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# EVALUATION OF THE EFFECTS OF AFRICAN CONTINENTAL FREE TRADE AREA (AFCFTA) ON AFRICA'S BIODIVERSITY

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# EVALUATION OF THE EFFECTS OF AFRICAN CONTINENTAL FREE TRADE AREA (AFCFTA) ON AFRICA'S BIODIVERSITY

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## Abstract

Free Trade Agreements (FTAs), such as the African Continental Free Trade Area (AfCFTA), can significantly influence biodiversity conservation based on their design and implementation. While AfCFTA may encourage countries to strengthen environmental regulations in line with international agreements like the Convention on Biological Diversity (CBD) and CITES, there are concerns that economic goals might overshadow ecological considerations. This could lead to industrial growth in agriculture and mining, risking deforestation, soil erosion, and water pollution. Using a combination of qualitative and quantitative methods, this study employs the Energy-Environment Integrated CGE (EEICGE) Model to analyze AfCFTA's impacts on Africa's biodiversity. Simulation results for Nigeria indicate a rise in fossil fuel demand and carbon emissions. Stakeholder insights reveal that increased trade may drive intensified land use, contributing to deforestation and biodiversity loss. The study underscores that the impact of AfCFTA on biodiversity is contingent on specific provisions, enforcement capacities, and implementation contexts. To ensure FTAs support sustainable development, strategic measures are vital, including robust environmental regulation enforcement, local community engagement, and investment in renewable energy to meet rising energy needs while adhering to global commitments like the Paris Agreement.

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## 1. Introduction

The creation of the African Continental Free Trade Area (AfCFTA) presents opportunities for furthering intra-African trade and promoting sustainable development. Conversely, an increase in opportunities for intra-African trade also pose a threat to the continent's biodiversity and conservation. With significant reductions in trade tariffs, there will be increasing human pressures on ecosystems and biodiversity, impacting those in vulnerable areas hosting endangered species, tropical forests, and important wildlife. Although the AfCFTA is poised to promote wealth creation, employment, and welfare, when critically examined in terms of environmental and social impacts, there are potential threats and benefits to the conservation and sustainable use of biodiversity.

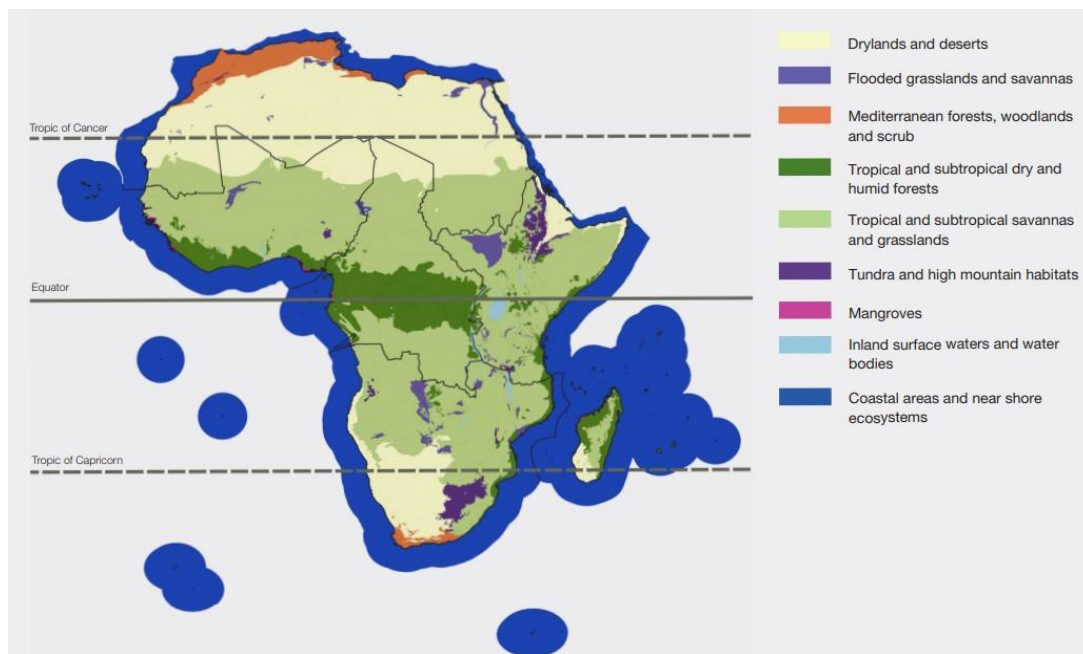
Given this premise, the broad objective of this study is to analyse the potential impact of the AfCFTA on the promotion of biodiversity conservation and sustainable use in Africa, with a specific focus on Nigeria. Specifically, this study estimates the potential impact of the AfCFTA on biodiversity through changes in the scale of production (i.e. growth of productive activity) and through technological, structural (i.e. changes in patterns of economic activity), and product-related impacts.

The study uses mixed research methods involving both qualitative and quantitative approaches. The quantitative analysis involves computable general equilibrium (CGE) modelling commonly used in quantifying the foreseen impacts of trade liberalisation. The qualitative analysis involves an expert in-depth assessment, to better assess some variables that the applied CGE model could not measure due to the non-availability of data. Results of our analysis reveal some of the key anticipated causal links between trade liberalisation and biodiversity on the African continent and provide insights into how the AfCFTA can support and promote the conservation and sustainable use of biodiversity in Africa.

## 1.1. Background: the role and importance of biodiversity in Africa

According to the Convention on Biological Diversity, biological diversity means “the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems” (Comway 1998).

The African continent is host to a fifth of the world’s known species of mammals, birds, and plants, which reflects the richness of the continent’s ecosystem services. Africa’s floral diversity comprises more than 62,000 plant species distributed across different sub-regions of the continent. Tropical Africa, for example, has around 30,000 species, the islands of the Indian Ocean, like Madagascar and Zanzibar, have more than 10,000 species, 80% of which are endemic, while in North Africa, more than 7,000 species remain despite large depletion (Sosef *et al.*, 2017; Takoueu 2021). Africa is also especially rich in charismatic fauna such as elephants, lions, monkeys, rhinoceroses, gazelles, and many others. Also abundant in Africa are about 100,000 species of insects, and 2,600 species of birds (Takoueu 2021). In addition, Africa’s ecological systems are very diverse, consisting tropical forests, savannahs, montane grasslands, mangroves, deserts, and wetlands, as shown in Figure 1.



**Figure 1: Ecosystems in Africa**

Source: IPBES (2018) The regional assessment report on biodiversity and ecosystem services for Africa.

As part of the Sustainable Development Goals (SDG), Goal 15 aims to protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss. In other words, SDG 15 aims to sustain and promote conservation and sustainable use of biodiversity. The target advocates for sustainable management of forests and actions towards combating desertification, and reversing land degradation. The goal is expected to contribute to actions geared toward curtailing biodiversity loss.

As a result of the inclusion of biodiversity in the SDGs, there is also increasing awareness about the negative social and economic impacts associated with the loss of biodiversity and well-functioning ecosystems, including the costs of inaction. Nevertheless, pressures underpinning the loss persist. There are growing concerns about the loss and degradation of biodiversity – including both species, habitats, ecosystems, and the benefits they provide – arising from population growth, infrastructural development, increased agricultural practices, illicit wildlife trafficking, and unregulated urban development.

It is estimated that without concrete efforts to reverse biodiversity loss, Africa is projected to experience an economic loss of about 9.7 percent of the GDP annually by 2030 (World Bank, 2022). More than half of food crops are supported by animal pollination, which reduces biodiversity loss. Also, land degradation affects food security, with low soil quality contributing to diminished yields and previously used land for cultivation being converted into housing and dwelling places. Furthermore, the continued dry-up of water bodies directly affects the livelihood of households whose income is generated from the activities supported by rivers, such as fishing. Further, the economic effect of ecosystem degradation and biodiversity loss is higher in rural areas than in urban areas in Africa. In rural areas, about 60 percent of the rural dwellers depend on ecosystem services for food, water, energy, health, and livelihood, and this is much lower in urban areas (IPBES, 2016). Compared to other continents of the world, rural areas in Africa are the most dependent on nature and its services to survive (IPBES, 2016).

Sustainable tourism is central to policies supporting economic prosperity across African countries. It serves as a key means to incentivize biodiversity conservation and sustainable use. Africa's conservation areas attracted about 70 million local and foreign in 2015. The revenue generated from these visits was more than US\$ 50 billion (Balmford *et al.*, 2015). Moreover, receipts from wildlife tourism account for 88% of total annual revenues for trips to Africa (UNWTO 2015). Brian O'Donnell/Mehta (2022) states that *"Tourism can be both one of the biggest drivers of biodiversity loss or a vehicle for biodiversity conservation. And it all comes down to the policies in place from governments and the approaches that the tourism operators and the tourists themselves take."* The loss of biodiversity invariably implies a loss of tourism potential.

Additionally, biodiversity loss is a threat to the African traditional healthcare system, scientific discoveries of potential treatments, and the well-being of the people (WHO, 2015). For most rural dwellers in Africa, faced with poorly distributed and non-functional health facilities, traditional medicine often remains the most accessible option (Ojagbemi and Gureje 2020; Mbongo 2021). Medicinal plant use is a key component of the traditional healthcare system in Africa (Ojagbemi and Gureje 2020; Mahomoodally 2013). The continued supply of most traditional medicine depends on the sustainable use and conservation of plant biodiversity.

## 1.2. Background: AfCFTA

Africa contributes less than 3 percent to total world trade but holds about 16.7 percent of the world population (World Bank, 2020). The low contribution of Africa to the world's trade has been attributed to the fragmented nature of the continent's trade structure. Intra-Africa trade is about 15 percent, which is low compared to intra-continental trade of about 46 percent in America, 60 percent in Asia, and 67 percent in Europe (Mold and Chowdhury, 2021).

If successfully implemented, the African Continental Free Trade Area (AfCFTA) agreement is expected to result in an increase in intra-African trade and related increases in economic productivity, foreign direct investments, and improved participation in the global value chains (World Bank, 2020).

In line with the African Union (AU) Agenda 2063 for Africa, which envisions an integrated, prosperous, and peaceful Africa, AfCFTA negotiations were launched in June 2015. The agreement became operational in January 2021 after a series of negotiations and ratification of the agreement by 22 member countries in May 2019 (van der Ven and Signe, 2021; World Bank, 2020).

The commencement of the operation of the AfCFTA in 2021 can be considered a key step towards actualizing the Abuja 1991 Treaty aspiration of unifying the continent of about 1.3 billion persons and \$3.4 trillion gross domestic product economy into a single market (World Bank, 2020; van der Ven and Signe, 2021; UNCTAD, 2021). In the 1991 Abuja Treaty, member States in the Organisation for African Unity (OAU) agreed on the roadmap for creating a common African market. However, it took more than two decades before the African Union (AU) Trade Ministers agreed to the establishment of AfCFTA.

The AfCFTA agreement seeks to create a single market for goods and services produced on the African continent, facilitated by the free movement of people with the intention of deepening the economic integration of member countries and actualizing the Agenda 2063 (World Bank, 2020; UNCTAD, 2021). Consequently, as part of AfCFTA, 90 percent of the intra-African tariffs have been dropped. Non-tariff barriers, such as unnecessary bureaucratic or legal issues and burdensome import/export permit processes, are gradually being addressed (African Union, UNECA, and ATPC 2018; World Bank, 2020; Olapade and Onyekwena, 2021). Before the removal of tariffs, the average tariffs for goods and services stood at 6.1 percent, which contributed to the high trading cost and low intra-African trade (African Union, UNECA, and ATPC, 2018).

The agreement entails two phases of negotiation (World Bank, 2020). While the first phase has been largely completed, the second phase negotiations are also progressing (van der Ven and Signe, 2021). The first phase of negotiation comprised the protocol on trade in goods, the protocol on trade in services, and the protocol on settling the disputes. A recent update by the African Union (2023) shows that the phase one negotiations have advanced significantly. Under the Phase One Protocol on Trade in Goods, for example, State Parties have committed to reducing tariffs on 90% of goods traded among the States in equal annual instalments until they are eliminated within 5 years for Developed Countries and 10 years for Least Developed Countries (LDC). Likewise, for 7% of 'Sensitive' goods, tariffs will be eliminated within 10 years for Developed Countries and 13 years for LDCs. However, 3% of 'Excluded' products are to



retain their tariffs to allow flexibilities for State Parties with particular sensitivities but will be subject to review every five years

The second negotiation phase has started but is yet to be completed. The negotiation in the second phase entails the protocol on competition policy, intellectual property, investment, e-commerce, digital trade, and women and youth. A recent update by the African Union (2023) also shows that the Phase II Protocols on Investment, Competition, and Intellectual Property Rights have been concluded and were approved by the 36th Ordinary Session of the Assembly of Heads of State and Government of the African Union.

Emerging studies exploring the foreseen outcomes of AfCFTA indicate that the implementation of the agreement would increase trade among members, as well as the continent's economic output and trade, and reduce the poverty level (World Bank, 2020; UNECA, 2021). For instance, the World Bank (2020) indicates that the continent's real GDP would increase by 7 percent, translating to an additional income level of \$450 billion by 2035. Similarly, it is expected that the continent's export level would reach \$560 billion and an intra-Africa trade of about 29 percent. The latter is a significant increase compared to the current 16 percent.

The increase in economic output and export flows is expected to be accompanied by a reduction in extreme poverty for 30 million people and 68 million for people that are moderately poor. Further, the World Bank (2020) study indicated that the effective implementation of AfCFTA would increase real wages, especially female wages, thereby narrowing the gender wage gap. Also, the agreement is expected to create millions of jobs for both skilled and unskilled people.

In another study, UNECA (2021) shows that by 2045, intra-African trade would increase by 27 percent to reach 20 percent on the backdrop of the existing global value chain without the existence of AfCFTA from 15 percent as of 2020. However, with the implementation of AfCFTA, the study shows that intra-African trade would increase by 40 percent and the share of intra-African trade in total world trade would increase to 26 percent. Furthermore, the elimination of uncoordinated bureaucratic procedures that have contributed to high trade costs could be drastically reduced by AfCFTA, thereby contributing to an increase in intra-African trade.

Over the next few decades, with the successful completion of all necessary negotiations, the AfCFTA is estimated to be a strategic initiative that can drive the reform and integration of economic activities in African countries. However, the magnitude of the increase might vary across countries depending on the readiness and the willingness of the country's administration to address both physical and human infrastructural deficiencies that have historically constrained the continent's performance in global output, especially manufacturing and trade (Olapade and Onyekwena, 2021).

Since the AfCFTA aims at ensuring that African trade with each other more industrialised goods, the imports of manufactured goods from other continents would be replaced by those produced within the continent, suggesting that beyond economic integration, the agreement would enhance the continent's level of industrialization.

As forecasted by UNECA, depending on the degree of liberalization, AfCFTA will increase industrial production by approximately 25%, agricultural and food production between 20%

and 30%. In contrast, energy and mining activities will increase between 11% and 15%. Conversely, these activities result in changes, posing pressures on the African ecosystems and biodiversity, which can lead to loss of natural habitat and degradation (especially through agricultural expansion), pollution, and overexploitation of wildlife and fishery species. Furthermore, the anticipated changes and related emissions may also negatively impact the continent's efforts toward its climate change targets.

Without safeguards and mitigation actions, the increased pressures on ecosystems associated with AfCFTA – including changes in land use and the expansion of industry and human activities – are likely to become significant drivers for the degradation of ecosystems and loss of biodiversity across African regions.

### **1.3. Trade Integration and Possible Impact on Biodiversity**

Despite Africa's rich and diverse ecological resources and the role they play in supporting sustainable development on the continent, the AfCFTA makes limited provisions for the environment, including the sustainable use and conservation of biodiversity (UNCTAD, 2021).

The environmental provisions are not very conspicuous but narrowly enshrined in the AfCFTA protocols on Trade in Goods, Trade in Services, and Dispute Settlement. While the preamble to the AfCFTA Protocol on Trade in Goods references environment and sustainable development, the preamble of the Trade in Services Protocol recognizes the right of parties:

*“to regulate in pursuit of national policy objectives, and to introduce new regulations, on the supply of services, within their territories, in order to meet legitimate national policy objectives, including ... overall sustainable development with respect to the degree of the development of services regulations in different countries, the particular need for State Parties to exercise this right, without compromising ... environmental protection and overall sustainable development.”*

The above provisions stipulate that State parties can decide on the best national policy measures and objectives in implementing the AfCFTA, including environmental policies. Although the provisions encourage that State parties should not compromise on environmental protection and sustainable development, the provisions do not amount to explicit clauses nor strong commitment to environmental protection, including biodiversity conservation, nor are they legally binding on the State to protect the environment (UNCTAD, 2021).

Examples with existing Free Trade Areas indicate that the AfCFTA can have a significant impact on biodiversity and biological resources through trade-related opportunities for economic growth and potentially undermining national and international conservation objectives, policies, and even laws. Without any explicit clauses for the protection and sustainable use of biodiversity and biodiversity resources in the agreement, the AfCFTA might lead to promoting economic incentives for the exploitation of natural resources over sustainable use and conservation, exacerbating the associated negative impacts on biodiversity and ecosystems and, as a consequence, sustainable development more widely.

The existing literature on trade liberalization and biodiversity impacts indicates that trade can negatively and positively impact biodiversity. Some studies envisage a positive relationship between international trade and the use of biological resources, arguing that international trade promotes efficient use of biological resources, and as trade expands, the tradeoff between trade and pollution will become inverse in the long run (UNCTAD, 2021). However, studies also show that increased trade has a negative impact on the environment due to land use changes and other pressures exerted on ecosystems.

For instance, Lenzen et al. (2012) determined the importance of international trade as a driver of threats to species in 187 countries, they found that excluding invasive species, 30% of global species threats are due to international trade. Similarly, Chaudhury & Kastner (2016) used the Species Area Relationship model to estimate the number of mammals, birds, amphibians, and reptile species lost (i.e., species 'committed to extinction') due to agricultural land use within each of the 804-terrestrial ecoregion. They found that while 83% of total species loss was incurred due to agricultural land use devoted to domestic consumption, 17% was due to export production. Treweek *et al.* (2006) analyzed agriculture, biodiversity, and poverty and concluded that agricultural expansion is a major driver for the loss of biodiversity as changes in land use associated with trade liberalization have major consequences. Alam & Quyet (2007) used the General Equilibrium Model to show how free trade can negatively impact the South's biodiversity stock .

More recent empirical literature also established that global biodiversity faces an extinction crisis. Among other factors, land use for export production accounts for 25% of these projected global extinctions (Chaudhury & Brooks, 2019;). Agricultural expansion induced by international trade continues to drive deforestation (Tradehub 2023; FAO 2021; WWF 2021). The data indicates that the existing WTO rules fail to ensure agricultural trade patterns are sustainable (Ruppel 2022). Trade seems to be intensifying the overexploitation of natural resources and habitat degradation through externalities of transport and indirect displacement in land use (Ruppel 2022; Sun *et al.*, 2022).

Although several studies, such as those above, have established a general negative relationship between international trade, trade liberalization, and biodiversity, that does not preclude the possibility of using trade-related policies and measures to support biodiversity conservation objectives, including promoting sustainably produced and/or sourced products, or products that are explicitly biodiversity-friendly (so-called "bio-trade" products). Furthermore, trade policies and measures can also be used to facilitate trade in technologies and services that support conservation and sustainable use, making them more globally available. There is increasing interest in making global supply chains more biodiversity-friendly, including with many multinational businesses adopting practices and putting in place policies to "green" their supply chains.

Despite the potential impacts of the AfCFTA agreement in boosting intra-African trade and regional development, concerns are growing over its potential negative impacts on the environment, sustainable land and natural resource use, ecosystem status, and biodiversity conservation. Given that intra-African exports are largely manufacturing commodities (40%) (IMF, 2019), the implementation of AfCFTA may promote trading in manufacturing commodities, which may engender industrialization and structural transformation. Such

transformation comes with linked environmental implications, including changes in land and resource use, pollution levels, and increased CO<sub>2</sub> emissions. Therefore, the trade agreement could possibly elevate pressures on land and natural resource use and, through that, biodiversity.

Even without the impacts of AfCFTA, the degradation, and overexploitation of Africa's biodiversity have been estimated to lead to the exhaustion of 50% of the continent's animal species as well as 20-30% of its lake productivity by the end of the century (year 2100) (UNEP-WCM, 2016). This will result in modifying the structures and functions of ecological systems, which play an important role in underpinning human well-being and security. Ultimately, the above developments will lead to conceding the efforts to achieve the Sustainable Development Goals, including not only SDGs 14 and 15 on sustaining life below water and on land but also a range of other SDGs including for example poverty reduction (SDG 1), food and water security (SDGs 2 and 6), health (SDG 3) and peace and security (SDG 16). Against this backdrop, the importance of understanding – and addressing – the possible impacts of AfCFTA on biodiversity seems vital.

#### **1.4. Objectives of the study**

This study aims to bridge the gap in the existing knowledge on the impacts of AfCFTA by analyzing the foreseen changes in the production, consumption, and investment patterns associated with the AfCFTA in Nigeria – and assessing the resulting implications on biodiversity in Nigeria and more widely in Africa.

The study aims to do the above by analyzing the foreseen impacts of AfCFTA on key direct and indirect drivers for biodiversity change in Nigeria, including those related to production patterns, methods and scale, and CO<sub>2</sub> emissions and pollution. Causal chain analysis will be used to assess the implications of changes in these drivers on ecosystems and biodiversity, supported by qualitative insights from studies and expert interviews.

Our underlying assumption is that the impacts of the AfCFTA on biodiversity in Nigeria – and also in Africa more broadly – will vary depending on sectors and products, and from country to country. The variation may be influenced by institutional settings, legislation, and level of enforcement. The results, including both region-wide impacts on changes in production patterns and specific insights from Nigeria on predicted biodiversity impacts, will help to inform governments, businesses, and stakeholders in their overall strategy and planning for the impacts of AfCFTA.

## **2. Methodology**

The study uses a mixed-method research design involving qualitative and quantitative approaches.

The quantitative analysis assesses the foreseen key impacts on resource and land use in the Nigerian context and interprets their causal impact on biodiversity. The qualitative analysis follows from the above, re-reflecting the insights of the quantitative assessment and also making some interpretations on biodiversity impacts in the African context more broadly.

### **2.1. Quantitative analysis**

In terms of the quantitative approach, the Energy-Environment Integrated Computable General Equilibrium (EEICGE) model was used as a basis to analyze the effect of the AfCFTA on key environment-related variables, particularly energy consumption and carbon dioxide (CO<sub>2</sub>) emissions. Causal chain analysis was then used to interpret how changes in the modeled variables are likely to impact ecosystems and biodiversity.

The EEICGE model is an extension of a single economy CGE model (Decaluwe, Lemelin, Robichaud, & Maisonnave, 2013) and it is used to capture the energy consumption and environment-related aspects associated with trade liberalization on an economy. There are nine (9) aspects captured in the EEICGE model including production, domestic demand, prices, income & savings, supply & international trade, energy & environment, real GDP, national output, and market clearing blocks.

Five (5) different scenarios were designed to capture the AfCFTA policy design in this study. These are the 20% (low), 40% (weak), 60%(moderate), 80% (strong), and 100% (full) tariff or duties reduction simulations between Nigeria and the rest of Africa.

A detailed description of the EEICGE model, the scenario design, and as well as the empirical data used in this analysis are presented in the Annex.

### **2.2. Qualitative analysis**

The quantitative modeling was complemented by qualitative assessment building on stakeholder interviews.

The key informant interviews were qualitative in-depth interviews with stakeholders knowledgeable about international trade and biodiversity. Interviews were conducted via the following channels (i) telephone interviews (ii) Zoom meetings, and (iii) face-to-face interviews.

A total of 13 stakeholders were interviewed as presented in figure 4. These included 5 stakeholders from government ministries, departments, and agencies (GMD&A), 3 stakeholders from academia, 2 stakeholders from umbrella bodies of trade and conservation societies (CSOs), and 3 stakeholders who are knowledge experts from NGOs.

The interviews started with the most factual and easy-to-answer questions first, which were followed by questions that asked the informants' views about different foreseen impacts of AfCFTA and biodiversity in Nigeria and more broadly on the African continent . It also asks questions about the recent Kunming-Montreal Global Biodiversity Framework, adopted in December 2022. Further clarifying questions were asked during the interview, which helped

to clarify the informant’s comments and get detailed information. The interviews lasted between 30 minutes to one hour and were rounded off with questions that asked for key recommendations from the stakeholders.

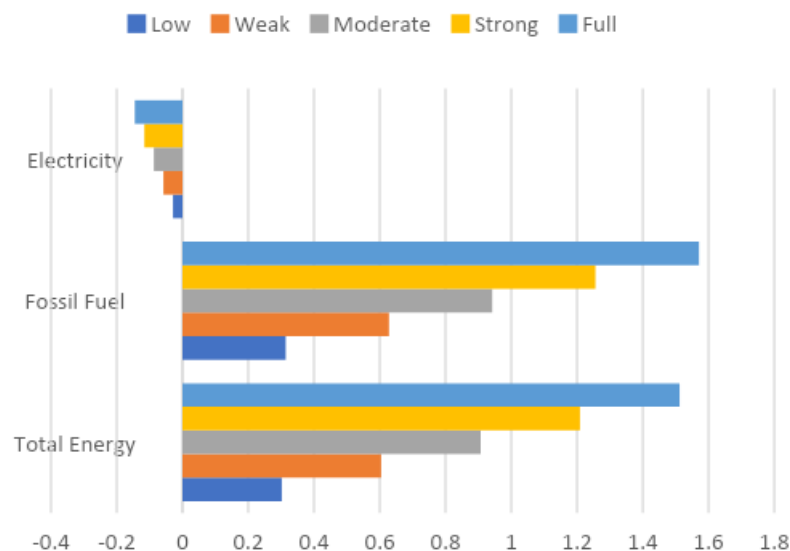
### 3. Quantitative Results: Nigeria

#### 3.1. Effects of AfCFTA on carbon emissions in Nigeria

It is important to state that despite the intrinsic difference between energy consumption and energy demand, energy demand is used as a proxy for energy consumption. The EEICGE (like other CGE) model analysis results only depict comparative statistics. It more or less shows expectations given policy shocks. As such, the results do not capture actual energy consumption, however, increases in the energy demand suggest and imply increases in energy consumption. On this premise, we discuss the energy demand results as energy consumption results.

Given the AfCFTA scenario designs, Nigeria’s industrial energy demand, in *Figure 2*, shows that more demand for energy inputs is inevitable. Within the five AfCFTA scenarios outlined in the Annex, the total energy demand for production purposes would increase from 0.3% (Low AfCFTA) to 1.5% (Full AfCFTA).

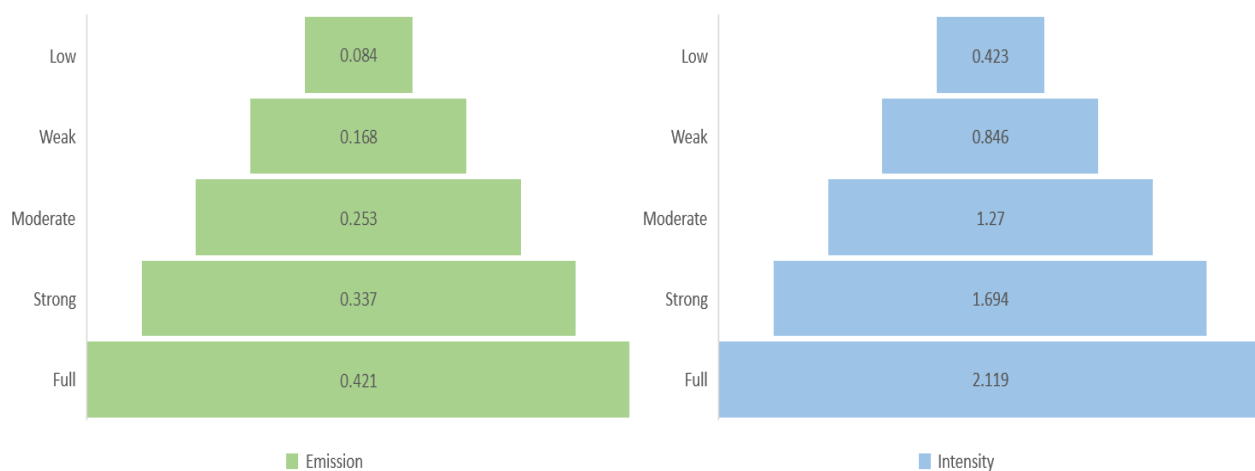
Moreover, the largest share of this increase in energy inputs is on fossil fuels for private generating sets. The current state of energy supply in Nigeria is poor. Given trade liberalization through AfCFTA, firms, and businesses have greater opportunities to increase production since their market has expanded from domestic to include other African countries’ markets. As such, this explains the increase in fossil fuel energy inputs.



**Figure 2: Industrial Energy Demand**

From the scenario design simulations, the increases in the demand (or consumption) of energy inputs, mostly fossil fuel, indicate an increase in the level of carbon emissions. From *Figure 3*, the percentage changes as a result of the five (5) AfCFTA scenario designs are plotted

in a funnel chart. The results confirm that there would be an expected increase in the level of Nigeria's carbon emissions owing to AfCFTA. The increases in Nigeria's carbon emission range from 0.084% (low AfCFTA) to 0.421% (full AfCFTA). Similarly, the comparative statistics of carbon intensity are shown in the right panel of *Figure 3*. Carbon intensity captures the emission of carbon per output value added. Therefore, it deals with emissions relative to output production activities. Given positive changes are recorded in both carbon emission and value added due to the AfCFTA policy designs, increased carbon intensity suggests a relatively higher emission change over value-added change. In other words, value-added is associated with an increase in carbon emissions. Again, this finding is not surprising since the major source of energy for Nigeria is fossil fuels. As such, increasing production activities to meet both the Nigerian and African markets' demands translates to more consumption of fossil fuel energies, which then results in emitting more carbon per value added.



**Figure 3: Carbon Emission and Intensity**

## 3.2. Effects of AfCFTA on Land- and Resource Use in Nigeria

This section analyses two key indirect drivers for biodiversity loss associated with AfCFTA, namely the 'structural & technological changes' and 'scale & welfare changes'. These drivers affect the production activities of an economy, which in turn affect land and resource use, which in turn affect climate and biodiversity.

### 3.2.1. Structural & Technological Changes across Economic Sectors

Based on traded volumes, the leading export commodity of Nigeria is crude oil while its leading import commodity is (other) industrial products. This is true for both ex-ante and ex-post AfCFTA policy shocks. Out of the (other) industrial commodity imports of Nigeria, African countries account for 38.9%. This makes Africa the leading import partner of (other) industrial products in Nigeria. On the other hand, Africa only accounts for 12.9% of the crude oil volume export of Nigeria. This ranks Africa as the fourth crude oil export partner of Nigeria behind ROW, the European Union, and China.

Table 3 shows the percentage changes, for different industries, in the level of traded (import & export) goods and services due to the AfCFTA designs. Based on this result, the import of refined oil will be more pronounced than the import of solid minerals. In other words, AfCFTA will result in more importation of oil relative to the current oil import level while there will be a decrease in the imports of solid & other minerals from the level. This translates to the fact that given the AfCFTA policy implementation, the importation of (refined crude) oil to power the increased energy demand of the Nigerian economy would increase rapidly (to match its demand) relative to the other sectoral/industrial imports.

Similarly, the maximum export good growth is recorded for iron & steel while the minimum export good growth is that of other industrial goods. This does not however imply a structural change in terms of the export of goods and services from Nigeria. Crude oil remains the leading export commodity of Nigeria pre- and post-AfCFTA policy implementation but, relatively the growth in the export of iron & steel supersedes that of crude oil exportation. As such, it might take precedence over the export of crude oil in the long run. Table 3 also confirms relatively more exports (against imports) in sectors like textiles & footwear, iron & steel, cement & construction, and solid minerals.

Therefore, given the AfCFTA policy, Nigeria's key export commodities, in addition to crude oil, would be iron & steel, textiles & footwear, cement & constructions, and other solid minerals. To export relatively more of these goods than Nigeria imports, technological advancement seems to be a feasible step towards achieving such an outcome leveraging AfCFTA policy. Invariably, the demand for more capital (and land) would result in more emissions.



**Table 3: Changes in Import and Export Commodities**

Sectors	Import					Export				
	Low	Weak	Mod.	Strong	Full	Low	Weak	Mod.	Strong	Full
Agricultural Produce	0.066	0.133	0.199	0.266	0.332	0.016	0.033	0.049	0.065	0.082
Oil	0.363	0.727	1.094	1.461	1.831	0.034	0.068	0.103	0.137	0.171
Solid & Other Minerals	-0.005	-0.01	0.016	0.021	0.026	0.025	0.05	0.076	0.101	0.126
Food Beverages	0.067	0.135	0.202	0.27	0.338	0.015	0.03	0.045	0.06	0.075
Textiles & Footwear	0.032	0.065	0.097	0.129	0.162	0.047	0.094	0.141	0.188	0.235
Iron & Steel	0.017	0.033	0.05	0.067	0.083	0.052	0.104	0.156	0.208	0.26
Other Industrial Goods	0.021	0.041	0.062	0.082	0.103	0.001	0.002	0.003	0.004	0.005
Other Utilities	0.058	0.116	0.174	0.232	0.29	-	-	-	-	-
Cement & Construction	0.008	0.016	0.024	0.032	0.04	0.011	0.022	0.033	0.044	0.055
Transportation	0.062	0.125	0.187	0.25	0.313	0.016	0.033	0.049	0.066	0.082
Telecommunication	0.056	0.111	0.167	0.223	0.279	0.027	0.054	0.081	0.108	0.135
Arts & Recreation	0.061	0.122	0.183	0.244	0.305	0.012	0.023	0.035	0.047	0.059
Finance	0.069	0.139	0.208	0.278	0.347	0.014	0.029	0.043	0.058	0.072
Real Estate	0.062	0.124	0.186	0.248	0.31	0.012	0.024	0.036	0.048	0.06
Other Services	0.068	0.137	0.205	0.274	0.343	0.017	0.034	0.051	0.068	0.085

All the values are in percentages. They represent percentage changes due to the scenario design shocks

Table 4 captures the growth rates in production factor inputs. It is important to know that semi-skilled labour demand is subsumed under skilled workers. The results indicate decreases in the demand for labour, both for skilled and unskilled workers, while there are increases in the demand for capital & land. This suggests that the AfCFTA policy would result in higher unemployment and an increase in the use of capital and land. This can also be explained by the increases in energy consumption/demand, which translates to increases in capital use. Furthermore, the growth in skilled labour is relatively more than that of unskilled labour. Therefore, there will be more employment for skilled labour relative to unskilled labour. This is not surprising since the world's technological advancements and the computer age have made it possible to automate some sets of production actions or activities to be executed by computers, machines, or robots.

Again, the results in Table 4 provide evidence for technological advancement in the Nigerian production processes. It is also important to mention that Table 4 shows the aggregate and not individual industrial primary input demand growth. The effects of the AfCFTA are heterogeneous across industries. For instance, the AfCFTA policy resulted in more unskilled labour employment for sectors like electricity, textiles & footwear, health, education, etc., while unskilled labour unemployment is recorded for refined oil, other utilities, transportation, finance, real estate, cement & construction, etc. Similarly, differences in the demand for skilled labour, capital, and land are also observed.

Like the primary inputs, the AfCFTA policy also shows changes in the intermediate demand inputs. The results in Table 5 show the growth in intermediate input demands due to the AfCFTA policy.

These intermediate input demands are grouped into energy and non-energy intermediate demands. The results confirm an overall growth in the level of energy and non-energy intermediate input demands for production purposes. Once again, this confirms the overall increase in the production of goods and services in Nigeria due to implementing the AfCFTA policy. These increases in input demand for production activities invariably result in more emissions, which subsequently adversely affect biodiversity in Nigeria and Africa at large.

**Table 4: Changes in Primary Input Demands**

<b>Factor Inputs</b>	<b>Moderate</b>				
	<b>Low</b>	<b>Weak</b>	<b>e</b>	<b>Strong</b>	<b>Full</b>
Unskilled Labour	-0.108	-0.215	-0.322	-0.431	-0.538
Skilled Labour	-0.111	-0.222	-0.333	-0.445	-0.556
Capital & Land	0.099	0.199	0.298	0.398	0.497

All the values are in percentages. They represent percentage changes due to the scenario design shocks.

**Table 5: Changes in Intermediate Input Demands**

<b>Inputs</b>	<b>Moderate</b>				
	<b>Low</b>	<b>Weak</b>	<b>e</b>	<b>Strong</b>	<b>Full</b>
Energy Inputs	0.139	0.277	0.416	0.555	0.694
Non-Energy Inputs	0.518	1.037	1.556	2.076	2.596

All the values are in percentages. They represent percentage changes due to the scenario design shocks

### 3.2.2. Changes related to economic welfare in Nigeria

In terms of the scale effects of the AfCFTA in Nigeria, Table 6 shows the sectorial and aggregate growth in output and prices. A common finding both at the sectorial and aggregate levels is that there is positive growth in output while prices show negative changes. Mainly, the price decrease is largely due to the competition that comes with trade liberalization as every economy seeks to achieve a comparative advantage in the production and sales of goods, and services. On the macroeconomic level, these results in deflation as the Consumer Price Index (CPI) measure of aggregate price level also shows negative growths.

**Table 6: Sectoral and Aggregate Effects**

	Moderate				
	Low	Weak	e	Strong	Full
Sectoral Output	0.079	0.158	0.237	0.316	0.395
Sectoral Prices	-0.415	-0.831	-1.246	-1.662	-2.077
Real GDP	0.001	0.001	0.002	0.002	0.003
CPI	-0.018	-0.036	-0.054	-0.072	-0.09

All the values are in percentages. They represent percentage changes due to the scenario design shocks

Using the Hicksian Equivalent Variation (EV) to measure the Nigerian welfare given the AfCFTA scenario designs. From Table 7, the welfare measures of the economic agents are all positive, indicating economic welfare improvements. As such, these positive economic welfare values signify that the AfCFTA policy is desirable for Nigeria and Africa. In Table 7, these values are not percentages but monetary values in billions of Naira (₦). They represent the extra amount of money the agents need to maintain the post-AfCFTA level of utility at current prices. This implies that *ceteris paribus*, without the AfCFTA policy, the Nigerian economic agents would need increases in their income, up to the values in Table 7, to maintain the same level of utility, assuming the AfCFTA policy is implemented.

**Table 7: Equivalent Variation Welfare Measure**

Agents		Moderate				
		Low	Weak	e	Strong	Full
Poor Households	Rural	0.324	0.648	0.972	1.296	1.620
	Urban	0.407	0.815	1.223	1.631	2.040
Rich Households	Rural	0.209	0.418	0.628	0.837	1.047
	Urban	0.425	0.85	1.276	1.701	2.127
Public Sector		0.524	1.049	1.574	2.099	2.625

All the values are in billions of Naira (₦). They represent income equivalent variations due to the scenario design shock simulations

### 3.3. Foreseen biodiversity impacts based on the quantitative analysis

While trade liberalization in the case of Africa (AfCFTA) might have positive impacts on economic development, it's equally important to show its effects on the drivers underpinning ecosystem degradation and biodiversity loss in Africa, using Nigeria as a case study. To this end, this study provides overwhelming evidence that AfCFTA will not only lead to relatively more fossil fuel consumption but also emit more carbon per value added or output. This raises concern since the intensifying effects of the AfCFTA on carbon emission will exacerbate climate change and related pressures on ecosystems and biodiversity in Africa.

As African countries, including Nigeria, produce more for intra-Africa trade through the AfCFTA, land use change is imminent. As export demand for iron and steel, cement and construction, textiles and footwear, and other solid minerals grows, forests and other natural habitats are often cleared for land and mineral extraction.

The Iron and steel production process involves several stages, each of which can contribute to environmental degradation and loss of biodiversity. The exploration and mining of iron ore in Nigeria have often led to deforestation and habitat destruction (Omotehinse & Ako 2019). The North-central area, for example, has experienced extensive deforestation due to iron ore mining activities.

The growth in the cement and construction industry can have a complex causal chain effect on the ecosystem and biodiversity, involving multiple interconnected stages and impacts. For example, the cement industry relies on raw materials such as limestone, clay, and sand, which are often extracted from natural habitats. The consequential impacts include habitat destruction, soil erosion, and disruption of ecosystems, which can lead to direct loss of biodiversity. In addition, construction activities often require large amounts of water, leading to increased demand for local water sources. The resulting overuse of water resources can lead to habitat degradation, altered hydrological patterns, and drought, affecting aquatic ecosystems and biodiversity.

The growth in the quantity exported of textiles and footwear also has foreseen biodiversity impacts. Many textile and footwear production materials, such as cotton and leather, are linked to deforestation. Notably, the use of chemicals in textile production, such as dyes, finishing agents, and synthetic materials, can result in the release of harmful substances into the environment. These pollutants can have long-lasting effects on ecosystems and biodiversity.

The quantitative analysis further shows that the AfCFTA policy results in shifts in employment and unemployment across a range of sectors. While unskilled labour employment for some sectors like electricity, textiles and footwear, health, and education is predicted to increase, similar employment in sectors such as oil, transportation, and cement & construction is foreseen to decrease. Depending on the outcomes of these sectoral shifts for unemployment, this can also have cascading implications for ecosystems and biodiversity. Unemployment often correlates with poverty, which could drive individuals and communities to rely more heavily on natural resources for their livelihoods. This increased dependence and pressure can lead to overexploitation of ecosystems as people may resort to activities like logging, fishing, or hunting to meet their basic needs. Moreover, this could further contribute to an increase in illegal activities, such as poaching and wildlife trafficking, as individuals seek

alternative sources of income. This poses a threat to biodiversity and can undermine conservation efforts.

The fact that the AfCFTA will positively impact the African economy in terms of welfare improvement is also confirmed by the quantitative results. However, caution is needed as welfare improvement could lead to lifestyle changes. As welfare increases, individuals may experience changes in their income levels and dietary preferences. Some studies suggest that as people's income rises, there tends to be a shift towards consuming more meat, including exotic or wild meats, due to the perception of them as luxury or status symbols (Andong *et al.* 2023; Kouassi *et al.* 2023; Moloney *et al.* 2023; McNamara, Fa, & Ntiamoa-Baidu, 2019). In Nigeria, for instance, a survey by WildAid (2021) shows that increased welfare is one of the factors driving urban demand for wild meat, such as pangolins and antelopes. Wildmeat trade directly threatens wildlife by reducing the population of endangered species, as evident in the Peruvian Amazon (Mayor *et al.* 2022), West African protected area (Sonhayé-Ouyé *et al.* 2022), and Tanzania national parks (Foya *et al.* 2023), among others. The report by WildAid (2021) also established that Nigeria is becoming the main African transit center for the shipment of pangolin scales and ivory to Asian countries. Between 2016 and 2019, the nation was connected to over half of all pangolin scale seizures worldwide. Despite the fact that wildlife rules and penalties were updated in 2016, authorities often fail to implement them, and the public and law enforcement officers frequently have a poor understanding of the rules. Therefore, as AfCFTA contributes to improving welfare and influencing dietary preferences, stricter regulations on hunting and trading in wild animals, combined with enforcement measures, may be necessary in order to curtail the availability and demand for wild meats.

#### **4. Qualitative results: Nigeria and broader Africa**

The quantitative modelling of the likely effect of the AfCFTA on biodiversity was complemented in this study by qualitative assessment with stakeholders. The qualitative research included collecting insights from stakeholders from key government ministries, departments and agencies (MDAs), academia, non-governmental organizations (NGOs), CSOs, and umbrella bodies of biodiversity conservation societies in Nigeria.

Overall, the qualitative assessment's findings compliment the quantitative assessment's findings, highlighting the cause of concern regarding the increase in energy consumption and related carbon emissions. They also provide further nuance to the modelling outcome and show that the impact of AfCFTA on biodiversity will depend on the specific provisions of the agreement - some yet to be negotiated- the capacity of countries to implement and enforce environmental regulations, and the broader socio-economic context in which the agreement is implemented. In general, the stakeholders submitted that AfCFTA can positively and negatively impact biodiversity.

#### 4.1 Changes in the demand for and supply of biodiversity-based commodities

The AfCFTA has the potential to incentivize African consumers to demand more biodiversity-based commodities as well as incentivize farmers to supply more biodiversity-based commodities such as palm oil, coffee, cocoa and fisheries. However, stakeholders expressed worries that if not carefully implemented, the AfCFTA could contribute to widespread unsustainable production and overexploitation, with negative impacts on ecosystems and biodiversity in Africa. On a more positive note, it was highlighted that the AfCFTA could help to reduce illegal trafficking of wildlife species and facilitate legal transaction in wildlife species.

The stakeholders' opinions are in tandem with the findings of the quantitative results and also align with previous empirical findings, which show that trade liberalization policies in Africa have often led to increased and unsustainable exploitation of natural resources (Opuala, Omoke, & Uche 2023; Dada *et al.* 2022; Ibrahim & Hanafy 2021). This includes minerals, timber, and wildlife products, which can result in habitat destruction, deforestation, and biodiversity loss.

Increased demand for nature-based commodities contributes to a rising ecological footprint, which often impacts negatively on biodiverse habitats and endangering rare and important species that are uniquely found in Africa. To mitigate this, the respondents expect to see increased commitment from farmers and support from international supply chain actors to fostering greener ways of producing biodiversity-based food for consumers. An example of such an initiative is the UK's support to Ethiopian coffee farmers which provides price premium and support for diseases resistant coffee crops in Ethiopia.

**Changes level and type of production:** Feedback from the stakeholders shows that as the AfCFTA promotes increased production of commodities for export, it could result to reducing the number of plant and animal species in any given area which implies reduced biodiversity. This concern is in line with the results of the CGE modelling which earlier shows that export will increase in key sectors, including agriculture.

Some of the stakeholders emphasized that the prioritization of increased production and supply of commodities for intra-Africa trade over community management of biodiversity would lead to negative environmental and social impacts. However, some stakeholders also reflected that if AfCFTA is implemented with appropriate sustainability and safeguard frameworks in place, it can promote trade practices that support conservation and sustainable use of biodiversity, such as certification schemes for timber and seafood.

**Changes in land use:** The stakeholders interviews indicate that the AfCFTA can lead to increased intra-Africa trade and economic activity, which can increase land use change for agriculture, forestry, mining, and other natural resource extraction activities. This can lead to environmental concerns such as deforestation, soil degradation, and loss of biodiversity.

However, it was also noted that the AfCFTA had the potential to promote conservation and sustainable management in parks and tourism services if the trade in services protocol were well implemented, with dedicated focus on encouraging the tourism sector. The AfCFTA can also create incentives for more sustainable land use practices were it to include, for example, provisions to promote sustainable forestry or requirements on environmental impact assessments for major development projects. Such provisions are not, however, yet part of any the existing AfCFTA protocols.

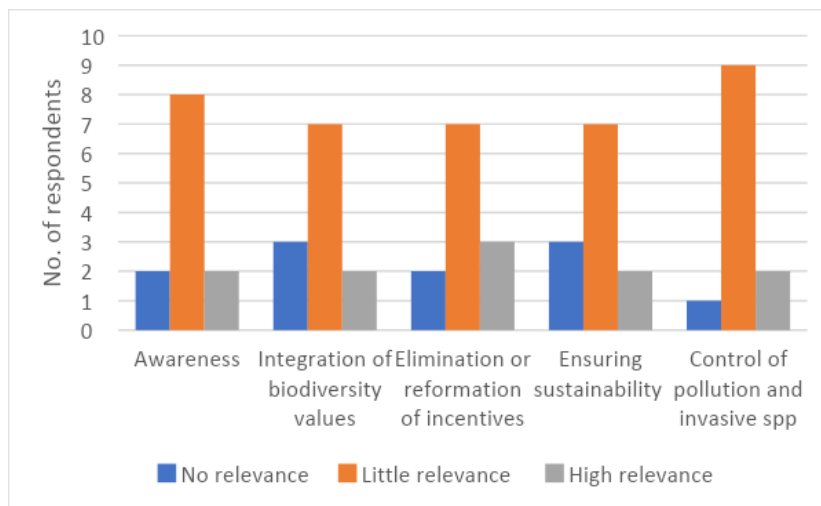
In addition, it was revealed that free trade agreements such as the AfCFTA can also have indirect effects on land use by influencing factors such as labor costs, technological innovation, and market demand for certain products. For example, if the AfCFTA leads to increased competition in the agricultural sector, farmers may adopt more intensive land use practices to increase productivity and reduce costs on the expense of environmental concerns, leading to negative impacts on ecosystems and biodiversity.

Overall, the impact of AfCFTA on land use will depend on a variety of factors and will require careful consideration and monitoring to ensure that environmental and social concerns are adequately addressed.

#### 4.2. Direct effects of AfCFTA on biodiversity conservation

According to the findings presented in figure 5, one-third of the stakeholders interviewed believe that the AfCFTA would have no impact on awareness creation about the values of biodiversity and the steps producers and consumers can take to conserve and use it sustainably in Africa. Approximately two thirds of the stakeholders said it would have little relevance while two interviewees stated the AfCFTA would be of great importance.

This suggests that majority of the stakeholders are not optimistic that the AfCFTA can contribute to the development and implementation of targeted public awareness campaigns that will increase public appreciation for the value and importance of conserving biodiversity.

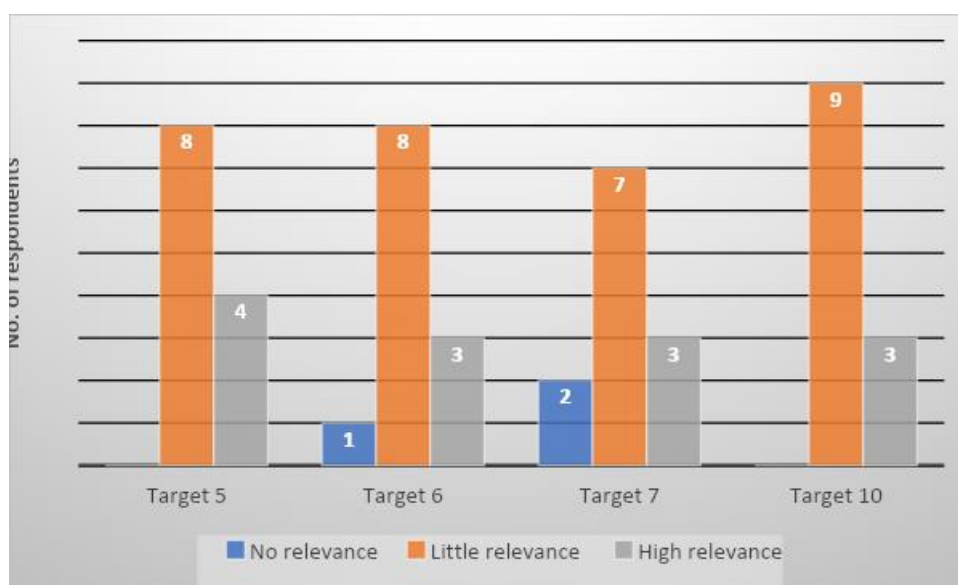


**Figure 5: Potential effect of AfCFTA on key dimensions of biodiversity conservation**

Additionally, the results of the stakeholder interviews indicate that a majority of the respondents expect that the AfCFTA will have little relevance for the integration of biodiversity values into strategies for development and poverty reduction at the national and local levels in Africa. Approximately 50% of the stakeholders expressed the opinion that the AfCFTA has little relevance in fostering the elimination or reformation of incentives, including subsidies, that are harmful to biodiversity.

Stakeholders' views suggest that the AfCFTA will have limited potential to incentivize governments, business and stakeholders at all levels to implement plans for sustainable production and consumption, while effectively managing the impacts of natural resource utilization well within safe ecological limits. This is further demonstrated by the fact that the majority of interviewed stakeholders expressed that the AfCFTA had little relevance in ensuring that pollution, including from excess nutrients, is reduced to levels that are not detrimental to ecosystem function and biodiversity in Africa.

The qualitative analysis further assessed stakeholder's perception of the relevance of AfCFTA to a number of key trade-related targets of the recent Kunming-Montreal Global Biodiversity Framework, adopted in December 2022. The results of the assessment are highlighted in figure 6.



**Figure 6: Relevance of AfCFTA to key trade-related targets of the Kunming-Montreal Global Biodiversity Framework.**

Target 5 seeks to ensure the sustainable, safe and legal use, harvesting and trade of wild species in order to prevent overexploitation, while target 6 aims to 'eliminate, minimize, reduce and or mitigate the impacts of invasive alien species on biodiversity and ecosystem services'. Target 7 is focused at reducing 'pollution risks and the negative impact of pollution from all sources, by 2030, to levels that are not harmful to biodiversity and ecosystem functions and services', while target 10 aims to 'ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity'

Stakeholders' perceptions about each of the targets were assessed by asking them to use a ranking of 1-3; with 1 being no relevance, 2 being little relevance, and 3 being high relevance, which is defined as an expectation of a positive impact.

Figure 6 shows that stakeholders have varied perceptions about Target 5 of the recent Kunming-Montreal Global Biodiversity Framework. A majority of the stakeholders



interviewed opined that the AfCFTA has little relevance to the achievement of Target 5; their perception was similar for Target 6. Through further inquiry into the stakeholders' perceptions, the interview revealed that a majority of the participants hold the belief that the AfCFTA has little potential to mitigate the risks of pathogen spill-over across the continent.

The interviews revealed that most stakeholders are not optimistic about the AfCFTA's potential to significantly contribute to the achievement of Target 7 of the Kunming-Montreal Global Biodiversity Framework. Although the majority of stakeholders perceive it as having low relevance, some stakeholders however proposed that African countries can utilize the AfCFTA as a means to reduce excess nutrients lost to the environment and reduce the overall risk from pesticides by implementing integrated pest management.

Moreover, stakeholders stated that the AfCFTA is a potential policy instrument for African countries to work towards achieving Target 10 of the framework. This suggests that the AfCFTA can have relevance in Africa's progression towards sustainable intensification, agroecology and other innovative approaches that contribute to building resilience and long-term efficiency.

## **5. Conclusions and policy recommendations**

Free trade agreements (FTAs) such as the AfCFTA can have both positive and negative effects on the conservation of biodiversity, depending on how they are structured and implemented.

On the positive side, FTAs can encourage countries to adopt and enforce environmental regulations and conservation measures. Some FTAs include provisions that require countries to comply with international environmental agreements, such as the Convention on Biological Diversity or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). These provisions can help protect endangered species, prevent overexploitation of natural resources, and promote sustainable development.

However, FTAs can also have negative effects on biodiversity conservation if they prioritize economic growth over environmental protection. For example, FTAs can lead to the expansion of industrial agriculture and mining, which can lead to deforestation, soil erosion, and water pollution. These activities can have devastating effects on biodiversity, including the loss of habitat and species extinction.

Unfortunately, a critical review of the AfCFTA shows that the agreement is void of explicit provisions for African countries to comply with international environmental agreements such as CITES. This suggests that the AfCFTA will not contain sufficient safeguards to strengthen biodiversity-related policies and commitments in the face of increasing economic and trade-related opportunities and related pressures.

Although the AfCFTA is expected to increase intra-Africa Trade, promote wealth creation, employment, and welfare, when examined critically in terms of its impact on biodiversity, this study shows that there are potential threats and benefits to the conservation and sustainable use of biodiversity. These are evident in the quantitative and qualitative results.

For instance, the scenario design simulations of the CGE modelling for Nigeria shows that the AfCFTA will promote an increase in the demand (or consumption) of energy inputs, mostly fossil fuel, which are suggestive of increases in the level of carbon emission. In addition, the perspectives gained from the stakeholders' interviews shows that as the AfCFTA leads to increased intra-Africa trade, it will consequently create pressure for increased land use for agriculture, forestry, mining, and other natural resource extraction activities. This can lead to environmental concerns such as deforestation, soil degradation, and loss of biodiversity. These unintended outcomes will have undeniable adverse effects on global climate and as a result of climate change, will also affect Africa's environment, ecosystems and biodiversity.

Therefore, to avoid the cascade of negative climate and environmental outcomes of AfCFTA it is expedient for African economies to invest more in the development and use of clean and renewable energy alternatives. These alternatives should be capable of meeting Africa's growing energy demands while implementing the AfCFTA policy. This aligns with the global commitments of the Paris Agreement which aims to promote the production and consumption of clean and renewable energy alternatives as a means of reducing greenhouse gas emissions. Unlike fossil fuel, renewable energy is sustainable, cost-effective, and climate-friendly; it is also essential to Africa's sustainable development. Therefore, Africa should tap into existing clean and renewable energy sources, while advancing innovation in the further use of these sources. Africa's renewable energy sources have large potential to boost domestic market performance and expand firms' production capacity, which could in turn foster Africa's industrialization and development objectives.

Moreover, the qualitative assessment suggests that the likely effects of the AfCFTA on biodiversity and the Kunming-Montreal Global Biodiversity Framework can vary depending on the specific provisions of the agreement and the context in which it is implemented. On the one hand, the AfCFTA can facilitate the adoption of environmental regulations and standards that aim to protect biodiversity. For instance, the AfCFTA could commit African countries to adopt measures to prevent the illegal trade in wildlife, promote sustainable forest management, and protect endangered species. In addition, the trade agreement could provide economic incentives for the conservation of biodiversity by promoting the trade of sustainably sourced products, such as timber and fish, thereby encouraging the development of eco-tourism. The final outcomes will depend on the willingness and resources of African States to push for the desired impact through policy domestication, innovative financing, capacity building, among other factors.

On the other hand, trade liberalization could likely lead to an increase in the production of goods, such as palm oil, soy, and beef, that are linked to deforestation and the loss of biodiversity. Overall, the impact of the AfCFTA on biodiversity can be complex and context-specific, relying on various factors including the specific provisions of the agreement, how it is implemented, the capacity of countries to enforce environmental regulations, the types of traded products, and the broader socio-economic context surrounding the agreement. Therefore, it is important to ensure that FTAs such as the AfCFTA are designed to promote sustainable development and protect biodiversity. This can be achieved by promoting sustainable implementation of the agreement, including through the enforcement of existing environmental regulations and shifting to more sustainable trade and production practices, as well as through agreement design, such as the inclusion of strong environmental provisions, and other factors, such as the involvement of local communities in decision-making processes.

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## Appendix

### The Energy-Environment Integrated CGE Model

A CGE model is a system of equations built to capture agents' optimization behaviours, choices, and decisions, as well as a holistic picture of an economy (single or multiple/global economies) at a given time or across time. Notwithstanding, the Energy-Environment Integrated CGE (EEICGE) model is developed to capture, in addition, the energy and environmental implications of policy evaluations in an economy. In other words, the EEICGE model is an extension of a single economy CGE model (Decaluwe, Lemelin, Robichaud, & Maisonnave, 2013) to capture the energy and environmental aspects of an economy.

Similar models such as the GTAP-E (Burniaux & Truong, 2022), and AIM/CGE V2.0 (Fujimori, Hasegawa, & Masui, 2017), etc. have also been proposed to incorporate policy evaluation impacts on the energy and environmental areas of an economy. Among others, one of the differences between the EEICGE and AIM/CGE or GTAP-E is in the aggregate output modelling design. The EEICGE models output as a function of value-added and intermediate inputs. The value added is a function of labour factor inputs and energy-capital inputs. Then, energy-capital is a function of energy and capital factor inputs. This modelling structure follows the argument that energy use is a capital-dependent intermediate input of production processes (Okorie, 2021). On the other hand, AIM/CGE V2.0 models output as a function of value-added, energy aggregates, intermediate inputs, and non-energy related GHG (greenhouse gases) while GTAP-E models output as a function of factor inputs, energy (electricity & non-electricity) and intermediate inputs.

There are nine (9) blocks captured in the EEICGE model. These are the production, domestic demand, prices, income & savings, supply & international trade, energy & environment, real, national output and market clearing blocks. A brief description of the modelled behaviours in these blocks is presented below.

#### EEICGE Model Blocks

The production block depicts a one-to-one mapping between the industries and produced goods and services. As such, every industry produces a single commodity or service in the economy. Based on the information in Figure 1, outputs are produced by employing factor inputs (labour & capital) and other industrial outputs (intermediate inputs). These inputs (primary and intermediate) are combined through different production technologies to produce outputs. Studies have equally shown that the Nigerian economy exhibits the Constant Elasticity of Substitution (CES) production function, including its variants like the Cobb-Douglas function (Okorie, 2021; 2017). The primary inputs are further disaggregated into homogenous groups such as skilled labour, unskilled labour capital, and land. Similarly, the intermediate inputs are disaggregated into Non-Energy and Energy intermediate inputs. The Aggregated use of energy during production processes is a CES function of Fossil and Electricity energy inputs. While electricity use is further disaggregated into Renewable and Non-Renewable electricity inputs, the Fossil fuels inputs are disaggregated into Basic Fossils and Refined Oil Nonetheless, Solid and Crude are disaggregation of Basic Fossils while Coal and Other Solids are for Solids.

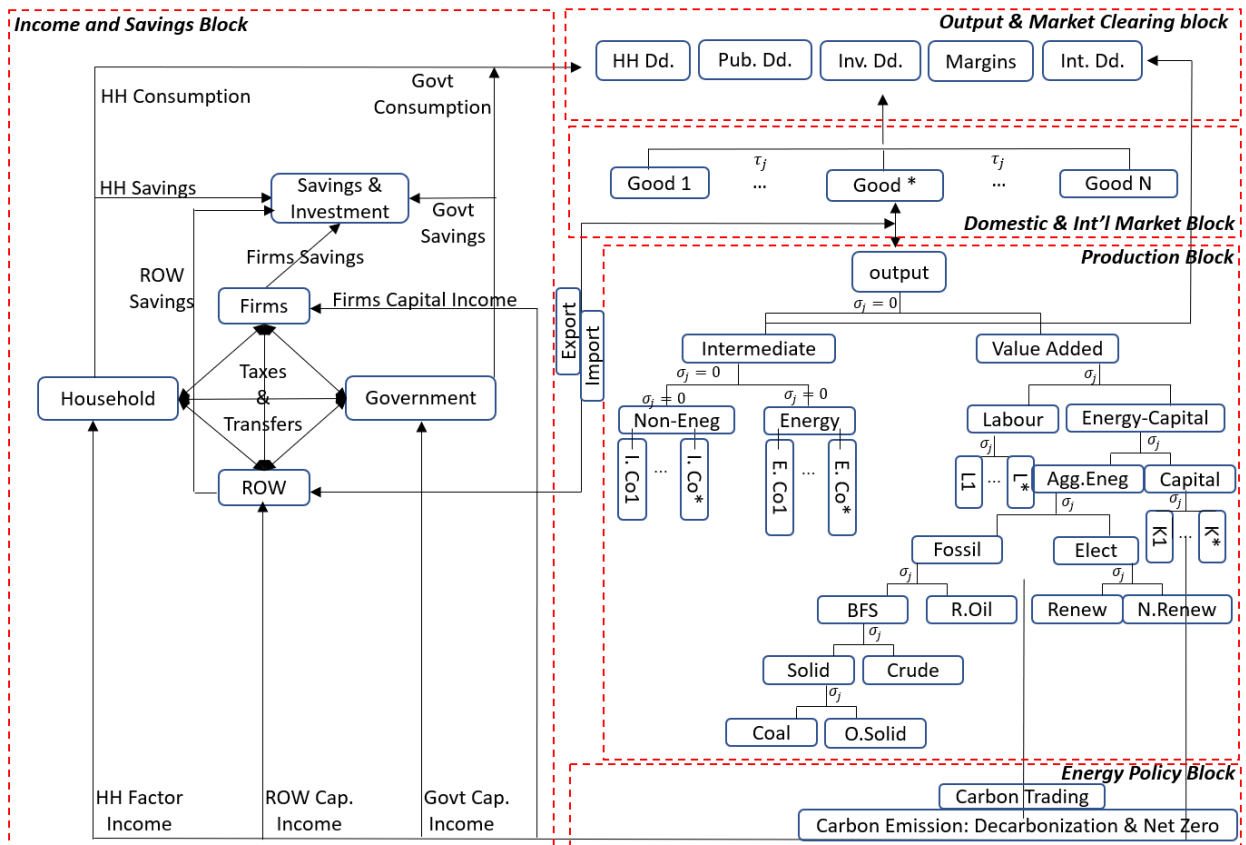


Figure 1: EICGE Schema<sup>3</sup>

The production demand for energy inputs produces undesired output in the form of Greenhouse Gas (GHG) emissions. This in turn affects the environment and the diverse living organisms within the environment (biodiversity). As such, the emission of carbon and other pollutants, as a result of production activities, directly affects biodiversity and leads to climate change and global warming. As such, the demand for fossil fuel energy inputs is discouraged for renewable and clean energy inputs and carbon taxes. Conversely, carbon taxes also serve as a means of revenue generation for the government as well as a deterrent for fossil fuel energy inputs. As such, economies set their Carbon Efficiency Rate (CER) or Carbon Abatement Rate<sup>4</sup> (CAR) as the policy target level of carbon mitigation an economy sets to achieve decarbonization and actualizing Net Zero.

<sup>3</sup> Used Abbreviations: Household Demand (HH Dd.), Pubic Demand (Pub. Dd.), Investment Demand (Inv. Dd.), Intermediate Demand (Int. Dd.), Non-Energy Intermediate Input (Non-Eneg), Aggregate Energy Demand (Agg. Eneg), Electricity Demand (Elect), Renewable Electricity Demand (Renew), Non-Renewable Electricity Demand (N. Renew), Basic Fossils (BFS), Refined Oil (R. Oil), Other Solids (O. Solid), Household (HH), Government (Govt), Capital (Cap), and Rest of the Word (ROW).

<sup>4</sup> The EICGE model assumes a 10% CER or CAR.

Before shock simulations in a CGE model, there must be an existing equilibrium in all markets. These can be confirmed by the verification of Walras' law of no excess supply of the last market, zero infeasibility, attainment of a feasible solution, and normal completion of the model's execution. Therefore, the EEICGE model closure assumes the labour market clears, the capital market clears, the investment market clears, domestic and international goods & services market clears.

### Scenario Designs

The Africa Continental Free Trade Area (AfCFTA) is designed to improve the trade of goods and services among African countries. As such, the EEICGE model allows for the disaggregation of the taxes and duties between the reference economy (Nigeria) and its trading partners or economies. The trading partners in this study are Africa (African countries), the USA (United States of America), the EU (European Union), China, India, and the ROW (Rest of the World). Five (5) different scenarios were designed to capture the AfCFTA design in this study. These are the 20%, 40%, 60%, 80%, and 100% tariff or duties reduction simulations between Nigeria and Africa. Table 1 captures the five scenarios and their corresponding names, used hereafter.

**Table 1: Scenario Designs**

S/N	Scenario Name	Shock Simulation
1	Low AfCFTA	20% Africa's Tariff/Duties Reduction
2	Weak AfCFTA	40% Africa's Tariff/Duties Reduction
3	Moderate AfCFTA	60% Africa's Tariff/Duties Reduction
4	Strong AfCFTA	80% Africa's Tariff/Duties Reduction
5	Full AfCFTA	100% Africa's Tariff/Duties Reduction

### Empirical Data

The Social Accounting Matrix (SAM) is the dataset used by a computable general equilibrium model. It is an array of data that captures the flows (expenses and receipts) between different agents, industries, sectors, etc. within an economy. In other words, it shows the picture of what is going on (i.e. economic activities) in an economy within a particular period. The 2014 Nigerian SAM<sup>5</sup> is used for the EEICGE model parameter calibration, shock simulations, and analysis of results. The cross-entropy technique is used to balance the data matrix given that it outperforms the other available methods like the ordinary least squares, RAS, manual, linear programming, etc. (Lee & Su, 2014). Generally, this SAM captures four (4) disaggregated household blocks. They are the poor households (rural and urban), and the rich households (rural and urban). Conversely, there is only one firm representative and one public administrator (i.e. government). Also, there are twenty-one (21) industry aggregates captured

<sup>5</sup> The original 2014 Nigerian SAM was constructed during the PEP programme at Addis Ababa by Henry Okodua and his team. This 2014 version is not yet published, as such, there is/are no available reference(s). Access requests can be made directly to the team. The structure of the 2014 SAM was updated to suit the purpose of this study. It's arguable that the structure of the Nigerian economy has not strategically and substantially changed since 2014. Therefore, the results, from the use of this 2014 SAM, are quite robust and reliable.

in the SAM. These are Finance-Insurance, Education, Solid Minerals, Other Utilities, Refined Oil, Construction- Cement, Arts-Entertainment-Recreation, Trade, Food-Beverage-Tobacco, Clothing, Iron-Metals-Steel, Real Estate, Other Industries, Electricity, Agriculture, Crude, Transportation, Communications, Other Services, Health, and public sector.

**Table 2: Nigerian Trade Shares**

	<b>China</b>	<b>European Union</b>	<b>Africa</b>	<b>United States</b>	<b>India</b>	<b>ROW</b>
Import Share	0.249	0.166	0.389	0.047	0.071	0.078
Export Share	0.197	0.306	0.130	0.015	0.063	0.288
Net Export	-0.052	0.14	-0.259	-0.032	-0.008	0.21

All the values are in Millions of Nigerian Naira (₦).

Based on the objectives of this study, Nigeria is selected as a case study to represent and picture the behaviour in Africa due to the AfCFTA policy. As such, it's vital to quickly examine the trade shares (imports and exports) between Nigeria and the included trade partners in the Nigerian 2014 SAM. It is also important to state that the SAM values are in Millions of Nigerian Naira (₦) and at 2010 prices. From Table 2, Nigeria imports the largest proportion of goods and services from Africa while exporting most of its goods and services to the European Union. However, considering the net export values, Nigeria is at a trade deficit with African countries since it imports more from Africa relative to what it exports to Africa. In general, Nigeria is mostly at a trade deficit with its trading partners. This finding intuitively suggests that implementing the AfCFTA policy would spell more trade deficit for Nigeria with other African countries. As such, Nigeria will import relatively more than it exports to Africa since Nigeria's most trade deficit is with Africa. This is implied from the state of the Nigerian economy presented in the 2014 Nigerian SAM. Nevertheless, the expected changes in the export and import between Nigeria and Africa, given the AfCFTA policy, are simulated in different scenarios and were presented (with discussions) in this paper.



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