Durable des Terres au Niger et son Plan d'investissement 2015–2029 (November 2014)*, there was an enormous financial gap to cover. The financial resources acquired for the implementation of the *Cadre Stratégique de la Gestion Durable des Terres* activities were only 4 percent, with 96 percent remaining to be obtained.

2.9. Conclusion

Land degradation in Niger is regionally concentrated along the Niger River in the regions of Niamey, Tillaberi, and Dosso and along the southern agricultural belt on the border with Nigeria. Those areas have experienced warming temperatures, more irregular and intensive rainfall events, and higher windspeeds. They have also witnessed a population explosion, a steady conversion of pastoral land to cropland, a rise in conflicts between resident farmers and herders, and a rise in migrants forced into Niger from conflict-zones of neighboring countries.

The cost of land degradation is a burden on the national economy, as the value of yield loss accounted for 5 percent of the overall GDP. Land degradation is an important factor affecting agricultural productivity, food security, and the trade balance. Cereal imports are growing relative to other food categories: in 2020, it represented 57 percent of the monetary value of total food imports, up from 47 percent in 2014. In addition, the share of livestock in total exports has been declining during the same period.

Land degradation erodes local livelihoods and causes migration and fragility. Local adaptation techniques to climate variability and change are insufficient to sustain traditional livelihoods.

Pastoralists are pressured by the expansion of agricultural cropland and by transhumant herders arriving in growing numbers from outside of Niger. Crop farmers relying on rainfed agriculture are vulnerable to changes in precipitation without local irrigation to mitigate the impact. This exacerbates existing vulnerabilities in host communities and further strains the natural resources base, which in some cases lead to further deterioration of the land as conflict between user groups and access rights comes at the expense of sustainable management practices.

Niger has taken important proactive measures to ensure a participatory and inclusive approach to begin rehabilitation of the land and the shared access to natural resources. Through farmer-led initiatives to assist the natural regeneration, the adoption of a Land Policy that addresses the underlying issues of land tenure, and the approval of an irrigation strategy to make farmers less dependent on rainfed agriculture, Niger has shown a great commitment to the sustainable land and water management of its natural resources. Support for the implementation and enforcement of those measures will be critical to addressing land degradation on a larger scale and reversing the trend in the most affected areas.

3

Photo: World Bank Group

Photo: Andrea Borgarello / World Bank Group

3 Deforestation and forest degradation

3.1. Overview

Forest resources are notable environmental assets for Niger. They provide a variety of goods and services, for example, wood for energy and timber, non-wood forest products, carbon sequestration, as well as social benefits, for example, job creation. Moreover, certain species have high potential to improve the welfare of local communities. These include the Arabic gum trees, most of which concentrate in the Dosso and Tillaberi regions;[21] moringa trees, which are primarily found in Maradi and Tillaberi (Niamey in particular); and Doum palm, which is mostly present in the Goulbi N'kaba Valley of the Maradi region.

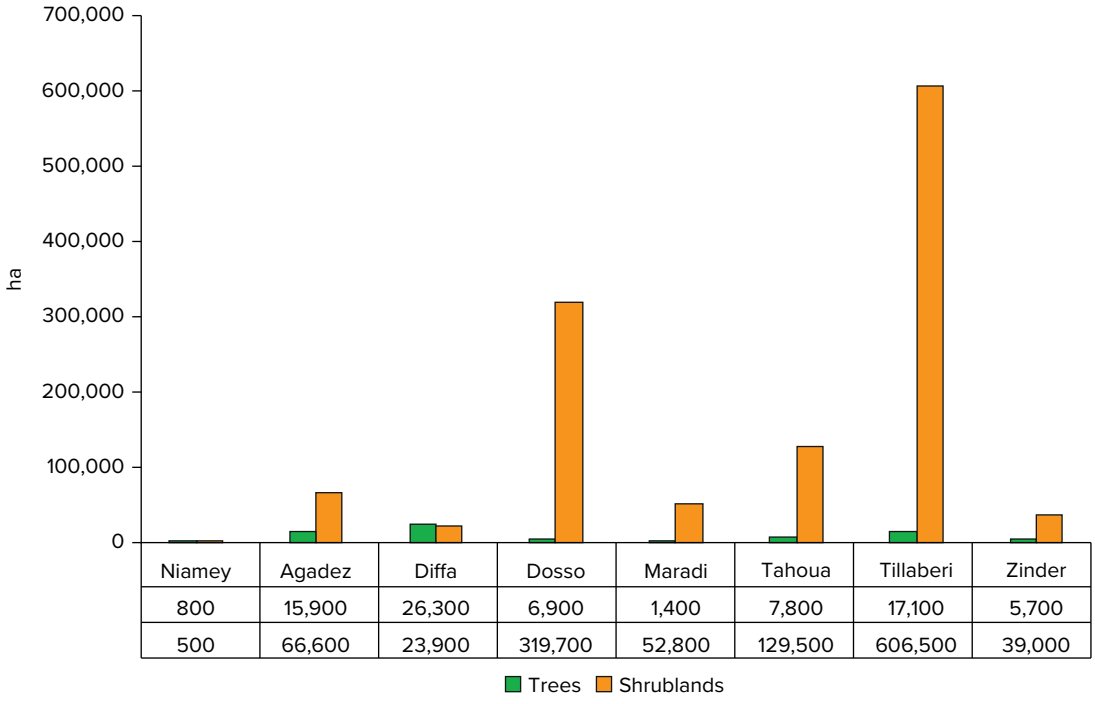
Deforestation and forest degradation are prevalent in the Sahelian domain of the country. The *Sahelian* zone has vegetation varying from clear shrub formations in the north to more diffuse and often degraded wooded formations in the south. Here, many areas are characterized by trees' dieback, often accelerated by water stress with little prospects of reconstitution due to competition of the dominant species. Livestock producers have observed that the palatable species are becoming increasingly rare in the plateau, which is grazed in the rainy season and at the beginning of the dry season (FAO 2001). In addition, climate change, abusive cuts, and strong pastoral pressure are threatening many species in this zone (CNEDD 2011). The *Sahelo-Sudanese* zone, accounting for about 1 percent of the country's area, consists of a continuous herbaceous stratum dominated by perennial Gramineae and a woody stratum containing shrubs and trees with quite varied recovery rates.

Available information on forest resources is limited and often inconsistent across sources. National-level data related to historical trends and current extent of forests in Niger are limited, discontinued in time and space, and outdated.[22] Therefore, in the absence of updated information, this chapter provides an analysis of forest-related problems based on international datasets (FAO, European Space Agency [ESA]). The analysis encountered difficulties related to *data inconsistency* across these sources, primarily related to differences in forest definitions and classifications. Against this backdrop, the following sections introduce the Nigerien forest cover and

21 More than 90 percent of Arabic gum production is commercialized unprocessed.

22 For example, the latest State of the Environment reports 1991 data on forest area in Niger, of 16 million ha (CNEDD 2021). Assessments are often discontinued in time and space and when available, information is often outdated. Adding to this, the various forest definitions and classifications have made comparative and trend analysis difficult, be it for the quantification or characterization of forests and/or tree cover.

FIGURE 3.1. Trees and shrublands areas in Niger (ha)



	Niamey	Agadez	Diffa	Dosso	Maradi	Tahoua	Tillaberi	Zinder
Trees	800	15,900	26,300	6,900	1,400	7,800	17,100	5,700
Shrublands	500	66,600	23,900	319,700	52,800	129,500	606,500	39,000

Source: ESA WorldCover 10 m—2020.

Note: Areas shown in the table are rounded numbers.

main species, the key drivers of deforestation and forest degradation, and the known extent of these phenomena. This is followed by a summary of key government efforts to address the above problems and concluding remarks.

3.2. Forest cover

Based on the ESA data, Nigerien forest resources extend on 1.3 million ha. The ESA indicates that trees[23] are scattered and cover about 82,000 ha, while the remaining area is covered by shrublands.

Figure 3.1 shows that tree cover is primarily found in the regions of Diffa, Tillaberi, and Agadez while shrublands[24] are predominant in Tillaberi, Dosso, and Tahoua (Figure 3.1). These estimates are based on the ESA's WorldCover 10 m classification, as defined by Land Cover Classification System developed by the FAO. It is important to note that despite being default datasets for land degradation reporting per UNCCD guidance documents, the ESA provides different data compared to the FAO Global Resource Assessment 2020 report, mostly due to existing differences in definitions and classifications.

23 This class includes any geographic area dominated by trees with a cover of 10 percent or more. Other land cover classes (shrubs and/or herbs in the understorey, built-up, permanent water bodies, and so on) can be present below the canopy, even with a density higher than trees. Areas planted with trees for afforestation purposes and plantations (for example, oil palm, olive trees) are included in this class. This class also includes tree covered areas seasonally or permanently flooded with freshwater except for mangroves.

24 This class includes any geographic area dominated by natural shrubs having a cover of 10 percent or more. Shrubs are defined as woody perennial plants with persistent and woody stems and without any defined main stem being less than 5 m tall. Trees can be present in scattered form if their cover is less than 10 percent. Herbaceous plants can also be present at any density. The shrub foliage can be either evergreen or deciduous.

FIGURE 3.2. Forest area (1,000 ha)

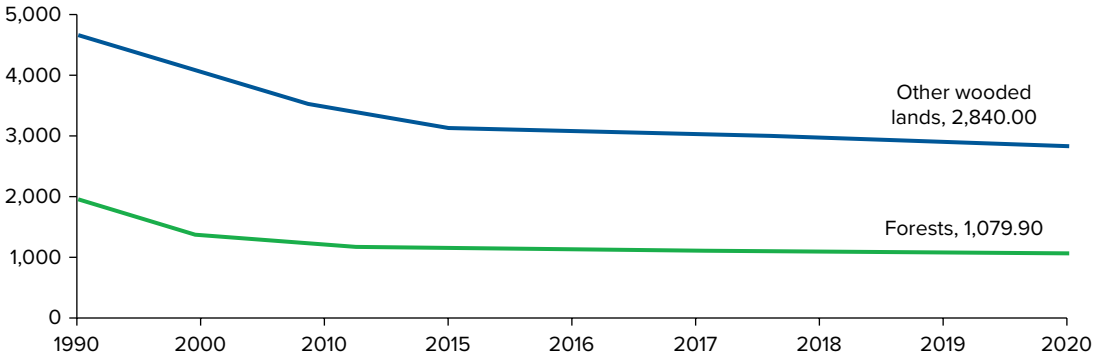
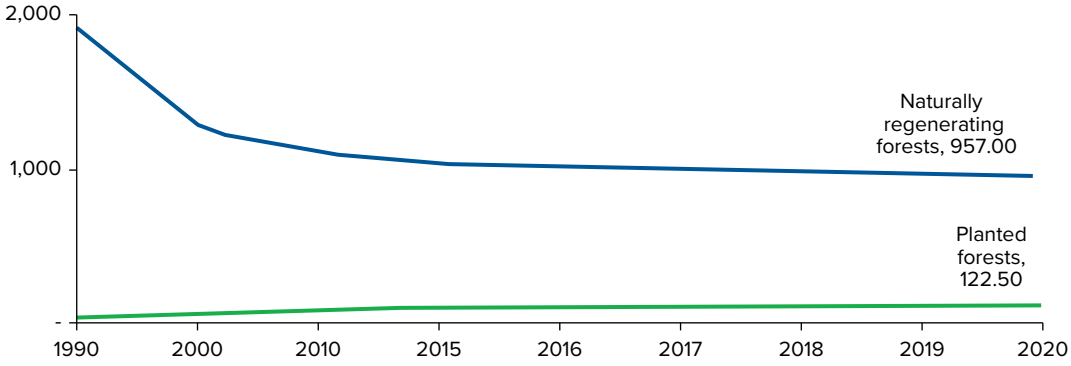


FIGURE 3.3. Area of natural forests (1,000 ha)



Source: FAO FRA Niger 2020.

According to the FAO, Niger's forest resources cover 3.9 million ha (FAO 2020b). These include the following:

- *Natural forests*, which account for 1.1 million ha and include forest formations evolving particularly along waterways, marshy areas and lowlands, and dune soils with the predominance of trees. About 89 percent are naturally regenerating forests and comprise the forests of the W Park,[25] while the remaining are plantations (Figures 3.2 and 3.3).
- *Other wooded land*, which extends on about 2.8 million ha and includes woody formations composed mainly of *Combretaceae* species.

3.3. Drivers of deforestation and forest degradation

Nigerien forests have been subject to many drivers of deforestation and forest degradation. Since the 1970s, forests have been affected by several anthropogenic factors, for example, expansion of the cultivated areas at the expense of forests due to increased food demand; overcutting of trees for fuelwood; unsustainable harvesting of non-timber products and overgrazing. Moreover, natural factors, such as climate change and the natural process of aging, affected the health of existing forests. The paragraphs below provide an analysis of key drivers.

25 A protected area maintaining a surface of 220,000 ha since 1990.

UNSUSTAINABLE HARVESTING OF FUELWOOD

Wood is harvested at rates considerably higher than forest productivity. Unsustainable harvesting of fuelwood accounts for more than 93 percent of the biomass used for the energy needs at the household level (UEMOA 2019). Wood consumption is about 0.6 kg/day/person for large urban centers, 0.7 kg/day/person for average cities, and 0.8 kg/day/person in rural areas. These consumption patterns, exacerbated by the population growth, have contributed to large-scale deforestation and to increasing desertification.

The need for fuelwood is no longer satisfied by wood removal in the areas surrounding cities. For example, for Niamey, Dosso, Maradi, Zinder, and Diffa, fuelwood comes from remote areas of neighboring countries such as Burkina Faso, Benin, and Nigeria. Overall, wood supply is lower than the demand, suggesting a potential regressive trend in forest resources (Ministère de l'Energie et du Pétrole 2015).

OVEREXPLOITATION AND POOR HARVESTING PRACTICES OF NTFPs

These practices contribute significantly to the reduction of biodiversity in natural forests and to forest decline. For example, unsustainable sampling of roots, bark, leaves, and fruits of several forest species has serious effects on the health and vitality of trees often used for traditional pharmacopoeia. Moreover, the intensive exploitation of agroforest parks for fodder, particularly during the lean season, is another major concern threatening the potential of forest natural regeneration (FAO 2020a). Certain local species are particularly affected:

- **Gum trees.** They have deteriorated due to both natural and anthropogenic pressures. The drought of 1973–74 severely decimated the natural stands of gum trees. At the same time, trees are aging with an increasing mortality rate, and natural regeneration is insufficient to compensate for the loss of trees. Human activities, especially bushfires and overgrazing, have also contributed to the poor condition of gum plantations. In addition, the proliferation of other less desirable invasive species in most gum plantations and reduced infiltration due to soil compaction contributed significantly to the degradation of these resources (Ministere de l'Hydraulique de l'Environnement et de la Lutte Contre la Desertification 2003).[26]
- **Moringa tree.** The production of moringa and its by-products is hampered by a defoliator pest, *Noorda blitealis Walker* for which farmers lack a practical management approach. According to farmers, the perceived yield losses ranged from 4 to 99 percent across the regions, with the highest losses being recorded in the September–November production period. In addition, overharvest of moringa leaves is compromising the production and the quality of the seeds, which are expensive for an average producer in Niger.
- **Doum palm.** Intensive harvesting of juvenile leaves strongly affects the development of the Doum palm throughout the country. The arborescent habit changes into a subterranean creeping habit, and palm stands are reduced to dense carpets of leaves emerging from the ground; the field resembles a nursery of Doum palms. Furthermore, the early harvesting of the green fruit, appreciated by children and women, is compromising the regeneration of the tree (Kahn and Luxereau 2008). In addition, the dams built in Nigeria negatively influence the doum areas, hence the degradation in the downstream part of the Goulbi (in the west) despite the remarkable adaptation capacity to drought and resilience to bushfires (Peltier, Serre Duhem, and Ichaou 2008).

26 Despite the absence of a well-organized sector, more and more landowners, especially the officials and traders, invest in gum tree plantations. *Acacia senegal* is often the species of choice in land restoration operations as interest in gum production increases.

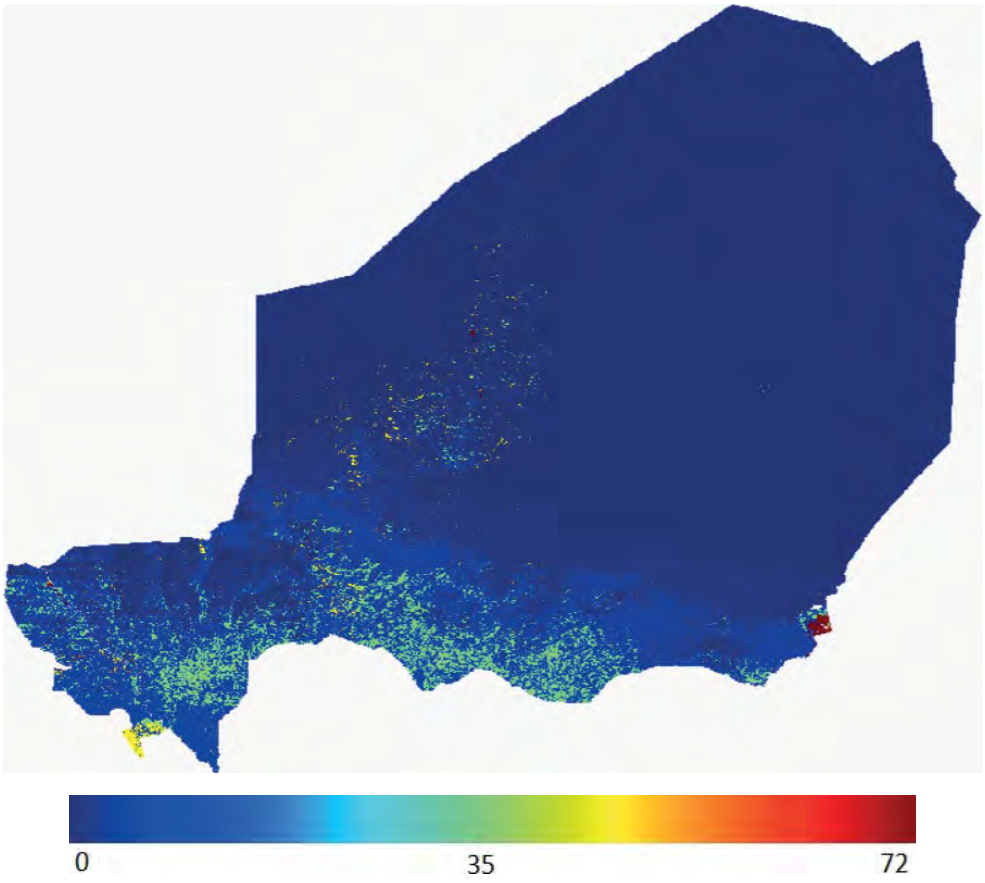
OTHER THREATS

Overgrazing is a widespread phenomenon on the national territory, but to varying degrees. It is observed especially in pastoral and agropastoral areas, where plants, particularly herbaceous, are extremely dependent on annual rainfall. **Bushfires** are another threat that affect especially pastoral zones. In the past decade, burnt areas decreased substantially from nearly 257,500 ha in 2010 to about 22,100 ha in 2017. Overall, the average burnt area during this period was about 131,700 ha per year. Zinder, Tahoua, and Maradi were the most affected regions (CNEDD and AFDB 2019).

3.4. Deforestation and forest degradation: extent and carbon loss

In the past decade, the deforestation rate in Niger has been close to double the Sub-Saharan average. During 1990–2000, the annual loss of natural forests was as high as 3.7 percent per year, according to the FAO. Although during 2010–2020 it fell to *1.1 percent*, it remained much higher than the average deforestation rate for Sub-Saharan Africa, estimated at 0.6 percent (FAO 2020a; World Bank 2020). Available data suggest that the regions of Dosso and Diffa are most affected.[27] It is noteworthy that during this period, the Government made impressive reforestation efforts, for example, through the support provided

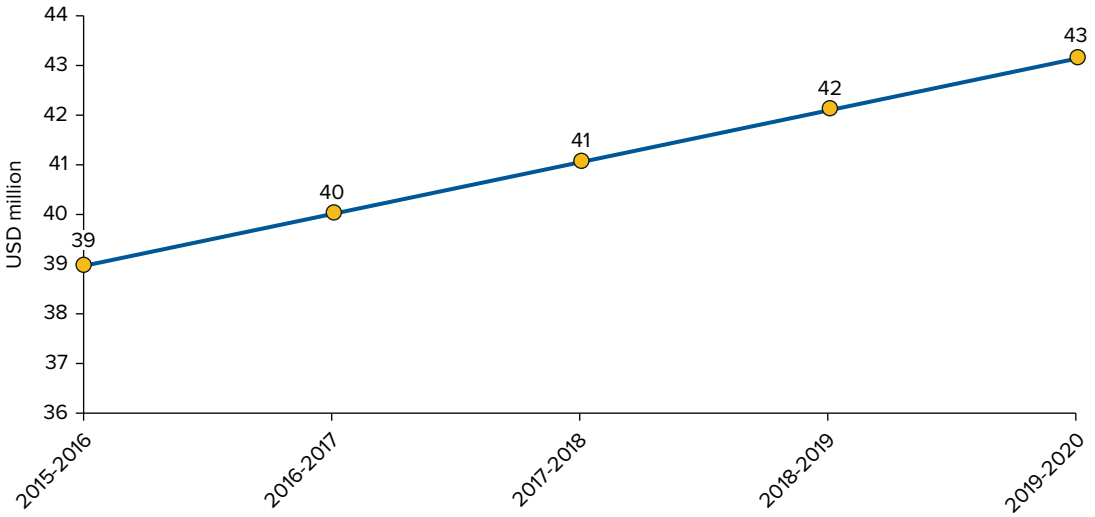
MAP 3.1. Carbon storage in Niger



Source: ARIES.

27 Hansen/UMD/Google/USGS/NASA.

FIGURE 3.4. Social cost of carbon due to forest loss during 2015–2020



Source: Retrieved from the GoN and calculated by the World Bank task team.

to the assisted natural regeneration and farmer management natural regeneration practices (FAO 2020a). However, these efforts were conducted at a much slower rate (2,500 ha per year on average), compared to the average deforestation rate (14,920 ha per year).[28]

The extent of forest degradation is not known. However, it was reported that the forests known as *forêts classées* have been severely degraded and more than 50 percent have lost their regeneration potential (CNEDD 2011). At the same time, the natural expansion of the forest seems improbable because the pressure on land is only increasing, making fallows less likely to appear (FAO 2015).

The social cost of carbon associated with forest loss between 2015 and 2020 attains over US$205 million. It represents the social damage that would result from emitting carbon dioxide in the atmosphere. The economic valuation is based on (a) the loss of forest cover during 2015–2020, derived from FAO data; (b) the unit carbon storage in biomass, estimated at about 23 t/ha[29] (FAO 2020b) and illustrated in Map 3.1; and (c) the shadow price of carbon, based on the low-bound price provided by the World Bank guidelines (World Bank 2017b). Figure 3.4 presents the distribution of the social cost per year of analysis.

3.5. Current efforts to address key issues related to forests

The GoN developed strategic documents aiming at the sustainable management of forest resources. A recent cornerstone initiative is the *National Forestry Plan* 2012–2020. Developed in line with national and international commitments, the National Strategy for Sustainable Development (2003), and the '3N—*Nigériens Nourrissent les Nigériens*' initiative, the National Forestry Plan recognizes the livelihoods' dependence on forests

28 The same document estimates the net forest loss of 12,420 ha per year, through the difference between the two numbers (FAO 2020a).

29 According to FAO's latest Forest Resources Assessment for Niger, the carbon stored by natural forests in Niger is estimated at 17.95 t/ha for the aboveground biomass and 5.14 t/ha for the below-ground biomass in 2020.

TABLE 3.1. Additional strategic documents and relevant texts

Strategic documents	Promoted technologies
Economic and Social Development Strategy (PESDS 2022–2026) *updating ESDS, 2012–2015*	FMNR, Integrated Soil Fertility Management (ISFM), irrigation, improved fodder management
Sustainable Development and Inclusive Growth Strategy (*Stratégie de Développement Durable et de Croissance Inclusive,* SDDCI 2021–2035)	FMNR, ISFM, irrigation, improved fodder management
National Action Plan for the Integrated Management of Water resources (*Plan d'Action National de Gestion Intégrée des Ressources en Eau,* PANGIRE 2017)	Irrigation, sustainable land management, reforestation, and rehabilitation of degraded lands
National Strategy and Plan for Agricultural Adaptation to Climate Change (*Stratégie et Plan National de l'Adaptation de l'Agriculture,* SPN2A 2020–2035)	FMNR, ISFM, irrigation, improved fodder management
Nationally Determined Contribution (NDC)	FMNR, ISFM, irrigation, improved fodder management
National Environmental Plan for a Sustainable Development (*Plan National pour l'Environnement et le Développement Durable,* PNEDD 2000)	FMNR, ISFM, irrigation, improved fodder management
Rural Land Policy in Niger—Action Plan (2021–2027)	FMNR, ISFM, irrigation
Sustainable Livestock Development Strategy (*Stratégie de Développement Durable de l'Élevage,* SDDEL 2013–2035)	Improved fodder management
Association for the Revitalization of Livestock in Niger (*Association pour la Redynamisation de l'Élevage au Niger,* AREN)	Improved fodder management
Strategic Framework for Sustainable Land Management (SFLM) in Niger and its Investment Plan (2015–2029)	FMNR, ISFM, irrigation, improved fodder management
National Policy for the Management of Wetlands and its Action Plan, 2019–2021	Irrigation, integrated natural resources management

and sets a roadmap to increase forests area, improve their management, restore degraded ecosystems, and invest in research and development for adaptation to climate change (Ministère de l'Hydraulique et de l'Environnement and FAO 2012). In addition, according to Niger's Land Degradation Neutrality targets, the GoN has committed to halt land conversion of forests, shrublands, and wetlands into other land uses and increase carbon stocks by 292,000 t by 2030 through improved farming and agroforestry practices (République du Niger 2017). Furthermore, recognizing the importance of forest resources in rural livelihoods, a *Strategy and action plan for the protection and promotion of Non-Timber Forest Products* was developed in 2020 with the objective of enhancing their potential, sustainable exploitation, and contribution to the households' and national economy. Table 3.1 quotes other strategic documents aiming at the sustainable forest management and improved livelihoods of local populations.

In 2014, the Ministry of Environment put in place a strategic framework for sustainable land management and an investment plan for 2015–2029. These initiatives were conducted with the support of the United Nations Development Programme (UNDP), World Bank, UNCCD, TerrAfrica, and New Partnership for Africa's Development (NEPAD). The strategy foresees the improvement of forest production on the basis of more informed investments. In this light, the country has adopted certain fiscal tools to increase

BOX 3.1. Differential taxation, a fiscal instrument to protect forest resources

The taxation scheme on fuelwood harvesting stipulates taxes decline as the distance from the town increases, which incites traders to look for wood over longer distances in the bush instead of overharvesting. As such, for one stere[1] of wood purchased for CFAF 1,315 by a transporter, CFAF 113 is reinvested in the silvo-pastoral management of the harvested forest (setting up mulching with branches and seeding to regenerate the grassy and woody cover, and so on), and CFAF 295 is paid into the village fund to serve various purposes such as maintaining the school, the dispensary, the places of worship, the roads; setting up a veterinary pharmacy; and building a store for cereals or concentrates for the livestock; and so on. Accordingly, if all the wood for Niamey were to come from the managed forests, CFAF 150 million would be reinvested each year for village development, and CFAF 60 million for silvo-pastoral management. Lastly, CFAF 15 million would go to the state and CFAF 40 million to the local communities to enhance their administration and make them independent with regard to current operations.

Source: Extracted from FAO's Management of Natural Forests of Dry Tropical Zones Case Study 4: Niger's Forest Management Experience (fao.org). The case study was carried out based on the following documents: Bertrand (1990); Hamadou (1994); Madon (1995); Montagne et al. (1994); Peltier (1991); Peltier et al. (1994a, 1994b); Seed and CTFT (1991).

1 The stere or stère (st) is a unit of volume in the original metric system equal to one cubic meter.

revenues while protecting forest resources, such as differential taxation (Box 3.1). However, the availability of financial resources remains a bottleneck; the economic potential of the emerging mining sector, if sustainably extracted, can mobilize the needed resources to reverse degradation trends and operationalize the strategy laid out in 2014 for sustainable land management, particularly of forests in Niger (République du Niger 2017).

The GoN developed several regulatory texts that address the exploitation of forest resources. For example, the *Rural Code* includes provisions for forest management in articles 58 to 107, in addition to its provisions for the management of agricultural and animal resources. Together with the *Forest Law* n° 2004-040 dated June 8, 2004, these texts place a high importance on meeting the community needs while maintaining forest resources, protecting biodiversity, and accounting for local interests. The formal local management structures are created for the management of forest products from extraction to trade; and a profit-sharing scheme was laid out to ensure that the local communities, traders, and the Government benefit from the sustainable exploitation of forest resources.

To reduce pressure on forests, the GoN decided to reduce the reliance on traditional biomass to 67 percent of the energy mix in Niger (Ministere de l'Energie 2019). In this light, it aims at improving efficiency through the *National Household Energy Program* initiated in 2015 and the Program for the Promotion of Improved Stoves, as well as other alternatives including carbonized mineral coal, biofuel energy generation, liquefied petroleum gas (LPG), solar cooking stoves, and the use of renewable energy sources for electricity production (Adamou et al. 2021). In addition, several *land restoration projects* were implemented in Niger to reverse degradation and build capacity and knowledge base at the national level (Box 3.2). Allocated resources, though useful, remain insufficient in addressing knowledge gap and reverse degradation trends.

BOX 3.2. Land restoration initiatives in Niger

Community Action Program (CAP)

Actual cost: US$52.41 million (CAP-1), US$39.42 million (CAP-2), US$70.4 million (CAP-3). Status: Closed.

The World Bank has played a key role in helping Niger in the implementation of its Rural Code throughout its history. The CAP is a three-phase adjustable program loan designed to empower local governments and communities to progressively achieve their collective local development aims in a participatory and sustainable way.

The first phase CAP-1 (2003–2010) was designed to support learning by doing. It helped establish local planning and financing mechanisms in 54 communes with instruments and processes designed to foster participation and transparency and build trust in the new electoral system. It included a wide range of activities, for example, capacity building, transfer of financial resources to communes and communities, financial management systems, policies and regulations on natural resource management, and natural resource and agricultural extension work.

The second phase CAP-2 extended the local planning and financing mechanisms to 164 communes, or 65 percent of all communes in the country. The program mainly financed community development plans; a local investment fund that included support for economic, social, and environmental subprojects; and technical assistance for institutional strengthening at the community, commune, and national levels.

The third phase CAP-3 facilitated the GoN and communes in strengthening its local development planning and implementation capacities, to support the targeted population in improving agricultural productivity and to respond promptly and effectively to an eligible crisis or emergency. It addressed sustainable management of land use, land use change and forestry, agro-ecosystem services or forest ecosystem services in dry lands sustaining the livelihoods of local communities and promoted climate-smart technologies and agriculture.

The CAP helped finance the planting of 7,000–8,000 ha of Acacia Senegal, which facilitated land restoration and short-term vulnerability reduction in designated parts of the program area. The Biocarbon Fund-financed plantations included as part of this project were managed by 26 rural communities and spread across six separate administrative regions in Niger. In total, Nigerien communes received US$346,650 in Biocarbon Fund payments during the CAP.

Community Action Project for Climate Resilience

Actual cost: US$74.68 million. Status: Closed

In 2010, the GoN developed its Strategic Program for Climate Resilience with the general objective to increase food security in Niger by improving resilience of populations and production systems to climate change. The Strategic Program for Climate Resilience rested on four complementary investment projects, including the Community Action Project for Climate Resilience.

The project promoted an innovative approach by addressing climate-resilient sustainable land management as well as social protection for the most vulnerable populations. It sought to support climate resilience of populations and their production systems in targeted communes by enhancing the absorptive capacity and preparedness of populations and their production systems against the adverse impact of climate change. It included technical assistance and investments to improve the resilience of agro-silvo-pastoral systems by (a) scaling up sustainable land management practices to reduce climate change impacts through capacity-building activities in the areas of agriculture, agroforestry, agropastoralism, and pastoralism, selected with a gender-sensitive approach and (b) financing activities to improve agricultural productivity (40 percent), sustainable management of forest resources (30 percent), and productivity of grazing areas (30 percent). About 125,400 households benefited from pastoral support and 108,400 households from forest support.

Source: Compiled from World Bank project reports.

Several institutions are involved in forest management in Niger. The *Ministry of Environment* is the leading public institution mandated with the management of forest resources. The sector is also steered by several inter-ministerial *committees and bodies* which oversee the development and implementation of sectoral policies, strategies, and action plans, for example, the Commission for the 3N Initiative, the Committee for the Implementation of the Rural Development Strategy, the National Council for Sustainable Development, and other institutions overseeing Niger's regional and international commitments. In addition, the *private sector and civil society organizations* are central to the sustainable management of forest resources. Some contribute to the organization of the sector: the National Association of Professionals of Arabic Gum (*Association Nationale des Professionnels de la Gomme Arabique*, ANGA), the National Association of Wood Harvesters (*Association Nationale des Exploitants de Bois*, ANEB), the Federation of Rural Markets for fuelwood, while other groups and networks operate in the field of traditional medicine and practices.

3.6. Conclusion

Since the 1990s, the GoN has invested in the management of the forest resources, testifying to their importance to the local and national economies. Legal and regulatory texts have been developed to organize the management and exploitation, be it for timber products and/or NTFP—most importantly the Arabic gum sector. However, it is unclear to which extent these texts have contributed to the conservation and sustainable management of forest resources. In addition, as the National Forestry Plan expired in 2021, it would be judicious to undertake an evaluation of the plan's outcomes, before a new planning exercise is initiated, with consideration of the ongoing GoN commitments to regional and international conventions.

The analysis indicated that deforestation and forest degradation are significant problems in Niger. However, the *lack of consistent data* related to forest cover and extent of degradation is a major challenge in determining the real magnitude of these issues. Indeed, in the absence of a national inventory, available databases (for example, FAO, ESA) often rely on experts' judgments instead of field data and include outdated information. Furthermore, forest resources management is characterized by a *limited understanding* of the regeneration dynamics, grazing potential, and forestry potential for processing and commercialization. Lastly, the forest contribution to the national economy is *undervalued*: for example, the economic value of the NTFPs and of other ecosystem services (for example, erosion control, water protection) is largely unknown. This further affects the development of appropriate policies, strategies, and even the allocation of public spending on forest-related initiatives. A set of concrete recommendations addressing these issues is provided in Chapter 5.

Photo: Andrea Borgarello / World Bank Group

4

Photo: Andrea Borgarello / World Bank Group

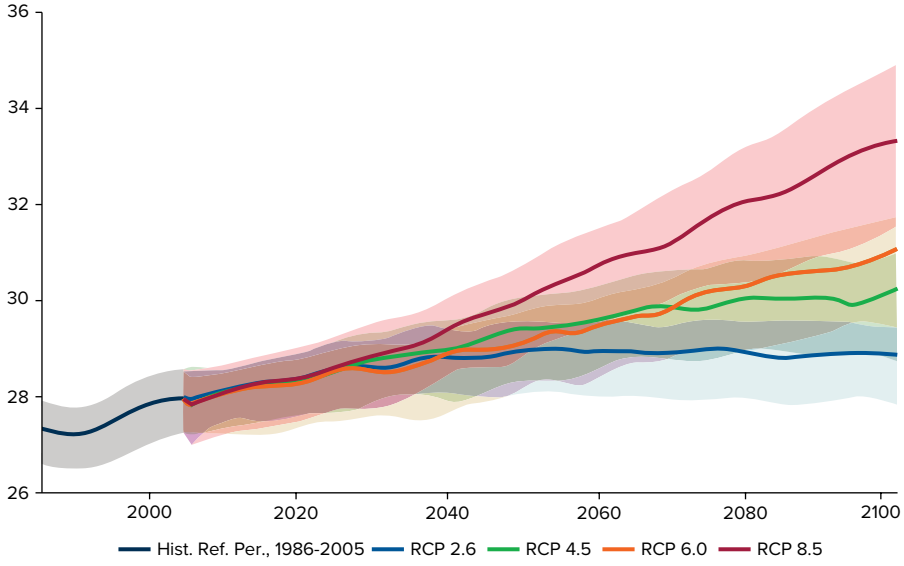
Photo: World Bank Group

4 Climate change

4.1. Overview

Niger is the seventh most vulnerable country to climate change in the world, according to the Notre Dame Global Adaptation Initiative country index.[30] With a large share of its land under desert, the country is characterized by hot climate, with high temperatures year round, an intense dry season, and a rainy season with irregular rainfalls (World Bank Climate Change Knowledge Portal, n.d.). Climate change is predicted to translate into an increase of Niger's average temperature up to about **6°C by 2100,** depending on the scenario (Figure 4.1)[31] (World Bank Climate Change Knowledge Portal, n.d.). The annual number of very hot days—days with daily maximum temperatures above 35°C—is projected to rise substantially and with high certainty, particularly in

FIGURE 4.1. Projected mean temperature in Niger

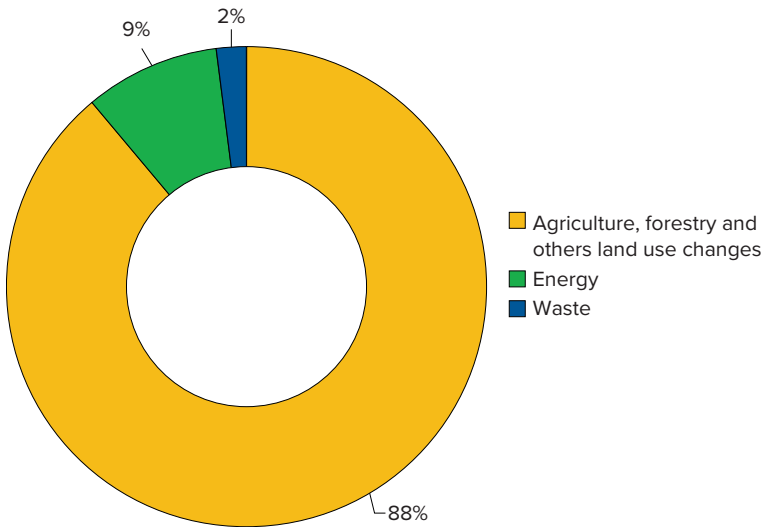


Source: World Bank Group Climate Change Knowledge Portal.

30 According to the Notre Dame Global Adaptation Initiative country index, Niger ranks 176 out of 182 countries with a high vulnerability score (0.677) and low readiness score (0.338).

31 The Representative Concentration Pathways (RCPs) try to capture future trends. They make predictions of how concentrations of greenhouse gases (GHGs) in the atmosphere will change in future as a result of human activities. The four RCPs range from very high (RCP8.5) to very low (RCP2.6) future concentrations. The numerical values of the RCPs (2.6, 4.5, 6.0 and 8.5) refer to the concentrations in 2100.

FIGURE 4.2. Niger's GHG reference profile for 2014



Source: CNEDD & AFDB. (2020).

south-western Niger (Tomalka et al. 2021). It is noteworthy that precipitation trends are highly uncertain, with projections ranging from a slight decrease to stronger increase of the total annual precipitation.

Niger has low GHG emissions, most of which originate from the agriculture, forestry, and other land use (AFOLU) changes. Niger's GHG emissions have been estimated at about 0.1 tons carbon dioxide equivalent (CO_{2e}) per capita in 2018.[32] This is substantially lower than the Sub-Saharan average, assessed at 0.8 tCO_{2e} per capita for the same year. The most recent national GHG inventory indicates that the AFOLU sector was the single most important contributor, with 88 percent of the total (Figure 4.2).

The country aims at concrete emission reductions from AFOLU sector by 2030. Under a *business-as-usual scenario*, the AFOLU sector is likely to *quadruple its emissions during 2014–2030*, from 24 million tCO_{2e} to 107 million tCO_{2e}. (République du Niger 2021a). However, the GoN has made a firm commitment through its NDC to the United Nations Framework Convention on Climate Change (UNFCCC) to move the country's development pathway toward a green economy. The document aims for unconditional reductions of 13 percent from this sector compared to the *business-as-usual* scenario for the same year and conditional reductions of about 23 percent.[33]

4.2. Expected impacts of climate change

Climate change is expected to exacerbate the existing vulnerabilities in Niger. Since 1968, the country has suffered from frequent droughts, storms, and floods, which caused significant damages on agriculture, food security, and livelihoods.[34] Climate change is projected to increase their frequency and severity in the coming century: for example, floods are expected to increase both in intensity and frequency where it will have devastating effects in the densely populated southern areas (Tomalka et al. 2021). In addition,

32 Extracted from World Bank Open Data: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=NE.

33 There is a level of uncertainty about future emissions, particularly beyond 2020. Predictions are based on varied assumptions of economic growth and the anticipated capacity and technical support from development partners.

34 They affected over 3 million people in 2000 and 2001 and over 7 million people in 2002.

TABLE 4.1. Broad-scale sectoral vulnerabilities and potential climate change impacts in Niger

Sector	Impacts
Agriculture	• Crop loss and reduced yields owing to increased temperatures, changing rainfall patterns, and increased water stress • Increased incidence of pests and diseases • Increased potential for conflict between farmers and pastoralists • Shifting agricultural seasons due to changes in seasonal rainfall patterns • Desertification and loss of agricultural and grazing land • Increased migration from rural to urban areas
Fisheries	• Reduced size of Lake Chad, reducing fisheries catches • Encroachment of aquatic weeds • Increased migration of fishermen in search of more productive waters • Reduced fishery productivity owing to increased water temperatures and decreased river flows
Water resources	• Increased variability of run-off, leading to increased variability in surface water availability • Increased demand for irrigation water coupled with reduced irrigation water potential • Increased potential for conflict over limited water resources
Built infrastructure and human settlements	• Increased potential for damage to infrastructure, especially in urban areas and near the Niger river, owing to flooding • Increased potential for negative impacts on some infrastructure owing to extreme temperatures • Damage to or destruction of roads owing to increased intensity of extreme rainfall events • Increased potential for migration from rural to urban areas
Human health	• Increased risk of water-borne diseases, such as cholera and diarrhea • Increased prevalence of vector-borne diseases such as malaria • Increased potential for malnutrition and stunting, especially during drought • Increased prevalence of respiratory diseases due to increased Harmattan winds

Source: African Development Bank 2018.

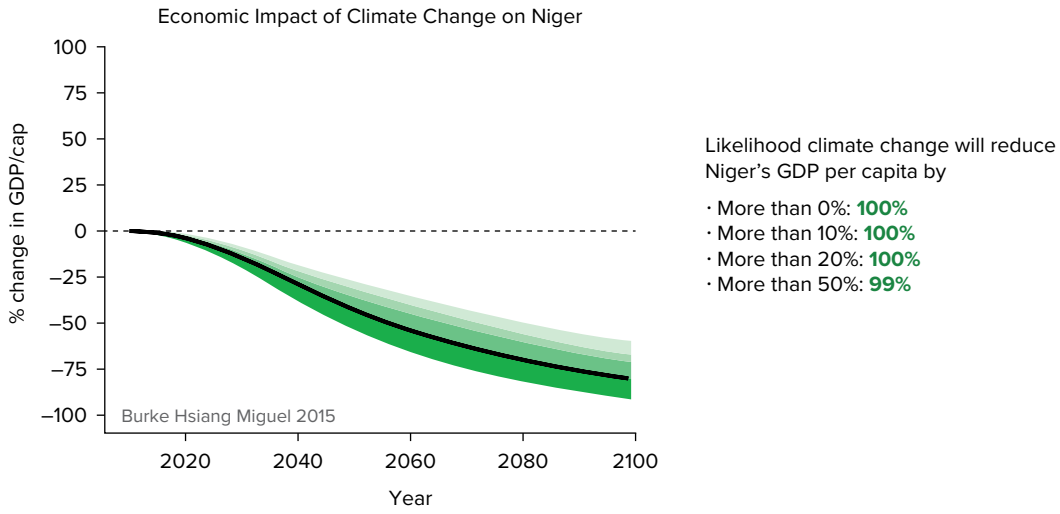
the country already suffers from other vulnerabilities: high dependence on rainfed agriculture for food security, food crisis brought about by severe droughts experienced in recent years (2005, 2008, 2010, and 2012), pervasive poverty, and political instability. Climate change is expected to compound these problems, which could further trigger new conflicts, humanitarian crisis, and forced migration (USAID 2017). Table 4.1 provides a list of vulnerabilities and potential climate change impacts in Niger. The next paragraphs summarize results of the available literature that quantified some of these impacts.

IMPACTS ON GDP

Most climate models expect Niger's GDP to be negatively affected by climate change. For example, Stanford University predicts an 80 percent decrease in the GDP per capita by 2100 compared to 2020 (Figure 4.3).[35] In the short run, the social and economic impact of the health pandemic is threatening to wipe out five years of development progress (Savadogo, Tsimpo Nkengn, and Sanoh 2022).

35 Based on Burke, Hsiang, and Miguel (2015); https://web.stanford.edu/~mburke/climate/map.php

FIGURE 4.3. Economic impact of climate change in Niger



Source: Stanford University 2015.

IMPACTS ON AGRICULTURE

Several studies were conducted at the regional and country levels, with distinct results:

- **Niger could potentially lose its entire rainfed agriculture by 2100** (USAID 2017). Smallholder farmers are increasingly challenged by the uncertainty and variability of weather. Since crops are predominantly rainfed, yields highly depend on water availability from precipitation and are prone to drought. However, the length and intensity of the rainy season is becoming increasingly unpredictable, and the use of irrigation facilities remains limited (Tomalka et al. 2021).
- **There may be an increase in the mean annual precipitations throughout the century, which could translate into increased suitability of millet**, according to a recent study conducted by the Potsdam Institute for Climate Impact Research (PIK). This would be due to greater annual rates of groundwater recharge and higher annual mean river discharge. However, the potential for multiple cropping would decrease from mid-century onward, limiting farmers' diversification options. Moreover, the study suggested that the grazing potential is likely to decrease in the south and increase in the central regions of Niger (Röhrig et al. 2022).
- **Yields of heat- and drought-sensitive crops are projected to decline, while those of less-sensitive crops are expected to increase**, according to the climate risk profile developed for Niger by the German Federal Ministry for Economic Cooperation and Development (Tomalka et al. 2021). Cowpeas and groundnuts are so-called C3 plants, which follow a different metabolic pathway than maize, millet, and sorghum (C4 plants), and benefit more from the CO_2 fertilization[36] effect under higher concentration pathways. This would result in increased yields by 54 percent (cowpeas) and 52 percent (groundnuts) by 2080 relative to 2000.

36 CO_2 fertilization effect is when the increase of CO_2 in the atmosphere increases the rate of photosynthesis in plants.

Given the level of uncertainties in the different models, the overall adaptation strategies should take a cautionary approach and focus on improved and more climate-resistant crop varieties.

IMPACTS ON WATER

Sahel is one of the most water-stressed regions of the world. The region's water supply is unevenly distributed, poorly accessible due to undeveloped hydraulic supply systems, and crosses national boundaries. A global economic model developed by the World Bank suggests that climate-related water scarcity could lead to a decrease of the GDP in the Sahel by as much as 11.7 percent by 2050 (World Bank 2016). In Niger, climate change is expected to affect water supply in different ways:

- **Reductions in water flows from neighboring countries.** More than 90 percent of Niger's water supply comes from neighboring countries (USAID 2017). Hence, a reduction in the flow of transboundary waters can affect Niger's water supplies. For example, the Fouta Djallon Highlands in Guinea, West Africa's 'water tower', are expected to experience rainfall reductions of up to 26 percent by 2100, affecting basins such as the Niger River (USAID 2017).
- **Changes in rainfalls, temperatures, and drought patterns.** Surface water is limited and often seasonal, making groundwater a primary source of water for many people in the country. Changes in rainfall patterns, increases in temperature, and more frequent droughts may contribute to a decline in surface water and groundwater availability and accessibility. This is concerning, especially in the current context where less than half of the population in Niger has access to safe drinking water (Wateraid, n.d.). The situation highlights the urgency to invest in water saving measures and technologies for future water consumption.

IMPACTS ON HEALTH[37]

Niger faces several key challenges, including mortality and morbidity related to vector-borne diseases (for example, malaria), water-borne diseases related to flooding (for example, diarrhea and cholera), meningitis, and so on. Many of them are expected to become more severe due to climate change. Examples include the following:

- **Malaria.** The risk of malaria is projected to fall due to rising temperatures; however, some areas are likely to become more vulnerable to the disease, such as those exposed to more frequent floods.
- **Meningitis.** Niger is part of the African *Meningitis Belt,*[38] which is at high risk of epidemics of meningitis. Temperature increases and low humidity due to climate change have the potential to prepone the seasonal onset of meningitis and significantly increase the number of cases.
- **Malnutrition.** Climate change poses a threat to food and water supplies, which can increase the risk of malnutrition and hunger.
- **Heat-related mortality.** Rising temperatures will result in more frequent heatwaves in Niger. The population affected by at least one heatwave per year is projected to increase from 1.7 percent to 12.0 percent during 2000–2080. Consequently, heat-related mortality is predicted to increase threefold during the same period if no adaptation to hotter conditions takes place.[39]

37 This section relies heavily on the information drawn from Tomalka et al. (2021).

38 It is a region in Sub-Saharan Africa, extending from Senegal to Ethiopia. It is especially recognized to be at high risk of epidemics of meningococcal and pneumococcal meningitis. (https://www.who.int/news-room/fact-sheets/detail/meningitis).

39 The estimates of this paragraph refer to the RCP6.0 scenario.

4.3. Government efforts to address climate change

The GoN recognizes that the development of the country depends largely on its ability to better manage all its natural resources by promoting a more holistic approach that is oriented toward the stakeholders, and particularly toward rural communities. In this context, over the last years, several national institutions have been created and/or strengthened with a direct focus on climate vulnerability and change. For example, the Executive Secretariat of the National Council for the Environment for Sustainable Development is the national focal point of the so-called Rio and post-Rio conventions on Biological Diversity, the fight against desertification, climate change, and political focal point of the GEF; and the Permanent Secretariat of the National Mechanism for the Prevention and Management of Food Crises, which is the executive body responsible for the overall supervision of the NDCs. Today, the institutional landscape on environmental issues in general and on those related to climate variability and change in particular is rich and diverse in Niger.

Niger adopted strategies and policies that seek to tackle climate change and variability. Niger is signatory to the UNFCCC, where it ratified the Paris Agreement and submitted its NDC. The document identified financial and technical support to the AFOLU sector as high priority. In addition, several key strategies and programs have been developed, including the National Policy on Climate Change (*Politique nationale sur le changement climatique*, PNCC) and the National Strategy and Plan of Action for Climate Change and Variability (*Stratégie nationale et plan d'action sur les changements et la variabilité climatiques*, SNPA-CVC). Considering the potential offered by the country's resources, Niger highlights as top priority adaptation measures that would result in higher co-benefits with respect to climate change mitigation.

There are regional efforts that support Niger in tackling climate change. Niger is a member of the Economic Community of West African States (ECOWAS), which is working toward a coordinated effort to integrate climate-smart agriculture into regional and national policy. Furthermore, the Niger Basin Authority is part of a transboundary river basin organization working cohesively with several states for the protection and restoration of shared water resources (USAID 2018). Regional coordination on climate change issues needs to be strengthened for better knowledge and capacity on adaptation and mitigation efforts.

4.4. Conclusion

The analysis highlighted that Niger is vulnerable to climate change. Average temperatures will increase throughout the country, but the south-west will be particularly affected by a rise in the number of very hot days. Floods will be more intense and frequent in the country's south. Precipitation trends are highly uncertain, with projections ranging from a slight decrease to stronger increases of the total annual precipitation. These changes in climate are likely to affect the country's economy and the health of its population. Although the results of available studies do not always converge to the same specific conclusions, some suggest that yields of heat- and drought-sensitive crops might decline, while those of more resistant crops (cowpeas, groundnuts) might increase. In addition, there is a risk that climate change will restrict the water availability and accessibility and exacerbate health outcomes, such as malaria, meningitis, and heat-related mortality.

Given that Niger is a low GHG emitting country, it is important to **implement adaptation measures**, such as sustainable land management practices, alternative livelihoods, and more efficient water harvesting techniques. In addition, it would be useful to put in place efficient disaster risk management and disaster risk financing systems focused on its most vulnerable but productive areas (south).

Photo: Andrea Borgarello / World Bank Group

5

Photo: Andrea Borgarello / World Bank Group

Photo: Olivier Girard / World Bank Group

5 Recommendations

This CEA demonstrated that environmental degradation is worrisome in Niger. *Land degradation* is a priority problem: losses in crop yields affect particularly Tillaberi, Tahoua, and Dosso regions, with potential future impacts on food security, livelihoods, and migration. *Deforestation* rates are nearly double the Sub-Saharan average, and *forest degradation* threatens the health of valuable local species. Moreover, *climate change* is likely to have negative implications on agriculture, water resources, and people's health.

Addressing these problems is important for the country's sustainability, particularly in the current context of poverty, food insecurity, and fragility. Financing needs are large; however, available funds are just a fraction of what is needed. While the answer on how to mobilize more financing is beyond the scope of this report, this chapter provides some guidance on how to use existing resources more efficiently to achieve better impact.

Given the multiple emergencies faced by the country, a simple, yet effective, way forward would be to focus on more **integrated projects** where on one hand, issues requiring urgent attention are being addressed and on the other, activities focused on longer-term solutions are being implemented. Resilience aspects should consider rural youth employment, given the young age of the majority of the population, gender inclusion, women's high potential in contributing to the country's GDP, and investing more on education (literacy training, business skills, nutrition, family planning, and so on).

It is important that the GoN plays an essential role of ensuring proper donor coordination. This would provide good visibility on the activities that are being implemented in the different regions and, more importantly, would identify **synergies between the activities and/or projects for a higher impact**. For example, landscape projects should, to the extent possible, geographically overlap with emergency projects on food insecurity, droughts, floods, and so on, as well as social protection projects. This would ensure that the most affected population is receiving support from all fronts, where its immediate needs are being met and its longer-term livelihoods are being secured.

Given that Niger is highly dependent on its natural resources, such as its land and forests, focus should be on their **restoration and sustainable utilization**, especially in highly populated and productive areas, where vulnerability is the highest. As per the findings of this report, the southern areas of the country, in particular Tillaberi, Tahoua, and Dosso, are found to be highly vulnerable, and therefore focus should be there. The objective involves a three-step approach: (1) to restore the productivity of degraded land and forests; (2) to increase yields of restored land utilizing sustainable land and forest management practices, and (3) to improve

livelihoods by efficiently engaging in value chains or other successful alternative livelihoods. In addition, better ownership of natural resources by local communities as well as improved participation and inclusion of key members of the community is essential to enhance good governance of natural resources, leading to reduced degradation and conflict over natural resources. Scaling up the MP model would support communities and help promote the Government's decentralization strategy (Box 5.1).

The following recommendations are categorized into three groups: Enhancing operations, Supporting policy, and Building knowledge.

BOX 5.1. Maison du Paysan

The Maison du Paysan (MP) is a transformative community-based institution that improves planning and coordination at local and national levels, supports citizen engagement and participation, and underpins the GoN's decentralization strategy.

The concept and interest in the establishment of MPs at the commune level was first introduced by the national food security initiative, 'Nigeriens Nourish Nigeriens' Initiative, in 2012.

The World Bank Niger Community Action Project for Climate Resilience (P125669), which closed in 2021, piloted the MP concept in a dozen municipalities. The services provided through the MPs delivered direct benefits to rural producers and brought national services closer to local needs through a feedback mechanism between national and local policies and practices.

The MPs provide integrated services to local communities through several modules tailored to the needs of the community. They are central to farmers and rural producers seeking advisory services, training, and equipment to improve sustainable and climate-resilient land management practices.

The MPs were implemented through a bottom-up, results-oriented management approach, supported by a coaching system, which yielded excellent results and holds great potential for replication in other communes.

Coaching offers a new paradigm for capacity building and implementation support, particularly in rural and fragile areas.

The MPs are now powerful organizational anchors for local communities to continue their engagement in sustainable agro-silvo-pastoralism, to scale up local best practices and to support social resilience activities because they provide a physical space for coordination of and access to services and information. The potential for replication is high, and there is growing interest from neighboring communes and national ministries to deploy the MP concept on a wider scale.

5.1. Enhancing operations

- **Promote farmers' access to financing and to Farmers' Field Schools (FFS) linked to the implementation of sustainable land management techniques.** Niger strongly relies on international funding to scale up implementation of environmental projects supporting sustainable land management. For farmers, direct costs consist of labor time and knowledge acquisition through experience. Thus, targeted assistance to improve farmers' access to economic resources to furnish start-up capital and to facilitate a knowledge exchange through FFS to remove technical constraints for the application of sustainable land management farming practices is needed, particularly in the regions most affected by land degradation. Focusing on the most affected areas will increase the possibilities to achieve results that positively affect the environment, the population, and the economy.
- **Support smart agricultural technologies.** Better access to smart technology for small landowners is necessary to enhance environmental performance of farmers and pastoralists. Building capacity in smart agriculture technologies is a win for both land and farmers. It will not only help scale the development and implementation of sustainable land practices but will also enhance human capital as a natural asset. Successfully implemented initiatives such as FMNR, a lost-cost land regeneration technique, involving leaving trees on land to protect crops, helped regreen large parts of the Maradi and Zinder region and could easily be replicated in Tillaberi and Dosso. A presidential decree regulating and promoting FMNR was adopted in July 2020, which should be able to boost its dissemination. Vegetable gardens have proved successful, especially among the women and youth, but careful training on their maintenance and sustainability is still needed.
- **Scale up water harvesting techniques to fight degradation of croplands.** Applying water harvesting techniques can improve water retention and infiltration into the soil by forming a barrier that slows down runoff and spreads it more evenly over the land. Such techniques include contour stone bunds built with earth or stones, which increase the amount of water available to crops and vegetation, thus contributing to the restoration of degraded land. Over time, this results in build-up of sediment and formation of terraces, which are favorable conditions for natural vegetation to emerge along the structure. Evidence shows that bunds that have been in place for over 15 years have positive effects on yields. Other successful techniques include modern boreholes and drip irrigation.
- **Introduce improved and climate-resistant crop varieties to increase production.** To mitigate the risk of food insecurity, Niger must invest in improved seed varieties. In the millet and cowpea belt, where the demographic pressure is high, the arable land is almost entirely in use. Consequently, food security can only be achieved through increased production. The improved millet variety, HKP, is a drought-resistant variety adapted to the Sahelian context, and which performs better due to its lower sensitivity to worms and the photoperiod. With a potential yield of 1.5 to 2.5 tons per ha, the HKP is three times more productive than current varieties. Similarly, the cowpea variety IT90K-372-1-2 has a short cycle, multiple resistance, and is adapted to Niger's agro-ecological zone. With a potential yield of 1.2 to 1.5 tons per ha, the performance of improved cowpea variety is five times higher than other varieties. Difficulties related to the technical management of the Nigerien seed system and to a lack of access to improved seeds for local producers have delayed their wider introduction in the country. Future actions to counter food security must prioritize improvements to make adapted and climate-resistant crop varieties more widely available to local farmers.
- **Develop and implement a food storage system across regions.** Lack of adequate storage facilities of agricultural and food products causes significant economic losses and strong

price fluctuations. Therefore, the development and implementation of a food storage system across regions is key to counter food insecurity in Niger.

- **Link smallholder farmers to local markets to bring incentives for sustainable land management and move beyond subsistence farming.** Reducing land degradation and rural poverty requires more than initiatives to regreen degraded areas. Connecting local farmers to markets and to consumers can bring about the needed economic incentives to engage smallholder farmers to adopt sustainable land management practices. This requires better access to financing, improvements in community support services such as local food storage and extension services, and creation of an enabling environment for small businesses and markets to flourish.
- **Encourage rural youth employment through vocational training and as a means to modernize agriculture.** The German Federal Ministry for Economic Cooperation and Development has put in place a successful regional project on rural youth employment focused on Sub-Saharan countries.[40] Niger should explore ways in which it can be integrated. The project supports the following three areas with an integrated approach to employment promotion:
    - Labor supply: Young people improve their employment prospects by obtaining access to modern, market-oriented agricultural qualifications.
    - Labor demand: Micro, small and medium-size enterprises and start-ups continue to develop their businesses and business models, thus creating employment prospects for themselves and others.
    - Matching: A supportive business environment and needs-based placement services bring potential employers and employees together.
- **Expand value chains by promoting Niger's industrial capacity to transform agricultural products into food products.** Growing the agricultural value chain will help reduce Niger's dependency on single crops and counter the growing food trade imbalance. The value chains of dry cereals, including millet and sorghum, are the basis of food in Niger. High dependence on millet, which alone covers 65 percent of the total cultivated area, makes Niger vulnerable to climate variability. To increase resilience and reduce dependence, Niger needs to diversify agricultural crops and strengthen the capacity of local industrial producers to maintain more of the value added involved in food production. For example, local processing and sales of animal products such as milk can save scarce revenue streams, which could be used for importing other goods and services.
- **Invest in the promotion and development of the Arabic gum industry including the expansion and rehabilitation of existing stands.** In view of the worldwide demand of Arabic gum estimated at 50,000 tons per year, Niger is well positioned to increase its supply and thus its share of the international market. It is opportune to build on the results of previous projects—the Program of Research and Development on Acacia Gum, along with the pilot project Operation Acacia (Ministère de l'Environnement de la Salubrité Urbaine et du Developpement Durable 2012)—and roll out the implementation of the strategy from 2003. Perhaps a critical aspect is to reinforce local capacities and create the structures that will allow efficient coordination and management of the production and trade of Arabic gum. Furthermore, in addition to the added value of the sector for the national economy, the positive impact at the local level is not to be underestimated. The organization of the community into informal groups and formal cooperatives will be critical for the development of its production and trade potential with a spillover onto other value chains. There is also potential for the sector to mobilize women and youth,

40 https://www.giz.de/en/worldwide/67975.html.

especially in rural communities, in natural resource management, and households' food security. Access to finance is essential for funding of the core programs aiming to operationalize the strategy, be it for the rehabilitation of the Acacia gum landscapes and their expansion based on landscape and suitability mapping or in programs investing in infrastructure needed for starting and maintaining production, market access, access to finance, and trade. It is therefore recommended that public funds be earmarked and mobilized for the development of the sector in recognition of its potential, with subsequent support from the international development community.

- **Upgrade the wood energy subsector.** The use of wood energy can encourage landowners and farmers to better manage woodlands and invest in plantations. Wood energy production is suitable for community management of forests and woodlands and is in line with the current trend of deregulation and privatization of the energy and forestry sectors. In addition, the sustainable production of domestic fuels can lead to rural development consistent with coherent town and country planning. The use of woody fuels promotes transport over relatively short distances with low environmental risks. Unlike other energy sources requiring more sophisticated technologies, woody fuels create jobs and income at the local level, especially for the poorest and most disadvantaged groups. Implementing the modernization of the wood energy value chain will require numerous institutional measures, including (a) improving the sustainable production of wood energy by promoting participatory management of natural forests and increasing the area under plantations and agroforestry; (b) improving exploitation and processing of wood energy by building the capacity of local actors, increasing efficiency of resource use, and testing and disseminating innovative methods to use agricultural residues; (c) improving the transportation and marketing of wood; (d) and testing models of improved household cookstoves and disseminating them in urban and rural areas. Moreover, in line with the GoN commitments to reduce reliance on fuelwoods, intensifying awareness raising and promoting alternative fuels would help reduce pressures on natural resources.

- **Raise awareness among communities and local institutions on climate change risk, which can systematically build community ownership and leverage local knowledge for more effective climate-smart solutions tailored to the specific local contexts.** There is a lack of institutionalized mechanisms at the local level for citizen engagement and social accountability for local communities to participate meaningfully in decision-making related to natural resource management or climate adaptation and disaster risk management.

- **Strengthen local engagement.** Participatory approaches to natural resources management that is socially inclusive can contribute to conflict reduction, notably between pastoralists and farmers. Box 5.2 illustrates a successful example from Burkina Faso.

5.2. Supporting policy reform

- **Enhance local governance structures in planning and managing natural resources.** The GoN has recognized the importance of local communities in the management of their natural resources base. Indeed, decentralization efforts have empowered local communities and allowed for the rise of local structures (formal and informal groups) to use and manage, among others, forests for timber and NTFP. That said, these efforts ought to be more regulated to allow the formalization and/or revitalization of inclusive local structures engaged in the sustainable use of natural resources. Additionally, and in line with a broader landscape consideration, the management of these resources should only be done based on communal/local development plans integrating social, economic, and environmental dimensions.

BOX 5.2. TerriStories—An innovative participatory planning tool

Recent experience from Burkina Faso has demonstrated the potential for improving land use planning at the community level through an integrated landscape management approach developed in a participatory manner.

The TerriStories approach incentivized local actors to find solutions to challenges related to natural resources through role play. Local actors included different users of land as well as customary and administrative authorities at municipal and village levels. Under the municipalities' leadership, priority sites for conservation activities in forests and pastoral areas, and accompanying investments around these sites, were identified by the participants through consensus and developed into Integrated Community Development Plans (ICDPs). The plans outlined a comprehensive vision of activities to reduce deforestation and woodland degradation. At project closing, all 32 municipal ICDPs had been developed and financed following consultation with more than 6,600 participants in 128 villages.

By directly funding the plans through the local municipalities, the project demonstrated the potential for decentralized natural resources management.

The involvement of communities led to greater local ownership and sustainability of investments, reduced conflicts over the access to natural resources, strengthened social ties among community members and local authorities, and improved accountability for lasting results.

- **Institute land use planning as it is an important policy tool for long-term sustainable development.** The tool is deemed necessary to continue the decentralization process, mitigate conflicting interests and competition over land and resources, regulate migration, and plan the use of lands per sector. Integrated land use planning is highly encouraged as it is carried out across sectors and levels of government and involves the allocation of land for different uses across a landscape in a way that balances economic interests, social value, and forest and land cover. It also helps secure land restoration investments.
- **Support the implementation of the National Nutritional Security Policy (PNSN) with explicit attention to climate change vulnerability..** This national policy aims to eliminate all forms of malnutrition by mobilizing institutional, human, and financial resources across multiple sectors. The policy and its associated action plan constitute the sole framework for all activities to combat malnutrition while considering climate resilient actions.
- **Improve country's capacity to sustainably use its stock of natural capital to achieve the objectives of the Niger 2035 Sustainable Development and Inclusive Growth Strategy (SDIGS).** The importance of its natural assets is recognized in the Renaissance Program 2 (2016–2021), which identifies the restoration and sustainable management of land as necessary to ensure food and nutrition security. Lessons derived from the implementation of the ESDS 2012–2015 point to a need to implement initiatives comprehensively and strategically across sectors. The ESDS 2017–2021, Niger's first five-year plan designed with SDIGS in mind, highlights the precarious state of the country's natural capital.

- **Develop regulations, including monitoring and enforcement provisions in preparation for increased demand on forest resources to ensure the exploitation is supply driven rather than market driven.** The absence of updated regulation could lead to a depletion of existing resources, noting that the overarching legal framework is well advanced in this regard.
- **Promote integrated landscape management and landscape resilience in restoration strategies.** Tree, shrub, and forest cover provide landscape resilience and agroforestry-related production benefits in the Western Sahel in general. Large-scale, forest-water interaction-based processes must be incorporated into landscape restoration strategies, including the Great Green Wall initiative. Indeed, resilient ecosystem restoration is best understood on the basis of the forest-water and land-atmosphere interaction lens. Agroforestry parklands are reported to cover over 7 million ha of lands in Niger and are mostly found in the agricultural zone that stretches across the southern part of the country, commonly along the Niger River and in territories with a marked human. Agroforestry can further promote landscape resilience. Strategies broadly focused on agroforestry expansion/restoration, increase of rainfall recycling, water availability, and the promotion of landscape resilience are more likely to steer future efforts in useful directions. In line with the above, it is recommended that ecosystem management plans be put in place covering mosaic landscapes, and where available, that they be revisited to integrate community preferences using participatory approaches in both their management and restoration. Special attention ought to be given to urban and peri-urban forest landscapes to ensure their conservation and sustainable management.
- **Implement the new Land Policy and sustainable land management action plans to help prevent conflicts linked to land and natural resource management.** These may include delivering land transaction acts, establishing rules for shared resources (transhumance corridors, water points, grazing areas), and formalizing land rights (particularly for vulnerable populations such as displaced people, pastoralists, and women). Local conflict management structures and committees need to be strengthened through adequate funding and decision-making power, inclusive participation of stakeholders (this includes traditional chiefs, religious leaders, administrative authorities, farmers, pastoralists, women, youth, and displaced populations), and training for traditional leaders and others in conflict resolution and management strategies. In addition, service delivery to mobile pastoralist populations needs to be improved, and adaptation and flexibility to this population's needs are required, while being inclusive of the sedentary communities that are present where mobile services are provided.

5.3. Building knowledge

- **Develop natural accounts for agricultural land, water, and forests to address the five strategic axes noted in ESDS 2017–2021.** The process of creating and analyzing natural capital accounts is key to Niger's sustainable development. The exercise should facilitate and enhance cross-sectoral links, improve data collection and analysis, support institutional capacity building, and foster more effective economic planning.
- **Assess and monitor forest resources to drive sector growth.** Since the early 1990s, Niger has developed impressive experience managing forests. However, the limited knowledge on the potential of the forestry sector is a major limiting factor to the expansion of the sector. Niger has never undertaken a national-scale forest inventory impeding the elaboration of resource use plans and a valuation of forest services. Despite the development of the National Strategy for the promotion of NTFP, lack of data and statistics prevails, thus keeping the exploitation of NTFP a traditional and informal activity. It also shines a light on the role of forest

degradation and depletion of their resources, which can undermine the sustainability of potential economic growth. In this regard, it is recommended that a set of indicators be established allowing medium- and long-term monitoring of these resources and alignment with national and international reporting obligations. A comprehensive assessment of forest resources, including the quantification of some assets, particularly biomass for energy production and NTFP, can help ensure they receive an appropriate level of economic policy consideration given their importance to sustainable economic prosperity. The monetary valuation of their contribution to national economy would drive policy changes and steer investments in the sector. Furthermore, an assessment of the potential for a public-private arrangement for sustainability, including operations, particularly for the payment of environmental services or carbon finance, is essential to mobilize resources, attract the private sector, formalize resource use, and regulate it.

- **Improve access to and strengthen technical national entities for climate data collection and archiving.** Overall, scientific data are mainly produced during one-off collections for projects or programs, information is gathered by development partners, and it is dispersed at the national level. Implementing a dedicated mechanism for funding data collection, supporting modelling capacities at the national level would help build national capacities, promote better access to climate information, and could complement ongoing initiatives. For example, an improved water management and meteorological data and information dissemination into rural areas will improve the population's response to droughts, and the development of an early warning system is needed to increase the resilience in the agricultural sector.[41]

41 World Bank Group Climate Change Knowledge Portal: https://climateknowledgeportal.worldbank.org/country/niger/vulnerability

Photo: Andrea Borgarello / World Bank Group

Photo: Andrea Borgarello / World Bank Group

Annex 1. Main actors involved in environmental management in Niger[43]

Institution	Remit
Climate Commission of the Sahel Region—*Commission Climat pour la Région du Sahel* (CCRS)	• Contribute to the implementation of the Investment Plan Climate-Sahel Region (ICP-RS) and its Regional Priority Programme (PRP). • Support member countries in the operationalization of National Working Groups (NWGs). • Mobilize non-state actors (civil society, NGOs, private sector, local authorities, and so on). • Prepare the Terms of Reference of the feasibility study relating to the implementation of the CCRS financial mechanism.
Water, Environment, and Sanitation Unit—*Cellule Eau, Environnement et Assainissement (CEEA)*	• Support implementation of the '3N' Initiative. • Evaluate and develop propose actions in terms of sustainable development and sanitation. • Instill a dynamic of compliance for urban master plans and related plans. • Monitor and evaluate the implementation of PANGIRE, PNEDD, other programs and environmental projects, and of the projects under the National Action Plan for Combatting Desertification and Management of Natural Resources (NAP/LCD-GRN).
High Commission for the 3N Initiative—*Haut-Commissariat à l'Initiative 3N* (HC3N)	• Coordinate, plan, and conduct technical, economic, and financial studies. • Mobilize financing. • Promote as well as monitor and evaluate the implementation of the 3N Initiative.
Kandadji Dam Agency—*Agence du Barrage de Kandadji* (ABK)	The ABK is tasked, among others, with the following: • Mobilize finance. • Manage and operate the Kandadji Dam. • Supervise and coordinate the implementation of the Social and Economic Management Plan (PGES). • Recover fee.

43 Extracted from the GoN report on the State of the Environment, 2021.

Institution	Remit
Executive Secretariat of the National Council for Environment and Sustainable Development—*Secrétariat Exécutif du Conseil National de l'Environnement pour un Développement Durable* (SE/CNEDD)	• Coordinate activities related to the implementation of the recommendations of United Nations Conference on Environment and Development. • Define a national framework containing: the policy, directions, objectives, strategies, and programs on Environment for Sustainable Development. • Design and promote the implementation of a framework and adequate institutional mechanisms, ensuring coordination and harmonization of the activities of all stakeholders in the related National Plan. • Ensure compliance with national and international environmental standards in all development economic, social, and cultural activities. • Mobilize financing for the development and the implementation of the National Plan. • Promote sustainable management and use of natural resources and environment within the framework of the United Nations Conference on Environment and Development.
National Centre of Ecological and Environmental Monitoring—*Centre National de Surveillance Écologique et Environnementale* (CNSEE)	• Ensure the establishment and management of relevant observatories for ecological and environmental monitoring. • Ensure the collection and processing of relevant biophysical, biological, and socioeconomic data. • Generate and publish through the network of observatories and in partnership with national and international institutions, information relating to the natural or anthropogenic impacts on environment and natural resources, such as desertification and climate change and variability. • Set environmental indicators of the quality of the living environment of populations. • Address environmental biosafety emergencies and disasters. • Ensure in the medium-and long term management measures on natural resources. • Ensure database management. • Disseminate information through periodic reports, documents, and journals.
National Agency of the Great Green Wall—*Agence Nationale de la Grande Muraille Verte du Niger*	• Coordinate, monitor, evaluate, and implement the Great Green Wall initiative in Niger.
National Office of Environmental Evaluation—*Bureau National d'Évaluation Environnementale* (BNEE)	• Promote and implement environmental assessments in Niger at the national level. • Cover all policies, strategies, plans, programs, projects, and all activities, for which an environmental assessment is mandatory or necessary pursuant to Law No. 2018-28 of May 14, 2018 and its Decree No. 2019-027/PRN/MESU/DD of January 11, 2019, determining the fundamental principles of Environmental Assessment in Niger.

Institution	Remit
General Directorate of Pastoral Development, Production and Livestock Industries—*Direction Générale du Développement Pastoral, de la Production et des industries animals* (DGDP/P/IA)	• Oversee four national technical directorates – Directorate for the Promotion of Livestock Sectors and Quality (DPFA/Q) – Directorate of Pastoral Development (DDP) – Directorate of Livestock Industries (DIA) – Directorate of Genetic Improvement and Livestock Biotechnology (DAGBA) • Promote livestock sectors • Promote livestock industries • Support genetic improvement • Develop and secure pasturelands and pastoralism • Monitor pastoral resources • Risk management
General Directorate of Agriculture—*Direction Générale de l'Agriculture* (DGA)	The DGA comprises four national technical directorates • Directorate of Extension and Technology Transfer (DV/TT) • Directorate for the Promotion of Crop Sectors and Quality (DPFV/Q) • Directorate of Agricultural Mechanization (DMA) • Directorate of Seed Control and Certification (DCCS). Design, develop, and implement national agriculture strategies, value chain strategies, agricultural extension, technology transfer, laws and regulations on production, packaging, quality control, and certification of seeds and fruit crops and ensure their application, and finally monitor agricultural seasons.
General Directorate of Crop Protection—*Direction Générale de la Protection des Végétaux* (DGPV)	• Design and implement the national policy for crop protection. It carries out its mission through four technical departments: • Directorate of Phytosanitary Interventions and Training (DIPF) • Directorate of Biological Studies (DEB) • Directorate of Phytosanitary Regulation and Environmental Monitoring (DRP/SE) • Directorate of Phytosanitary Logistics and Equipment (DLEP).
National Centre of Locust Control—*Centre National de Lutte antiacridienne* (CNLA)	• Prevent desert locust infestations of the Gregarinous areas of the national territory. • Monitor and observe the presence of desert locust. • Coordinate desert locust control and eradication efforts. • Monitor health and environmental conditions in its area of intervention. Environmental and health monitoring is carried out by the Directorate of Environmental Monitoring (DES) of the CNLA in collaboration with the DGPV, the services of Health, Livestock and Environment. The CNLA is structured as follows: • A Technical Operations Department • An Environmental and Health Monitoring Directorate • A Monitoring and Evaluation Directorate • A Directorate of Administrative and Financial Affairs.

Institution	Remit
National Institute of Agronomic Research of the Niger—*Institut National de Recherches Agronomiques du Niger (INRAN)*	• Contribute to the development and implementation of research policy for rural development. • Develop and implement research agronomic programs. • Provide scientific and technical support for rural development. • Contribute to training and informing technical, research, and development actors. • Develop appropriate technologies for increasing and improving the productivity of the rural sector. • Contribute to the dissemination of experimental results of research with interested services and organizations. • Provide services in the areas of its competence.
Public Universities in Niger	The Public Universities of Niger are under the ministry of Higher Education, Research, and Innovation (MESRI). Their mission is teaching, scientific research, and technological innovation. They contribute to the sustainable development at both national and regional levels. The Abdou Moumouni University of Niamey (UAM) includes the Faculties of Science and Technology, Agronomy, Legal, and Economic Sciences and Humanities, Health Sciences, the Ecole Normale Supérieure and the Institutes of specialized research (CRESA, IRSH, IRI, IREM). The UAM has, among others, the following missions: • Train technical managers, teaching managers, and so on. • Train researchers. • Train and retain managers for different types of scientific and technical activities.
Network for the Management of Natural Resources and Decentralization—*Réseau Gestion des Ressources Naturelles (GRN) et Décentralisation*	In charge of the following: • Promotion of sustainable, fair, and efficient management of natural resources including policies and practices • Transfer of local skills and resources through learning groups (pastoralism, local conventions, and so on) and research on access to rural resources and land • Inclusive participation through the exchange and dissemination of experiments and the implementation of a communication strategy.
Directorate of National Meteorology—*Direction de la Météorologie Nationale* (DMN)	• Coordinate and harmonize national meteorology policy. • Ensure atmospheric observation. • Provide weather forecasts and disseminate the corresponding information. • Provide meteorological assistance to all socioeconomic sectors in Niger. • Implement data collection through the establishment of a network of data monitoring stations, processing, forecasting, archiving and dissemination of data. • Promote meteorological research and applications, in particular in the fields of global climate change and environmental protection. • Monitor regional and international institutions dealing with meteorological issues. • Disseminate weather reports, agro-hydrometeorological bulletins (annual and 10-year reports).

Institution	Remit
National Institute of Statistics of the Ministry of Finance—*Institut National de la Statistique (INS) du Ministère des Finances*	• Collect, integrate, produce, disseminate statistics necessary for the development of the economic and social policy and the assessment of their results. • Coordinate the national statistical system and sectoral, macroeconomic, and socio-demographic studies and research. • Coordinate work guiding short-term economic and financial policy, in relation to other government departments. • Prepare and monitor short-term economic and financial programs, in coordination with other departments of the Ministry of Finance, ministries, and subregional organizations. • Prepare guidance notes on the national budget as well as economic and financial reports of the finance law.
Research Institution for Development—*Institution de Recherche pour le Développement* (IRD)	• Develop scientific projects centered on the relationship between humans and their environment in the Sahel that address – Water resources – Weather – Conservation of endangered species in the Aïr Ténéré reserve – Erosion of cultivated soils – Genetics of millet – Management of natural resources.
Regional Center Agrhymet—*Centre Régional Agrhymet* (CRA)	The CRA is a specialized institution of the Permanent Interstate Committee for Drought Control in the Sahel (CILSS) created in 1974. It has its headquarters in Niamey (Niger). It brings together the 13 member countries of CILSS: Burkina Faso, Cabo Verde, Benin, Côte d'Ivoire, Togo, The Gambia, Guinea, Guinea-Bissau, Mali, Mauritania, Niger, Senegal, and Chad. The center's main objectives are to • Contribute to food security and increased food production in CILSS member countries; • Help improve the management of natural resources of the Sahel region; and • Provide information to and train development actors and their partners in the fields of agro-climatology, hydrology, crop protection, food security and nutrition, integrated management of water resources, sustainable land management, and so on.
African Center for Meteorological Applications for Development—*Centre Africain pour les Applications de la Météorologie au Développement* (ACMAD)	• Develop and transfer tools and technologies to national meteorological systems. • Develop weather and climate information and products to support sustainable development. • Disseminate meteorological and climatic information to users, particularly in rural areas. • Communicate the impact of the activities of member states and partners. • Monitor climate, forecast weather and climate change, train African meteorologists in new techniques and technologies.
International Crops Research Institute for the Semi-Arid Tropics—*Institut international de recherche sur les cultures des zones tropicales semiarides* (ICRISAT)	ICRISAT is a nonprofit, apolitical organization belonging to the Future Harvest Alliance pertaining to centers supported by the Consultative Group on International Agricultural Research (CGIAR). ICRISAT's mission is to help 644 million resource-poor farmers in the semi-arid tropics overcome hunger, poverty, and environmental degradation through improved agricultural practices.

Institution	Remit
Niger River Basin Authority—*Autorité du Bassin du Fleuve Niger* (ABN)	• Harmonize and coordinate national policies for the development of basin resources. • Plan basin development by developing an integrated basin development plan. • Design, build, operate, and maintain works and common projects. • Ensure the control and regulation of all forms of navigation on the river, its tributaries, and sub-tributaries in accordance with the 'Niamey Act'. • Participate in the formulation of requests for assistance and the mobilization of funding for studies and necessary works for the development of basin resources.
Intergovernmental Committees for Drought Control in the Sahel—*Comités Inter-états de Lutte contre la Sécheresse au Sahel* (CILSS)	CILSS is an international organization bringing together the Sahelian countries. It was created in 1973, during the first major drought in the region, to mobilize the Sahelian populations and the international community around emergency aid and the implementation of programs related to rainfed and irrigated agriculture, hydraulics, environment, transport, and communication. The executive secretariat is based in Ouagadougou (Burkina Faso). The agro-hydrometric center (AGRHYMET), created by the World Meteorological Organization, is housed in Niamey (Niger) and the *Institut du Sahel*, a center for agro-socioeconomic and 'population and development' research, is based in Bamako (Mali).
Civil Society Platform for Climate Change and Sustainable Development—*Plateforme De La Société Civile Sur Le Changement Climatique Et Le Développement Durable*	• Establish a synergy framework on the one hand between civil society organizations working in the areas of climate change, environment, and energy for sustainable development and on the other hand between the Government and the said civil society. • Ensure that the change dimension is considered in climate policies, strategies, and programs for sustainable development. • Ensure justice and equity in the UNFCCC negotiation process and adequately protect the climate while safeguarding development.
General Directorate of Water Resources—*Direction Générale des Ressources en Eau* (DGRE)	• Monitor and protect water resources.
General Directorate for Water and Forests—*Direction Générale de l'Environnement et des Forêts* (DGEF)	• Implement policies, strategies, conventions and international agreements and action plans in the areas of forestry, fishing, aquaculture, beekeeping, wetlands, landscaping, and environmental preservation.
General Directorate for Sustainable Development and Environmental Standards—*Direction Générale du Développement Durable et des Normes Environnementales* (DGDD/NE)	• Implement national policies, strategies, and action plans for environmental preservation, environmental economics, sustainable development, environmental standards, pollution and nuisance, and disaster risks as well as that of multilateral environmental conventions and agreements.
Lake Chad Basin Commission—*Commission du Bassin Lac Chad* (CBLT)	• Promote the common and sustainable management and exploitation of Lake Chad, as well as cross-border security in a context where the fluctuating design of the shores of the lake generates internal and cross-border migrations as well as banditry.

Institution	Remit
Liptako-Gourma Authority—*Autorité de Développement Intégré des États du Liptako-Gourma* (ALG)	The role of the Integrated Development Authority of the Liptako-Gourma region (ALG) is to strengthen ties of cooperation and solidarity binding the three states, through the integrated and harmonious development of the Liptako-Gourma region. The Liptako-Gourma Authority covers the historical-geographical areas of Liptako (northeastern Burkina Faso) and Gourma, but also, more generally, the entire convergence zone of the three borders of the member countries, with the Niger River Basin as the central axis.

A1.1. Other institutions involved in environmental management

- National Council for Environment and Sustainable Development (CNEDD)
- National Water and Sanitation Commission (CNEA)
- Energy and Sustainable Development Technical Commission (CTEDD)
- Technical Commission on Biological Diversity (CTDB)
- Technical Commission on Climate Change and Variability (CTCVC)
- Technical Commission for the fight against desertification and the management of natural resources (CTLCD/GRN)
- National RAMSAR Committee
- MAB/UNESCO National Committee
- National Rural Code Committee (CN/CR)
- National Coordination Committee of NGOs on Desertification (CNCOD)
- National Multisectoral Energy Committee (CNME)

A1.2. Environmental Management Frameworks and Platforms

- National Consultation Framework on Domestic Energies (CNCED)
- Framework for Consultation of Actors involved in Adaptation to Climate Change (CCAACC)
- Consultation Framework on Migration (CCM)
- Framework for Consultation of Actors in the implementation of the 3N Initiative (CCA/3NI)
- National Civil Society Platform on Climate Change and Sustainable Development (PN/CC/DD)
- National Platform for Dialogue on Climate Change, Agriculture, Research and Food Security in Niger (PNSP/CCASAN)

Annex 2. Cost of agricultural productivity loss due to land degradation

A2.1. Land Degradation analysis

$$LPL = \frac{LDA}{TAA} \times LDPL$$

LPL = Land productivity loss expressed in %

LDA = Land degradation area (ha)

TAA = Total arable area (ha)

LDPL = Land degradation productivity loss (%)

A2.2. Agricultural Productivity Loss

$$CPLi = LPL \times CAi \times CPi$$

CPLi = Crop productivity loss per crop expressed in tons

LPL = Land productivity loss estimated in 1.1

CAi = Crop area (ha)

CPi = Crop productivity (t/ha)

This methodology is based on Panagos et al. (2018). This method assumes that the productivity loss is equally distributed across all crop types in each region. In equation 2.1, we are using 16.5 percent based on the estimates of productivity loss due to erosion from Lal (1995) for Sub-Saharan Africa for 2020. The estimates of productivity loss vary between 2 and 40 percent depending on the erosion severity.

In equation 2.2, once the agricultural productivity loss due to land degradation is calculated, to obtain the economic values, the CPL is multiplied by the market price of each crop.

Due to the lack of data, and considering the main land degradation drivers in Niger, land degradation is assumed to be produced by wind and water erosion.

TABLE A.2.1. Results of the analysis by region and crop

Region	Millet	Sorghum	Maize	Niébé	Rice	Nuts	Fonio	Sesame	Total
Agadez	3,682	9,935	41,002	3,817					**58,435**
Diffa	2,558,891	691,240		3,289,274	75,235	225,938		1,497,541	**8,338,118**
Dosso	29,513,580	8,596,433	104,494	49,917,960	1,948,693	2,129,168	116,477	67,582	**92,394,387**
Maradi	20,769,500	15,272,321	28,943	27,585,157		5,712,692		822,926	**70,191,539**
Niamey	494,663	30,480	729	1,397,650	2,436,631	8,702			**4,368,854**
Tahoua	45,549,568	25,201,595	77,764	53,383,345	185,921	2,936,854		343,848	**127,678,895**
Tillaberi	83,429,431	30,455,984	58,433	126,777,673	42,574,077	2,886,389	2,714	1,072,296	**287,256,995**
Zinder	15,535,075	11,708,079	7,694	22,385,346	143,836	4,707,742		1,527,513	**56,015,284**
Total	**197,854,390**	**91,966,066**	**319,058**	**284,740,221**	**47,364,393**	**18,607,485**	**119,191**	**5,331,705**	646,302,507

References

Adamou, R., B. Ibrahim, A. Bonkaney, A. Seyni, & M. Idrissa (2021, January 19). "Niger—Land, Climate, Energy, Agriculture and Development: A Study in the Sudano-Sahel Initiative for Regional Development, Jobs, and Food Security." ZEF Working Paper Series. https://ssrn.com/abstract=3769119.

Comité permanent Inter-états de Lutte contre la Sécheresse dans le Sahel (CILSS). 2016. Landscapes of West Africa—A window on a changing world. Ouagadougou, Burkina Faso. CILSS, p219. doi:10.5066/ F7N014QZ

AFDB. 2018. *National Climate Change Profile: Niger.*

Comité permanent Inter-états de Lutte contre la Sécheresse dans le Sahel (CILSS). 2016. Landscapes of West Africa—A window on a changing world. Ouagadougou, Burkina Faso. CILSS, p219. doi:10.5066/ F7N014QZ

CNEDD. 2011. *Impacts des changements climatiques sur les forets au Niger*.

CNEDD. 2014. *Strategie Nationale et Plan d'Action en matiere de Changements et Variabilité Climatiques.*

CNEDD. 2018. *Processus de Définition des Ciblés de Neutralité en matière de Degradation des Terres.* https://knowledge.unccd.int/sites/default/files/ldn_targets/Niger LDN TSP Country Report.pdf.

CNEDD. 2019. *Cartographie de la vulnérabilité des activités agropastorales des régions du Niger dans le cadre du Projet PDIPC.*

CNEDD. 2021. *Etat de l'Environnement au Niger, 4eme rapport National.* Niamey: CNEDD.

CNEDD, and AFDB. 2019. *Cartographie de la vulnérabilité des activités agropastorales des régions du Niger dans le cadre du Projet PDIPC.*

CNEDD & AFDB. (2020). *Quatrième Communication Nationale sur les Changements Climatiques*.

FAO. 2001. *Management of Natural Forests of Dry Tropical Zones (FAO Conservation Guides).*

FAO. 2015. *Evaluation des Ressources Forestières Mondiales 2015 – Rapport National Niger.* Rome: FAO.

FAO. 2020a. *Evaluation des Ressources Forestieres mondiales, Rapport Niger.* Rome: FAO.

FAO. 2020b. *Global Forest Resources Assessment 2020: Main Report.* Rome: FAO.

FAO. 2021a. *Étude de cadrage du système agroalimentaire au Niger.*

FAO. 2021b. *The Niger—Analysis of Conflicts Over Transhumance in Diffa Region: Summary.* Rome: FAO.

FAO. n.d. "Adapting Irrigation to Climate Change (AICCA)." https://www.fao.org/in-action/aicca/country-activities/niger/background/en/.

FAO, electronic files and web site. 2020. “Forest Area (% of land area)—Sub-Saharan Africa.” The World Bank. https://data.worldbank.org/indicator/AG.LND.FRST.ZS?end=2020&locations=ZG&start=1990&view=chart.

FEWS NET. 2011. *Niger – Livelihood zones.*

FEWS NET. 2021. *Perspectives sur la sécurité alimentaire.*

Funk, C., S. Shukla, W. Thiaw, J. Rowland, A. Hoell, A. Mcnally, J. Verdin. 2019. “Recognizing the Famine Early Warning Systems Network (FEWS NET): Over 30 Years of Drought Early Warning Science Advances and Partnerships Promoting Global Food Security.” *Bulletin of the American Meteorological Society* 100 (6): 1011–1027. doi:10.1175/BAMS-D-17-0233.1.

GIZ GmbH. n.d. “Promotion of National Decentralisation and Good Governance.” https://www.giz.de/en/worldwide/23276.html.

Government of Niger. 2017. *Economic and Social Development Strategy (ESDS) for 2017–2021.*

ITIE Niger. 2021. *Dispositif National de Mise en œuvre de l’Initiative pour la Transparence des Industries Extractives au Niger—Rapport 2019.*

Kahn, F., and A. Luxereau. 2008. “Doum Palm Habit and Leaf Collecting Practices in Niger.”

Mahé, G., and J. Paturel. 2009. “1896–2006 Sahelian Annual Rainfall Variability and Runoff Increase of Sahelian Rivers.” *Comptes Rendus Geoscience* 341:538–546.

Ministere de l’Energie. 2019. *Prospectus D’Iinvestissement de l’Energie Durable Pour Tous (Seforall) Du Niger.*

Ministère de l’Energie et du Pétrole. 2015. *Plan d’Actions National des Energies Renouvelables (PANER) 2015–2020/2030.*

Ministere de l’Environnement de la Salubrite Urbaine et du Developpement Durable. 2012. *Strategie nationale de relance de la production et de la commercialisation de la gomme arabique au Niger.*

Ministère de l’Environnement de la Salubrite Urbaine et du Developpement Durable. 2014. *Cadre Stratégique de la Gestion Durable des Terres (CS-GDT) au Niger et son Plan d’Investissement 2015–2029.*

Ministere de l’Environnement de la Salubrite Urbaine et du Developpement Durable. 2016. *Stratégie et Plan d’Actions de Promotion des Produits Forestiers Non Ligneux (PFNL) au Niger.*

Ministère de l’Hydraulique et de l’Assainissement. 2017. *Plan d’Action National de Gestion Intégrée des Ressources en Eau PANGIRE Niger.*

Ministère de l’Hydraulique et de l’Environnement, and FAO. 2012. *Plan Forestier National PFN—Niger 2012–2021.*

Ministere de l’Hydraulique de l’Environnement et de la Lutte Contre la Desertification. 2003. *Stratégie Nationale de Relance de la Production et de la Commercialisation de la Gomme Arabique au Niger.*

Ministere du Developpement Agricole et Ministere des Ressources Animales. 2017. *Recensement General de l’Agriculture et du Cheptel 2005–2007.*

Ministère du Plan. 2021. *Améliorer le fonctionnement des systemes alimentaires grace au commerce alimentaire exterieur au Niger.*

Mohamadi, M., and A. Kavian. 2015. Effects of Rainfall Patterns on Runoff and Soil Erosion in Field Plots." *International Soil and Water Conservation Research* 3 (4): 273–281.

ND-GAIN (Notre Dame Global Adaptation Initiative). 2019. "ND-GAIN Country Index." https://gain.nd.edu/our-work/country-index/rankings/.

Nkonya, E., Y. Ru, and K. Edward. 2018. "Chapter 2. Economics of Land Degradation in Niger." In *Fostering Transformation and Growth in Niger's Agricultural Sector*, edited by Fleur Wouterse and Ousmane Badiane, 35–59. Wageningen Academic Publishers. doi:10.3920/978-90-8686-873-5_2.

Panagos, Panos & Standardi, Gabriele & Borrelli, Pasquale & Lugato, Emanuele & Montanarella, Luca & Bosello, Francesco. (2018). Cost of agricultural productivity loss due to soil erosion in the European Union: From direct cost evaluation approaches to the use of macroeconomic models. Land Degradation & Development. 29. 10.1002/ldr.2879.

Peltier, R., C. Serre Duhem, and A. Ichaou. 2008. "Valoriser les produits du palmier doum pour gérer durablement le système agroforestier d'une vallée sahélienne du Niger et éviter sa désertification." *VertigO—la revue électronique en sciences de l'environnement* 8 (1). https://doi.org/10.4000/vertigo.1452.

République du Niger. 2016a. *Le programme de Renaissance acte 2.*

République du Niger. 2016b. *Politique nationale de sécurité nutritionnelle au Niger (2016–2025). 1–25.*

République du Niger. 2017. *Engagement du Niger à mettre en œuvre la Neutralité en matière de Dégradation des Terres d'ici à 2030.*

République du Niger. 2020a. *Politique Minière Nationale 2020—2035.*

République du Niger. 2021a. *Contribution Déterminée au Niveau National.* Niamey.

République du Niger. 2021b. *Feuille de route pour opérationnaliser les voies de transformation des Systèmes Alimentaires pour une Alimentation Saine à l'horizon 2030 au Niger.*

Röhrig, F., N. Gloy, S. von Loeben, P. Arumugam, P. Aschenbrenner, H. Baek, C. Gornott. 2022. *Climate Risk Analysis for Identifying and Weighing Adaptation Strategies for the Agricultural Sector in Niger.* Potsdam Institute for Climate Impact Research (PIK) and GIZ. doi:10.48485/pik.2022.002.

Savadogo, A., C. Tsimpo Nkengn, and A. Sanoh. 2022. "Understanding poverty and reversals in five charts on Niger." *World Bank Blogs*, February 1, 2022. https://blogs.worldbank.org/nasikiliza/understanding-poverty-and-reversals-five-charts-niger.

Tomalka, J., S. Lange, F. Röhrig, and C. Gornott. 2021. *Climate Risk Profile: Niger.* Potsdam Institute for Climate Impact Research (PIK).

UEMOA. 2019. *Chiffres clés sur l'énergie au Niger et dans l'espace UEMOA.*

UNCCD. 2017. *Neutralité de la dégradation des terres au Niger: Analyse de la situation de références et des facteurs de dégradation.*

United Nations, Department of Economic and Social Affairs, Population Division. 2019. "Dat Query." https://population.un.org/wpp/DataQuery/.

USAID (United States Agency for International Development). 2017. *Climate Change Risk Profile: West Africa.* https://www.climatelinks.org/sites/default/files/asset/document/2017%20April_USAID%20ATLAS_Climate%20Change%20Risk%20Profile%20-%20Sahel.pdf.

USAID. 2018. *Climate Risk Profile: West Africa.*

Wateraid. n.d. "Niger." https://www.wateraid.org/where-we-work/niger.

Wendling, Z., J. Emerson, and A. de Sherbinin. 2020. *Environmental Performance Index.* New Haven: Yale Center for Environmental Law & Policy. https://epi.yale.edu/epi-results/2020/country/ner.

WFP. 2019. "Niger Country Strategic Plan (2020–2024)." https://docs.wfp.org/api/documents/WFP-0000108569/download/?_ga=2.34007777.1304093385.1653577873-2094096522.1653577873.

World Bank. 2016. *High and Dry: Climate Change, Water, and the Economy.* Washington, DC: World Bank.

World Bank. 2017a. *Niger. Priorities for Ending Poverty and Boosting Shared Prosperity. Systematic Country Diagnostic.*

World Bank. 2017b. *Shadow Price of Carbon in Economic Analysis Guidance Note.*

World Bank. 2020. "Niger." https://data.worldbank.org/country/niger?view=chart

World Bank. 2021. *The Changing Wealth of Nations 2021. Managing Assets for the Future.*

World Bank. 2022a. "Overview." https://www.worldbank.org/en/country/niger/overview#1.

World Bank. 2022b. *Macro Poverty Outlook Country-by-Country Analysis and Projections for the Developing World.* https://thedocs.worldbank.org/en/doc/bae48ff2fefc5a869546775b3f010735-0500062021/related/mpo-ner.pdf.

World Bank Group. 2022. *G5 Sahel Region Country Climate and Development Report. CCDR Series.* Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/37620.

World Bank Climate Change Knowledge Portal. n.d. "Climate Data Projections—Niger." https://climateknowledgeportal.worldbank.org/country/niger/climate-data-historical.

World Bank national accounts data, and OECD National Accounts data files. 2020. "Agriculture, Forestry, and Fishing, Value Added (annual % growth) Niger." https://data.worldbank.org/indicator/NV.AGR.TOTL.KD.ZG?locations=NE.

World Bank national accounts data, and OECD National Accounts data files. 2020 "GDP (current US$)—Niger." T. W. Bank, Compiler. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=NE.

Wouterse, F., and O. Badiane, eds. 2018. *Fostering Transformation and Growth in Niger's Agricultural Sector.* Wageningen Academic Publishers. doi:10.3920/978-90-8686-873-5.