



FOCUS-BRI Country Report

**Framing Opportunities for Conservation by Understanding Safeguards
in the Belt and Road Initiative**

Rwanda

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Acronyms

ADB	African Development Bank
BRI	Belt and Road Initiative
CBI	Composite Biodiversity Index
CDB	China Development Bank
CHEXIM	China Export-Import Bank
DRC	Democratic Republic of Congo
EADB	East African Development Bank
EIA	Environmental Impact Assessment
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GNI	Gross National Income
GoR	Government of Rwanda
HDI	Human Development Index
HIPC	Heavily Indebted Poor Countries
IMF	International Monetary Fund
IUCN	International Union for the Conservation of Nature
ITA	(United States) International Trade Administration
JADF	Joint Action Development Forum
KBA	Key Biodiversity Area
LI	Linear Infrastructure
MDRI	Multilateral Debt Relief Initiative
MEA	Multilateral Environmental Agreement
NBSAP	National Biodiversity Strategy and Action Plan
NCA	Natural Capital Accounts
NGO	Non-Governmental Organization
PA	Protected Area
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Agency
RMB	Rwanda Mines, Petroleum, and Gas Board
RWF	Rwandan Franc
TFCA	Trans-Frontier Conservation Area
WB	World Bank

Rwanda Factsheet



Figure 1. Political map of Rwanda. Source: Nations Online Project.

Region	Central/Eastern Africa
Capital	Kigali
BRI Corridor	None
BRI investment (\$ in millions)	346
Income Status	Low Income Country
Population	12,000,000
GDP	10.3 Billion
Land Area	26,000 km ²
Protected Areas (km ²)	3624 km ²
Species Richness (ranking)	4
Biodiversity Intactness (ranking)	48
ND-GAIN Country Index; Climate vulnerability (ranking)	168
GDP Growth Rate Projections	5.1% in 2021, usually around 7%
Inequality (Gini Coefficient)	43.7 in 2016
Human Development Index (HDI)	0.543
Key exports	Coffee, tin, tantalum, tungsten, and gold

Table 1. Rwanda country statistics. Information assembled from the Stimson Center, World Bank, and the Convention on Biological Diversity.

I. Introduction

The Republic of Rwanda is an East African nation that has been a regional exemplar of political stability, economic growth, and ethnic reconciliation following the catastrophic genocide of the mid-1990s. This landlocked country is known as the “land of a thousand hills” for its scenic mountains, valleys, hills, and lakes. The Albertine rift lies to the west, thrusting a north-south range of mountains upward from its flank and forming the border between the Congo and Nile watersheds. This rift defines the geography of the country, with peaks that soar above 4,500 meters (14,500 feet), in contrast to the central plateau and eastern plains that sit as low as 1,000 meters (3,200 feet). A range of ecosystems thus spans the country: from the densely vegetated bamboo and tropical rain forests of the volcanic mountains to the heavily cultivated lands of the central plateau, and eastward to the savannah plains of the Akagera National Park.

Bordered by Uganda, Tanzania, Burundi, and the Democratic Republic of Congo (DRC), Rwanda straddles East and Central Africa. However, politically and culturally it is closer to its eastern neighbors, even joining the East African Community intergovernmental organization. Rwanda is one of the more densely populated countries in the world, ranking 25th in 2019, with a density of 512 people/km² – a number that is only increasing (World Bank, 2022). The majority of the workforce is engaged in agriculture, on diversified small holdings, or working in the cash crop industries of coffee, tea, tobacco, and pyrethrum¹. The country’s landscape is heavily influenced by the proliferation of agriculture for both subsistence and cash cropping on large plantations, together covering approximately 90% of land (REMA, 2021). This proliferation has converted most of the forest and natural vegetation to cropland or plantation causing problems with erosion on its “thousand hills.”

Transboundary coordination for conservation is most obvious in the Greater Virunga Transboundary Collaboration between Rwanda, Uganda, and the DRC, which is dedicated to protecting one of Africa’s most biodiverse landscapes. The Greater Virunga comprises the Albertine Rift – a globally important biodiversity hotspot and one of the most biodiverse regions on the African continent. The Albertine Rift, itself the western branch of the East African Rift, is not only home to incredible biodiversity, but in some areas high human density, and unfortunately, conflicts. In addition to the Virunga area, the Kagera TFCA and Nyungwe-Kibira transboundary landscapes are partially located in Rwanda.

In principle, the Republic of Rwanda is a multi-party, democratic nation, with presidential elections occurring every seven years. In practice, however, the degree to which free speech and opposing political parties are stifled under the guise of protecting the country from ethnic tensions and the possibility of another genocide is a debated question. The current President, Paul Kagame, started his third term in office in 2017, winning a reported 98.79% of the vote. The president has the power to appoint all cabinet members and the Prime Minister, negotiate and ratify treaties, declare a state of emergency or war, and much more. Despite some shortcomings, Rwanda ranks relatively well - #52 out of 180 in 2021 - on Transparency International’s Corruption Perception rating (Transparency International, 2021). The country also has relatively strong governance capacity across the federal government and five provinces - one for each cardinal direction and the area encompassing Kigali. This capacity means that the natural resources inside national park boundaries are considered to be well protected and Akagera National Park, for example, has undergone extensive restoration efforts (IUCN Eastern and Southern Africa Regional Office, 2020).

¹ The primary input in pyrethrin, a common pesticide.

The Rwandan central government is focused on continuing the country's rapid growth, aiming for Middle Income Country status by 2035 and High-Income Status by 2050. While that may sound unlikely, under the Vision 2020 development strategy, growth averaged 7.2% from 2009-2019 and GDP grew at 5% annually during the same period. At the end of the decade, the Vision 2050 strategy was introduced, and with it the National Strategy for Transformation reports, which are released every 7 years. Foreign, and especially Chinese, lending has appeared to play a role in Rwanda's economic growth. Between 2000 and 2020, Chinese institutions lent over US\$630 million across 14 loans, with the majority of funding going to the transportation and power sectors (China Africa Research Initiative & Boston University Global Development Policy Center, 2021). The relationship between China and Rwanda seems to be strengthening, as loan amounts have trended positively in the last decade.

Agriculture is the primary driver of the economy, with the majority of the workforce employed in the sector, but mineral resources contribute as well. The primary exports are coffee, tin, tantalum, and gold. Home to rich deposits of the "three T's" – tin, tantalum, and tungsten – large-scale mining development, and even small-scale illegal mining (Muhire et al., 2021), are prevalent in the country. Recently, exploration for additional resources in existing and similar veins has blossomed, for instance, the potential for previously unnoticed lithium deposits in Tin-tantalum mines (Africa Museum, 2022). As much of the mining has been traditional, artisanal operations, the scope of the potential for industrially mined materials is not yet clear, but certainly not insignificant. Changing pressures around mining that will actualize in the push towards renewable energies make this an important lens to consider.

The maps (Fig. 2) below illustrate the array of protected areas in Rwanda according to their IUCN classification and the existing LI network, as captured by four distinct datasets (Appendix A). This overlay provides an overview of the extent of the road systems across Rwanda's PA system. The protected area system of Rwanda has a definite impact on LI, made all the more obvious by the ubiquitous nature of the road network everywhere else in the country, besides the mountainous west.

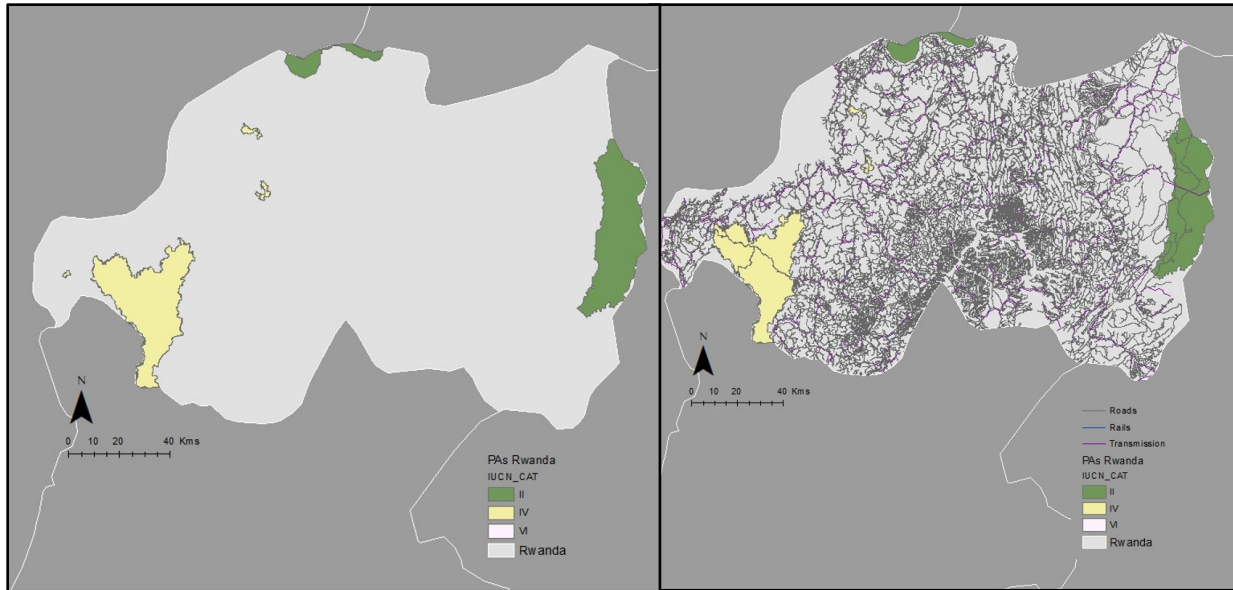


Figure 2. (a) There are multiple types of Protected Areas in Rwanda affording varying degrees of protection to multi-use landscapes. Highest protection afforded to IUCN categories I and II. **(b)** Existing infrastructure already compromises multiple protected areas. We consider only roads, rails, and transmission lines as linear infrastructure for this study (see Appendix A for methodology).

II. Linear Infrastructure Investment Landscape

Following the horrific events of the Rwandan Genocide (1994), the fabric of the society and its institutions were in disarray: 1 in 8 Rwandans lost their lives, poverty levels increased dramatically, and the government, including the education and health-care systems, effectively collapsed. Many nations responded with support in the form of loans, to help the struggling nation regain its feet. However, the burden of these loans was oppressive: by the end of 1999, the government owed approximately US\$1.5 billion, mostly to multi-lateral external creditors (Cassimon et al., 2016). After years of burdensome payments, in 2005 and 2006 the Heavily Indebted Poor Countries (HIPC) and the Multilateral Debt Relief (MDRI) initiatives helped to restructure Rwanda’s debt, providing a clean slate (Cassimon et al., 2015) and relieving about US\$1.25 billion of external debt stock through a variety of mechanisms. Although this might have created a circumstance where there was a reluctance to rely too heavily on international investment, the government fervently pushed towards its Vision 2020 goal of middle-income status, requiring, at least in the short term, an expansion of its reliance on foreign aid and capital investment. Figure 3 shows the steady increase in debt stock before and after the genocide, the relief provided by HIPC and MDRI, and the subsequent explosion in foreign debt obligations. While Covid-19 has exacerbated these conditions, it is clear this trend began long before the pandemic. This trend is also correlated with high growth: in 2019 Rwanda achieved 9.5% GDP growth, so in terms of percent GDP or GNI, the growth of debt stock is less worrying (Fig. 3).

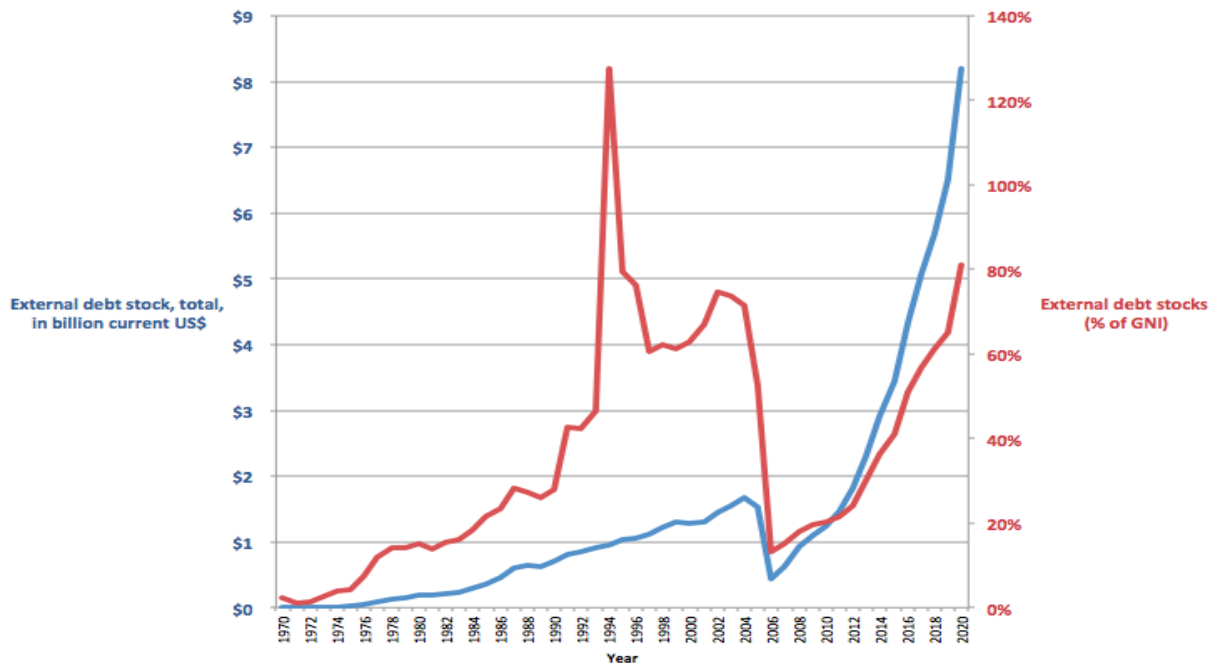


Figure 3. Rwanda’s external debt stocks from 1970 to 2020. Represented in total stocks, current US\$, billions, and as a % of GNI; reformatted from (World Bank, 2022).

BRI and Chinese activities in Rwanda

Currently, the majority of foreign loans to Rwanda come from international lenders such as the International Monetary Fund (IMF), World Bank, and African and East African Development Banks, as well as bilaterally from China, the US, Japan, and more. Chinese lending began to play a more prominent role around 2010 and has been increasing since. The 2018 visit by Chinese President Xi Jinping marked a pivotal moment for relations between the countries. Not only did Rwanda sign an MoU joining the BRI, but the top officials promised to strengthen existing ties, using the opportunity to sign an additional 14 bilateral MoUs, including a loan agreement to expand the road to Bugesera International Airport, and agreements strengthening cooperation on infrastructure development, e-commerce, and mining, among many others. The Chinese Loans to Africa Database captures US\$126 million in 2018, and US\$214 million in 2020 (China Africa Research Initiative & Boston University Global Development Policy Center, 2021), the two highest yearly sums for Rwanda. Much of this lending has targeted transportation projects (Table 2).

Table 2. CDB and CHEXIM loans to Rwanda between 2009-2019. Source: GDPC, Boston University.

Project	Type	Borrower	Lender	Signed	Total (USD millions)
Kigali Urban Road Upgrade	Transport	Public	CHEXIM	2009	36.00
Huye – Kibeho - Munini Road Upgrade	Transport	Public	CHEXIM	2018	76.00
Bugesera International Airport Access Road Construction	Transport	Public	CHEXIM	2018	50.00
Mwityazo-Ruvumbu-Karongi Road Construction	Transport	Public	CHEXIM	2012	113.00
Kigali Urban Road Upgrade	Transport	Public	CHEXIM	2016	71.00

Chinese-funded linear infrastructure projects are not uncommon, but also not overwhelming, with the majority being road upgrades in human-modified landscapes. As one key informant put it, there simply isn't the same wealth of natural resources in Rwanda to drive Chinese investment as places like Angola. Additionally, the smaller area and population means that projects are generally of a smaller scale, perhaps another factor diminishing Chinese interest.

Despite the current lack of more targeted Chinese interest, the country does have the potential to attract more investment. Years of artisanal and illegal mining (for instance, see Muhire et al., 2021) point to the potential mineral richness of the area, and recent exploratory work is being done to understand the potential for large critical mineral deposits, for example, lithium (Africa Museum, 2022). If these deposits prove to be extensive, the situation could change rapidly. East Africa has already been called a “frontier” for technology metals, and Rwanda is more highly rated than its neighbors due to its stable governance (Kinch, 2020). Even the US International Trade Administration (ITA) declared mining as the best prospect for industrial sector investments in Rwanda (ITA, 2021). Furthermore, the development of mining projects remains a central fixture of the Rwanda Development Board (RDB), the nation's one-stop-shop institution for international investment information, permitting, and acceleration. Because mineral deposits are spread all over the country and are especially prevalent in the more biodiverse west, it is clear that however the situation evolves, ensuring safeguarding in these developments is vital.

III. Rwanda's Biodiversity landscape

Summary of biodiversity and conservation efforts

The Albertine Rift, the greater geologic/ecologic region in which Rwanda sits, is host to more species of vertebrates than anywhere else in Africa. Much of the diversity is focused in the humid montane forests that once composed vast swathes of the western half of the country. However, the conversion from forest to agricultural land has severely impacted biodiversity: large swathes of naturally occurring vegetation are now mostly restricted to the country's four National Parks. These National Parks are bolstered by smaller forest reserves as well as a Ramsar² wetland site and 7 Important Bird Areas. These wilder places and the human mosaics in between are home to over 1000 species of bird, the world-famous mountain gorillas and chimpanzees, over 400 other species of mammal, nearly 300 species of reptiles and amphibians, and over 5000 species of plants (RoR, 2020). Beyond the national parks, the human landscapes in Rwanda are generally composed of relatively diverse, family-owned agricultural plots. Often terraced and surprisingly heterogeneous, smallholders utilize dynamic approaches to meet the demands of their unique situations (Kim et al., 2022), and in doing so create a diverse agricultural mosaic that can aid in small mammal, bird, insect, and microbial biodiversity.

In Rwanda today, biodiversity is threatened by habitat loss, encroachment, agricultural intensification, the unsustainable extraction of resources (e.g., charcoal production, logging, poaching, and mining), and a lack of ecological connectivity. For example, large mammals such as the elephant, giraffe, and buffalo have faced sharp declines, and the population of black rhino in the country was completely extirpated by 2007 – until their reintroduction in 2018 (RoR, 2020). In contrast, the population of the country's

² The Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat is an international treaty for the identification, conservation, and sustainable use of globally important wetlands.

most famous mammal, the mountain gorilla, has increased in recent years and evidence points to stable populations (Granjon et al., 2020). Bird diversity has also remained relatively rich, due to the diversity of habitat across the country and the fact that much of the habitat conversion has been toward generally diverse small-scale farms that still support fairly high levels of biodiversity.

The government does recognize the importance of biodiversity and the many ecosystem services and values it provides. The country ratified the Convention on Biological Diversity in 1995 and has followed through on the commitment, developing a National Biodiversity Strategy and Action Plan (NBSAP) in 2003, revising it in 2016, and delivering the required reports - the most recent being the 2020 6th National Report. Some focus areas of the country’s strategy include the valuation of ecosystem services, reforestation, conserving endangered and critically endangered species (especially in protected areas), and improving rural livelihoods by integrating development and conservation. While the country currently has no UNESCO World Heritage Sites, it is in the process of nominating Nyungwe National Park based on its biodiversity values and natural beauty.

Government strategy has acknowledged the economic values that biodiversity and natural resources offer. For example, projects have evaluated ecosystem services and developed Natural Capital Accounts (NCA) in an attempt to more precisely value and manage its natural resources. See Table 3 for the four major valuation projects carried out thus far (RoR, 2020). Working with the WAVES program, the country has completed NCA for land and water accounts as of 2018; this focus was chosen because of the centrality of agriculture in the Rwandan Economy.

Table 3. *The four main ecosystem service valuation projects implemented by the Government of Rwanda.*

Area	Year	Total Economic Value - per annum
Nyungwe Montane Forest	2014	\$4.8 Billion
Rugezi Wetlands	2014	\$374 Million
Mukura Landscape	2014	\$1.44 Million
Akagera Wetland Complex	2019	\$11.9 Million

Due to increasing governance capacity and high levels of commitments from international NGOs in National Parks, especially those with large primates (see for instance the International Gorilla Program, Diane Fossey Foundation, WWF, and African Wildlife Foundation), biodiversity and population trends for charismatic megafauna have been generally positive in these areas. That is not to say threats have abated, but rather that there is a steady commitment from local communities, the government, and the international community to protect those resources. However, National Parks cover less than 10% of Rwanda’s land mass, and the story outside of them is almost exclusively agricultural and much more complicated. The maps (Fig. 4) below, demonstrate that biodiversity hotspots are spread throughout the country and a majority of them are not protected in the PA system (see the west half of the country). These PAs also miss many important Key Biodiversity Areas, a potentially worrisome trend given the importance of these regions and the pressures natural systems face outside of PAs. The fact that existing Chinese-funded LI is absent from the database in part displays the shortcomings of the Custer et al. (2021) method in the context of incredibly opaque data practices and a lack of geospatial mapping for large BRI and Chinese-funded LI projects.

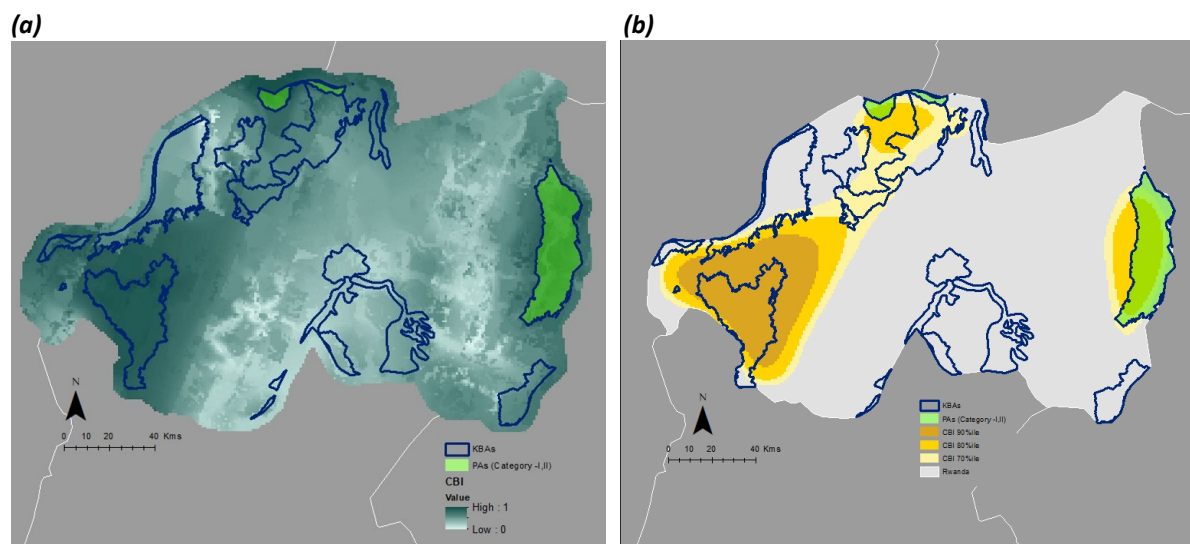


Figure 4. (a) In Rwanda, PAs with the highest protection (at IUCN Category II) and (Key Biodiversity Areas) KBAs overlap to a great degree and cover some areas with high CBI values. **(b)** Chinese-funded linear infrastructure (here, lack thereof), as captured by Custer et al., 2021, overlaid with PAs, KBAs, and CBI biodiversity cores (top 70, 80, and 90 percentiles), demonstrates the gaps in such datasets as no projects are mapped. Methodology and further analysis in Appendix A.

People, livelihoods, and agrobiodiversity

The famous moniker really does hold true: approximately 90% of Rwandan territory is composed of sloping terrain and approximately the same percentage is agricultural land, often terraformed into terraces to increase productivity in this landscape (REMA, 2021). In this context, agrobiodiversity is a vital consideration in any conversation about biodiversity. Besides being a critical asset to overall biodiversity, agrobiodiversity increases food productivity, security, and yields, reduces reliance on external inputs, and improves human nutrition (Thrupp, 2000) – essentially improving standards of living for people while bolstering natural systems.

Agrobiodiversity is a complex concept and can include the range of crops produced, the diversity of plants and animals found on-site, and even the microbiota in the soil. One simpler, and more cost-effective, frame of analysis is the Farmland Biodiversity Score – an indicator based on a body of research demonstrating the correlation between trees on farms and biodiversity more broadly (Harrison & Ryan, 2021). Trees on farms improve biodiversity in a landscape in three main ways: 1) provision of habitat and ecological connectivity, 2) reducing human pressure on nearby habitat, and 3) provision of other ecosystem services that reduce biodiversity loss, such as soil biodiversity and water regulation (P. Udawatta et al., 2019). The Rwandan government is aware of these benefits and has been aiding in the development of this indicator and using it to guide management since 2015 (RoR, 2020). The FBS metric uses the presence, composition, and configuration of trees on farms to provide proxy information about biodiversity, landscape integrity, and ecological connectivity.

This focus on trees has in part oriented the government towards reforestation efforts. Embedded in its development and environmental planning was the goal of achieving 30% forest cover by 2020. Although the goal was reached with 30.4% cover, the waters are slightly muddied because the government redefined “forest cover” to include patches as small as 25 m² with a canopy density of less than 10%

(REMA, 2019). While this decision does align with the above discussion about the importance of trees on farms and their relative density, it also undermines the significance of such an accomplishment. Because forest datasets for western Rwanda overestimate forest area (compared to other regions), ongoing forest loss and increasing isolation remain significant threats (Arakwiye et al., 2021). Additionally, the government has been inconsistent in its valuation of forests on farms and agrobiodiversity. For example, government-supported agricultural intensification since 2017 has undermined the very heterogeneity on farms so important for biodiversity and livelihoods (Kim et al., 2022).

As the two main biodiversity spaces are protected areas and agricultural spaces, these are the two most common focal areas for NGO and government interventions on behalf of biological values. NGOs focused on protected areas tend to follow a fortress conservation model, protecting resources with a focus on those found in PAs. Recently, however, they are also incorporating local communities surrounding these PAs quite centrally into programming (see, for example, the suite of community development projects pursued by NGOs in the vicinity of Volcanoes National Park). Agricultural and agrobiodiversity initiatives are much more diverse, ranging from the government’s potentially problematic focus on intensification to local and community-based groups working on implementing conservation agriculture principles and practice (for example, [APEFA Rwanda](#) and others, and as analyzed in Murindangabo et al., 2021).

IV. Country policy and planning landscape for biodiversity & infrastructure

National and international commitments to conserve biodiversity

Rwanda has ratified a large number of policy instruments, both at the national and international levels, to address the management and regulation of environmental resources. Tables 4 and 5 highlight some of the most important conventions, laws, and instruments for this purpose. For a more in-depth compendium of relevant MEAs, policies, laws, and ministerial orders, see the State of the Environment and Outlook Report 2021 (REMA, 2021).

Table 4. Selection of Relevant International Commitments.

Convention/Instrument	Main Purpose
Convention on Biological Diversity (CBD)	To conserve species, genetic, and ecosystem diversity
Convention on International Trade in Endangered Species (CITES)	To control trade in endangered species of plants and animals
United Nations Framework Convention on Climate Change (UNFCCC)	To monitor and reduce greenhouse gas emissions
African Convention on the Conservation of Nature and Natural Resources	To ensure the protection and development of natural resources for the good of the population
Convention on the Conservation of Migratory Species of Wild Animals	To promote multi-party consideration and conservation of migratory species
Ramsar Convention of Wetlands of International	To designate and protect wetlands of

Importance Especially as Waterfowl Habitat	international importance
UNESCO Convention	To protect the world’s great cultural and natural heritage
Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa	To establish the Central African Forests Commission (COMIFAC) to conserve and develop these forest ecosystems.

Table 5. Selection of Relevant National Policies.

Policy/Instrument	Year
Constitution of the Republic of Rwanda	2003, amended 2015
National Environment and Climate Change Policy	2019
Rwanda Biodiversity Policy	2011
Rwanda Wildlife Policy	2013
National Forest Policy 2013, Revised National Forest Policy	2018
National Policy and Strategy for Water Supply and Sanitation Services	2010

Relevant Rwandan laws and decrees surrounding biodiversity and infrastructure safeguards

In Rwanda, there is an array of environmental policy and legislation aimed at protecting natural systems and biodiversity, ensuring sustainable use, and reducing the negative impacts of development, i.e., the Biodiversity Policy, Wildlife Policy, Revised National Forest Policy, and more. These policies are further bolstered by a host of related individual laws and ministerial orders (REMA, 2021). As demonstrated in the previous section, Rwanda is unlike many other contexts, in that there is very little in the way of naturally vegetated “wild” land. Because the land-use matrix is largely composed of heterogeneous small-holdings, the most important interventions for the protection of biological diversity are in protected areas, supporting smallholders to maintain agrobiodiversity and the correlated ecological connectivity, and reducing the environmental impacts of development.

Protected areas in Rwanda enjoy strict legal protections and support from the government. This can be seen in policies forbidding development and extractive activities, while attempting to support the surrounding communities. They often employ collaborative initiatives integrating local needs into conservation, as evidenced by the compensation scheme for crop-raiding events surrounding Nyungwe National Park, for example. This program aims to compensate local villagers for their losses to deter the killing of animals and illegal extraction during and after such events. However, the outcomes of such programs are often mixed, leaving local communities feeling unsatisfied (Gloriose, 2019) or highlighting the importance of including NGOs in such mechanisms (Bernhard et al., 2021). Illegal artisanal mining has occurred in protected areas, but currently, large-scale development in Rwandan PAs is effectively prohibited.

As in other countries, one of the most practical and evident ways environmental laws are implemented in regard to the development of infrastructure is the EIA process. The Rwanda Environment Management Authority (REMA) defines an EIA as a “systematic, reproducible, and multilevel process of identification, prediction, and analysis of significant environmental impacts of a proposed project or activity and its practical alternatives on the physical, biological, cultural, and socio-economic characteristics of a particular geographic area” (REMA, 2006). Further verbiage in Ministerial Order No. 04, from 2008, explicitly includes the construction and repair of international and national roads, large bridges, electrical lines, and mines as projects requiring EIA processes. First managed under REMA, the process was transferred to the authority of the RDB in 2009. This transition has led to mixed outcomes: on the one hand, the EIA process has become quicker through its housing in a development-focused institution; on the other, explained one expert, compliance is no longer as thorough. Following many international standards, the content of EIA policy is familiar: projects, plans, and policies that may impact natural resources must undergo an EIA and receive approval before they can be implemented (see Fig. 5 for details).

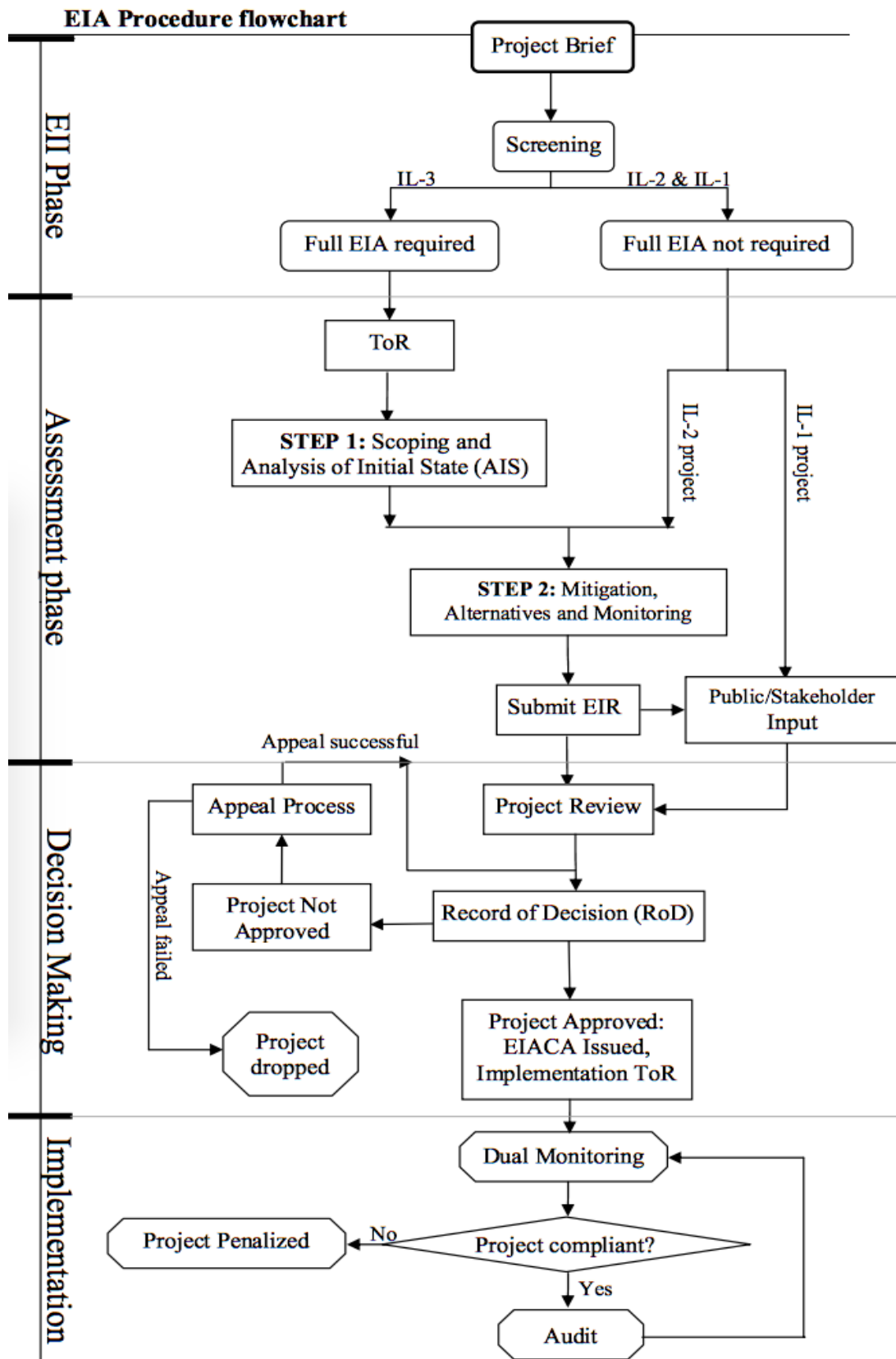


Figure 5. Flowchart of the EIA process in Rwanda (Nkundabose et al., 2020).

Despite the relative strength of governance in Rwanda, there remain challenges with effective EIA implementation. The systemic lack of capacity building in the structure of the EIA system is one recognized issue (Munyazikwiye, 2011). This absence of capacity building has been amplified, and capacity is perhaps the largest current barrier. Additionally, there is a need to institutionalize environmental units and officers in specific industries in the face of poor institutional coordination and generally low capacity to implement EIA (Harelimana et al., 2020).

As in other contexts, the majority of problems arise not in the letter of the law, but in implementation. According to a key informant familiar with the process, the legislative and policy mandates are clear and comprehensive, it is the institutional capacity from which the biggest shortcomings arise. In this interviewee's opinion, one had to look no further than REMA's personnel for evidence, where staff often lack expertise and are consistently understaffed, and where resources are limited, leading to insufficient and inappropriate assessments and monitoring. Harelimana et al. (2020), provide an in-depth analysis of the shortcomings of the system in relation to three vital Rwandan industries and highlight specific capacity deficiencies. A final key issue is that the EIA process lacks explicit consideration of biodiversity concerns, for example, the 2006 guidelines (REMA, 2006) do not explicitly mention biodiversity; an even more impactful gap considering the capacity needs of the country.

Formal spaces for coordination are generally included in EIA processes, but specific conditions and processes are lacking. One expert noted that the REMA should be responsible for the facilitation of such spaces for large infrastructure projects, but in practice, it is very inconsistent; with certain funders, (such as the World Bank) these spaces are often funded and facilitated, but in other cases they are absent. At the district level³, Joint Action Development Forums (JADFs) - multi-stakeholder platforms for sustainable socio-economic development - are generally effective at facilitating inclusive spaces for participatory decision-making processes, according to one expert. JADFs, however, usually focus on district or sub-level development projects, as opposed to large, central government and foreign-financed projects. This could be a space where coordination from the international and national scales is brought down to more local levels.

³ In Rwanda, governmental administrative structure is split into central (federal), provinces (four provinces and Kigali city), districts, sectors, cells, and villages.

Box 1 Spotlight: Infrastructure, Biodiversity, and Critical Mineral Reserves

For decades now, illegal artisanal and small-scale mining incursions have plagued Rwanda's protected areas. However, unlike recent proposals on the DRC side of the Virunga landscape, these incursions have remained a local problem, and have not been driven by big business or government development offices. They have involved informal sites and pathways, as opposed to large infrastructure to facilitate the movement of mass quantities of ore. With the global transition to renewable energy and the ensuing explosion in demand for critical mineral reserves, the question becomes, how likely is it to remain this way? And if these mineral reserves are to be more fervently pursued, what are the threats to Rwandan biodiversity?

Since the turn of the century, increasing the capacity of the mining sector has been a major goal of the Government of Rwanda (GoR), as evidenced in the Vision 2020, Vision 2050, and the National Strategy for Transformation documents. With the hope of creating off-farm jobs, increasing export revenues, and encouraging foreign investment, the GoR views mining as an essential pillar in its attempt to rise out of Low-Income Country status. The “3T’s” of tantalum, tin, and tungsten, which are extracted from cassiterite, coltan, and wolfram respectively, are the country’s focus and are especially vital given their importance in the renewable transition. Figure 6, below demonstrates the 2018 production volumes and distribution by mineral type for each of Rwanda’s districts, highlighting that outside of the northeast and southwest of the country, the mining industry is already widespread and productive. Unfortunately, besides the southwest, ongoing mining production overlaps considerably with CBI cores and thus important biodiversity regions. While maps demonstrating mining sites are available (for instance, Barreto et al., 2018), they do not necessarily provide more concrete information about where the most productive potential veins might be for advanced industrial extraction.

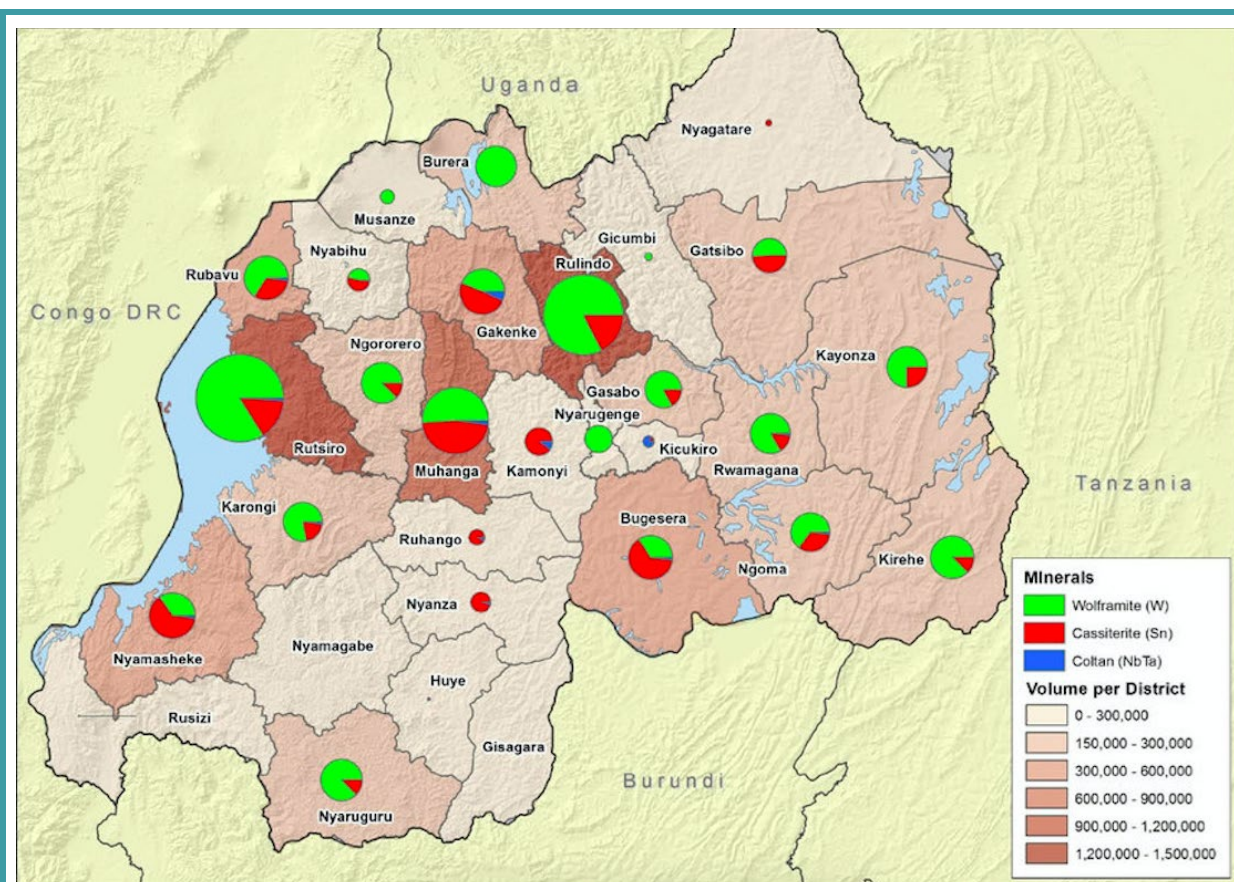


Figure 6: Existing volumes of 3T mineral production by district, as of 2018. Source: Barreto et al., 2018.

Given the overlap between biodiversity values, KBAs, PAs, and productive 3T mineral deposits, the EIA system and sustainable management of these deposits is critical. The Rwanda Mines, Petroleum, and Gas Board (RMB) is the main entity regulating this industry and while recent policy does incorporate environmental concerns (RMB, 2018), there is no specific verbiage about biodiversity or the effects of linear infrastructure. Nguepjoou and Runge (2019) highlight the importance of strengthening law and enforcement of environmental considerations, while the GoR's Natural Capital Accounts for Mineral Resources Flow (NISR & RMB, 2019) highlight numerous recommendations, the most pertinent of which include:

- Building capacity and transparency in EIA processes
- Improve enforcement of rehabilitation and restoration requirements
- Study and internalize the costs of mining externalities.

As has become apparent in the broader analysis, one of Rwanda's largest barriers to effectively incorporating holistic concerns such as biodiversity and local communities into development is the capacity of its institutions. This barrier is clear in the mining sector as well as more general environmental management, EIA, and more. Improving capacity within EIA processes and the mining sector will be of great benefit, both for lessening the impacts of the mining industry, and improving development outcomes more generally. This is especially important in light of the potential rush for critical minerals more broadly and the GoR's commitments to growth and mining development.

V. Understanding stakeholders and power dynamics

Stakeholder Mapping: Key groups across interacting organizations in Rwanda for linear infrastructure and wildlife conservation are detailed below (Fig. 7).

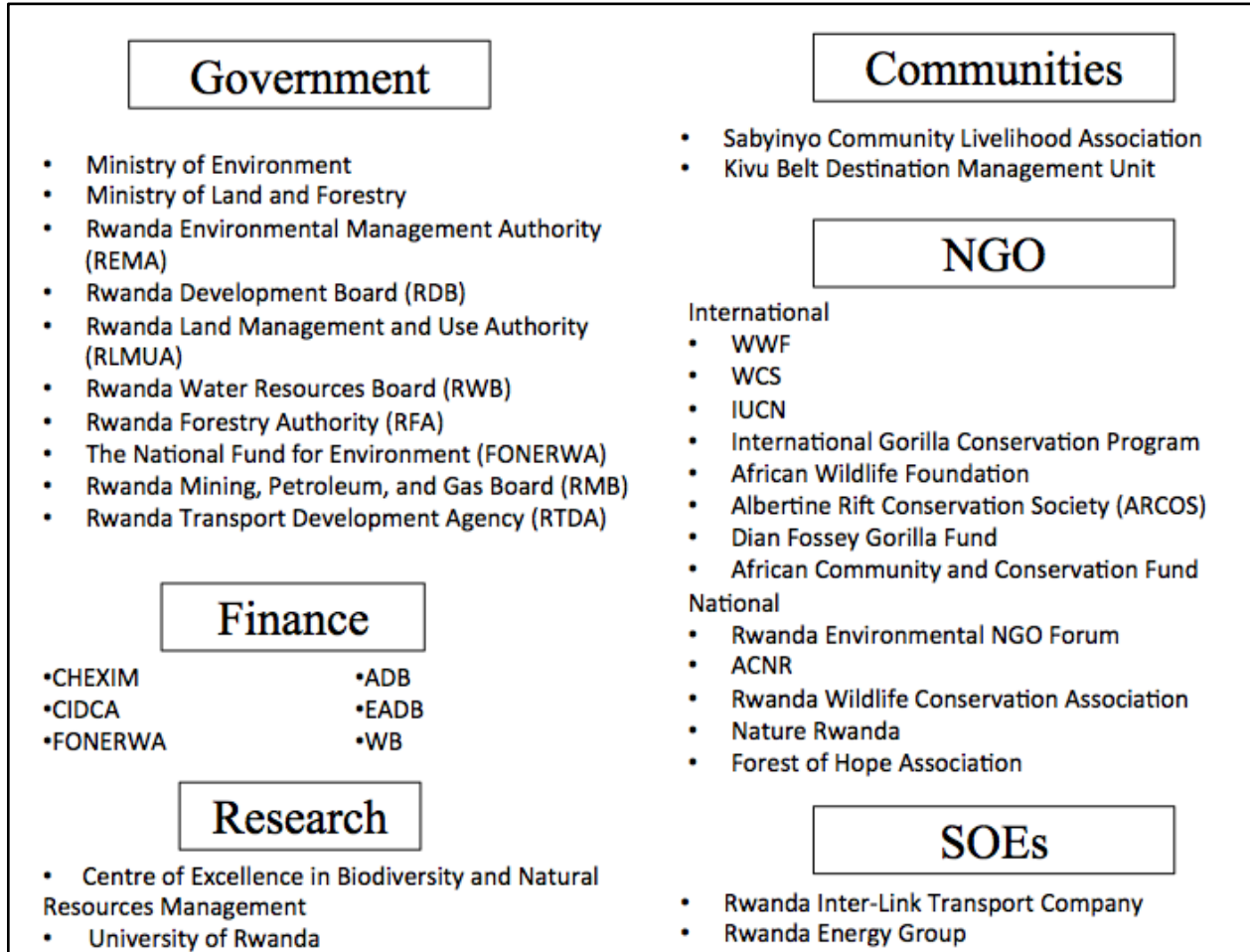


Figure 7. Key stakeholders by group.

Key actors and interests

Civil society, non-governmental and intergovernmental organizations

Avenues of influence

- Public Engagement
 - Education, community work, rallying public support.
- Civil Action (lawsuits)
- Engaging with government
 - Engaging (limited) with EIA process
 - Helping build capacity for government officials/offices
 - Sharing information and expertise with government and each other
- Data creation and distribution
 - Scientific research
 - Information sharing
- Projects to ground

Dynamics:

- Siloed into different areas of concern
 - For instance, development OR environmental – these lines often preclude collaboration and instead foster competition. A development NGO may fight for a new project while an environmental NGO fights against it.
 - Not yet integrated through collaboration or knowledge of the interconnectedness of systems.

Government

Avenues of Influence

- Institutional purview
 -
- Legislation
 - Existing law - EIA process, legislation, etc.
 - New legislation
- Guidelines
 - Guidelines for biodiversity protection, biodiversity inclusive EIA, and more

Dynamics

- Strong governance capacity and low levels of corruption mean the government is a trusted stakeholder across stakeholder groups.
- Relatively forward-thinking, the government is a vital partner.
- Capacity is limited across the government, in part due to the size of the nation, so resource allocation, staff, and expertise are often insufficient (see page 19, BIOFIN, 2017).
- Lack of effective ministerial interchange of important information - siloed institutions.
- No specific Biodiversity Institution

Private sector

Avenues of Influence

- Project Development and financing

Dynamics

- Relatively low levels of large LI project investment could change rapidly depending on shifting critical mineral dynamics and potential richness of deposits.

VI. Recommendations

The case of Rwanda represents a stark contrast to many other nations hosting BRI investment in large LI projects. A smaller nation, both in terms of area and population, the scale of investment is much smaller, governance tends to be more effective, and there are no endless pools of exploitable natural resources to “unlock”. Therefore, Chinese investment in LI to present has been limited, appearing to facilitate relations more than generating vast sectoral inroads and investments. However, mining potential may be changing this dynamic — see previous “Spotlight” section.

Financing

1. Establishing a biodiversity facility within FONERWA.
 - a. FONERWA is Rwanda’s environment and climate change investment fund, providing funding to address these issues across three main mechanisms: grants (for public institutions and NGOs), innovation grants (for private entities, 20% match required), and credit lines. Since its inception in 2012, the fund has mobilized over 64 billion RWF. Supporting a dedicated biodiversity facility would allow for strategic, targeted investments and support integrating biodiversity into development and management across the nation.
2. Ensuring capacity needs are addressed and explicitly included in funding
 - a. According to one expert, certain western financial institutions are much more consistent in ensuring that projects include allocations for capacity building such as hirings, trainings, workshops, and more. If this were to become standard across the nation, large foreign investments would be able to be more effectively assessed, monitored, and managed.

Coordination Spaces

1. Mandating and funding REMA to pursue high-level coordination on large infrastructure projects.
 - a. As there is currently no centralized biodiversity institution, REMA is the best option to facilitate high-level coordination between ministries, developers, financiers, NGOs, and other stakeholders for large LI projects. This opportunity was highlighted by one expert, to address the inconsistent way in which REMA coordinates and the siloed nature of institutions.
2. Coordination spaces for NGOs
 - a. Another expert detailed how for large development projects, even the NGO community is often siloed; with development NGOs supporting projects, and environmental groups opposing them. This has created division, a lack of understanding of the interconnections between these issues, and a fracturing of the NGO voice to effectively influence development such that it is good for people and the environment. Creating

and funding collaborative spaces for the NGO community to develop shared understandings, create relationships, and work together on relevant initiatives could have a large impact.

Community Work

1. JADFs are acknowledged by one expert to be a great example of inclusive, collaborative development at the district level of government. A great step could be to support JADFs and community organizations to engage with large-scale development projects, i.e. attending public EIA hearings, working with REMA and ministries on projects in their area, and influencing these projects to include their needs.

Agroecology

1. Research into the state and conservation of biodiversity in heterogeneous human-influenced agricultural landscapes is especially important in the Rwandan context. Furthering this area of knowledge will have large implications informing development, not just of LI, across this densely populated country.

EIA Processes

1. Mainstreaming Biodiversity into EIA processes. Especially given the lack of expertise in Rwandan environmental impact assessment processes, there is a clear need for the explicit inclusion of biodiversity into guidelines and processes. One clear way this can be achieved is through a re-issue of the EIA Guidelines from 2006 to include clear and actionable directives to these managers.
 - a. Biodiversity inclusive EIA guidelines. In May of 2021, Rwanda issued a [request for proposals](#) to do exactly this. The current status of the project does not appear to be publicly available. There may be room to facilitate and support this process, ensuring an effective product is produced and distributed to those who need it most.
2. Building capacity for EIA
 - a. Providing training, tools, and investments to the professionals involved in EIA processes in Rwanda could help boost limited capacity and ensure a more effective process. There are already civil society groups to plug directly into, for example, the Rwanda Association of Professional Environment Practitioners. Some acknowledged needs include trainings related to implementation, annual environmental audits, and monitoring.
 - b. Several scholars (Harlimana et al., 2020) highlight the need for the establishment of discrete units or teams, that would be responsible for administering EIA within just one or two select industries. This would allow teams to build expertise in specific industry impacts and processes.
3. Providing explicit standards for public inclusion into EIA
 - a. In the EIA Guidelines (REMA, 2006), public hearings are described as including the relevant ministries, industries, environmental professionals, NGOs, the developer, local communities, and local government. But there are no directives or requirements ensuring that the space is actually inclusive, well-advertised, and fairly facilitated such that all voices are heard.

References

- Africa Museum. 2022. *Critical Minerals in the Great Lakes Region of Central Africa*.
https://www.africamuseum.be/en/research/news/critical_minerals
- Arakwiye, B., Rogan, J., & Eastman, J. R. 2021. Thirty years of forest-cover change in Western Rwanda during periods of wars and environmental policy shifts. *Regional Environmental Change*, 21(2), 27. <https://doi.org/10.1007/s10113-020-01744-0>
- Barreto, M. L., Schein, P., Hinton, J., & Hruschka, F. 2018. *Economic Contributions of Artisanal and Small-Scale Mining in Rwanda: Tin, Tantalum, and Tungsten*. EARF, DFID, and Pact.
https://www.responsiblemines.org/wp-content/uploads/2018/03/Rwanda_case_study.pdf
- Bernhard, K. P., Smith, T. E. L., Sabuhoro, E., Nyandwi, E., & Munanura, I. E. 2021. Effects of integrated conservation–development projects on unauthorized resource use in Volcanoes National Park, Rwanda: A mixed-methods spatio-temporal approach. *Oryx*, 55(4), 613–624.
<https://doi.org/10.1017/S0030605319000735>
- BIOFIN. 2017. *Biodiversity Finance Policy and Institutional Review*. Rwanda Biodiversity Finance Initiative.
- Cassimon, D., Essers, D., & Verbeke, K. 2015. *What to do after the clean slate? Post-relief public debt sustainability and management* (ACROPOLIS-BeFinD Working Paper No.3).
- Cassimon, D., Essers, D., & Verbeke, K. 2016. *The Changing Face of Rwanda’s Public Debt* (Working Paper No. 14). Belgian Policy Research Group on Financing for Development.
- China Africa Research Initiative, & Boston University Global Development Policy Center. 2021. *Chinese Loans to Africa Database, Version 2.0*. chinaafricaloandata.bu.edu/
- Custer, S., Dreher, A., Elston, T. B., Fuchs, A., Ghose, S., Lin, J., Malik, A., Parks, B. C., Russell, B., Solomon, K., Strange, A., Tierney, M. J., Walsh, K., Zaleski, L., and Zhang, S. 2021. *Tracking Chinese Development Finance: An Application of AidData’s TUFF 2.0 Methodology*. Williamsburg VA: AidData at William & Mary. From Dreher, A., Fuchs, A., Parks, B. C., Strange, A., and Tierney, M. J. (Forthcoming) *Banking on Beijing: The Aims and Impacts of China’s Overseas Development Program*. Cambridge, UK: Cambridge University Press.
- Gloriose, U. 2019. Community Perceptions of Human-wildlife Conflicts and the Compensation Scheme Around Nyungwe National Park (Rwanda). *International Journal of Natural Resource Ecology and Management*, 4(6), 188. <https://doi.org/10.11648/j.ijnrem.20190406.15>
- Granjon, A. C., Robbins, M. M., Arinaitwe, J., Cranfield, M. R., Eckardt, W., Mburanumwe, I., Musana, A., Robbins, A. M., Roy, J., Sollmann, R., Vigilant, L., & Hickey, J. R. 2020. Estimating abundance and growth rates in a wild mountain gorilla population. *Animal Conservation*, 23(4), 455–465.
<https://doi.org/10.1111/acv.12559>
- Harelimana, V., Gao, Z. J., Nyirantezirayayo, E., & Nwankwegu, A. S. 2020. Identification of weaknesses in the implementation of environmental impact assessment regulations in industrial sector: A case study of some industries in Rwanda, Africa. *Journal of Cleaner Production*, 258, 120677.
<https://doi.org/10.1016/j.jclepro.2020.120677>
- Harrison, S., & Ryan, C. 2021. *The Farmland Biodiversity Score for consistent monitoring of biodiversity based on the measurement of trees on farms*. World Agroforestry.
<https://doi.org/10.5716/WP21038.PDF>
- ITA. 2021. *Rwanda—Country Commercial Guide*. International Trade Administration.
<https://www.trade.gov/country-commercial-guides/rwanda-mining-and-minerals>
- IUCN Eastern and Southern Africa Regional Office. 2020. *The state of protected and conserved areas in Eastern and Southern Africa*. IUCN, International Union for Conservation of Nature.
<https://doi.org/10.2305/IUCN.CH.2020.15.en>
- Kim, S. K., Marshall, F., & Dawson, N. M. 2022. Revisiting Rwanda’s agricultural intensification policy:

- Benefits of embracing farmer heterogeneity and crop-livestock integration strategies. *Food Security*. <https://doi.org/10.1007/s12571-021-01241-0>
- Kinch, D. 2020. East Africa, led by Rwanda, is “frontier” for technology metals: Mine developers. *S&P Global Commodity Insights*. <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/080720-feature-east-africa-led-by-rwanda-is-frontier-for-technology-metals-mine-developers>
- Muhire, I., Manirakiza, V., Nsanganwimana, F., Nyiratuza, M., Inzirayineza, T. A., & Uworwabayeho, A. 2021. The environmental impacts of mining on Gishwati Protected Reserve in Rwanda. *Environmental Monitoring and Assessment*, 193(9), 600. <https://doi.org/10.1007/s10661-021-09372-9>
- Munyazikwiye, F. 2011. *An assessment of Environmental Impact Assessment (EIA) procedures and challenges faced by environmental officers in EIA implementation in Rwanda* [MSc, University of KwaZulu-Natal]. <https://researchspace.ukzn.ac.za/xmlui/handle/10413/5363?show=full>
- Murindangabo, Y. T., Kopecký, M., & Konvalina, P. 2021. Adoption of Conservation Agriculture in Rwanda: A Case Study of Gicumbi District Region. *Agronomy*, 11(9), 1732. <https://doi.org/10.3390/agronomy11091732>
- NISR, & RMB. 2019. *Natural Capital Accounts for Mineral Resource flows, Version 1.0*. [WAVES Natural Capital Accounts].
- Nkundabose, J. P., Ingabire, T., Nshimiyimana, E., Niyotwizera, J. J. Y., & Twagirayezu, G. (2020). Analysis of Current Environmental Impact Assessment System in Rwanda. *Energy and Environmental Engineering*, 7(3), 51–61. <https://doi.org/10.13189/eee.2020.070301>
- P. Udawatta, R., Rankoth, L., & Jose, S. 2019. Agroforestry and Biodiversity. *Sustainability*, 11(10), 2879. <https://doi.org/10.3390/su11102879>
- REMA. 2006. *General Guidelines and Procedure for Environmental Impact Assessment*.
- REMA. 2019. *Rwanda Forest Cover Mapping* [Forest Cover Report]. Rwanda Environmental Management Authority.
- REMA. 2021. *State of the Environment and Outlook Report 2021*. Rwanda Environmental Management Authority.
- RMB. 2018. *N° 58/2018 of 13/08/2018—Law on Mining and Quarry Operations*. https://rmb.gov.rw/fileadmin/user_upload/MINING__QUARRY_OPERATIONS_LAW.pdf
- RoR. 2020. *Rwanda 6th National Report to the Convention on Biological Diversity*. Republic of Rwanda. <https://www.cbd.int/doc/nr/nr-06/rw-nr-06-en.pdf>
- Thrupp, L. A. 2000. Linking Agricultural Biodiversity and Food Security: The Valuable Role of Sustainable Agriculture. *International Affairs (Royal Institute of International Affairs 1944-)*, 76(2,), 265–281.
- Transparency International. 2021. *Corruption Perceptions Index*. <https://www.transparency.org/en/cpi/2021>
- World Bank. 2022. *World Bank Open Data Portal*. <https://data.worldbank.org/>

Appendix A: Methodology

The complexity of LI project development and safeguarding means that understanding local and regional cultural, political, historical, and environmental conditions is essential. The FOCUS BRI research process was developed to ensure consultation with the experts in their fields and locations, who also either constitute or represent overlooked or marginalized perspectives. To this end, the project relied on key informant interviews, focus groups, and the field expertise of its team members. Below, we detail our methodology across two key contributions of FOCUS BRI:

1. Country Case Studies

A. Country Selection

Country selection played an important role in defining project bounds and ensuring that goals may be effectively and efficiently met. Countries without involvement with the BRI (as evidenced by an MoU) were removed from our list, leaving 140 countries (as of September 2021). Next, we decided to focus our efforts in Africa and Asia, which represent the majority of BRI investment. Additionally, CLLC maintains a widespread professional network, decades of combined experience, and ongoing programmatic work in these regions. To further narrow the list, a dataset of indicators was built around the key selection criteria, including:

1. Level of Chinese investment
2. Biodiversity
3. Existing network and stakeholder connections
4. Climate vulnerability

With different metrics populated for each category and remaining country, we developed a function to combine and rank countries, which resulted in a prioritized list. We then selected twelve countries from the top 30, with an eye toward a diverse and representative suite of country case studies.

B. Case Study Development

The twelve country cases were developed through two main methods: a desk-based research process and key informant interviews. We opted to conduct in-depth reviews of relevant secondary data prior to carrying out interviews. In this way, researchers became familiar with the country context, the relevant bodies of work, and potential interviewees who are actively involved in work related to either environmental or biodiversity conservation or infrastructure development. This process consisted of a secondary literature review guided by a research template, to ensure consistency and efficiency across the country cases. The literature review captured relevant academic work and gray literature pertaining to biodiversity issues, Chinese infrastructure development and relations, and national policy and implementation landscapes for biodiversity protection and LI project development. The following briefly summarizes the report sections:

1. **Introduction** - including country context, relations with China, and broader transboundary issues.
2. **Linear infrastructure investment landscape** - including statistics, projects, type of projects, and agencies involved.
3. **Biodiversity landscape** - describing the biodiversity characteristics and hotspots, national conservation spaces and policy frameworks, and the key work focused on conserving biodiversity. Agrobiodiversity considerations were also noted where relevant.

4. **Country policy and planning landscape for biodiversity and infrastructure** - the national environmental and biodiversity laws and regulations, ESIA processes, actors in charge and their role, and especially the way these pieces play out in the context of large LI projects.
5. **Exemplary projects** - describing illustrative projects, whether successes or failures, to add texture to the above information.
6. **Understanding stakeholders and power dynamics** - highlighting the network of stakeholders and the degree and ways in which these stakeholders can influence processes.
7. **Recommendations** - gathered from research and interviews; what interventions and investments can best improve LI development outcomes for biodiversity, local communities, and climate, and how might they proceed.

Following the secondary literature review, interviews were organized and conducted by the country research lead. To connect with interviewees, leads contacted existing CLLC connections in the country, relied on personal networks, and reached out to voices identified as especially relevant in these fields in-country. Interviewees thus consisted of actors from the academy, non-governmental organizations, government, the private sector, or communities. We aimed to gather 3-5 key informant interviews to ground the research, add texture to the information, fill gaps and connect to resources, and share their expert opinions on barriers, opportunities, and more.

Interviews followed a semi-structured template, tailored to the informational needs of the specific report and interviewee. The main sections of the interviews were:

1. Introduction to the FOCUS project, interview, and purpose.
2. The current country “landscape” of implementation processes, actors, and resources.
3. Understanding the formal and informal spaces for coordination and inclusion of diverse stakeholders and interests into these processes.
4. The barriers to safeguard implementation and how to overcome them.
5. Any additional/more specific questions
6. Concluding remarks

Interviews were recorded for ease of transcription and information gathered during interviews was then integrated into reports. Upon the completion of individual country case studies, a process of synthesis was initiated to uncover the trends and common threads found across these twelve countries and within each region (Africa, Central Asia, Southeast Asia). These findings were then incorporated into the summary report.

2. Spatial Context and Mapping

A. Context maps

We used ARCmap 10.8 and R Studio 2021.09.1+372 to develop all maps for this project. The aim of the first set of maps was to provide contextual detail by capturing the intersections between protected areas (PAs) and existing infrastructure in a given country. To visualize the diversity of PA uses within a country, we classified them according to the IUCN categories (Ia, Ib, II, III, IV, V, and VI). These categories are internationally recognized standards that classify PAs according to their management objectives. All PA polygons were acquired from the World Protected Areas layer found on the Protected Planet clipped to country boundaries (Table A). To add existing linear infrastructure (LI) line shapefiles for each LI type (roads, rails, and transmission lines) were clipped to the countries’ borders. These layers were overlaid

with the PAs to highlight the intersection of LI and PAs. The Global Roads Open Access Data Set (gROADS) (CIESIN - Columbia University, and ITOS - University of Georgia, 2013), a global road layer for 1980-2010, was used to represent the road network. The railway layer was acquired from the World Food Program's global railway dataset, which was last updated in 2017. For the transmission lines, we used Aderne et al's (2019) dataset, which was last updated in 2019 (Table A). A more updated road layer (up to 2018), the Global Roads Inventory Project (GRIP) roads dataset was clipped to the country boundary and is represented in a separate map. The higher density of roads in the GRIP dataset often overshadows railways and transmission lines if visualized on the same map with PAs. We include the more recent dataset to highlight that spatial data needs regular updating to reflect continued LI construction and that our maps offer problem setting context but underrepresent the extent of LI interacting with wildlife habitat.

B. Composite Biodiversity Index and cores

We created a Composite Biodiversity Index (CBI) to identify regions of high biodiversity. To develop a CBI layer for each country, we applied a method created by Dr. Tyler Creech for the Center for Large Landscape Conservation. Dr. Creech created the CBI based on nine existing biodiversity indices related to species richness, endemism, abundance, intactness, ecological condition, rarity, and complementarity. The value of CBI ranges from 0 (lowest biodiversity value) to 1 (highest biodiversity value). We selected three percentile cut-offs from the CBI layer, representing biodiversity richness areas by the 70th, 80th, and 90th percentile, which we refer to as biodiversity cores. For more details of the CBI methodology, see the LISA project spatial annex⁴. The amount of overlap between PAs and CBI is of importance to spatial planning for LI as not all CBI areas have formal protection but provide for connected wild populations. To demonstrate this point, we overlay PAs from IUCN Categories Ia, Ib, and II, (i.e., areas with higher protection regulations and supported by country environmental and biodiversity laws), Key Biodiversity Areas (KBAs) - which enjoy wide acknowledgment as important for long-term conservation of wildlife though are not always formally protected, - and CBI. We acquired KBAs from Birdlife International (updated 2021) and clipped them to the respective country's boundaries. We then overlaid the resulting PAs and KBAs over the CBI layer to highlight protection provided to important biodiversity areas.

Finally, to identify where Chinese-funded projects intersect with PAs and top percentile CBI cores, we looked to Chinese-funded LI in the AidData dataset within each country. AidData captures projects with development, commercial, or representational intent that are supported by official financial and in-kind commitments (or pledges) from China between 2000 and 2017, with implementation details covering a 22-year period (2000-2021) (Table A). Given the inconsistent sharing of data, dearth of publicly available geospatial information for LI projects, and many disparate institutions involved, AidData's list is one of the most comprehensive and publicly available to date. We filtered results to include only roads, rails, and transmission projects. The layer for Chinese-backed LI was overlaid with PAs, KBAs, and the three percentile cores, summarizing the impact of such LI on biodiversity-rich regions and the incidences of

⁴ USAID ((U.S. Agency for International Development). 2021. Annex 1: Spatial analyses of linear infrastructure threats to biodiversity in Asia. *In: Building a foundation for linear infrastructure safeguards in Asia*. Authors: Creech T, Stonecipher G, Bell M, Clevenger AP, Ament R. Prepared by Perez, APC for Contract no. AID-OAA-I-15-00051/AIDOAA-TO-16-00028, ESS WA#13. U.S. Agency for International Development, Washington, DC. 98 pp.

Chinese LI impinging on PAs.

C. Summary statistics from our analyses (Appendix B)

We converted CBI cores for each percentile (70th, 80th, and 90th) to polygons, then calculated the area of each polygon using the ‘Calculate Geometry’ tool in Arcmap. Each of the cores was clipped to the category I and II PA boundaries, resulting in layers representing the overlap of each core with PAs. The area of the overlap layers was similarly calculated using the ‘Calculate Geometry’ tool. We then determined the percentage of the PA overlap area with the total core area. We then clipped AidData’s LI layer to each country boundary. The length of each of the line attributes within the clipped layer was calculated using the ‘Calculate Geometry’ tool. The linear length of each LI type (roads, rails, and transmission lines) was calculated using the ‘summary statistics’ function. We repeated this process for each of the percentile cores by clipping the LI to each core boundary in the first step. Finally, the Chinese LI layer was also clipped using the PA (Category I and II) polygons. The length of each of the line attributes within the clipped layer was calculated using the ‘Calculate Geometry’ tool. The length of each of the LI type (roads, rails, and transmission lines) was calculated using the ‘summary statistics’ function.

Table A. Datasets used to visualize protected areas and linear infrastructure in each of the 12 countries chosen for FOCUS-BRI

Dataset	Year Last Updated	Geographic Scale	Dataset Format	Source	Data Download link
World Protected Areas (WDPA)	2021	Global (separated by continents)	Vector polygon shapefile	UNEP-WCMC and IUCN (2021)	Explore the World's Protected Areas (protectedplanet.net)
gROADS	2010 (1980-2010)	Global	Vector lines shapefile	CIESIN - Columbia University, and ITOS - University of Georgia(2013)	https://www.globio.info/download-grip-dataset
GRIP Road Data	2018	Global	Vector lines shapefile	Meijer et al. (2018)	https://sedac.ciesin.columbia.edu/data/set/groads-global-roads-open-access-v1

Global Transmission Lines	2019	Global	Vector lines shapefile	Arderne, Christopher, Nicolas, Claire, Zorn, Conrad, & Koks, Elco E. (2019). Data from: Predictive mapping of the global power system using open data [Data set]. In Nature Scientific Data (1.1.0, Vol. 7, Number Article 19). Zenodo. https://doi.org/10.5281/zenodo.3538890	Data from: Predictive mapping of the global power system using open data Zenodo
Global Railway	2017	Global	Vector lines shapefile	World Food Program/ Humdata	https://data.humdata.org/dataset/global-railways
Key biodiversity areas - KBA	2021	Global	Vector polygon shapefile	BirdLife International (2021)	Key Biodiversity Areas GIS Data Request
Chinese development projects	2021	Global	Vector polygon shapefiles	Custer et al., 2021 - AidData	https://github.com/aiddata/china-osm-geodata

Limitations

This project was exploratory and survey-oriented in nature. It is intended to be a first step that sketches the biodiversity, infrastructural, and local policy landscapes in each country. As such, it was also intended to raise important and possibly overlooked questions and issues for funders to direct their money. Given the scale and scope of this project, there were several limitations. First, it would be practically impossible to detail the complete policy landscape of each country, as they are both vast and constantly evolving over time. Second, we used spatial data to set the context for this project. Due to data limitations, our maps are likely very conservative. They do not include spatial data for planned LI, nor the expansion of existing LI. Instead, we highlighted only existing LI to showcase how biodiversity is currently impacted. Finally, due to the exploratory nature of this project, we gathered information to address particular foci in our reports and, thus, our methods did not lead to a comprehensive review.

Appendix B: Spatial Data Tables

The following table provides summary information from the spatial analysis:

PAs (IUCN categories I and II) and CBI cores overlap

Rwanda	70th Percentile Core	80th Percentile Core	90th Percentile Core
CBI Core Area (km ²)	7542	5028	2309
Overlap with Protected Areas (km ²)	894.519	633.366	0.22185
Percentage of CBI Core within PAs (%)	11.8605	12.5968	0.009608