



Burundi

COUNTRY ENVIRONMENTAL ANALYSIS

Understanding the Environment within the Dynamics of a Complex World: Linkages to Fragility, Conflict and Climate Change

Burundi

Country Environmental Analysis

*Understanding the Environment within the
Dynamics of a Complex World: Linkages to
Fragility, Conflict, and Climate Change*



WORLD BANK GROUP



TERRAFRICA
REGIONAL SUSTAINABLE LAND MANAGEMENT



Photos: Cover, courtesy of Alvaro Zapata Cadavid and CIPAV; pages 41 and 71, courtesy of Elie Hakizumwami and IUCN.

Contents

<i>Foreword</i>	<i>vii</i>	
<i>Acknowledgments</i>	<i>ix</i>	
<i>Acronyms and Historical Exchange Rate</i>	<i>xi</i>	
<i>Executive Summary</i>	<i>xiii</i>	
Chapter 1	Nature of Environmental Problems in Burundi	1
	Introduction	1
	<i>Economic Expansion Based on Natural Capital Depletion</i>	2
	<i>Burundi's Overall Environmental Performance</i>	6
	<i>Country Environmental Analysis</i>	6
	<i>Objective of Burundi CEA</i>	8
	<i>Structure of the Report</i>	9
	Context of Environmental Problems	10
	<i>Population Growth</i>	10
	<i>Conflict and Fragility</i>	12
	<i>Climate Change</i>	13
Chapter 2	Key Environmental Problems	17
	Introduction	17
	<i>Approach and Data</i>	18
	Deforestation and Forest Degradation	21
	<i>Causes and Drivers</i>	22
	<i>Consequences and Costs</i>	23
	Land Degradation	24
	<i>Causes and Drivers</i>	25
	<i>Consequences and Costs</i>	27
	Indoor Air Pollution	30
	<i>Causes and Drivers</i>	30
	<i>Consequences and Costs</i>	31
	Water Pollution	32
	<i>Causes and Drivers</i>	32
	<i>Consequences and Costs</i>	34

	Natural Disasters	34
	Biodiversity Loss	38
	Interactions with Climate Change	38
	Overall Cost of Environmental Degradation	39
Chapter 3	Environmental Policies and Institutions	43
	Institutional Framework of Environmental Protection and Management	43
	<i>The Ministry of Water, Environment, Physical Planning, and Urban Development</i>	43
	<i>Office Burundais pour la Protection de l'Environnement</i>	43
	<i>National Institute of Geography</i>	44
	<i>Other Relevant Organizations</i>	45
	Legal Framework of Environmental Protection and Management	45
	Public Environmental Expenditure Review	46
	<i>Overall Characteristics and Evolution of Public Environmental Expenditures, 2010–16</i>	46
	<i>Structure of Burundi's Public Environmental Expenditure, 2011–15</i>	47
	<i>Execution Rate</i>	48
	Assessment of Burundi's Capacity to Address Environmental Problems and Recommendations	49
	<i>Benchmarking Burundi's Environmental Policies and Institutions</i>	49
	<i>Implementing Legal Framework</i>	51
	<i>Financial Capacity</i>	51
	<i>Capacity of OBPE</i>	52
Chapter 4	Recommendations and a Way Forward	53
	Overall Recommendations	53
	<i>Addressing the Fundamental Issues</i>	53
	<i>Addressing the Causes and Consequences of Environmental Challenges</i>	53
	<i>Holistic Approach at Landscape Level and Building Resilience</i>	54
	<i>Complementarity of State-Led Initiatives and Community-Based Programs</i>	55
	<i>Raise Public Awareness on National Environmental Challenges through Environmental Education</i>	55
	Specific Recommendations and Priority Programs	57
	<i>Deforestation and Land Degradation</i>	58
	<i>Indoor Air Pollution</i>	64
	<i>Water Pollution</i>	67
	<i>Climate Change and Natural Disasters</i>	69
	Concluding Remarks	69
	References	75
	Foreign Publications	82

Appendices

1. Deforestation and Forest Degradation	87
<i>Causes and Drivers</i>	87
<i>Consequences</i>	92
<i>Costs</i>	94
2. Land Degradation	94
<i>Causes and Drivers</i>	95
<i>Consequences</i>	98
<i>Costs</i>	99
3. Indoor Air Pollution	99
<i>Consequences</i>	100
<i>Costs</i>	102
4. Water Pollution	103
<i>Causes and Drivers</i>	103
<i>Consequences</i>	107
<i>Costs</i>	110
5. Natural Disasters	111
<i>Costs</i>	115
6. Biodiversity Loss	117
<i>Drivers of Biodiversity Loss</i>	119
7. Climate Change	122
<i>Climate Change Impacts in Burundi</i>	122
8. Environmental Policies and Institutions	127
<i>Institutional Framework of Environmental Protection and Management in Burundi</i>	127
<i>Sectoral Ministries MEEATU Is Mandated to Coordinate</i>	133
<i>Local Government's Roles and Responsibilities in Environmental Protection</i>	135
<i>Civil Society</i>	136
<i>Legal Framework</i>	137
<i>Assessment of Burundi's Capacity to Address Environmental Problems and Recommendations</i>	139
<i>Laws and Regulations</i>	142
<i>Financial Capacity</i>	145
9. Recommendations for Burundi's Disaster Risk Management Framework and Capacity	146
<i>Improve Resilience and Adaptation</i>	147
<i>Prevent Water Issues Related to Climate Change</i>	147
<i>Improve Adaptation and DRM Preparedness through Institutional Policies</i>	148



Foreword

Over the past decades, Burundi's economic growth has been hindered by continued impoverishment and increasing depletion of its natural capital. Rapid population growth has led to forests being cleared for subsistence farming. In addition, unsustainable practices have damaged soil fertility and integrity. Water resources have been polluted, harming multiple sectors as well as the health of a population already suffering from severe air pollution caused by burning biofuels. Climate change is amplifying these problems and increasing the risks of natural disasters.

A lack of proper institutional arrangements has left the environment vulnerable to rapid degradation. The situation has been further complicated by the conflicts that have gutted Burundi in recent decades and which have worsened the impacts of having no natural resource management policies.

This Country Environmental Analysis (CEA) is a first step in the World Bank's support for helping Burundi transition to inclusive and sustainable development. It was facilitated by a GoB Steering Committee chaired by the Ministry of Water, Environment, Physical Planning and Urban Development (MEEATU) and co-chaired by the Ministry of Finance, Budget and Privatization. The World Bank also set up a Coordination Committee led by the ENR team with experts from Social, Urban, Rural, and Resilience (SURR) and Macroeconomics and Fiscal Management (MFM). In addition, a Technical Committee in charge of monitoring progress included the MEEATU, the Ministry of Agriculture and Livestock, the Ministry of Energy and Mining, provincial governments, the Burundi Environment Protection Office (OBPE), the Burundi National Institute of Geography, its national statistical and economic research office, the Burundian private sector, and World Bank experts on water, agriculture and climate change.

The CEA describes the main environmental problems in Burundi, analyzes their causes, and discusses the physical and

economic extent of associated losses. It also evaluates the institutional and financial capacity of Burundi to address these challenges, and presents the following recommendations:

- population growth, fragility, and climate change are fundamental issues that must receive priority treatment;
- both the causes and consequences of environmental problems must be addressed;
- a holistic approach to landscapes with a focus on building the resilience of the environment and communities should be used; and
- complementarity between state-led initiatives and community-based programs should be leveraged.

While Burundi may face a daunting number of environmental challenges, we are convinced that the country can overcome them through commitment, determination, and support from partners such as the World Bank. These elements will enable Burundi to start down a new path of sustainable and inclusive development rooted in the integrated management of its natural resources.

Minister of Water, Environment,
Land Use and Urban Development
Honorable Celestin Ndayizeye

Country Director for Burundi
Bella Bird

Acknowledgments

The Burundi Country Environmental Analysis (CEA) is a result of close collaboration between the government of Burundi (GoB) and the World Bank. The two interrelated committees—the GoB’s Steering Committee and the World Bank’s Coordination Committee—facilitated project implementation.

- *GoB’s Steering Committee:* The Ministry of Water, Environment, Physical Planning and Urban Development (MEEATU) presided over the CEA’s coordination, while the Ministry of Finance took on the role of co-president. A geographic information system (GIS) specialist of the Ministry of Environment was nominated as the main CEA focal point and was assisted by another focal point nominated by the Ministry of Finance. Moreover, the Ministry of Agriculture and Livestock, the Ministry of Energy, provincial governments, the Burundi Environment Protection Office (OBPE), the National Institute of Geography (IGEBU), the *Institut de Statistiques et d’Etudes Economiques du Burundi* (ISTEEBU), universities, nongovernmental organizations (NGOs), the private sector, and international partners were also part of the technical committee that reviewed the CEA’s progress.
- *World Bank’s Coordination Committee:* The Environment and Natural Resources (ENR), the Social, Urban, Rural, and Resilience (SURR), and the Macroeconomics and Fiscal Management (MFM) Global Practices (GPs) co-presided the committee. The two co-Task Team Leaders of the project belong to the ENR GP and the SURR GP. The Agriculture GP, the Water GP, the Climate Change Cross-Cutting Solutions Area (CCSA), and the TerrAfrica program were members of a technical body assessing the advancement of the CEA.

The Burundi CEA report was prepared by a team of experts from GoB and the World Bank. The Burundi team was led by Alphonse Polisi, MEEATU Director of Environment and Climate Change, and Aime Claude Ntahorwaymiye, adviser to the Minister

of Finance. The World Bank team was led by Paola Agostini, Lead Environment Specialist and Global Lead for Landscapes, and co-led by Jean-Baptiste Migraine, Disaster Risk Management Specialist. Mimako Kobayashi, Senior Natural Resources Economist, led the finalization of the report; Michael Vaislic, World Bank consultant, contributed to the preparation of the report; Steven Silverstein, World Bank consultant, contributed to the initial research; and Jumaine Hussein, World Bank consultant, contributed to the coordination and country dialogue in Burundi.

This report is a synthesis of inputs from a wide range of contributors. The chapter on the environmental challenges (Chapter 2) relied on the contributions of Elie Hakizumwami, the International Union for Conservation of Nature (IUCN) Forest Program Manager for Central Africa; Dr. Jacques Ndikubagenzi, head of the department of community medicine at the University of Burundi; and Dr. Charles Niyonkuru, consultant at the University of Burundi. The cost of environmental degradation analysis was conducted by Elena Strukova, World Bank consultant, with contributions from Ferdinand Bararuzunza, Burundi's sustainable land management program coordinator, who also reviewed the country's public environmental expenditures. Mohammed Bekhechi, World Bank consultant, analyzed the country's legal and institutional framework for environmental protection.

Collection of key geographic and spatial data relative to the environment was conducted by Philippe Rapaport, World Bank consultant, and three NGOs, Enviro-Protex (*Association pour la Protection de l'Environnement*), ODEB (*Organisation pour la Défense de l'Environnement au Burundi*), and AVEDEC (*Association Villageoise d'Entraide Communautaire pour le Développement*), with the following focal points: Nestor Nikobagomba, OBPE head of GIS and main focal point; Joseph Niyongabo, OBPE Regional Forest Inspector; Melchiade Nzigamasabo, OBPE Regional Forest Inspector; and Aloys Rurantije, OBPE Director of hydro- and agro-meteorology. Many of the important details in the analysis were obtained through discussions with representatives of the public sector and NGOs during a series of consultation events from 2014 to 2016 and produced constructive comments.¹

The team would like to thank the peer reviewers who provided valuable advice and comments, namely Carter Brandon, Lead Economist; Fernando Loayza, Senior Environmental Economist; and Katelijn Van den Berg, Senior Environmental Specialist. Colleagues from Fragility, Conflict, and Violence (FCV) CCSA and Energy and Extractives (EEX) GP at the World Bank, as well as Dr. Jerome Y. Gaugris at Flora Fauna & Man, Ecological Services Ltd., also provided suggestions that substantially improved the report.

Special recognition goes to Simon Sindayihebura, MEEATU Permanent Secretary, who supported this work and facilitated the preparation of the report from the GoB. The team is grateful for the guidance and leadership at the World Bank, specifically Bella Bird, Country Director for Tanzania, Burundi, Malawi, and Somalia, and Magda Lovei, Practice Manager, Environment and Natural Resources GP.

¹A geo-portal information system with a virtual library referencing the existing data and documents related to the environment and natural resources sector in Burundi was established in March 2014 with the help of three local NGOs in charge of collecting relevant environmental information in the field. See <http://bi-risk.pigeo.fr>.

Acronyms and Historical Exchange Rate

ADB	Asian Development Bank
ALRI	acute lower respiratory illness
BIF	Burundian Francs
CBA	cost-benefit analysis
CEA	Country Environmental Analysis
COED	costs of environmental degradation
COPD	chronic obstructive pulmonary disease
DALY	disability adjusted life year
DOE	Directorate of Environment
EIA	Environmental Impact Assessment
EM-DAT	Emergency Events Database
FAO	Food and Agriculture Organisation
FAOSTAT	Statistical database of the FAO, including AQUASTAT
GoB	Government of Burundi
GBD	Global Burden of Disease
GDP	gross domestic product
GHG	greenhouse gases
GIS	geographic information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
ha	hectare
HAP	household air pollution
ISTEEBU	Burundian Institute of Statistics and Economic Studies
MEEATU	Ministry of Water, Environment, Physical Planning and Urban Development
m	meters
mg/L	milligrams per liter
µg/m ³	microgram per cubic meter
µm	micrometer
MINAGRIE	Ministry of Agriculture and Livestock

NAPA	National Action Plan for Adaptation to Climate Change
NDC	Nationally Determined Contribution
NPV	net present value
OECD	Organisation for Economic Co-operation and Development
PA	protected area
PM	particulate matter
PPP	purchasing power parity
PRSP	Poverty Reduction Strategy Paper
RR	relative risk
SDG	sustainable development goal
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNISDR	United Nations Office for Disaster Risk Reduction
VSL	value of statistical life
WASH	water supply, sanitation and hygiene
WB	World Bank
WDI	World Development Indicators
WFP	World Food Programme
WHO	World Health Organization

Historical exchange rate (BIF/US\$)
2011: 1,261
2012: 1,443
2013: 1,555
2014: 1,547
2015: 1,572

Source: World Bank 2015a.

Executive Summary

Abstract

Over the past decades, Burundi's economic growth has relied on steady depletion of its natural capital, and as a result, the country's natural environment has been substantially degraded. The main driver of environmental degradation has been rapid population growth. In particular, to feed the growing population, substantial areas of forest have been cleared for agriculture, and poor agricultural practices have harmed soil fertility and integrity. Water resources have also been degraded, affecting several sectors and public health. In addition, biofuel burning continues to expose the population to severe indoor air pollution. In some cases, climate change is amplifying these consequences, particularly the frequency and severity of natural disasters. Without proper institutional arrangements in place, the environment has not been safeguarded from the expansive forces. Further, environmental degradation and resulting resource scarcity have led to conflicts, and, in turn, conflict and fragility have aggravated environmental degradation.

With the government of Burundi, the World Bank has undertaken this Country Environmental Analysis (CEA) as a first step to help Burundi transition toward inclusive and sustainable development. This report begins by discussing the fundamental context and conditions of environmental problems that must be taken into consideration. The CEA then describes the main forms of environmental degradation observed in Burundi. This report attempts to measure the extent of degradation in monetary terms to demonstrate the economic impact and cost of environmental deterioration. The report finds a geographical overlap regarding the concentration of poverty and the degraded environment. Climate change will only exacerbate the situation, leaving the poor population more vulnerable to environmental shocks.

Finally, the report then offers sets of recommendations relative to the diagnosis presented in the first part of the report. Overall, the CEA stresses the importance of a holistic approach at the landscape level to address environmental problems and build the resilience of the environment and the communities. Favoring practical and simpler options, the report presents programs to address deforestation, land degradation, indoor air pollution, water pollution, and natural disaster management in the face of global climate change. These suggested policy programs may be implemented through a combination of state-led initiatives and a community-based, bottom-up framework. These recommendations also serve the country's preparation for implementation of Nationally Determined Contribution (NDC) toward climate change mitigation and adaptation.

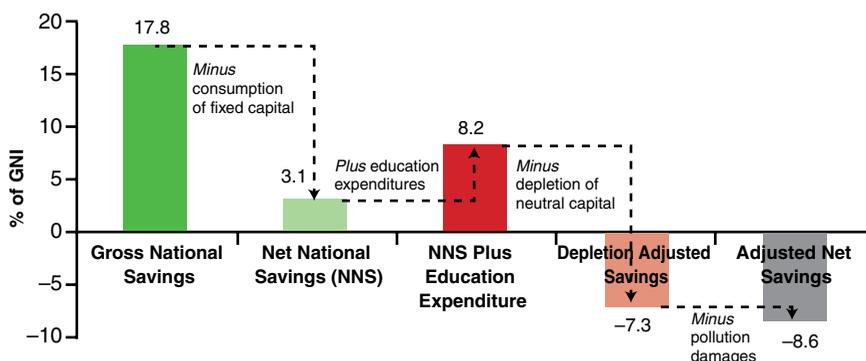
Extended Summary

Nature of Environmental Problems in Burundi

Burundi is a small, landlocked country. The country is endowed with valuable natural assets. In particular, abundant rainfall, a dense river network, fertile arable land, productive marshlands, and freshwater lakes generate a range of ecosystem services, as well as directly support the lives and livelihoods of the population. Its economy is dominated by small-scale agriculture, which employs 90 percent of the population, though cultivable land is extremely scarce.

The country has been suffering from pervasive environmental problems. With the rapid population growth, which averaged over 3.3 percent per year over the past two decades, the pressure on natural resources has increased considerably. The resulting extreme population density and overwhelming reliance on the agricultural sector to absorb the additional population have both caused new and exacerbated existing environmental degradation. In addition, the fragility of the country has prevented it from implementing environmental safeguards. Since the early 1990s, Burundi has experienced periods of repetitive sociopolitical tensions characterized by violent conflicts within the population, resulting in a weakened government capacity, and positioning the country as a fragile state, one of poorest in the world.

The dependence of Burundi's economic expansion on natural capital and how it is depleting that capital can be seen in some macroeconomic statistics. The economy of Burundi grew at an average annual rate of over 4 percent over the past two decades. However, due to rapid population growth, the economy has not been growing on a per capita basis. In real terms (in 2010 U.S. dollars [USD]), the per capita gross domestic product (GDP) has been more or less constant at around US\$215 since the latter half of the 1990s. In Burundi, much of the overall GDP increase has been supported by savings or the existing capitals in various forms, namely physical, financial, human/social, and natural capitals, rather than investing in those capitals to support income generation for the long term. That is, the current economic expansion of Burundi is unsustainable.

Figure ES.1. Burundi's Adjusted Net Savings, 2013 (as percentage of GNI)

Source: World Bank, World Development Indicators 2016.

Figure ES.1 illustrates this point. In 2013, the gross national savings (GNS) of Burundi was 17.8 percent of gross national income (GNI), while the net national savings (NNS) was 3.1 percent of GNI, reflecting the consumption of fixed (physical) capital (14.7 percent of GNI). In the conventional national accounts, therefore, the figure suggests that Burundi managed to save (that is, invest in future consumption) 3.1 percent of its income in 2013. The other three columns in Figure ES.1 result from adjustments in savings figures due to changes in the quantity and quality of intangible (human and social) capital and natural capital. According to the statistics found in the World Development Indicators 2016, Burundi managed to invest, in net terms, 5.2 percent of its GNI in the form of education expenditures to build its human/social capital. On the other hand, Burundi lost the value of its natural capital due to depletion of natural resources (equivalent to 15.6 percent of GNI) and pollution damages (1.3 percent of GNI). Overall, Burundi depleted the country's capitals in 2013, equivalent to 8.6 percent of GNI.

Country Environmental Analysis

It is clear that Burundi needs to halt the unsustainable expansion path based on the depletion of natural capital and find a new and sustainable development trajectory. Consequently, it was determined that the government of Burundi (GoB) would benefit from a Country Environmental Analysis. This CEA will:

- describe key environmental problems, analyze their causes, and discuss the physical and economic extent of associated losses;
- evaluate the institutional and financial capacity of the GoB in addressing these challenges; and
- present a set of recommended programs to address priority environmental problems.

These recommended programs may be implemented through a combination of state-led initiatives and a community-based, bottom-up framework. These recommendations also serve the country's preparation for implementing the Nationally Determined Contribution (NDC) toward climate change mitigation and adaptation.

Context of Environmental Problems

Before the analysis of specific problems, the CEA discusses several issues that fundamentally influence the extent and the consequences of Burundi's environmental problems. Rapid **population growth**, **fragility** due to conflict and political instability, and **climate change** act as both drivers and amplifiers of environmental problems. Addressing these issues certainly will have positive impacts on the environmental problems discussed in this report. In particular, the successful implementation of actions to mitigate and adapt to climate change as laid out in Burundi's NDC is a commitment to the global community, while some of those actions also form the recommended programs of the CEA. Although the CEA does not directly discuss solutions to address these underlying issues, the discussions presented in the report reference the issues, as they define the context and conditions of environmental problems and the effectiveness of their solutions.

Key Environmental Problems

Overall, the CEA has identified six key environmental problems as summarized in Table ES.1. The table also lists their major causes and consequences. These problems are overlapping and intertwined, with one problem being a cause or consequence of another. The first two problems, **deforestation** and **land degradation**, pertain to changes in rural land vegetation cover and their quality. These two problems overlap because, while forested areas are typically converted into agricultural lands, the latter are subsequently degraded due to poor agricultural practices. **Indoor air pollution** that is the result of households' use of "dirty" fuel for cooking is a serious problem; it causes death for many Burundi people each year and increases demand for fuelwood, a major reason for tree cutting by households. Activities related to agriculture are also a major cause of **water pollution**. In addition, inadequate sanitation infrastructure leads to contamination of Burundi's freshwater sources. While a **natural disaster** is by definition a natural phenomenon, the extent of the damages is aggravated by the compromised resilience of the environment, especially that due to deforestation and land degradation. All of these problems pose a threat to the integrity of the environment. The **loss of biodiversity** in particular threatens the health of the ecosystem and the lives and livelihoods of people who depend on it.

Cost of Environmental Degradation

To demonstrate the extent of environmental issues in Burundi, this report includes the estimated cost of environmental degradation (COED). The total

Table ES.1. Key Environmental Problems in Burundi

<i>Problems</i>	<i>Major Causes^a</i>	<i>Major Consequences</i>
Deforestation	<ul style="list-style-type: none"> • Population growth • Clearing for agriculture, residence 	<ul style="list-style-type: none"> • Reduced provision of forest products • Loss in biodiversity and other ecosystem services • Soil erosion, severer damages of natural disasters
Land degradation	<ul style="list-style-type: none"> • Intensive cropping without adequate management practices • Cropping on steep hills without erosion control • Uncertainty of land tenure regime 	<ul style="list-style-type: none"> • Agricultural productivity loss • Loss in biodiversity and other ecosystem services • Soil erosion, severer damages of natural disasters
Indoor air pollution	<ul style="list-style-type: none"> • Indoor cooking with • “Dirty” fuel • Insufficient ventilation 	<ul style="list-style-type: none"> • Compromised public health • Deforestation • Greenhouse gas (GHG) emission
Water pollution	<ul style="list-style-type: none"> • Poor sanitation • Insufficient implementation of regulations, especially agricultural processing (for example, palm oil, coffee) 	<ul style="list-style-type: none"> • Compromised public health • Compromised health of aquatic wildlife • Scarcity of safe drinking water
Natural disaster	<ul style="list-style-type: none"> • Drought (exacerbated by climate change) • Flood, landslide (exacerbated by soil erosion, climate change) 	<ul style="list-style-type: none"> • Physical damage to environment • Physical damage to infrastructure • Loss of lives and livelihoods
Biodiversity loss	<ul style="list-style-type: none"> • Deforestation, land degradation, air pollution, water pollution, and natural disaster 	<ul style="list-style-type: none"> • Compromised ecosystem health • Loss in vital genetic diversity • Loss in ecosystem services

Source: Authors' compilation.

^a Weak policy framework and implementation applies to all problems.

annual COED is estimated at about US\$376 million, or 12.1 percent of the country's GDP in 2014. Significant public health losses and losses associated with natural resources degradation in Burundi are noted. The largest damages are caused by deforestation and land degradation (32 percent), water pollution (31 percent), and indoor air pollution (30 percent). These respectively correspond to an economic loss of 4.0 percent, 3.8 percent, and 3.6 percent of GDP in 2014.

The COED estimates represent a substantial underestimation and are interpreted as such. Only selected aspects of environmental costs could be included in the calculation of each environmental problem due to data limitations. The estimated costs would substantially increase if the calculations included, for example, the value of lost timber and non-timber forest resources, lost ecosystem services due to land degradation, impacts of water pollution on aquatic ecosystems, the cost of GHG emissions by households, and the cost of

landslides that are associated with anthropogenic failures. Continued efforts to refine these estimates are warranted. Nonetheless, the cost estimates presented in this CEA, along with an earlier estimate of “cost of inaction” against land degradation,² can serve as the basis of future policy discussions to reduce pressures and damages on the country’s natural resources.

Environmental Policies and Institutions

In Burundi, the Ministry of Water, Environment, Physical Planning and Urban Development (MEEATU) is mandated to administer and regulate environmental management and protection. It has multifaceted mandates, including the development and implementation of national policies, laws, and regulations in the fields of water, environment, land management, and urbanization. The Burundi Environment Protection Office (OBPE), established in 2014 under the trusteeship of MEEATU, has a broad mandate ranging from the enforcement of all environment protection-related legislation to the monitoring of international trade in flora and fauna, or to establishment of environmental standards and norms including safeguards for the protection of nature. This wide-ranging set of mandates and responsibilities requires resources, which the OBPE seems to lack thus far.

There have been substantial achievements in Burundi’s institutional and legal framework since 1980. Most importantly, the Environmental Code of Burundi (ECB), enacted in 2000, constitutes a framework dealing with all major aspects of environmental protection and management. The decree on Environmental Impact Assessment (EIA) issued in 2010 specified the content, rules, principles and procedures for EIA, which was further completed through a ministerial order on the scoping in the EIA process in Burundi. Despite progress made on Burundi’s institutional, legal, and regulatory framework for environmental management, more needs to be done to effectively and efficiently deal with environmental challenges. Notably, the technical and financial capacity of MEEATU, especially of OBPE, must be strengthened at the national and local levels.

To assess Burundi’s financial capacity to implement environmental management and protection practices, a **public environmental expenditure review** (PEER) was conducted. The review shows that the current level of public environmental expenditures is too weak to help reverse environmental degradation, which is estimated to cost US\$376 million each year. As Burundi’s total expenditures go beyond its domestic financing capacity, the country has a structural budget deficit and a dependence on donors, resulting in an imbalance between economic services (20 percent of the budget over 2006–14) and general services (35 percent).

²MEEATU, *Étude sur les coûts de l'inaction contre la dégradation des sols au Burundi*, Bujumbura, government of Burundi, 2011.

Environmental expenditures are far from being a priority in budgetary tradeoffs. Expenditures managed by the MEEATU—covering the water, environment, land-use planning, and urban sectors—varied between 2010 and 2016, but their budget share remains below 2 percent, except in 2013 when it reached 3.5 percent. Over the 2010–16, the average share of environmental expenditures in the government’s budget was 1.6 percent. This is in line with the average figure for Botswana during 2006–11 (1.6 percent), but less than that for Eastern African countries, such as Rwanda during 2009–13 (1.9 percent) and Mozambique during 2007–10 (4.3 percent).

Recommendations and a Way Forward

Overall, four key messages have emerged from the CEA.

- The CEA reiterates the importance of addressing the fundamental issues—population growth, conflict and fragility, and climate change—as they define the context and conditions of environmental problems and the effectiveness of their solutions.
- Both causes and consequences must be addressed. Where the effects of environmental damages are acute and threaten lives and livelihoods, physical restoration is a priority. The causes of the problems must also be addressed at the same time to prevent further damages and to reverse the degradation trend.
- As many of the identified problems occur on rural landscapes, it is useful to adopt a holistic approach that considers intricate linkages at the landscape level, with a focus on building the resilience of the environment and the communities. Note also that the environmental problems cut across various



sectors of the economy, particularly, the agriculture, public health, energy, and infrastructure-related sectors.

- Complementarity of state-led initiatives and community-based programs should be leveraged, while ensuring enabling conditions for value chain development likely will help catalyze some necessary changes.

The CEA identified several priority programs for the major causes and consequences of environmental problems summarized in Table ES.1. Recommended programs are discussed in three dimensions: technical, behavioral, and policy/institutional (Table ES.2).

Table ES.2. Summary of Recommended Programs to Address Environmental Problems in Burundi

<i>Recommended Programs</i>			
<i>Problems</i>	<i>Technical</i>	<i>Behavioral</i>	<i>Policy/Institutional/Tool</i>
Deforestation, land degradation	<ul style="list-style-type: none"> • Erosion control • Sustainable agricultural practices • Improved forest management 	<ul style="list-style-type: none"> • Study on constraints/motivation for investment in land • Value chain development 	<ul style="list-style-type: none"> • Land certification • Restoration opportunities assessment methodology (ROAM)
Indoor air pollution	<ul style="list-style-type: none"> • Ventilation (installation of windows) • Cleaner cooking technologies (fuel, stove, pots) 	<ul style="list-style-type: none"> • Awareness raising • Value chain approach (development and distribution of fuel, stove, pots) 	<ul style="list-style-type: none"> • Enabling conditions for cleaner cooking development and adoption • Cleaner and renewable energy development (propane, biogas, solar, hydropower)
Water pollution	<ul style="list-style-type: none"> • Hygiene/sanitation technologies 	<ul style="list-style-type: none"> • Hygiene education 	<ul style="list-style-type: none"> • Water supply and sanitation (WSS) sector services
	<ul style="list-style-type: none"> • Water-saving technology in agro-industrial processing 	<ul style="list-style-type: none"> • Value chain development • Community participatory monitoring 	<ul style="list-style-type: none"> • Regulation of agro-industrial plants • Environmental Impact Assessment (EIA)
Climate change, natural disasters	<ul style="list-style-type: none"> • Technologies of adaptation and response • Household income/asset diversification 	<ul style="list-style-type: none"> • Study on household income/asset diversification • Study on risk and insurance 	<ul style="list-style-type: none"> • Implementation of Nationally Determined Contribution (NDC) • Disaster risk management (DRM) tools

Source: Authors' compilation.

Nature of Environmental Problems in Burundi

Introduction

Burundi is a small, landlocked country situated in the eastern part of the Great Lakes Region of Central Africa. It is home to over 10 million people living within 27,834 square kilometers (km²). Of this area, 25,200 km² are terrestrial, while the remaining 2,000-plus square kilometers are within the territorial waters of Lake Tanganyika. Burundi is bordered to the north by Rwanda, to the west by the Democratic Republic of Congo, and to the south and east by Tanzania. The economy of Burundi is dominated by small-scale agriculture, which employs 90 percent of the population, though cultivable land is extremely scarce.

Burundi is endowed with valuable natural assets. In particular, its abundant rainfall, dense river network, fertile arable land, productive marshlands, and freshwater lakes generate a range of ecosystem services, as well as directly support the lives and livelihoods of the population. The country's hydrological system contributes to two transboundary catchments: the Nile Basin and the Congo Basin. Burundi is home to key biodiversity hotspots in the Rift Valley. The Kibira National Park is one of the last remaining intact stretches of Afromontane forests in the region. The Ruvubu National Park is a unique region of woodlands and savannah and related fauna. The Northern Aquatic Landscape (Lacs du Nord) is an important habitat for migratory birds. Lake Tanganyika is one of the largest lakes in the world, with at least 1,500 species of wildlife, 600 of which are endemic.¹ Burundi is also part of the Lake Victoria Basin with Kenya, Rwanda, Tanzania, and Uganda. The world's second largest freshwater body, Lake Victoria is a shared natural resource; its water and fish stocks freely cross national boundaries.

However, Burundi also suffers from pervasive environmental problems. Over the past decades, substantial areas of forest have been cleared for agriculture, and subsequent poor agricultural practices have harmed soil fertility and integrity on those lands. Water

¹Lake Tanganyika Authority, http://Ita.iwlearn.org/thelake_and_basin.

resources have also been degraded, affecting several economic sectors and public health, and the population has also been exposed to severe air pollution due to the indoor burning of fuelwood. The fragile soil integrity of the deforested or degraded lands triggers and amplifies the severity of natural disasters such as flooding and landslides. The frequency and severity of extreme weather events, such as storms and droughts, in turn, are escalating due to global climate change.

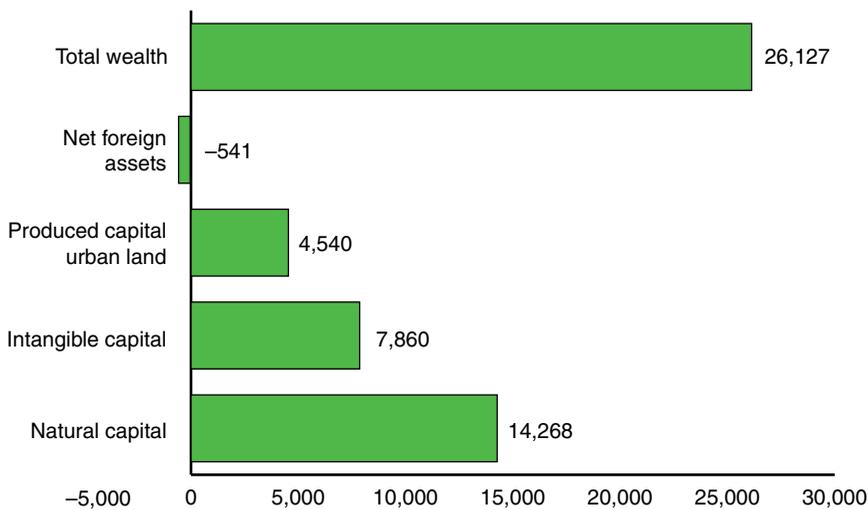
It is important to understand the context in which these environmental problems occur. Rapid population growth, which averaged over 3.3 percent per year over the past two decades, is fundamentally affecting the resource–population balance in Burundi. In particular, the resulting extreme population density and overwhelming reliance on the agricultural sector have resulted in the degradation of land resources. In addition, political instability of the country has prevented the necessary environmental safeguarding. Since the early 1990s, Burundi has experienced periods of repetitive sociopolitical tensions characterized by violent conflicts within the population, resulting in weakened government capacity and positioning the country as a fragile state and one of the poorest in the world. Another compounding factor is climate change, which affects the frequency and severity of natural disasters.

Economic Expansion Based on Natural Capital Depletion

The economy of Burundi grew at an average annual rate of over 4 percent over the past two decades.² In particular, real gross domestic product (GDP) growth in 2014 was estimated at 4.7 percent. This rapid growth was mainly due to a surge in coffee production and a dynamic construction sector implementing large-scale infrastructure projects, such as fiber optics and roads (AfDB 2015). However, due to the rapid population growth, on a per-capita basis, the economy has not been growing. In real terms (in 2010 U.S. dollars), the per-capita GDP has been more or less constant around US\$215 since the latter half of the 1990s.

As is typical in low-income countries, the economy of Burundi relies heavily on natural capital and human capital for income generation, while the importance of produced capital is expected to increase as the economy grows and transitions to a middle-income country. According to the latest update of the World Bank report *The Changing Wealth of Nations* (World Bank 2011b), the total wealth of Burundi, defined as the aggregate of all of the country's assets, was US\$26 billion in 2011. Of the total wealth, natural capital represented 55 percent, while intangible, human, and social capital represented 30 percent (Figure 1.1). These assets are what underpin the income that the nation

²At the average annual rate of 4.2 percent during 1996–2000, 4.0 percent in 2001–05, 4.6 percent in 2006–10, and 4.7 percent 2011–15 (World Bank 2015a).

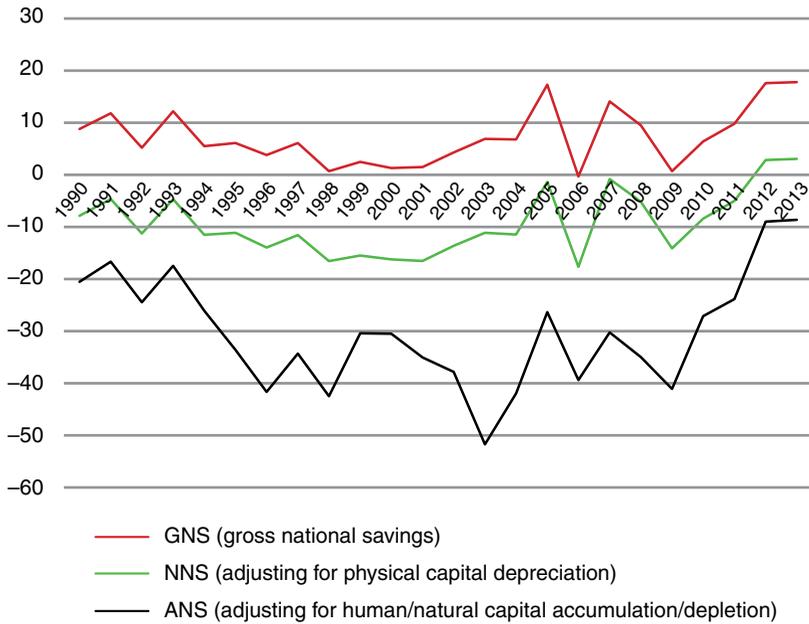
Figure 1.1. Structure of Total Wealth in Burundi, 2011 (in millions of 2010 U.S. dollars)

Source: World Bank forthcoming.

generates. Accumulating wealth is to invest in the future welfare of the nation, and a country's development path depends crucially on how wealth changes over time, both in terms of the total volume and the composition of assets. Given the importance of natural capital in Burundi's economy, recognizing the value of natural capital and appropriately managing it is extremely important.

However, Burundi's wealth has not been managed sustainably. More precisely, much of the increase in the country's overall GDP has been supported by depleting the country's existing capitals, in particular, natural capital, rather than investing in the accumulation of capitals to support income generation for the long term. Figure 1.2, generated based on the data from the World Development Indicators (WDI) 2016, illustrates this point. Burundi has managed to maintain positive gross national savings (GNS) since the 1990s (see Figure 1.2). But the gross savings have been insufficient to compensate for the depreciation of physical capital, and as a result, the net national savings (NNS) were negative until 2012. The series ANS (adjusted net savings) represents the result of further adjustments of these traditional national accounts series for investment (accumulation) and disinvestment (depletion) in other capitals, such as human and natural capitals. Figure 1.2 clearly shows that ANS has been consistently negative, indicating that the economy is depleting, rather than accumulating, the nation's wealth.

Figure 1.2. Savings in Burundi, 1990–2013 (as a percentage of GNI)

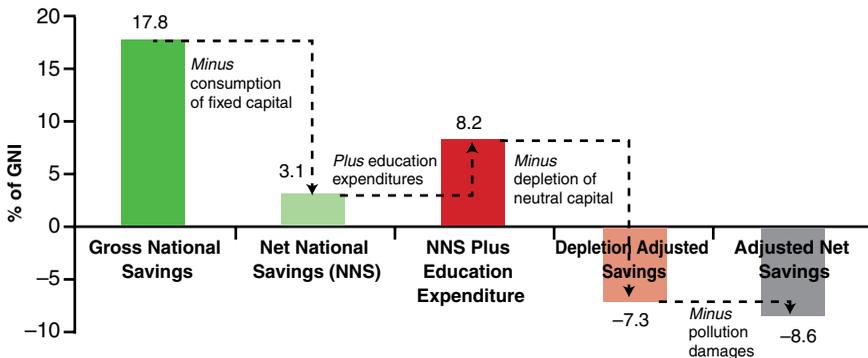


Source: World Bank 2016d.

Notes: GNI: gross national income; GNS: gross national savings; NNS: net national savings; ANS: adjusted net savings.

Figure 1.3 illustrates the composition of Burundi’s savings in the most recent year for which data are available. In 2013, the GNS of Burundi was 17.8 percent of gross national income (GNI), while NNS was 3.1 percent of GNI, with the consumption of fixed (physical) capital (14.7 percent of GNI) accounting for the difference. In the conventional national accounts, therefore, Figure 1.3 suggests that Burundi managed to save 3.1 percent of its income in 2013 to invest in capital formation for future consumption. The other three columns in Figure 1.3 show the results from the adjustments in savings figures due to

Figure 1.3. Burundi’s Adjusted Net Saving, 2013 (as percentage of GNI)

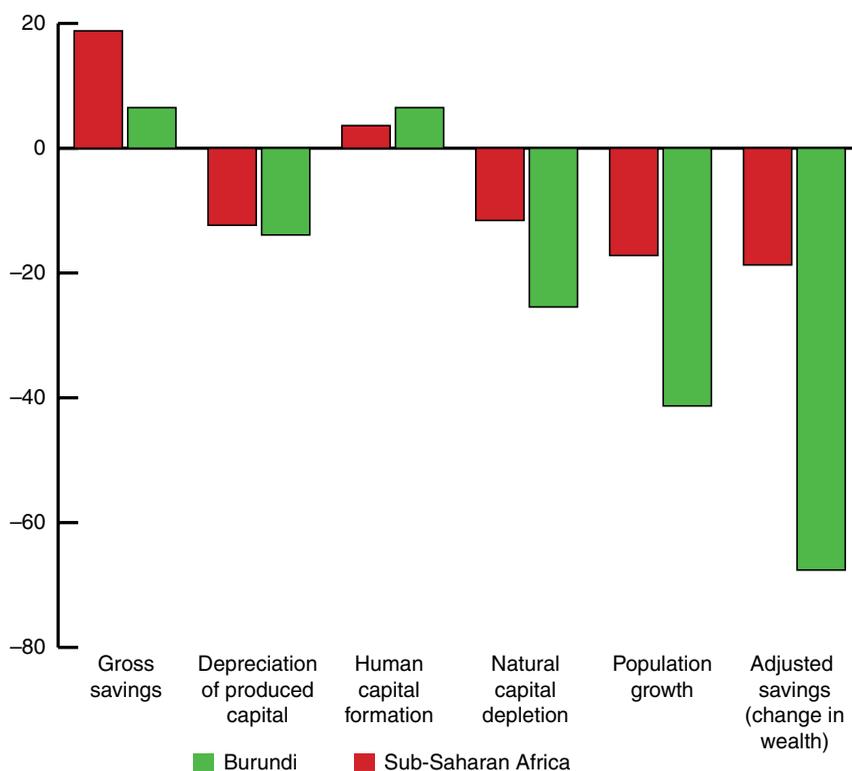


Source: World Bank 2016c.

changes in the quantity and quality of intangible (human and social) capital, natural capital, and pollution. Burundi managed to invest, in net terms, 5.2 percent of its GNI in the form of education expenditures to build its human and social capital. On the other hand, Burundi lost the value of its natural capital due to depletion of natural resources (equivalent to 15.6 percent of GNI) and pollution damages (1.3 percent of GNI). Overall, Burundi depleted the country's capitals by the equivalent of 8.6 percent of its GNI in 2013.

In the face of the rapid population growth, the continued depletion of natural wealth means that increasingly smaller wealth is available per capita. According to the data from the World Development Indicators 2016, per capita wealth in Burundi has been shrinking by US\$100–200 each year.³ Figure 1.4 illustrates the composition of Burundi's savings in 2010 on a per capita basis. Even though the gross savings and education expenditure (for human capital formation) were positive on a per capita basis, depletion of natural

Figure 1.4. Change in Wealth per Capita Components, 2010 (as a percentage of GDP per capita)



Source: Authors' calculations and World Bank 2016d.

³The calculation is based on the following formula: *change in wealth per capita = gross saving – consumption of fixed capital + education expenditures – natural capital depletion – population adjustment.*

capital, combined with population growth, pulled down the adjusted “negative savings” per capita, that is, reduction of wealth per capita, to an equivalent of 67.6 percent of the GDP per capita. This percentage starkly contrasts with the Sub-Saharan Africa average, where the wealth per capita also declined in 2010, but only by an equivalent of 18.7 percent of GDP per capita.

In summary, over the past decades, Burundi’s economic expansion has relied on the steady depletion of its natural capital. The main driver of the environmental degradation has been rapid population growth compounded by widespread poverty, as the poor often do not have means to rely on other than natural resources for food and incomes. Without proper institutional arrangements in place, the environment has not been safeguarded from the expansive forces. Further, conflicts that have plagued the country on and off over the decades have prevented the effective implementation of environmental and natural resource management policies.

Burundi’s Overall Environmental Performance

Burundi’s environmental performance is weak when compared to the Sub-Saharan African standard, according to the Yale Environmental Performance Index (EPI).⁴ The EPI ranks countries’ performance on high-priority environmental issues in two areas: protection of human health and protection of ecosystems. Within these two policy objectives, the EPI scores national performance in nine issue areas (Health Impacts, Air Quality, Water & Sanitation, Water Resources, Agriculture, Forests, Fisheries, Biodiversity & Habitat, and Climate & Energy), which include more than 20 indicators (Figure 1.5). Figure 1.6 compares the EPI scores of selected countries.⁵ According to the figure, in 2016, Burundi ranked 168th of 180 countries, with a score of 43.37, where the maximum score is 100. Burundi is only followed by Mozambique (with a score of 41.82 and a rank of 172) among Southeastern African countries, and Burundi scores nearly 10 points below the Sub-Saharan Africa’s average score of 53.29.

Country Environmental Analysis

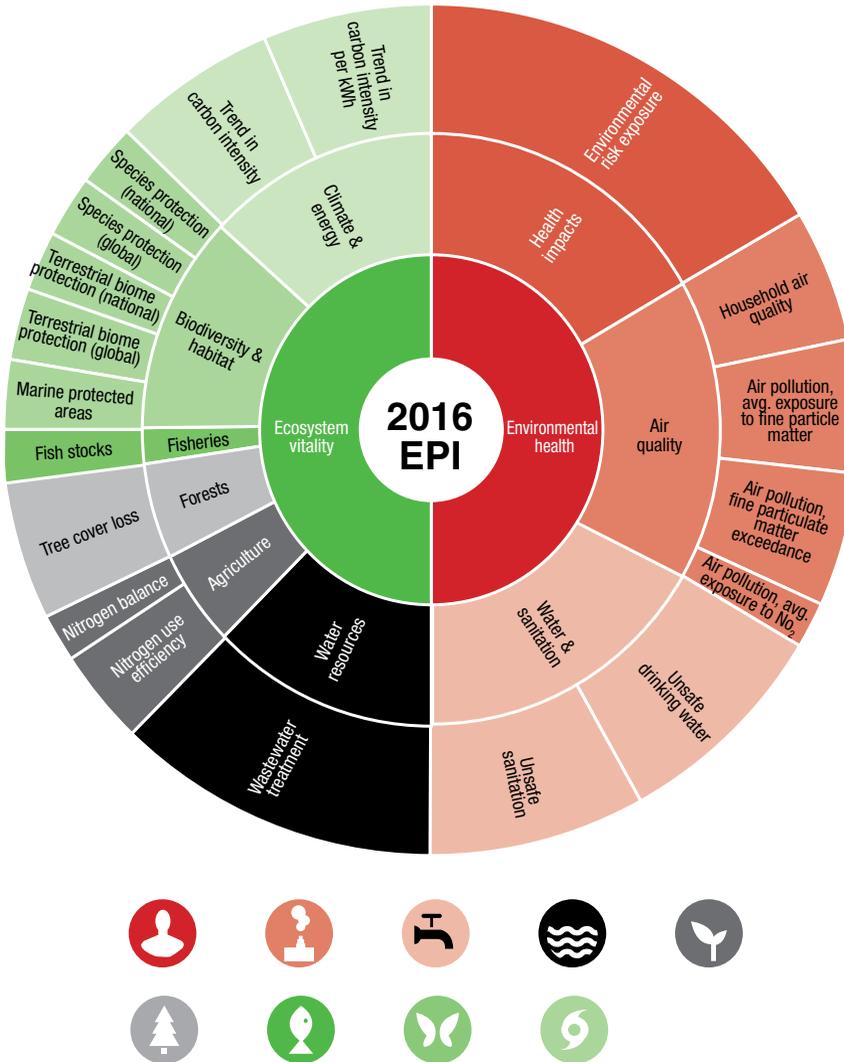
It has become clear that Burundi needs to halt its unsustainable expansion path based on the depletion of natural capital and find a new and sustainable development trajectory. Consequently, it was determined that the government of Burundi (GoB) would benefit from a Country Environmental Analysis (CEA). A CEA is a country-level systematic, diagnostic analysis of the environment with the following aims:

- integrating environmental considerations into national development assistance strategies and programs;

⁴The EPI was developed by Yale University, and the data are accessible at <http://epi.yale.edu/data>.

⁵To calculate the EPI, raw datasets are transformed into comparable performance indicators, which requires standardizing raw values according to population, land area, GDP, and other common units of measurement. Statistical transformations are then performed to normalize data distributions. Country scores are determined by how close or far countries are to an identified policy target. Scores are therefore standardized (that is, on a scale of 0 to 100) for comparability, weighting, and aggregation.

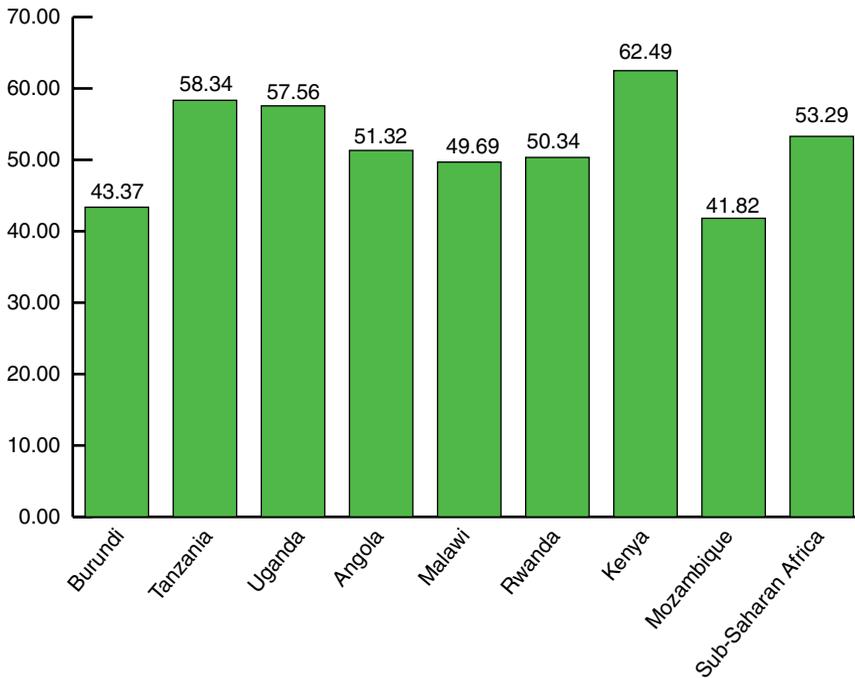
Figure 1.5. Yale Environmental Performance Index Issue Areas and Indicators



Source: Yale University, Environment Performance Index 2016 Report, 2016.

- opening avenues for upstream discussion of key cross-sectoral policy issues behind a country’s environmental challenges; and
- guiding capacity building and institutional reform efforts.

In addition to its original analysis, a CEA also draws heavily on existing work on sustainability and environmental indicators and analyses conducted by the countries and various development partners.

Figure 1.6. EPI cores across Selected Countries, 2016 (out of 100)

Source: Yale University 2016.

CEAs inform World Bank operations toward achieving the goals of the World Bank Group: ending extreme poverty—reducing the share of the global population living in extreme poverty to 3 percent by the year 2030—and promoting shared prosperity—increasing the income of the bottom 40 percent of the population in each country—*in a sustainable manner*.

Objective of Burundi CEA

As a first step toward finding a new and sustainable development trajectory of Burundi, this CEA will:

- describe key environmental problems, analyze their causes, and discuss the physical and economic extent of associated losses;
- evaluate the institutional and financial capacity of the GoB in addressing these challenges; and
- present a set of recommended programs to address priority environmental problems.

These recommended programs may be implemented through a combination of state-led initiatives and a community-based, bottom-up framework. These recommendations also serve the country's preparation for implementation of

Nationally Determined Contribution (NDC) toward climate change mitigation and adaptation.

To achieve the objectives, this CEA employed a combination of methods, including desk reviews of existing literature, collecting of primary and secondary data, and conducting original analysis. The CEA faced severe limitations due to the inability for the team to conduct field visits because of the political crisis that took place during the project period and due to the general lack of data and their poor quality. The difficulties were partially overcome through the innovative information collection process of “crowd sourcing” as described in Chapter 2.

Relevant Documents Foundation

The CEA builds on the GoB’s environment and natural resources management strategies and studies financed by the World Bank and other development partners. Key strategies conducted by the GoB are the following:

- Action Plans to Combat Land Degradation (2013)
- Action Plan to Strengthen National Capacities for Risk Reduction, Preparation, and Response to Emergencies (2013–2016)
- NAPA (2007)
- Intended Nationally Determined Contribution (INDC) (2015)
- Readiness Preparation Proposal (2014).

These strategies would allow the country to develop a Reducing Emissions from Deforestation and Forest Degradation (REDD+) Strategy to address the causes of deforestation and forest degradation. The CEA incorporates analysis from the study on *The Costs of Inaction against Land Degradation in Burundi* (conducted by GoB and GIZ in 2013). The CEA also builds on the *Burundi Vulnerability Assessment—Deprivation, Vulnerability and Inequality of Opportunity* (World Bank 2014b) which assesses the extent to which the country’s recent economic performance, together with the stabilization of the political context, has had a positive effect on the living conditions of Burundi households, especially the poorest. Finally, the CEA relies on the *Burundi Poverty Assessment* (World Bank 2016), which provides a diagnostic of poverty and inequality in Burundi and brings new evidence to better inform policies to alleviate poverty and ensure equity.

Structure of the Report

This report has four chapters. The remainder of chapter 1 discusses the fundamental context and conditions of environmental problems that must be considered when addressing specific environmental problems. Chapter 2 describes the environmental problems that were identified through stakeholder consultations as the most pressing and serious. The chapter also presents estimated costs associated with the identified environmental problems. Chapter 3 describes and assesses the governance and institutional arrangements for

environment and natural resource management in Burundi and presents the results of the public environmental expenditure review (PEER) conducted for the CEA. Finally, Chapter 4 presents a set of recommended programs.

Context of Environmental Problems

While some issues are not environmental problems *per se*, there are several issues that fundamentally influence the extent and the consequences of Burundi's environmental problems. The rapid population growth, fragility due to conflict and political instability, and climate change act as both drivers and amplifiers of environmental problems. In other words, addressing these issues certainly will have positive impacts on the environmental problems discussed in this report. While the CEA does not directly discuss solutions to address these issues, the discussions presented in the later chapters cannot be made without referencing these issues, as they define the context and conditions of environmental problems and the effectiveness of their solutions.

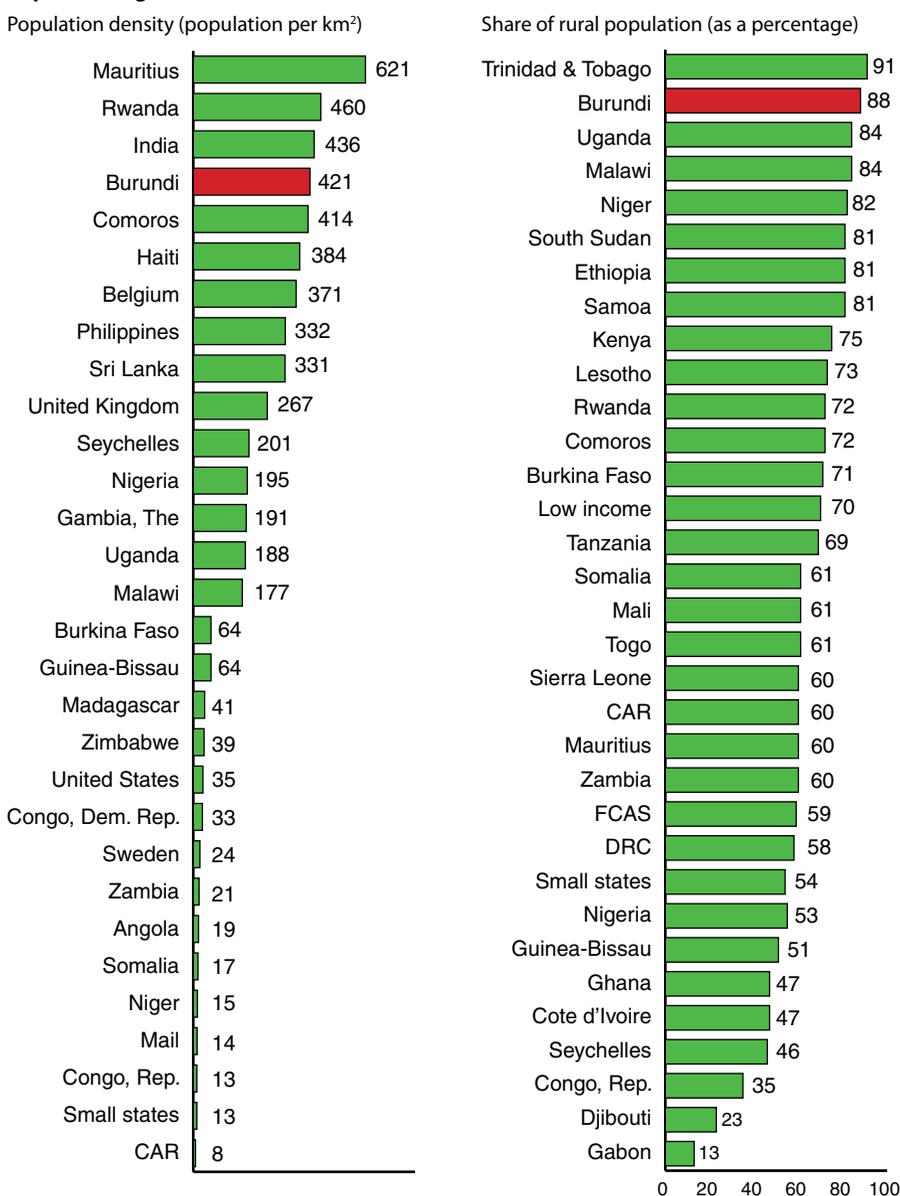
Population Growth

As mentioned earlier, Burundi's population has been increasing at an alarming pace, averaging growth higher than 3.3 percent per year over the past two decades. In addition to depressing the per capita growth rate figure of the overall economy, the rapid population growth in the small country has resulted in an extremely high population density. As seen in Figure 1.7, Burundi's population density is comparable to that of India. With slow urbanization, almost 90 percent of the population resides in rural areas in Burundi. This in turn has resulted in substantial pressures on rural natural resources. In particular, as



the rural population depends on agriculture for livelihoods, the pressures on forests and agricultural lands have been substantial. As the population grew, forests were cleared for agricultural production, both cropping and livestock. Subsequently, agricultural lands were divided and fragmented to absorb the ever-growing rural labor force, prohibiting the exploitation of scale economies.

Figure 1.7. Benchmarking of Burundi's Population Density and Share of Rural Population against Selected Countries, 2014



Source: World Bank 2016d.

Additionally, because of the intensive use of the crop and grazing lands without proper management practices and measures, the lands are becoming increasingly less productive. Expansion of agriculture and associated processing activities has also increased water pollution. Together these factors are essentially reducing the availability of productive resources on a per capita basis.

Fundamentally, Burundi has reached the limit of its resource–population balance that would allow a sustainable expansion of the economy. With the forested area having declined to 6.6 percent of the country’s territory, there is virtually no more new land to bring under cultivation. It is clear that Burundi needs to halt the current path of unsustainable expansion that is based on depletion of natural capital and find a new and sustainable development trajectory. However, even with full utilization of advanced production technology and land management practices, improving agriculture alone would be insufficient to turn the direction of the country’s development trajectory. The country must address the rapid population growth, the economy must diversify, and the urban economy must grow.

Conflict and Fragility

There is a clear link between conflict and the environment. Violence could arise, for instance, due to competition over scarce natural resources, such as water, and conflicts may perpetuate when conflicted interest groups seize natural resources to be used as leverage. Many conflicts that have affected Africa for decades have caused environmental resources to decline and deteriorate, notably in the form of deforestation and overutilization of other resources, such as agricultural land, freshwater, and wild fish resources.⁶

The Great Lakes Region has incurred a number of complex and interrelated conflicts, with great impacts on the regional ecosystems. In particular, since its independence in 1962, Burundi has been marred by successive waves of political conflicts: it has suffered three civil conflicts, eight attempted coups, and two genocides. The most devastating conflict, fueled by neighboring countries’ instability, lasted from 1993 to 2005. Violence escalated again in 2015, which has led to the forced migration of 200,000 people and the death of hundreds of Burundians since June 2015 (Human Rights Watch 2016). Though the concrete impacts on the environment of the 2015–16 events would need further investigation, one may estimate, based on recent conflict history, that migration, scarcity of land, and loss of economic activities will be particularly detrimental to the environment and natural resources. Indeed, hectares (ha) of high-altitude forest would be cut down for fuelwood and timber by internally displaced persons, which would also cause negative impacts on ecologically fragile hillsides. Plantation forests would be either damaged or destroyed during the conflict and the immediate aftermath (Kairaba 2002). At some point, hundreds of thousands of refugees will return to Burundi from Tanzania and Rwanda, and this will add further pressure on land and the environment.

⁶International Environmental Law Research Centre 2005.

In Burundi, local-level conflicts over access to land and water are widely prevalent. For example, poor municipal and urban planning cause conflict between communities when valuable lands for cropping or livestock grazing are used for *ad hoc* construction. Mining, which is intensifying, may also aggravate conflict over resources as well as soil degradation and environmental damage. Poaching may increase in areas with limited land availability and few economic opportunities, especially in protected areas. There has been a veritable exodus of people from the countryside to the cities to find work, especially to Bujumbura. People have settled in slums with poor hygiene and services, leading to resentment and a source for antigovernment mobilization. While most of these local-level conflicts are solved peacefully by customary authorities, many turn violent. As resource scarcity severely increases in the face of rapid population growth, this local-level tension is likely to worsen in the future.

Climate Change

According to the studies conducted for the initial national communication on climate change, the average annual temperature in Burundi is expected to rise by 1°C to 3°C through 2050. Rainfall is estimated to increase by around 10 percent, and the precipitation regime will be disrupted such that there will be only two seasons remaining, each lasting six months: a rainy season from November to April, followed by a dry season.⁷ Another set of estimates that provides projections further into the future (years 2031–2100) indicates that effects of climate change on Burundi's future are expected to become even more severe (Table 1.1).

One crucial implication of the climate projections is their effect on agricultural productivity. While productivity is already compromised due to past poor soil management, the modification of the agricultural calendar due to climate change will likely further affect the crop yield and the quantity and quality of forage available for livestock. Further, climate change has already increased the intensity and frequency of natural disasters, such as drought, torrential rains, hail and violent storms, flooding and flash flooding, and landslides and mudslides. The climate projections would imply a further exacerbation of these problems.

While highly exposed to the effects of climate change, Burundi has extremely low capacity to respond in the case of severe climate shocks. Notre Dame Global Adaptation Index (ND-GAIN, 2014) measures countries' vulnerability and readiness to climate change (Figure 1.8). Vulnerability measures the exposure, sensitivity, and ability to cope with climate-related hazards by accounting for the overall status of food, water, environment, health, and infrastructure within a country. Readiness targets those portions of the economy, governance, and society that affect the speed and efficiency of adaptation. Overall, Burundi ranks 174th of 178 countries, which is slightly better than its ranking in 1995.

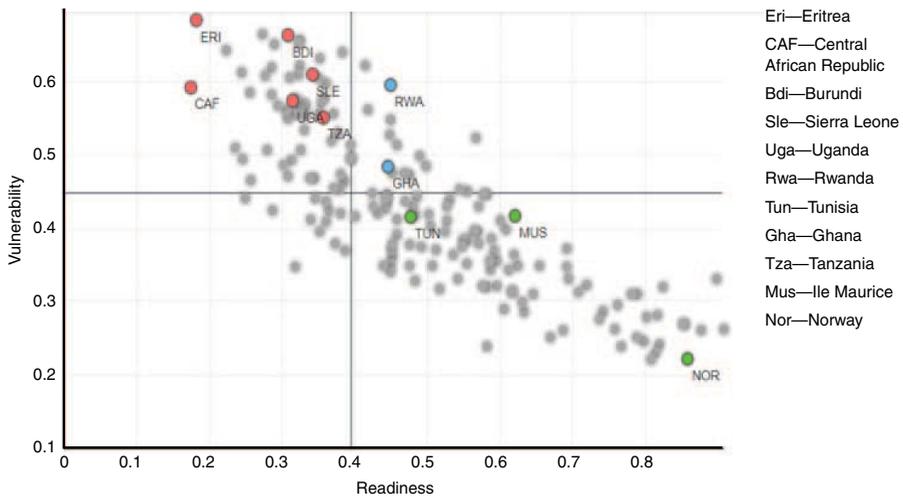
⁷Burundi's Second National Communication 2010.

Table 1.1. Climate Change Projections, 2031–2100

Projection	Direction of anticipated change (up/down)	2031–60	2071–2100	Comments
Average annual precipitation (during wet season)	↑	5.7–7.7 %	8.6–13.2 %	Pronounced impact in Congo–Nile highlands, central plateau, and east (depression)
Average annual precipitation (during dry season)	↓			
Length of dry season	↑			August/September, before onset of rainy season, to become drier
Average annual air temperature	↑	1.7–2.1°C	2.2–4.2°C	Highest increase is during the dry season
Risk of extreme rainfall	↑			Surplus of precipitation may cause extreme weather events
Agricultural production	↓			Cultivation is adversely affected by temperature, precipitation changes

Source: MEEATU/MINAGRIE.

Figure 1.8. Benchmarking Burundi’s Vulnerability and Readiness to Climate Change



Source: ND-GAIN 2014.

Burundi is the fourth most vulnerable country and the 20th least prepared country, meaning that it is extremely vulnerable to, yet very unprepared to, combat climate change effects.

Burundi submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC) prior to the 2015 Conference of the Parties 21 (COP21) held in Paris, France. Coming to now Nationally Determined Contribution (NDC), in terms of climate change mitigation, Burundi intends to cut greenhouse

Table 1.2. Burundi's Nationally Determined Contribution

Expected Reduction	Unconditional contribution	Reduction of GHG emissions by 3 percent compared to the business-as-usual scenario for 2030
	Conditional contribution	Reduction of GHG emissions by 20 percent, beginning in 2016, compared to the business-as-usual scenario for 2030
Baseline year		2005
Target year		2030
Total reduction in emissions by 2030		1,958 Gg CO ₂ e for the unconditional objective 14,897 Gg CO ₂ e for the conditional objective

Source: Republic of Burundi 2015.

Note: CO_{2e} = carbon dioxide equivalent.

gas (GHG) emissions by 3 to 20 percent by 2030, while in terms of adaptation, Burundi requests support in human, institutional, technical, and financial capacity building, as well as in technical and technology transfer (Table 1.2). The unconditional scenario of a 3 percent reduction of GHG emission is to be pursued through two efforts: (i) a National Reforestation Programme to reforest 4,000 hectares between now and 2030 to increase its carbon stock and (ii) the building of three hydroelectric power plants, which will increase the country's electrification rate to 35 percent. The conditional scenario of a 20 percent reduction, reliant on additional financing from the international community, would accomplish by 2030: (i) reforestation of 8,000 hectares per year, (ii) the replacement of the country's entire stock of charcoal kilns and traditional cook stoves, and (iii) a complete replacement of mineral fertilizers with organic fertilizers (Republic of Burundi 2015). A commitment to this intended contribution and implementation of actions to fight against climate change will have positive impacts on the environmental problems discussed in this CEA.



CHAPTER 2

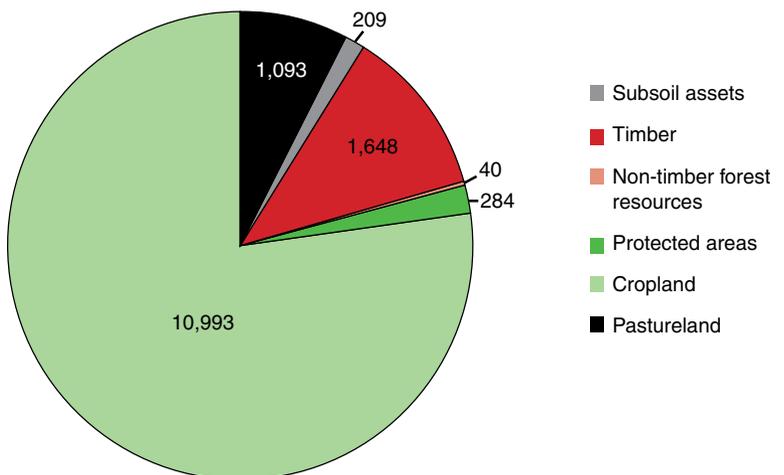
Key Environmental Problems

Introduction

As discussed in Chapter 1, much of the national wealth underpinning Burundi's economy is in the form of natural capital, which represents 55 percent of its national assets. Human capital is the second most important category (30 percent), while the conventional produced capital represents only 17 percent of the national wealth. The analysis in Chapter 1 also revealed that the natural capital has been under steady depletion. Overall, per capita wealth in Burundi has been shrinking by US\$100–200 each year. This chapter sheds light on the process of natural capital depletion, its consequences, and the economic costs associated with the change.

Figure 2.1 illustrates the composition of natural capital included in the calculation of the wealth of Burundi (World Bank 2011b). Almost all of Burundi's natural assets are in the form of rural lands

Figure 2.1. Composition of Natural Capital in Burundi, 2011 (in millions of 2010 U.S. dollars)



Source: World Bank 2016c.

with certain vegetation cover: forest, cropland, rangeland, and pastureland. Accordingly, much of this chapter discusses how seriously the rural land asset has been depleted and degraded.

Approach and Data

The CEA begins by identifying key environmental challenges, analyzing their causes or drivers, and discussing their consequences. The key environmental challenges were identified in consultation with a range of stakeholders. Key institutions were consulted at different stages of the process, including the staff of the central government, local officials, local development committees, civil society, private sector, academia, think tanks, media, trade unions, vulnerable groups, donors, and other international partners.

The subsequent effort of describing the environmental problems and their extent relied heavily on geographic information systems (GIS) data from various sources. GIS data on land cover for the last 20 years enabled spatial analysis of land-use change (including deforestation) and land degradation, as well as an analysis of risk concentrations of soil erosion and natural disasters, such as landslides and floods. The data and results of spatial analysis are publicly available via a web-map portal.⁸ The portal was developed as a contribution to the national GIS platform set up in March 2014 under the umbrella of the National Geospatial Data Infrastructure.⁹

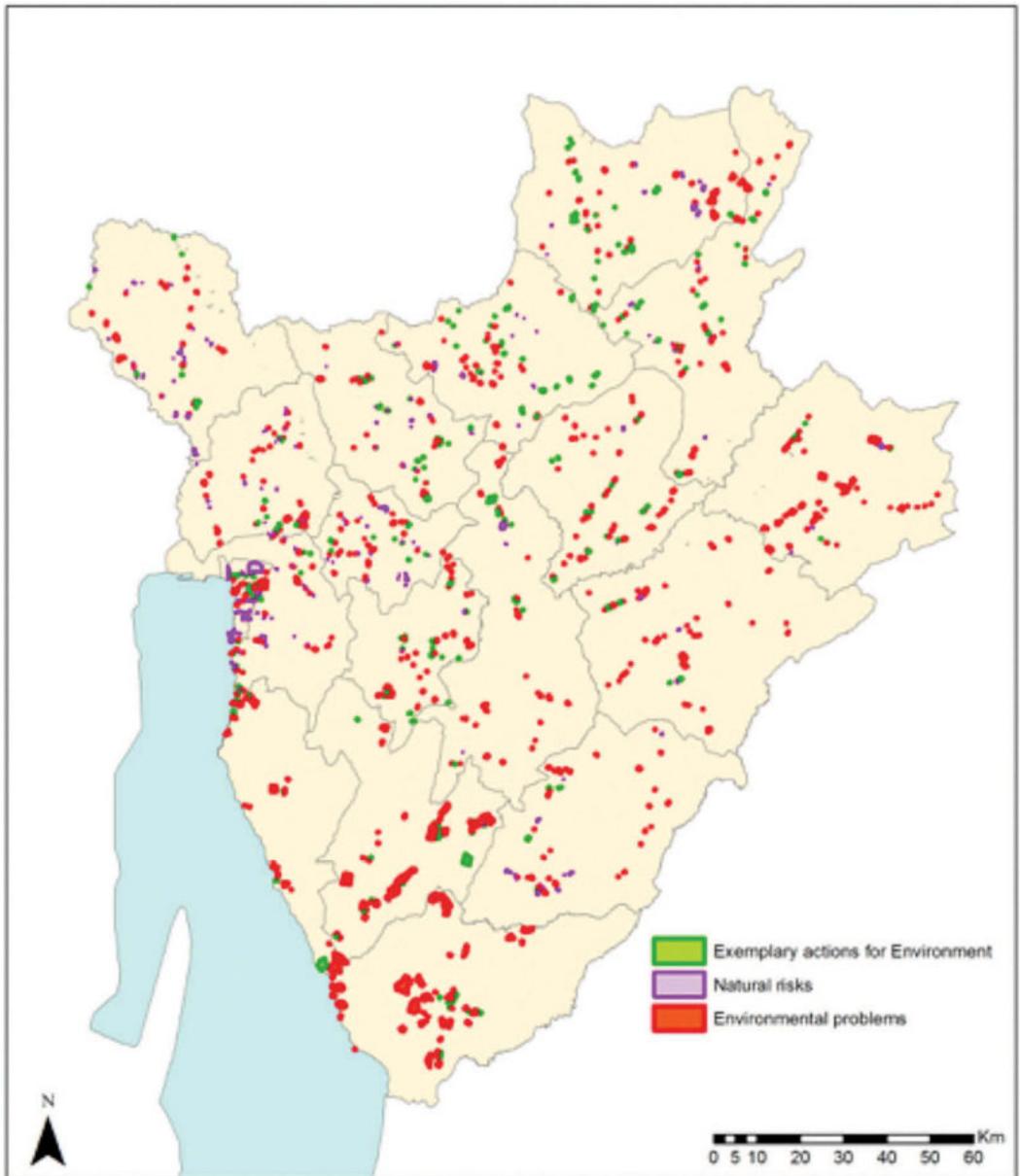
In addition, the analysis relied on the locally specific information collected through a “crowd sourcing” process, where three Burundian nongovernmental organizations (NGOs) lent their expertise to the collection of data in the field. They surveyed approximately 500 sites across the country, interacting with the local population to complement available quantitative and qualitative data (Figure 2.2).

Overall, the CEA has identified six key environmental problems, as summarized in Table 2.1. The table also lists the major causes and consequences of these problems. As clearly seen in the table, these problems overlap and are intertwined, with one problem being a cause or consequence of another. The first two problems, **deforestation** and **land degradation**, pertain to changes in rural land vegetation cover and their quality. These two problems overlap because, while forested areas are typically converted into agricultural lands, the latter are subsequently degraded due to poor agricultural practices. **Indoor air pollution** that is the result of households’ use of “dirty” fuel for cooking is a serious problem; it causes death for many Burundi people each year and increases the demand for fuelwood, a major reason for tree cutting by households. Activities related to agriculture are also a major cause of **water pollution**. In addition, inadequate sanitation infrastructure leads to contamination of Burundi’s freshwater sources. While a **natural disaster** is by definition a natural phenomenon, the extent of the damages is aggravated by the compromised resilience of the environment, especially when due to deforestation and land degradation. All of these problems pose threats to the integrity of the

⁸Gestion des Risques au Burundi, <http://bi-risk.pigeo.fr>.

⁹Republic of Burundi, see <http://www.presidence.bi/spip.php?article4500>.

Figure 2.2. Map of Sites Surveyed by Burundi NGOs



Source: Information Géographique et Environnement 2016.

Table 2.1. Key Environmental Problems in Burundi

<i>Problems</i>	<i>Major Causes^a</i>	<i>Major Consequences</i>
Deforestation	<ul style="list-style-type: none"> • Population growth • Clearing for agriculture, residence 	<ul style="list-style-type: none"> • Reduced provision of forest products • Loss in biodiversity and other ecosystem services • Soil erosion, more severe damages from natural disasters
Land degradation	<ul style="list-style-type: none"> • Intensive cropping without adequate management practices • Cropping on steep hills without erosion control • Uncertainty of land tenure regime 	<ul style="list-style-type: none"> • Agricultural productivity loss • Loss in biodiversity and other ecosystem services • Soil erosion, more severe damages from natural disasters
Indoor air pollution	<ul style="list-style-type: none"> • Indoor cooking with • “Dirty” fuel • Insufficient ventilation 	<ul style="list-style-type: none"> • Compromised public health • Deforestation • GHG emission
Water pollution	<ul style="list-style-type: none"> • Poor sanitation • Insufficient implementation of regulations, especially agricultural processing (for example, palm oil, coffee) 	<ul style="list-style-type: none"> • Compromised public health • Compromised health of aquatic wildlife • Scarcity of safe drinking water
Natural disaster	<ul style="list-style-type: none"> • Drought (exacerbated by climate change) • Flood, landslide (exacerbated by soil erosion, climate change) 	<ul style="list-style-type: none"> • Physical damage to environment • Physical damage to infrastructure • Loss of lives and livelihoods
Biodiversity loss	<ul style="list-style-type: none"> • Deforestation, land degradation, air pollution, water pollution, and natural disaster 	<ul style="list-style-type: none"> • Compromised ecosystem health • Loss in vital genetic diversity • Loss in ecosystem services

^aWeak policy framework and implementation applies to all problems.

environment. The **loss of biodiversity** threatens the health of the ecosystem and the lives and livelihoods of people who depend on it.

The remainder of this chapter investigates each problem in detail. For each problem, the following points are addressed:

- **The nature, extent, and trend of the problem:** What exactly is the problem? What has been the historical trend?
- **The causes of the problem:** What are the direct causes of the problem? What are the fundamental factors underlying the direct causes, if any? For all problems, weak policy framework and implementation to safeguard environment act as an “amplifier” of the problem. This topic is briefly discussed, more substantial discussion is in Chapters 3 and 4.
- **The consequences of the problem:** How does the problem affect the environment and the people?
- **The cost of the problem:** What is the economic cost associated with the environmental problems? A cost of environmental degradation (COED) analysis has been conducted for the CEA.

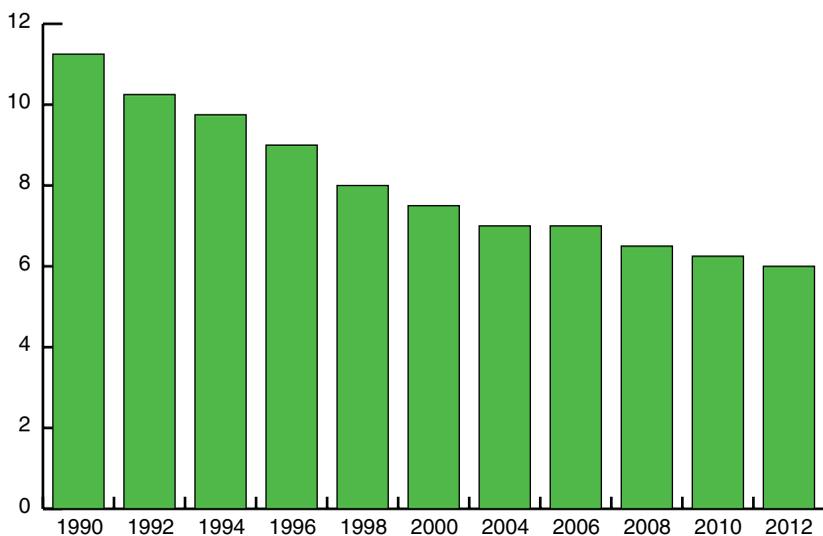
The appendix provides a further description and analysis of each problem. Given the priorities indicated by experts, the CEA will focus on the first four problems: deforestation, land degradation, indoor air pollution, and water pollution. These issues are closely linked with the agriculture sector, the public health sector, and the infrastructure of the country.

Deforestation and Forest Degradation

While natural forests once covered 30–50 percent of the country’s territory, human activities have vastly reduced the national forest cover.¹⁰ From 1990 to 2005, the country’s forest area decreased by over a third (37.3 percent), and there is approximately 6.6 percent of forest area remaining in the country. None of the remaining forest is considered pristine forest (World Bank 2015, 2015a; World Bank Group 2015). However, as seen in Figure 2.3, deforestation has slowed in recent years.

During the conflict period of the 1990s, Burundi likely experienced a deforestation rate as high as 9 percent, the highest in the world at that time.¹¹ More recently, from 2000 to 2011, Burundi saw an average deforestation rate of 1.4 percent, which is almost three times as much as the sub-Saharan Africa

Figure 2.3. Trends in Forested Area, 1990–2012 (by percentage of land area)



Source: World Bank 2015a.

¹⁰USAID/REDSO, 2003, as quoted in USAID 2010.

¹¹Athman et al. 2006, as quoted in USAID 2010.

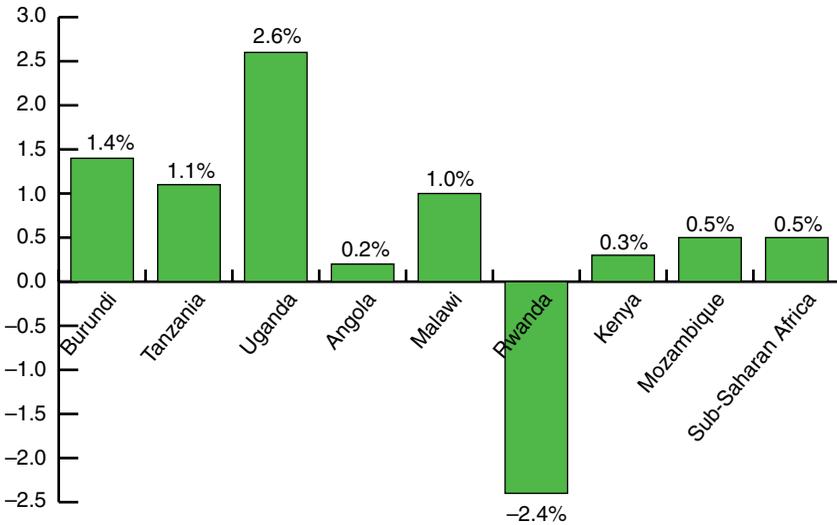
average (0.5 percent) and, except for Uganda, the second highest among neighboring countries (World Bank 2015a; Figure 2.4).

One can establish a link between deforestation and poverty incidence in Burundi. Figure 2.5 shows that most provinces in the center and northeast part of the country exhibit medium to high poverty rates combined with high tree cover loss.

Causes and Drivers

The fundamental driver of the past deforestation was the rapid population growth and the need for the rural lands to absorb the incremental labor force. As the forested area has shrunk considerably, forest clearing has slowed down. However, the demand for fuelwood, typically used for household cooking and rural brick production for construction, continues to be a serious driver of the exploitation of forest resources. It is estimated that an average Burundi consumes 1.22 m³ of wood and 0.04 m³ of wood furnishings per year. See the appendix for a detailed discussion of the demand for fuelwood and other causes of deforestation, including wildfires, mining activities, timber demand, and the lack of proper forest management.

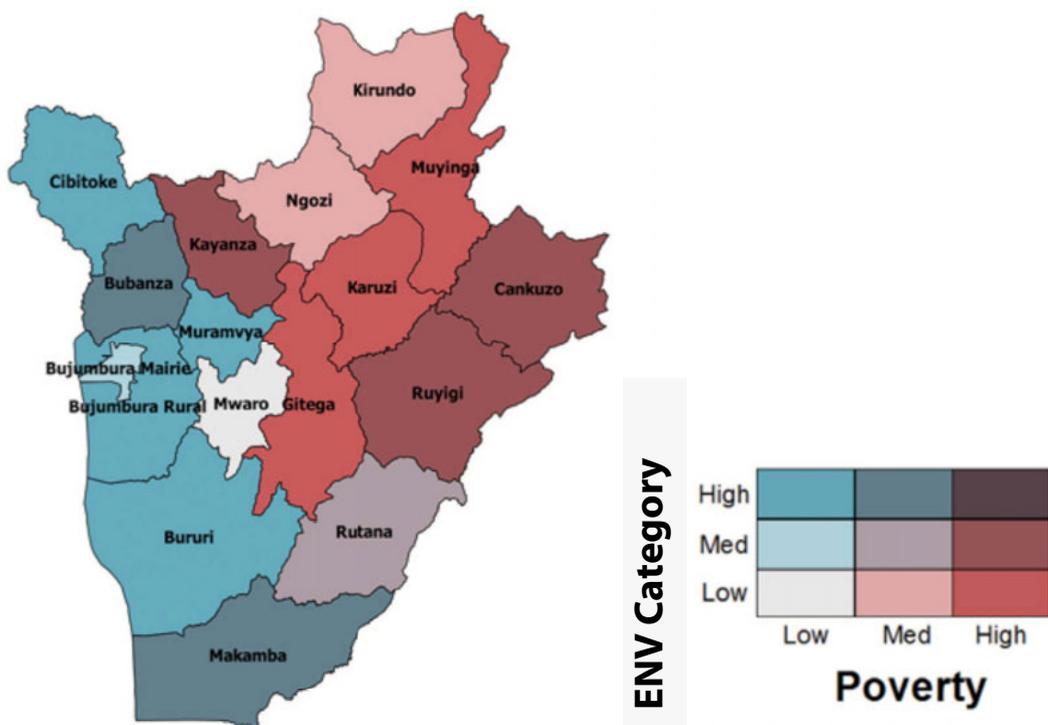
Figure 2.4. Deforestation Rate during 2000–11 in Selected Countries (average annual rate)



Source: World Bank Group 2015.

Note: A negative deforestation rate means that at the aggregate the forest cover gains are greater than the losses.

Figure 2.5. Map of Poverty Incidence and Tree Cover Loss by Province in Burundi



Source: Authors’ calculation based on data from Hansen et al. 2013 and Naipal et al. 2015.
 Notes: (i) Tree cover loss is calculated as the share of the area under tree cover in 2000 that suffered from a tree cover loss between 2000 and 2010 (Hansen et al. 2013). Data used at the 30 m × 30 m resolution. (ii) Poverty: low = <53%, medium = 53–67%, high = >67%, based on poverty headcount rate. (iii) Tree cover loss: low = < 0.43, medium = 0.43–0.79, high = >0.79, based on share of forest area affected by tree cover loss.

Consequences and Costs

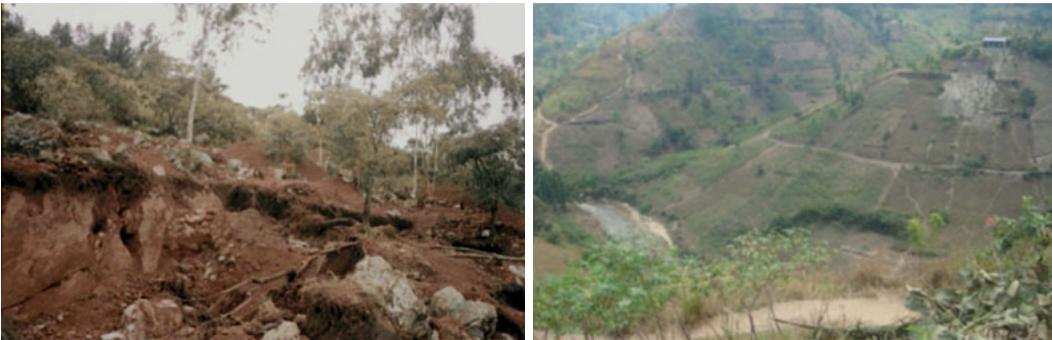
Consequences of deforestation and forest degradation are the loss in goods and services that forest ecosystems would otherwise provide to society. Forests provide timber and non-timber resources to the population. The most significant among the uses of forest resources is wood fuel. Like many developing nations, Burundi strongly depends on fuelwood and charcoal for energy: more than 95 percent of the energy consumed by households is wood based.

Forests also provide a range of ecosystem services. Forests maintain an integral function in regulating the water cycle—helping to regulate the proper microclimates needed for agriculture—and protecting watersheds. Burundi’s forests help prevent siltation and pollution of the country’s network of waterways by reducing erosion that leeches into the watershed. Preventing soil

erosion may be the most important service that forests provide in Burundi. For example, deforestation of the hills overlooking Bujumbura has contributed immensely to the vulnerability of the city. Bujumbura is situated downstream from the steep-sloped hills of the Mumirwa, the region most vulnerable to hillside soil erosion in Burundi. Forests are also conducive to biodiversity. The carbon sequestration services offered by natural forest ecosystems are important for both the country's economy and the global environment.

The cost of deforestation is estimated in terms of the annual value of lost ecosystem services, as the present value of the flow of net benefits from lost forest and one-time cost of carbon storage loss in deforested areas. This flow of net benefits is obtained as a product of a value of ecosystem services per hectare and annual average acreage deforested over the period 2001–14. Applying a 5 percent discount rate,¹² the total annual cost of deforestation in Burundi is estimated at US\$3.4 million, which is equivalent to 0.1 percent of GDP in 2014. Note that the estimate is an underestimation of deforestation cost, as the calculation does not include the value of lost timber and non-timber forest resources, including the value of lost fuelwood provision, due to deforestation.

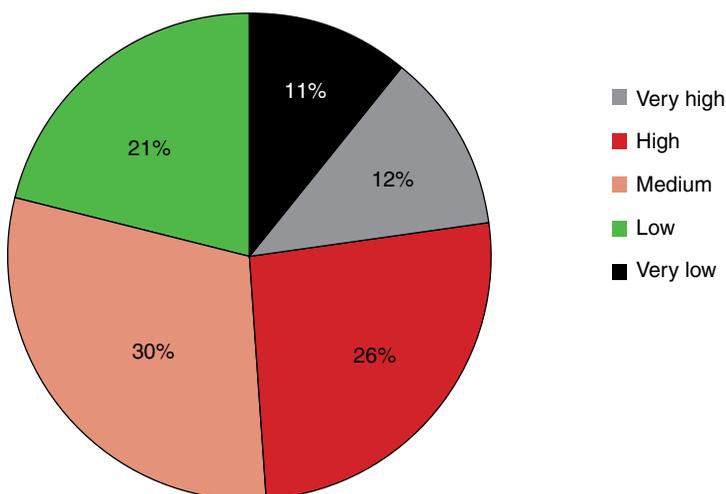
Land Degradation



Source: University of Burundi, Institut de Pédagogie Appliquée (IPA).

For this CEA, land degradation is defined as the decline in the quality of land within a certain land-use category. As the degradation of forested areas was discussed in the previous section, this section covers the rest of rural terrain, which comprises lands under cultivation and shrub and herbaceous covers. Note that the discussion here also pertains to the lands that have been previously deforested and subsequently cultivated or grazed. In severe cases, land degradation manifests in physical transformation of the land structure, as seen in the photos. On agricultural lands, loss of soil nutrients (soil erosion) is a typical and serious symptom of land degradation.

¹²This discount rate is used to estimate the social cost of carbon.

Figure 2.6. Land Degradation in Burundi by Severity Classification, 2014

Source: MESA 2014.

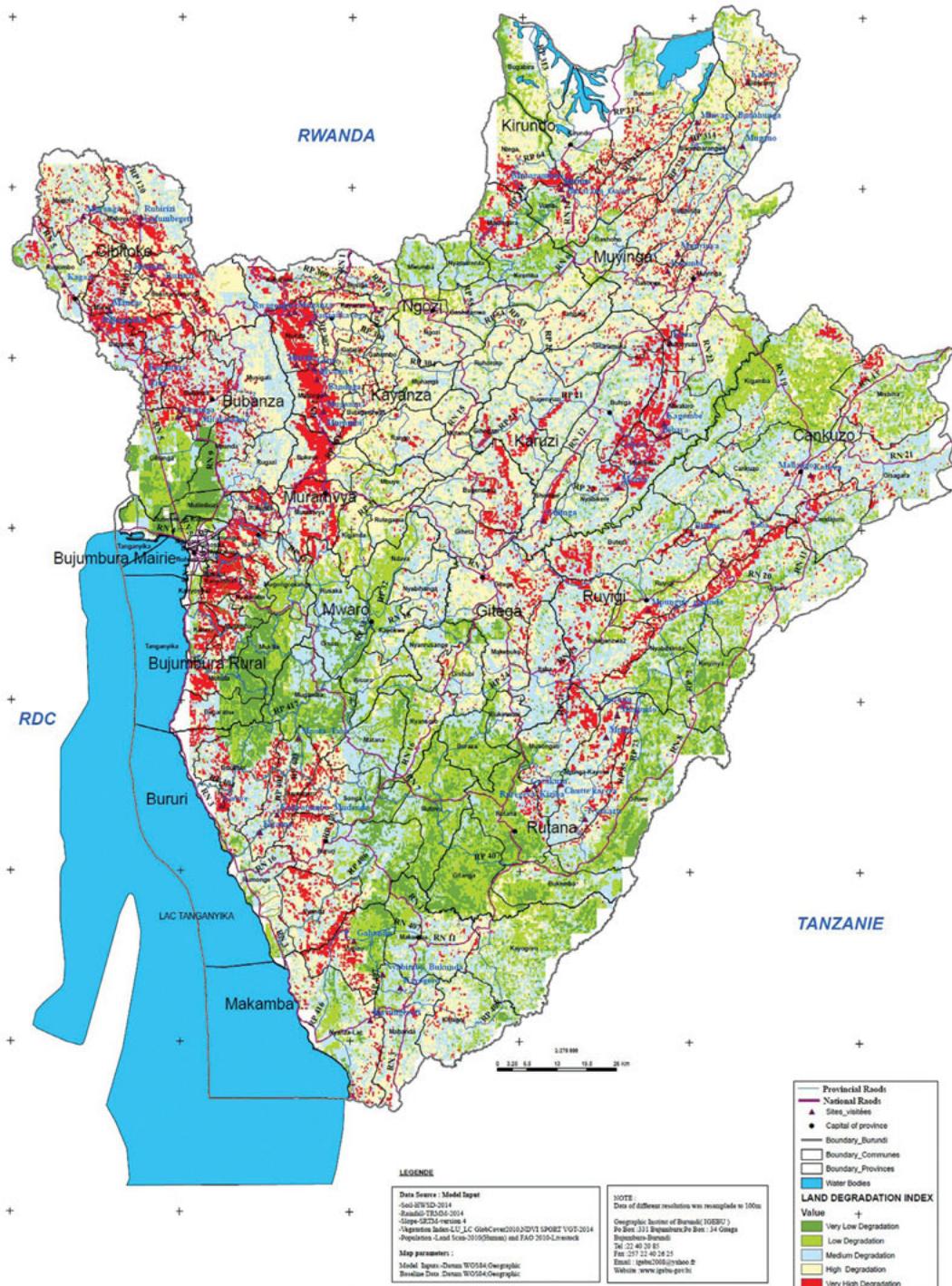
According to MESA (2014), 38 percent of Burundi's land is considered very highly or highly degraded (Figure 2.6). Figure 2.7 illustrates the spatial distribution of severe land degradation: the land in the center, center west, and along the west coast of the country is the most degraded. The region corresponds to where intensive subsistence farming of beans, bananas, sweet potatoes, corn, and sorghum occurs (as well as coffee growing in the center west).

Land degradation threatens to weaken an economy already hobbled by 15 years of political crisis and dependency on the primary sectors. The poverty rate is generally higher in the regions of the country marred by severe land degradation. Eight of the most impoverished provinces (Muyinga, Ruyigi, Gitega, Cankuzo, Kayanza, Kirundo, Karusi, and Rutana) are also identified as being among the most heavily degraded in the country.

Causes and Drivers

Again, the fundamental driver of rural land degradation is rapid population growth and the resulting need to grow more food and other crops for income. As the need for additional agricultural lands grew, marginal lands with low fertility and lands with fragile soil structure or high environmental sensitivity were brought under cultivation (that is, expansion at the "extensive margin"). Those lands include hillsides, marshlands, and protected areas, as well as the clearing of or encroachment into forested areas. These expansions, however, were not accompanied by appropriate soil erosion control systems. Across the country, three out of four plots have no erosion control systems in place. For those parcels with erosion control measures, contour lines with hedges are the

Figure 2.7. Map of Land Degradation in Burundi, 2014 (low, medium, high, very high)



Source: IGEBU 2014.

most commonly used apparatus at 13.6 percent; plots that have contour lines without hedges represent 3.2 percent of all cultivated plots; radical terraces with hedges are present on only 2 percent of cultivated land.

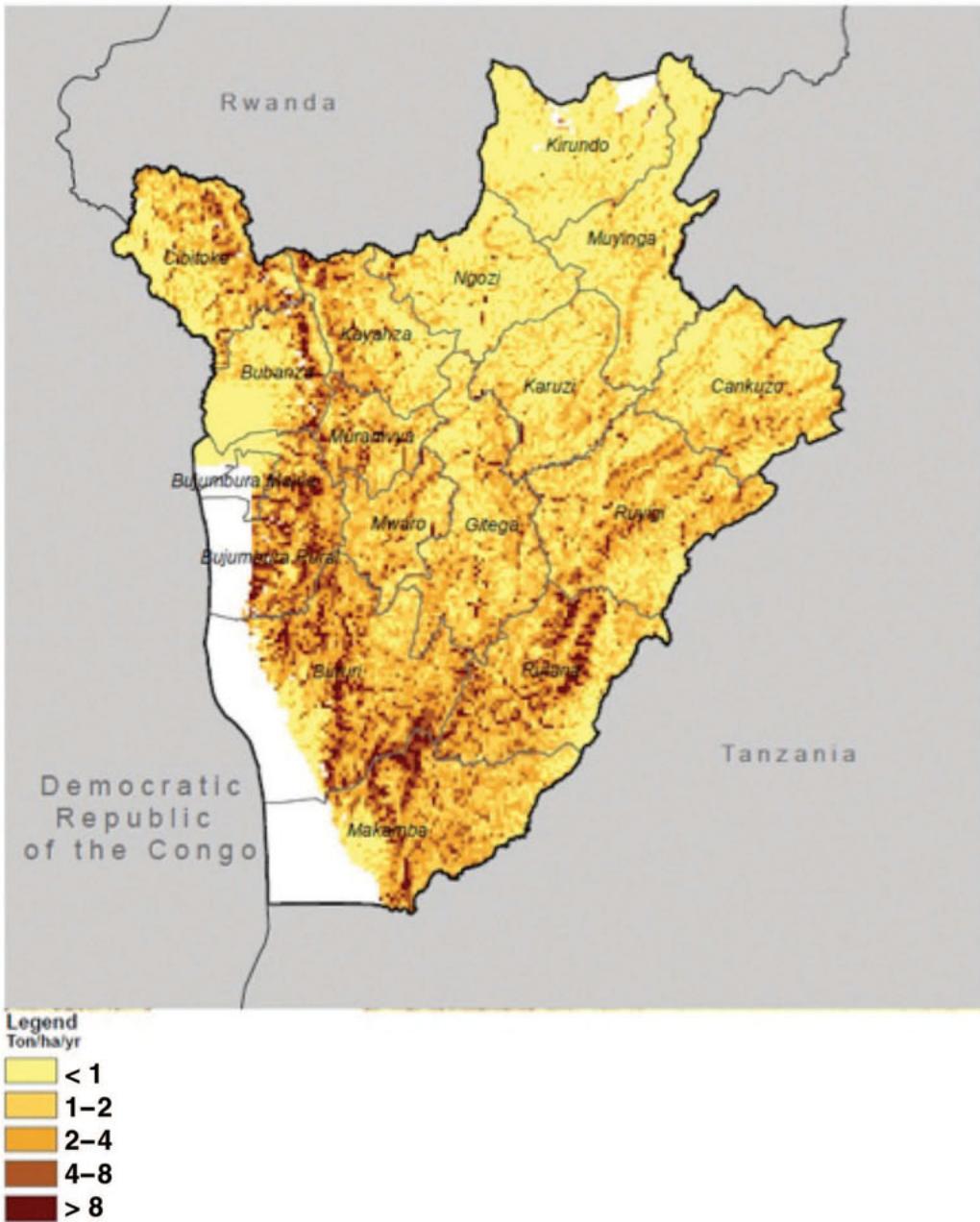
At the same time, the use of agricultural lands intensified without appropriate land management measures (that is, exploitation at the “intensive margin”). In particular, for vital livelihood needs, farmers could not afford fallowing of their plots, and as result a decline in soil fertility was inevitable. Application of farm inputs (for example, fertilizer) to improve crop yield is also limited, which in turn accelerates the intensity of land use and results in the depletion of soil nutrients. Several important links exist in terms of organic fertilizer use. As the forested area diminishes and availability of fuelwood declines, the deficit is typically offset by using organic waste from agriculture and livestock as household fuel. This reduces the organic matter applied as fertilizer on their plots. In the case of coffee production, the solid waste resulting from de-pulping coffee cherry had been directly released into river streams, thereby polluting the water. With the increased adoption of composting at the household level, however, water pollution due to solid waste from coffee processing has decreased, and the use of organic fertilizer has increased on those farms. These examples illustrate that environmental problems on rural landscapes are linked to one another, and interventions to address the problems must bear these links in mind for effectiveness and for leveraging synergies.

Another factor that indirectly contributes to rural land degradation is the substantial fragmentation of croplands. While several provinces in the east, the most sparsely populated part of the country, have surface areas larger than the national average of 0.52 hectares, the heft of the country’s population belt sees agricultural operation size well below that of the national average. Households in Bubanza, Bujumbura Rural, Muramvya, Ngozi, Gitega, and Mwaro have plots, on average, between 0.329 hectares and 0.373 hectares (Republic of Burundi 2013). In addition to this limited availability of cropland, land fragmentation occurs in the process of conveying from father to son (Oketch and Polzer 2002). The extremely small average farm size prevents farmers from exploiting scale economies in production and renders any investments in their croplands financially less attractive. Thus, the observed lack of investment by farm households in erosion control and soil fertility improvement, which would reduce the problem of land degradation, seems at least partially explained by the fragmentation of cropland. The potential role of land tenure reform is clear.

Consequences and Costs

The most significant manifestation of land degradation in Burundi is soil erosion on agricultural lands. Soil erosion occurs as water and wind wash and blow away precious mineral content from the farmland. In addition to fertility loss on farmlands, it results in the silting up of marshes and wetlands, which are among the last land resources with agricultural potential. Erosion of topsoil is particularly acute in the steep sloped areas of Mumirwa, the Congo Nile ridge, and the highest points of the Central Plateau (MEEATU 2011; Figure 2.8).

Figure 2.8. Map of Soil Erosion in Burundi



Source: World Bank database; ISRIC (World Soil Information) database; NASA database.

With an estimated 3 percent of soil being lost every year in the agro-ecological zone of Mumirwa, the agricultural horizon could disappear within three decades if no action is taken to prevent it. The amount of soil lost nationally to erosion has been calculated at 37,921,100 tons per year.

Land degradation also has an impact on the availability of water resources. Large-scale erosion disrupts the proper functioning of watersheds and waterways—causing sedimentation in downstream rivers—and the water cycle. Such degradation has led to shrinking bodies of water, such as Lake Tanganyika and the northern lakes, as well as siltation and drying up of various rivers, including those feeding hydroelectric dams (for example, Mugere and Rwegura [MEEATU 2011]). The degradation phenomenon can also be linked to a downward trend in rainfall: a shift of isohyets—the lines on a weather map connecting points having the same amount of rainfall over a given period—can be seen in the depressions of Bugesera and Kumoso (MEEATU 2011). Altered vegetation cover on the landscape affects a range of other ecosystem services that rural lands provide, including the capacity of carbon storage, regulation of air quality, and maintenance of biodiversity (MEEATU 2011). Finally, weak soil integrity due to deforestation and improper use of agricultural lands also triggers natural disasters, such as floods and landslides, which can damage homes and public and private infrastructure and destroy the lives and livelihoods of rural residents.

The cost of land degradation is estimated in terms of reduced crop yield due to soil erosion. With the assumption that severely eroded lands cannot be used for crop production and the assumed percentages of yield loss for moderately and lightly eroded crop lands, the costs of yield loss due to erosion are estimated for beans, maize, and sweet potato production. The estimated total cost of land degradation ranged between US\$31 and US\$209 million, depending on the yield loss scenarios, with a midpoint at US\$120 million per year or 3.9 percent of GDP in 2014. Note that this is an extremely conservative estimate obtained using only the yield reduction for three major crops in Burundi. Not included in the estimates are the costs associated with yield losses in other crops due to soil erosion, the costs associated with changes in freshwater availability, and the loss of other ecosystems services described in the previous paragraph. For example, the United Nations Environment Programme (UNEP) estimates that over 75 percent of Burundi's agricultural land is degraded, and crop losses from such degradation are placed at US\$400 million per year. The costs associated with floods and landslides triggered by soil erosion are included in the costs of natural disasters.

Indoor Air Pollution



Causes and Drivers

In Burundi, indoor cooking using traditional methods is common. Around 55 percent of households cook inside their homes, 36 percent have their kitchen in a separate building, and 8 percent cook outside. In fact, outdoor cooking is more common in urban areas than in rural areas (37 percent versus 5 percent), while indoor, in-home cooking is the predominant mode in rural areas (59 percent in rural areas versus 17 percent in urban areas). In poor areas, the health of women and children, who are next to their mothers when food is cooked, suffers the most (Ndikubagenzi 2016).

Wood is the major cooking energy for households in Burundi. Nearly all Burundi households (98.5 percent) use solid fuels for cooking, with 85 percent of homes using fuelwood (Republic of Burundi 2012b). In rural areas, agricultural residues (plant leaves and husks, cow dung, and so forth) accounted for 28 percent of the total fuel used in rural areas, and 36 percent of households mainly used vegetable waste for cooking.¹³ Charcoal is used by only 2 percent of the households in the countryside (ISTEEBU and MSPLS 2012). In urban areas,

¹³Besse and Guizol 1991, and Ndabirorere 1999, as quoted in Rwabahungu, Niyonkuru, and Bukobero 2013.

charcoal is the predominant energy source for cooking (70 percent of the households; ISTEEBU and MSPLS 2012). Oil and gas are still the preserve of privileged households, most of which are situated in Bujumbura (World Bank 2014b). The national electrification rate was limited to 5 percent in 2013 (IEA 2015).

Consequences and Costs

Indoor cooking using traditional methods and fuels is an environmental problem. As discussed earlier, demand for fuelwood is the major reason for cutting trees from the rural landscape of Burundi. The traditional burning method emits substantial GHGs. According to the UNFCCC Burundi National Communication, residential activities accounted for 90 percent of total GHG emission in Burundi in carbon dioxide (CO₂) equivalent in 2005.

Indoor air pollution certainly affects public health, particularly among women and children who stay close to their mothers as they cook (Ndikubagenzi 2016). Following an incomplete burning of solid fuel (fuelwood, charcoal, agricultural residues, or manure), small particles and other elements detrimental to health are released into the indoor air. Soot particles particularly may deeply penetrate lungs. Chronic and acute poisoning due to carbon monoxide (CO) causes serious diseases and deaths. Particles with diameters less than 2.5 microns (PM 2.5) can carry toxic and carcinogenic chemicals at their surface and could reach blood due to their small size. These could therefore potentially impact the whole human organism. Studies provide evidence of the links between indoor pollution and low birth weight, tuberculosis, cataract, and nasopharyngeal and pharyngeal cancers. In addition, massive pollution may bring about acute nasal and eye mucosa irritation, coughing, chest tightness, exhaustion, and headaches.

The cost of household air pollution (HAP) is estimated in terms of mortality due to exposure to particulate matter PM 2.5 due to household cooking (indoor and outdoor). The relevant mortality is estimated using assumptions of concentration of particulate matters in Burundi households, while the cost of mortality is obtained by adjusting the value of statistical life (VSL) of Organisation for Economic Co-operation and Development (OECD) countries. Annual losses attributed to indoor air pollution in Burundi are estimated at US\$87–137 million, with a midpoint of about US\$112 million or 3.6 percent of GDP in 2014. The estimates are very close to the estimations of health losses due to air pollution risk, as presented by the Institute for Health Metrics and Evaluation.¹⁴ However, the estimate is an underestimation. The calculations do not include the cost of deaths due to CO poisoning. The cost of acute and chronic morbidity is not included in the calculations, nor is the cost of GHG emission into atmosphere.

¹⁴Institute for Health Metrics and Evaluation, <http://www.healthdata.org>.

Water Pollution

Water resources in Burundi are generally abundant thanks to plentiful rainfall and good water retention by marshes and lakes, especially Lake Tanganyika. The network of streams, rivers, and marshes occupy about 10 percent of Burundi's total area, divided between the two watersheds of the Congo and Nile. Burundi's waters serve the other countries with which it shares the Congo and Nile watersheds. Lake Tanganyika is one of the largest lakes and freshwater reserves in the world, with a total area of 32,600 km² (of which 634 km² belong to Burundi), containing 20,000 km³ of water. The lake permits maritime shipping, fishing, and tourism and is home to most of Burundi's fisheries. The lakes of the north—Rweru, Cohoha, Rwihinda, Kanzigiri, Gacamirinda, and Narungazi—form a complex, interconnected lake-swamp system. Figure 2.9 depicts the network of water resources of Burundi.

Causes and Drivers



Factories, in particular, agro-industrial companies, are major water polluters. Almost all food industries and factories are located near water courses and bodies as a source of constant water provision, as well as a means of egress for by-products. Palm oil extraction plants, coffee-washing stations, and tea and other agro-industrial factories pose a major pollution threat from nonrecycled, nontreated wastewater and other solid and liquid effluents that are injected into nearby water sources.¹⁵

The Burundi water supply and sanitation (WSS) sector is characterized by three main issues: (i) inadequate water service quality, (ii) inadequate sanitation service quality, and (iii) inadequate hygiene. Burundi's WSS sector

¹⁵See the appendix for a description of these pollutions, as well as other sources of water pollution, including mining activities.

endured years of destruction brought on by sabotage and neglect during the civil war and its aftermath. Consequently, access to adequate sanitation is extremely low at 13 percent in rural areas and 33 percent in urban areas (GIZ 2013b). The appendix presents the results of a case study on water quality in Bujumbura, revealing the severity of the water source contamination problem.

Consequences and Costs

While the supply of clean, safe water is scarce due to the limitations of the WSS sector, water pollution from various sources further reduces the supply of clean water. In urban areas, the need for drinking water doubles every 10 years, while the growth rate of the demand for drinking water reaches 58 percent every 10 years.¹⁶ Solutions to resolve water scarcity issues must address the prevention of pollution while increasing the services of the WSS sector.

Aside from the anticipated future deficit of clean and safe drinking water, the immediate impacts of water pollution are felt by those exposed to unsafe water. For example, pollution from palm oil-processing plants seriously affects the downstream aquatic environments, killing wild fish and impacting local fisheries. In terms of public health consequences, poor hygiene is the primary cause of 80 percent of deaths in Burundi (IRC 2011). Unsafe water continues to cause epidemics (cholera, bacillary dysentery, malaria, and so forth) with great loss of life, especially among children.

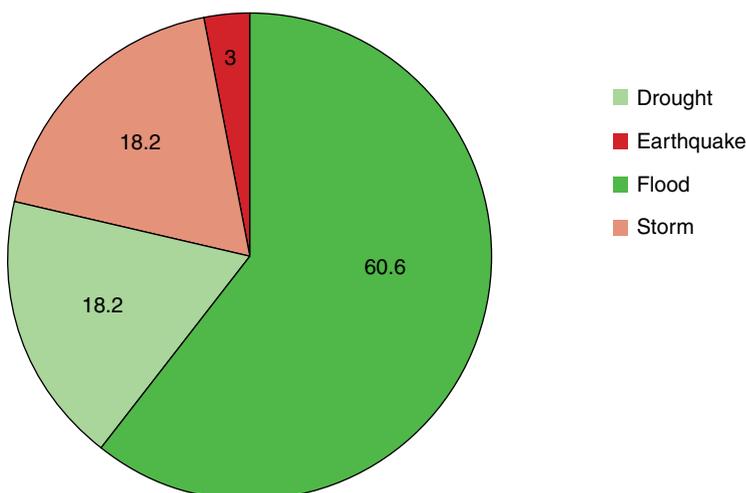
The cost of water pollution is estimated in terms of mortality and morbidity attributed to unsafe water. Taking into account that 61 percent of diarrheal illness is attributable to water, sanitation, and hygiene, the disability adjusted life years (DALYs) lost due to diarrhea and other diseases can be estimated. Valuation of life follows the estimation of the cost of air pollution. The total annual cost of water pollution in Burundi is estimated at US\$91–144 million, with a midpoint of US\$117 million, or at about 3.8 percent of GDP in 2014. This is an underestimation of the total cost of water pollution—for example, the impacts of pollution on the aquatic ecosystem are not included in this estimate.

Natural Disasters

Many types of natural disasters affect Burundi. Flood is the most common disaster, followed by storm and drought; Burundi also faces earthquake risks (Figure 2.10).

Natural disasters linked to human activities are droughts, floods, and landslides. They are so-called extensive risk disasters that are magnified by environmental degradation and other anthropogenic factors. Burundi has been facing drought hazards since 1998, especially in the northern part of the country, where many people have had to migrate to Rwanda and Tanzania (EAC

¹⁶NAPA 2007.

Figure 2.10. Distribution of Natural Disasters in Burundi, 1990–2014

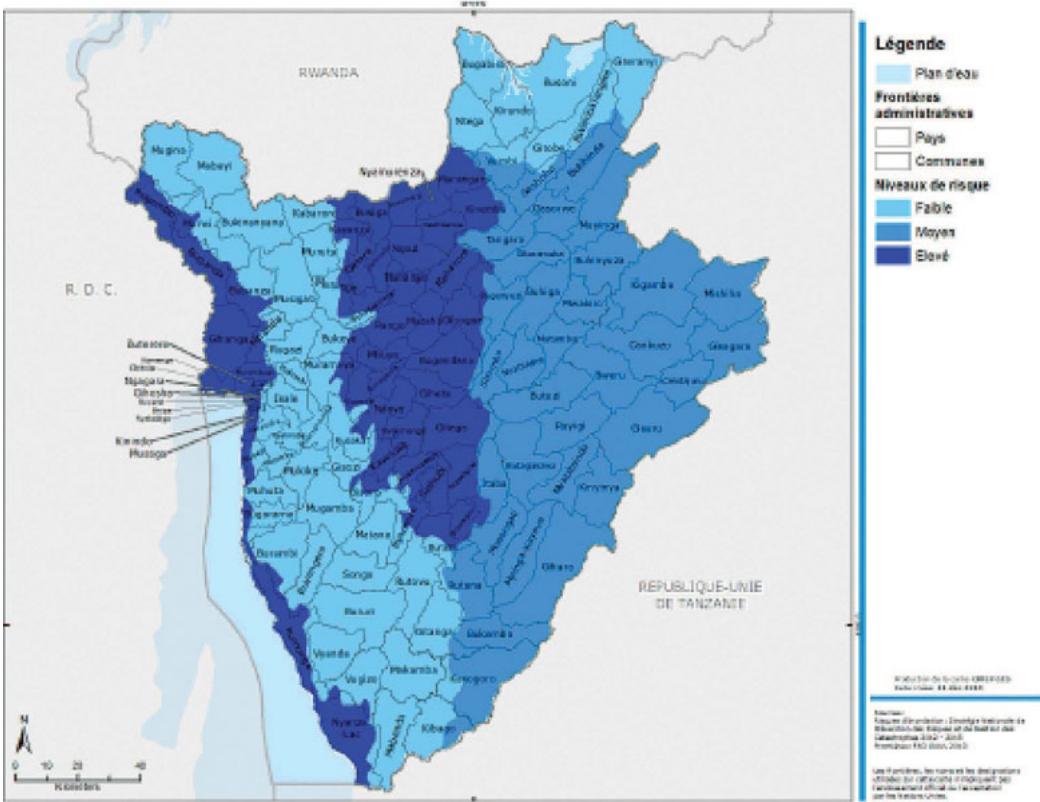
Source: EM-DAT database.

Note: According to the EM-DAT International Disaster Database, for a disaster to be entered into the database, at least one of the following criteria must be met: (i) 10 or more people are reported killed, (ii) 100 or more people are reported affected, (iii) a declaration of a state of emergency has been called, and/or (iv) there has been a call for international assistance.

Secretariat 2012). Floods usually affect large river basins, such as the Congo basin, but flashfloods can impact any region after extreme rainfall. In Burundi, floods occur in the area of Lake Tanganyika. The capital Bujumbura is often flooded. For example, the flood in 2010 caused widespread damage to Bujumbura International Airport (MEEATU 2013a). Since 2000, floods are registered almost every year. The risk of a landslide is high in the areas with hilly terrain, high levels of rainfall, soil erosion, and deforestation due to unsustainable land management.



Figure 2.11. Map of Flood Risks in Burundi (high, medium, and low)



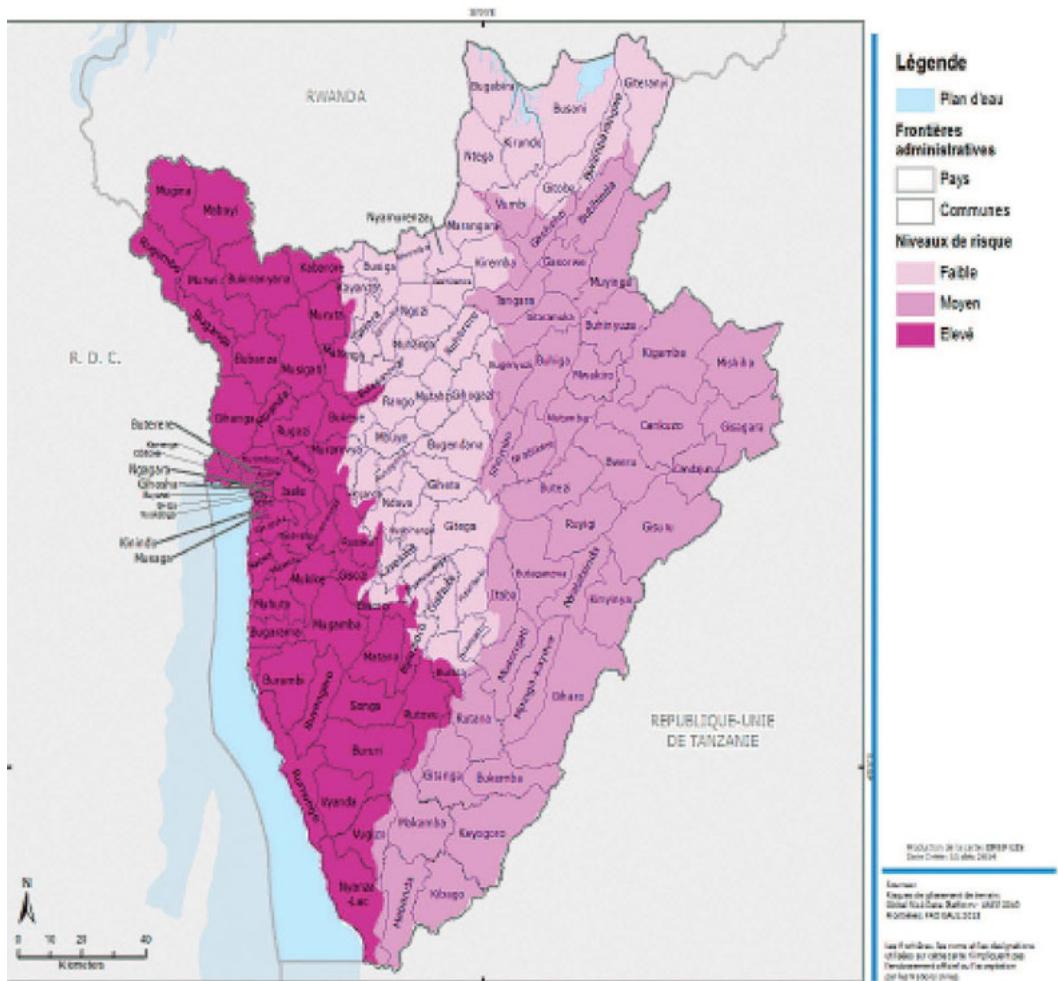
Source: PAM-ICA 2015.

Figures 2.11 and 2.12 show the geographical distribution of flood risks. According to an integrated analysis of Burundi’s vulnerability, conducted as part of the ACCES (Climate Change Adaptation for Soil and Water Resources Conservation) Project, the country’s “hotspots of vulnerability” are located in the north and northwest. The slope of the ridge (and not the ridge itself) leading to the Imbo Plain to the west, the topographical structures to the north, and the central plateau are the regions most vulnerable to erosion.

Economic losses from natural disasters include direct and indirect costs, while financial costs of flood include three assessment categories (ADB and WB 2010):

- Direct cost refers to the monetary value of the completely or partially destroyed assets, such as the social, physical, and economic infrastructure immediately following a disaster.
- Indirect costs are income losses and comprise both the change of flow of goods and services and the other economic flows, such as increased expenses, curtailed production, and diminished revenue, which arise from the direct damage to production capacity and social and economic infrastructure.

Figure 2.12. Map of Landslide Risks in Burundi (high, medium, and low)



Source: PAM-ICA 2015.

- Reconstruction costs measure the cost of rebuilding lost assets and restoring lost services. It is generally assessed as the replacement cost with a premium added for building back smarter.

Only floods and droughts are included in the cost of natural disasters' estimation in this CEA. First, economic losses per disaster are estimated based on the methodology of value at risk from the report by the United Nations Office for Disaster Risk Reduction (UNISDR 2013).¹⁷ Then, there is a hazard assessment to identify the intensity and the recurrence of natural phenomena and a

¹⁷PreventionWeb.

vulnerability analysis to establish a damage function for a given hazard based on exposure and fragility of population, ecosystems, and economy.

Following this approach, PreventionWeb provides the annual economic cost of flood risk in Burundi at about US\$3.3 million.¹⁸ According to the UNISRD (Erian et al. 2013), crop production has been affected by five moderate droughts (cassava) and five slight droughts (sorghum, maize) between 1999 and 2011 in Burundi, which affected 0.15 percent of all production. The estimated economic damage from droughts in 1999–2011 in Burundi is estimated at US\$239 million, or about US\$20 million annually. The total economic costs of natural disasters with extensive risk are estimated at a midpoint of US\$23.3 million annually or 0.7 percent of GDP in 2014. Because the calculation does not include the costs associated with landslides, it is an underestimation of the costs of natural disasters associated with anthropogenic activities, such as deforestation, improper agricultural practices, and climate change. For reference, in 2010, the Ministry of Water, Environment, Physical Planning and Urban Development (MEEATU) estimated partial costs of rehabilitating the nationwide infrastructure affected by environmental degradation at 13 billion FBu (about US\$8.3 million; MEEATU 2011).

Biodiversity Loss

All the environmental problems discussed in this chapter are relevant to the loss of biodiversity that supports the health of ecosystems. The extinction of animal and plant species has notably been observed in places such as Kibira Park; Ruvubu Park; Rukoko Reserves; and the Reserves of Bururi, Rumonge, and Vyanda, due to changes in habitat as a result of the unsustainable exploitation of natural resources. Biodiversity is a natural resource that is vital to all life on this planet, thus prevention of its losses as well as its active protection should be recognized as essential policy objectives. Protected areas cover 5.6 percent of the national territory of Burundi (Damien and Séverin 2015). Vegetation cover in protected areas plays a significant role in erosion control and provides shelter to a wealth of animal and plant species.¹⁹ Explicit estimation of the cost of biodiversity loss was not conducted for this report.

Interactions with Climate Change

All the environmental problems discussed in this CEA are intertwined with global climate change. The anticipated changes in the future climate regime in Burundi, in particular the elongated rainy and dry seasons, likely will result

¹⁸Ibid.

¹⁹See the appendix for further discussions.

in further declines in agricultural yields going forward, amplifying the trends caused by land degradation. Residential activities accounted for 90 percent of all GHG emissions (in CO₂ equivalent) in Burundi in 2005, with firewood burning in rural areas largely responsible for the household emissions. With the ever-growing population, household emissions will increase at the aggregate unless critical changes are made to household cooking methods. On the other hand, the ever-shrinking forest area in Burundi implies that the natural capacity to sequester the emitted carbon and purify the air and water is diminishing. Climate change will increase the frequency and severity of extreme weather, in particular droughts and rain events. In addition to causing catastrophic damages to agriculture, droughts and water scarcity will intensify the problems of water pollution and the difficulties of supplying clean, safe water to the population. Intensive or prolonged rainfalls on soils with compromised integrity will cause additional and more severe floods and landslides. Thus, addressing the environmental problems is also addressing climate change, in particular, mitigating the impacts of and adapting to climate change.

Overall Cost of Environmental Degradation

Based on the individual cost estimates for deforestation, land degradation, air pollution, water pollution, and natural disasters as presented in the earlier sections, the total COED in Burundi is estimated at about US\$376 million or 12.1 percent of the country's GDP in 2014 (Table 2.2).

Damages by category for Burundi are shown in Figure 2.13. The largest damages are caused by deforestation and land degradation (32 percent), water pollution (31 percent), and indoor air pollution (30 percent). Note, because much of land degradation originates from deforestation, the costs of deforestation and land degradation are combined and presented as one category.

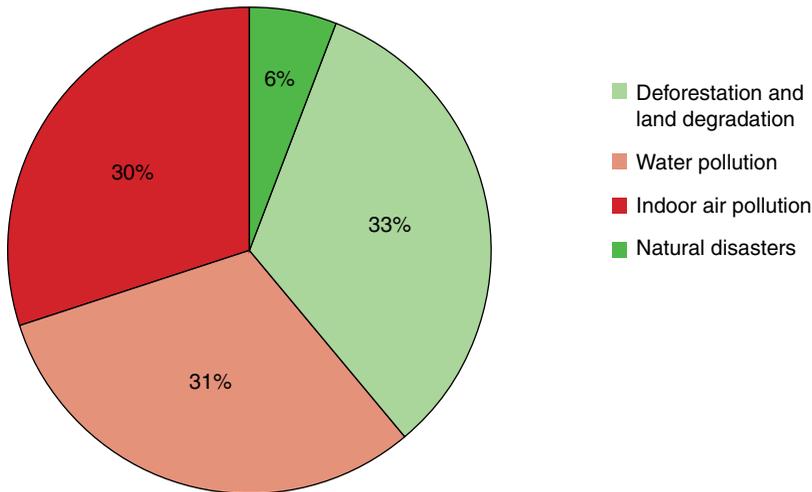
As stated previously, the COED estimates represent a substantial underestimation and are interpreted as such. Only selected aspects of environmental

Table 2.2. Summary of Annual Costs of Environmental Degradation in Burundi (in millions of U.S. dollars)

<i>Environmental Degradation</i>	<i>Low</i>	<i>High</i>	<i>Midpoint</i>
Deforestation and land degradation	34	212	123
Water pollution	91	144	117
Indoor air pollution	87	137	112
Natural disasters	23	23	23
Total	235	516	376
Percentage of GDP in 2014	7.6%	16.6%	12.1%

Source: Authors' estimates.

Figure 2.13. Costs of Environmental Degradation by Category (share in total)

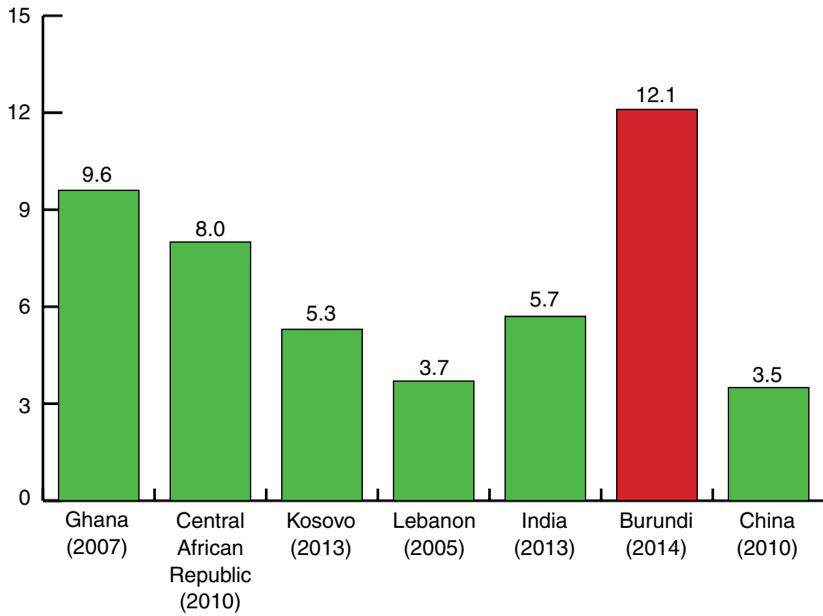


Source: Authors' calculations.

costs could be included in the calculation of each environmental problem due to data limitations. The estimated costs would substantially increase if the calculations included, in particular: the value of lost timber and non-timber forest resources, lost ecosystem services due to land degradation, impacts of water pollution on aquatic ecosystems, the cost of GHG emissions by households, and the cost of landslides associated with anthropogenic failures. Continued efforts to refine these COED estimates are warranted.

Nonetheless, the cost estimates presented in this CEA, along with an earlier estimate of “cost of inaction” against land degradation (MEEATU 2011), can serve as the basis for discussing policies to reduce pressures and damages on the country’s natural resources in the future. In particular, even with its known underestimation, the Burundi COED is greater than available estimates for other countries (Figure 2.14). Burundi’s higher cost of environmental degradation relative to its income, as compared to other African nations, is consistent with the larger negative adjusted net savings in Burundi (Chapter 1). Environmental degradation results in costs to Burundi’s current generation, meanwhile the country is preserving few resources for future generations.

Figure 2.14. Cost of Environmental Degradation in Selected Countries (as a percentage of GDP)



Sources: Authors' calculations (Burundi), World Bank report on the Lebanon CoED (2005) and India CoED (2013), China's Ministry of Environmental Protection, Ghana CEA (2007), Central African Republic CEA (2010), and Kosovo CEA (2013).

Note: The base year is different for each country.





Environmental Policies and Institutions

Having identified the most pressing environmental problems and their extent in Burundi, the CEA now shifts its focus to assessing the country's capacity to address these challenges. This chapter first summarizes the institutional and legal framework in which the country protects and manages the environment, and then reviews public expenditures on the environment. The latter half of the chapter provides a capacity assessment and identification of bottlenecks.

Institutional Framework of Environmental Protection and Management

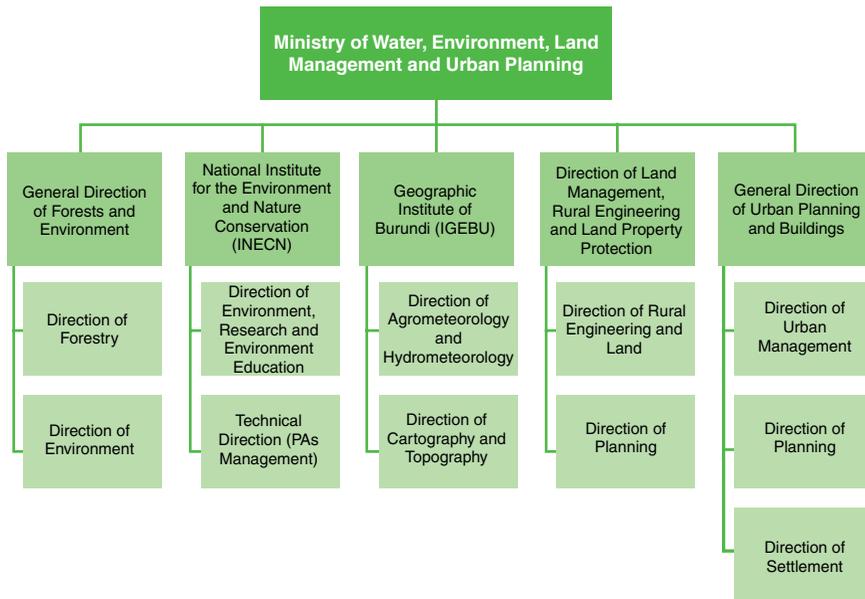
The Ministry of Water, Environment, Physical Planning, and Urban Development

The Ministry of Water, Environment, Physical Planning and Urban Development is the primary ministry that administers and regulates environmental management and protection. The two organizations under MEEATU that are most relevant to the discussions in this CEA are the Office Burundais pour la Protection de l'Environnement (OBPE), which took over the National Institute for the Environment and Nature Conservation (INECN), and the National Institute of Geography (IGEBU). Figure 3.1 describes the organizational structure of MEEATU.

Office Burundais pour la Protection de l'Environnement

The newly established OBPE has a broad mandate:

- enforcing all environment protection–related legislation (water, forest, pollution control);
- following up on and monitoring trade mechanisms and international trade in flora and fauna;
- establishing environmental standards and norms including safeguards for the protection of nature;

Figure 3.1. MEEATU Organization Chart

Source: USAID 2010.

- monitoring and evaluating development programs and their consistency and compliance with environmental standards during the planning and implementation phases, including development projects that may have a negative impact on the environment;
- ensuring and monitoring the implementation of government's obligations under international conventions and agreements relating to the environment to which Burundi is a party;
- identifying and proposing protected areas and other areas of high biodiversity requiring special protection;
- undertaking and encouraging research and accompanying measures for the maintenance of biological diversity; and
- establishing mechanisms for mitigation and adaptation to climate change.

This wide-ranging set of mandates and responsibilities requires resources, which the OBPE seems to lack thus far.

National Institute of Geography

Among its responsibilities and mandates, and in addition to its unique mandate to develop, print, and market Burundi's general and thematic geographical maps, the IGEBU is empowered to do the following:

- plan, develop, and manage the national network of meteorological and hydrological stations;
- gather, control, analyze, store, and disseminate hydro-meteorological data;

- improve the seasonal climate forecasts for early warning;
- establish general forecasts, especially for meteorological assistance to air navigation;
- ensure monitoring and systematic observation in real-time of weather variability and climate change;
- participate in the work on statistical parameters of climate change;
- conduct studies to identify and evaluate aquifers, taking into account the geological configuration;
- develop relationships and exchanges with specialized institutions to promote cooperation in information and training in matters of meteorology and hydrology;
- promote theoretical studies and/or practices that contribute to a better knowledge of meteorology and hydrology in Burundi; and
- provide technical support to the government in matters of negotiation of multilateral environmental agreements and in matters of policy, strategies, and legislation relating to the implementation of the international conventions on climate and water resources.

With these mandates and responsibilities, the IGEBU is the main technical institution to assist the MEEATU to fulfill its core environmental protection and management mandate. The IGEBU is the focal point institution for the UNFCCC in Burundi.

Other Relevant Organizations

In addition, the rules governing the functioning of the MEEATU explicitly stated that in implementing parts of its various mandates, it must coordinate and collaborate with other government departments, including the Ministry of Public Health (MPH); the Ministry of Agriculture and Livestock (MAL); the Ministry of Commerce, Industry, Posts, and Tourism (MCIPT); the Ministry of Energy and Mining (MEM); and local governments. Further descriptions of the institutional framework are found in the appendix, including the roles of local governments and civil society.

Legal Framework of Environmental Protection and Management

Over the years, particularly since 1980, Burundi has adopted a number of laws, regulations, and guidelines to address major environmental issues facing the country. The 2005 Constitution of Burundi²⁰ refers to environmental protection and management in three provisions (articles 35, 159.4, and 293). It states that (i) the government ensures the good management and the rational exploitation of natural resources of the country, while preserving the environment and the conservation of these resources for future generations; (ii) the citizens of Burundi enjoy a right to a clean and healthful environment; and (iii) protection of the environment and conservation of natural resources shall be subject to specific laws.

²⁰Constitution of the Republic of Burundi promulgated by law no. 1/010, March 18, 2005.

Law 01/10 of June 30, 2000, related to the Environmental Code of Burundi (ECB), constitutes a framework addressing all major aspects of environmental protection and management. Other laws and regulations complete the ECB by governing specific sectors, such as the forest (1985 Forest Code). This code states the basic rules for the protection and rational management of the environment. In 2010, the Decree on Environmental Impact Assessment (EIA) was issued. It laid down the content, rules, principles, and procedures for EIA,²¹ which was further completed through a ministerial order on the scoping in the EIA process in Burundi.²² See the appendix for other relevant laws, decrees, and orders.

Public Environmental Expenditure Review

This section presents the Public Environmental Expenditure Review (PEER). Due to the lack of detailed data, the review is based on the budget and expenditures of the MEEATU. There are two immediate caveats. First, not all MEEATU expenditures are directly related to the challenges discussed in the CEA. However, without a detailed breakdown of expenditures by category, it was not possible to isolate pure expenditures on environment protection and management. Second, while the MEEATU has the largest share of environmental expenditures, the Ministry of Agriculture and Livestock also conducts activities related to environment conservation, for example, water retention, epidemiologic diseases monitoring, cropland degradation surveillance, research, pond management, or afforestation with fruit trees. These activities simultaneously target agricultural productivity and environment conservation. Again, the lack of detailed data does not permit the inclusion of expenditures of other ministries in the analysis.

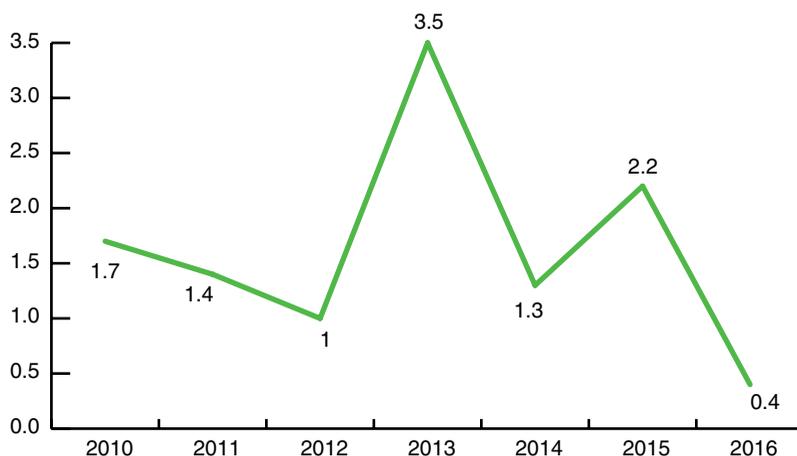
Overall Characteristics and Evolution of Public Environmental Expenditures, 2010–16

Burundi's overall expenditures exceed its domestic financing capacity, bringing about a structural budget deficit and a dependence on donors. Expenditures managed by the MEEATU, which covers the areas related to water, environment, land-use planning, and urban development, appear to vary between 2010 and 2016, but their budget share remains consistently below 2 percent, except in 2013 when it reached 3.5 percent. Over 2010–16, the average environmental expenditures share in the government's budget was 1.6 percent (Figure 3.2). This is consistent with Botswana's average share (1.6 percent) during 2006–11, but less than East African countries, such as Rwanda (1.9 percent) during 2009–13, and Mozambique (4.3 percent) during 2007–10 (Figure 3.3).

²¹Decree no. 100, October 22, 2010, on Environmental Impact Assessment.

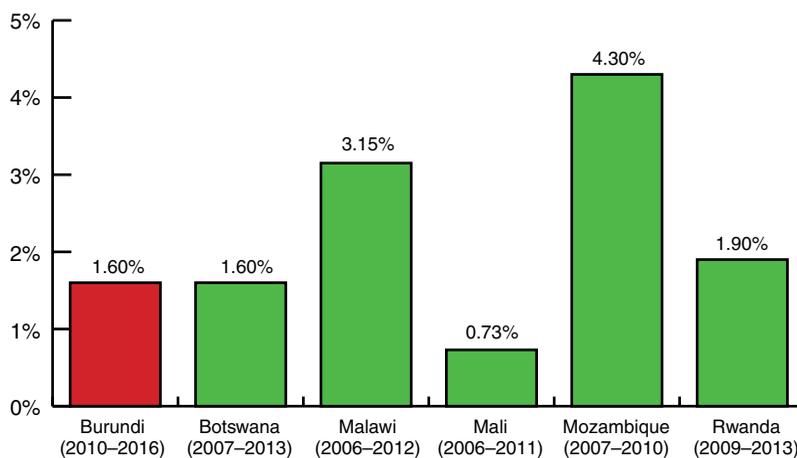
²²Ministerial Order no. 770/083 of January 9, 2013.

Figure 3.2. Evolution of Environmental Expenditures as Share of Government Expenditures, 2010–16 (as a percentage of budget)



Source: Ministère des Finances et de la Planification du Développement Economique 2016.

Figure 3.3. Average Share of Environmental Expenditures in the National Expenditures for Selected Countries (as a percentage)



Source: World Bank (calculation from this PEER) and UNDP-UNEP Poverty Environment Initiative, <http://www.unpei.org/africa-poverty-environment-initiative-regional-support-programme>.

Note: Burundi's environmental expenditures include only the MEEATU budget.

Structure of Burundi's Public Environmental Expenditure, 2011–15

As seen in Table 3.1, capital expenditures, at 59.3 percent over 2011–15, represent the largest share of environmental expenditures. Current expenditures reached nearly 50 percent of the MEEATU budget in 2015, affecting the capital expenditures share. Natural resources protection would nevertheless need

Table 3.1. Structure of the Environmental Expenditures in Burundi, 2011–15 (as a percentage of environmental expenditures)

	2011	2012	2013	2014	2015	Average 2011–15
Current expenditure	41.1	39.3	38.8	35.9	48.5	40.7
Wages	38.1	35.9	36.5	33.7	45.5	37.9
Goods and services	3.0	3.4	2.3	2.2	3.0	2.8
Capital expenditures	58.9	60.7	61.2	64.1	51.5	59.3
Equipment	1.3	2.1	0.9	0.9	1.3	1.3
Studies	0.2	0.2	0.0	1.0	0.2	0.3
Rehabilitations	19.1	20.5	21.6	23.5	13.5	19.6
Constructions	38.2	37.9	38.7	38.7	36.5	38.0

Source: Ministère des Finances et de la Planification du Développement Economique 2016.

investments in equipment, infrastructure, or construction. Pollution and wastewater management represent the largest share of environmental capital expenditures, with 29.7 percent and 18 percent respectively of the ministry's capital expenditure budget.

Overall, economic services are increasingly represented in budgetary decisions. Their share of the total budget is increasing, from 8.6 percent in 2010 to 32.7 percent in 2016. This increase is largely due to the importance of the agriculture and public works and equipment sectors, which are mostly funded by external resources. Among economic services, environmental expenditures are ranked fourth among five, with the Ministry of Commerce (MCIPT) ranked fifth (Table 3.2).

Execution Rate

The MEEATU budget execution rate is weak. As seen in Table 3.3, over 2011–15, the rate reached 35.7 percent on average. Every year, more than 60 percent

Table 3.2. Comparison of Economic Services Environmental Expenditures of MEEATU and Other Ministries, 2010–16 (as a percentage of the total budget)

Year	2010	2011	2012	2013	2014	2015	2016
Ministry of Agriculture	2.5	5.8	5.1	10.3	11.9	11.7	12.3
Ministry of Commerce	1.8	0.3	0.3	0.5	0.3	0.4	0.2
Ministry of Energy and Mines	2.4	2.2	3.2	8.0	6.2	7.7	3.1
Ministry of Transportation	0.2	2.2	1.9	8.0	4.9	5.7	16.7
MEEATU	1.7	1.4	1.0	3.5	1.3	2.2	0.4
Total Economic Services	8.6	11.9	11.5	30.3	24.6	27.7	32.7

Source: Loi de Finance 2011, the Republic of Burundi.

Table 3.3. Execution Rate of the MEEATU Budget, 2011–15 (as a percentage)

	2011	2012	2013	2014	2015	2011–15
Total MEEATU budget	34.4	36	39.5	35.8	32.6	35.66
Current expenditures	67.4	67	76.9	79.6	57.1	69.6
Wages	100	100	100	100	100	100.0
Permanent staff	100	100	100	100	100	100.0
Temporary staff	100	100	100	100	100	100.0
Goods and services	100	100	100	100	100	100.0
Transfers and interventions	64.7	63.8	75.4	78	53.9	67.2
Wages	100	100	100	100	100	100.0
Goods and services	100	100	100	100	100	100.0
Capital	64.1	63.2	74.1	76.7	53.6	66.3
Capital spending	11.4	16	15.8	11.3	9.6	12.8
Water management	26	9.1	9.8	11	12.1	13.6
Waste management	9.4	16.7	9.5	9.1	11.1	11.2
Wastewater management	14	22.8	15.1	15	15.6	16.5
Pollution management	8.9	11.7	17.7	10	5	10.7

of the budget is not spent, meaning that many activities are canceled or postponed. Categories where the execution rate is high are current expenditures, with a 69.6 percent execution rate for the 2011–15 period. Notably, the execution rate reached 100 percent for wages and goods and services purchases.

As current expenditures consume a large share of the budget, the implementation of projects related to capital investment is relatively slow. Hence, over the 2011–15 period, the execution rate was extremely low, at 12.8 percent. This was due to the fact that projects were planned before feasibility studies were completed. This slow execution pace is also the result of institutional capacity weakness, which lengthens tender procedures.

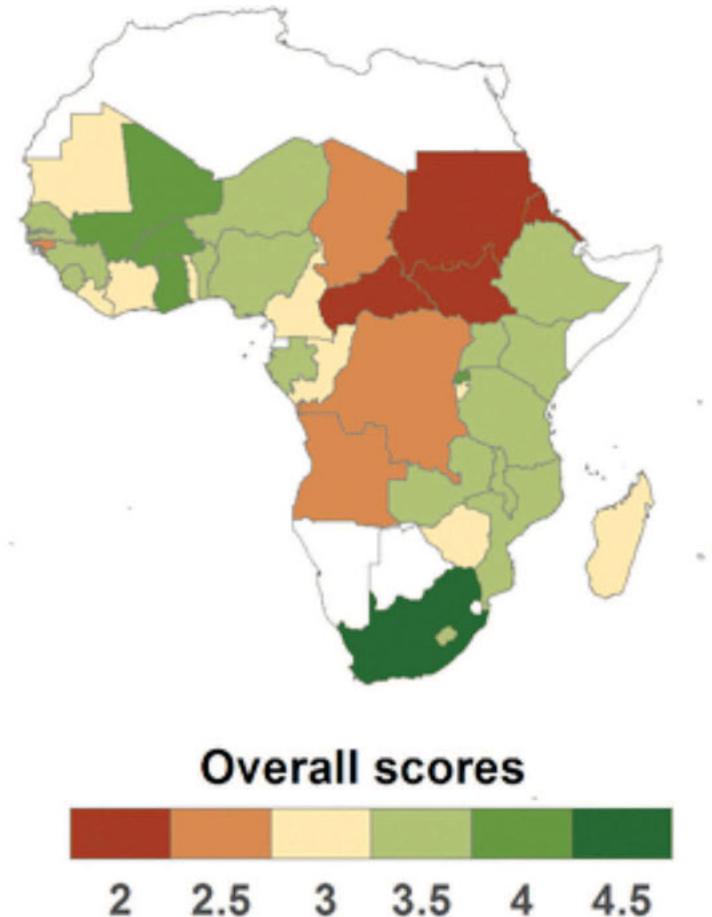
Assessment of Burundi's Capacity to Address Environmental Problems and Recommendations

Benchmarking Burundi's Environmental Policies and Institutions

Burundi institutional difficulties compromise its ability to enforce the environmental laws. The threat encountered by Burundi's environment and natural resources stems in large part from the state's lack of capacity to implement comprehensive sustainable environment and natural resource management

programs. Figure 3.4 shows how Burundi's environmental policies and institutions fare against those of other countries in Africa. Burundi's Country Policy and Institutional Assessment (CPIA) includes a standardized measurement of (i) the appropriateness and implementation of policies across a range of environmental topics and (ii) the strength of cross-cutting institutional systems. Burundi received an overall average score of 3.33, which is above the 2013 regional average of 3.24 (World Bank 2014c). Individual country scores ranged from 2.0 to 4.5, with two-thirds of the countries (28 of 43) scoring between 3.0 and 3.5. Average scores between 3.0 and 3.5 generally indicate that the country has relatively comprehensive environmental policies, but there are gaps between policy and implementation.

Figure 3.4. CPIA for ENRM Scores for IDA Countries in Sub-Saharan Africa, 2014



Source: World Bank 2014a.

Note: ENRM = environment and natural resource management; IDA = International Development Association.

Implementing Legal Framework

The review of legal framework has revealed that the 2000 Environmental Code is yet to be followed by all the needed implementation regulations, without which the code cannot be effectively and completely implemented and enforced. Table 8.1 in the appendix lists the regulations that are necessary to implement the framework of ECB, but are not yet developed or adopted.

Although the EIA decree represents an important step forward, environmental quality norms and standards and other needed regulations and standards are yet to be issued and applied to projects and programs with detrimental environmental impacts. Also, good practice in other countries has shown that governments are well advised to issue sectoral guidelines for EIA. In Burundi, sectoral guidelines for hydropower projects, mining projects, urban development projects, road construction, and other infrastructure development make EIAs easy to complete and ensure uniformity and consistency in content and review processes. A review of the existing documentation shows that EIA is being applied to projects supported by donors, including World Bank-supported development projects. The EIAs for donor-supported projects and activities are subject to donors' policies and procedures, but rarely to a substantive review and approval process by the Directorate of Environment (DOE) and other relevant institutions and stakeholders.

While adopting and implementing these necessary regulations is a priority, so is strengthening the legal infrastructure and capacity to improve the effectiveness of implementation and enforcement. Harmonization among the ECB, sector-specific legislation, and international agreements and treaties to which Burundi is a party are also essential. Further, while the current environmental legal framework is based mainly on command-and-control approaches, to improve its effectiveness, it is important to establish a process for bargaining and negotiations among affected groups and environmental conflict resolution through alternative dispute resolution mechanisms. Finally, the existing legal framework is not conducive to effectively engaging and empowering a local government ("commune") or community for environmental management and protection.²³

Financial Capacity

The PEER has observed that the environmental expenditures are too low to curb the present environmental degradation in Burundi. Chapter 2 indicates that Burundi's cost of environmental degradation represents 12.1 percent of the country's GDP, and it is mostly driven by land degradation, indoor air

²³See the appendix for further discussions on the review of legal framework.

pollution, and water pollution. The conclusion of the PEER can be summarized in the following three recommendations to more efficiently allocate and manage environmental expenditures:²⁴

- Structural policies should include more environmental variables.
- The capacity to mobilize financial resources requires enhanced institutional capacities.
- Creating a special budget for interventions related to natural disasters is necessary.

While the emphasis on environment in the national budget is low, the Burundi budget itself is extremely low, and the economy is declining due to the political crisis and other factors. Given the political and economic environment, it would likely be difficult for the MEEATU and other relevant ministries to substantially increase their budgets to tackle environmental problems. This would necessitate improving the efficiency and effectiveness of allocating and spending limited resources while also securing greater resources for environmental protection and management.

Capacity of OBPE

OBPE is in theory organized as a modern institution to deal with comprehensive aspects of environmental management and protection. It has an Environmental Department, which deals with five main functions in five separate units: (i) environmental education, (ii) environmental assessment, (iii) climate change, (iv) research and development, and (v) environmental regulation. In addition, OBPE has a dedicated Center for Environmental Information, which reports directly to the director general. The number of staff involved seems to be adequate—630 staff, according to a recent report. However, the distribution of staff and expertise across the various units must be subject to a more in-depth review and analysis to ensure that major environmental management and protection functions are covered adequately and that expertise is used to monitor the national environment. This review and analysis must be conducted using an inclusive process that involves major national stakeholders to ensure the ownership of its outcomes and built institutions and to develop laws and regulations that will be commensurate with the challenges facing Burundi now and in the future. Further, as seen in the PEER, the bulk of the environmental public budget is allocated for wages and construction. Accordingly, OBPE critically lacks the resources necessary to implement the wide range of activities for which the institution is responsible, in particular ensuring compliance with environmental regulations. The financial capacity of OBPE must be substantially strengthened to apply the Environmental Code in practice.

²⁴Further discussions are included in the appendix.

CHAPTER 4

Recommendations and a Way Forward

Overall Recommendations

Addressing the Fundamental Issues

While the recommended programs presented in this chapter are specific to the environmental problems discussed in Chapter 2, the CEA reiterates the importance of addressing the fundamental issues discussed in Chapter 1—population growth, conflict and fragility, and climate change—as they define the context and conditions of environmental problems and the effectiveness of their solutions. The country must implement a comprehensive program to tackle its rapid population growth, while the economy must diversify and the urban economy must grow to divert the excessive pressure on natural resources under the current economic structure. Fragility is another sensitive and extremely difficult issue that the country must overcome. Successfully implementing actions to mitigate and adapt to climate change as laid out in Burundi’s NDC is a commitment to the global community, and some of those actions indeed form the recommended programs of the CEA. None of the actions recommended here will be effective unless the root environmental problems are resolved.

Addressing the Causes and Consequences of Environmental Challenges

The diagnostic analyses of the CEA have identified three major areas of environmental challenges in Burundi: deforestation and degradation of rural lands, indoor air pollution, and water pollution. Natural disasters and biodiversity loss may be considered secondary problems caused by these three main challenges. With 90 percent of the population residing in rural areas of the country, many of the solutions to address these problems must be sought in rural areas, even though urbanization is a necessary force to change the country’s development trajectory. Essentially, the way rural activities are conducted must drastically change. Further deforestation must be

stopped, agricultural production must adopt sustainable practices, the cooking process in rural homes must become cleaner, and the damaged environment must be repaired.

Both the causes and the consequences of the identified problems must be addressed. Where the effects of environmental damages are acute and threaten lives and livelihoods, physical restoration is a priority. Restoration will include a suite of activities: planting trees on deforested and fragile terrain, restoring soil nutrients on eroded lands, cleaning up the polluted water, and so on. Given the scale of the damages to Burundi's environment, restoration efforts will require substantial time and resources. Essentially, a proposed World Bank project, Burundi Landscape Restoration Project, though a US\$50 million effort, will cover only a small part of the required effort. Urgent commitments of larger-scale funding are necessary.

To prevent further damages and to reverse the trend, the causes of the problems must also be addressed simultaneously. There are technical solutions to some problems, as discussed in the next section, such as adoption of sustainable agricultural practices and use of clean cooking technologies in homes. But fundamentally, policy and institutional arrangements must (i) ensure that the environment is appropriately safeguarded against expansive forces, such as population growth and localized fragility, and (ii) encourage the adoption of those technical solutions. This will imply, among other things, that the land tenure regime needs to be reviewed and reformed. To design effective institutional arrangements for environmental management, intricate factors that affect interactions between people and the environment—most importantly poverty and fragility—must be better understood.

A constant factor underlying environmental problems in Burundi is the clear link between environmental issues and poverty. Poverty is behind the high rates of deforestation, the excessive fragmentation of land, and the use of unsustainable agricultural and animal husbandry practices. Poverty also explains an informal mining sector with significant environmental impacts, as well as biodiversity degradation due to the encroachment in protected areas and the hunting of wild animals. The high costs resulting from and countering indoor air and water pollution—the use of firewood and the lack of sanitation facilities across the country—are strongly linked to poverty. Consequently, the CEA stresses the importance of reducing poverty to help improve Burundi's environmental sustainability. The ultimate question then is how can Burundi significantly grow its economy and reduce poverty? Burundi must investigate the potential sources of growth and their associated environmental and natural resource risks so the country can plan a development trajectory for inclusive and sustainable growth adapted to its particular conditions.

Holistic Approach at Landscape Level and Building Resilience

In pursuing actions to address the causes and consequences of environmental problems, a more integrated approach to inclusive and sustainable development

will be useful. Moving from its current sectoral approach, Burundi can adopt a holistic approach that considers the entire landscape, including all relevant environments and people, and focuses on building the resilience of the overall system for the ecosystem and for the community. A landscape approach will consider the intricate interactions between human activities and the environment and their physical impacts and socioeconomic links across the landscape. Widespread poverty among the population is a critical underlying factor, and thus needs to be at the center of designing and implementing intervention activities. Resilience means the ability of a system to recover after a shock, and both the environment and the people need to build their resilience. In particular, enhancing the ability of people to cope with shocks is an important part of resilience building for communities. The focus on resilience building is most relevant in the context of adapting to climate change and fragility surrounding local conflicts (Rwabahungu, Niyonkuru, and Bukobero 2013). Note that the notion of a landscape approach to inclusive and sustainable development includes the concept and process of integrated water resources management (IWRM), as water resources are an integral element of a landscape. Note also that the problems identified in the CEA also cut across various sectors of the economy. In particular, the problems are shared across the agriculture, public health, energy, and infrastructure-related sectors. Box 4.1 describes the World Bank's approach to resilient landscapes.

Complementarity of State-Led Initiatives and Community-Based Programs

The implementation of a landscape approach to resilience building can be pursued with collaboration among the state and local communities. Communities often have the best local knowledge of relevant landscapes, and a community-based, bottom-up approach seems more practical when the capacity of government institutions is limited in delivering effective programs. On the other hand, existing regulatory frameworks and mechanisms that are effective may be suitably mobilized for supporting and facilitating the delivery of community-based programs. As discussed in the next section, the CEA views the role of value chains as essential in catalyzing some necessary changes. The state can facilitate the process by ensuring there are enabling conditions for the private sector, community, and individuals to engage.

Raise Public Awareness on National Environmental Challenges through Environmental Education

To decentralize the environmental management effort, a program to implement a national awareness campaign will help inform people at all levels of society on environmental issues. The awareness campaign must be able to explain to the various segments of the population the socioeconomic and environmental benefits derived from the development, implementation, compliance with, and updating of the main environmental policies and laws. Such an awareness

Box 4.1. World Bank's Approach to Resilient Landscapes

The world's multidimensional challenges of poverty, population growth rates, land degradation, deforestation, unsustainable watershed management, climate variability, unsustainable land use, migration, and fragility have undermined its resilience to natural and economic shocks. These challenges require integrated solutions across boundaries. The World Bank Group (WBG) is increasingly supporting its country clients to implement a more integrated landscape approach that moves beyond single-sector interventions to take into account the resilience of both ecosystems and livelihoods. WBG believes this is the most efficient means of support, given the complex interlinks among the different components of natural capital. It is essential that the communities understand and adapt to their reality—that they are all connected by the landscape.



Wide-Scale And Mosaic Restoration Opportunities

Source: https://www.iucn.org/sites/dev/files/import/downloads/roam_handbook_lowres_web_singlepage.pdf.

© IUCN/Michael Verdone

The landscape approach refers to taking both a geographical and a socioeconomic approach to managing land, water, and forest resources that form the foundation for meeting the goals of food security and inclusive green growth. It is about land-use planning and then connecting protected areas, forest, woodlands, agro-silvo-pastoral lands, watersheds, croplands, and irrigated agricultural lands for the provision of ecosystem services, adaptation to climate change, and increased productivity.

Implementing the landscape approach toward creating resilient landscapes that provide the full range of services for productive sectors and livelihoods requires long-term collaborative action at scale. A landscape approach typically means that, for development projects across sectors, planning takes place on a much larger scale to enable stakeholders to see the bigger picture in terms of upstream-downstream links, externalities, market links, hotspots, and priorities for investments. The landscape approach also requires:

- the coordination of planning and management decisions across a range of sectors and stakeholders;
- supportive policies and regulations;
- investments in effective programs;
- capacity building to generate learning and replication of good practices; and
- strategies for scaling up successful programs.

The WBG's landscape approach builds on three core principles: the existence of a key common goal within a landscape, the need for adaptive planning and management, and the opportunity for collaborative actions.

campaign would fund a wide variety of activities within existing government and nongovernment organizations, including schools, universities, research institutions, women and youth organizations, and community organizations. The awareness campaign needs to involve activities ranging from training courses, seminars, workshops, and public meetings to rallies, exhibitions, essay competitions, debates, poster contests and traditional folk activities, and include the production and distribution of environmental education resource materials.

Specific Recommendations and Priority Programs

Chapter 2 discussed various aspects of the environmental challenges faced in Burundi. The major causes and major consequences, as summarized in Table 2.1, must be addressed to reverse the direction of development toward a more sustainable path. This section recommends several priority programs that emerged from the analysis as well as those cited in key references.²⁵ Recommended programs are discussed in three dimensions: technical, behavioral, and policy/institutional dimensions (Table 4.1).

- **Technical:** Recommended technical options are based on the specific nature of the problems in Burundi, as well as on the successful experiences of other countries. For the purposes of this CEA, simpler and concrete options are favored as opposed to complex, longer-term solutions.
- **Behavioral:** Many of the identified problems in Burundi are caused by undesirable actions by individuals (for example, tree cutting, intensive land use, poor hygiene) whose aggregate outcomes can be catastrophic on a larger scale as well as on an individual level. Thus, to ensure that effective technical options are adopted by individual users and that the results of landscape-level technical interventions are sustained, behavioral change must be promoted at the same time. Little is known about what influences individual decision making in the topics discussed in the CEA, and systematic studies and experiments are necessary to determine appropriate instruments and mechanisms for each problem.
- **Policy/institutional:** The key roles of the public sector are to (i) provide regulatory oversight to deter actions that harm the environment, (ii) develop and provide services that replace the causes or mitigate the consequences of environmental problems, and (iii) create enabling conditions for innovative ideas and opportunities to be exploited and conducive to action. Available tools to support these roles are also discussed.

²⁵Including Cervigni and Morris (eds.); Consultative Group for International Agricultural Research 2016; World Bank 2016a; World Bank 2016d.

Table 4.1. Summary of Recommended Programs to Address Environmental Problems in Burundi

Problems	Recommended Programs		
	Technical	Behavioral	Policy/Institutional
Deforestation, land degradation	<ul style="list-style-type: none"> Erosion control Sustainable agricultural practices Improved forest management 	<ul style="list-style-type: none"> Study on constraints/motivation for investment in land Value chain development 	<ul style="list-style-type: none"> Land certification Restoration opportunities assessment methodology (ROAM)
Indoor air pollution	<ul style="list-style-type: none"> Ventilation (installation of windows) Cleaner cooking technologies (fuel, stove, pots) 	<ul style="list-style-type: none"> Awareness raising Value chain approach (development and distribution of fuel, stove, pots) 	<ul style="list-style-type: none"> Enabling conditions for cleaner cooking development and adoption Cleaner and renewable energy development (propane, biogas, solar, hydropower)
Water pollution	<ul style="list-style-type: none"> Hygiene/sanitation technologies Water-saving technology in agro-industrial processing 	<ul style="list-style-type: none"> Hygiene education Value chain development Community participatory monitoring 	<ul style="list-style-type: none"> WSS sector services Regulation of agro-industrial plants EIA
Climate change, natural disaster	<ul style="list-style-type: none"> Technologies of adaptation and response Household income/asset diversification 	<ul style="list-style-type: none"> Study on household income/asset diversification Study on risk and insurance 	<ul style="list-style-type: none"> Implementation of NDC Disaster risk management (DRM) tools

Deforestation and Land Degradation

Technical Options

Erosion control. There are known technical solutions to address the degradation of rural lands. First, coordinated efforts should focus on controlling soil erosion on agricultural lands, especially in areas susceptible to landslides. Terracing has been used for centuries to increase crop yields, restore degraded land, and protect human settlements from landslides and are therefore recommended to help Burundi reverse its land degradation. Targeted and strategic restoration of vegetation cover (for example, planting trees for windbreaks) is another important option for erosion control. Though labor-intensive, these methods have been effectively used to maximize arable land area in variable terrains and to reduce soil erosion and water loss. Terracing may also enhance the sequestration of atmospheric CO₂ into the soil (CGIAR 2016). Given the abundant labor in Burundi, these projects can be completed by public works, providing temporary employment to rural residents. Box 4.2 describes managed fire as another technical option for land restoration.

Sustainable agricultural practices. To prevent further soil erosion and to restore and maintain soil fertility on agricultural lands, various aspects of agricultural practices must be drastically improved. Agroforestry is an example of a

Box 4.2. Wildfire as a Tool of Land Restoration

Most fires in Burundi are of anthropogenic origin, even though natural fires do occur as a result of lightning strikes, particularly in national parks (for example, Ruvubu National Park). Setting brush fires is an oft-performed means of clearing land for agriculture (slash-and-burn) or for pastoralism (clearing of savanna). These man-made fires often run uncontrolled and can create significant damage as a result, especially when burning occurs at the wrong time of year, that is, at the end of the dry season, and if there has been no fire previously and the grass sward has a high biomass. Uncontrolled man-made fires at the wrong time of the year are usually detrimental from an ecological point of view. The damages are substantial, especially when they are coupled with the degradation of natural forest that opens to the tropical montane rainforest lower canopy and, more importantly, the ecotones between such habitats (such as the ecotone of the Kibira Forest National Park) and thus promotes unnatural levels of low humidity. If a wildfire progresses toward a degraded natural forest at the end of the dry season, this would be a significant problem.

However, man-made fires can also be helpful. If the fire coincides at a good time of year and the conditions are appropriate, brush fires can have substantial ecological benefits. They can promote tree cover, improve soil fertility, and increase the availability of significant grazing land. In other words, careful actions to properly manage wildfires can influence the direction of the species composition in the vegetation mix and thus can be used as a tool to restore degraded lands in combination with other measures.

Sources: Sankaran, Hanan, and Scholes et al. 2005; Bond and Keeley 2005; Bond, Woodward, and Midgley 2005.

beneficial investment in sustainable land use, which involves deliberately integrating woody perennial plants (trees and shrubs) on agricultural lands (NAPA 2007).²⁶ One such agroforestry method is farmer-managed natural regeneration (FMNR), under which farmers identify naturally regenerating tree seedlings in their fields and actively manage them to provide various benefits (for example, fuelwood, livestock feed, and ecosystem services; Winterbottom, Reij, Garrity, et al. 2013). In Burundi, cultivation of shade-grown coffee is a promising viable option for agroforestry and is promoted under an ongoing World Bank project, the Sustainable Coffee Landscape Project (PAZDOC). Coffee is the country's primary export commodity, accounting for more than 60 percent of all export earnings on average. Combining the production of this important cash crop with cultivation of other trees (for example, banana and citrus) provides additional sources of income, while generating important ecosystem services (for example, habitat, biodiversity, and soil integrity; World Bank 2011a).

Improved agricultural productivity also helps reduce pressure on lands as it reduces the intensity of land use. For example, improved milk yield per cow allows the reduction of the number of cows to keep in a given grazing area

²⁶Marc Rwabahungu et al.

without much affecting the quantity of milk produced. With a reduced grazing pressure, dairy cattle production can be more beneficial for the land as the manure helps soil fertility to recover. Similarly, improving crop yield can allow farmers to adopt sustainable practices, such as proper crop mix and rotation with fallowing, allowing soil fertility to restore.

Improved forest management. State-run woodlots, representing much of the remaining forests in Burundi, are not properly managed. In fact, they have lent themselves to state predation—by local police and government authorities—as well as local populations, who do not seriously follow the injunction to not use these areas (see the deforestation section of the appendix). Improper management of Burundi's forest plantations is largely the result of a lack of widespread agronomic training, and the situation must be reversed (Rwababunga, Niyonkuru, and Bukobero 2013). Similarly, the management of protected areas (PAs) must be improved. In 1980, 14 PAs were created, but only 4 of them have legal delimitations. The creation of PAs has often resulted in the exclusion of the local population that either lived inside the areas or were highly dependent upon them. This has resulted in tension and illicit forest use (USAID 2010). However, as seen in Box 4.3, with improved management, PAs can be conducive to land restoration and preservation of biodiversity.

Promoting Behavioral Change

While some technical options discussed here are to be promoted within public or donor-funded projects implemented at the landscape or community level, others must be implemented as initiatives of individual farm households, especially the introduction of sustainable agricultural practices. Given that these practices are not commonly observed in Burundi today, interventions will be necessary to encourage farmers to adopt the new sustainable methods. This requires behavioral change on the part of the farmers. A wide array of knowledge and tools exist in the area of promoting behavioral change (for example, *World Development Report (WDR) 2015*), and they need to be incorporated in the search for appropriate designs of an instrument or mechanism to encourage farmer adoption of sustainable practices. However, what works most effectively for specific situations in Burundi must be found through targeted research and investigation. In this case, the essential step is to learn what prevents Burundi farmers from adopting those technical options and what would motivate them to adopt such practices. Do the farmers lack knowledge? Do the farmers' cost-benefit calculations persuade them it's not worthwhile? Are the risks of adopting a new method the major obstacle? How is poverty interacting with farmer decision making? How about social norms? As is discussed in Chapter 11 of *WDR 2015* (World Bank 2015b), there are techniques to experiment with different project designs to gain insights into the farmers' perspectives during project implementation, with subsequent adjustments in project designs. A tool called "impact evaluation" has already been adopted in PAZDOC. Similar efforts in other projects are expected to improve the delivery of development projects by better targeting scarce resources and utilizing more effective delivery mechanisms.

Box 4.3. Progress in Protected Area Management in Burundi

As one of its activities, the Sustainable Coffee Landscape Project (PAZDOC) supports the improvement of the protection and management of the Bururi Natural Forest Reserve (RNFB). Around 23,000 people live next to the reserve, and most rely on its natural resources for their livelihood. Given the land scarcity and the increase in several crops' profitability (including coffee), this protected area faces a risk of agricultural encroachment. Pilot projects have thus recently been developed to study the interrelations among coffee, protected areas, and biodiversity. This would enable the stakeholders to reach an agreement on the RNFB borders and reduce the risk of agricultural encroachment on the reserve. Based on discussions with the OBPE, which is in charge of the national protected areas management, these pilot projects focus on the following activities: (i) setting up an RNFB management and zoning plan, (ii) establishing the physical dividing line of the reserve, (iii) restoring the reserve's headquarters, (iv) purchasing relevant equipment, (v) setting up monitoring stations, (vi) training reserve staff, (vii) offering ecology education, (viii) following up on ecological and socioeconomic issues, (ix) supporting law enforcement, (x) promoting sustainable livelihoods for local communities, including the Batwas, and (xi) **implementing the chimpanzees' habituation.**

Positive outcomes are already observed. A specific tool (named the METT) assessed the efficiency of the RNFB management at 76 percent in 2015, which represents a great achievement compared to 2013 (39 percent) and 2014 (53 percent). The reserve protection was also characterized by the planting of 200,000 forest and agroforest plants, including 150,000 native species and 50,000 *Eucalyptus grandis* plants. At the end of the second quarter of 2016, 74 hectares of the RNFB were restored and 30 hectares of private afforestation occurred on 424 local farms. It is also noteworthy that the local community is increasingly involved in biodiversity protection efforts, as they tend to gather in associations protecting their rights, and 80 employees are working daily on the restoration of degraded sites.

Source: République du Burundi 2016.

In the case of coffee production, the international coffee value chain appears to be a promising mechanism that can catalyze changes in the behavior of individual coffee producers. The supply chain can be used as a powerful mechanism to communicate relevant information (for example, about technologies, know-how, and markets) to participating actors, including consumers. A coffee value chain begins with the natural resources (for example, land and water) and the primary production of growing coffee, followed by the processing of the raw material and various distribution channels of the products, and finally reaching the consumer. Direct or indirect collaboration with coffee consumers that value sustainable processes of coffee production can be an effective mechanism of engaging coffee producers and processors and promoting sustainable practices in Burundi. Certification is one method of carrying out indirect collaboration with final consumers.

Roles of Policies and Institutions

Due to confusing laws regarding land titles, interacting with poverty, it is unlikely that producers are willing to take risks and experiment with alternative practices on their lands unless they are given some institutional assurance or shown the direct benefits of adopting such practices. Although such a conclusion cannot be decisively drawn without a rigorous analysis, observers generally agree that Burundi needs serious agricultural land reform to address the increasingly fragmented farm size and the associated problems (for example, loss of scale economies and accelerated land degradation). Clear and secure land titles, or certificates for the short term, constitute a critical enabling condition for farmers to invest in their lands. Providing this and other enabling conditions for rural individuals and communities (for example, value chain development) is a critical role of the recommended policy so that the implementation of the recommended technical options are facilitated and aligned with the interests of individual producers or those of communities.

While comprehensive land reform would not occur quickly, for the short term, tools can be used to improve the effectiveness of interventions addressing deforestation and land degradation. In particular, the Restoration Opportunities Assessment Methodology (ROAM; IUCN 2016) provides a framework for countries to quickly identify and analyze areas that are suitable for forest landscape restoration (FLR) and to determine specific priority areas at a national or subnational level. For example, ROAM is capable of (i) identifying priority areas for restoration, (ii) listing the most relevant and feasible restoration intervention types across the assessment area, (iii) quantifying costs and benefits of each intervention type, (iv) estimating the values of additional carbon sequestered by these intervention types, (v) analyzing the finance and investment options for restoration in the assessment area, and (vi) diagnosing “restoration readiness” and strategies to address major policy and institutional bottlenecks. ROAM can also be used to identify the intervention needs to address land degradation around refugee camps. The return of refugees likely will pose complex issues for Burundi in the years ahead, including from an environmental perspective. The return of those displaced in 1972 and 1993 caused great pressure on sensitive lands, including protected areas. This has caused the degradation of protected areas and sensitive watersheds, especially when returnees have inevitably expanded the agricultural horizon (USAID 2010; Rwabahungu, Niyonkuru, and Bukobero 2013).

Box 4.4 describes an integrated approach that incorporates interventions in the three dimensions—technical, behavioral, and institutional—applied to the land restoration problem in Ethiopia.

Box 4.4. Ethiopia's Experience with Landscape Restoration

The vast majority of Ethiopians rely on natural resources for their livelihoods. However, the resources were degraded for decades. In particular, the degradation of agricultural lands lowered productivity and water availability, entrenching food insecurity and rural poverty. While agriculture employs over 80 percent of the population, 40 percent of crop and pasturelands have been severely degraded, with another 20 percent now facing degradation. Open grazing, firewood demand, and unsustainable crop production all exert pressure on land resources, interacting with the effects of climate change. Land tenure insecurity also undermines investment in long-term land productivity.

Since 2008, Ethiopia has developed, in partnership with the World Bank, a set of land management techniques through the Sustainable Land Management Project (SLMP). Taking an inclusive, community-based integrated watershed management approach, the SLMP has helped scale up landscape restoration in 142 districts via an integrated package of solutions designed to break the degradation-poverty cycle. Technical measures in the package include terracing, closure of pastures to regenerate tree and vegetation cover, reforestation, gully reclamation, and woodlots. The project also aims to support livelihoods and promote better crop and livestock management practices for climate-smart agriculture, all toward building community resilience to shocks related to climate change. It also supports land-use and watershed planning, land tenure certification, and infrastructure, such as small irrigation and rural roads.

There is evidence that these activities directly resulted in increased land productivity, restoration of the overall environment, and improvement of livelihoods. Key outcomes include:

- Since 2008, sustainable land management practices are being applied on 260,000 hectares of crop and grazing lands (including both individual lands and communal lands).
- Agricultural productivity increased by an average of 10 percent during 2008–13; yields for major crops increased in all participating watersheds in 45 districts.
- Protective vegetation cover increased by 9 percent during 2011–13.
- Soil carbon content increased from 1.9 percent to 2.5 percent during 2009–13.
- Expanding vegetation cover and increasing soil carbon content together implied improved ecological function and agricultural productivity potential in the participating watersheds.
- With an experimental issuance of land certificates, the sense of tenure security increased among many of the farmers who received certificates.
- Land under small-scale irrigation increased by 2,800 hectares during 2009–13.
- Farmers engaged in income generation activities (for example, beehives, goat and sheep raising, poultry and horticulture production, and dairy products) increased by 69 percent during 2008–13; 40 percent were female beneficiaries.

Source: World Bank 2016b.



Indoor Air Pollution

Technical Options

Ventilation. To the extent that indoor air pollution is leading to a substantial number of deaths among children and adults as well as acute and chronic health conditions, ensuring improved ventilation in homes may be the immediate action to be recommended. Simply by installing windows, improved ventilation has the potential to reduce household exposure to particulate matters by 20–98 percent in laboratory settings and 31–94 percent in field settings (Barnes 2014). However, improved ventilation is only a short-term remedy, and not a long-term solution. Ventilation will not change the amount of particulate matter released into the air or the total GHG emissions.

Cleaner cooking. Improvement of household fuel and cooking stoves are two of the medium- to long-term solutions. Both objectives of making traditional cooking cleaner and making modern cleaner cooking available and affordable should be pursued in parallel, depending upon the targeted segments of the population. With regard to traditional fuel, fuelwood, which should be produced sustainably, can be sufficiently dried before burning to reduce the amount of smoke as a short-term measure. Production of charcoal, which burns more efficiently than fuelwood and hence reduces the amount of wood used as fuel, must be increased using more sustainable methods. With regards to modern energy, Burundi is committed to increase its hydropower electricity generation, as indicated in its NDC. However, national electrification is a long-term process, and the promotion of other types of fuel and

cooking stoves will be a more practical solution. The replacement of traditional stoves is also indicated in the NDC. Many types of clean stoves have been developed that combine environment and public health objectives, including those that use electricity (for example, battery, solar power), liquid fuel (for example, ethanol), and gas (for example, propane, biogas).²⁷ Box 4.5 describes the challenges of cooking fuel and stoves faced in refugee camps in Burundi.

Promoting Behavioral Change

Again, the challenge is how to convince Burundis to adopt cleaner cooking. International experiences show that people can be inflexible in switching cooking methods. The distribution of cook stoves with no or low cost has not

Box 4.5. United Nations High Commissioner for Refugees (UNHCR) Improved Cook Stove and Briquette Distribution in Burundi

The environment in Burundi has been negatively impacted by over-reliance on firewood and charcoal as cooking fuel. Until October 2013, refugee camps were among the largest consumers of firewood for cooking fuel in Burundi, alongside military settlements, prisons, and schools. UNHCR now provides firewood to refugees in camps, reducing the protection risks faced by women and girls as they ventured into unsafe territory to collect firewood or to produce charcoal. Unfortunately, continued distribution of firewood to all refugees will exceed the capacity of Burundi's forests in the near future. The Burundi government has raised this issue with UNHCR, and has asked that its plans reflect environmental protection. UNHCR has begun to replace firewood with briquettes as a means of reducing deforestation and preventing tension with the host community.

The project started before UNHCR and its partners had the skills to evaluate the performance of cooking stoves and briquettes. After attending a training in Rwanda hosted by the Global Alliance for Clean Cookstoves, the staff realized they needed to test both the stoves and the briquettes. For example, refugees still complain about excess smoke produced by the briquettes, when properly made briquettes should not increase indoor air pollution. A Kitchen Performance Test (KPT) is needed to test the stoves and improve the quality of both stoves and fuel in order to effectively and efficiently meet the fuel and energy objectives. Stoves built outside communal kitchens were often broken into by thieves who stole the iron bars inside. A total of 344,034 kg of briquettes were distributed to refugees each month in the four camps, which cost 130,732,920 BIF (about US\$79,232). In the current financial context, it will be a challenge to secure these funds. Further proposals should include the possibility of building briquette production units in or around camps as a form of income-generating activity. This SAFE (Safe Access to Fuel and Energy) project also needs to include the host communities as direct beneficiaries so as to strengthen existing relationships between Burundians and refugees.

Source: Safe Access to Fuel and Energy (January 5, 2017).

²⁷Global Alliance for Clean Cookstoves, <http://cleancookstoves.org/>.

been effective, and a phenomenon called “stacking” (possessing many different cooking devices but not necessarily using them) has been common. In the case of cook stoves, ensuring that the appropriate fuel is available and that the stoves are used properly is another important aspect of promotion programs. Sustained effort is necessary to influence behavioral change, including an awareness raising campaign.

It is recommended that promotion of cleaner cooking should be conducted in a market-based approach. For example, a successful ongoing World Bank project in Bangladesh places an initial focus on establishing robust distribution channels of simpler stoves.²⁸ Once the distribution channels are stronger, more sophisticated stoves could be sold. A study is necessary to determine what will work most effectively in Burundi, but it is likely that a successful program will be consumer driven and take into account the entire value chain, that is, from fuel collection or production of charcoal and other types of fuel, to the use of a stove for home cooking, and thus be receptive to the needs of women or those in charge of household cooking.

Roles of Policies and Institutions

Burundi’s NDC lists two important energy-related goals: (i) the replacement of traditional cook stoves and (ii) increased electricity supply from hydropower. To successfully achieve these goals, Burundi must approach them in a realistic time frame. For example, the immediate objective may be to improve the use of the current cooking methods (for example, ventilation of homes, adequate drying of fuelwood). In the short to medium term, the production and use of charcoal may be encouraged. The development of other clean renewable energy sources, such as solar power, should also be pursued. In the medium to long term, clean stoves operated with electricity or gas may be promoted. National electrification will only be achieved in the long term. In the case of promoting efficient and clean cook stoves, enabling conditions for value chain development is essential to promote a range of activities from productive development to innovative distribution.

Further, Burundi must approach these efforts within the intricate links that occur on the landscape in mind. In particular, the efficiency of hydro-power plants can be significantly affected by upstream land degradation. As mentioned in Chapter 2, hydroelectric dams in Mugere and Rwegura are already affected by large-scale erosion (MEEATU 2011). Improving upstream land management, therefore, is a matter of energy security in Burundi. And yet, those farm households whose agricultural activities contribute to the land degradation are not connected to the national electricity grid; they are the target of the cookstove replacement goal. This

²⁸This project built on existing channels for promoting solar home systems.

disconnection likely gives rise to difficulties in coordinating the activities and interests of the energy and agriculture sectors. An important role of the policies and institutions, therefore, is to provide effective coordination mechanisms, while ensuring that these links are addressed in the national energy planning.

Water Pollution

Hygiene and Sanitation

As stated in Chapter 2, public health is substantially compromised due to unsafe water in Burundi. The utmost priority is to improve hygiene practices in cities and rural towns to reduce concentrated contamination of water bodies, which would in turn reduce the burden of the WSS sector in supplying safe water. Technical options must be sought in the appropriate landscape contexts. For example, use of biogas and bio-latrines technologies could be piloted with collaboration by the public health, WSS, and agriculture sectors, with the latter as the receiver of organic fertilizer generated as a byproduct. Again, behavioral change in hygiene practices of individuals lies at the bottom of the success of such programs. The policy's role is to ensure such landscape-level collaboration across sectors is institutionally supported. Box 4.6 describes Malawi's vision in WSS sector development.

Pollution from Agro-Industrial Plants

Technical options and good practice guidelines exist in relevant agricultural processing industries (for example, palm oil extraction, coffee processing). For example, in the coffee industry, coffee-washing equipment that uses less water and a water treatment system that adequately filters wastewater before discharging into the stream can be introduced. In the case of Burundi, however, the issue is how to encourage local processors to adhere to such guidelines as a routine, rather than as a rarity. Regulatory needs are great to facilitate widespread adoption. As discussed in Chapter 3, some key regulations for managing agro-industrial plants have not yet been adopted, and these are of the utmost priority. In addition, Burundi can effectively use EIAs, which are supported by the decree issued in 2010. While the discussions seem to focus on its use in the energy sector, a widespread application will be beneficial, including in the agro-processing industry. There is indeed a need for sectoral EIA guidelines to ensure that specific content for EIAs in the various sectors and the review and approval processes are defined and consider the specific issues of each sector (see the appendix for further discussions). Again, in the case of the coffee industry, collaborating with an international coffee value chain will likely be an effective way to catalyze behavioral change (for example, adherence to good practice guidelines). Further, because water pollution by agro-industrial plants is sometimes visible, community-based, participatory surveillance programs may be useful to deter undesirable activities by these plants. The public sector can facilitate such activities by providing necessary and timely institutional support.

Box 4.6. Malawi's Progress toward Its National Water Policy Vision: "Water and Sanitation for All, Always"

With 84 percent of Malawi's population living in rural areas, rural water supply remains a key priority both for the social and economic development of the country. In 2011, about 16 percent of Malawians did not have access to a clean water supply and 47 percent did not have access to improved sanitation. Safe hygiene practices remain insufficient, resulting in a high prevalence of water and sanitation related diseases: in 2011, 11 percent of the rural population suffered from diarrhea due to poor water and sanitation, and diarrheal diseases are the second highest cause of mortality (18 percent) of children under age five. This, in turn, contributes to poor health, loss of productivity, and deepening poverty.

As the country needs to increase its efforts to achieve its national water policy vision of "Water and Sanitation for All, Always," the Sustainable Rural Water Infrastructure for Improved Health and Livelihood (SRWSIHL) project has been developed by the African Development Bank and is financed by the ADF (African Development Fund), NTF (Nigerian Trust Fund), RWSSI (pan-African Rural Water Supply and Sanitation Initiative) and the government of Malawi. It is estimated to cost UA 25.61 million and will be implemented over a period of five years beginning in the second half of 2014. The project comprises three components:

1. Water infrastructure development
 - Rehabilitation and expansion of 12 gravity-fed schemes
 - Construction of 600 m³ localized storage reservoirs and break pressure tanks
 - Construction of 2,925 communal water points
 - Construction of 450 new boreholes
 - Catchment protection and management
 - Twelve Catchment Management Committees formed and trained, 50 percent of the members are women and 30 percent of the leadership positions are held by women
 - Establishment of five ground water monitoring and eight hydrometric stations
 - Rehabilitation of two water quality laboratories
 - Design and supervision services
2. Sanitation and hygiene
 - Promotion and education on health and hygiene in water and sanitation
 - Construction of 166 sanitation facilities at public institutions (schools, health centers, and market centers) disaggregated by sex and for those who are physically challenged
3. Capacity development and project management
 - Training of district coordination teams and extension workers
 - Capacity building of water users associations (WUAs) and water point committees (WPCs), 60 percent of the members are women and 30 percent of the leadership positions are held by women
 - Construction of district WASH (water, sanitation and hygiene) offices and staff houses
 - Rolling out operations and maintenance (O&M) framework
 - Strengthening of maintenance and engineering systems, including training in collecting, analyzing, and reporting on gender and social issues
 - Review of the National Water Policy and review of the policy's gender and social equity dimensions
 - Preparation of a gender-responsive district WASH investment plan
 - Impact evaluation of the National Water Development Project
 - Project management, monitoring, and reporting system with gender and social indicators
 - Audits

Under this intervention, approximately 516,000 people in marginalized rural areas will have access to an improved water supply and 575,000 to improved sanitation, helping the government of Malawi meet its objectives.

Climate Change and Natural Disasters

With the increased frequency and severity of natural disasters anticipated due to climate change, the county must be better prepared for these incidents, and individuals and communities must build resilience to shocks. At the individual household level, resilience can be strengthened by diversifying households' income sources and asset bases, as this will increase the ability of households to cope with shocks (Hallegatte et al. 2015). Understanding how rural farm households can achieve this and what the major constraints are important first steps. While successfully implementing the NDC is an international obligation, the country must also strengthen its disaster risk management (DRM) framework and its capacity for preparedness and effective response to natural disasters. For strategic recommendations, knowledge management capacity should be strengthened rapidly, and sharing of responsibilities across ministries and government agencies would require updated operational procedures.²⁹ It is urgent to develop operational procedures to define the role of ministries, directorates, and technical services for knowledge management,³⁰ maintenance,³¹ prevention, and rehabilitation.³² The development of national disaster loss databases is the crucial first step to generate the information necessary for risk estimation and to inform public investment planning. Restoration of the hydro-meteorological information system is also essential. Box 4.7 describes Uganda's plan to improve its DRM system.

Concluding Remarks

To the extent that most of Burundi's population resides in rural areas and that most of the environmental challenges are concentrated in the rural landscape, any intervention targeted for rural residents or landscape essentially would involve in some way the recommended actions discussed in the previous section. Table 4.2 lists the ongoing and pipeline projects of the World Bank. The total amount for these projects is estimated at US\$1.12 billion, which still represents only a portion what Burundi would need to support the recommended actions of the CEA. All in all, Burundi faces a serious shortfall in the resources needed to address the environmental challenges presented in the CEA, and urgent commitments of a larger scale are needed.

²⁹Improved coordination among the various ministries and with the 13 municipalities of Bujumbura is a prerequisite to provide an adequate response and manage cross-cutting risks with a long-term approach.

³⁰For example, the Directorate-General for Water and Sanitation and the Directorate-General for Urban Development followed completely independent approaches to create urban development and rainwater drainage schemes in 2012 and 2013. It took more than a week for the mission to obtain a copy of these documents, and many technical services have discovered the existence of these documents.

³¹Establishing effective operation and maintenance of existing drainage infrastructure and networks is the first step to reduce the occurrence and severity of urban floods. Improved financial management in the Municipality of Bujumbura should be considered a priority toward meeting its responsibilities.

³²A month after the event, the latrines in schools and health centers had not been pumped out. This created a public health issue. The cost of such an operation is less than US\$1,000 per block (less than US\$10,000 required in total to avoid this public health issue).

Box 4.7. Uganda's Effort to Improve Disaster Risk Management

Uganda is particularly vulnerable to frequent and severe droughts, floods, and severe storms. These climate-related hazards, which particularly impact sectors such as agriculture and fisheries, as well as infrastructure, have increasingly adverse effects on the country, particularly on the livelihoods of the poor. Climate change is likely to continue to exacerbate the situation.

Until recently, information on weather and climate, as well as disaster management in Uganda, has mostly focused on relief and rehabilitation. Limited hard (for example, weather/climate observing infrastructure and communications equipment) and soft (for example, weather forecasting and analysis) technologies have indeed been noticed, as well as a weak human capacity to utilize these tools. This has resulted in:

- inadequate monitoring and forecasting of weather/climate hazards;
- insufficient communication and restricted responses to impending weather hazards; and
- constrained planning for long-term climate change in economic development and risk reduction efforts.

In light of these issues, the United Nations Development Programme (UNDP), with funding from the Global Environment Facility (GEF), is supporting the government of Uganda with a four-year project (2014–17, US\$4 million) designed to ensure the establishment of the needed information infrastructure for weather, climate, and disaster management. This project covers 28 districts in the country, focusing on the disaster-prone areas of Mbale, Teso, and the northern and western regions. The objectives are to:

- establish a functional network of meteorological and hydrological monitoring stations and associated infrastructure to better understand effects of climatic change;
- develop and disseminate tailored weather and climate information (including color-coded alerts for advisories, watches, and warnings for floods, droughts, severe weather, and agricultural stresses; integrated cost-benefit analyses; and sector-specific risk and vulnerability maps) to decision makers in the government, the private sector, civil society, development partners, and local communities in the Teso and Mt Elgon subregion; and
- integrate weather and climate information into national policies, annual work plans, and local development, including the National Policy for Disaster Preparedness and Management, and district and subcounty development plans in the priority districts of Bukedi, Busoga, Elgon, Teso, Acholi, Karamoja, and Lango subregions.

Source: UNDP 2014.

Environmental reforms, whether to address the fundamental issues, such as population growth, political stability, and climate or the specific environmental problems discussed in the CEA, have been stalled due to political causes. Elite capture, “clientelism,” corruption, and a general lack of interest and appreciation of the environmental issues are widespread. Again, Burundi is already at the limit of the resource–population balance, on the verge of system collapse. The country needs to halt its unsustainable expansion path based on the depletion of natural capital and find a new and sustainable development trajectory. This requires true political determination and commitment.



Table 4.2. Relevant World Bank Projects in Burundi (ongoing and pipeline)

<i>Project Code</i>	<i>Project Name</i>	<i>Objective</i>	<i>Amount (Millions of US\$)</i>
P107343	Agro-Pastoral Productivity and Markets Development Project	To increase small producers' productivity and market access for targeted commodities in the project area.	43
P143307	AFCC2/RI—Regional Great Lakes Integrated Agriculture Development Project	To (i) increase agricultural productivity and commercialization in targeted areas in the territory of the recipient and improve agricultural regional integration and (ii) provide immediate and effective response in the event of an eligible crisis or emergency.	150
P151869	Burundi Coffee Sector Competitiveness Project	To increase coffee productivity and improve its quality among small-scale coffee growers in Burundi.	55
P075941	AFCC2/RI—Regional Rusumo Falls Hydroelectric Project	To increase the supply of electricity to the national grids of Rwanda, Tanzania, and Burundi.	347.5
P133610	BI—Jiji and Mulembwe Hydropower	To increase the supply of clean and low-cost hydropower electricity to Burundi's national grid.	100
P145719	BI—SE4ALL TA for Burundi (TA)	To (i) enhance government capacity to engage with the private sector and (ii) mobilize donor financing for energy access by preparing an investment program for grid expansion, off-grid lighting, and household fuels.	
P118316	AFCC2/RI—Lake Victoria Environmental Management Project (Burundi and Rwanda)	To (i) improve the collaborative management of the transboundary natural resources of the LVB among the partner states and (ii) improve the environmental management of targeted pollution hotspots and selected degraded subcatchments for the benefit of communities who depend on the natural resources of LVB.	30
P127258	Sustainable Coffee Landscape Project	To pilot sustainable land and water management practices in the coffee landscape of Burundi.	4.23
P156727	Burundi Country Environmental Analysis (ESW)	To assist the GoB in understanding key environmental factors affecting development and providing policy and institutional guidance.	NA
P147808	IE Gender Norms and Empowerment in Burundi (IMP EVAL)	To (i) identify, through rigorous research, effective policies that can address underlying economic and social gender inequality in Africa, and increase the take-up of these policies by the government and the private sector and (ii) to support an impact evaluation for an innovative intervention that engages Burundian men in the process of their female partners' economic and social empowerment.	NA
P149176	Strengthening Institutional Capacity for Government Effectiveness Project	To strengthen government institutional capacity to improve fiscal management. This objective will be achieved by supporting government efforts to mobilize domestic revenue, improve public expenditure management and controls, produce timely statistics for policy making, and improve mining sector regulatory capacity and practices.	22
P151575	BI—Public Expenditure Review 2015 (ESW)	To improve fiscal policy formulation and management, especially through the budget process—planning, execution, and control.	NA
P101160	Health Sector Development Support	To increase the use of a defined package of health services by pregnant women, children under the age of five, and couples of reproductive age.	84.77

<i>Project Code</i>	<i>Project Name</i>	<i>Objective</i>	<i>Amount (Millions of US\$)</i>
P111556	AFCC2/RI—East Africa Public Health Laboratory Networking Project	To establish a network of efficient, high-quality, accessible public health laboratories for the diagnosis and surveillance of tuberculosis and other communicable diseases.	128.66
P147489	AFCC2/RI—Great Lakes Emergency Sexual and Gender-Based Violence; Women & Health Project	To (i) expand the provision of services to mitigate the short- and medium-term impact of sexual and gender-based violence and (ii) expand utilization of a package of health interventions targeted to poor and vulnerable females.	106.96
P129993	Burundi—Result-Based Financing (RBF) Impact Evaluation	To assess the effects of the introduction of criteria focusing on malnutrition prevention and care activities in the existing RBF system on (i) acute and chronic malnutrition rates in the community, (ii) better equity in those nutrition outcomes, and (iii) externalities on other health outcomes.	NA
P149369	Burundi: Supporting Evolution Toward a Coordinated Social Protection System (TA)	To support the government of Burundi to move from fragmented social protection programs and projects to a coordinated and increasingly harmonized system of social protection programs.	NA
P154583	Strengthening DRM in Burundi (TA)	To support vulnerable countries in the Africa region in their efforts to better manage climate and disaster risks and strive toward disaster-resilient and climate-smart development at regional and national levels.	NA
P151187			NA
P107851	Burundi—Financial & Private Sector Development	To strengthen the financial system and improve the business enabling environment.	25.58
P094103	AFCC2/RI—Regional Communications Infrastructure Project	To (i) contribute to lower prices for international capacity and extend the geographic reach of broadband networks (the “connectivity development objective”) and (ii) contribute to improved government efficiency and transparency through e-government applications (the “transparency development objective”).	NA
P150929	Burundi—Infrastructure Resilience Emergency Project	To enhance the climate resilience of key transport and drainage infrastructure in Greater Bujumbura while strengthening the country’s capacity to manage and prevent natural disasters.	25
P152080	Burundi—ICT for Transformation	To support the government of Burundi, in coordination with the relevant stakeholders (national authorities, incumbent operator, operators of the private sector, consumer associations, and others), to develop an overall strategic vision for leveraging ICT for increased growth and development.	NA
P143981	Agriculture, Biodiversity, and Land (ESW)	NA	NA

NA: not available



References

- Acharya, Anjali, and Mikko K. Paunio. 2008. *Environmental Health and Child Survival: Epidemiology, Economics, Experiences*. Washington, DC: World Bank.
- ADB (Asian Development Bank), and World Bank. 2010. "Pakistan Floods 2010." *Preliminary Damage and Needs Assessment*. ADB and World Bank.
- AfDB (African Development Bank). 2014. "Sustainable Rural Water Infrastructure for Improved Health and Livelihood (SRWSIHL) Project." 2014. Appraisal Report, Côte d'Ivoire.
- . 2015. *African Economic Outlook 2015*. AfDB, Organisation for Economic Co-operation and Development, United Nations Development Programme, Côte d'Ivoire.
- Attina, T., and L. Trasande. 2013. "Economic Costs of Childhood Lead Exposure in Low- and Middle-Income Countries." *Environmental Health Perspectives* 121 (9): 1097–1102.
- Banderembako 2006; USAID/REDSO 2003 quoted in USAID. 2010. *Burundi Environmental Threats and Opportunities Assessment (ETOA)*. Washington, DC: USAID.
- Barnes, B. R. 2014. "Behavioural Change, Indoor Air Pollution and Child Respiratory Health in Developing Countries: A Review." *Int J Environ Res Public Health* 11(5): 4607–18.
- Blössner, M., and M. de Onis. 2005. *Malnutrition: Quantifying the Health Impact at National and Local Levels*. Environmental Burden of Diseases Series, No. 12. Geneva: World Health Organization.
- Bond, W. J., and J. E. Keeley. 2005. "Fire as a Global 'Herbivore': The Ecology and Evolution of Flammable Ecosystems." *Trends Ecol. Evol.* 20: 387–96.
- Bond, W. J., F. I. Woodward, and G. F. Midgley. 2005. "The Global Distribution of Ecosystems in a World Without Fire." *New Phytol.* 165: 525–38.
- Burnett, R. T., C. A. Pope III, M. Ezzati, C. Olives, S. S. Lim, S. Mehta, H. H. Shin, G. Singh, B. Hubbell, M. Brauer, H. R. Anderson, K. R. Smith, J. R. Balmes, N. G. Bruce, H. Kan, F. Laden, A. Prüss-Ustün, M. C. Turner, S. M. Gapstur, W. R. Diver, and A. Cohen. 2014. "An Integrated Risk Function for Estimating the Global Burden of Disease Attributable to Ambient Fine Particulate Matter Exposure." *Environmental Health Perspectives* 122: 397–403.
- Burundi Vulnerability Assessment. World Bank. 2014.

- Carrasco, L., T. Nghiem, T. Sunderland, and L. Koh. 2014. "Economic Valuation of Ecosystem Services Fails to Capture Biodiversity Value of Tropical Forests." *Biological Conservation* 178: 163–70.
- Cervigni, Raffaello, and Michael Morris. 2016. *Confronting Drought in Africa's Drylands: Opportunities for Enhancing Resilience*. Washington, DC: World Bank; and Agence Française de Développement. <https://openknowledge.worldbank.org/handle/10986/23576>.
- CGIAR (Consultative Group for International Agricultural Research). 2016. "Terracing Practice Increases Food Security and Mitigates Climate Change in East Africa." <https://ccafs.cgiar.org/blog/terracing-practice-increases-food-security-and-mitigates-climate-change-east-africa#.WG6Z3S0rL3g>.
- Croitoru, L., and M. Sarraf. 2010. *The Costs of Environmental Degradation: Case Studies from the Middle East and North Africa*. Washington, DC: World Bank.
- Cropper, M., and S. Khanna. 2014. "How Should the World Bank Estimate Air Pollution Damages?" Report RFF DP, pp. 14–30, Resources for the Future, Washington, DC.
- Cropper, M., J. K. Hammitt, and L. A. Robinson. 2011. "Valuing Mortality Risk Reductions: Progress and Challenges." *Annual Review of Resource Economics* 3:313–36.
- Damien, Nindorera, and Nyamuyenzi Sévérin. 2015. *Rapport d'Etude sur le Niveau d'Implication des Groupes Cibles dans la Protection des Aires Protégées au Burundi*. Bujumbura: Republic of Burundi.
- Den Biggelaar, C., et al. 2004. "The Global Impact of Soil Erosion on Productivity II: Effects on Crop Yields and Production Over Time." *Advances in Agronomy* 81: 49–95.
- DHS. 2010. Burundi Demographic and Health Survey. <http://dhsprogram.com/publications/publication-FR253-DHS-Final-Reports.cfm>
- EAC (East African Community) Secretariat. 2012. *Disaster Risk Reduction and Management Strategy (2012–2016)*. Arusha, Tanzania.
- EM-DAT. Feb. 2015. The OFDA/CRED—International Disaster Database <http://www.emdat.be>—Université catholique de Louvain Brussels—Belgium.
- Erian, W., et al. 2013. "Agriculture Drought in Africa Mediterranean and Middle East." Background paper prepared for *Global Risk Assessment Report on Disaster Risk Reduction, 2013*. Geneva: United Nations Office for Disaster Risk Reductions.
- Eswaran, H., R. Almaraz, E. van den Berg, and P. Reich. 1996. *An Assessment of the Soil Resources of Africa in Relation to Productivity*. Washington, DC: U.S. Department of Agriculture Natural Resources Conservation Service.
- Food and Agriculture Organization of the United Nations. 1998. FAOSTAT statistics database. Rome: FAO.
- FAO (Food and Agricultural Organization of the United Nations). 2010. *Global Forest Resources Assessment 2010*. Country Report: Burundi. Rome.
- FAOSTAT. 2015. <http://www.fao.org/faostat/en/>.
- FEM-UNIDO. 2006. "Plan national de mise en oeuvre de la convention de Stockholm sur les polluants organiques persistants au Burundi." PNM Burundi-INECN.
- Fewtrell, L., R. Kaufmann, and A. Prüss-Üstün. 2003. *Lead: Assessing the Environmental Burden of Disease at National and Local Levels*. Environmental Burden of Disease Series, No. 2. Geneva: World Health Organization.
- Fewtrell, L., A. Prüss-Üstün, R. Bos, F. Gore, and J. Bartram. 2007. *Water, Sanitation and Hygiene: Quantifying the Health Impact at National and Local Levels in Countries with Incomplete Water Supply and Sanitation Coverage*. Environmental Burden of Disease Series, No. 15. Geneva: World Health Organization.

- Fishman, S. M., L. E. Caulfield, M. de Onis, M. Blössner, A. A. Hydner, L. Mullany, and R. E. Black. 2004. "Childhood and Maternal Underweight." In *Comparative Quantification of Health Risks*, vol. 1, ed. M. Ezzati, A. D. Lopez, A. Rodgers, C. J. L. Murray. Geneva: World Health Organization.
- GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH). 2013a. ———. 2013b. "Improving Water Supply and Sanitation (Sector Programme Water and Sanitation (PROSECEAU) in Burundi." <https://www.giz.de/en/worldwide/19214.html>.
- Golub, E. 2014. *A Physical and Monetary Losses from Natural Resource Degradation in Piaui (Brazil)*. Draft Report, World Bank, Washington, DC.
- Hallegatte, Stephane, Mook Bangalore, Laura Bonzanigo, Marianne Fay, Tamaro Kane, Ulf Gerrit Narloch, Julie Rozenberg, David Oliver Treguer, Adrien Camille Vogt-Schilb. 2015. *Shock Waves: Managing the Impacts of Climate Change on Poverty*. Washington, DC: World Bank.
- Hansen, M. C., P. V. Potapov, R. Moore, et al. 2013. "High-Resolution Global Maps of 21st Century Forest Coverage Change. *Science* 342: 850–53.
- Hsu, A. et al. 2016. *Environment Performance Index 2016 Report*. New Haven, CT: Yale University. www.epi.yale.edu.
- Human Rights Watch. 2016. "Burundi: Events of 2015." In *World Report 2016*. New York: Human Rights Watch. <https://www.hrw.org/world-report/2016/country-chapters/burundi>.
- Hussain, S. et al. 2011. *The Economics of Ecosystems and Biodiversity: The Quantitative Assessment*. Final Report to the United Nations Environment Programme.
- IEA (International Energy Agency). 2015. "World Energy Outlook." Paris.
- IMF (International Monetary Fund). 2010. *Burundi: Poverty Reduction Strategy Paper—Second Implementation Report*. IMF Country Report No. 10/312, Washington, DC.
- Information Géographique et Environnement. 2016. Consultant report. Washington, DC: World Bank.
- International Environmental Law Research Centre. 2005. "Environment and Conflict Linkages in the Great Lakes Region." IELRC Working Paper, <http://www.ielrc.org/content/w0506.pdf>.
- ISTEEBU (Institut de Statistiques et d'Études Économiques du Burundi). 2012. "Burundi Demographic and Health Survey" (Enquête Démographique et de Santé Burundi). <http://dhsprogram.com/publications/publication-FR253-DHS-Final-Reports.cfm>.
- ISTEEBU, Ministère de la Santé Publique et de la Lutte contre le Sida [Burundi] (MSPLS), and ICF International. 2012. Enquête Démographique et de Santé Burundi 2010. Bujumbura.
- IUCN (International Union for Conservation of Nature). 2016. "Forest Landscape Restoration—Restoration Opportunities Assessment Methodology (ROAM)." <https://www.iucn.org/theme/forests/our-work/forest-landscape-restoration/restoration-opportunities-assessment-methodology>.
- Kairaba, A. 2002. "Integrating Land Issues into Poverty Reduction Strategies and the Broader Development Agenda: Rwanda Case Study." Paper presented at regional workshop on land issues in Africa and the Middle East, Kampala, Uganda, April 29–May 2, 2002.
- Lapetra, M. G., et al. 2016. "The Healthcare Cost of Pollution." Working paper. New York, NY.
- Libère Bukobero, Aster Bararwandika e Deogratias Niyonkuru, « La dynamique de gouvernance des ressources naturelles collectives au Burundi », *VertigO—la revue électronique en sciences de l'environnement* [Online], Hors-série 17 | septembre

- 2013, posto online no dia 12 Setembro 2013, consultado o 06 Julho 2015. URL : <http://vertigo.revues.org/13856> ; DOI : 10.4000/vertigo.13856
- Lim, S. S., T. Vos, A. D. Flaxman, G. Danaei, et al. 2012. "A Comparative Risk Assessment of Burden of Disease and Injury Attributable to 67 Risk Factors and Risk Factor Clusters in 21 Regions, 1990–2010: A Systematic Analysis for the Global Burden of Disease Study 2010." *Lancet* 380: 2224–60.
- Lindhjem, Henrik, Ståle Navrud, Nils Axel Braathen, and Vincent Biousque. 2011. "Valuing Mortality Risk Reductions from Environmental, Transport, and Health Policies: A Global Meta-Analysis of Stated Preference Studies." *Risk Analysis* 31 (9): 1381–1407.
- Mechler, R. 2005. *Cost-Benefit Analysis of Natural Disaster Risk Management in Developing Countries*. Manual. Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ), Bonn, Germany.
- MEEATU (Ministry of Water, Environment, Physical Planning and Urban Development). 2011. *Étude sur les coûts de l'inaction contre la dégradation des sols au Burundi*. Bujumbura: Republic of Burundi.
- . 2013a. *Plan régional de mise en œuvre de la Stratégie Nationale et Plan d'Action sur la Biodiversité en zones écologiques de Muminwa et de la crête Congo-Nil*. Bujumbura: Republic of Burundi.
- . 2013b. Burundi Readiness Preparation Proposal. Bujumbura.
- MEEATU, and UNDP (United Nations Development Programme). 2010. "Burundi's Second National Communication regarding United Nations Framework Convention on Climate Change." <http://adaptation-undp.org/projects/trust-burundi-second-national-communication>.
- Mehta, S., H. Shin, R. Burnett, T. North, and A. Cohen. 2013. "Ambient Particulate Air Pollution and Acute Lower Respiratory Infections: A Systematic Review and Implications for Estimating the Global Burden of Disease." *Air Qual Atmos Health* 6: 69–83.
- MESA (Monitoring for Environment and Security in Africa). 2014. "Land Degradation Assessment Using Earth Observation Data in IGAD Region." Bulletin IV: Sep 2014–March 2015. Nairobi: Regional Centre for Mapping of Resources for Development.
- Ministry of Health, Burundi. 2011. "Pro-Poor Sanitation and Hygiene in East Africa: Turning Challenges to Opportunities."
- MIS (Ministère de la Santé Publique et de la Lutte contre le Sida). 2012. *Enquête sur les Indicateurs du Paludisme, Burundi 2012*. Final Report. <http://dhsprogram.com/publications/publication-MIS14-MIS-Final-Reports.cfm>.
- Muhigirwa, Georges. 2011. *L'approche de prévention et de gestion des risques naturels au Burundi et le droit international de l'environnement*. Memoire de fin d'etudes, UNU.
- Naipal, V., C. Reick, J. Pongratz, and K. Van Oost. 2015. *Improving the Global Applicability of the RUSLE Model—Adjustment of the Topographical and Rainfall Erosivity Factors*.
- National Climate Change Adaptation Action Plan (NAPA). 2007. Republic of Burundi. Bujumbura.
- Narain, U., et al. 2016. "Methodology for Valuing the Health Impacts of Air Pollution: Discussion of Challenges and Proposed Solutions." Draft Working Paper, World Bank, Washington, DC.
- Navrud, S., and H. Lindhjem. 2011. "Valuing Mortality Risk Reductions in Regulatory Analysis of Environmental, Health and Transport Policies: Policy Implications." OECD, Paris.
- ND-GAIN. 2014. Notre Dame Global Adaptation Index 2014. <http://index.gain.org>.

- Ndikubagenzi, J. 2016. *Utilisation du combustible bois: impact sur la pollution de l'air à l'intérieur des habitations, sur la santé et sur la dégradation de l'environnement*. Consultant report. Washington, DC: World Bank.
- Ngueta, G., and R. Ndjaboue. 2013. "Blood Lead Concentration in Sub-Saharan African Children below 6 Years: A Systematic Review." *Tropical Medicine and International Health* 18 (10): 1283–91.
- Niang, I., O. C. Ruppel, M. A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart. 2014. "Africa." In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, 1199–1265.
- Nyonyintono, Grace Lubaale, and Samuel Musembi Musyoki. 2011. "Pro-Poor Sanitation and Hygiene in East Africa: Turning Challenges to Opportunities." IRC, Background Paper Presented at the East Africa Practitioners Workshop on Pro-Poor Urban Sanitation and Hygiene, Kigali, Rwanda.
- Obalum, S., M. Buri, J. Nwite, H. Sah, Y. Watanabe, C. Igwe, and T. Wakatsuki. 2012. "Soil Degradation-Induced Decline in Productivity of Sub-Saharan African Soils: The Prospects of Looking Downwards the Lowlands with the Sawah Ecotechnology." *Applied and Environmental Soil Science*. <https://www.hindawi.com/journals/aess/2012/673926/>.
- Oketch, Johnstone Summit, and Tara Polzer. 2002. "Conflict and Coffee in Burundi." In *Scarcity and Surfeit: The Ecology of Africa's Conflicts*, eds. Jeremy Lind and Kathryn Sturman, 84–156. Pretoria: Institute for Security Studies.
- PAM-ICA (Programme Alimentaire Mondial/ Integrated Context Analysis). 2015. *Plan de Réponse Catastrophe Naturelle—Inondation*. Republic of Burundi.
- Pennise D., Brant, S., Mahu Agbeve, S., Quaye, W., Mengesha, F., Tadele, W., Wofchuck, T. 2009. Indoor air quality impacts of an improved wood stove in Ghana and an ethanol stove in Ethiopia. *Energy for Sustainable Development* 13 (2009) 71–76.
- Pope, C. A. III, et al. 2002. "Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution." *JAMA* 287 (9): 1132–41.
- Pope, C. A. III et al. 2015. "Health Benefits of Air Pollution Abatement Policy: Role of the Shape of the Concentration-Response Function." *Journal of the Air & Waste Management Association* 65:1–7.
- Pope, C. A. III, R.T. Burnett, D. Krewski, et al. 2009. "Cardiovascular Mortality and Exposure to Airborne Fine Particulate Matter and Cigarette Smoke: Shape of the Exposure-Response Relationship." *Circulation* 120: 941–48.
- Pope, C. A. III, R. T. Burnett, M. Turner, et al. 2011. "Lung Cancer and Cardiovascular Disease Mortality Associated with Ambient Air Pollution and Cigarette Smoke: Shape of the Exposure-Response Relationships." *Environmental Health Perspectives* 119 (11): 1616–21.
- Prüss-Üstün, A., and C. Corvalán. 2006. *Preventing Disease through Healthy Environments. Towards an Estimate of the Environmental Burden of Disease*. World Health Organization, Geneva.
- Prüss-Üstün, A. et al. 2014. "Burden of Disease from Inadequate Water, Sanitation and Hygiene in Low- and Middle-Income Settings: A Retrospective Analysis of Data from 145 Countries." *Tropical Medicine and International Health* 19 (8): 894–905. doi:10.1111/tmi.12329.
- Republic of Burundi. 2007. National Climate Change Adaptation Action Plan (NAPA). Bujumbura.

- . 2010. *Executive Summary of the Second National Communication on Climate Change*. Bujumbura: Government of Burundi.
- . 2011. *Loi de Finance 2011*.
- . 2012. *Rapport National Synthèse: Elabore dans le cadre du processus de préparation de la conférence des nations unies sur le développement durable au Burundi*. Bujumbura: Government of Burundi.
- . 2012a. “Burundi Demographic Health Survey.” <http://dhsprogram.com/pubs/pdf/FR253/FR253.pdf>.
- . 2012b. *Rapport National Synthèse: Elabore dans le cadre du processus de préparation de la conférence des Nations Unies sur le développement durable au Burundi*. Bujumbura.
- . 2013. *Enquete Nationale Agricole du Burundi 2011–2012. Vol. 1 : Résultats de la campagne agricole*. Bujumbura.
- . 2014. <http://www.presidence.bi/spip.php?article4500>.
- . 2015a. “Intended Nationally Determined Contributions—Burundi.” Bujumbura.
- . 2015b. “Plan de Réponse Catastrophe Naturelle: Inondation (El Nino 2015).” Bujumbura.
- . 2016. *Burundi Poverty Assessment*. World Bank.
- . 2016. *Projet D’aménagement Durable des Zones Caféicoles (PADZOC)*.
- Roothaert, R., and G. Muhanji. 2009. “Profit Making for Smallholder Farmers.” *Proceedings of the 5th MATF Experience Sharing Workshop, Entebbe, Uganda, May 25–29*.
- Ruzima, Salvator. 2011. *Rapport de l’étude sur le renforcement des capacités institutionnelles pour la mise en œuvre de la Convention de Stockholm sur les POPs (MEEATU-INECN-UNEP)*, Bujumbura, Décembre 2011, 21 pages.
- . 2011a. *BNDF, Final Report on the Assessment of Mainstreaming Local Community Stakeholders Participation and Benefits on the NELSAP Sub-Regional Hydro-Power and Inter-Connection Project* (prepared by Consultant). Bujumbura, December 2011, 55 pp.
- . 2011b. “Rapport de l’étude sur le renforcement des capacités institutionnelles pour la mise en œuvre de la Convention de Stockholm sur les POPs.” MEEATU-INECN-UNEP, Bujumbura.
- Sabumukiza, Savin. 2015. *Etat de la dégradation des écosystèmes forestiers urbains et périurbains: cas de la ville de Bujumbura* [PowerPoint slides].
- Safe Access to Fuel and Energy. 2017. “UNHCR Improved Cookstove and Briquette Distribution in Burundi.” www.safefuelandenergy.org/where-we-work/project.cfm?p=109.
- Salkever, D. S. 1995. “Updated Estimates of Earnings Benefits from Reduced Exposure of Children to Environmental Lead.” *Environmental Research* 70: 1–6.
- Sankaran, M., N. Hanan, R. J. Scholes, J. Ratnam, D. J. Augustine, B. S. Cade, et al. 2005. “Determinants of Woody Cover in African Savannas.” *Nature* 438: 846–49.
- Schwartz, J. 1994. “Societal Benefits of Reducing Lead Exposure.” *Environmental Research* 66:105–12.
- Smith, K. R. 2002. “Indoor Air Pollution in Developing Countries: Recommendations for Research.” *Indoor Air* 12(3):198–207.
- TEEB. 2010. *The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations*, ed. Pushpam Kumar. London and Washington: Earthscan; Geneva: TEEB.
- Tokindang Sibave, Joel, and Daniel Gbetnkom. 2015. *African Economic Outlook*. AfDB, OECD, and UNDP.

- UNDP (United Nations Development Programme). 2014. "Strengthening Climate Information and Early Warning Systems for Climate Resilient Development and Adaptation to Climate Change in Uganda." <http://adaptation-undp.org/projects/ldcf-ews-uganda>.
- UNEP (United Nations Environment Programme). 2012. "Partnership for Clean Fuels and Vehicles." <http://www.unep.org/transport/pcf.v>.
- UNISDR (United Nations Office for Disaster Risk Reduction). 2013. *Global Assessment Report on Disaster Risk Analysis, Annex 2: Loss Data and Extensive Risk Analysis*. Geneva: United Nations.
- . 2015. *Global Assessment Report on Disaster Risk Reduction—Making Development Sustainable: The Future of Disaster Risk Management*. Geneva: United Nations.
- USAID (U.S. Agency for International Development). 2010. *Burundi Environmental Threats and Opportunities Assessment (ETOA)*. Washington, DC.
- Van der Ploeg, S. and R. S. de Groot. 2010. The TEEB Valuation Database—a searchable database of 1310 estimates of monetary values of ecosystem services. Foundation for Sustainable Development, Wageningen, The Netherlands.
- WHO (World Health Organization). Undated. "Health Statistics and Information Systems, Estimate for 2000–2012, Disease Burden." Geneva.
- . 2007. "Department of Public Health and Environment, Estimated Deaths & DALYs Attributable to Selected Environmental Risk Factors." Geneva.
- . 2010. "Childhood Lead Poisoning." Geneva. http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html.
- . 2014. "Burden of Disease from Household Air Pollution." Geneva.
- . 2014. Global Burden of Disease (GBD) http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html.
- WHO/UNICEF (United Nations Children's Fund) Joint Monitoring Programme for Water Supply and Sanitation (JMP). 2008. Progress on Drinking Water and Sanitation: Special Focus on Sanitation. New York: UNICEF; Geneva: WHO. http://www.who.int/water_sanitation_health/monitoring/sanitation.pdf.
- WHO/UNICEF. 2013. WHO/UNICEF Joint Monitoring Program. <https://www.wssinfo.org/>.
- Winterbottom, R., C. Reij, D. Garrity, J. Glover, D. Hellums, M. McGahuey, and S. Scherr. 2013. "Improving Land and Water Management." Working Paper, Installment 4 of *Creating a Sustainable Food Future*. Washington, DC: World Resources Institute.
- Wofchuck, T. 2009. "Indoor Air Quality Impacts of an Improved Wood Stove in Ghana and an Ethanol Stove in Ethiopia." *Energy for Sustainable Development* 13 (2): 71–76.
- World Bank. 2005. *Natural Disaster Hotspots: A Global Risk Analysis*. Disaster Risk Management Series No. 5. Washington, DC: World Bank.
- . 2011a. *Rapid Strategic Environmental Assessment of Coffee Sector Reform in Burundi*. Washington, DC.
- . 2011b. *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium*. Washington, DC.
- . 2012. *Inclusive Green Growth: The Pathway to Sustainable Development*. Washington, DC.
- World Bank. 2014. *Burundi : analyse des facteurs de risques, évaluation des dommages et propositions pour un relèvement et une reconstruction durables : Evaluation rapide conjointe suite à la catastrophe des 9–10 février 2014 aux alentours de Bujumbura*. Washington, DC : World Bank.

- . 2014a. *Country Policy and Institutional Assessment (CPIA)*. Washington, DC.
- . 2014b. *Burundi Vulnerability Assessment*. Washington, DC.
- . 2014c. *Environmental Country Policy and Institutional Assessment*. Washington, DC.
- World Bank. 2015. *World Development Indicators 2015*. Washington, DC: World Bank.
- . 2015a. *World Development Indicators, 2015*. Washington, DC.
- . 2015b. *World Development Report 2015: Mind, Society, and Behavior*. Washington, DC.
- . 2016a. *High and Dry: Climate Change, Water, and the Economy*. Washington, DC: International Bank for Reconstruction and Development and World Bank.
- . 2016b. *Restoring the Landscapes of Ethiopia's Highlands: Enhancing Livelihoods through Scaling-Up Sustainable Climate-Smart Land Management Practices and Improving Tenure Security*. Washington, DC.
- . 2016c. *World Development Indicators 2016*. Washington, DC: World Bank.
- . 2016d. Project concept note. Burundi Landscape Restoration Project. 2016. Washington, DC: World Bank.
- . Forthcoming. *The Changing Wealth of Nations*. Washington, DC.
- World Bank Group. 2015. *The Little Green Data Book 2015*. Washington, DC: World Bank and International Bank for Reconstruction and Development.
- World Health Organization and United Nations Children's Fund Joint Monitoring Programme for Water Supply and Sanitation (JMP). 2008. Progress on Drinking Water and Sanitation: Special Focus on Sanitation. UNICEF, New York and WHO, Geneva, http://www.who.int/water_sanitation_health/monitoring/sanitation.pdf
- World Population Prospects. 2015 Revision. United Nations, Department of Economic and Social Affairs, Population Division (database). <https://esa.un.org/unpd/wpp/>.
- Wroblewski, Julie, and Hendrik Wolff. 2010. "Risks to Agribusiness Investment in Sub-Saharan Africa." Prepared for the Agricultural Policy and Statistics Team of the Bill & Melinda Gates Foundation. Seattle: Evans School of Public Affairs, University of Washington.

Foreign Publications

- Bigawa, S., and V. Ndorere. 2002. Evaluation des besoins en matière de formation forestière au Burundi. RIFFEAC/FAO. http://pfbc-cbfp.org/tl_files/archive/formation/burundi.pdf.
- Bizindavyi, L. 2012. *Enjeux et contraintes environnementaux de la filière huile de palme en commune Rumonge*. Mémoire, Université du Burundi.
- Centre d'Echange de la République du Burundi. 2002. Problématique de gestion de la biodiversité au Burundi, particulièrement celle des aires protégées.
- INECN (Institut National pour l'Environnement et la Conservation de la Nature). 2002. *Rapport National d'évaluation des dix ans de mise en œuvre de l'Agenda au Burundi 1992–2002*, 167pp.
- . 2004. *Stratégie Nationale et Plan d'Action en renforcement des capacités en matière de diversité biologique, Bujumbura*, 102pp.
- INECN, and United Nations Development Programme (UNDP). 2009. 4ème Rapport du Burundi à la Convention sur Diversité Biologique, La mise en oeuvre de l'objectif 2010 de la CDB, Bujumbura.
- Khair, A. 2008. Rapport de la Cour Suprême du Burundi sur le droit pénal de l'environnement, Porto-Novo. AHJUCAF, Port-Novo, Benin.
- Lauginie, F. 2007. Réalisation d'une étude d'identification d'un projet pour la réhabilitation et la protection du Parc National de la Ruvubu, Rapport final, Commission Européenne, HPC.

- Libère Bukobero, Aster Bararwandika, and Deogratias Niyonkuru. 2013. "La dynamique de gouvernance des ressources naturelles collectives au Burundi." *VertigO—la revue électronique en sciences de l'environnement* 17 (September 2013). <http://vertigo.revues.org/13856>; DOI : 10.4000/vertigo.13856.
- Ministère de l'Eau, de l'Environnement, de l'Aménagement du Territoire et de l'Urbanisme. 2010. Deuxième communication sur les Changements Climatiques. Bujumbura.
- Niyonkuru, Deogratias, Marc Rwabahungu, and Mulungula Pascal Masilya. 2013. « "Déterminants de la pérennité des systèmes antiérosifs au Burundi." *VertigO—la revue électronique en sciences de l'environnement* [En ligne], Hors-série 17 (September 2013). <http://vertigo.revues.org/13890>; DOI : 10.4000/vertigo.13890.
- Nzigidahera, B. 2012. "Vulnérabilité des forêts ombrophiles de montagne aux changements climatiques au Burundi: Renforcement de leur pouvoir d'adaptation." *Bulletin Scientifique de l'Institut National pour l'Environnement et la Conservation de la Nature* 10: 35–45.
- PNUE (Programme des Nations Unies pour l'environnement). 2006. L'avenir de l'environnement en Afrique 2, Notre environnement, notre richesse, éd. 1, Nairobi.
- Prieur, M. 1994. Service, droit et développement, FAO, Bureau juridique, Evaluation des impacts sur l'environnement pour le développement durable: Etude juridique, Rome.
- Republic of Burundi. 2010. SOS-Environnement n°004, 2ème Communication sur les changements Climatiques, Bujumbura, <http://unfccc.int/resource/docs/natc/burnc2.pdf>.
- Rwabahungu, Marc, Deo Niyonkuru, and Libère Bukobero. 2013. "Dégradation et prédation des boisements communaux avant, pendant et après la guerre au Burundi." *VertigO—la revue électronique en sciences de l'environnement* 17 (September 2013.) <http://vertigo.revues.org/13811>. DOI : 10.4000/vertigo.13811.
- Union Internationale pour la Conservation de la Nature (UICN). 2011. Evaluation de l'efficacité de la gestion des aires protégées, Parcs et Réserves du Burundi.

Internet Sites

- <http://www.unicef.fr/droit/coursteichen-M1-2011.pdf>
- Alternatives Economiques. <http://www.alternatives-economiques.fr>.
- Center Blog. "Definition de l'Environnement." <http://www.centerblog.net/environnement/292160-1-definition-de-environnement-> consulté en avril.
- EM-DAT: The International Disaster Database. Center for the Research on the Epidemiology of Disasters. <http://www.emdat.be/>.
- Gestion des Risques au Burundi. <http://bi-risk.pigeo.fr>.
- Global Alliance for Clean Cookstoves. <http://cleancookstoves.org/>.
- Global Forest Watch. <http://www.globalforestwatch.org>.
- Institute for Health Metrics and Evaluation. <http://www.healthdata.org>.
- Ministère de l'Environnement, de l'Énergie et de la Mer. La Convention sur la diversité biologique (CDB). <http://www.developpement-durable.gouv.fr/La-Convention-sur-le-diversite.html>?
- Planète Verte. <http://planeteverte-laia.blogspot.com/p/la-pollution.html>.
- Prevention Web. United Nations Office for Disaster Risk Reduction. <http://www.preventionweb.net/english/>.

- Réseau de chercheurs francophones en droit de l'environnement. <http://www.denv.auf.org/>.
- The Economics of Ecosystems & Biodiversity, United Nations Environment Programme. <http://www.teebweb.org>.
- UNDP-UNEP Poverty Environment Initiative. <http://www.unpei.org/>.
- WFPGeoNode, Burundi: Land Degradation (World Food Programme). http://geonode.wfp.org/layers/geonode%3Abdi_phy_landdegradation_icpac_2011_1.
- World Bank Open Data (database). <http://data.worldbank.org>.

Sectoral Policy Documents That Impact Environment Management

1. Burundi's National Forest Policy (2012–25), <http://faolex.fao.org/docs/pdf/bur143696.pdf>
2. National Agricultural Strategy (SAN-2008/2015), <http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC143702>
3. Burundi's National Environment Strategy and Action Plan (SNEB/PA)
4. National Biodiversity Strategy and Action Plan
5. MINATET Sector Policy
6. Forest Policy

Burundi's Environmental Framework

A. Constitutional and Legal Framework Applicable to the Protection and Management of the Environment

1. Constitution of the Republic of Burundi promulgated by Act No 1/ 010 of March 18, 2005
2. Act No 11/ 010 of June 30, 2000 laying down the Environmental Code of the republic of Burundi
3. Decree No 100/22 of October 7, 2010 laying down measures for the application of the Environmental Code in reference to the Environmental Impact Assessment procedure.

B. Institutions

1. Decree No 100-198 of September 15, 2014 amending Decree No 100-95 of March 28, 2011 on the mandate, organization and functioning of the Ministry in charge of Water, Environment, Land Use and Urban Development
2. Decree No 100-241 of October 29, 2014 amending Decree No 100-186 of October 5, 1989 establishing Burundi's Geographic Institute
3. Decree No 100-191 of June 29, 2012 on the establishment, mandate, membership and functioning of the interministerial steering committee of Burundi's land reform
4. Act No 1-016 of April 20, 2005 on the organization of communal administration as amended by Act No 01-02 of January 225, 2010
5. Decree No 100-243 of October 06, 2013 on intercommunality regulations in Burundi

6. Decree No 100-202 of September 15, 2014 reorganizing Burundi's National Agricultural Research Institute du Burundi (ISABU)
7. Decree No 100/240 of October 29, 2014 on the establishment, mandate and functioning of Burundi's Environmental Protection Agency, (OBPE)
8. Decree No 100/154 of October 19, 1993 on the Organization of the Ministry of Agriculture and Livestock
9. Decree No 100-191 of June 29, 2012 on the establishment, mandate, membership and functioning of the interministerial steering committee of Burundi's land reform.

C. Treaties, Conventions, and Agreements Ratified by Burundi

1. Decree ratifying the July 11, 2003 African Convention on the Conservation of Nature and Natural Resources
2. United Nations Framework Convention on Climate Change (UNFCCC)
3. 1992 Convention on Biological Diversity
4. 1994 United Nations Convention to Combat Desertification in countries severely by drought and/or desertification, particularly in Africa
5. 1997 Kyoto Protocol relating to UNFCCC
6. 1971 RAMSAR Convention on Wetlands of International Importance especially as Waterfowl Habitat
7. Convention on the Sustainable Development of Lake Tanganyika of June 12, 2003
8. 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
9. 1972 Paris Convention concerning the Protection of the World Cultural and Natural Heritage
10. African Convention on the Conservation of Nature and Natural Resources (1968 Algiers Convention) as amended in 2003
11. February 05, 2005 Treaty on the conservation and sustainable management of Central African forest ecosystems establishing the Central African Forest Commission (COMIFAC)
12. The September 10, 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade was adopted and opened for signing during the Plenipotentiary Conference in Rotterdam and came into force on February 24, 2004.

D. Sectoral Legislations

1. Forests and Biodiversity

- Decree of June 30, 1971 to regulate hunting and the protection of animal species
- Act No 1-02 of March 25, 1985 on the Forest Code
- Act No 1-10 of May 30, 2011 on the establishment and management protected areas in Burundi
- Decree No 100-115 of April 12, 2011 on the demarcation of the Mpotso Natural Forest Reserve

- Decree No 100-113 of April 12, 2011 on the demarcation of the Ruvubu National Park
- Decree No 100-113 of April 12, 2011 on the demarcation of the Monge Natural Reserve
- Act No 1-17 of September 10, 2011 on Wild Fauna and Flora Trafficking

2. Water

- Act No 1-02 of March 26, 2012 laying down the Water Code
- Law-Decree No 1/41 of November 26, 1992 on the establishment and organization of the water public domain
- Joint Ministerial Ordinance No 770/468/1a of March 25, 2014 establishing standards for domestic and industrial wastewater in Burundi
- Decree No 100-189 of August 25, 2014 on the determination and establishment of protection areas of water intended for human consumption
- Decree ratifying the June 12, 2003 Convention on the sustainable management of Lake Tanganyika

3. Energy, Mines, and Hydrocarbon

- Act No 1-21 of October 15, 2013 laying down Burundi's Mining Code
- Decree of July 11, 2001 ratifying the Convention on the African Energy Commission

4. Agriculture

- Decree-Law No 1/033 of June 30, 1993 on plant protection in Burundi
- Act No 1/08 of April 23, 2012 on the organization of the seed production sector

5. Property/Real Estate

- Act No 1-13 of August 9, 2011 amending Burundi's Land Code as modified to date

6. Public Health

- Decree-Law No 1-16 of May 17, 1982 laying down the Public Health Code

7. Natural and Cultural Heritage

- Act No 1/6 of May 25, 1983 on the protection of national cultural heritage
- Decree No 100-116 of April 12, 2011 on the demarcation of the Gisagara protected landscape.

Appendices

1. Deforestation and Forest Degradation

As discussed in the main text of the CEA report, while natural forest once covered 30–50 percent of the country’s territory, deforestation has left only 6.6 percent of remaining land area as forest in Burundi. At the same time, the quality of the remaining forest is also declining (forest degradation). Indeed, declining forest quality is one of the main threats to Burundi’s forests, with the rate of offtake from the forest being more than the natural regeneration capacity (UNEP 2006). However, data are limited and the extent of forest degradation could not be studied in this report.

Deforestation and forest degradation have been concentrated mainly in the most densely populated areas (MEEATU 2013b). Figure A1.1 indicates the areas of Burundi that experienced higher deforestation rates during 2000–2014. Six western provinces are significantly affected (Cibitoke, Bubanza, Bujumbura Mairie, Bujumbura Rural, Rumonge, and Makamba), as well as—though to a lesser extent—the three Eastern provinces of Rutana, Ruyigi, and Cankuzo. The center of Burundi had already experienced high levels of deforestation prior to the study period.

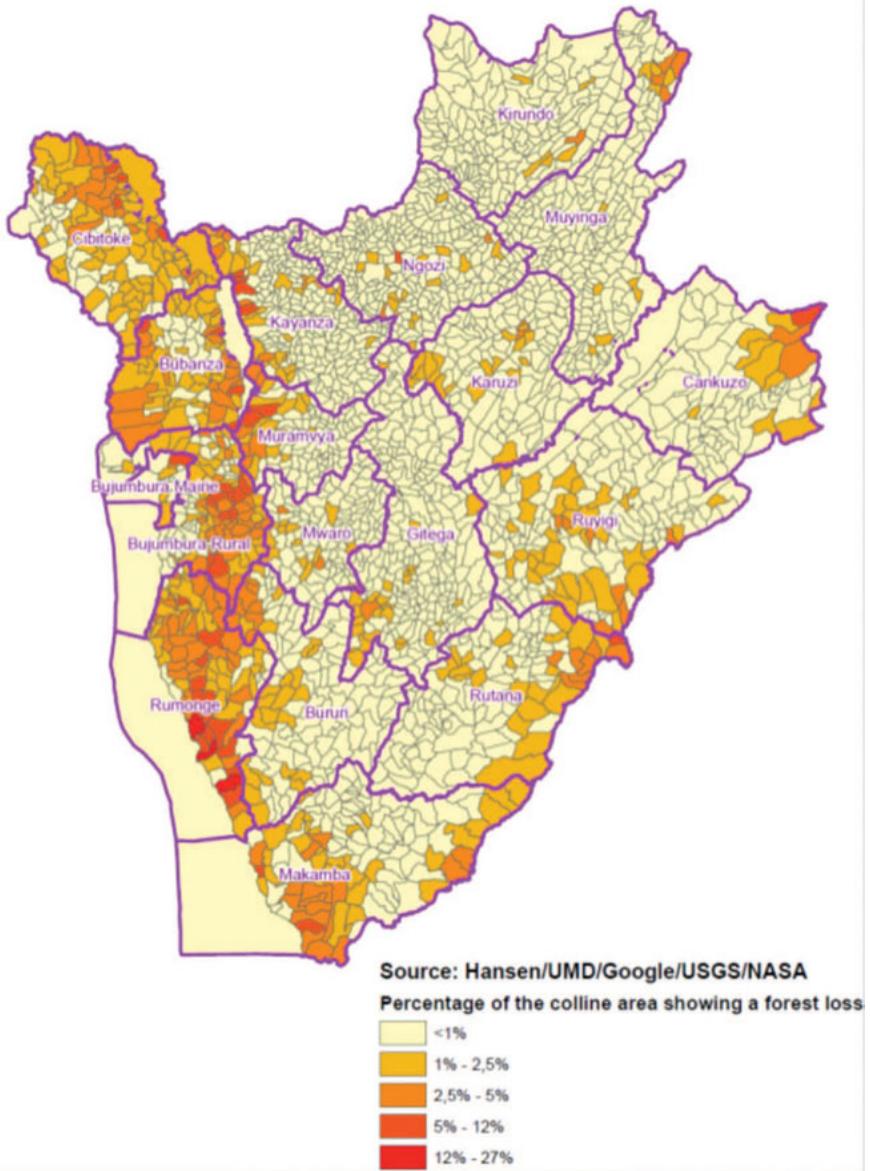
Causes and Drivers

The Burundi Readiness Preparation Proposal (R-PP) highlights four major factors contributing to deforestation and forest degradation: agricultural expansion, mining, timber demand, and over-exploitation of forest resources (MEEATU 2013b). Additionally, the GoB’s 2013 Forest Policy Document adds the following drivers: overgrazing, uncontrolled introduction of exotic forest species, depletion of indigenous genetic forest heritage, and climate change.

Agricultural Expansion

Urbanization has been increasing, but remains too slow to ease the pressure on the natural resources caused by the rapid rural

Figure A1.1. Rate of Forest Cover Loss in Burundi, 2000–2014 (average annual rate)



Source: Hansen, UMD, Google, USGS, NASA.

population growth. Young farmers are often driven to look for land in uncleared areas, including protected areas. Rusizi National Park, for example, has lost approximately 6,000 ha of open forest savannah since 2000 (MEE-ATU 2013b). Forested buffer zones around Lake Tanganyika are also under threat.³³ In Mumirwa, agricultural clearing remains the major cause of deforestation (MEEATU 2013b). Unsustainable and unregulated coffee production in Burundi is a major contributor to the expansion of the agricultural frontier into forests and other protected areas. The elimination of tree cover on hillsides for increased coffee production has had significant impacts on various soil quality parameters—including topsoil erosion.³⁴

However, it is not only small farmers who have put the ecosystem at risk. Industrial-scale cultivation of tea, coffee, sugar, palm oil, and cotton is expected to increase Burundi's planted areas, including onto marginal spaces. Tea and sugar growers have significantly altered vegetation on the borders of Kibira National Park, where the extension of tea cultivation has reached approximately 1,060 ha (another 3,178 ha in the immediate vicinity are sown by local tea producers).³⁵

Unmanaged Fire

Unmanaged fire presents a considerable threat to Burundian forests, both natural and artificial. Setting bush fires is an oft-performed means of clearing land for agriculture (slash-and-burn), or for pastoralism (clearing of savannah). This agronomically and environmentally inappropriate practice has persisted due to lack of farmer education and administrative oversight. Fire affects the dynamics of competition between plant species and hence the composition of vegetation mix. On the Imbo plain, the *Hyphaene* palm forest has been ceding space to low grasses. In the Kumoso depression, open forests have begun evolving into grassy savannah as the area's native bamboo is continuously destroyed through repetitive incendiarism, resulting in the increasing rarity of the African bamboo species *Oxythenanthera abyssinica* (MEEATU 2013b). Some fires are the result of arson, such as the burning of state-owned plantations in an act of civil defiance. Estimates report 8,000–32,000 ha of land were destroyed this way during the decade-long civil war in the 1990s and early 2000s (Banderembako 2006). Artificial forests are especially susceptible to fire, because the species selected for cultivation are often inflammable and fuel loads are often built up due to suboptimal management practices (USAID 2010).

³³Nzigidahera (2011), as quoted in MEEATU (2013b).

³⁴Project appraisal document (PAD). Sustainable Coffee Landscape (SCLP), World Bank.

³⁵MINAGRIE (2008), as quoted in MEEATU (2013b).

Mining

Mining has likewise helped contribute to the degradation of Burundi's ecosystems. Mines and quarries are found in the hills, plains, river and lakesides, and in the woodlands, sparing no ecosystem in the whole of the country. Artisanal mining, which makes up the bulk of the mining activities in the country, poses the gravest danger to forests. These activities cause the uprooting of trees when artisans in search of minerals like gold (near Kibira National Park), coltan (Bugesera Protected Aquatic Landscape and Murehe Reserve), and nickel (Ruvubu National Park) decimate tree stands to get at the soils below. In the Bururi Forest Reserve, indigenous Batwa communities quarry sand and rubble as a way to supplement their income. Minerals extractors release slag into the nearby waterways that is rich with heavy metals, thus contributing to environmental degradation (MEEATU 2013b).

Fuelwood Demand

Harvesting of wood for fuel has been conducted in an unsustainable and indiscriminate manner, and has contributed to increasing demands on forest resources. Conflict and fragility are some of the causes behind this driver. The Food and Agriculture Organization (FAO) observes that, regardless of socio-economic level, societies will switch to wood-based energy when confronted with economic difficulties, civil conflict and strife, natural disasters, or fossil fuel supply shortages.³⁶ Firewood is becoming increasingly scarce. It is estimated that an average Burundian consumes 1.22 m³ of wood and 0.04 m³ of wood furnishings per year. Trees are no longer left to reach maturity, but are cut at two or three years of age. This deficit in fuelwood is generally made up for through the use of vegetable waste and other organic residues from agriculture and livestock, which could be more efficiently used as organic fertilizer. This heavy dependency on wood means that the yearly increase in forest cover has not been able to keep pace of yearly population growth. Previous studies have shown that the demand for firewood is 6 million cubic meters, while supply is 1 million cubic meters.³⁷ To meet the country's needs in wood products, afforestation over an area of 390,000 ha, or a doubling of existing forest plantations, would be necessary (MEEATU 2011). Others suggest that the country's current needs are 686,000 ha of afforestation. However, with the increased atomization of land plots, Burundi is not equipped currently to provide for these energy needs. The cost of inaction of not providing for readily available fuelwood is estimated at over €2.6 billion, a value set to increase at least 10 percent annually after accounting for population growth and inflation (MEEATU 2011).

Timber Demand for Residential and Industrial Purposes

The relentless pursuit of timber for construction is often at the expense of forested landscapes. New housing needs in the country stand at around 30,000 units per year, to which must be added nonresidential construction and public works, both of which are major consumers of forest materials. Communal

³⁶FAO, Wood Energy, <http://www.fao.org/forestry/energy/en/>.

³⁷Besse et al. (1991) as quoted in MEEATU (2011).

and state forests, such as Kibira forest, among others, have been logged to make charcoal or wooden planks, often with the complicity of local authorities (Rwabahungu, Niyonkuru, and Bukobero 2013).

Unmanaged Exploitation of Forests and Woodlots

The unsustainable harvesting of timber and non-timber forest products is another driver of deforestation and forest degradation. This disorderly use of the forest impacts timber potential and causes the disappearance of species through erosion, soil depletion, and, of course, the depletion of the forest itself. In natural forests, indigenous species of high economic value are no longer found (for example, *Entandrophragma excelsum*, *Prunus africana*, *Symphonia globulifera*; MEEATU 2013b).

Moreover, the state tends to plunder forest resources, which is known locally as “*gusagata*” (from the Swahili “to take quickly”). State-owned nonnatural forest plantations, which make up around 45 percent of afforested lands, had been intended for the purposes of providing fuelwood for local consumption, combatting erosion, and providing pulp for a national paper industry (USAID 2010; Rwabahungu, Niyonkuru, and Bukobero 2013). Instead, these forests have been degraded, disregarded, and given away by local authorities (USAID 2010). Their approach may be attributed to low state capacity to oversee, monitor, and convey the significance of the forest to the local populace, as well as a lack of physical demarcation to distinguish state from nonstate use. Corruption and embezzlement of state property started in earnest during the civil conflict of the 1990s. Felling trees for timber and firewood is sometimes used to supplement the revenues of the local government. Sometimes municipalities will clear land, in contravention of national law, to construct social infrastructure, for example, schools, health clinics, sports fields, cemeteries, housing for teachers, or peace villages for returned refugees and internally displaced persons. Deforestation is thus justified in the eyes of the local population when it is done to meet local social needs or to fill municipal coffers for local public works (Rwabahungu, Niyonkuru, and Bukobero 2013).

Improper management of Burundi’s forest plantations mainly hinges on a lack of widespread agronomic training. Some causes of this poor forestry oversight include a failure to properly time wood cutting; the use of unsuitable tools and inefficient techniques for felling trees; contravention of the forestry code and the environmental code, which remains poorly understood by the general public; aforementioned administrative clearing of forest; and a lack of proper plantation maintenance (Rwabahungu, Niyonkuru, and Bukobero 2013). However, even though state-owned and communal forests are the most easily recognized as being subject to predation, research has indicated that the majority of timber actually comes from farms.

Weak Management of Protected Areas

Out of the 14 protected areas (PAs) created in 1980 and established by the *Institut National pour l’Environnement et la Conservation de la Nature* (now housed under MEEATU), only four have legal delimitations. The creation of PAs has indeed often resulted in the expropriation of the local population, who either lived inside the areas or is highly dependent upon them, resulting

in tension and illicit forest use (USAID 2010). In both communes of Kabarore and Rutegama, degradation of afforested areas after the war decreased with the exception of predation from the indigenous Batwa community in Rutegama. The Batwa's incursion into these PAs is explained by the fact that they are among the most impoverished of Burundi's people, possessing neither agricultural properties nor communal woodlands, nor are they able to find non-agricultural work. As they ask the state to grant them the land for agriculture, municipalities sometimes install them on wooded sites or near these sites. Having no assets, they steal wood for survival, to meet household needs and to sell to generate cash income (Rwabahungu, Niyonkuru, and Bukobero 2013).

Consequences

Deforestation, or conversion of forested area into another land type, does not necessarily constitute a problem. Converted land could be productively utilized and its productivity sustainably managed to generate greater overall, long-term benefits than if the land remained as forest. However, as noted in the section on land degradation, this is not usually the case in Burundi. Forests that have been converted to agricultural production are now severely degraded. Thus, this report considers deforestation as a negative change made on the land cover. On the other hand, forest degradation is always a negative change in the forest cover.

Loss of Timber and Non-Timber Products

The most significant of forest resources used is fuelwood. Like many developing nations, Burundi is strongly dependent upon fuelwood and charcoal for household energy: more than 95 percent of the energy consumed by households is provided by wood. This is due to wood's ready availability and the lack of cheaper alternatives—electricity and gas are very expensive and often inaccessible to people in rural areas (MEEATU 2011). Wood is also highly sought for construction and carpentry (bricks, woodwork and tile), in the baking of bricks, used to dry tea and tobacco leaves, and in the smoking of fish (MEEATU 2011). Non-timber forest products include plants, fungi, and animal products used in traditional medicine; fodder trees and shrubs; and tannins, gum and saps that can be used for industrial purposes (Rwabahungu, Niyonkuru, and Bukobero 2013).

Forest and agroforest resources contribute around 3 percent to Burundi's GDP and 6 percent to national employment (Republic of Burundi 2013). Electricity production depends on the health of forests and their ability to regulate the flow of water into hydroelectric dams, such as the one at Rwegura, which provides 50 percent of Burundi's electricity needs. Fuelwood enables the country to decrease the amount of hydrocarbons that it would otherwise import from abroad, with adverse effects on the national balance of payments (Republic of Burundi 2013). Burundi's forests, which host a wide array of flora and fauna—including a chimpanzee corridor that connects Tanzania and Rwanda and a RAMSAR site³⁸—can be developed for ecotourism purposes. Tourism currently accounts for 3 percent of GDP and 2.4 percent of jobs,

³⁸Under the Ramsar Convention, a Ramsar site is a site placed on the List of Wetlands of International Importance.

though these numbers may drop following the 2015 sociopolitical security crisis (Republic of Burundi 2013).

Loss of Forest Ecosystem Services

Forests also provide a range of ecosystem services. Forests maintain an integral function in regulating the water cycle—helping to regulate the proper microclimates needed for agriculture—and protecting watersheds. Burundi's forests help prevent siltation and pollution of the country's network of waterways by reducing erosion that leeches into the watershed. Compared to cropland, pastures and paved areas, forests' infiltration capacity is higher, meaning that runoff is absorbed into the ground at a faster rate and is thus less apt to erode the soil. Forest litter, which acts as a sponge to absorb precipitation and runoff, serves the same purpose, while the additional surface area provided by trees—branches, leaves, foliage and litter—provides a temporary home for water before it is evapotranspired (Rwabahungu, Niyonkuru, and Bukobero 2013).³⁹ Stopping soil erosion may be the most important service that forests provide in Burundi, especially to the farmers who depend on their soil's stability for their livelihoods. Forests are also conducive to biodiversity. They provide habitats for game that can be hunted. The carbon sequestration services offered by natural forest ecosystems are important for both the country's economy and the global environment. Inland fisheries depend on forests as well, since forest ecosystems keep lakes, such as Lake Tanganyika, conducive to healthy fish populations through the deterrence of siltation and pollution-induced eutrophication that asphyxiates fish and disrupts their habitats (Rwabahungu, Niyonkuru, and Bukobero 2013).

The deforestation and forest degradation encourage erosion, leading to the loss of soil fertility and endemic species, and increased microclimate variability. Afromontane forests in Burundi used to occupy an area of 104,000 ha. However, due to pressures on the country's forest resources, they now take up no more than 55,000 ha, including Kibira National Park (MEEATU 2011). Unfortunately, anthropogenic impacts to vegetative cover during the crisis of the 1990s left a lasting mark on Kibira's ability to provide ecosystem services. This destruction led to massive flood-related damages on the Imbo plain several years later in 2010, with flooding across the Rusizi plain and notably including widespread damage to Bujumbura International Airport (MEEATU 2013a). Bujumbura is situated downstream from the steep-sloped hills of the Mumirwa, the region most vulnerable to hillside soil erosion in the whole of Burundi. Public works to safeguard these hills from erosion have not progressed at a fast enough pace to keep up with population-induced and climate change pressures. In addition to the denuding of the hills on the city's periphery, there are other factors, such as lack of urban planning, driving vulnerability in the area. The quarrying of rubble stone and sand from peri-urban zones and rivers for use in local construction has also weakened the resilience of urban forest and aquatic ecosystems (Sabumukiza 2015).

Active forest plantations provide protection for the soil, timber and non-timber products, carbon sequestration, and contributions to the microclimate.

³⁹Coufourier et al. (2008), as quoted in (Rwabahungu, Niyonkuru, and Bukobero 2013).

Burundi's tree plantations sequester approximately €90 million (2009) worth of carbon; it remains in the interest of Burundi to safeguard these plantations, especially since the cost of afforestation is greater than the cost of conserving existing stocks. MEEATU/GIZ assessed this cost of inaction at €124 million, or 11 percent of GDP in 2009 (MEEATU 2011).

Costs

To estimate the total value of ecosystem services by tropical forests in each map cell, 20 ecosystem services were added up according to the three categories of services (provisioning, regulating, and cultural) that were used in the data to construct the models for ecosystem services valuation in the TEEB (The Economics of Ecosystems and Biodiversity) database (Van der Ploeg and de Groot 2010).

Based on the estimated per unit monetary values of ecosystem services, low and high values are applied for tropical forests, estimated at about I\$300 per hectare per year, including climate regulating service. FAOSTAT (1998) provides an implied emission factor per hectare of net forest conversion in Burundi (351 t CO₂ per hectare). Then annual climate-regulating service could be estimated for Burundi applying the share between tropical forest mean total values and mean climate-regulating values (24 percent) as in table S1 in Carrasco et al. (2014). Then total annual forest value lost in Burundi is estimated at I\$228 per hectare per year without climate service (US\$85, I\$1 = US\$0.4).

The cost of deforestation is estimated in terms of the annual value of lost ecosystem service, as the net present value (NPV) of flow of net benefits from lost ecosystem area and one-time cost of carbon storage loss in deforested areas. This flow of net benefits is obtained as a product of a value of ecosystem services per hectare and annual average acreage deforested over the period 2001–14. To capitalize the flow of ecosystem services, the NPV of losses (excluding climate services) is calculated by applying a 5 percent discount rate.⁴⁰ Then total cost of annual deforestation in Burundi without climate regulation service is estimated at US\$2.2 million. Total annual cost of deforestation in Burundi is estimated at a midpoint of US\$3.4 million (0.1 percent of GDP in 2014). With the upward scenario of population growth, deforestation and related costs are expected to increase.

2. Land Degradation

As stated in the main text, there appears to be a positive correlation between prevalence of land degradation and poverty in Burundi. Eight of the most impoverished provinces (Muyinga, Ruyigi, Gitega, Cankuzo, Kayanza, Kirundo, Karusi, and Rutana) are also identified as being among the most heavily degraded in the country. Table A2.1 shows the poverty rate by province in Burundi.

⁴⁰This discount rate is used to estimate the social cost of carbon.

Table A2.1. Poverty Rate in Burundi by Province, 2016

<i>Province</i>	<i>Poverty Rate (%)</i>
Ruyigi	85.4
Muyinga	83.5
Cankuzo	79.4
Karusi	79.2
Kayanza	76.9
Gitega	75.7
Kirundo	72.9
Rutana	71.6
Bubanza	63.8
Makamba	63.1
Muramvya	61.5
Ngozi	60.7
Mwaro	60.1
Cibitoke	55.6
Bururi	46.3
Bujumbura	20.8

Source : Burundi Poverty Assessment, World Bank (2016).

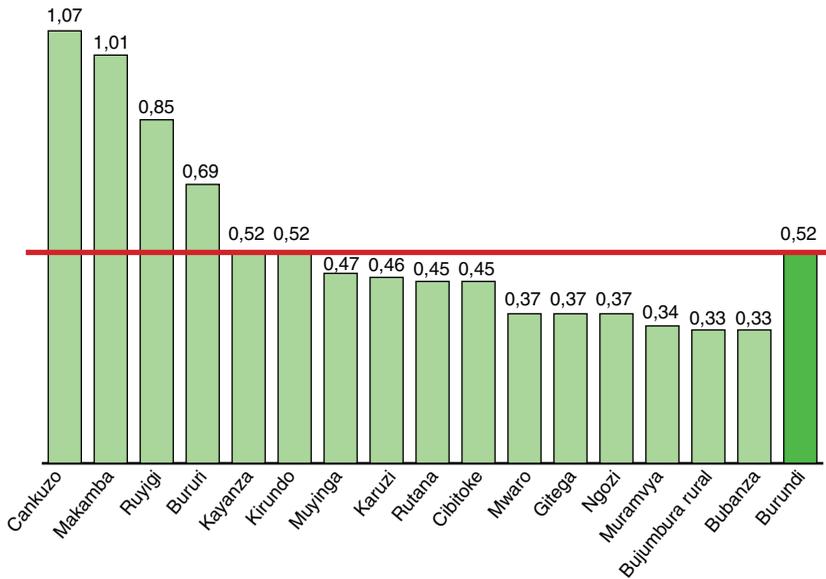
Causes and Drivers

Fragmentation of Cropland

The average size of a farm household in Burundi is slightly over five people and is headed by a man or woman around 40 years of age; the family typically has a goat. They sow three main crops: some combination of cassava, banana, sweet potato, and beans (Republic of Burundi 2013). Within a single farm, the land is divided into several fields, which are in turn subdivided into multiple parcels. This fragmentation is a primary signal of overexploitation and constitutes a major hindrance to intensive farming systems. As seen in Figure A2.1, the left of the country's population belt sees agricultural operation size well below the national average (Republic of Burundi 2013).

Oketch and Polzer (2002) outline four land degradation causes in Burundi. First, land is scarce in both the rural and urban milieu. Second, the tradition of passing land from father to son has led to the doling out of unviable, small parcels to the multiple sons within a family, which affects economies of scale and puts major pressures on soil fertility. It is important to note that the traditional system excludes women from inheritance. Third, due to this fragmentation of land, some family members are forced to migrate because their parcels are too small to be functional. Finally, sons are thus compelled to look for new lands in marginal and environmentally sensitive areas, such as marshlands and PAs, as well as those of dubious productivity potential, such as steep hillsides. Combined, these situations lead to major competition for land resources, increased

Figure A2.1. Average Surface Area Belonging to a Household by Province (ha)



Source: Republic of Burundi (2013).

erosion and declining soil fertility, and hence increased food insecurity (Oketch and Polzer 2002). Land ownership patterns also indicate the presence of varying social categories.

Poor Soil Management and Traditional Practices of Cultivation

Traditional agriculture practices have taken their toll on Burundi’s soils. Continued reliance on inappropriate agricultural practices, overexploitation of soils, and poor crop choice have all contributed to diminished soil fertility. Burundians were reluctant to consider the natural composition of the soil and its fragility when planting certain crops (MEEATU 2011). The majority of Burundians grow crops parallel to the slope, which promotes erosion. For communities whose access to wood is constrained, the population will turn to the use of plant debris and animal waste for household fuel, removing organic fertilizer from their lands, thus contributing to soil fertility loss.

Overgrazing

Animal husbandry is quite extensive in Burundi, though pastoralism is concentrated in the regions of Mugamba and Batutsi (MEEATU 2013b). Animals graze on ever-shrinking, less productive lands that are constantly deteriorating. Because most available lands are cultivated, pastoralists have lost premium grazing lands. The decrease in transhumance has also led to overgrazing, with animals ruminating and trampling on plants in the same area over long periods of time, causing the soil to become bare and infertile and leading to erosion. The combination of overgrazing with soil erosion leads not only to the denuding and impoverishment of the soil, but also to a loss in biodiversity when

native species cede their place to hardier, nonlocal ones. To find fresh areas for grazing, pastoralists may herd their animals in national parks, like Rusizi and Kibira, and PAs like Bugesera's protected aquatic landscape, all of which have suffered mightily from this practice (MEEATU 2013b). The persistence of inadequate pastoral practices is due to relatively weak farmer education in agro-sylvo-pastoral techniques, as there is no comprehensive agricultural extension program to address this issue (MEEATU 2011).

Lack of Erosion Control Systems

Since the colonial era, development programs have invested in combating erosion in the hilly, undulating country with modest results. In modern day Burundi, upward demographic pressure has been the limiting factor for effective erosion control. This is mostly due to the limited land availability in the country, which forces rural dwellers to sow crops wherever possible, without attention to the consequences that this may have on the surrounding landscape (Niyonkuru, Rwabahungu, and Masilya 2013). Across the country, three out of four plots have no erosion control systems in place. For those parcels with erosion control measures, contour lines with hedges are the most commonly used apparatus at 13.6 percent; plots that have contour lines without hedges represent 3.2 percent of all cultivated plots; radical terraces with hedges are present on only 2 percent of cultivated land. The lowest use of erosion control tools occurs in the natural areas of Mumirwa (10 percent, and the most rapidly eroding of all Burundi's regions), Imbo (12.7 percent), and Moso in the east (14 percent; Republic of Burundi 2013).

Poor Municipal and Urban Planning

For lack of comprehensive municipal land-use planning, the population has steadily encroached on both marginal lands and slopes that are both unsuitable for agriculture and could be set aside for reforestation to limit degradation due to erosion. In other cases, public woodlands and urban and semi-urban centers were located on top of fertile soils or community pastureland, reducing spaces to conduct agricultural and pastoral activity and engendering conflict between the administration and the population (MEEATU 2011). This failure rests at two levels: (i) the national, provincial, and local authorities under which urban and town planning are found; and (ii) the legislator, whose job it is to enact regulations on land tenure and land use (MEEATU 2011). A multi-stakeholder platform is necessary to bridge the differences between competing land uses that have combined to leave Burundi's soil in a poor state.

In Burundi, there are four distinct categories of habitation occupying the majority of the land: urban areas, metropolitan/suburban areas, villages, and wildlife habitats scattered on the hills. While urban areas have experienced a growth rate of 5.6 percent in the past year, the number of rural dwellers still outnumbers those in urban areas by about 9:1, and 3 out of 5 urban dwellers live in Bujumbura Mairie (World Bank 2015).⁴¹ The level of urbanization in the country is still quite low. Because of haphazard urban planning, some public and private infrastructure is situated on the border (and even inside)

⁴¹Mininter (2011), as quoted in MEEATU (2013b).

of vulnerable areas, such as forests and rivers. There are settlements that have been erected on the country’s steepest slopes, leaving these homes vulnerable to erosion pressures. Roads have also been constructed on steep slopes, often without any safeguard systems.

Consequences

As Burundi relies so heavily on agriculture for its national income, soil erosion on agricultural land is a critical matter to the national economy as well as to the farmers. Indirect effects of land degradation on the economy, while difficult to measure, are equally important. First, the siltation of waterways and dams and its impact on water flow has resulted in the loss of precious kilowatt hours in a country that is already electricity impoverished. The link between land degradation and natural disasters that occasion damage to homes and public and private infrastructure, especially trade, industry and transportation, has deeper effects than those that can be measured quantitatively, such as the trauma of losing one’s livelihood and personal possessions. Finally there are ecosystem health impacts related to land degradation, including the loss of carbon sinks and its effect on air quality, as well as the loss of biodiversity and the unknown ramifications that this can instigate (MEEATU 2011).

The effects of land degradation in rural areas are summarized in Table A2.2.

Table A2.2. Effects of Degradation on Rural Lands

<i>Land Type</i>	<i>Symptoms of Land Degradation</i>	<i>Main Effects of Degradation</i>
<i>Agricultural land</i>	<ul style="list-style-type: none"> • Loss of soil fertility • Different forms of erosion 	<ul style="list-style-type: none"> • Decline in agricultural production • Impoverishment of farmers • Cyclical famines and migration • Malnutrition • Food importation
<i>Forests and natural formations</i>	<ul style="list-style-type: none"> • Biodiversity loss • Destabilization of the proper functioning and provision of ecosystem services 	<ul style="list-style-type: none"> • Reduced agricultural productivity downstream • Disruption of water and climatic cycles • Loss in productivity of forest products • Impoverishment of the population • Elevated risk of natural disasters (floods, rise in water level, landslides, drought)
<i>Livestock grazing areas</i>	<ul style="list-style-type: none"> • Disappearance of forage species with high nutritional value • Inability to regenerate sufficient vegetative cover • Soil destabilization • Deterioration of soil quality 	<ul style="list-style-type: none"> • Circumscribing of livestock routes • Destabilization and exposure to erosion • Livestock feed deficit • Decreased production of milk and meat • Impoverishment

Table A2.3. Estimated Annual Cost of Soil Erosion

Crop	Potential Yield Loss, %	Potential Yield Loss, T/Ha/Year	Cost from Annual Soil Loss, US\$/Ha/Year	NPV from Annual Soil Loss, Low, Million US\$/Year	NPV from Annual Soil Loss, High, Million US\$/Year	NPV from Annual Soil Loss, Medium, Million US\$/Year
Beans	5	0.03	9	15		N/A
	31	0.21	62		104	N/A
Maize	5	0.06	8	5		N/A
	31	0.41	52		32	N/A
Sweet potato	5	0.43	24	11		N/A
	31	2.95	164		73	N/A
Total "low," million US\$				31		N/A
Total "high," million US\$					209	N/A
Total "medium," million US\$						120

Source: Author's estimate.

Costs

Since there are no data on the erosion rate of agricultural lands, we assume a lower bound of 3t/y/ha (31 percent of the territory of Burundi) and the African average erosion rate on Ultisol and Oxisol type soil of 12t/y/ha (Den Biggelaar et al. 2004) as the upper bound. We assume that severely eroded lands are not used in crop production in Burundi. Yield loss on lightly eroded lands is estimated at 4 percent and on moderately eroded lands at 24 percent. Potential productivity losses on the eroded lands for each type of crops are then estimated.⁴²

Table A2.3 presents the estimated annual cost of soil erosion in Burundi.

Thus, soil erosion in Burundi is associated with economic losses at a mid-point of US\$120 million or 3.9 percent of GDP in 2014. This is a conservative estimate obtained using productivity reduction for three major crops in Burundi.

3. Indoor Air Pollution

In Burundi, indoor cooking using traditional methods is very common. In rural areas, wood fires and kerosene lamps are also still the main means for lighting homes. Following a 56 percent increase in fuel prices between 2010 and 2012, the use of oil lamps in rural areas declined from 37 percent to 22 percent. Furthermore, reforestation programs and increases in the price of charcoal by over 74 percent resulted in a decline in the use of wood fuel. Consequently,

⁴²Using the following formula: $P_{ij}^m = \frac{P_r^m * k_j}{1 - k_j}$, where P_{ij}^m = estimated productivity loss; P_r^m = reported productivity; j = degree of land degradation; and k_j = productivity loss due to soil degradation of type j .

rural households have had no choice but to employ rudimentary means of household lighting, use of biomass primarily, resulting in increased indoor air pollution (World Bank 2014b).

The share of wood in the overall energy balance in Burundi is substantial. In 1999, a study carried out by the Ministry of Energy and Mines observed that wood and agricultural biomass were used for approximately 97 percent (equivalent to 5.4 million tons) of all energy needs, and that it was the rural areas that consumed the largest amount of wood, at 76 percent of total consumption. For the remainder of the national energy balance, electricity usage represented 0.47 percent, while petroleum products represented 2.4 percent. Energy from peat moss, of which Burundi has a good supply, was only 0.04 percent of the national energy balance.⁴³ Reliance on traditional energy sources (wood, charcoal, and plant residues) has since declined to 90 percent of the country's energy needs (Bukobero, Bararwandika, and Niyonkuru 2013).

One driver of household energy choice is prices. Rwabahungu et al. observed that the cost of a standard bag of charcoal in Bujumbura was 9,000 FBU in 2005 (approximately US\$5.80). More than three years later, in 2009, the cost had increased to 15,000 FBU (US\$9.70), or a price increase of two-thirds (Rwabahungu, Niyonkuru, and Bukobero 2013).

The national electrification rate was also limited to 5 percent in 2013 (IEA 2015). It is due to two main factors: the geographic scattering of habitations, especially in nonurban areas, and the poverty of the population and their inability to pay for electricity. The electric power production capacity is low and accessibility is limited, with few households connected to the national electricity grid.

Consequences

There is no denying that man-made pollution affects individuals' health, the environment, and economic growth. Global health care expenditures attributable to pollution ranges from over US\$230 billion to almost US\$660 billion. This represents between 3 percent and 9 percent of global spending on health care in 2013, and nearly 14 percent of this spending is in lower- and middle-income countries (Lapetra et al. 2016). Globally, 4.3 million deaths in 2012 were attributable to household air pollution, including 600,000 in Africa (WHO 2014). It was also estimated that US\$1.30 billion was spent in low-income countries on household air pollution (Lapetra 2016).

The rural poor use the most solid fuel, often in open fires or with inefficient cook stoves. The health and economic consequences of this situation compound their poverty level and prevent them from having access to cleaner and more expensive energy sources such as gas and electricity. Tables A3.1 and A3.2 show the quantity of emitted pollutants in Burundi by type of fuel used and the distribution of death causes due to solid fuel use, respectively.

Moreover in 2002, the use of solid fuels represented 5.2 percent of Burundi's total disease burden, and was the cause of 6,600 deaths (WHO 2007; Table A3.3). It is also noteworthy that from 2011 to 2013, pneumonia was the third most frequent cause of consultation (after malaria and respiratory

⁴³Ndabirorere (1999), as quoted in Rwabahungu, Niyonkuru, and Bukobero (2013).

Table A3.1. Quantities of Pollutants Emitted by Fuel Type in Burundi, 2002 (in percent and g/MJ)

Type of Fuel	Hearth Efficiency (%)	Emission (g/MJ)				
		CO ₂	CO	Methane	COVNM	N ₂ O
Butane	53.6	126	0.61	Neg	0.19	0.002
Biogas	57.4	144	0.19	0.10	0.06	0.002
Kerosene	49.5	138	1.9	0.03	0.79	0.002
Wood fuel	22.8	305	11.4	1.47	3.13	0.018
Agricultural residues	14.6	565	36.1	4.13	8.99	0.028
Charcoal	14.1	710	64.0	2.37	5.60	0.018
Cow dung	10.0	876	38.9	7.30	21.80	0.022

Source: Smith 2002.

Table A3.2. Distribution of Deaths Due to Indoor Pollution Caused by Solid Fuel

Cause	Percentage of Deaths
Cerebrovascular accident (stroke)	34
Ischemic heart diseases	26
Chronic obstructive pulmonary disease	22
Pneumonia	12
Lung cancer	6
Strokes	Nearly 25 percent of all premature deaths due to cerebrovascular accidents (around 1.4 million, half of them being women) could be attributed to chronic exposure to pollutants emitted indoors during cooking with solid fuels

Source: WHO (2014), "Indoor Air Pollution of Housings," Aide-mémoire 292.

Table A3.3. Impacts of the Use of Solid Fuels on Public Health in Burundi, 2002 (in absolute terms and percent)

Indicator	Value
Number of annual deaths by acute lower respiratory infections due to the use of solid fuels for children under five years old	5,930
Number of annual deaths by chronic obstructive pulmonary disease due to the use of solid fuels for adults (> 30 years old)	640
Number of deaths due to the use of solid fuels	6,600
Number of ischemic strokes due to the use of solid fuels	212,600
Share of the use of solid fuels in the national disease burden	5.9 percent
Percentage of population using solid fuels	98.5
DALYS /1,000 capita per year	32

Source: WHO 2007.

Note: DALY = disability adjusted life year.

infections other than pneumonia) in health care centers in Burundi for children under five years old, representing 6.95 percent, 5.19 percent, and 4.05 percent, respectively, of total consultations for children under five years old. These data on health care centers consultations are likely to be lower than actual morbidity cases because half of ill children do not receive any modern medical treatment.

Costs

The WHO recently reduced its particulate matter (PM) guideline limits to an annual average ambient concentration of 10 microgram per cubic meter ($\mu\text{g}/\text{m}^3$) of PM_{2.5} and 20 $\mu\text{g}/\text{m}^3$ of PM₁₀ in response to increased evidence of health effects at very low concentrations of PM.⁴⁴ As reported in MIS 2012 and DHS 2010, in Burundi, 98.5 percent of the population uses solid fuels for cooking from which they are exposed to household air pollution levels that average over 100 times the WHO standard. Since in Burundi some of the population cooks outside or in a separate building, in this study it was approximated that about 40–50 percent of Burundians have outdoor kitchens and 50–60 percent cook indoors (DHS 2010). Then from international studies, those who cook outside have 100–200 $\mu\text{g}/\text{m}^3$ average annual concentration of PM_{2.5} in their household. Those who cook inside with poor ventilation have 400–600 $\mu\text{g}/\text{m}^3$ average annual concentration of PM_{2.5} in their household (Pennise et al. 2009).

The most substantial health effects of PM_{2.5} are cardiovascular disease, chronic obstructive pulmonary disease (COPD), and lung cancer among adults and acute lower respiratory infections (ALRI) among young children (Pope et al. 2009, 2011; Lim et al. 2012; Mehta et al. 2013). Additional mortality is estimated using an integrated exposure-response (IER) relative risk function (RR) associated with exposure to fine particulate matter pollution (PM_{2.5}) both in the outdoor and household environments.

Based on the estimated total mortality due to particulate air pollution and the parameters shown in Table A3.4, estimated annual costs of the air pollution impacts on health in Burundi are presented in Table A3.5.

Table A3.4. Estimated Value of Statistical Life (VSL) in Burundi

	VSL		Source
Average VSL in OECD (US\$ millions)	1.4	4.5	Narain (2016)
Average GDP/capita in OECD	40300	40300	World Bank (2015a)
GDP per capita in Burundi in 2014	769	769	World Bank (2015a)
Income elasticity	0.8	1.2	Cropper (2014) ; Navrud and Lindhjem (2011)
Estimated VSL in Burundi (million US\$)^a	0.021	0.013	Estimated for Burundi

Source: Estimates by the authors.

^a Adjusted for PPP.

⁴⁴PM_{2.5} and PM₁₀ are particulates with a diameter smaller or equal to 2.5 and 10 micrometers (μm), respectively.

Tableau A3.5. Estimated Annual Cost of Health Impacts Associated with Household Air Pollution (HAP)

	<i>Low</i>	<i>High</i>	<i>Midpoint</i>
Total cost of air pollution, US\$ millions	87	137	112
Share of GDP in 2014	2.8 percent	4.4 percent	3.6 percent

Source : Estimates by the authors.

Thus, annual losses attributed to indoor air pollution in Burundi are estimated at a midpoint of about US\$112 million, or 3.6 percent of GDP in 2014. Health losses in DALYs estimated in this report are very close to the estimations of health losses due to air pollution risk, as presented by the Institute for Health Metrics and Evaluation.⁴⁵

4. Water Pollution

Causes and Drivers

Burundi's water pollution originates largely from waste related to agro-pastoral activities, plus other sources. These include the use of chemical fertilizers and pesticides, household and industrial waste, garages and car washes, unregulated mines and quarries, and invasive flora, namely water hyacinth and Nile cabbage. As a result of these, surface waters are polluted by runoff while ground water is sullied through leaching. In Burundi, the majority of industrial companies are emplaced in or near wetland areas. The various effluents and byproducts are sent into the water without any treatment, which is in violation of the relevant provisions under the 2012 Water Code (Box A4.1). Another threat is the refuse generated from urban living: plastic sachets, plastic packaging, and glass. No action is currently being taken to minimize this waste, despite the fact that the imports generating this garbage are intensifying.

Traditional Farming Practices

Coupled with the absence of watershed management plans, traditional farming practices have caused, in particular:

- downstream pollution, typified by increased levels of stripped topsoil, fertilizer, and pesticides;
- landslides and rock falls;
- flooding accompanied by pollution brought downstream; and
- siltation and eutrophication of downstream rivers, marshes, and lake coastal areas.

Unmanaged and Unplanned Mining and Quarrying

Use of toxic separation products in mining, for example, mercury and cyanide, can pollute nearby ecosystems, especially water streams, and also be fatal

⁴⁵<http://www.healthdata.org>.



Destruction to riverbanks in Matongo commune due to gold mining: (from L to R) Inampemba and Nyawisesera Rivers
Source: Prof. Charles Niyonkuru (2014).

when improperly used. Since mineral washing occurs in nearby water courses, some of the ore is transported downstream due to lack of appropriate technologies, thus polluting these courses with heavy metals. Further, tailings—the byproducts of the extraction process—are also washed downstream (Republic of Burundi 2013).

Poorly Located Factories and Industries

Box A4.1. Case Study: Palm Oil Manufacture and Water Pollution in Rumonge

In Rumonge commune, approximately 94 percent of artisanal palm oil factories are located at the edges of rivers, which allows the manufacturers easy access to the water supply necessary for operations and subsequent effluent disposal. Water needs are enormous during the palm oil extraction process. Field observations and surveys show that:

- to produce 20 liters of “Dura” variety oil, 1,200 liters of water are necessary; and
- two barrels of water, each with a volume of 200 liters, are needed to produce 20 liters of “Tenera” variety oil (this variety generates more waste than the “Dura” variety^a).

The consequences of this water pollution are measured through tests of biochemical oxygen demand (BOD) and chemical oxygen demand (COD).^b Such tests were performed at the site of the *Huilerie de Palme du Burundi* (HPB). The BOD of palm oil extraction effluents easily reached 11,200 mg/L, which is 50 times the amount typically found in sewage; the standard for discharge into rivers is 20 mg/L. This palm oil factory, with a capacity of 3.5 t/h, pollutes as much as a city of 35,000 inhabitants. The COD in the waters surrounding HPB are 16,000 mg/L, far beyond the acceptable standards that can be discharged into rivers, which is 30 mg/L.

Other parameters demonstrate a consistent pattern of extreme levels of pollution: copper (5 mg/L; standard: 0.2 mg/L); zinc (with 9.75 mg/L; standard: 5 mg/L); oils and fats still high (greater than 4.8; standard: 0 mg/L); potassium (650 mg/L; standard: 50 mg/L); orthophosphate (up to 340 mg/L; standard: 30 mg/L); and total bacteria are present in much greater quantities than the accepted norms. Turbidity, which illustrates the amount of material suspended in the water, is also extremely high. Turbid water reduces light intensity and consequently decreases the productivity of autotrophic plants; it may also be responsible for asphyxiating fish by clogging their gills.

Regardless of their more formal status, semi-industrial and industrial factories rarely pre-treat the wastewater refuse left behind from their extraction processes, although article 73 of the 2012 Water Code requires such treatment. When queried about this problem, two HPB employees reported that effluents were channeled, by drains, toward the Murembwe River.

Cottage industry palm oil extraction is another culprit in water pollution in the commune. Under the artisanal mode of extraction, oil losses are considerable: these producers lose 6 percent when compared to industrial extraction. In addition, small-scale rural producers do not treat their wastewater at all before sending it into the rivershed. Despite an already worrying situation, current trends demonstrate ever-increasing levels of palm oil extraction in the country. According to the *Office d'Huile de Palme*, between the 1990s and 2005, Burundi doubled its palm oil production from producing roughly 8,000 tons, to 18,000 tons in 2005. In conjunction with the production uptick is a rise in the effluents that are eventually dumped into Lake Tanganyika. If conducted under business as usual, the rehabilitation of palm plantations in Rumonge is likely to further exacerbate water pollution.

As a direct result of palm oil waste discharge into local water bodies, there is an observed loss of biodiversity in downstream aquatic environments. Pollution affects many spawning fish that are typically found at the mouths of these rivers. The population of some species, such as local catfish and cichlids, have thinned considerably in the catches of the Murembwe and Buzimba rivers. These species are, among others, local catfish (*Clarias gariepinus*) and two types of cichlids (*Astatoreochromis vanderhorsti*, *Astatotilapia burtoni*). One species of tigerfish and one of lungfish have disappeared completely.

Hence, article 2 of the Water Code of Burundi requires immediate attention in order to properly recognize the economic value of water and possibly introduce the principle related to payment for environmental services, where users need to pay for their withdrawals.

- a. Bizindavyi (2012, p. 48).
- b. "Biochemical oxygen demand is the amount of dissolved oxygen needed (i.e., demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a surrogate of the degree of organic pollution of water" https://en.wikipedia.org/wiki/Biochemical_oxygen_demand.

"Chemical oxygen demand is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g., lakes and rivers) or wastewater, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution" https://en.wikipedia.org/wiki/Chemical_oxygen_demand.

Transportation Infrastructure

Transport on the majority of Burundi's roads has caused negative effects on the environment related to:

- inadequate protection of roadsides, which are subject to severe erosion, landslides, and falling rocks;
- areas located downhill from steep, sloping roads often become unstable and prone to severe erosion, thus constituting a permanent threat to homes,

social infrastructure (schools, hospitals), crops and vegetation, and others; and

- gutters built along the roads are often poorly maintained, leading to the creation of floods; these same conduits sweep along various materials (mud, sand, stones) that cause heavy sedimentation in downstream plains and marshes.

Because Burundi is a landlocked country, regional lake transportation and port infrastructure are essential for economic growth. While there is no readily available data on the intensity and extent of lacustrine pollution, anecdotal evidence demonstrates that pollution comes in the form of oil spills and slicks from boat maintenance and accidents, as well as boat engine exhaust released into the aquatic environment.

Invasive Plant Species

The main invasive aquatic plant is water hyacinth (*Eicchornia crassipes*). Lake Tanganyika, some lakes in northern Burundi (Rweru, Cohoha, and others), and many rivers in the country are being threatened by this species. Water hyacinth impedes the productivity of aquatic ecosystems by reducing oxygen at night and hindering proper water circulation. The only way to fight this species is by removal from the water, usually mechanically. Another less prevalent invasive species is Nile cabbage. This plant forms a mat on the surface of the water, thereby reducing the oxygen available for aquatic fauna's nocturnal respiration needs.

Additional Causes of Water Pollution

Garages and car parks, frequented by individual or professional motorists, are used to perform car maintenance. With no proper supervision oils, paints and heavy metals are left to flow into nearby water sources. In the case of garages near Buyenzi, automobile waste trickles into the Ntahangwa River, a tributary of Lake Tanganyika.

Solid household waste is often deposited in adventitious garbage dumps located along rivers or in places where the water table is near. Leaching or erosion of these wastes directly causes the pollution of close by water resources.



Invasive plants in Burundi (from L to R), water hyacinth on Lake Tanganyika; Nile cabbage, in Rumonge commune, in a sewer opening into Lake Tanganyika

Source: Prof. Charles Niyonkuru (2014).



From L to R: Buyenzi informal garbage dump near the Ntakangwa River, a tributary of Lake Tanganyika; a wild garbage dump in Rumonge commune is located near a sewer pipe that opens into Lake Tanganyika.

Much of the packaging used in commerce, such as bags and plastics, is not biodegradable. Carried away by wind, water or sheer neglect, these wrappings present a real problem for aquatic ecosystems and wildlife.

Consequences

Unsafe water, inadequate sanitation, poor hygiene, and ineffective management of water resources represent half of the factors causing stunting and wasting in children. In Burundi, the use of potable water for human consumption is low compared to that employed in agriculture (NAPA 2007). In urban areas, the drinking water needs are doubling every 10 years, while in rural areas, the growth rate for drinking water demand reaches 58 percent every 10 years (NAPA 2007). Inadequate sanitation jeopardizes the health of almost a quarter of the population of developing countries worldwide, and in Burundi, poor hygiene is the primary cause of 80 percent of deaths in the country (Ministry of Health 2011). Poor management of human waste is also the main cause of contaminated drinking water. Unsafe water continues to cause epidemics (cholera, bacillary dysentery, malaria, and so forth) with great loss of life, especially for the poor. Treatment of these diseases can be very expensive and can contribute to pushing the population deeper into poverty.

Impacts of Water Source Pollution “en ville” on Health: The Case of Bujumbura

The CEA embarked on a sampling of degraded water sites in the city of Bujumbura. The review consisted of six sites; Table A4.1 highlights the results.

Nitrogen compounds (nitrates and nitrites especially) generally come from the use of fertilizers, organic matter (biodegradable) decomposing the chemical industry and the food industry. A high nitrite concentration indicates organic pollution. These results show that the studied sites are loaded with nitrogenous substances that result in eutrophication. The values obtained for nitrates exceed the recommended extreme value of 100 mg/L (except for the public collector of Eden).

An analysis of the levels of sulphates, fluoride, iodine, phosphorus, all of which are toxic at high concentrations, reiterated the stark situation of water

Table A4.1. Water Sampling Sites in Bujumbura

<i>Site</i>	<i>Description</i>
Eden du Lac, storm drain	Found near the port of Bujumbura, in the southernmost part of the city, this is a main storm drain for the city that is generally full regardless of the season—rainy or otherwise—because of sewerage emanating from domestic and commercial uses, for example, garages and others.
Bujumbura Station, sewers	Situated close to the Eden drainage system, these sewers receive wastewater and refuse from car/truck washing and oil changes, including from many multi-axle vehicles. Most of the liquid waste is drained into Lake Tanganyika.
Brarudi, principal drain	The only drain pipe in the northwest, it drains effluent from the Brasserie of Burundi (BRARUDI).
Buyenzi, sewers	This sewer leads out to the Ntahangwa River, a tributary of Lake Tanganyika. The river receives almost all of the wastewaters emanating from both garages and riverside garbage dumps.
Kinyankonge River	This river is another tributary of Lake Tanganyika; it passes by the SAVONOR soap factory.
Ngagara, storm drain	Another large storm drain that receives residual waters of all sorts (household, commercial, industrial, and so forth) and leads to the Ntahangwa River.

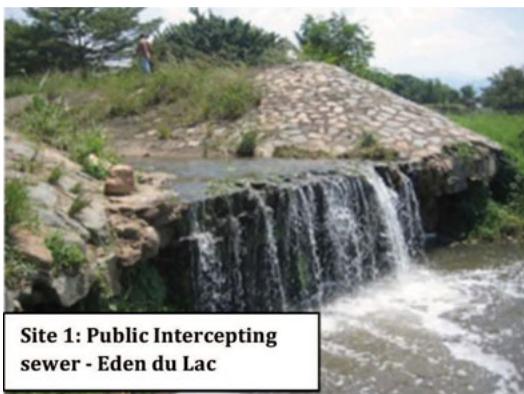
Source: Authors' compilation.

pollution in Bujumbura. The worst sites for these four were the Bujumbura station and Eden du Lac. This is because high concentrations of sulfides, fluorides, and iodine can be found in garages, painting workshops, industrial and commercial centers and the various building materials, such as those that abound near the two sites.

Other heavy metals—bromates, chromium, copper, iron, and manganese—were also found in copious and dangerous quantities. The values obtained through the study far exceed international standards and constitute a danger to the environment. These waters are very contaminated, especially by iron and manganese. The Buyenzi sewers had the highest levels of these heavy metals. As mentioned earlier, this is a sewer receiving various types of solid waste and wastewater from automotive garages and artisanal workshops. This metallic waste is visible to the naked eye in the sewer's various ducts. All the results far exceed WHO human potability standards. The water from these sites is undrinkable, even though during field visits, the researchers observed people swimming and bathing near these sites, thus running the risk of ingesting these waters.

Bacteriological analysis of these results shows that all sites are polluted by fecal bacteria (such as fecal coliforms and *E. coli*) with values far higher than WHO standards. Observations on the ground recorded people relieving themselves near rivers or in landfills and the presence of human feces in the study area, thus confirming laboratory results.

Most of the drinking water consumed in the city of Bujumbura comes from Lake Tanganyika, which might become an issue in the years to come. Given the ever-rising levels of water pollution in the coastal areas along the city, the REGIDESO water collection point was forced to move farther ashore in 1984.



Site 1: Public Intercepting sewer - Eden du Lac



Site 2: Bus station sewer



Site 3: Brarudi's main public intercepting sewer



Site 4: Buyenzi's sewer



Site 5: Kinyankonge's river



Site 6: Ngagara's public intercepting sewer

Note: The various sites where water samples were collected.

This collection point, which was initially 800 meters from the beach in 1981, was pushed to 3,500 meters away. If precautionary measures to limit pollution of the lake are not taken soon, there is a concern that, in the future, water-related conflict between Burundi and neighboring countries that share the waters of Lake Tanganyika, in particular the Democratic Republic of Congo, will arise due to disagreements over the international lake boundary.

Table A4.2. Results of Water Sampling in Bujumbura

Sites	Fecal Coliforms (UFC/100 ml)	Escherichia Coli (UFC/100 ml)
Eden du Lac, storm drain	3,35.105	1,72.104
Bujumbura Station sewers	2,21.105	3,44.105
Brarudi, principal drain	7,65.105	1,72.105
Buyenzi sewers	9,12.105	1,29.105
Kinyankonge River	2,72.105	5,37.105
Ngagara storm drain	5,16.105	2,32.105

Source: Authors.

Costs

The Burundian water and sanitation sector is challenged by the following issues: (i) inadequate water service quality; (ii) inadequate sanitation service quality; and (iii) inadequate hygiene. WHO states that health impacts regarding inadequate drinking water supply and sanitation are correlated with the population coverage with so-called improved water supply and improved sanitation and good hygiene practices (WHO 2008).

Table A4.4 presents the estimated health impacts from inadequate water, sanitation, and hygiene. The estimates are based on the data in Table A4.3, taking into account that 61 percent of diarrheal illness is attributable to water, sanitation, and hygiene (see below). DALYs from diarrheal illness (morbidity only) also are presented in Table A4.4, based on the estimated cases, disability weight, and an average duration of diarrheal morbidity of 3–4 days. It is noteworthy that there are other diseases (schistosomiasis, dengue, ascariasis, and others) attributed to water pollution. As indicated in Prüss-Üstün et al. (2014), 66–100 percent of their burden could be attributed to water pollution; this

Table A4.3. Baseline Data for Estimating Health Effects

	Baseline	Source
Under-five child mortality rate in 2014 (per 1,000 live births)	96	GBD 2014, DHS 2010
Diarrheal mortality in children under five years (% of child mortality)	13.4 percent	GBD 2014
Diarrheal two-week prevalence in children under five years	25 percent	DHS 2010
Estimated annual diarrheal cases per child under five years	5.2	Estimated from DHS 2010
Estimated annual diarrheal cases per person (> 5 years)	0.65–0.9	Estimated from a combination of DHS 2010 and Egypt Survey, Columbia Survey
Hospitalization rate (% of all diarrheal cases)	3 percent	Ministry of Health
Diarrheal cases attributable to inadequate water supply, sanitation and hygiene	61 percent	Prüss-Üstün et al. 2014

Table A4.4. Estimated Annual Diarrheal and Other Disease Burden Attributed to Water Pollution in Burundi

	<i>Children < 5</i>	<i>Adults</i>	<i>Total DALYs</i>
DALYs lost due to mortality diarrhea	260,099	172,630	
DALYs lost due to morbidity diarrhea	13,933	7,364	
Total diarrhea	274,033	179,994	454,026
DALYs lost due to other diseases		50,792	50,792
Total DALYs lost			504,818

Source: Authors' estimation.

Table A4.5. Estimated Annual Cost of Water Pollution (US\$ million)

	<i>Low</i>	<i>High</i>	<i>Midpoint</i>
Diarrheal and other disease burden	91	144	117
Share of GDP in 2014	2.9 percent	4.6 percent	3.8 percent

Source: Authors' estimates.

report attributes 75 percent. The total DALYs lost due to these other diseases reach 67,700.

Annual cost of water pollution, including diarrheal burden and burden of other diseases, is estimated with an approach similar to that used for air pollution; the methodology is presented in Cropper and Khanna (2014) and Narain et al. (2016). Cost of illness for diarrhea is estimated from WHO-CHOICE database for Burundi at about US\$100 million annually. Total annual cost of water pollution in Burundi is estimated at a midpoint of US\$117 million (Table A4.5), or at about 3.8 percent of GDP in 2014.

5. Natural Disasters

In Burundi, seven natural disaster risks, whose origins are linked to environmental factors, are recurrent: drought, flooding (in flood plains), torrential floods, rockslides, mudslides and landslides, earthquakes, and bushfires (Figure A5.1). Other risks include biological ones, such as epidemics, pandemics, and infestation of invasive species (mentioned in the section on biodiversity; Muhigirwa 2011).

According to EM-DAT (2015) data, between 1992 and 2015, 298 Burundians died due to natural disasters including drought, storms, floods, landslides, and earthquakes (Figure A5.2). A look at the 10-year moving average of natural disasters in Burundi shows an average of two events and 27 deaths per year. The World Bank reports that 96.6 percent of Burundi residents, who live on 96.3 percent of the total land area, are at relatively high mortality risk from two or more hazards (World Bank 2005).

Figure A5.1. Frequency of Natural Disasters, 1990–2015

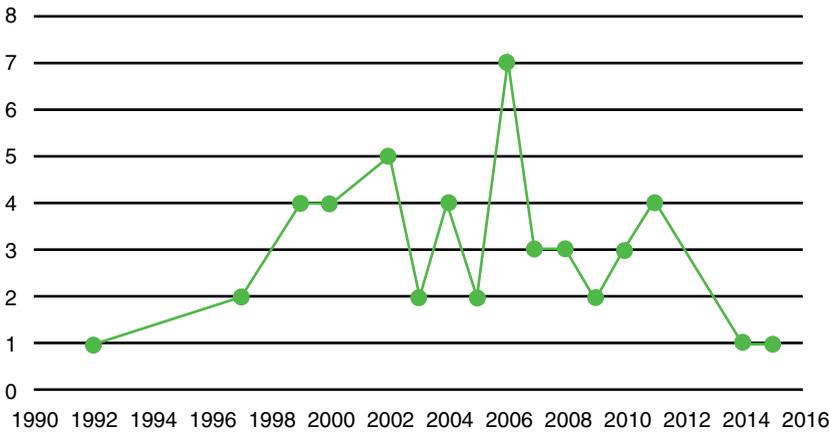
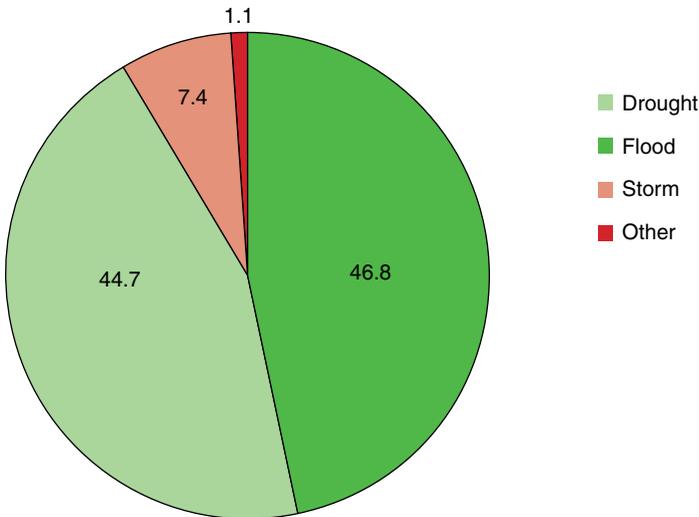


Figure A5.2. Distribution of Mortality Associated with Natural Disasters in Burundi



Source: EM-DAT 2015.

Probabilistic risk assessment looks at a country’s exposure to possible future natural disaster scenarios to provide an estimate of probable losses. Average annual loss (Table A5.1) is the expected loss per annum associated with the occurrence of future hazards. The results for floods look at the potential risks associated with river flooding in Burundi.

The geological, morphological, and topographical aspects clearly influence the distribution and concentration of landslides and rockslides in Burundi.⁴⁶ Regionally, the tectonic and structural context has created a situation of intensely faulted and fractured massifs. On top of this is a climatic

⁴⁶Nigibira et al. (2013), as quoted in World Bank (2014).

Table A5.1. Average Annual Loss by Hazard

Hazard	Absolute Loss (US\$ millions)	Capital Stock (%)	Gross Fixed Capital Formation (%)	Social Expenditure (%)	Total Reserves (%)	Gross Savings (%)
Earthquake	3.87	0.107	0.502	1.278	1.179	0.892
Flood	3.05	0.084	0.395	1.007	0.929	0.703
Multi-hazard	6.92	0.191	0.897	2.285	2.109	1.595

Sources: EM-DAT; WDI.

factor that accelerates the weathering, erosion, and geomorphological remodeling processes. In many cases, landslides have occurred within the immediate vicinity of riverbeds, indicating both that rivers contribute to landslide risk—due to the continual burrowing of these beds into the soft rock beneath—and that over three quarters of landslides threaten to obstruct these riverbeds and create temporary water retention structures. These temporary structures can suddenly give way and generate runoff in the form of flash flooding, with massive destructive potential (World Bank 2014).

Bujumbura is located on the eastern shore of Lake Tanganyika in the African Rift Valley and is exposed to erosion and landslides. Its topography is characterized by: (i) steep slopes that permit torrential flows from the high mountains that form the Congo–Nile Ridge, which hosts the sources of four major rivers that cross the city from east to west; and (ii) very low slopes on the plain with meandering waterways discharging insufficient flows. The Mirwa River’s watersheds upstream of Bujumbura are composed of deep humus-rich, silty red fer-risols. Although highly fertile, cultivation in these soils must be undertaken with caution as the potential for erosion is extreme, with very high water retention often causing landslides. The level of degradation from these soils is accentuated by the convex shape of the city’s longitudinal profile (Figure A5.3).

The extension of cultivated areas has gradually reduced the space of natural vegetation, which is typically woodland. Primary forest cover no longer exists in the city. Overexploitation of the land coupled with inadequate farming

Figure A5.3. Topographic Profile along the Mirwa River



Source: World Bank 2014.



practices has increased soil erosion, contributing to flooding of the plain and the creation of ravines around Bujumbura. Most farming is conducted without considering the effect on slopes, where oftentimes plowing takes place in the center of the slope, which greatly favors erosion. The period immediately following plowing is therefore very erosion prone, with deconstructed and exposed soil. Rainfed irrigated areas upstream of Bujumbura see cultivation during the year's two rainy seasons, continuously on the same soil and without a fallow period, all of which leads to intense levels of land degradation and subsequent soil erosion. Natural and man-made forests are practically nonexistent, and agroforestry is not developed. Without adequate vegetation cover and with other priming for erosion in the catchment areas of the major rivers

that cross the city, storm water runoff—during the rainy season—causes landslides and rock falls. This erosion is also recognized as a major contributor to water pollution, most critically to Tanganyika, which negatively impacts water quality and aquatic ecosystems (World Bank 2014).

Costs

Economic losses per disaster (including direct, indirect, and reconstruction costs) were estimated based on the methodology of value at risk from the report by UNISDR (2013).⁴⁷ The development of national disaster loss databases is the crucial first step to generate the information necessary for risk estimation and to inform public investment planning. As a second step, the physical losses recorded in the databases can be translated into monetary/economic losses enabling an initial evidence-based estimate of recurrent losses. Then, hazard assessment and vulnerability analysis are prerequisites of risk analysis (UNISDR 2013, 2015). Hazard analysis is identification of intensity and recurrence of natural phenomena. Vulnerability analysis should establish a damage function for a given hazard based on exposure and fragility of population, ecosystems, and economy.

Following this approach, PreventionWeb provides a risk profile for Burundi, where it is estimated from a probabilistic model that the annual estimated economic cost of floods in Burundi is about US\$3.3 million.⁴⁸

UNISDR initiated a study of economic losses associated with droughts in Africa in 2012 (Erian et al. 2013). Table A5.2 presents corresponding analysis in Burundi. It is estimated that Burundi crop production has been affected by five moderate droughts (cassava) and five slight droughts (sorghum, maize) between 1999 and 2011, which affected 0.15% of all production.

Losses from average are estimated and valued at producer prices (FAO-STAT 1999–2011). Burundi's estimated economic damage from droughts in 1999–2011 is estimated at US\$239 million, or about US\$20 million annually.

Then total economic costs of natural disasters with extensive risk in Burundi are estimated at a midpoint of US\$23.3 million annually, including US\$3.3 million from floods and US\$20 million from droughts (0.7 percent of GDP in 2014). It is a preliminary estimate relying on a hazard assessment, a vulnerability analysis, and costs of crop production loss, and based on secondary data from UNISDR (2013, 2015).

⁴⁷<http://www.preventionweb.net>.

⁴⁸<http://www.preventionweb.net>.

Table A5.2. Analysis of Stability of Crop Production in Burundi

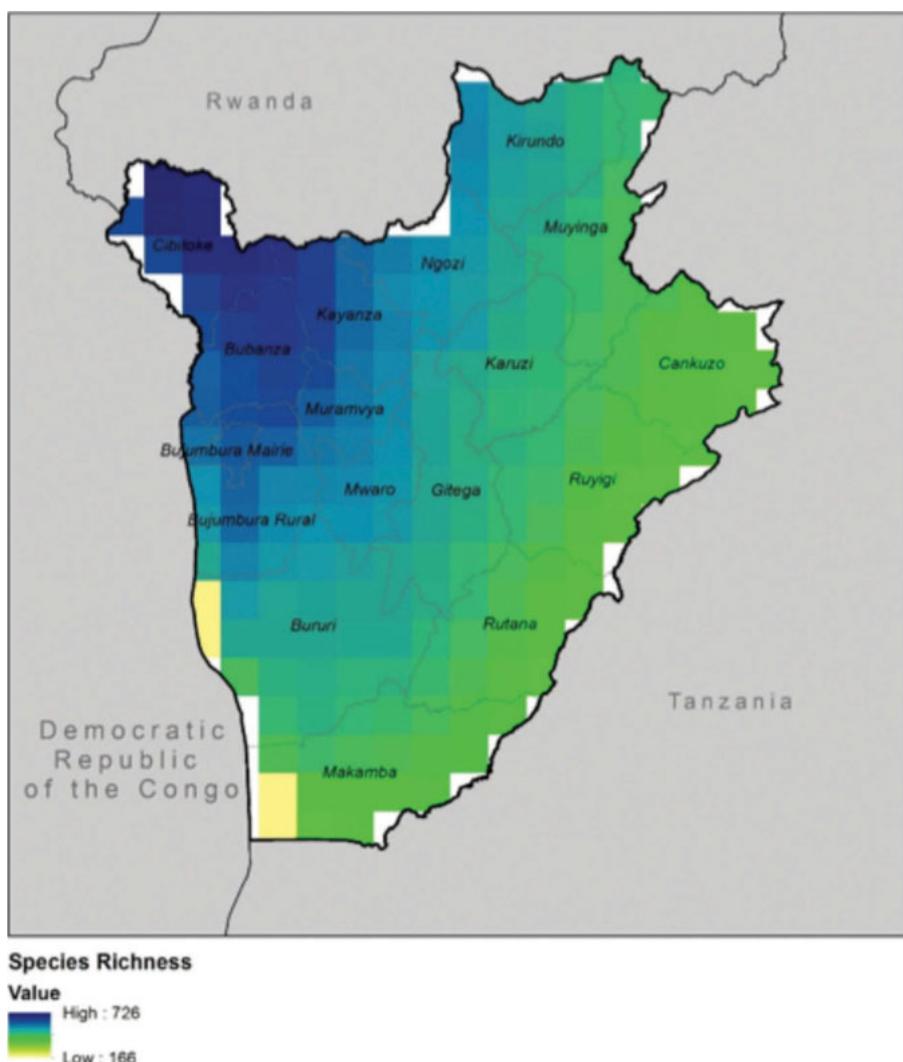
CROP	Years	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cassava	Ton	617483	656656	712713	749938	720000	709574	700000	571114	558557	577063	235369	187901
	Total Loss in Ton	34452	73625	129682	166907	136969	126543	116969	-11917	-24474	-5968	-347662	-395130
	Loss % from Av.	6	13	22	29	23	22	20	-2	-4	-1	-60	-68
Sorghum		130000	123518	136612	141393	121000	145000	140000	145000	80000	75046	86080	100400
		11329	4847	17941	22722	2329	26329	21329	26329	-38671	-43625	-32591	-18271
		10	4	15	19	2	22	18	22	-33	-37	-27	-15
Maize		128706	117840	124395	126799	127000	123199	135000	116825	115507	117681	120379	126412
		5394	-5472	1083	3487	3688	-113	11688	-6487	-7805	-5631	-2933	3100
		4	-4	1	3	3	0	9	-5	-6	-5	-2	3
Sweet Potato		734172	687382	780859	833470	833500	834394	880000	837311	873663	900415	484207	303432
		-14395	-61185	32292	84903	84933	85827	131433	88744	125096	151848	-264360	-445135
		-2	-8	4	11	11	11	18	12	17	20	-35	-59

Source: Erian et al. 2013.

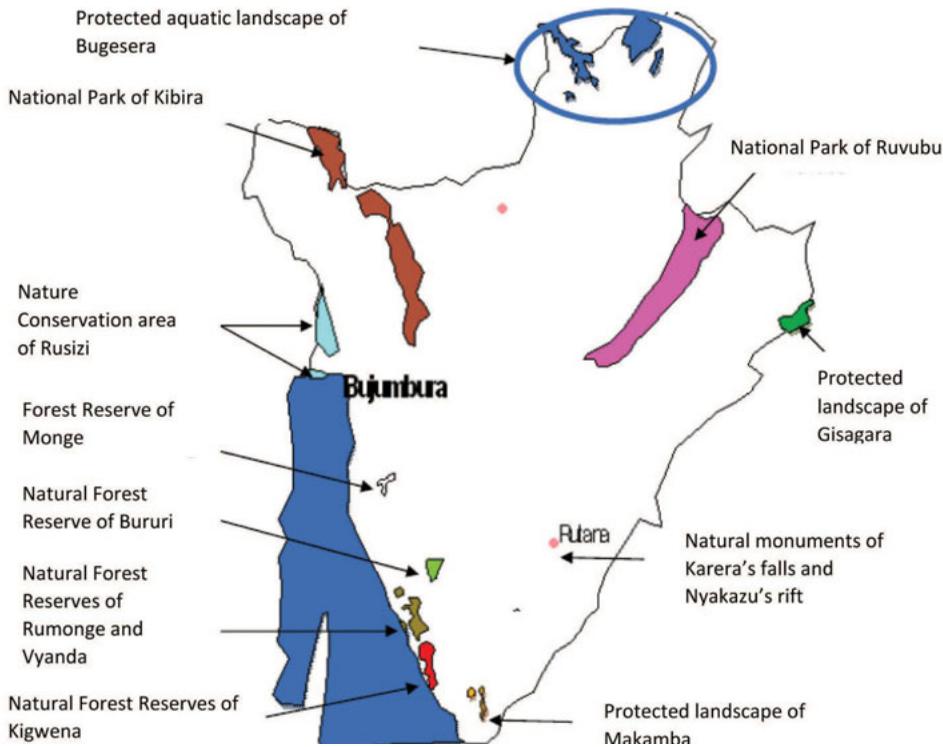
6. Biodiversity Loss

Biodiversity is of paramount importance in Burundi, a country where over 90 percent of the population survives from the grace of agricultural products, fisheries, forests, and medicinal plants (Figure A6.1). The consideration of biodiversity of both fauna and flora is not a theoretical exercise, but rather links directly to the ability of average Burundians to support themselves, their families, and their way of living. Burundi is home to a wealth of plant and animal species, as well as delicate ecosystems particular to central-eastern Africa and the Great Rift Valley (Republic of Burundi 2012).

Figure A6.1. Map of Biodiversity in Burundi



Source: Biodiversity Mapping Project.

Figure A6.2. Map of Protected Areas in Burundi

Source: IUCN 2011.

PAs cover 157,923 hectares or 5.6 percent of Burundi (Figure A6.2; Damien and Sévérin 2015). Unlike in unprotected areas, which have been fully or partially denuded, the vegetative cover in PAs plays a significant role in the fight against erosion. This cover also provides shelter to a wealth of animal and plant species. In a heavily degraded country, PAs imbue the surrounding landscape with a climatological aura of freshness, promoting local rainfall and serving as a sink for the world's greenhouse gases (Damien and Sévérin 2015).

Two major challenges are noted: (i) the protection of fauna and flora threatened with extinction; and (ii) the application of the decree establishing protected areas and the decree on the procedure of environmental and social impact assessments, given the serious threat posed to PAs by unchecked population growth.

In parallel, policies on PA conservation in Burundi have long been characterized by strict restrictions for local residents to PAs' resources. In fact, the relevant laws and regulations governing PAs often do not account for the survival needs of the local population. This has engendered a situation of tension and conflict between communities and the government authorities charged with protecting these areas.

Drivers of Biodiversity Loss

In Burundi, the loss of biodiversity is the result of several factors, particularly institutional weakness, demographic pressures, poverty, overexploitation, deforestation/repeated clearing, the introduction of alien species, poaching and logging in PAs, arson, pollution, and natural causes such as floods and drought. Extinction of animal and plant species has notably been observed in places such as Kibira Park, Ruvubu Park, Rukoko Reserves, and the reserves of Bururi, Rumonge, and Vyanda due to changes in habitat as a result of the unsustainable exploitation of natural resources (MEEATU 2011). Biodiversity suffers from a lack of expertise in biotechnology, as well as poor knowledge of forest resources due to failure of the inventory of woodlands. In addition, good programs for biodiversity conservation have been developed, but without concomitant financing (Republic of Burundi 2012).

Expansion of the Agricultural Horizon

Faced with declining soil fertility and the urgent needs of their households, many of Burundi's farmers choose to farm inside PAs. Farmers degrade PAs when they set up farms inside of the boundaries of or adjacent to these sensitive landscapes. The frenetic search for new farmland for people close to PAs is at the heart of the degradation of these biodiversity hotspots. As in the rest of Burundi, agricultural parcels around these areas have been infinitely atomized along the lines of Xeno's paradox, and have been leached of nutrients. This is notably due to farmers' lack of education and a lack of economic diversification. The government claims that even educated farmers cannot resist encroaching onto PAs to increase their production (Damien and Sévérin 2015). It should also be noted that the use of reserves, natural areas, and protected ecosystems for industrial agriculture—tea, cotton, palm oil, and sugar cane—represent the latest and perhaps gravest of existential threats to Burundi's ostensibly protected areas (Damien and Sévérin 2015).

Overgrazing

Livestock grazing is another key factor underlying the degradation of biodiversity. Riparian and lacustrine communities, which are typically the ones located closest to PAs, are often the ones responsible for clearing or grazing in PAs (Damien and Sévérin 2015). Overgrazing is another major threat to PAs, as pastoralists let their animals furtively graze within the confines of these nationally protected areas. This phenomenon is observed in all of the country's PAs, since high population density makes pastureland increasingly scarce; the phenomenon is, however, most pronounced near the national parks of Rusizi and Ruvubu. The one significant deterrent available, enforcement of the laws protecting these areas, remains unused. Finally, there is no incentive for herders to commit to stabling their animals (Damien and Sévérin 2015).

Overgrazing notably increases soil erosion because of a combination of the animals' nibbling and trampling of vegetative cover in areas typically already deprived of trees. Runoff from precipitation thus carries away the soil as the vegetative barriers preventing such degradation are no longer there to perform their essential ecosystem service (Damien and Sévérin 2015).



Hunted animals in Burundi's protected spaces (L to R: Harlequin quail, African rock python)
 Source: Bernard Dupont (Harlequin quail); www.bigsnake.ch (African rock python).

Overexploitation of Biological Resources

Overexploitation of biological resources consists of many actions: illegal cutting of plants, tree cutting, unsustainable harvesting of medicinal plants, overfishing and fishing with inappropriate equipment, poaching and overexploitation of wildlife, and others.

Currently, most hunting occurs within Burundi's PAs. Hunting for bushmeat is often driven by the deep impoverishment of the local people for whom animal protein is too expensive to acquire through husbandry or at local markets. Breeding animals in rural areas can be quite expensive, especially for poor farmers whose livelihoods depend on subsistence farming. As such, hunting can provide both food and income for the poorest of the rural poor. The indigenous Batwa—1 percent of the country's populace and a traditional hunter/gatherer people—are those most often involved in hunting and poaching. Other reasons for poaching animals are selling for use in traditional medicines and participation in illegal international wildlife trade (Damien and Sévérin 2015).

Illegal hunting has resulted in a drastic reduction of animals within the country's PAs. Moreover, while the indigenous Batwa play a large role in poaching, illegal hunting is certainly not restricted to this group, and includes hunters living on the borders of neighboring countries, as well as those living at the border of the PAs themselves, for example, buffalo hunters in Ruvubu National Park. In some cases, the illegal hunt is well organized, consisting of large teams of men to decimate the number of animals, such as the case of the serval cat hunters in Kibira National Park.

The demand for traditional medicines is robust in Burundi. Uprooting a plant is common when one considers the entire plant to be medicinal, as is often the case with medicinal herbs. Debarking trees and shrubs is also a typical method of collection. Even in the face of resource scarcity, traditional medicine gatherers have no choice but to harvest what they find. Plants species have been threatened and have even disappeared as a result.

Box A6.1. Aquatic Biodiversity and Environmental Degradation

Water pollution has two nefarious and interrelated impacts on aquatic ecosystems: (i) the loss of biodiversity, and (ii) the lower productivity of ecosystems. Biodiversity loss has repercussions for ecosystem productivity, namely through decreasing the amount of material available to consumers in the primary (herbivorous) and secondary (carnivorous/omnivorous) food chains.

Pathologies of aquatic animals living in heavily polluted environments: Pollution-linked diseases affecting aquatic living organisms are diverse and can be corporally manifested both externally and internally. The exact nature of these diseases is unknown due to the limited in-country capacity for rigorous study in this area.

Negative impacts of pollution on biodiversity are manifold. When suspended solids are equal to 30 mg/L, water quality is considered sufficient to support fish life, but renders fish reproduction random. At levels higher than that, fish life is limited to only pollution-hardy species.

Levels of dissolved oxygen in water should be greater than 3 mg/L, otherwise only a few of species adapted to an oxygen-starved environment can survive. *Clarias gariepinus*, a type of catfish found in Burundi, is able to survive in some of the country's polluted waters.

High levels of nitrates and phosphates discharged into the aquatic environment cause eutrophication. Aquatic plants (phytoplankton and higher plants) take advantage of these fertilizers and grow abundantly. After nightfall, the phenomenon of photosynthesis occurs: plants and animals compete for oxygen and results in the mass mortality of aquatic animals, including fish. The presence of phosphorous and nitrogen due to eutrophication leads to increased growth of algae, microscopic floating plants, and larger floating plants such as water hyacinths and Nile cabbage. The presence of the additional plant matter at the water's surface, and the consequent release of oxygen into the atmosphere, deprives the lower levels of water of necessary oxygen. Such conditions of oxygen depletion will kill fish and invertebrates and can spur the release of poisonous gases, affecting not only plants and animals, but also hydroelectrical facilities. Fluorine is also an element with carcinogenic potential. At high doses (about 20 mg/kg or more), it may result in biodiversity loss, especially wildlife.

Bioaccumulation: Some metals and metalloids—lead, zinc, iron, copper, chromium, arsenic, aluminum, and others—can, by bioaccumulation, cause grave harm even when released in small quantities. These metals come mainly from the metallurgical industries, such as foundry, surface finishing, textile industry, tanneries (chromium), paint facilities (zinc), chemical industries (arsenic), and the manufacture of batteries (lead). They are transmitted through the food chain all the way up to humans and can accumulate in the flesh and cause abnormalities such as cancer, birth defects, infertility and tumor formation, respiratory problems, or immunodeficiency.

While chromium is not known to accumulate in the bodies of fish, high concentrations can damage the gills of fish swimming in water close to the point of its discharge. In animals, chromium can cause respiratory problems, a lower ability to fight against diseases, birth defects, infertility, and tumor formation. It should be noted that in concentrations greater than 1.5–2 mg/L, copper is toxic to both animal and plants, and that all measured copper concentrations at the field sites are higher than the limits to support aquatic life.



Photo showing a fish (*Mastacembelus* sp.) caught in a polluted part of Lake Tanganyika
Source: Niyonkuru 2012.

Burundian fishermen usually do not respect the spawning periods of fish, leading to the disruption of fish eggs and larvae, and in fact, sometimes the fish at these stages sell at a higher price than the adults. In the protected landscape of the north, and in the deltas of the Rusizi River in the Rusizi National Park, fishing often takes place in spawning grounds. As a result, fish biomass in these lagoons and lakes has been enormously reduced and at risk of disappearing. Not only do these practices lead to significant biodiversity loss, but there is also a large reduction in potential catch volume, with drastic ramifications on the future income of the fishermen depending on the stocks of marine species in the deltas and northern lakes.

Mining

Unregulated, anarchic, and illegal mining is another cause of degradation in PAs. It destroys soils and forests and disrupts river paths. Such is the case in Kibira National Park (gold mining), Rusizi National Park (sand mining), and Murehe Reserve (extraction of coltan and cassiterite; Damien and Séverin

Box A6.2. Invasive Species *Lantana camara* Fills in Gap Left from Degradation and Destruction of Local Flora

Lantana camara—also known as big-sage, wild-sage, red-sage, white-sage, and tickberry—finds its origins in the American tropics, but has spread throughout the world. The plant, considered a weed in many parts, is capable of out competing other species in agricultural areas and secondary forests to become the dominant understory shrub, thus leading to a reduction in local biodiversity.

The plant is prolific, as well as hardy. The proliferation of *L. camara*, “in dense thickets,” can impede the growth of new trees and hence the regeneration of forests. The plant is known to survive across a wide range of climatic conditions, including drought, heat and humidity, salinity, and in an array of soil types. Resistant to fire, coppices filled with the plant have the ability to increase the prevalence of bushfires through the accumulation of fuel loads; the plant is also eager to reappear in recently burned sites.

L. camara is a foe of the farmer, as it reduces the productivity of crops on cultivated lands due to its tendency to cluster in thickets, which crowds out other crops and makes harvesting difficult. It is also toxic to livestock, which is problematic given its pervasiveness. *L. camara* bushes also pose a human health risk as they serve as shelter for malaria-bearing mosquitoes and tsetse flies.

Several of the reasons that make *L. camara* such a successfully invasive species illustrate why the plant has had success in Burundi. Firstly, the plant is tolerant of a wide range of enviro-climatic conditions, ideal in a country with a wide range of altitudes, temperatures, weather patterns and levels of rainfall—not to mention the fact that Burundi is currently experiencing additional fluctuations due to climate change. Secondly, deforestation and encroachment into wooded areas is favorable for *L. camara*, which likes to grow in “disturbed habitats.” Thirdly, grazing animals—of which there are many, given Burundi’s proclivity towards animal husbandry—tend to avoid the plant since it poisons them. These same toxins also prevent the growth of competitor plants.

Simply put, long-term management of *L. camara* requires rehabilitation and restoration of the degraded spaces where the plant thrives. If Burundi’s ecosystems remain in disrepair *L. camara* and other invasive species will dominate and eliminate indigenous flora.

2015). As mining presents a tangible financial gain and biodiversity seemingly presents no monetary value, many stakeholders flout conservation regulations in the Environmental and Mining Codes to exploit the mineral resources that lay beneath the soils in Burundi's PAs. Typically, artisanal miners come from afar, and as such, they have no stake in preserving the environment. Mineral extraction necessitates the digging of wide and deep trenches and pits to tap into metal veins. Occurring along water courses, vegetation is destroyed, unsightly slag heaps are created, and streams and rivers polluted with hazardous chemicals, all of which combine to increase the loss of local biodiversity. In the case of quarrying for rubblestone, sand and other construction materials, river banks are annihilated, disfiguring and permanently changing water courses and slope sides.

Introduction of Invasive Species

The introduction of alien species poses a real threat to the endemic organisms of Burundi's PAs. The propagation of water hyacinth in Lake Rweru, which forms a part of the Northern Burundi Protected Aquatic Landscape, is becoming increasingly worrisome. The introduction of *Lantana camara*, originally from the western hemisphere, in Rusizi National Park has notably supplanted several types of plant formations (Box A6.2; Damien and Sévérin 2015).

7. Climate Change

Climate Change Impacts in Burundi

Table A7.1 lists the past, present, and future impacts of climate change on Burundi's economic sectors and environment, summarized from Burundi's Nationally Determined Contribution (NDC).⁴⁹ Table A7.1 shows that many of the interactions of climate change with the environmental challenges discussed in this chapter are related to (i) a further drop in agricultural yield, which has been a major result of land degradation, and (ii) an increased frequency and severity of natural disasters associated with extreme weather events such as storms and droughts.

Further Drop in Agricultural Yield

Estimates of annual losses due to all extreme climate change-related weather events are in the realm of 5–17 percent of GDP. Agriculture, Burundi's key economic growth sector, provides income and jobs for 85 percent of the population and represents 40.6 percent of GDP (2012). One crucial adverse effect of climate change on crop productivity is the modification of the agricultural calendar, which may alter the limits of pastoral vegetation, the quality and quantity of fodder, the duration of the vegetable growth season, animal productivity, and water quality. Beyond the lower crop yield due to land degradation, climate change is already being felt: between 1995 and 2001, Burundi experienced decreases in yield per hectare for nearly all food crops, and wheat production dropped significantly from 1995 to 2005.

⁴⁹Burundi's Intended Nationally Determined Contribution (Republic of Burundi 2015a).

Table A7.1. Summary of Major Climate Change Impacts on Key Sectors and Ecosystems

<i>Sector</i>	<i>Impacts</i>
Water	<ul style="list-style-type: none"> • Drying up of lakes and other waterways, and disappearance of aquatic flora • Deterioration of surface water quality • Increased rainwater erosion and silting of certain rivers • Decline in production by hydroelectric power plants • Increased competition for the use of unpolluted groundwater resources
Energy	<ul style="list-style-type: none"> • More frequent shutdowns of certain active hydroelectric power plants because of exceeding operating thresholds due to insufficient rainfall and prolonged drought • Complete silting of certain dams due to heightened erosion caused by more abundant precipitation leading to the complete shutdown of a few hydroelectric power plants, the most endangered among them being the Marangara, Buhiga and Kayenzi plants • More frequent flooding of electricity production infrastructure like in Mugere, leading to production shutdowns for longer periods of time • Increased runoff from land degradation in the hydroelectric power plants' watersheds • Major fluctuations in electricity production due to stresses on the water supply system and changes in rainfall patterns • A larger deficit in the electricity sector leading to real electrical power supply problems in the country's various socioeconomic domains • Widespread scarcity of firewood and wood charcoal due to heightened, combined pressure from human activities, rising temperatures and changes to biomass growth rates
Agriculture and livestock farming	<ul style="list-style-type: none"> • Declines in harvests, cattle, goats, sheep and poultry aggravated by more prolonged, more frequent drought with likelihoods of occurrence of between 40% and 60% • Meat and dairy production yields will be even more heavily affected and reduced, along with fish production in the event of drought • Lightning appearing during tornadoes will increase, causing additional livestock deaths in mountainous areas • Decline in the quality and quantity of pastureland
Health	<ul style="list-style-type: none"> • Increased number of cases of malaria
Landscapes	<ul style="list-style-type: none"> • Risk of more frequent, larger scale flooding of lowlands • Escalation of soil erosion along groundwater trenches in the watersheds of the Mirwa Mountains • The levels of Lakes Cohoha, Rweru, Rwihinda and Kanzigiri in the Bugesera Depression could further decrease with the intensification of drought, with their waters retreating at above 400 m, which has already been seen toward the centres of those lakes and puts some of the shallower ones at risk of completely disappearing • The level of Lake Tanganyika will rise due to heavy precipitation
Terrestrial ecosystems (forests)	<ul style="list-style-type: none"> • Disappearance of the subalpine zone starting at an elevation of 2,450 m • Disappearance of certain plant species and aggravation of erosion and bush fires • Degradation of the groves in Bugesera and forests of Hyphaene palm trees on the Ruzizi Plain, with an increased vulnerability to bush fires

Source: Burundi's Intended Nationally Determined Contribution, UNFCCC (2015).

Increased Frequency and Severity of Natural Disasters Associated with Extreme Weather Events

Climate change has increased the intensity and frequency of natural hazards—drought, torrential rains, hail and violent storms, flooding and flash flooding, landslides and mudslides—and will be a major driver of poverty in the face of increased global warming. Floods, accounting for 60.6 percent of the distribution of natural hazards in Burundi, are more frequent as well as more fatal. Extreme flood and drought events alone reduce long-term GDP growth in

the region by 2.4 percent per year. Floods are already taking their toll on cities and smaller urban centers across Africa; in East Africa in 2002, heavy rains caused floods and mudslides that forced tens of thousands out of their homes in Burundi, as well as in Kenya, Rwanda, Tanzania, and Uganda (Douglas et al. 2008, as quoted in Niang et al. 2014).

The impact of global climate change on the local climate is expected to bring torrential rains during the wet period followed by periods of drought during the dry period. Change in climate patterns opens Burundi up to the risk of increasingly frequent flooding with drastic consequences. Extreme precipitation will tend to flood the lowlands, increase soil erosion in the croplands and along the drainage axes of the mountain hillsides of Mumurwa, and spur a rising water level in Lake Tanganyika. After the new modified rainy season, Burundi likely will see a reduction in the water levels of its northern lakes and an increase in drought (Republic of Burundi 2010).

Bujumbura's location next to Lake Tanganyika means that increasing numbers of people may become vulnerable to flooding and flash flooding linked to climate change-related increases in torrential precipitation, which can flood the lake's tributaries, as well as the lake itself. Additionally, given the city's location in the Imbo plain, downstream from much of the land degradation occurring in the Mumurwa, occurrences of landslides, mudslides, and rockslides may increase. In fact, two major landslides within the past two years demonstrate the toll on human life and national infrastructure that these hazards can incur.

A recent study conducted by the World Bank in the Bujumbura area (World Bank 2014) highlights the relationship between climate change and disaster risk. On February 9–10, 2014, Burundi experienced heavy rainfall: more than 80 mm were recorded in 3.5 hours on February 9th. The rainfall generated intense runoff in the watersheds, along with landslides and the outburst of a small unplanned reservoir on the Gasenyi River. The main road, RN1, and the unserviced neighborhood of Gatunguru in Kinama, downstream Gasenyi River, were washed away by a violent flash flood, responsible for the majority of the casualties. Rainfall also induced flooding along several rivers including Gikoma and Nyabagere, and resulted in flooding in the plain along Lake Tanganyika. Eighty percent of the damages occurred in the municipalities of Buterere, Isale, Kamenge, Kinama, and Mutimbuzi. Overall, about 1,000 houses collapsed, a large market was washed away, 20,000 people were without shelter, and 77 casualties were reported. In terms of infrastructures, the event damaged roads, bridges, water supply, and electricity networks, as well as two markets (see Box A7.1).

Moreover, since September 2015, Burundi has been severely affected by the El Niño climate phenomenon. The rainy season (from September to December) was indeed extremely heavy—due to the sea surface temperature increases in the West Equatorial part of the Indian Ocean—and brought dangerous floods to Burundi's most vulnerable zones. The situation is already particularly worrisome in the Bubanza and Rutana provinces—notably on the Karambira and Nyekarange hills—where torrential rains that led to sliding caused the death of three persons and damaged 1,000 ha of fields in June 2015. In September 2015, the Mitakataka, Gahongore, Buramata, Gihungwe, Rugunga, Kagwema, and Kizina hills were impacted and caused the death of one person as well as damaged crops and more than 680 houses. It was observed that, due to

Box A7.1. Rains and Flooding in Bujumbura in 2014

Burundi's paradox is that climate change has caused one of its greatest assets, a copious water supply, to become one of its greatest threats. February 9–10, 2014, during the “small” rainy season, Burundi experienced 80 mm of heavy rainfall. The rainfall generated intense runoff, leading to landslides and the outburst of a small, unauthorized reservoir on the Gasenyi River. The bursting of the reservoir caused parts of the densely populated neighborhood of Gatinguru (Bujumbura) and the country's main highway to wash away in a violent flash flood. Many factors contributed to aggravate the risk, including (i) land degradation, (ii) lack of coordination between urban and drainage planning, and (iii) absence of an early warning and evacuation system (the weather forecast was available 24 hours before the rains and the potential for the reservoir to overflow was known since 2008).

Overall, there were 77 casualties, more than 3,000 homes were destroyed, and 20,000 people were left homeless.

The total cost of damage to infrastructure amounted to FBu 6.9 billion, equivalent to US\$4.5 million, as well as 0.18 percent of GDP. Costs were divided among:

- 3,4 billion FBu for roads,
- 775 million FBu for bridges,
- 675 million FBu for schools,
- 650 million FBu for agricultural infrastructure,
- 640 million FBu for markets,
- 627 million FBu supply system for drinking water, and
- 80 million FBu for the power grid.



Source: World Bank (2014).

It is estimated that an additional 2.5 billion Fbu worth of crops (US\$1.6 million) were lost.

These damages are presented in five categories: (i) destruction in the flash flood zone at the Gasenyi crossing work site, as well as the severe gully erosion along the 2 km approaching this work site on the RN1 and in the local roads of Gatunguru; (ii) landslides, resulting in runoff on the pavement following the blocking of drainage, causing varying degrees of deterioration to the pavement and the collapse of earthen embankments alongside the road; (iii) erosion or landslides on the side of road embankments, which carried away entire sections of roadway, and could be linked to the aggressiveness of the river flow and groundwater seepage under the road platform; (iv) the obstruction or destruction of sewerage and drainage works, mostly related to sediment and various materials—sometimes made of boulders and landslides originating from river banks—transported by runoff, and; (v) destruction of/to bridges.

El Niño, the rainy season extended until the first quarter of 2016, which, as of March 2016, destroyed more than 14,000 houses in the country, according to an assessment carried out by the authorities, with support from the Red Cross (International Organization for Migration 2016). The 2016 Season A (from September to January) was especially threatened by the El Niño–induced heavy rainfalls, which affected yields and food security nationally. It should also be noted that the Cibitoke province registered more than 100 cases of cholera in September 2015 (Republic of Burundi 2015b).

Rural household livelihoods have been affected by two main weather shocks: droughts and hail-related damages. Droughts and shortfalls in water supplies impacted 53.4 percent of rural farmers between June 2007 and June 2008. Hail-related damages notably affected over 11 percent of the rural population. In 2012, key informants at the commune level indicated that their respective hills were degraded mostly by water/rainfall deficits and droughts (25.4 percent), and hail (15.2 percent). Some provinces have been intensely impacted by different shocks. In rural Bujumbura, the majority of complaints about the shocks affecting household livelihoods revolved around rainfall shortfalls and droughts (33.9 percent) and erosion (15.5 percent). The other affected provinces included Muramvya in the Centre East, Bubanza and Cibitoke in the West, and Ngozi and Kayanza in the North (World Bank 2015).

8. Environmental Policies and Institutions

Institutional Framework of Environmental Protection and Management in Burundi

The Ministry of Water, Environment, Physical Planning, and Urban Development (MEEATU)

The Ministry of Water, Environment, Physical Planning, and Urban Development (MEEATU) is mandated to administer and regulate environmental management and protection.⁵⁰ Under the 2014 decree,⁵¹ the ministry enjoys a multifaceted mandate including the development and implementation of

⁵⁰It was reorganized by Decree No. 100/108 of November 22, 2005, and its mandate was first revised in 2007 as Ministry of Environment, Land Use Planning and Public Works in 2007, and further in 2011 by Decree No. 100-95 of March 28, 2011, and finally in 2014 (see note 20).

⁵¹Decree No. 100-198 of September 15, 2014, on the mandate, organization and functioning of the Ministry in charge of Water, Environment, Land Use and Urban Development.

national policies, laws, and regulations in the field of water, environment, land management, and the urban sector. The decree lists more than 30 specific mandates of MEEATU solely or in cooperation with other ministries and government agencies, as summarized in Box A8.1.

Box A8.1 Specific Mandates of the MEEATU: Decree 100-198 of September 2014

I. Overall Environmental Management and Protection Mandate

- (i) Ensuring the protection and conservation of natural resources.
- (ii) Define and implement the national policy on prevention, development of response plan, and management of natural disasters in cooperation with other concerned agencies.
- (iii) Develop, disseminate, and implement a national program for environmental education.
- (iv) Define, adopt, and enforce environmental standards to serve as a code of conduct for environmental management.
- (v) Define and implement a national policy on sanitation and industrial pollution control policy in collaboration with other relevant departments.
- (vi) Contribute to the implementation of international conventions and programs on the management and protection of the environment and natural resources.
- (vii) Follow up on the implementation of the Environmental Code and ensure its regular updating.

II. Forest and Biological Diversity Sector

- (i) Manage and develop national forests and wildlife.
- (ii) Creating and managing protected areas, including national parks and nature reserves.
- (iii) Define, implement, and enforce a consistent policy of reforestation at national level.
- (iv) Implement programs and projects of reforestation to protect the urban, semi-urban, and rural environment.
- (v) Work with stakeholders in rural areas to promote reforestation within a collaboration framework.

III. Water Sector

- (i) Develop and implement the national policy and legislation on water.
- (ii) Establish a stable structure for coordination of water resources management.
- (iii) Set up a national structure for water resources data management.
- (iv) Set up specialized structures for training and production of materials related to water supply.
- (v) Establish a regulatory body to mediate between users of the water sector.
- (vi) Establish a national laboratory for water quality monitoring.
- (vii) Initiate any reform necessary to promote sound management of the water and sanitation sector.
- (viii) Develop appropriate strategies to achieve the Millennium Development Goals in the water sector.
- (ix) Participate in exchange programs and partnerships with regional and international institutions in which Burundi is a member to promote and implement integrated water resources management (IWRM).

IV. Land and Soil Protection and Management

- (i) Develop, implement, and enforce, in cooperation with relevant ministries, the national policy and national management strategy on sustainable land use.
- (ii) Cooperate with all stakeholders and other government agencies to fight soil erosion.
- (iii) Develop, implement, and enforce national policy and legislation on land use, urban planning, and housing.
- (iv) Define the criteria for public lands' allocation to urban land, semi-urban, and rural areas within the national land-use master plan, including town planning, urban, semi-urban, and rural habitats.
- (v) Administer the national land registry and cadaster.

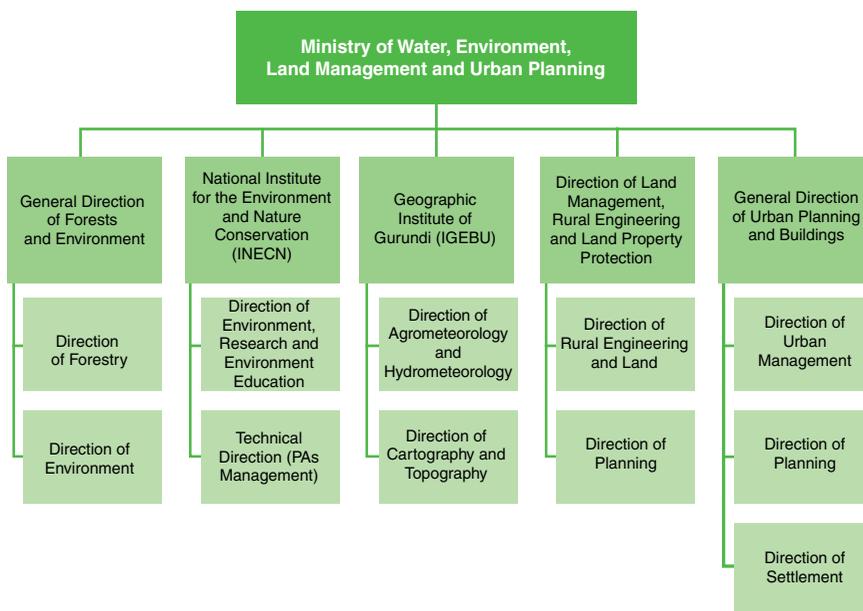
V. Other Areas of Competence, Including Climate Change

- (i) Develop and monitor the investment projects of the department.
 - (ii) Implement, in collaboration with other agencies, relevant adaptation policies to address climate change challenges.
-

Figure A8.1 describes the organization structure of MEEATU. The ministry comprises three general directorates. These are: (i) the General Directorate of Forests and Environment (DGFE), with two separate directorates: the Directorate of Forestry (DoF) and the Directorate of Environment (DoE); (ii) the General Directorate of Land Management, Rural Engineering, and Land Property Protection, which includes the Directorate of Planning (DoP) and the Directorate of Rural Engineering and Land (DoREL); and (iii) the General Directorate of Urban Planning and Buildings, which is responsible for the design and execution of government policy on urbanization. The General Directorate of Urban Planning and Buildings provides management, land allocation and designation, and declares urban land use.⁵² In addition, MEEATU has, under its trusteeship (“*tutelle*”), specialized government agencies. These include (i) the National Institute for the Environment and Nature Conservation (INECN), which was later replaced by *Office Burundais pour la Protection de l’Environnement* (OBPE), and (ii) the Geographic Institute of Burundi (IGEBU).

In addition, the rules governing the functioning of the MEATU mentions explicitly that in implementing parts of its various mandates, it must coordinate and collaborate with other government departments, including the Ministry of Public Health, the Ministry of Agriculture and Livestock, the Ministry

Figure A8.1. MEEATU Organization Chart



Source: USAID, Burundi: Environmental Threats and Opportunities Assessment (ETOA), prepared by the USDA Forest Service International Programs (2010, pp. 8–13).

⁵²This general directorate used to be under the Ministry of Public Works; on January 29, 2009, it was moved to the Ministry of Environment (for urban centers).

of Industry and Mining and local governments. A summary of the respective role and mandate of each of these ministries and agencies is provided below.

Office Burundais pour la Protection de l'Environnement (OBPE)

The OBPE was established by decree No. 100/240 of October 29, 2014, which defined its mandates, responsibilities, organization, and operating rules. The OBPE is the successor of the National Institute for the Conservation of Nature, created by decree No. 100/47 of March 3, 1980, and of the National Institute for the Environment and Nature Conservation (INECN), created by the decree of October 5, 1989.⁵³ The OBPE is established as an autonomous legal entity that has its own legal personality, enjoying financial and administrative autonomy. The OBPE is established under the trusteeship of the MEEATU.

The newly established OBPE has a very broad mandate, including:

- (i) enforcing all environment protection–related legislation (Box A8.2; water, forest, pollution control);
- (ii) following up on and monitoring trade mechanisms and international trade in flora and fauna;
- (iii) establishing environmental standards and norms including safeguards for the protection of nature;
- (iv) monitoring and evaluating development programs and their consistency and compliance with environmental standards during the planning and implementation phases, including development projects that may have a negative impact on the environment;
- (v) ensuring and monitoring the implementation of government's obligations under international conventions and agreements relating to the environment to which Burundi is a party;
- (vi) identifying and proposing protected areas and other areas of high biodiversity requiring special protection;
- (vii) undertaking and encouraging research and accompanying measures for the maintenance of biological diversity; and finally
- (viii) establishing mechanisms for mitigation and adaptation to climate change.

This is obviously a wide-ranging set of mandates and responsibilities, which requires resources and the capacity to manage them, which the OBPE seems to lack thus far.

⁵³The INECN was empowered with a very broad mandate that included "managing parks and protected areas," which the OBPE seems not to enjoy. As defined in its statutes, the mandates of the INECN were defined as follows: (i) collecting and interpreting data related to the control of the state of environment provided by different agencies, national as well as international; (ii) enforcing environmental standards to combat pollution of any kind through administrative and judicial monitoring; (iii) collaborating and cooperating with the relevant competent authorities and agencies to promote and implement sound management of natural resources; (iv) creating, developing, and managing parks and nature reserves to ensure sustainability and exploitation for ecotourism purposes; (v) initiating and encouraging research and incentives for the maintenance of biodiversity; (vi) ensuring the implementation of domestic legislation and international conventions related to biodiversity including, among others, the 1992 Convention on Biological Biodiversity (CBD); and (vii) contributing to the promotion of environmental education in collaboration with concerned organizations and institutions. The INECN was structured around two directorates including: (i) the Technical Directorate, in charge of Protected Areas Management, and (ii) the Directorate of Environment, Research, and Environment Education.

Box A8.2. Mandates and Organization of the OBPE: Decree No. 100/240 of October 29, 2014
I. OBPE's Mandate Covers:

- (i) Ensuring compliance with and enforcing the Water Code, the Forest Code, the Environment Code, and other legislation related to environmental protection.
- (ii) Implementing and supervising mechanisms related to international trade of flora and fauna species.
- (iii) Enforcing environmental standards and safeguards and protecting nature.
- (iv) Monitoring and evaluating development programs to monitor compliance with environmental standards including the planning and implementation of all development projects that can have a negative impact on the environment.
- (v) Ensuring implementation of obligations under international conventions and agreements relating to the environment to which Burundi is a party.
- (vi) Identifying and proposing new protected areas and other areas of high biodiversity requiring special protection measures.
- (vii) Undertaking and encouraging research and other measures for conservation of biological diversity.
- (viii) Establishing quality standards for forest species.
- (ix) Establishing mechanisms for mitigation and adaptation to climate change.
- (x) Preparing studies to be considered by the National Commission of the Environment.

II. OBPE's Administered by Board of Directors, and Equipped with Three Departments:

- (i) **Forestry Department, is responsible for:**
 - a. Ensuring the implementation and monitoring of the government's policy on forest resource management and development, including:
 - 1. Defining and implementing a forest master plan;
 - 2. Defining and adopting strategy and policies for and regulating the wood industry;
 - 3. Promoting the availability and quality of forest product seeds for adapted agroforestry projects taking into account the objective to protect the sustainability of water resources and the interaction between the soil, the climate, and the vegetation;
 - 4. Maintaining and extending forested areas through reforestation and afforestation of vacant lands;
 - 5. Centralizing data on forests in collaboration with the concerned departments and preparing reports on the status of forest resources in Burundi.
 - b. Promoting protection activities and management plans for protected areas, including:
 - 1. Preparing plans for management and development of protected areas;
 - 2. Establishing corridors connecting protected areas in Burundi and neighboring countries within existing or planned regional frameworks to ensure the sustainability of biodiversity resources;
 - 3. Adopting and implementing oversight and monitoring mechanisms and management of protected areas;
 - 4. Developing and implementing sound recovery mechanism of biological resources in protected areas and promoting *ex situ* conservation through the creation of botanical gardens, arboreta, zoos, and other vivarium; and
 - 5. Preparing annual reports on the status of protected areas.
 - c. Promoting active public participation in community management and development of forest resources through agroforestry and farm forestry.
- (ii) **Directorate of Environment and Climate Change is responsible for:**
 - a. Preparing reports on the state of the environment in Burundi;
 - b. Developing national strategies and policies on air pollution and Persistent Organic Pollutants (POPs);
 - c. Implementing and enforcing policies and laws on environmental protection and climate change;

(continued)

Box A8.2. Continued

- d. Coordinating all activities related to climate change and monitoring the implementation of climate change policies, national strategies and action plans by all stakeholders;
 - e. Developing and promoting studies on climate change-related aspects;
 - f. Reviewing Environmental and Social Impact Analysis (ESIA);
 - g. Monitoring the protection of green areas and fighting invasive species; and
 - h. Promoting environmental protection activities, public awareness, and education on environmental issues.
- (iii) **Administrative and Financial Directorate is responsible for:**
- a. Managing OBPE's human and material resources; and
 - b. Preparing and executing OBPE's budget, including financial reporting.
-

Replacing the INECN, the OBPE's organization has been amended to include three new directorates. These new directorates are in charge of: (i) forestry including protected areas and all the national green agenda, (ii) environmental affairs including climate change, and (iii) administrative and financial affairs. The 2014 decree spells out all functions and responsibilities of the main operational directorates (forestry and environment). The Directorate of Forestry Affairs deals with both forest development and use and protected areas and biological conservation, which may be a source of confusion and conflict. The Directorate of Forestry Affairs' mandates range from adopting policies on pricing for access to forest resources to promoting existing and developing new protected areas. The OBPE is not mandated to deal with urban environmental issues although reference to maintenance of "green areas" and air pollution may also relate to urban environment. The municipal code mandates municipal councils to deal with environment issues without any specification. Clarification of OBPE's mandate with regard to urban environment is needed, especially whether it is a regulatory mandate or more operational and management mandate.

The National Institute of Geography (IGEBU)

Burundi's Institute of Geography (IGEBU)⁵⁴ was established in 1989 as a key institution for the management of geographical and other environmental information and data. IGEBU's mission is to promote geographical activities in Burundi, namely cartography, topography, meteorology, and those relating to water resources. The IGEBU comprises: (i) the Directorate of Cartography and Topography, and (ii) the Directorate of Agro Meteorology and Hydrometeorology. The IGEBU was restructured in 2014 and was placed under the trusteeship of the ministry in charge of the environment.

Among its responsibilities and mandates, and in addition to its unique mandate to develop, print, and market Burundi's general and thematic geographical maps, the IGEBU is empowered to:

⁵⁴Decree No. 100-241 of October 24, 2014, revising decree No. 100-186 of October 5, 1989, on the organization of the Geographic Institute of Burundi.

- (i) plan, develop, and manage the national network of meteorological and hydrological stations;
- (ii) gather, control, analyze, store, and disseminate hydro meteorological data;
- (iii) improve the seasonal climate forecasts for early warning;
- (iv) establish general forecasts, especially for meteorological assistance to air navigation;
- (v) ensure monitoring and systematic observation and in real-time of weather variability and climate change;
- (vi) participate in the work on statistical parameters of climate change;
- (vii) conduct studies to identify and evaluate aquifers, taking into account the geological configuration;
- (viii) develop relationships and exchanges with specialized institutions to promote cooperation in information and training in matters of meteorology and hydrology;
- (ix) promote theoretical studies and/or practices that contribute to a better knowledge of meteorology and hydrology in Burundi; and
- (x) provide technical support to the government in matters of negotiation of multilateral environmental agreements and in matters of policy, strategies, and legislation relating to the implementation of the international conventions on climate and water resources.

These mandates and responsibilities make the IGEBU the main technical institution assisting the MEEATU in fulfilling its core environmental protection and management mandate. The IGEBU is the focal point institution for the UNFCCC in the Burundi.

Sectoral Ministries MEEATU Is Mandated to Coordinate Ministry of Agriculture and Livestock (MAL)

Among other mandates, the MAL is in charge of the regulation of the use of chemicals, particularly pesticides and other mineral fertilizers that are used in agricultural processes.⁵⁵ To this end, the MAL is in charge of promoting: (i) the conservation, storage, and processing of agricultural and livestock products; (ii) animal and plant production; and (iii) in collaboration with other agencies, developing and implementing the national policy on crop protection and soil fertility, including crop defense strategies, genetic improvement of animal breeds, and protecting indigenous endangered breeds. Various parts of the MAL and related bodies have broad mandates to regulate import and use of chemicals and pesticides. These parts and bodies related to the MAL include: the Department of Plant Protection, the Department of Animal Health, the Institute of Agronomic Sciences of Burundi (ISABU), the Institute of Agricultural and Zoo technical Research (IRAZ), and the local branches of the MAL (DASP).⁵⁶ Finally, other institutions and state agencies have the mandate to

⁵⁵Decree No. 100-08 of September 13, 2010, on the structure, functioning and missions of the government of the Republic of Burundi.

⁵⁶SOGESTAL: Société de Gestion des Stations de Lavage du café; COGERCO: Compagnie de Gérance du Coton ; SOSUMO: Société Sucrière du Moso; OTB: Office du Thé du Burundi; OCIBU: Office des Cultures Industrielles du Burundi; OHP: Office de l'Huile de Palme.

manage industrial crops in the various sectors (coffee, cotton, tea, sugarcane, rice, palm oil). These are, among others: SOGESTAL, COGERCO, SOSUMO, OTB, OCIBU and OHP.⁵⁷

One of the oldest research institution in Burundi, founded under the trusteeship of the Ministry of Agriculture and Livestock (MAL), is the ISABU. Its mission statement is to contribute to the development of Burundi while ensuring prudent management of natural resources. Its main objective is to promote more intensive agriculture to meet the challenge of decreasing arable land, to help achieve sustainable use of Burundi's ecosystem services in agriculture, reduce land degradation, and develop innovative solutions to restore ecosystems and preserve biological diversity. The main feature of its activities includes working closely with farmers and other stakeholders to achieve its objectives.

Ministry of Public Health (MPH)

The MPH is responsible for, among others, developing the national public health policy, including hygiene and sanitation; ensuring quality control of medicines, water, food and all substances, solely or in cooperation with other ministries and departments; and promoting the safety of the human environment.⁵⁸ These mandates are completed by operational tasks such as managing hazardous chemicals through two central departments (the Department of Promotion of Health, Hygiene and Sanitation, and the Department of Pharmacy, Medicine and Laboratory) and the National Institute of Public Health (INSP). The MPH is empowered, in cooperation with the MEATU, to issue and enforce the water quality standards.

Ministry of Commerce, Industry, Posts, and Tourism (MCIPT)

The MCIPT⁵⁹ has an important role in regulating trade in chemicals and hazardous substances. The MCIPT, among other responsibilities, (i) defines and implements the national policy on trade, industry, and tourism and (ii) enforces quality standards of industrial goods and substances. The MCIPT has a Department of Industrial Development, with a mandate to monitor compliance with environmental standards by industries, users, and consumers. It is the Burundi Office of Standards, under the Decree No. 100/092 of 29 August 2001, that is responsible for (i) developing and disseminating national standards consistent with internationally recognized procedures and standards; (ii) promoting their application; (iii) establishing and maintaining evaluation, inspection, and certification methodologies to monitor compliance; and (iv) establishing and maintaining control of imported products regulated by mandatory quality standards. The MCIPT has a specialized office in the Burundi's Office of Standards (known under the French acronym BBN, which stands for "*Bureau Burundais de Normalisation*") divided into four divisions: (i) Standardization and Metrology; (ii) Technical Assistance and Training; (iii) Certification,

⁵⁷Provincial Directorates of Agriculture and Livestock.

⁵⁸Same decree under footnote 56\.

⁵⁹Same decree as footnote 56.

Accreditation, and Monitoring of Laboratories and Technical Inspection Bodies; and (iv) Documentation and Dissemination of Standards.

Ministry of Energy and Mining (MEM)

The MEM has a mandate over activities known to have detrimental impacts on environment. Generally, mining and energy activities are closely monitored by the national environment regulator. MEM is in charge of a sector that has been planned to develop at a fast pace in the future, as already mentioned. The Law 1/21 of October 15, 2013, on mining defines the conditions for mining operations and provides numerous incentives for investment in the mining sector. On the environmental aspects, the 2013 code requires mining development to be subject to prior Environmental Impact Assessment (EIA), including at the research stage (articles 43–44). The 2013 Mining Code does refer to a requirement to protect the environment for all mining operations, and environmental protection is considered a condition to be included in all mining permits, licenses, or concessions. Article 57 of the law specifies that once a discovery is made, the permit proponent must submit a feasibility study including a socio-economic study, a technical report and an EIA, which all must be approved by “the competent authority,” which is not defined. Whether the MEEATU will be involved at this stage is not clearly stated, although at research stage the EIA must be cleared by the MEEATU. Therefore, there is need to clarify whether it is the same EIA prepared for the purpose of a research operation that will be further used for the purpose of exploitation, or whether it is a new EIA. It is also important to note that the mitigation measures are included into the exploitation contract, which will be signed by the MEM and the Ministry of Finances. Article 64 does not specify whether these must be reviewed and/or approved by the MEEATU, and article 68 mentions again that the EIA is to be approved by the “competent authority” without further specification. In addition, it must be noted that a recent mining permit issued by the government does not refer to any environmental condition, although the permit’s “whereas” section mentions the Environmental Code. This vagueness may be interpreted as a token given to mining operators not to be overburdened by environmental impact management of their activities.⁶⁰

Local Government’s Roles and Responsibilities in Environmental Protection

The Law on Municipal Administration states that the Municipal Administrator (Mayor) is empowered to take any measure to protect the environment.⁶¹ It is surprising that the Municipal Council, which is in charge of deciding on local laws and regulations (“*réglementation municipale*”), has no general mandate to decide on the legal status of environmental protection or make rules for environmental management at the local level. Instead, the Law provides only for the mayor to make decisions. The Municipal Council has a power to decide on the gazettelement, de-gazettelement and allocation of municipal properties including municipal forest lands and other natural resources without prejudice

⁶⁰Decree No. 100/137 of June 3, 2014, granting mining operating license for the nickel deposit and associated Musongati ores to the Burundi Mining Metallurgy International Society (BMM International).

⁶¹Article 30.10 of law No. 1-016 referenced here above.

to the provisions of the Forest Code and the Environmental Code which provide for the MEEATU to manage and define the status of forest land and other natural resources.⁶²

Household solid wastes are managed by local and national authorities. Although it is the Minister of Interior and Municipal Development (MIMD) that is held responsible for household solid waste management, municipal councils are in charge of providing basic services on the ground, including maintaining the cleanliness of cities and removing, storing, and treating solid waste. However, solid waste management, including household waste, is shared by three ministries: the Ministry of Public Health (MPH), the Ministry in Charge of Environment (MEATU), and the MIMD through local authorities (the city council for the city of Bujumbura and municipalities for the provinces of the interior). Because of the growing importance of household solid waste management, it is essential to question the current institutional arrangements and define more specifically the role and mandate of local government regarding ministries and their local branches.

Civil Society

Civil society organizations are in general not very active in the environmental sector in Burundi. Two organizations are to be mentioned, although their respective track records are yet to be established and assessed. Both are governed by the law decree No. 0.1/011 of February 8, 2000, on not-for-profit associations (“association sans but lucrative”). The first is the Burundian Association for the Protection of Nature, which was recognized and authorized by the ministerial order No. 530/231 of April 8, 2000. The second is the Association for the Protection of Natural Resources for the Welfare of the Population in Burundi (known under the French acronym APRN/BEPB), recognized and authorized by the Ministry of the Interior and Public Security by ministerial order No. 530/1101 of 03/01/2003. This status as a recognized and authorized organization will allow them to receive government funding through subsidies. However, there are no data to confirm whether these organizations are receiving any assistance or government funding and reports on their respective track records. A third organization is mentioned in various reports, although there is no information or data on its actual work and track record. It is the Burundi’s Association for Environmental Impact Assessment (known under the French Acronym “ABEIE”), whose objective is to promote the use of EIA in Burundi through strengthening the national capacity for environmental assessment and the implementation of public awareness and education campaigns on the broad environment agenda. It also aims at disseminating good practices on EIA. Three active NGOs in the environment sector are worth mentioning: the *Organisation pour la Défense de l’Environnement au Burundi* (ODEB), the *Association Villageoise d’Entraide et de Développement Communautaire* (AVEDEC), and the *Association pour la Protection de l’Environnement* (Enviro-Protec).

⁶²Article 13.6 of law No. 1-016 of April 20, 2005, related to the organization of municipal administration.

Legal Framework

Over the years, particularly since 1980, Burundi has adopted a number of laws, regulations, and guidelines to address major environmental issues the country faces. The 2005 Constitution of Burundi⁶³ refers to environmental protection and management in three provisions (articles 35, 159.4, and 293). It states that: (i) the government ensures the good management and the rational exploitation of natural resources of the country while preserving the environment and conserving these resources for future generations, (ii) the citizens of Burundi enjoy a right to a clean and healthy environment, and (iii) protection of the environment and conservation of natural resources shall be subject to specific laws. A very specific provision in article 293 states that toxic waste and other substances that are harmful to public health and the environment cannot be stored in the territory of Burundi and no international agreement could authorize such storage. This provision is consistent with Burundi's participation in the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal,⁶⁴ and in the 1991 Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa.⁶⁵

Law 01/10 of June 30, 2000, related to the Environmental Code of Burundi (ECB), notably constitutes a framework dealing with all major aspects of environmental protection and management. Other laws and regulations complete the ECB by governing specific sectors such as forest (1985 Forest Code). This code sets the basic rules for the protection and rational management of the environment.

In 2010, the **Decree on Environmental Impact Assessment (EIA)** was issued. It laid down the content, rules, principles and procedures for EIA,⁶⁶ which was further completed through a ministerial order on the scoping in the EIA process in Burundi.⁶⁷ The EIA decree is up to good international practice in theory and includes major requirements in terms of analysis of environmental and social impact of projects and activities with potential negative impacts. It provides for strict requirements to be applied to projects and activities in sensitive areas and for public involvement through public consultation and inquiries to seek the views and opinions of affected communities. It is mentioned in the decree that the content of the EIA will be defined by terms of reference to be issued by DOE.

In addition to the ECB, several sectoral laws, decrees, and orders relate to environmental management and protection. These include the following: (i) decree/law of March 3, 1980, related to the creation of national parks and natural (wildlife reserves), (ii) law No. 1/008 of September 1, 1986: Land Code of Burundi, (iii) law No. 1/02 of March 25, 1985, on the Code of Forest, (iv) decree/ law No. 1/138 of July 17, 1976, and Petroleum Mining Code of

⁶³Constitution of the Republic of Burundi, promulgated by law No. 1/010 March 18, 2005.

⁶⁴<http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx>; Burundi ratified the Basel Convention on January 6, 1997.

⁶⁵<http://www.opcw.org/chemical-weapons-convention/related-international-agreements/toxic-chemicals-and-the-environment/bamako-convention/>; Burundi ratified the Bamako Convention on July 22, 1996.

⁶⁶Decree No. 100 of October 22, 2010, on environmental impact assessment.

⁶⁷Ministerial order No. 770/083 of January 9, 2013.

Burundi,⁶⁸ (v) decree/law No. 1/41 of November 26, 1992, establishing and organizing the Hydraulic Public Domain,⁶⁹ (vi) decree/law No. 1/16 of May 17, 1982, on the Public Health Code, (vii) Decree No. 100/138 of 26 March 2007 on the reorganization of the National Commission for the Environment, (viii) decree No. 100/241 of December 31, 1992, governing emission of wastewaters in urban areas, (ix) ministerial order No. 530/770/720/320/205 of February 27, 2009, on development and management of protected areas in the vicinity of ravines and rivers crossing urban and green spaces, (x) decree No. 100/007 of January 25, 2000, related to the establishment of a national park and four natural (wildlife) reserves, and (xi) ministerial ordinance No. 540/760/770/236/2006 determining the annual contribution for site rehabilitation research and exploitation of mineral substances.⁷⁰

Because major environmental issues in Burundi relate to the management and conservation of forest resources, the ECB states that forests are a national public good that must be subject to protection and sustainable use.⁷¹ The government decided to amend the 1985 **Forest Code** to update it and bring it to consistency with the ECB. However, such an amendment is yet to materialize and the 1985 Forest Code and its implementing regulations are still in force.⁷² In the meantime, article 69 of the ECB prohibits any forest exploitation that is not authorized in compliance with a management plan to be approved by the government and/or municipalities, depending on the status of the forest.

Burundi adopted a new **Mining Code** in 2013 and has committed to implementing appropriate mechanisms for transparency in the mineral trade with respect to the Lusaka Protocol on the illegal exploitation of natural resources. Among the tools involved are: the environmental management of the mining sector, the monitoring and certification of minerals, the harmonization of laws on mining, and the creation of a database to track mineral trade in the region. The Mining Code has numerous provisions on environmental protection and management, including the requirement of an environmental impact assessment of any mining-related operation, whether exploration (article 36) or exploitation (article 42.3, 57.1 and so forth). In total, the Mining Code has more than 25 provisions dealing with environmental management, protection, and enforcement in the mining sector. Under the code, no mining site could be developed without an approved EIA and EMP and closed without an approved

⁶⁸Mining was subject to amendment through a new and comprehensive mining code promulgated by law 1-21 of October 15, 2013.

⁶⁹A new law was promulgated in 2012 to deal more specifically and in a comprehensive manner with water resources management: law 1-02 of March 26 related to the Water Code.

⁷⁰Legislation dated from the colonial era is assumed to be in force in some areas where the government of Burundi has yet to enact new legislation. It is however important to question whether, if not amended or replaced, such legislation is consistent with international commitments made by Burundi under convention or agreements. This seems to be the case for fisheries that are governed by the decree of July 12, 1932, on fishery concession, the decree of April 21, 1937, on hunting and fishing, and the order dated December 16, 1961, related to fishing in Lake Tanganyika, which all need to be reviewed in light of the provisions of the international agreement on the sustainable management of Lake Tanganyika.

⁷¹Article 69: "Forests are a common good serving the general interest. They need to be protected and exploited while taking into account their impact on Burundi's environment. Forest management of the State and communes is regulated by management plans approved by the Forestry Administration and abiding by the principles established in this Code and its enabling texts, [and] the Forest Code, as defined by Law No. 1/02 of March 25, 1985, will be subject to an update that will take into consideration environmental concerns consistent with this Code's orientations."

⁷²Among which a critical piece is the decree No. 100/007 of January 25, 2000, related to the establishment of a national park and four natural (wildlife) reserves.

Box A8.3. Mining Sector of Burundi

The mining sector is promising in terms of generating value-added for the development of Burundi, which has untapped mineral potential offering real opportunities in the medium and long terms. The country has large reserves of nickel, coltan, vanadium, phosphates, carbonite, peat, and limestone. Specifically, Burundi has the second largest global reserves of nickel, representing 6 percent of the world's supply at nearly 200 million tons. However, today the mining sector contributes less than 1 percent of GDP, and the real challenge for the country is to establish the conditions for effective and transparent management of mineral resources.

mine closure and Site Restoration Plan (SRP). Approval of EIAs, EMPs and SRPs must be approved by the minister in charge of the environment.

In addition to the domestic legislation, Burundi is a party to major international environmental treaties, conventions, and agreements, including the:

- (i) 1992 United Nations Framework Convention on Climate Change (UNFCC),
- (ii) 1992 Convention on Biological Diversity,
- (iii) 1994 Convention on Desertification,
- (iv) 1997 Kyoto Protocol to the UNFCC,
- (v) 1971 Convention on Wetlands of International Importance, especially as Waterfowl Habitat (RAMSAR Convention),
- (vi) Convention on sustainable management of Lake Tanganyika dated June 12 June 2003,
- (vii) 1973 Convention on International Trade in Endangered Species of Fauna and Flora (CITES),
- (viii) 1972 UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention),
- (ix) 2003 African Convention on the Conservation of Nature and Natural Resources (Revised version), and
- (x) 2005 Convention on the Sustainable Management of the Forest Ecosystems of Central Africa and Establishing the Commission of the Forests of Central Africa (COMIFAC).

Assessment of Burundi's Capacity to Address Environmental Problems and Recommendations

Institutions and policy

Coordination between the Organizations Involved in Environmental Management

To achieve an effective environmental management system to address increased threats to the environment, Burundi has, so far, enacted legislation, but has yet to better define the responsibilities of the various agencies and ensure coordination of their activities.⁷³ In fact, there is no specific body in charge

⁷³See the case of Ministry of Energy and Mining versus MEEATU/DOE.

of coordinating and planning environmental programs, projects and activities, and no environmental priorities seem to be defined. Ad hoc committees and interministerial meetings may be useful to address limited specific issues, but cannot replace a formal coordination mechanism that would help harmonize policies, laws, and regulations and monitor implementation on a regular basis. Such coordination mechanisms would also help review the state of environment at the national level and advise on national policies among other issues. The newly established OBPE is not meant to fulfill that coordinating role, but instead to fulfill an operational mandate under the trusteeship of the MEATU. Coordination is an essential mechanism to address overlapping functions and jurisdictions because of the range of environmental legislation and the various institutions that are in charge of specific environmental mandates (forest and biodiversity, water, municipal environment, transport, agriculture, and others). A coordination mechanism is critical to address the shortcomings in the existence of data, and the availability of, or access to, adequate data, which is primarily related to database management and the legal right of access by potential users.

There is a consensus that the lack of good quality environmental data is a major problem of environmental management in developing countries, including Burundi, and underlying this problem is the unclear institutional mandates, and unclear uses of the data collected. Data and information collection and management must be given priority, both in terms of geographic coverage and thematic area, and a coordination mechanism will be in charge of investing to strengthen collectors of primary data, local government, sectoral agencies, universities/institutes, and NGOs.

Box A8.4 highlights an example of a lack of coordination in the case of persistent organic pollutants (POPs) management, underscoring the need for a coordination mechanism.

Box A8.4 The Example of the Management of Persistent Organic Pollutants (POPs)

A study undertaken under UNIDO and the GEF (FEM-UNIDO 2006) on the management of Persistent Organic Pesticides (POPs) showed clearly how the management mandate of POPs is scattered among numerous organizations, including: the Ministry of Land-Use Planning (« *Aménagement du Territoire* »), of MEEATU, Ministry of Public Health, Ministry of Agriculture and Livestock, Ministry of Labor and Social Affairs, (« *Travail et de la Sécurité sociale* »), Ministry of Trade and Industry, Ministry of Finances, Ministry of Transportation, Ministry of Post and Telecommunications, Ministry of Foreign Affairs and International Cooperation, Ministry of Interior and Public Security, and Ministry of Mining and Energy. In addition to these ministries, other government agencies including research centers and parastatals and civil society's organizations and corporations have stakes in the development, implementation, and enforcement of POPs policies, laws, and regulations,

However, the study demonstrated that the implementation of the various mandates by these organizations was weak and not coordinated because of a lack of: (i) national expertise, human and material resources, and (ii) overlaps and gaps in the definitions of the various responsibilities of each organization. Interministerial commissions and other ad hoc committees seem not to be able to overcome these weaknesses. Also, some of these organizations, which obviously have a stake in implementing policy and laws related to POPs, are not involved in implementation processes.

Improving National Environmental Information and Data Systems

Although the ministry in charge of environment and the OBPE has the mandate for environmental management and protection in very broad terms, OBPE is far from being able to implement a coherent and comprehensive environmental management system. Environmental management is a continuous process that consists of three interconnected steps:

- (i) the collection and analysis of relevant data, learning from worldwide “best practices,” and incorporating these in the planning and formulation of policy including the setting of standards;
- (ii) the effectiveness and location of the administration of environmental institutions; and
- (iii) program implementation and monitoring to ensure active compliance with established laws and standards.

Burundi’s environmental management system is characterized by clear weaknesses at each of the three main steps and every administrative level: both central and local government. This is confirmed in the numerous reports examined on the various aspects of environmental protection and management, including environmental impact assessments for donors’ funded projects. Environmental management from central government institutions, particularly the Ministry in Charge of Environment, is not effective because, among other issues, weak data collection and management affect policy planning and implementation. Despite the support provided by donors under specific investment projects, more needs to be done to strengthen Burundi’s institutions to build capacity in country in information and data collection and treatment to address the numerous environmental challenges it is facing, including forest resources depletion, soil degradation, air pollution, waste management, and other potential sources of pollutions deriving from mining, infrastructure development, and natural resources activities.

Therefore, recognizing that MEEATU-OBPE lacks the resources, technology, and skills to maintain well-managed and widely accessible environmental databases, there is a need to establish an environmental information system. This information system should focus on: (i) data needs for decision making and (ii) the technology required to meet those needs. The fulfillment of these needs must be tailored to each sectoral decision-making body and end users dealing with issues such as forests, mining, agriculture, water, local government, and to strengthen MEEATU-OBPE and sectoral ministries and agencies as well as establishing an effective coordination mechanism among them.

This CEA process has resulted in the creation of a knowledge platform of spatial data, a “geo-portal information system.”⁷⁴ Efforts to maintain and expand the system must be continued. The elaboration of a knowledge platform will provide a base for (i) identifying landscape management priorities based on hotspots of degradation and associated impacts, and complementarities between enhanced environmental and economic functions; (ii) monitoring indicators of landscape health and productivity; and (iii) sharing of information

⁷⁴URL: <http://bi-risk.pigeo.fr>.

and lessons among diverse stakeholders (World Bank 2016d). As landscape management issues are closely linked to gender issues, analytical products linking these two topics could be developed in parallel to raise awareness and increase women's involvement (GEF 2016).

Laws and Regulations

Promoting Incentive-Based Approach

Current environmental legislation, especially the 2000 law on environmental protection, relies heavily on command and control approaches to environmental protection against pollution. It does not appear that Burundi has used an incentive-based approach to environmental management and protection (besides defining sanctions to violations of the environmental and other codes). No financial or tax incentives have been used by the government to encourage compliance with environmental norms and standards for industries and projects that may affect the environment. Site restoration in the mining sector is the only financial incentive that is specifically stated. Intensive agricultural practices are not adequately framed by laws and regulations, especially measures to protect aquatic and underground water ecosystems (fertilizer and pesticide load, soil drainage that dries out grazing lands, and so forth).

It may be appropriate in some areas and under specific circumstances to mix approaches with other policies and utilizing compliance incentives using economic instruments, public disclosure, and voluntary programs and community engagement to achieve effective environmental protection at a lower cost. For example, the introduction of an incentive-based approach, such as the payment for environmental services (PES), could encourage the sustainable use of natural resources. The underlying principle of PES is that beneficiaries of environmental services are willing to pay a price for the service, and the providers of the services are to be compensated with a payment that is greater than the cost of providing the service. Such a set-up would compensate farmers for the downstream benefits they generate by keeping their slopes well managed. The development of community-based conservation measures in protected areas—including payment for their environmental services—could offer local communities an alternative activity that protects the area's integrity while simultaneously contributing to improving livelihoods (World Bank 2011).

Adopting Regulations Necessary for Implementing the Environmental Code

The 2000 law is yet to be followed by all the needed implementing regulations without which it cannot be effectively and completely implemented and enforced. Table A8.1 lists all the needed implemented regulations that are yet to be developed adopted and enacted.

While the ECB states that forests are a national public good that must be subject to protection and sustainable use, what is needed are more specific regulations aimed at protecting species and their reproduction sites. The concepts of biodiversity protection, resource conservation, and renewal should be integrated and harmonized into all sectoral policies and regulations. The legislative bases of national park creation have not been reviewed for many years and do not integrate biodiversity protection efficiently.

Table A8.1. Regulations Not Yet Adopted or Enacted to Implement the 2000 Environmental Code*Articles of Law 01-10 Implementing Regulations Yet to Be Issued*

Article 10	Implementing regulations on the conditions to be applied by existing plants and facilities to be brought in compliance with the Environmental Code, including fiscal and custom incentives to be granted to their owners and/or operators.
Article 11	Definition of environmental quality norms.
Article 24	Decree on the various categories of facilities and projects to be subjected to EIA.
Article 30	Regulations on the protection of soils against degradation, erosion and desertification, and fight against loss of agricultural lands and their pollution, notably by use of chemicals, pesticides, and fertilizers.
Article 91	Regulations on protection of endangered, rare, or remarkable animal and vegetal as well as their habitats, including: (i) lists of such species; (ii) protection modalities; (iii) conditions of their use, trade, transportation, and export; and (iv) conditions for the issuance of permits for hunting or harvesting such species for scientific reasons.
Article 111	Regulations on facilities to be subjected to special attention, including: (i) the provision of a technical presentation on the quality and quantity of their emissions and the planned treatment process of said emissions; and (ii) an EIA report consistent with the 2000 Environmental Code.
Article 120	Regulations on treatment and disposal of waste.
Article 126	Regulations of rules and principles applicable to the treatment of wastewater and oil issued by industrial installations and facilities.
Article 128	Regulations on import of chemicals including their marketing, sale, transportation, treatment, use and storage, and list of chemicals that are prohibited from entering the territory of Burundi.
Article 132	Regulations on norms applicable to noise emission and management in residential, commercial, and industrial areas.

Strengthening and Enhancing the Use of Environmental Impact Assessment

In order to strengthen EIA use, many issues should first be noted. Based on a study conducted by the Netherlands' EIA Association, the DOE has reported that it reviews 50 EIAs every year. However, no single EIA report is available online, or at least a list of such 50 EIAs and related projects that are reviewed by the DOE of the MEEATU-OBPE, and previously the INECN. It is clear that all donor-funded projects are subject to environmental review and EIA, as required by the donors' policies and procedures. However, whether all non-donor-funded and private and public sector-funded projects are subjected to such reviews and EIAs, as required by the national legislation, remains to be investigated on the ground. No specific information was provided on the number of EIAs conducted for private sector-funded projects and/or enforcement of EIA requirements. OBPE staff reported that 48 experts (including five female technicians)⁷⁵ are involved in EIA-related work. This seems to be

⁷⁵Information provided by Alphonse Polisi, in a document attached to an email dated November 13, 2015. This number is contradicted by the document "Informations sur l'OPBE" provided by the same author. This document mentions that OPBE has 630 staff (61 "cadres," 96 "agents de collaboration," and 473 "agents d'exécution"). From the total of 630 staff, 80 are women. In addition, this document provides a list of 39 experts (7 biologists, 26 agronomists, 4 environmental specialists, 1 civil works specialist, and 1 environmental lawyer).

an obvious overstatement that would need to be further investigated to clearly assess the work they handle in connection with EIAs.

EIA legislation conforms to general practice as known in other countries and jurisdictions; however, it remains incomplete. There is indeed a need for EIA sectoral guidelines to ensure that specific content for EIA in the various sectors and review and approval processes are defined taking into account the specificities of each sector. Mining, forest, and infrastructures are all in need of sectoral guidelines. In addition to issuing such guidelines, lack of and/or inadequate expertise in environmental planning and monitoring of projects must be addressed; they are major problems in performing EIA-related tasks.⁷⁶ Therefore development and adoption of sectoral guidelines and specific training programs must be completed to ensure sound implementation and enforcement of EIA requirements.

Also, even if we consider that environmental review and EIA are performed in accordance with national legislation and after environmental permits are issued, there is concern about the OBPE's capacity to follow up cases reviewed and/or cleared under EIA. There is no evidence that skilled staff is being employed within supportive infrastructure at national/local/regional levels to conduct such follow-up, or if there is any effective monitoring of implementation of the environmental management plans. It is therefore highly recommended that OBPE undertake an institutional audit to consolidate its expertise and human resources to focus on EIA processes and outcomes and to ensure it monitors harmful and negative impacts of development projects in the future, while also assessing past negative environmental impacts.

Issues of Implementation and Enforcement of Environmental Law

Two separate but connected issues need to be addressed regarding environmental law:

- (i) adopting and implementing further actions to strengthen implementation and enforcement of existing laws; and
- (ii) the adequacy of the substantive coverage of laws and the harmonization among existing laws and implementing regulations, including aligning domestic laws with international treaties, conventions, and agreements to which Burundi is a party (Ruzima 2011).

The legal framework described in Chapter 3 is far from being effective. This is notably for the following reasons:

- (iii) insufficient legal infrastructure in the MEEATU and OBPE for implementation and enforcement;
- (iv) weak dissemination of law and the decisions made thereunder;
- (v) insufficient monitoring of compliance because of lack of tools and technical and legal capacity to review compliance;

⁷⁶See footnote above on number of staff within OBPE and its repartition.

- (vi) inadequate capacity for effective inspection and for taking remedial actions including follow-up in courts or through other dispute resolution mechanisms;
- (vii) lack of required continuing legal training; and
- (viii) inadequate use of community and nongovernmental resources and customary law in implementation.⁷⁷

In addition, a more structural issue must be addressed to fix the main legal factors contributing to poor implementation and enforcement, namely:

- (ix) correct Burundi's environmental law framework, which is based mainly on command-and-control approaches, which proved to be ineffective without a strong institutional framework; and
- (x) provide an effective process for bargaining/negotiations among affected groups and environmental conflict resolution through alternative dispute resolution mechanisms.

Therefore, it is highly recommended that Burundi adopt a process that ensures decisions regarding environmental resources are made in a manner that provides a full accounting of all interests. Further, costs and benefits must be included to prevent, mitigate, or intermediate environmental conflicts in an orderly manner. Such process will rely on nonlitigation remedies with an inclusive and community-oriented system of decision making and dispute resolution⁷⁸ to avoid future conflicts (Ruzima 2011a).

Financial Capacity

Structural policies should include more environmental variables. When confronted with budgetary constraints, the priority is often given to socially or politically sensitive sectors, which prompts the government to sideline environmental protection. However, environmental degradation may directly or indirectly damage productive investments. Indeed, damaged public infrastructures, such as road and crop destruction or drought following climatic hazards, may occur following environmental degradation. Structural growth policies should therefore include environmental variables (pollution, water management, waste management) and balance the associated expenditures to secure the investments and production plans. A specific taxation might also result from a resources mobilization to significantly protect nature.

Mobilizing financial resources requires enhanced institutional capacities. Resources mobilization would require financial partners be convinced of each dimension of the services' quality. It would be therefore relevant to establish a

⁷⁷Current staffing and available skills within the OBPE, the MEEATU, other sectoral ministries, and the private sector as well as local environmental civil society's organizations are to be evaluated to confirm this opinion, which seems to be shared by numerous studies and assessments conducted on various aspects of environmental and natural resources management in Burundi.

⁷⁸In theory, citizens enjoy the right to start litigation, including constitutional, public interest litigation to defend their environmental rights. However, these rights are not effective because reliance on litigation is not accessible by almost all segments of affected or interested groups, including affected communities, and, in addition, there are no non-litigation remedies for affected persons/communities.

plan to strengthen institutional capacities such as professional training of staff in charge of the monitoring and evaluation of the budget related to environment, appropriate equipment, or an improvement of the coordination and evaluation mechanisms.

A special budget is necessary for natural disaster-related interventions. Environmental degradation requires efficient collaboration among the Ministry of Solidarity, the Ministry of Agriculture and Livestock, the MEEATU, and the international community. The unpredictability of environmental disasters should prompt the government to develop a special disaster risk management budget to ensure help for the poorest and those most vulnerable to natural disasters.

9. Recommendations for Burundi's Disaster Risk Management Framework and Capacity

Following the natural disasters that occurred in February 2014 (see Chapter 2), short-, medium-, and long-term recommendations have been proposed. Their objective is to increase the country's resilience and to advance the implementation of strategies set forth by the government in relation to infrastructure development and disaster risk management (drainage scheme, urban planning document, local development plans, national strategy for disaster risk reduction, and national adaptation program of action). Activities have been classified along three categories: *emergency*—activities to prevent further damage; *medium term*—activities to enable infrastructure rehabilitation; and *long term*—activities contributing to reconstruction with a sustainable approach. In particular, the most urgent activities are to protect infrastructure weakened by the disaster. Cross-cutting DRM activities—such as landslide hotspot mapping, riverbed surveillance, early warning systems, and drainage management teams—would, however, need to be implemented in parallel to emergency activities.

For strategic recommendations, knowledge management capacity should be strengthened rapidly, and sharing of responsibilities among ministries and government agencies would require updated operational procedures.⁷⁹ It is urgent to develop operational procedures to define the role of ministries, directorates, and technical services for knowledge management,⁸⁰ maintenance,⁸¹ prevention, and rehabilitation.⁸² It will be necessary to develop baseline information on risks, useful for various sectors; ensure better use of weather forecasts, especially when severe events are anticipated; and guide the contribution of various

⁷⁹Improved collaboration among the various ministries and with the 13 municipalities of Bujumbura is a prerequisite to provide an adequate response and manage cross-cutting risks with a long-term approach.

⁸⁰For example, the Directorate-General for Water and Sanitation and the Directorate-General for Urban Development created in 2012 and 2013 urban development and rainwater drainage schemes following completely independent approaches. It took more than a week for the mission to obtain a copy of these documents, and many technical services have discovered the existence of these documents.

⁸¹Effective operation and maintenance of existing drainage infrastructure and networks is the first step to reduce the occurrence and severity of urban floods. Improved financial management in the Municipality of Bujumbura should be considered a priority toward meeting its responsibilities.

⁸²A month after the event, latrines in schools and health centers had not been pumped out. This creates a public health issue, while the cost of such operation is less than US\$1,000 per block (less than US\$10,000 required in total).

sectors in prevention (planning, agriculture, public works, urban development, sanitation, and others).

Approaches to engage residents in adaptation could include:

- Communication products, such as pamphlets, that identify the climate vulnerabilities of the city and proposed adaptation activities and actions, as well as indicate where citizens can find more information and how they can get involved.
- Maps of vulnerability can be visually effective in communicating the local areas most likely to be affected by climate change.
- Public consultations in which adaptation plans are discussed, with reference to corresponding climate change impacts.
- Community meetings, potentially facilitated by NGOs, in different and diverse parts of a city.
- Using local media, social networks, and popular gathering places to spread climate change awareness and reach large audiences.

Improve Resilience and Adaptation

Burundi's INDC offers the following recommendations to enhance resilience to climate change:

- Integrated management of climate risk and forecasts over time (by means of probabilities and forward-looking studies) to be able to take action in advance.
- Protection of aquatic and land-based ecosystems.
- Coaching of the population to develop their resilience to climate change.
- Research on the vulnerability and adaptation of socioeconomic sectors to climate change.
- Research and extension of drought-resistant forest species.
- Promotion of climate-smart agriculture (agrometeorology; UNFCCC 2015).

Prevent Water Issues Related to Climate Change

Considering the potentially significant impacts of climate change on water resources, it is essential to bring into play local and global action to tackle climate change pressures precious water resources. Many of these actions must take into account an integrated water resources management (IWRM) approach through a policy of well-enforced water monitoring and savings. Moreover, increasing storage capacities and water reuse systems would be needed to build resilience. Better urban planning, risk management, and citizen engagement will likewise reduce the exposure of cities to flood risk. In rural areas, expanding crop insurance programs may also protect farmers against rainfall shocks. As the precise impacts of climate change are uncertain and large investments (such as dams) are costly and irreversible, their siting and design must be carefully chosen to minimize regret (World Bank 2016a).

Thus, to reduce the impact of climate change, Burundi will have to implement the priority actions listed in the Strategy and the National Action Plan

for Climate Change Adaptation (NAPA). Among the interventions proposed in these two documents, those related to water resources include:

- extension of rainwater harvesting techniques for agricultural or household purposes;
- development of erosion control systems in sensitive regions;
- establishment of buffer zones in the floodplain of Lake Tanganyika and around the lakes of Bugesera;
- identification and dissemination of drought-resistant tree species;
- popularization of short-cycle food crops; and
- control of water courses and torrents in the Mumirwa, as well as in the city of Bujumbura.

Expanding water supply and availability are key to curbing climate change impacts. This includes investments in storage infrastructure such as dams that make water available when it is needed as well as in water recycling and reuse. To be effective, these interventions must be accompanied by policies to promote water efficiency and improve water allocation across sectors (World Bank 2016a).

Improve Adaptation and DRM Preparedness through Institutional Policies

The climate change threat requires institutional actions to tackle it. These actions include the following:

- Harmonize policies and institutional frameworks affecting climate change adaptation across different approaches and strategies,⁸³ including amending current regulations to include climate change-related provisions.
- Develop institutional and operational capacities, as well as alternative adaptation options for the various plausible scenarios, and design and coordinate multiple adaptation programs for the diverse climates of Burundi so that all vulnerable populations can be reached.
- Provide rural financing to promote the adoption and use of proven technologies for climate change adaptation and forest cover protection and conservation, including reforestation, soil conservation, and irrigation.
- Establish functional monitoring and evaluation mechanisms for climate change, as well as knowledge management and information mechanisms. This could be, for instance, achieved by strengthening the Burundi's meteorological office, making climate forecasts available to smallholders to reduce climate-induced risks, and enhancing the environmental information management system.
- Design, implement, and maintain a training program for decision makers and communities on climate change adaptation and mitigation.

⁸³IGEBU has been designated by the MEEATU as the UNFCCC Focal Point. The General Directorate of Environment and Forests has also been designated by MEEATU as climate change projects operationalization institution.

