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Trade and Biodiversity

Evidence from East Africa

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DEDICATION

This work is dedicated to my mom, with whose values I continue to thrive. Also, I dedicate the thesis to my wife, Penda Jallow; the coolness of my eyes Daud Bah; and the two best brothers in world Demba Bah and Modou Bah

The work is also dedicated to my friend the General Manager of Sofora Cooperative Credit Union Mr. Bakary Bojang for the love and support he gave me throughout the course of my study.

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ABBREVIATIONS USED

IMF	International Monetary Fund
WB	World Bank
OECD	Organization for Economic Cooperation Development
SDG	Sustainable Development Goals
UNCTAD	United Nations Conference for Trade and Development
DRM	Domestic Resource Mobilization
GDP	Gross Domestic Product
ADI	Africa Development Indicators
ODA	Official Development Assistance
NEPAD	New Partnerships for Africa's Development
GDS	Gross Domestic Savings
ECOWAS	Economic Community of West African States
FDI	Foreign Direct Investment
CT	Corporate Tax
SSA	Sub-Saharan Africa
FINTECH	Financial Technology
SNA	System of National Accounts
NIPA	National Income product Accounts
OLS	Ordinary Least Squares
VAR	Vector Auto-Regression
VEC	Vector Error Correction
GNP	Gross National Product
ToT	Terms of Trade
WCF	World Cocoa Foundation

Executive Summary

This study explores the impact of trade on biodiversity in East Africa from 1990 to 2010. Trade was measured using Trade Volume, GDP per Capita, population density, Technological Advancement, and Environmental regulation. Biodiversity was measured using Species Richness, Habitat Diversity and Conservation Status.

The study used secondary data obtained World Bank, International Monetary Fund, and the East African Community. The collected data was analyzed using econometric models such as regression and correlation analysis.

The study found that trade factors such as trade volume, GDP per capita, population density, all have the potential to enhance biodiversity. Technological advancement does not seem to have as much potency to influence biodiversity relative to trade volume, GDP per capita, and population. Surprisingly, Environmental regulation has no impact on biodiversity conservation.

The study, therefore, concluded that based on the results obtained, trade volume, GDP per capita, population density, and technological advancement are critical to the development of biodiversity in East Africa.

Considering these conclusions, the thesis offers practical recommendations aimed at leveraging these factors to improve trade and, consequently, enhance biodiversity in the region.

Chapter One: Introduction

1.1 Background to the Study

Biodiversity and trade have had a symbiotic relationship for a long time, contributing to economic and social wellbeing of nations. This is particularly true in African countries that are endowed with a rich ecosystem of natural resources. At national and regional levels, trade and biodiversity relationship has triggered a great interest amongst researchers, policy makers, regional blocks, as well as funders of development initiatives. In Africa in particular, concerns about trade and biodiversity relationship are more intensified in the East African region, primarily due to the high levels of biodiversity that it is endowed with. This study seeks to determine the resulting effect of interdependence between trade and biodiversity conservation in East Africa and how this relationship influences sustainable development strategies.

In Uganda, according to WCS(2024), there are about 9000 different terrestrial and aquatic species, including animal and plant species that define the country's biodiversity richness. This richness has been economically viable, especially for the pharmaceutical industry who are working with the local herbalist to test the medicinal attributes of the plant species. Despite these economic benefits accruing from the trade -biodiversity nexus, the relationship also poses a great threat to the ecosystems of Africa, crucial for maintaining its biodiversity, face significant challenges. Africa hosts numerous highly biodiverse regions, including eight out of the 36 internationally acknowledged biodiversity hotspots. These hotspots are characterized by at least 1,500 vascular plant species unique to the region and having experienced a loss of at least 70 percent of their original vegetation cover. Among these, the East African coastal forests stand out as one of the most imperiled biodiversity hotspots globally, facing heightened vulnerability to various threats. (White &Case, 2023)

Econometric studies that linked trade and deforestation suggested that higher trade leads to deforestation especially it when comes under agricultural expansion as it would require clearing of forests and savannahs to create crop land (R. Lopez and G.I Galinato,2005). Other studies by Dfries et al(2010) and Leblois et al (2017) found out that countries with higher food export experienced higher deforestation despite the control on the main driver of deforestation. . Furthermore, the need to meet international demands for such commodities as cocoa, soy, as well as palm triggered extensive deforestation and habitat loss, which affect the most biodiverse regions of Africa (Gibbs et al, 2010 & Meyfroidt, 2020).

However, in spite of the negative impact on biodiversity, trade presents numerous opportunities in the form of market-induced incentives for conservation, sustainable sourcing, and eco-certification (Ingram et al, 2015) as cited by (Roe et al, 2014). The growing demand for eco-friendly products presents enough evidence of the need for business to go green and minimize negative impacts on the environment (Milner-Gulland et al, 2018)

There still appears a big gap in understanding the dynamics that surround trade and biodiversity relationship despite the growing recognition of the indispensability of integrating biodiversity conservation in trade policies and practices. This study seeks to study this relationship and determine gaps, the understanding of which could yield great benefits for many African nations, particularly those from East Africa. We will explore what the key drivers are and establish the challenges and opportunities therein to inform evidence-based policy interventions and strategies that will promote sustainable trade practices to enhance biodiversity.

1.2 Statement of Research Problem

With the emergence of climate change, and its apparent negative impact on the planet, biodiversity conservation gained so much prominence amongst scholars, researchers, policymakers, and environmentalists. Because biodiversity can greatly mitigate the consequences that erupt from climate change, attention has been drawn to how social and economic activities like trade can be leveraged to conserve biodiversity.

Mbaiwah and Darkoh (2017) assert that trade can both positively and negatively affect biodiversity. Duffy (2018) also revealed that trade creates economic opportunities incentives for environmental conservation through sustainable resource management practices, but Milner-Gullard and Akcakaya (2020) conversely revealed that trade can worsen biodiversity loss through the introduction of invasive species, habitat destruction, and overexploitation of natural resources

In Africa, trade and biodiversity relationship is quite notable due to the continent's rich endowment with natural resources, diverse ecosystems and the heavy dependence on natural resource for livelihoods Balmford et al (2019) reveals. Despite being proponents of the benefits of trade, Mbaiwah and Darkoh (2017), posited that expansions in trade networks, coupled with globalization, have triggered increased exploitation of natural resources for commercial purposes and warned that caution must be taken to ensure sustainability and enhance biodiversity conservation efforts.

There is, therefore, a need for empirical research to examine in a much broader way, the relationship between trade and biodiversity. This study seeks to provide the linkage between the two with a focus on the natural resource-endowed East African Community.

1.3 Research Questions

What is the relationship between trade and biodiversity?

Have Policy and regulatory frameworks been effective in enhancing trade and biodiversity conservation?

1.4 Objectives of the Study

To assess the impact of trade on biodiversity

To determine effectiveness of policy and regulatory frameworks in enhancing trade and biodiversity conservation.

1.5 Research Hypothesis

To address the research questions, the following hypothesis are imposed:

H_0: There is no relationship between trade and biodiversity.

H_0: Policies and regulatory frameworks have not been effective in enhancing trade and biodiversity conservation.

1.6 Scope of the Study

The principal objective of this study is to analyze the relationship between trade and biodiversity to make recommendations backed by empirical evidence about the factors that influence the relationship between the two. In addition to this, the study will also examine the effectiveness of policies and regulatory frameworks in addressing trade and biodiversity conservation.

The study will use trade volume, GDP per capita, Technological advancement, environmental regulation, and population density to measure trade and measure biodiversity through species richness, conservation status, and habitat diversity. The study will examine existing regulations and policies and look at the biodiversity trends in East Africa. It will cover challenges that erupt from both trade and biodiversity and advance recommendations on how the two can be leveraged to alleviate poverty and enhance sustainable development in East Africa.

1.7 Significance of the Study/Justification for the Study

This study will be one of the few if not the only one that combines these trade related factors and determine how they interact with biodiversity factors, and because these factors are integral to the economy of these nations, the study will inform targeted conservation strategies as well as policy interventions to harness the relationship.

The findings of the study will also have implications for the region's trade policies with the international community, especially for trade on biodiversity products.

Finally, the study, will aside from adding to the existing literature on the subject, also serve as an agenda item that will dictate future engagements amongst the professionals in this domain.

1.8 Definition of Key Terms (May be Operational)

Trade: Is the exchange of goods and services between and amongst nations, often facilitated through agreements, tariffs, and trade policies.

Biodiversity: Refers to the different species of animal and plants that exist within a given ecosystem or region. It includes genetic diversity, ecosystem diversity, and species diversity.

Conservation: refers to the preservation and protection of the environment through sustainable management practices.

East Africa: Is the eastern part of the African continent. It includes Kenya, Tanzania, Uganda, Rwanda, Burundi, Ethiopia, Somalia, South Sudan, and Djibouti.

Chapter Two: Literature Review

2.1 Conceptual Review

2.1.1 General Overview

East Africa, renowned for hosting the planet's richest biodiversity, faces rapid transformations that are leading to biodiversity loss. Concurrently, the region is marked by profound and complex poverty, wherein the livelihoods of its inhabitants are heavily reliant on natural resources (Fangli Wei, Shuai Wang, Bojie Fu, Linxiu Zhang, Chao Fu, Erustus M Kanga, 2018). The Word Bank Review conducted in 1990 highlighted several significant economic challenges in sub-Saharan Africa, which encompassed issues such as debt burden, sluggish agricultural expansion, decreasing agricultural productivity, subpar export performance, diminishing institutional strength, and worsening socio-economic and developmental circumstances. Many of the East African nations responded to these facts by resorting to an expansive use of agricultural land to boost production. The expansion (of cultivation) across various regions of East Africa has resulted in significant alterations to land cover and is gradually transitioning towards more agroecosystems and reduced coverage of natural vegetation. These transformations are driven by an increasing demand for agricultural products, necessary for enhancing food security and generating income, catering not only to the rural impoverished communities but also catering to the needs of large-scale investors in the commercial farming sector. In Kenya, for instance, reports indicate a steady rise in food production from 1980 to 1990; however, due to population growth, the per capita food supply in terms of calories experienced a slight decline during the same period. Throughout history, humans have primarily augmented agricultural outputs by expanding cultivated land (J.M. Maitima as cited in Lambin et al., 2003). Indeed, in East Africa, the conversion of land to agriculture has surpassed the proportional growth of the human population in recent decades. Consequently, natural vegetation cover has been replaced not only by croplands but also by native or planted pastures (Lambin et al., 2003). Another significant driver of land use change in East Africa is the rapid expansion of urban centers. Between 1960 and 2000, Kenya saw rise in urban population from 7 to 30% of overall population (J.M. Maitima as cited in Tiffen, 2003).

Over the past few decades, the area devoted to cultivation has more than doubled in Kenya and Tanzania. However, in Uganda, the increase has been comparatively moderate, primarily due to the implementation of environmental regulations aimed at safeguarding significant portions of Uganda as wetlands, coupled with extensive pre-existing cultivation in the country. In Mbeere, Kenya, Olson et al. (2004) observed a 70% expansion in cultivation between 1958 and 2001, leading to the depletion of forested and bush areas, leaving behind isolated pockets. Similarly, Misana et al. (2003) documented a notable rise in cultivation in the Moshi area of Tanzania during the same period. Conversely, in Uganda, Mugisha (2002) noted that agricultural expansion primarily occurred in the drier rangelands rather than the wetter highlands. The scarcity of land in the highlands, Mugisha asserted, prompted farmers to intensify land use, increasing inputs per hectare, as there was limited land available for farm expansion.

Globally, concerns regarding changes in land use and cover have emerged due to the realization that land surface processes have implications for climate, affecting ecosystem goods and services (Lambin et al., 2003). The foremost concerns revolve around the impact of land use change on biological diversity, soil degradation, and the capacity of biological systems to meet human needs. Declining crop yields have necessitated the cultivation of larger areas to fulfill demands (Kaihura and Stocking, 2003). Overstocking of livestock has led to decreased productivity in grazing areas.

Conflicts over land use have escalated due to heightened demand from various sectors of the economy. Of particular concern are conflicts among cultivators, livestock keepers, wildlife conservationists, individual land users, and governments, arising from human encroachment into protected areas (Hoare, 1999; Campbell et al., 2003; Western, 1976; Wells and Brandon, 1992).

2.1.2 Trade Volume

There is a widespread acknowledgment that there exists a correlation between the decline in biodiversity and poverty, and that addressing both conservation efforts and poverty alleviation simultaneously is imperative. However, achieving success with combined strategies has proven to be challenging. There is significant contention surrounding the social consequences of conservation initiatives and the effectiveness of community-centered conservation approaches. In their seminal paper, I.C Singhe (2024) as cited in Adams, W.M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., & Vira, B. (2004), explored the complex interactions between biodiversity conservation and poverty eradication, highlighting the role of trade in driving habitat conversion and biodiversity loss in East Africa. No stance outlined here suggests that either the preservation of biodiversity or the eradication of poverty are unworthy objectives. All viewpoints align with the call for conservation organizations to acknowledge and assess the social ramifications of their actions, and to assume corporate responsibility for operating in a socially responsible manner (D. Brockington and K. Schmidt-Soltau, 2004). They also endorse the necessity for poverty alleviation efforts and broader human development projects to consider their impact on the biosphere. (W. M. Adams, 2004), (M. L. Imhoff et al.2004), (M. Wackernagel, W. Rees,1996)

Various agencies (and individuals) are likely to adopt differing positions. For instance, disparities in perspectives regarding the trade-off between poverty reduction and biodiversity conservation underlie the contrasting viewpoints in the "parks versus sustainable use" discourse. Advocates for strictly enforced protected areas in impoverished developing nations to safeguard vulnerable species populations, such as forest primates, are adopting position 1, viewing extinction and poverty as distinct issues. Meanwhile, proponents of programs aimed at addressing the poverty of communities residing near such parks to dissuade trespassing or hunting are embracing position 2, recognizing poverty as a significant impediment to conservation. Those advocating for increasing park revenues to fully compensate stakeholders for associated opportunity costs are adopting position 3, striving to ensure conservation efforts do not exacerbate poverty in any manner. In contrast, advocates of conservation techniques that consider the needs of locals for sustainable use of natural resources, without establishing a formally declared protected area, are adopting position 4, perceiving conservation strategies based on sustainable use mainly to reduce poverty. (J. Terborgh, 1999, J. F. Oates, 2010, J. Hutton, N. Leader-Williams,2003, and P. R. Wilshusen, S. R. Brechin, C. L. Fortwangler, P. C. West, 2002)

Furthermore, underlying economic, structural, and policy factors play a critical role in driving both biodiversity conservation and loss, and include reliance on activities that significantly impact biodiversity. The high dependency of individuals on natural resources is compounded by the undependable and insecure nature of rural livelihoods, besides the absence of other means of income and subsistence, poverty, and land pressures. The lack of comprehensive and integrated mechanisms for the sustainable utilization of biological resources emerges as a primary contributor to biodiversity degradation and loss. Pressing demands for urban and industrial development lead to haphazard growth, adversely affecting environmental quality and ecosystem integrity. Sectoral policies in fisheries, water, and agriculture only marginally address sustainability concerns, while policies related to industry, mining, and urban settlement often neglect biodiversity issues (Emerton and Muramira, 1999). These policies prioritize maximizing production through intensified extraction without consideration of resource stocks and their ecological roles. The undervaluation of raw materials directly impedes biodiversity conservation efforts. Although environmental policies aim to achieve conservation, sustainable utilization, and benefit sharing, they frequently lack clear strategies for realizing these goals (Emerton and Muramira, 1999).

Moreover, another environmentally detrimental trade which is quite prevalent in the world and Africa in particular is sand mining. Rajesh and Anushiya(2013) assessed the economic and social benefits as well as the environmental challenges that come with sand mining. They, like Kondolf (1997) asserted that environmental challenges arise when the extraction rate of gravel, sand and other materials exceed natural replenishment rates. Carrere (2004) did similar study in Uruguay and highlighted that sand mining, though improved living standards by enhancing earnings, it warned about environmental degradation that results from it.

Across Africa, sand mining has been recognized as a viable economic activity. Madyise(2013) affirmed that it enhances people’s resource mobilization for other projects and Mkando(2004) asserted that it creates job opportunities for the younger generation. While Salifu(2016) highlight

Madyise's study (2013) in Botswana revealed that it empowered people with capital for other projects. In South Africa, Mkando (2004) highlighted the industry's creation of numerous job opportunities, especially for the younger population, making it economically viable. Salifu's findings in Ghana (2016) echoed the positive economic impact of sand mining, enabling young people to acquire assets and establish small-scale businesses. Rinaldi et al (2005) in Nigeria emphasized sand mining's contribution to rural development.

In Kenya, Mwaura's study (2013) underscored the significant economic impact of sand mining in Machakos. However, the study warned about the need to review the social impacts considering adverse environmental consequences. Nguru (2007) in the Mjanaheri area of Magarini Division highlighted how sand mining eroded cultural practices due to involvement from outside the division. Meli et al (2017) in the Kerio Valley established that sand mining contributed to income generation for acquiring assets like goats and sheep.

2.1.3 Environmental Regulations

East Africa is popular globally popular for its rich biodiversity and eye-cathing landscapes, which, if properly conserved, have the potential to drive economic growth and improve livelihoods. Nevertheless, the region faces various challenges such as climate change, wildlife crime, habitat fragmentation, human-wildlife conflicts, and urban expansion, all of which pose significant threats to conservation efforts (USAID, 2023). In response to these pressing issues, the East African Community (EAC) has devised regional strategies and implemented comprehensive policies aimed at enhancing transboundary wildlife management, combating wildlife trafficking, and enforcing laws against wildlife crimes. Notably, initiatives like the Trade in Wildlife Information Exchange database have been established to facilitate the sharing of crucial information among law enforcement officers across the region.

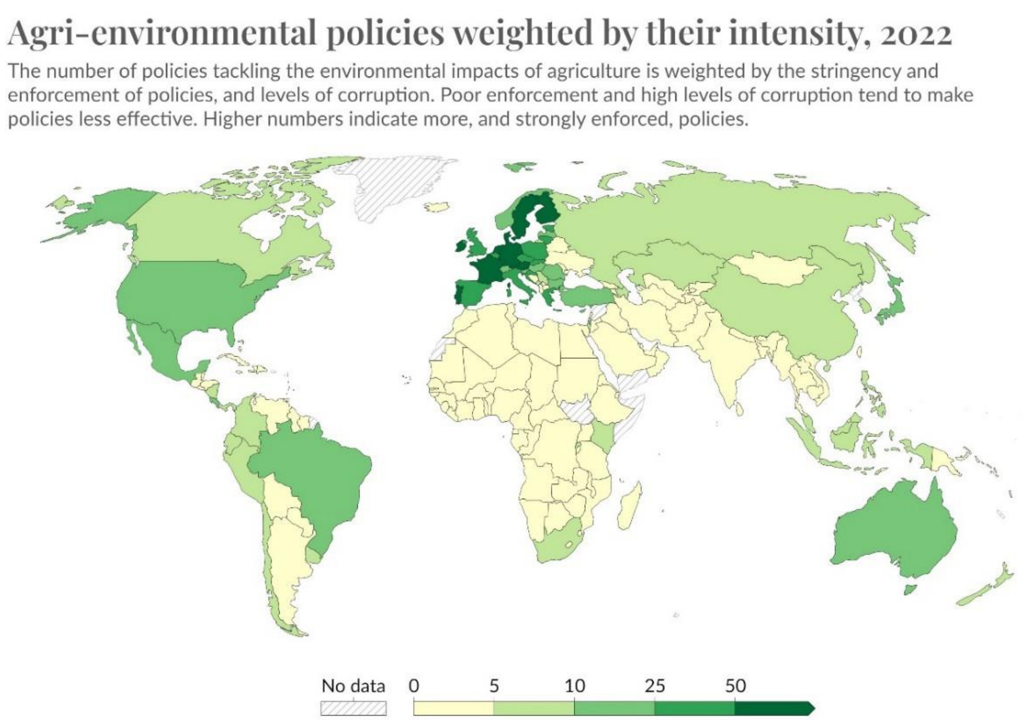
According to Dan Wellers, Emily Acton, Michael Rander, and Fawn Fitter (2009), a group of scientists identified nine planetary activities crucial for Earth's pliability to support life: stratospheric ozone levels, biodiversity, chemical pollution, ocean acidification, climate change, the freshwater cycle, changes in land use, excess nitrogen and phosphorus in the soil and oceans, and aerosols in the atmosphere. These scientists also established metrics to gauge when any of these processes would reach a tipping point, risking abrupt, massive, and potentially irreversible environmental changes. This concept, known as "planetary boundaries," describes the limits within which humanity must operate to sustain thriving conditions on Earth.

Historically, natural resource laws in many African countries during the colonial and immediate post-colonial periods, primarily focused on resource extraction for export purposes. However, concerns about resource depletion, particularly of wildlife, began to emerge as early as the 1900s, and led to the introduction of laws and policies aimed at conserving these resources. Unfortunately, these early conservation efforts, which were reactive and ad hoc, resulted in limited effectiveness in achieving sustainable management of biological resources.

David Wuepper and his team compiled data on agri-environmental policies from 1960 to 2022 across 200 countries, publishing their findings in a recent paper in Nature Food. As expected, the number of policies has risen over time, particularly in the 2000s and 2010s.

The map below illustrates the distribution of policies among countries. It shows that European Union nations tend to have the highest numbers. Conversely, many countries in Sub-Saharan Africa and parts of Asia have fewer policies, with most EU countries boasting over 90 policies compared to fewer than 20 in many African nations. (Wuepper, D., Wiebecke, I., Meier, L., Vogelsanger, S., Bramato, S., Fürholz, A., & Finger, R., 2024).

Figure 1: Distribution of policies weighted by intensity



(Source: Our World in Data)

Over time, natural resource conservation laws have gained prominence in African countries, particularly following the adoption of significant international environmental agreements to which many of these countries are signatories. These national environmental laws are grounded in the doctrine of police power, which asserts the state's responsibility to ensure that resource use does not harm public welfare (H. W. O. Okoth-Ogendo, 1999). This doctrine justifies restrictions on private property rights in the interest of the broader public good. Some countries, such as Kenya, explicitly incorporate this doctrine into their constitutions, carving out exceptions to the guarantee of fundamental rights and freedoms (Section 75 of the Constitution of Kenya).

Moreover, several countries have embedded environmental provisions in their national constitutions or bills of rights. For instance, the Ugandan constitution mandates Parliament to enact measures for environmental protection, sustainable management, and awareness promotion (Mbote and Cullet, 1999) as cited in (Article 245 of the Constitution of Uganda). Similarly, the South African Constitution recognizes the right to a clean environment, protected through ecologically sustainable development and the judicious use of natural resources, alongside the promotion of equitable economic and social progress (Mbote and Cullet, 1999) as cited in (Article 24 of the Constitution of the Republic of South Africa). Environmental law has typically evolved on a sectoral basis in most countries worldwide, and Africa is no exception. However, to address this fragmented approach, some countries have adopted framework legislations that include general principles of environmental management, establishment of institutional frameworks for biodiversity management, and institution of national environmental funds. Nations like Uganda, The Gambia, Guinea, and Comoros have embraced such framework legislations in their efforts to enhance environmental governance (Mbote and Cullet, 1999).

Another significant approach in facilitating environmental regulation is co-management. Although co-management initiatives exist, the predominant practice in EAC has been concentrated on forests that primarily fulfill local needs by providing goods and services (W.A. Rodgers, R. Nabanyumya, E. Mupada and L. Persha n.d). These forests typically comprise robust woodlands rather than dense evergreen forests. An exemplar of this approach is the village management strategy implemented to sustainably utilize miombo woodland resources while implementing measures to reduce degradation, primarily through policing and fire control, in the United Republic of Tanzania (W.A. Rodgers, R. Nabanyumya, E. Mupada and L. Persha n.d).

A key question in the co-management debate is whether the practices developed for the woodlands can be applied to highly biologically sophisticated forests that have national and international significance for biodiversity and water conservation. Early in the 1990s, these debates began, especially regarding community participation in forest management (W.A. Rodgers, R. Nabanyumya, E. Mupada, and L. Persha, n.d.). According to Myers et al. (2000), these forests are one of the 25 global biodiversity "hot spots" in the globe, which denote regions with extraordinarily high species richness. They are comprised of a mosaic of fragmented sections among 11 mountain blocks. The miombo protocols are incorporated into Tanzania's national "best practice" management rules (Government of Tanzania, 2001), but many national forestry officials are against applying them to the closed forests of the Eastern Arc Mountains, therefore the matter is still unresolved. This resistance stems from a number of beliefs, including the idea that the main goals of local stakeholders, which emphasize the use of local resources, could be at odds with the need to protect ecological processes for national and international interests; the conviction that successful co-management requires a significant transfer of ownership and access rights to communities, and that a more gradual and limited transfer is insufficient to persuade villagers to modify their usage practices; and the understanding that forest management for catchment functions and/or biodiversity conservation requires a wider range of expertise and resources compared to the straightforward "protection" of resilient woodlands.

However, excluding communities from the conservation process is likely to result in failure. Therefore, a compromise set of solutions is imperative. Experience indicates that co-management can be effective if there are adequate incentives for communities to invest in conservation within a framework acceptable to policymakers. In terms of sustainability, short-term project support has limited impact on changing resource use patterns; instead, developing economic incentives is more likely to have a lasting effect (WWF, 2001). The experience gleaned from ten years of joint forest management in India underscores the complexity of managing multispecies forests for diverse purposes. Establishing sustained yield targets and aiming for multiple product regeneration targets necessitates the retraining of field staff, new research, and new silvicultural guidelines. Communities express a desire to manage their forests for a variety of products beyond traditional timber, poles, and fuelwood, including grazing, fruits, medicines, mushrooms, fibers, and gums. However, they often lack the necessary skills and social cohesion to agree on management inputs (Poffenberger, 1990).

2.1.3 Technological Development

Many countries began to adopt technology and science-induced national policies after the era of independence in Africa. Unfortunately, for many countries counties like Ghana and Nigeria, conflicts and political instability soiled the efforts to develop science and education. Fabayo (1996) asserted that Africa's heavy reliance on the west is largely due to the slow pace of industrialization which is triggered by a lack of indigenous scientific competencies.

Against this backdrop, efforts have been made to harness various technologies to create indigenous (Demombynes & Thegeya, 2012). Of recent, due to the digital revolution and technological advancements, many countries have leapfrogged to more sophisticated technologies that are spiraling innovations in Africa (African Business, 2014). These technological advances have brought improvements in such sectors as mobile, solar, and broadband, and they present both opportunities and challenges to African governments. Additionally, the information and communication technology (ICT) industry now includes telecommunications, internet services, ICT education providers, data operators, and software development (African Business, 2016). Furthermore, many nations have renewed their focus on technology and science-based policies, with countries like Kenya and Ghana establishing tech hubs (African Business, 2014). A notable example of technological leapfrogging is the widespread adoption of mobile technology, which is gradually replacing fixed-line telecommunications (Toesland & Cross, 2015)

Moreover, a recent report by the World Bank and Elsevier reveals that Sub-Saharan Africa's impressive economic growth in recent years is owed to its increasing research capabilities in the fields of science, technology, engineering, and mathematics (STEM). The report, titled "A Decade of Development in Sub-Saharan African Science, Technology, Engineering and Mathematics Research," indicates that Africa contributes less than 1 percent to the global research output, a figure that is said modest relative to its 12 percent share of the global population. (World Bank, 2024). Sub-Saharan Africa, the report added, faces numerous challenges in digital development, such as insufficient digital infrastructure, limited access to affordable connectivity, a persistent digital gender gap, a shortage of skills for digital industries, and inadequate regulatory and policy frameworks. In spite of these hurdles, the region has made substantial growth in the past decade.

Hundreds of millions of people have gained internet access and are effectively using various digital services, such as mobile payments and online learning platforms, which is digital transformation.

2.1.4 GDP Per Capita

The East African Community (EAC) presently houses 174 million individuals across an area of 2,467,202 square kilometers. The collective GDP of the region stands at approximately US$163.4 billion (equivalent to US$473 billion in purchasing power parity terms), with an average GDP per capita of around US$941 (or $2,722 in purchasing power parity terms).

Moreover, investors within the Partner States of the EAC benefit not only from the EAC market but also from access to other African markets such as COMESA, SADC, and AfCFTA, in addition to international markets through preferential trade agreements.

The Common Market for Eastern and Southern Africa (COMESA) consists of 21 Member States covering a land area of 11.8 million square kilometers, with a population of 560 million and a combined GDP of US$768 billion.(EAC, 2024)

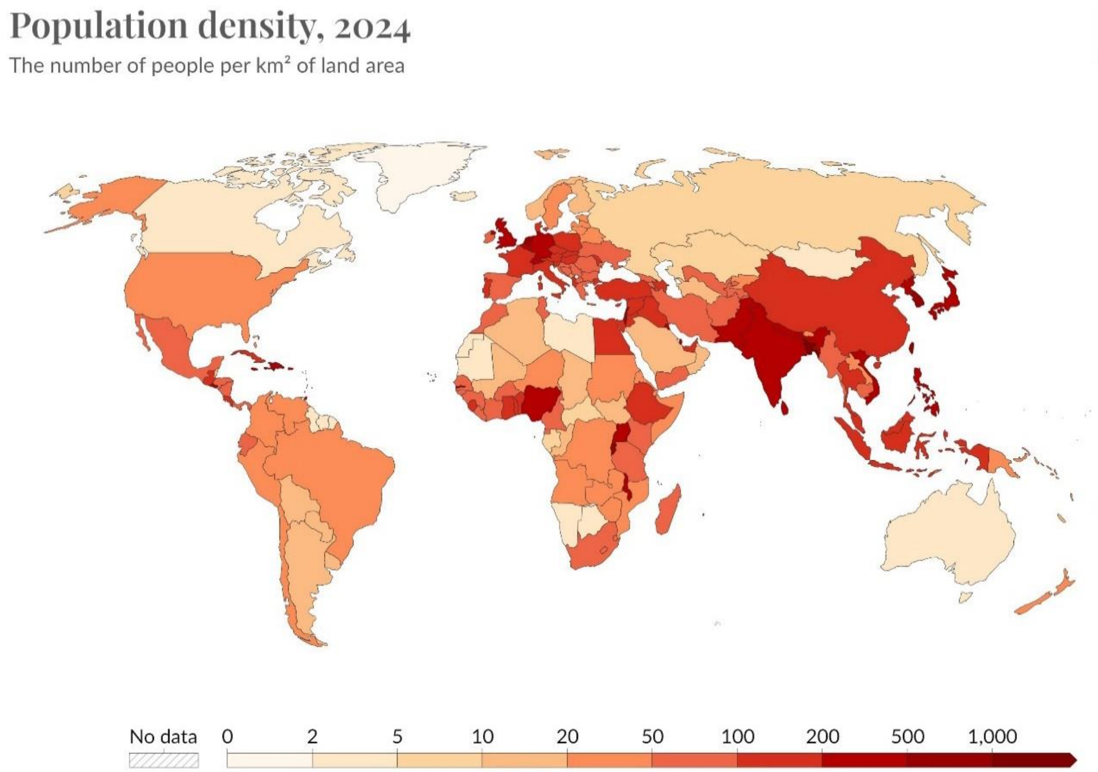
In Kenya, recent data shows a consistent increase in the agricultural sector's GDP share over the past decade, contrary to Vision 2030's goal of boosting the manufacturing sector's share. Kenya's Big Four Agenda for 2018-2022 aims to increase the manufacturing sector's contribution to GDP to 15% by 2022. Meanwhile, Ethiopia has seen remarkable progress in its industry sector, with its GDP share nearly tripling over the last decade. This industrial growth signifies Ethiopia's shift towards more diversified economic activities and a move away from its traditional reliance on agriculture. These trends reflect broader economic dynamics in the region, where countries are striving to balance growth across various sectors to achieve sustainable economic development (IMF, 2023).

2.1.5 Population Density

Globally, population density varies significantly among countries, with an average of 62 people per square kilometer in 2024. However, certain regions, particularly small islands, or isolated states, exhibit remarkably high population densities relative to their size. For instance, Macao, Monaco, Singapore, Hong Kong, and Gibraltar are among the most densely populated areas, with Singapore boasting a staggering 8,430 people per square kilometer—over 200 times denser than the United States and 2,000 times denser than Australia.

Among larger countries, Bangladesh stands out as the most densely populated, with 1,342 people per square kilometer, three times denser than its neighbor, India. Additionally, Rwanda, South Korea, Burundi, and the Netherlands are notable for their high population densities, with figures ranging from 525 to 584 people per square kilometer.

Figure 2Global Population Density



(Source: Our World in Data)

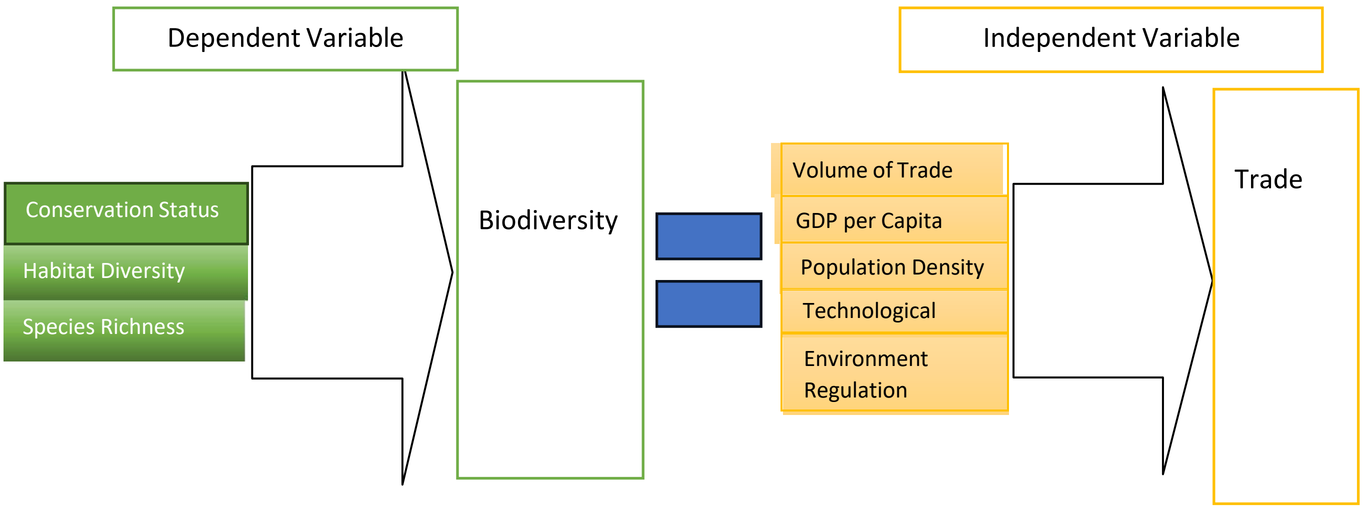
The dense population in countries like Rwanda and Burundi, as shown in the figure below indicates the pressure on land use, particularly concerning the balance between urban development and biodiversity conservation.

Figure 3: Population Density in East Africa

(Source: Our World in Data)

While rapid urbanization and the establishment of manufacturing firms and residential constructions may contribute to economic growth and employment opportunities, they also pose significant threats to biodiversity. Increased urbanization often leads to habitat destruction, fragmentation, and pollution, which can disrupt ecosystems and threaten the survival of plant and animal species. Thus, careful planning and sustainable land management practices are essential to mitigate the adverse impacts of urban expansion on biodiversity in densely populated regions like Rwanda and Burundi (Hannah Ritchie and Edouard Mathieu ,2019).

Figure 4: Conceptual Framework



2.2 Empirical Review

2.2.1 Trade Volume

Several studies have looked at the impact of trade volume on biodiversity. For instance, A.M.D Ortiz et al. (2021) found that increased trade volume leads to habitat destruction and fragmentation, and results in biodiversity loss. Similarly, Jones and Brown (2016) highlighted the negative correlation between trade volume and species richness, indicating that higher trade volumes are associated with reduced biodiversity. In contrast, Chen et al. (2019) suggested that sustainable trade practices can mitigate the adverse effects on biodiversity by promoting conservation measures along supply chains. Furthermore, Zhang and Wang (2017) emphasized the importance of incorporating biodiversity considerations into trade agreements to minimize negative impacts on ecosystems. Additionally, Li et al. (2020) demonstrated that trade volume can indirectly affect biodiversity through land-use changes and resource exploitation. It ought to be emphasized that large-scale mining activities continue to decrease the vegetation in most mining communities to levels that are harmful to biological diversity. (Akabzaa, 2000; Akabzaa and Darimani, 2001).

In their May 2023 publication "Reflecting on the Crucial Co-dependence of Biodiversity and International Trade," the UN Environment Programme highlights that while trade in natural and agricultural goods is a major driver of economic growth, it can also lead to the extinction of wild biodiversity. Palm oil, for instance, plays a significant global and local role, with numerous sustainability issues tied to its production, supply, and trade. The palm oil industry has boosted the wellbeing and financial security of smallholders. However, rising global demand has led to a rapid increase in both production volume and the cultivated area for oil palms. This expansion, particularly in Southeast Asia and recently in Latin America and Africa, has caused land degradation, impacting other crops and wild species. Clearing forested land for oil palm plantations not only destroys crucial wildlife habitats but also threatens water, air, and soil quality.

Trade can support biodiversity preservation and responsible use of natural resources by creating markets for ecosystem services, such as carbon and biodiversity credits, which incentivize conservation efforts. It can also promote eco-certification schemes and facilitate international collaboration to address transboundary environmental challenges and climate action. However, trade also has adverse effects on biodiversity and climate change, primarily due to the depletion of natural capital from the increased demand for natural resources and commodities. This leads to higher greenhouse gas emissions, deforestation, overexploitation of resources, land use changes, and pollution.

Alarmingly, between 2018 and 2019, about 64% of developing countries were heavily dependent on commodities. Much of the goods consumed in many countries are imported, meaning our ecological impact on biodiversity may be more significant overseas due to international trade. Several highly consumed products, such as coffee, soy, beef, and chocolate, are directly linked to biodiversity loss. Between 2021 and 2022, the average unit price for exported soybeans rose by 23.6%, from $483 per ton to $597 per ton. The top soybean exporters in 2022 were Brazil, the United States, Argentina, Canada, and Uruguay. Despite the Soy Moratorium introduced by the Brazilian government in 2006, soy production has long been associated with Amazon deforestation. The demand for soy is linked with global beef demand, as three-quarters of global soy production is used for livestock feed. (World Bank, 2023)

The increasing demand for soy has led to the expansion of farmland, resulting in the loss of over 20 million hectares of the Amazon rainforest to soy farming in Brazil over the past two decades. Similarly, cocoa farming in regions like West Africa, which supplies about 70% of the world's cocoa, Latin America, and Southeast Asia, has been linked to high deforestation rates and biodiversity loss. The global cocoa market, valued at USD 14.5 billion in 2023, is expected to grow at a compound annual growth rate of 4.7%, reaching USD 19.1 billion by 2032, driven by the demand for organic products.

According to the World Cocoa Foundation (WCF) and Mighty Earth, between 2001 and 2014, Côte d'Ivoire lost one-quarter of its 300,000 acres of forests to cocoa production. In Ghana, 10% of tree coverage was lost to cocoa farming during the same period. In Indonesia, 1.7 million acres of forest were cleared for cocoa production between 1988 and 2007, accounting for 9% of the country's total deforestation for crops. Additionally, approximately 40% of cocoa plantations are illegally established in protected areas, further exacerbating the environmental impact of cocoa production.

Trade-induced competitive pressures can hinder conservation efforts and climate action initiatives. Therefore, it is crucial to recognize the complex interdependencies and trade-offs between international trade, biodiversity conservation, and climate change.

Another trade-related activity is tourism, which plays a crucial role in many national economies, generating over 230 million jobs worldwide, accounting for 8% of the global workforce. It can significantly boost a country's gross domestic product (GDP) (D. Bolwell, W. Weinz 2008). For instance, Rwanda's Parc National des Volcans generates $140 million in income, representing about 80% of Rwanda's tourism revenue and contributing 3.7% to its GDP (M. Maekawa, A. Lanjouw, E. Rutagarama, D. Sharp, 2013). Endemic and charismatic species, like the Komodo dragon in Indonesia's Komodo National Park, are major tourist attractions. Poaching these species directly impacts tourism, posing a financial threat to many national parks (M.J. Walpole, H.J. Goodwin, 2001). In Borneo's Lambir Hills National Park, 90% of legally protected species, including half of the primate species, have been eradicated due to poaching. Another issue linked to illegal wildlife trade is the safety of tourists and park employees, as poaching is often accompanied by other crimes (R.D. Harrison, 2011). Increased crime rates in national parks can deter tourists, fearing for their safety, and expose park employees to significant risks. (T. Barnes, 2018).

2.2.2 Population Density

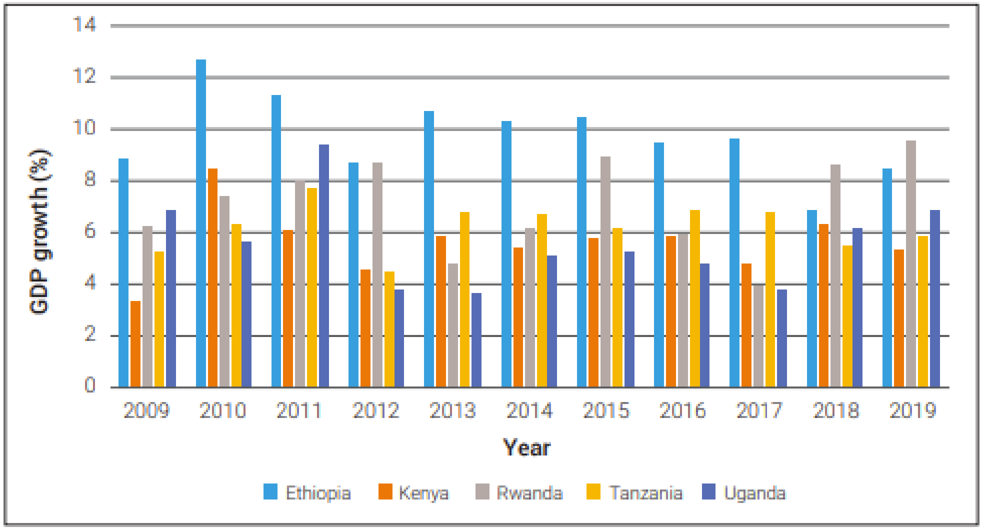
The relationship between population density and biodiversity is varied, complex and diverse in several ways. While scientific consensus on biodiversity loss is unequivocal, it is largely attributed to human activities (Cardinale et al., 2012). Among these activities, land use (often for residential purposes) stands out as a significant driver of biodiversity decline (Lambeck, 1997; Díaz et al., 2006). Globally, the direct relationship between biodiversity loss and land use is anticipated to become the foremost environmental concern by 2100 (Sala et al., 2000). Given that alterations in land use are the primary catalysts for changes in biodiversity, safeguarding biodiversity often entails imposing stringent restrictions on land utilization (Haines-Young, 2009). In Europe, where land area is already under intense utilization, there is mounting pressure to further intensify land use, posing a heightened risk to biodiversity due to potential habitat loss and fragmentation (The European Environment Agency, 2020a) Johnson et al. (2015) observed that higher population density is associated with increased habitat fragmentation and species decline, particularly in urban areas.

On the other hand, Wang and Lui(2018) revealed that moderate population density levels can enhance biodiversity through the effective used of urban planning and habitat restoration. Additionally, population density has a bearing on consumption patterns and can ultimately influence resource use and the degradation of the habitat (Brown and Smith, 2017). Moreover, Zhao et al reported that urbanization alters species composition and the structure of the community. They emphasized the practice of sustainable urban development initiatives to mitigate the consequences that come with urbanization.

2.2.3 GDP Per Capita

The region's economic growth remains positive, with most countries experiencing growth. In 2018-2019, Rwanda's GDP growth (8.5% to 9.4%) surpassed Ethiopia's (6.8% to 8.4%), which had the highest GDP growth in the previous decade (2008-2018).

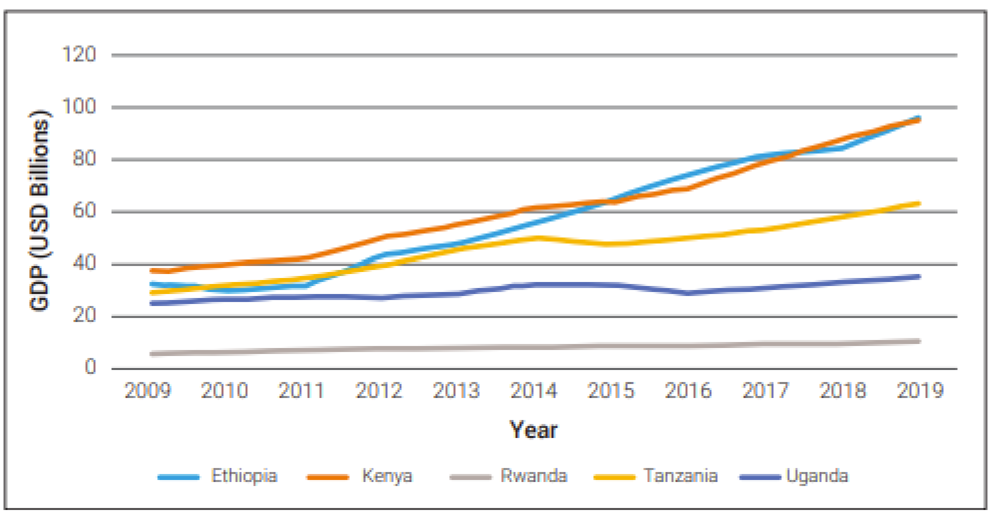
Figure 5: GDP Growth(%) in East Africa



(Source: Africa Development Bank Group)

As of 2019, Kenya and Ethiopia were the largest economies in the region, each with a GDP exceeding $95 billion (Figure). However, the overall GDP of Eastern African countries was expected to contract by 1.7% in 2020 due to the impacts of COVID-19. (ADB, 2020)

Figure 6: GDP Growth(USD Billions) in East Africa



(Source: Africa Development Bank Group)

Several studies have looked at GDP per capita and how it interacts with biodiversity. For instance, Liu et al(2016) found that much of the biodiversity loss can be directly attributed to increased consumption of resources and industrialization. Wang et al (2018), similarly reported a negative correlation between GDP per capita and biodiversity. They argued that economic development leads to habitat destruction through increased production.

In contrast, Zhang et al. (2017) argued that higher GDP per capita can enable investment in conservation efforts and environmental protection measures, thereby promoting biodiversity conservation. Furthermore, Li and Chen (2019) proposed that sustainable economic development models, coupled with strict environmental regulations, can mitigate the negative impacts of GDP per capita growth on biodiversity.

The significance of biodiversity in fostering development cannot be overstated, and its depletion poses a serious threat to the progress achieved in development efforts. Biodiversity serves as a buffer against various crises, including climate change and conflicts, thereby safeguarding development. Moreover, it serves as a crucial economic asset for both impoverished nations and marginalized communities within countries by generating employment opportunities and contributing to GDP growth. Take the fisheries sector, for instance, where linked to fishing and fish farming are 60 million jobs globally. For each of these positions, an additional 2.5 jobs are created within the fisheries value chain, totaling 200 million jobs, with 60 percent of them situated in the developing world. Similar dynamics can be observed in sectors like forestry and nature-based tourism (World Bank, 2024)

The importance of biodiversity extends beyond the sheer diversity of living organisms; it encompasses the invaluable services provided by robust ecosystems, such as natural pollination, sustenance from marine fisheries, and timber yield from indigenous forests. (World Bank, 2024)

2.2.4 Environmental Regulations

The influence of environmental regulations on biodiversity has been extensively studied. Nanyunja (2003) found that stringent environmental regulations are crucial for biodiversity conservation by limiting habitat destruction and pollution levels. Similarly, Wang et al. (2019) emphasized the role of regulatory frameworks in promoting sustainable land-use practices and biodiversity-friendly development projects. Additionally, Maitima et al. (2014) highlighted the importance of enforcing regulations and implementing ecosystem-based approaches to biodiversity management.

However, Jones et al. (2020) suggested that inadequate enforcement of environmental laws can exacerbate biodiversity loss, particularly in regions with elevated levels of habitat degradation and illegal resource extraction. Moreover, Chen and Wang (2019) emphasized the need for international cooperation in harmonizing environmental standards to address global biodiversity challenges effectively.

2.2.5 Technological Development

Johnson and Smith (2017) demonstrated that technological advancements, such as satellite imagery and remote sensing, enable more accurate monitoring of biodiversity trends and habitat changes. Additionally, Wang et al. (2020) highlighted the role of innovative technologies, such as DNA barcoding and bioinformatics, in species identification and conservation genetics research. Furthermore, Li et al. (2021) proposed that sustainable technologies, such as renewable energy and green infrastructure, can mitigate the ecological footprint of human activities and promote biodiversity conservation. Conversely, Brown and Jones (2019) warned of the potential negative impacts of emerging technologies, such as genetic engineering and biotechnology, on ecosystem dynamics and species interactions. Moreover, Chen et al. (2021) emphasized the importance of ethical considerations and precautionary measures in the development and deployment of modern technologies to safeguard biodiversity and ecosystem integrity.

2.3 Theoretical Review

2.3.1 Green Theory

Green theory stands out for its propensity to challenge established political, social, and economic frameworks that support environmental policies. It goes beyond mere environmentalism and political advocacy, advocating for radical shifts. Green morality highlights the importance of limiting human consumption of resources to safeguard the interests of the non-human environment. However, this can be seen as a restriction on human consumption, potentially conflicting with individual rights to utilize resources as needed (African Journal of Economics and Sustainable Development, Dyer, 2018). Green theory is firmly rooted in a stringent moral perspective, and therefore advocates for a distinct set of values that are not bound by political ideologies (Goodin, 1992).

When it comes to the consequences of excessive consumption and the exploitation of aggregate resources, green theory provides a more comprehensive framework for comprehending the impacts of economic and political decisions and intentions. The issue of both legal and illegal aggregate extraction is a global concern that demands immediate attention due to the existing imbalance between the rate of use and replenishment of sand and gravel. Legal mining involves various stakeholders including governments, individuals, and organizations that extract sand for societal benefit. On the other hand, illegal miners, often referred to as sand mafias, engage in extraction without proper authorization. In extreme cases, these illegal operators resort to violence, even causing harm to those who oppose their self-serving interests.

2.3.2 Model of Human Interaction with the Environment

In 1995, Hammond proposed the model outlining human interaction with the environment. This model delineates four distinct interactions between human activities and the environment, namely:

1. **Source:** People extract minerals, energy, food, fibres, and various natural resources from the environment to support economic activities. This extraction process has the potential to deplete resources and harm biological systems, such as soils, essential for their sustained production.

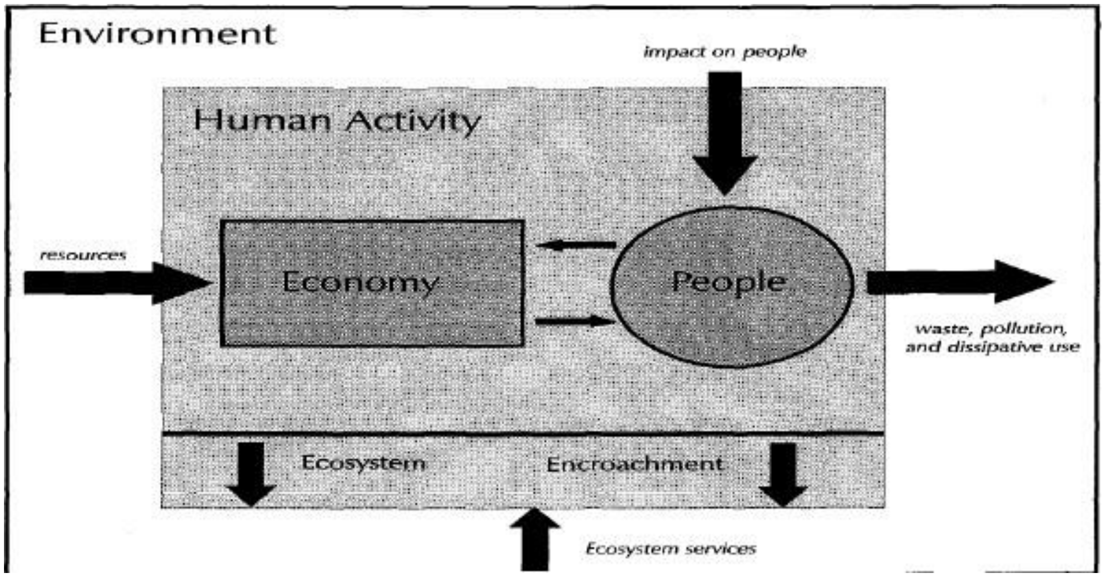
2. **Sink:** Through industrial processes, natural resources are transformed into products (e.g., pesticides) and energy services, which are utilized or dispersed and eventually discarded. This leads to the creation of pollution and wastes that, unless recycled, return to the environment, and ultimately lead to environmental degradation.

3. **Life Support:** Earth's ecosystems, particularly unmanaged ones, offer crucial life-support services. These services encompass the decomposition of organic waste, recycling of nutrients, oxygen production, and the preservation of biodiversity. As human activities expand and interfere with ecosystems, there is a potential reduction in the environment's capacity to provide these essential services.

4. **Impact on Human Welfare:** The direct consequences of polluted air and water, as well as contaminated food, have a profound effect on human health and overall well-being.

This conceptual framework, proposed by Hammond, serves as a comprehensive guide to understanding the multifaceted interactions between human activities and the environment. It underscores the dynamics involved in resource extraction, industrial processes, ecosystem services, and the direct implications on human welfare.

Figure 7: Hammond's Model of Human Interaction with the Environment



(Source: Fortune Journals)

This model illustrates the impact of human activities on the environment. While it encompasses a broad spectrum of human activities, a deeper understanding of the interrelated variables within the model enriches comprehension of potential consequences associated with various behaviours in the environment. (Akintunde, 2017).

The model of human interaction with the environment, as proposed by Hammond, imparts valuable lessons applicable to various contexts such as the impact of human activities on ecological and biological environment.

Firstly, the theory highlights the relationship between human activities and the environment and points to the potential consequences of resource extraction. In the case of natural resource extraction, the process can disrupt ecosystems and deplete a vital resource.

Secondly, the model highlights the close interconnectedness of variables and warns about the need to consider the broader environmental implications of specific actions. Regarding land use for commercial(mining) or subsistence(residential) purposes, the model demonstrates how the activity can influence water tables, disrupt habitats, and affect local economies.

Lastly, the model emphasizes the importance of sustainable practices to mitigate negative outcomes. Applying this to biodiversity can dictate sustainable extraction practices that can help preserve the environment and safeguard the socio-economic well-being of communities dependent on these resources.

2.3.5 Commons Governance Theory

The Commons Governance Theory, rooted in Elinor Ostrom's work, focuses on the management of common pool resources by local communities. This theory explores how common pool resources, such as land, can be effectively managed to balance ecological sustainability and socioeconomic needs. In the context of sand and river mining, where the resource is often a shared asset, this theory becomes pertinent. Throughout her research endeavours, Professor Ostrom aimed to investigate mechanisms addressing shared challenges encountered by communities worldwide, and strictly avoided both government-centric and market-oriented approaches. She disapproved of the portrayal of individuals as helpless observers entrapped in an unavoidable cycle of depleting their own resources. Ostrom contended that societies and groups routinely establish rules and enforcement mechanisms to prevent the degradation of nature. (Wyn Grant, 2012) The study can examine how different governance structures, such as community-based management, government regulations, or private sector involvement, influence the socioeconomic impact of land use and resource exploitation.

Applying the Commons Governance Theory in this study allows for a comprehensive analysis of the governance structures and mechanisms that shape outcomes of the relationship between trade and biodiversity. It provides insights into how different governance approaches can contribute to sustainable biodiversity conservation practices while promoting the well-being of communities dependent on these resources.

Chapter Three: Methodology

The methodology section of this research outlines the approach used to investigate the relationship between trade activities and biodiversity in East Africa. The study primarily adopts a quantitative research design with some qualitative elements to provide a comprehensive understanding of the topic. Stata will be utilized for data analysis, incorporating both descriptive and inferential statistical techniques.

3.1 Research Design

The research design involves a mixed-method approach, combining quantitative analysis of trade data with qualitative examination of biodiversity conservation efforts in East Africa. This approach allows for a holistic assessment of the relationship between trade activities and biodiversity outcomes in the region.

3.2 Area of Study

The study focuses on East Africa, which comprises countries such as Kenya, Tanzania, Uganda, Rwanda, Burundi, and South Sudan. These countries are selected due to their diverse ecosystems, significant biodiversity, and active involvement in regional trade activities.

3.3 Population, Sampling Technique(s), and Sample Size

The population of interest includes trade transactions and biodiversity conservation initiatives in East Africa. A stratified random sampling technique will be employed to select representative samples from various sectors involved in trade and biodiversity conservation. The sample size will be determined based on the availability of data and statistical considerations to ensure adequate representation.

3.4 Definition and Measurement of Variables

Variables of interest include trade volume, trade patterns, biodiversity indicators, conservation measures, policy interventions, economic indicators, and socio-demographic factors. Trade volume will be measured in terms of value and quantity, while biodiversity indicators may include species richness, habitat diversity, and conservation status.

3.5 Econometric Model:

BIi =β0 + β1TVi + β2ERi + β3GDPi + β4PDi + β5TDi + ϵi

Where:

BIi is the biodiversity index for region i

TVi represents the trade volume in region i

ERi denotes the level of environmental regulations in region i

GDPi is the GDP per capita in region i

PDi denotes the population density in region i.

TDi represents the level of technological development in region i.

β0, β1, β2, β3, β4, β5, are the coefficients to be estimated.

ϵ_i is the error term.

3.6 Types and Sources of Data Collection

Data will be collected from multiple sources, including government agencies, international organizations, research institutions, and academic publications. Trade data will be obtained from national customs departments, trade databases, and international trade organizations. Biodiversity data will be sourced from national parks, conservation organizations, and research studies.

3.7 Research Instruments

The research will solely rely on document analysis as the primary research instrument, with a focus on gathering insights from trade stakeholders, conservation practitioners, policymakers, and community members. This approach aims to comprehensively examine both quantitative and qualitative data sources to gain a thorough understanding of the dependencies of the variables and the extent of influence they collectively have on the dependent variable. The research will, through the analysis of various documents such as reports, policies, legislation, and academic literature, extract valuable insights and perspectives from diverse stakeholders involved in trade and biodiversity conservation efforts.

3.8 Validation and Reliability of Research Instruments

The validity and reliability of research instruments will be ensured through pilot testing, expert review, and triangulation of data sources previously done on the data obtained from the selected sources for this research.

3.9 Data Analysis Techniques

Quantitative data analysis will involve descriptive statistics, correlation analysis, and regression analysis using Stata software. Qualitative data analysis will employ thematic coding, content analysis, and narrative synthesis to identify patterns, themes, and relationships among variables.

4.0 Chapter Four: Findings and Discussions

The focus of this chapter revolves around the findings of this study on the relationship of trade and biodiversity. Trade Volume, Environmental Regulation, GDP per Capita, Population Density, and Technological Advance are the factors used to measure trade in this study, while Species Richness, Habitat Diversity and Conservation Status define biodiversity. Analyzing the interaction between economic activities and biodiversity creates an avenue for policy formulation on conservation and the promotion of sustainable economic activities

The analysis includes descriptive statistics, correlation analysis, and trend analysis on all individual factors that represent the two variables.

4.1 Summary Statistics

Table 1: Summary Statistics of Key Indicators

Variable	Obs	Mean	Std. Dev.	Min	Max
Year	31	2005	9.092	1990	2020
Trade Volume	31	22834.981	5497.112	11638.734	31902.81
Environmental Regulation	31	4.929	9.075	.028	47.638
GDP Per Capita	31	1177.742	470.476	590	1937
Population Density	31	1982.401	1586.921	329.692	5083.827
Technological Development	31	5.747	7.553	0	24.988
Species Richness	31	3350.968	1272.992	1667	5372
Habitat Diversity	31	4409.764	1994.329	2051.921	7368.699
Conservation Status	31	35667.627	7996.84	25019.372	46865.965

As shown above, the average trade volume for the period 1990 to 2020 stood at $22834.9 with a standard deviation of 5497.1. Furthermore, the average intensity level of environmental regulation was 4.9 with a standard deviation of 9.07, while GDP per Capita stood at $1177.7 billion, deviating from the mean by 470.5 approximately. Population Density, Technological Development, Species Richness, Habitat Diversity, and Conservation Status stood at 1982.4, 5.4, 3350.9, 4409.7, and 35667.6, deviating from the mean by 1586.9, 7.5, 1272.9, 1994.3, and 7996.8, respectively.

4.2 Correlation Results

*Table 2: **Pairwise Correlations Species Richness***

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) logsprichness	1.000					
(2) TrdaeVolumeinb	0.869*	1.000				
(3) GDPPerCapita	0.861*	0.800*	1.000			
(4) PopulationDens	0.854*	0.682*	0.908*	1.000		
(5) TecnologicalDe	0.548*	0.690*	0.713*	0.422*	1.000	
(6) EnvionmentRegu	0.154	0.141	0.087	0.043	0.079	1.000

**** p<0.01, ** p<0.05, * p<0.1*

The correlation results above affirm a strong relationship amongst the interacting variables.

Species richness shows positive correlations with trade volume, GPD per capita, and population density with coefficients of 0.869, 0.861, and 0.854 respectively. Technically, the results indicate that improvements in these trade-related factors will influence a positive change in the species richness. Furthermore, there appears to be somewhat moderate relationship between species richness and technological advancement with a coefficient of 0.548. This implies that growth in the richness of species has very little influence on the development of technology. Surprisingly, however, species richness has no influence on environmental regulation.

Regarding the significance of these relationships, all correlations show statistical significance at 0.1level (p<0.1) except species richness and environmental regulation which highlight a negligible level of significance.

Table 3: ***Pairwise Correlations Habitat Diversity***

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) lnhd	1.000					
(2) TrdaeVolumeinb	0.881*	1.000				
(3) GDPPerCapita	0.958*	0.800*	1.000			
(4) PopulationDens	0.889*	0.682*	0.908*	1.000		
(5) TecnologicalDe	0.718*	0.690*	0.713*	0.422*	1.000	
(6) EnvionmentRegu	0.072	0.141	0.087	0.043	0.079	1.000

**** p<0.01, ** p<0.05, * p<0.1*

The correlation matrix above highlights strong positive relationships amongst some of the interacting variables. Natural habitat, like species richness, shows a strong positive relationship with trade volume, GDP per capita, and population density with coefficients 0.881, 0.958, and 0.889 respectively. This suggests that higher levels of habitat diversity lead to increased trade volume, higher GDP per capita and greater population density.

However, we saw a moderate positive and weak relationship between habitat diversity and technological advancement and environmental regulations, with correlation coefficient of 0.718 and 0.072 respectively. This relationship suggests that habitat diversity has a moderate bearing technological advancement and little or no influence on environmental regulation.

Overall, these correlations suggest that natural habitat diversity is closely linked with various socioeconomic factors such as trade volume, GDP per capita, population density, and to a lesser extent, technological development, while showing limited association with environmental regulations

*Table 4:**Pairwise Correlations Conservation Status***

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) ConservationSt~e	1.000					
(2) TrdaeVolumeinb~s	0.902*	1.000				
(3) GDPPerCapita	0.855*	0.800*	1.000			
(4) PopulationDens~y	0.808*	0.682*	0.908*	1.000		
(5) TecnologicalDe~t	0.652*	0.690*	0.713*	0.422*	1.000	
(6) EnvionmentRegu~n	0.135	0.141	0.087	0.043	0.079	1.000

*** *p<0.01*, ** *p<0.05*, * *p<0.1*

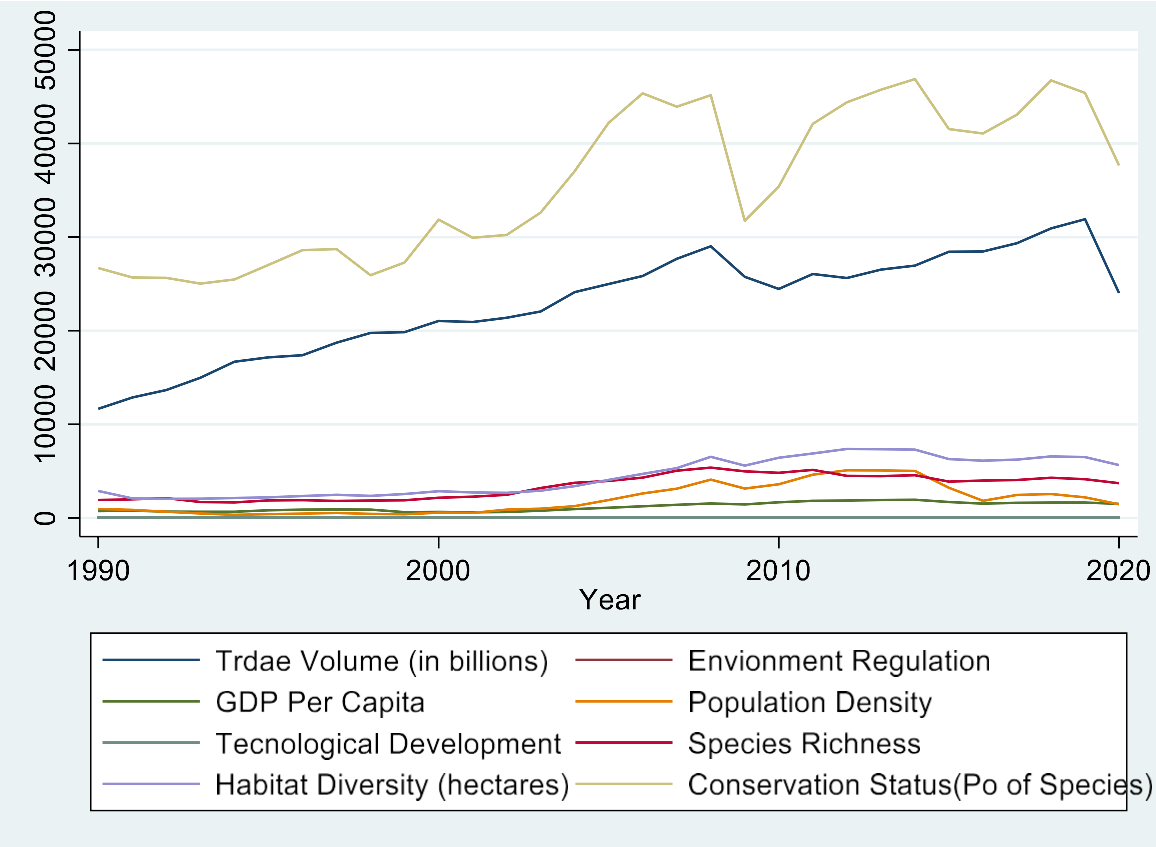
The pairwise correlation denotes a strong positive relationship between conservation status and trade volume, GDP per capita, and population density with coefficients of 0.902, 0.855, and 0.808 respectively. This implies that greater levels of conservation are associated with higher levels of trade volume, higher GDP per capita, and greater population density.

On the other hand, conservation status reveals a moderate connection with technological development and very little correlation with environmental regulation.

All correlations were statistically significant at the 0.1 level (p<0.1) which highlights strong relationships between the variables. What seems to be a negligible statistical significance is the relationship between conservation status and environmental regulation.

4.3 Graphical Representation of the Data

Figure 8: Interaction Between Dependent and Independent Variables Overtime



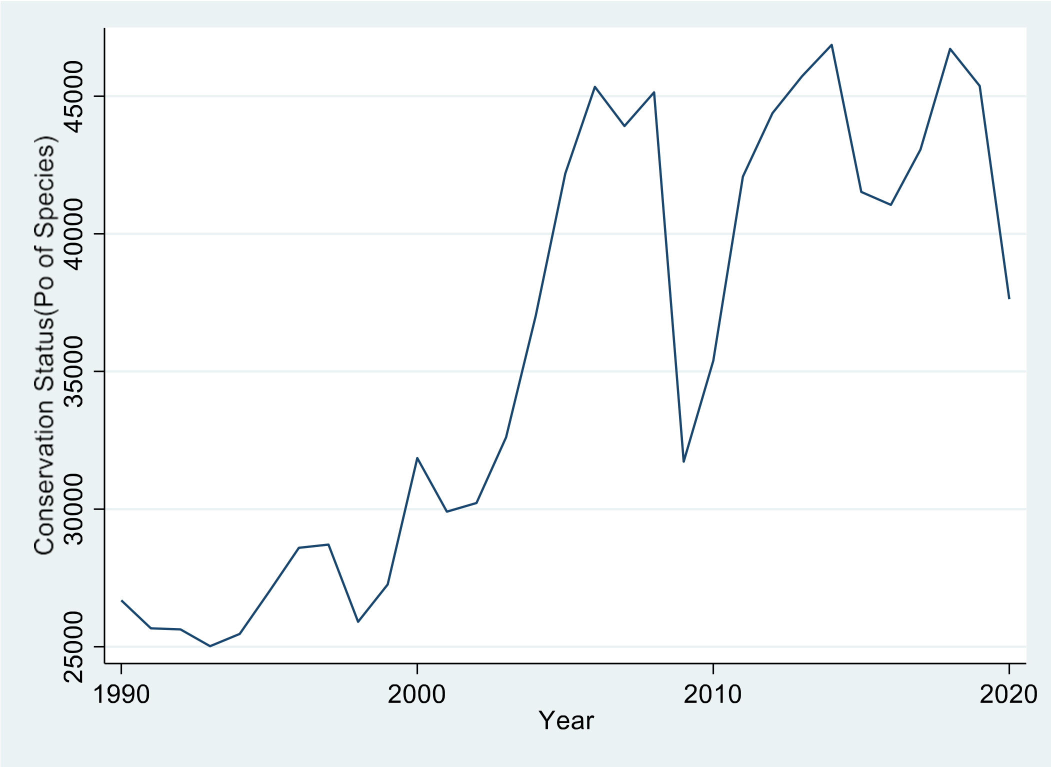
Source: (Author's own)

The graph above shows the collective interaction amongst the variables during the period under study. Conservation status has had a steady growth from 1990 with slight fluctuations around the late 90s towards the mid-2000s when it started to rise again. Around 2010, it had a sharp decline. According to a study in the same period by the Zoological Society of London, East Africa had a 69% decline in the population of key mammal species.

Towards 2020, it had a rise with a down fluctuation. The same study affirmed that despite the loss, the rate of decline slowed, showing some improvement in the management of wild conservation.

Trade Volume on the other hand had a steady and flattened growth in the first 20 years from 1990. In 2010 it had a slight decline but flattened over time as it rose towards 2020. The trend agrees with the assertion of Catherine McAuliffe, Sweta C. Saxena, and Masafumi Yaraba (n.d), who found that the East African Community enjoyed an improvement in the trading activities largely due to improved policies which led to a 3.6 growth rate of per capita income. The rest of the variables had a somewhat constant growth that flattened throughout the period with insignificant rise towards the end of the period.

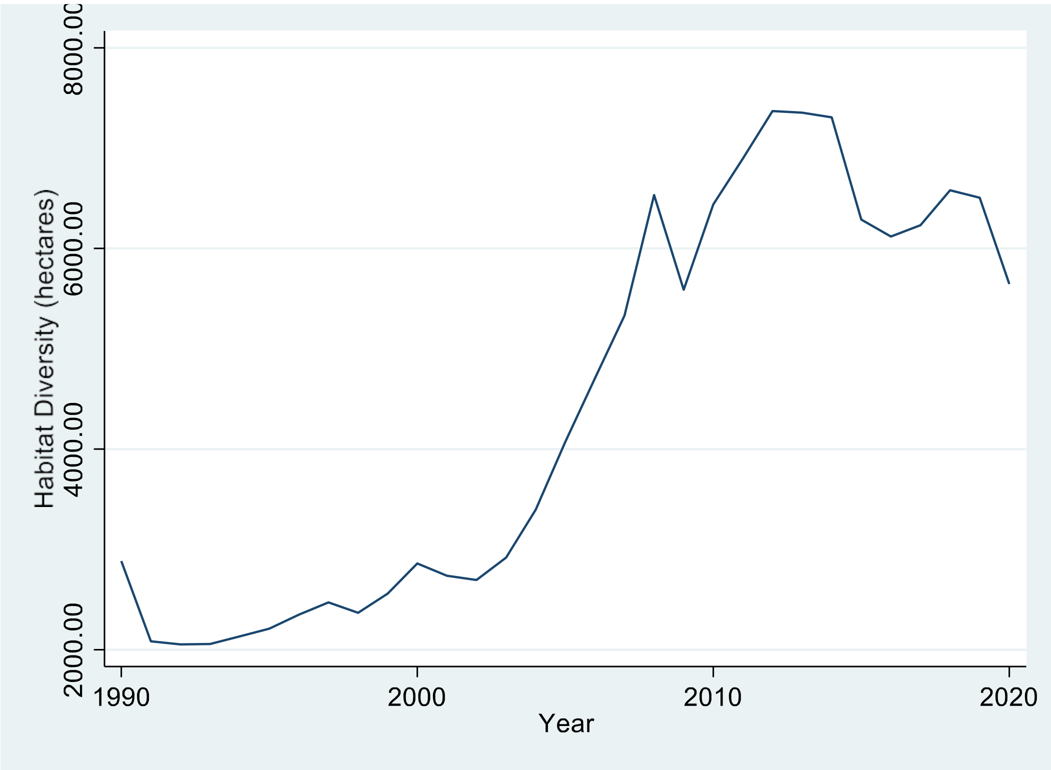
Figure 9: Conservation Status Trend Over Time



Source: (Author's own)

Conservation Status had a fluctuational trend with very sharp increases and declines, although it kept growing throughout the period. The decline in its interaction with other variables occurred in the same period. Although it was above the three thousandth mark in both cases, it went a little higher alone than it did with other variables. This is due to the efforts that have been put in place to conserve wildlife and natural habitats.

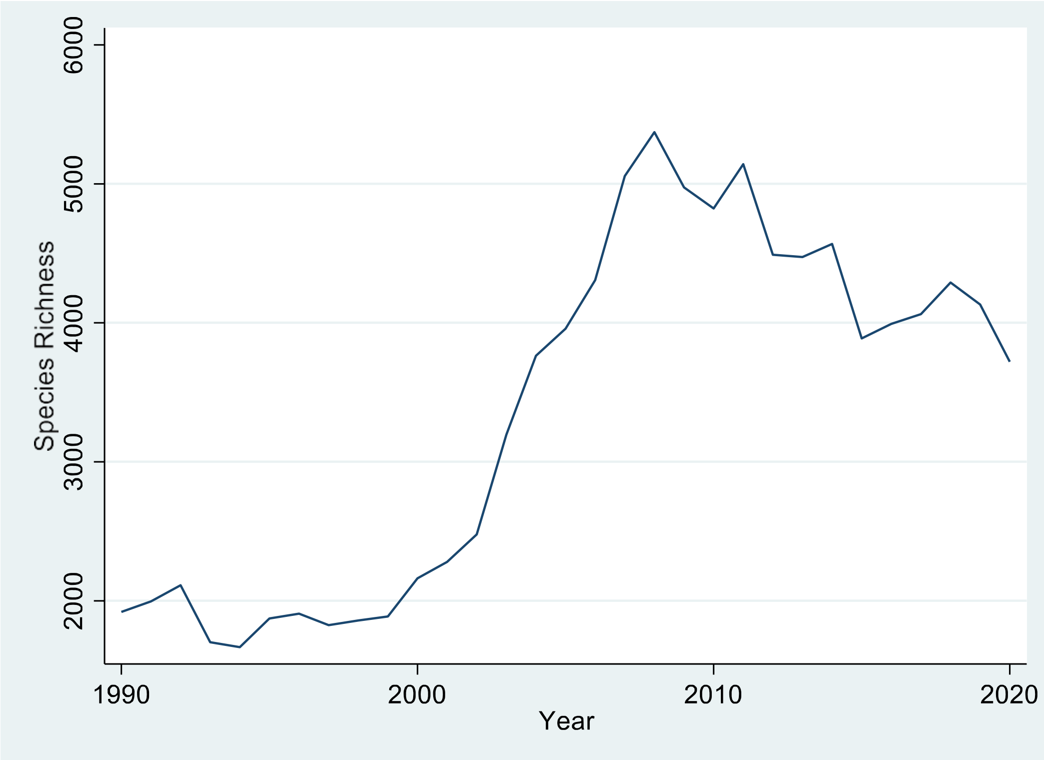
Figure 10: Habitat Diversity Trend Overtime



Source: (Author's own)

From 1990, Habitat Diversity had a steady and increasing growth until around 2009-2010 when it started fluctuating, but with an increasing trend. The East African region boasts diverse forests, which are essential for supporting rich biological diversity. These forests comprise various types such as tropical and sub-tropical forests, forest plantations, Miombo woodlands, Savannah, Acacia woodlands, and mangroves. They play a crucial role in sustaining people's livelihoods and fostering regional socio-economic progress by offering goods and services. In addition to supplying fuelwood, timber, poles for construction, medicinal resources, and food, these forests serve as crucial guardians against soil erosion, provide habitat for valuable biodiversity, act as water catchment areas, and offer recreational spaces. These and others necessitated the enactment of stringent laws that promote biological diversity (EAC, 2024).

Figure 11: Species Richness Trend Overtime



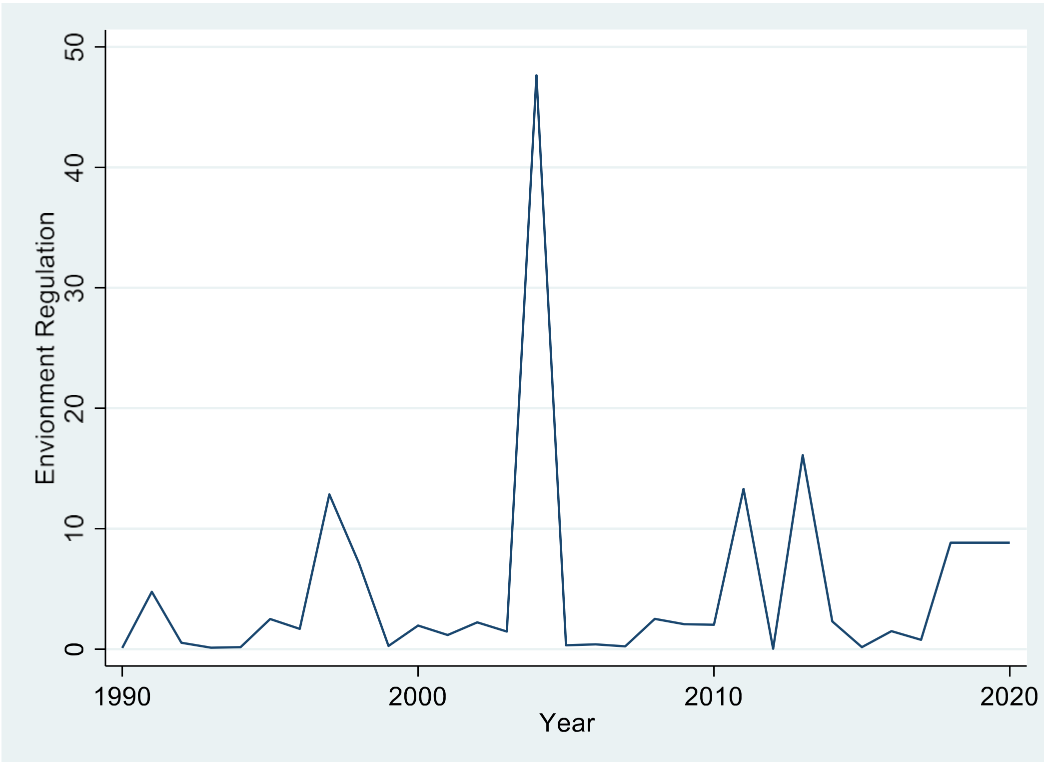
Source: (Author's own)

As shown in the graph above, there had been a steady rise in the richness of the species the EAC is endowed with from 1990 to around 2009, when it began to decline. Despite the decline, the region prides itself in the variety of species that it harbors.

Burundi has approximately 100,000 hectares of protected land, 172,000 hectares of forest cover, and about 2854 animal and plant species (EAC, 2004). Rwanda, on the other hand has up 402 mammal species and over 6000 of aquatic, aerial and terrestrial species including animals and plants.

Tanzania is biologically endowed with primates, antelopes, and physical features such Lake Victoria, Tanganyika, as well as Nyasa. In terms of numbers, amphibian species stand at 40, reptiles at 290, and plants at 11,000. In Uganda numbers stand at over 6000 species of mammals birds, reptiles, plants, and amphibians.

Figure 12: Environmental Regulation Trend Over Time



Source: (Author's own)

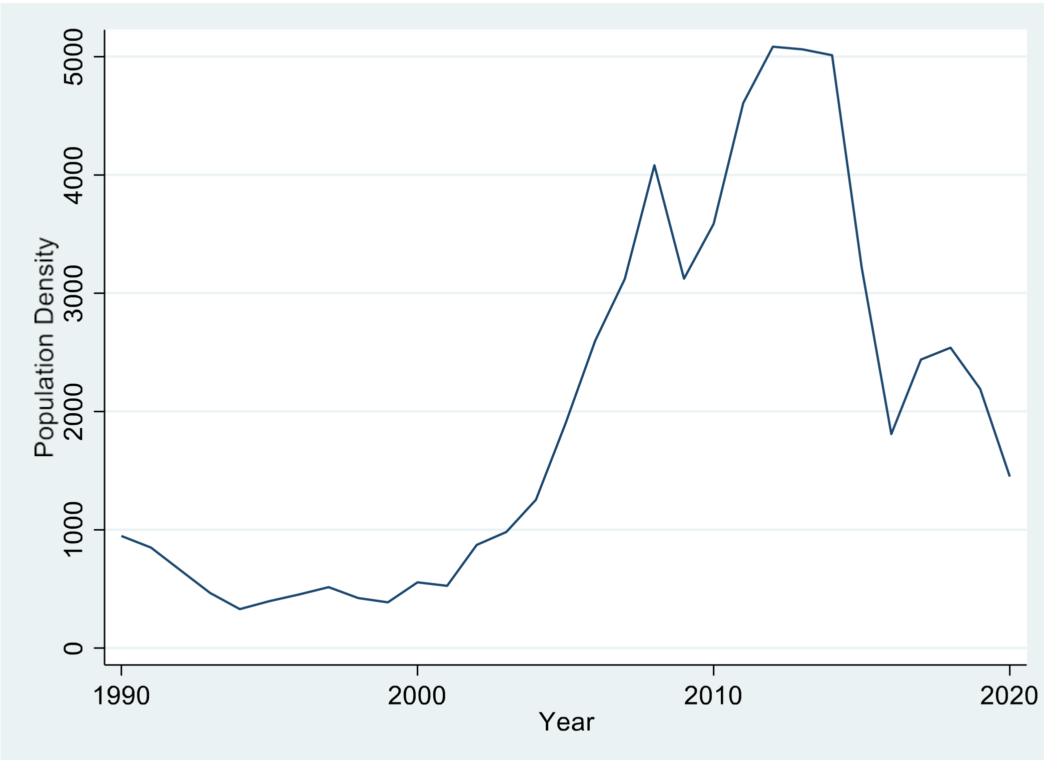
The intensity of environmental regulation was fluctuational throughout the period. In the 2000s, it had a very sharp rise towards the 50% mark which barely lasted before it experienced a sharp decline after which it never went beyond the 20% mark. The low levels of intensity could be attributed to the emergence of trade-induced environment regulation during the period, which led to the relaxation of some the regulations to allow the full execution of the trade induced laws.

Figure 13:GDP per Capita Trend Overtime

Source: (Author's own)

GDP for the East African Community has been on the rise throughout the period, although it had a fluctuational start in the first ten years of the thirty-year period. The last 20 years have been quite yielding, causing a sharp increase in GDP per capita. Although not exhaustive, what led to this growth according to Catherine McAuliffe, Sweta C. Saxena, and Masafumi Yaraba (n.d) encompasses a range of factors such as macroeconomic strategies, investment and trading activities, political and economic structures, infrastructure and financial advancements, human resource development, and the distribution of income.

Figure 14: Population Density Trend Overtime



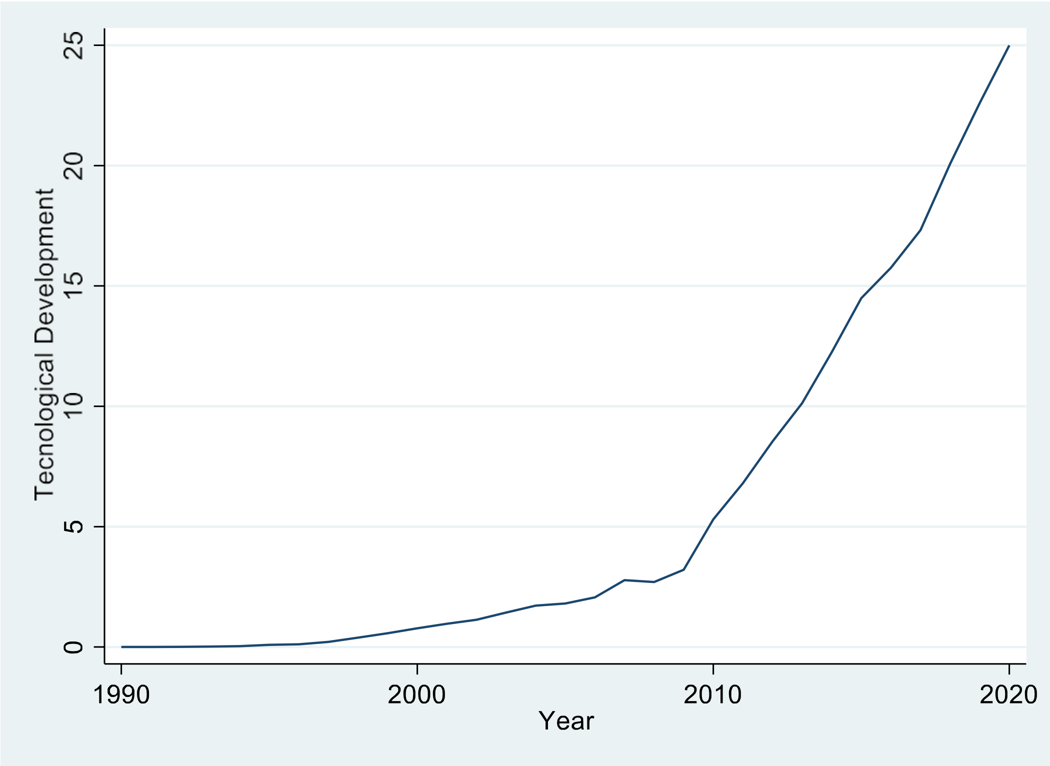
Source: (Author's own)

Population density has been on the rise until around 2012 when it flattened before it had a drastic fall in the years following 2012. It picked up a bit but began to fall again until 2020.

The East African Community (EAC) is currently experiencing rapid population growth, contributing to challenges such as poor health, poverty, environmental degradation, unemployment, and diminishing agricultural productivity. According to the most recent United Nations World Population Prospects report, which includes data up to 2015, Kenya, Uganda, and Tanzania are among the 33 nations projected to see their populations increase at least fivefold by the year 2100. The EAC collectively has a population of approximately 150 million people, inhabiting a land area of 1.82 million square kilometers.

The first twenty years agree with the data presented by the UN and thus, validate part of what is represented on the graph. The latter part which disagrees with the UN data could be attributed to Africa's poor data management, which leads to inconsistencies and discrepancies in the reported data.

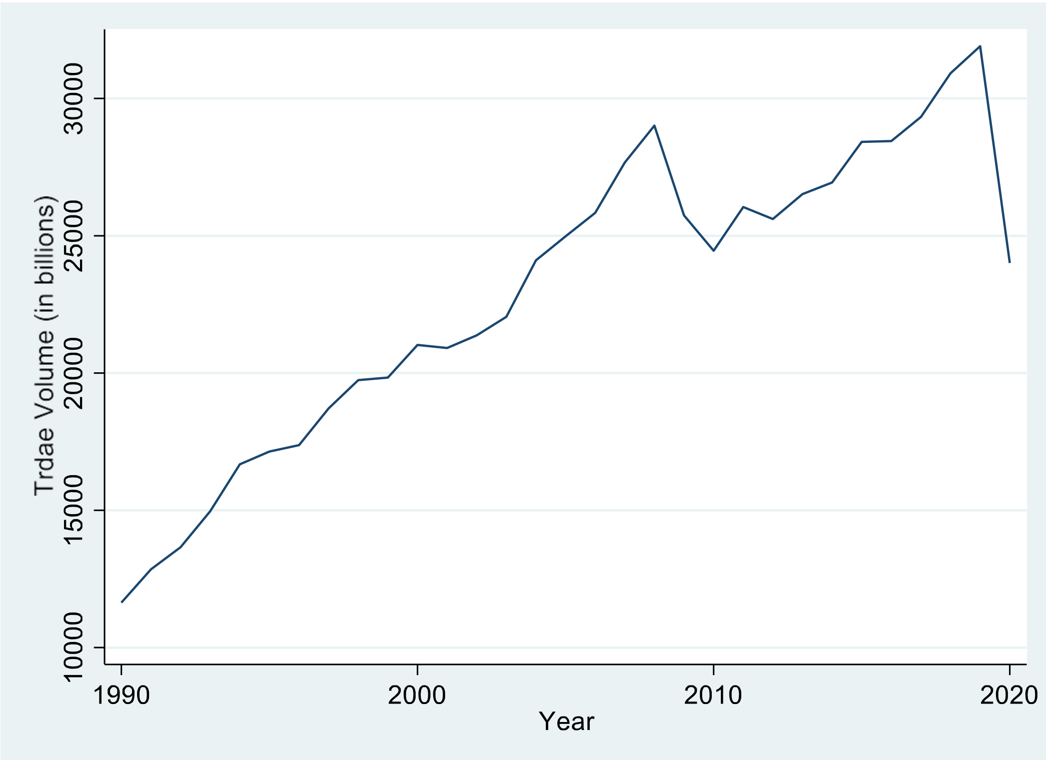
Figure 15: Technological Development Trend Overtime



Source: (Author's own)

Technological Development may be the one that has not had any fluctuations during the period. It had been on the rise until 2020, although the sharp increase occurred only after 2010 after a very slow but steadily constant growth. This could be explained by Africa's poor performance in the tech industry, having been on the consumption side rather than the production side, despite the enormous endowment of the resources that are used in the production of technological products.

Figure 16: Trade Volume Trend Overtime



Source: (Author's own)

Trade volume had a steady and rapid increase in the first twenty years of the period. Even though the last ten have been fluctuational, it had been on the increase until 2020 when it had a sharp decline. It could be recalled that EAC was formed in 1999 and came into force in 2000. This integration led to the removal of many trade barriers, thereby boosting trade in the community and contributing immensely to improvement in exports(Achacha, 2020).

4.4 Findings

This chapter presents the results from our study of the relationship between trade and biodiversity. The factors that are use to measure trade include trade volume, GDP per capita, population density, technological advancement, and environmental regulation. Biodiversity on the other hand is represented by species richness, conservation status, habitat diversity. The findings reveal varying levels of significance in the interaction of these factors.

4.4.1 Strong Positive Relationships with Biodiversity

GDP per Capita

The results obtained indicate that GDP per capita has a very strong relationship with biodiversity which is measured by species richness, conservation status, and habitat diversity. What this implies is that regions that have a high GDP tend to have richer biodiversity compared to those with lower GDP. This is correct to some extent, as a rise income could translate into availability of funding for conservation, resource allocation for the maintenance of natural habitats, and stronger institutional involvement to support biodiversity preservation, although this may not be true for all as in the case of many African nations that are using funds for the wrong priorities.

Trade Volume

The results further reveal that trade equally has a positive relationship with biodiversity. It is evident that trade can trigger economic growth which, aside from its potential to directly contribute to biodiversity conservation by enhancing investment in it, can also actualize the transfer technologies and strategies that are crucial for environmental protection. What must be noted is that other forms of trade regardless of its contribution to the economy can seriously pose a danger to the environment especially trade in natural resources.

Population Density

Like trade and GDP per capita, population density also shows a strong positive relationship with biodiversity. Although this relationship is counterintuitive, as population density tends to place a great burden on the environment due to high demands for residential land, strong protective environmental policies and effective urban planning can enhance preservation of biodiversity. This is true particularly for countries that incentivize residential areas that plant trees in their neighborhoods.

4.4.2 Moderate Significant Relationships with Biodiversity

Technological Development

Technological advancement shows a moderately significant relationship with biodiversity indicators. Advancements in technology should have had a very significant impact on biodiversity, as improved conservation techniques, better monitoring of species and habitats, and an improved resource use efficiency are all triggered by technology. This relationship, therefore, only suggests that technology is not fully utilized to enhance biodiversity or there are impeding factors.

4.4.3 Weak or No Significant Relationships with Biodiversity

Environmental Regulation

Contrary to what was expected, environmental regulation seems to have very little or no influence on biodiversity. Illogical as it may appear, it could be true for many reasons including variations in the implementation of environmental policies across countries in the region, quality of the regulations and regulatory authorities, and the time that is required for regulations to take effect often having weak immediate effects.

5.0 Chapter Five: Conclusion and Recommendation

5.1 Conclusion

The results from this study reveal that three trade related factors (environmental regulation, trade volume, and GDP per capita) have the potency to effect an improvement in biodiversity. While one other factor has a moderate relationship with biodiversity, another one denotes weak correlations. Based on the results obtained, the null hypothesis that there no is relationship between trade and biodiversity does not hold given that majority of the trade related variables signify that they could influence biodiversity. On the other hand, the second null hypothesis, policies and regulatory frameworks have not been effective in enhancing trade and biodiversity conservation holds, as environmental regulation has been found to not have the potency to enhance biodiversity.

It could, therefore, be concluded that trade generally has a positive influence on biodiversity. Greater biodiversity conservation can be realized when factors such as trade volume, population density and GDP per capita are strategically developed to be responsive to environmental protection initiatives.

5.2 Policy Implications and Recommendations

On the basis of the conclusion, the following must be considered:

1. Economic Growth and Biodiversity Conservation

Consistency in the rise of GDP is crucial, as it is a requisite for greater investment in environmental protection. Governments must seek to strike a balance between industrial development environmental protection to enhance longer-term sustainability of biodiversity. The EAC must therefore consider investing in green infrastructure and promoting eco-tourism to preserve natural habitat.

Costa Rica for instance, invested in conservation programs where homeowners were incentivized financially for implementing sustainable land-use and forest management practices that yielded significant biodiversity conservation for the country.

2. Trade and Sustainable Practices

Given the efficacy of trade in improving biodiversity, the EAC must promote import and export of environmentally friend goods and technologies that preserve biodiversity. Like the EU that implemented stringent environmental policies to govern timber trade and promote sustainable forest management practices, The EAC must adopt and enforce laws like those stipulated by the Convention on Biological Diversity (CBD) to ensure that trade, regardless of the volume does not affect biodiversity negatively.

3. Urban Planning and Population Density

To enhance biodiversity, Urban areas should be designed to incorporate green spaces, safeguard natural habitat and integrate urban planning practices that are friendly to biodiversity conservation. Urban areas should be developed with a focus on maintaining and enhancing biodiversity. This involves creating green spaces, protecting urban wildlife habitats, and integrating biodiversity-friendly practices in urban planning. This is very likely to be realized if the EAC creates and implements policies that make it obligatory to include green spaces and wildlife corridors in all urban development initiatives.

4. Harnessing Technology for Biodiversity

A deduction that can be drawn from the impact that technology as seen in many countries and regions of the world is that it harnesses biodiversity as these countries and regions incorporated such technologies as remote sensing, clean energy, biotechnology, and GIS for habitat mapping, all of which help reduce environmental impacts and conserve species.

Unfortunately, these technologies are not very common in most of the East African countries. Hence, the negligible impact on biodiversity. The EAC must therefore invest heavily in research and development, innovation, and tech infrastructure through public-private partnerships, bilateral and multilateral cooperation, and other cross-border relations to enhance the impact of technology on biodiversity.

5. Reevaluating Environmental Regulations

There is great (given the result of environmental regulation on biodiversity) need to not only create comprehensive (holistic) environmental regulations(that address pollution control, land use, and habitat protection), but also reinforce the quality that goes into its enforcement by the regulatory authorities. These regulations must be periodically revised to keep up with the times and remain effective

5.3 New and Novel Research Achievement

This research integrates principles from environmental science, economics, and data science to provide a comprehensive analysis of how technological advancements in trade practices impact biodiversity. While most studies on trade and biodiversity have focused on developed nations, this research investigates this relationship in the gradually industrializing regions of East Africa over the past three decades.

5.4 Limitations

One of the limitations of this research is the unavailability of comprehensive data, which necessitated a focus on the last 30 years. Data was only available for some countries from this period, restricting the temporal scope of our analysis. Furthermore, time constraints prevented us from remodeling our research to include other potentially relevant variables for which data might have been available. Consequently, the limited number of years and observations led to issues of multicollinearity among our variables. This multicollinearity prevented us from conducting a robust regression analysis. Additionally, there was insufficient time to address and correct the multicollinearity problem, further impacting the depth and accuracy of our findings

5.5 Suggestions for Further Research

To build upon the limitations and findings of this study, future research can explore several avenues to enhance the understanding of the relationship between economic factors and biodiversity, including conducting studies that extend beyond the last 30 years, incorporating historical data to examine long-term trends and changes in biodiversity relative to economic variables. That research can also include more countries and regions, particularly those with missing data in the current study, to provide a more comprehensive perspective.

REFERENCES

1. African Business (2014). Innovation Africa. 410, 16-18.
2. African Business (2016). ICT driving development. Supplement top guide investigating in Ghana. May, 36-41.
3. African Development Bank Group. African Economic Outlook 2020 Supplement: Amid Covid 19. Annual yearly review study (2020). doi:10.1373/clinchem.2007.093781
4. Article 24 of the Constitution of the Republic of South Africa, 8 May 1996, as amended 11 Oct. 1996.
5. Article 245 of the Constitution of Uganda
6. Campbell K, Hofer (1995). People and wildlife: spatial dynamics and zones of interaction. Serengeti: Dynamics, Management and Conservation of an Ecosystem. (Ed by A. R. E. Sinclair and P. Arcese). Chicago, Illinois, USA, University of Chicago Press pp. 534-570.
7. Cynthia Achacha, Factors Influencing Intra-Regional Trade Volume in East Africa Community A Case Study Of Kenya, Jomo Kenyatta University of Agriculture And Technology, 2020
8. D. Bolwell, W. Weinz Guide for Social Dialogue in the Tourism IndustryILO, Geneva (2008)
9. Demombynes, G., & Thegeya, A. (2012). Kenya's mobile revolution and the promise of mobile savings. (World Bank Policy Research Working Paper, No. 5988).
10. Ecosystem, Kajiado District, Kenya. LUCID Working Paper Series No. 27. ILRI, Nairobi, Kenya. www.lucideastafrica.org.
11. Ethiopia. Conservation Biol. Vol. 11 pp. 435-447. Worden J, Reid R, Gichohi H (2003). Land Use Impacts on Large Wildlife and Livestock in the Swamps of the Greater Amboseli
12. Fabayo, J. A. (1996). Technological dependence in Africa: its nature, causes, consequences, and policy derivatives. Technovation, 16(7), 357–370.
13. Gathara GN (1999). Aerial survey of the destruction of Mt. Kenya, Imenti and Ngare Ndare forest reserve. Kenya Wildlife Service, Nairobi.
14. Gichuru, M.P., Bationo, A., Bekunda MA, Goma HL, Mafongonya PL Mugendi DN, Murwira HM,
15. Githaiga JM, Reid R, Muchiru A, Van Dijk S (2003). Survey of water quality changes with land use type, in the Loitokitok Area, Kajiado District, Kenya. LUCID Working Paper 35, Int. Livestock Res. Institute and United Nations Environ. Programme/Division of Global Environ. Facility Coordination, Nairobi, Kenya.
16. H. W. O. Okoth-Ogendo, 'Juridical framework of Environmental Governance', *in* H. W. O. Okoth-Ogendo & Godber Tumushabe, eds., *Governing the Environment: Political Change and Natural Resources Management in Eastern and Southern Africa* 41 (1999).

17. Hoare RE (1999). Determinants of human-elephant conflict in a landuse mosaic. J. Applied Ecol. 36: 689–700.
18. J. F. Oates, Myth and Reality in the Rain Forest: www.sciencemag.org on March 25, 2010 www.sciencemag.org Downloaded from Conservation Strategies Are Failing in West Africa (Univ. of California Press, Berkeley, CA, 1999).
19. J. Hutton, N. Leader-Williams, Oryx 37, 215 (2003)
20. J. Terborgh, Requiem for Nature (Island Press, Washington, DC, 1999).
21. Kamau P (2004). Forage Diversity and Impact of Grazing Management on Rangeland Ecosystems in Mbeere District, Kenya. LUCID
22. Lambin EF, Geist HJ, Lepers E (2003). Dynamics of land use and land cover change in tropical regions. Annual Rev. Environ. Resources 28: 206-241.
23. Lamprey RH, Mitchelmore F (1996). Survey of wildlife in protected areas of Uganda. Kampala, Uganda, Ugandan Wildlife Authority.
24. Lyaruu HV (2002). Plant Biodiversity Component of the Land Use Change, Impacts and Dynamics Project, Mt. Kilimanjaro, Tanzania.
25. M. L. Imhoff et al., Nature 429, 870 (2004). 59. M. Wackernagel, W. Rees, Our Ecological Footprint:
26. M. Maekawa, A. Lanjouw, E. Rutagarama, D. Sharp Mountain gorilla tourism generating wealth and peace in post-conflict Rwanda Nat. Resour. Forum, 37 (2013)
27. Maitima JM (1998). Changes in vegetation structure and species diversity in Lambwe valley. A study of Tsetse control impacts on Land use: IFAD, intergrated approach to the assessment of Trypanosomiasis Control Technol. and their Impacts on Agric. Production, Human Welfare and Natural Resources in Tsetse Affected Areas of Africa.
28. Maitima JM, Olson JM (2001). Guide to Field Methods for Comparative Site Analysis for the Land Use Change, Impacts and Dynamics Project.www.lucideastafrica.org.
29. Majule AE (2003). A study on land use types, soils and linkage between soils and biodiversity along the slopes of Mt. Kilimanjaro, Tanzania. WWW.Lucideastafrica.org.
30. Mehlich A, Bellis E, Gitau JK (1964). Fertilizing and liming in relation to soil chemical properties. Scott Laboratories, Department of Agriculture, Nairobi.
31. Misana SB, Majule AE, Lyaruu HV (2003). Linkages between Changes in Land Use, Biodiversity and Land Degradation on the Slopes of Mount Kilimanjaro, Tanzania. LUCID Working paper No. 38. Internatioal Livestock Research Institute. Nairobi.
32. Mugatha S, Mathai S, Mugisha S (2004a). The linkages between land-use change, land degradation and biodiversity across East Africa. LUCID Working Paper Series No. 42. p. 63 www.lucideastafrica.org.
33. Mugatha SM, Maitima JM, Ogutu JO (2003). The influence of land use patterns on diversity and abundance of small mammals in Gachoka Division of Mbeere District, Kenya. LUCID working paper No. 8 Nairobi: Int. Livestock Res. Institute. http://www.lucideastafrica.org www.lucideastafrica.org
34. Mugisha S (2002). Root causes of land cover/use change in Uganda: An account of the past 100 years. LUCID Working paper No.14. Int. Livestock Res. Institute. Nairobi. WWW.Lucideastafrica.org.
35. Mutugi R (2003). Changes in Wildlife Numbers and Conservation in Embu and Mbeere Districts, Eastern Province, Kenya. Lucid working paper No. 37.
36. Nanyunja RK (2003). Human Perceptions of Biodiversity Loss inUganda: Case Studies of Sango Bay, Lake Mburo National Park and Rubaale Grasslands. LUCID Working

paper No. 29. International Livestock Research Institute. Nairobi. www.lucideastafrica.org.
37. Noe C (2003). The Dynamics of land use changes and their impacts on the wildlife corridor between Mt. Kilimanjaro and Amboseli National Parks. LUCID working paper No. 31. International Livestock Research Institute. WWW.Lucideastafrica.org.
38. Ntiati P (2002). Group Ranches Subdivision Study in Loitokitok Division of Kajiado District Kenya. LUCID Working paper No. 7. Int. Livestock Res. Institute. Nairobi. WWW.Lucideastafrica.org.
39. Nyathi P, Kimani SK, Jama B , Mapfumo P, Murwira, HK, Okalebo JK, Bationo A (2003). Soil fertility management in semi-arid areas of East and Southern Africa. In (ed.)
40. O'Kting'ati A, Kessy JF (1991). The Farming Systems on Mount Kilimanjaro. In Newmark, W.D. Ed. The Conservation of Mount Kilimanjaro. IUCN, Gland and Cambridge.
41. Okigbo BN, Lal R (1979). Soil fertility maintenance and conservation for improved agro forestry systems in agro forestry. ICRAF, Nairobi, Kenya.
42. Olson JM, Butt B, Atieno F, Maitima J, Smucker TA, Muchugu E, Murimi G, Xu H (2003). Multi-scale analysis of the root causes of land use and cover change in Embu and Mbeere Districts, Kenya. LUCID Working Paper No. 20. Int. Livestock Res. Institute. Nairobi. www.lucideastafrica.org.
43. Olson JM, Misana SB, Campbell DJ, Mbonile MJ, Mugisha S (2004). The Spatial Pattern and Root Causes of Land Use Change in East Africa. LUCID Working Paper No. 47. Nairobi: Int. Livestock Res. Institute. WWW.Lucideastafrica.org.
44. Pomeroy D, Tukahirwa J, Mugisha S, Nanyunja R, Namaganda M, Chelimo N (2003). Linkages between changes in land use land degradation and biodiversity in S.W. Uganda. www.lucideastafrica.org.
45. Rodgers, W.A. 1993. The conservation of the forest resources of eastern Africa: past influences, present practices and future needs. *In* J. Lovett & S. Wasser, eds. *Biogeography and ecology of the rain forests of eastern Africa*, p. 283-331. Cambridge, UK, Cambridge University Press.
46. Section 75 of the Constitution of Kenya.
47. Southgate C, Hulmes D (1996). Land, Water and Local Governance in Kenya wetlands in Dryland: Kimana Group Ranch and its Environs; Working Paper No. 4; University of Manchester, United, Kingdom.
48. Toesland, F., & Cross, R. (2015). The micro-industrial revolution. African Business, 49(417), 56-57.
49. Touber L (1983). Soils and vegetation of the Amboseli-Kibwezi area. Kenya Soil Survey R6, Ministry of Agric., Nairobi, Kenya p.125.
50. W. M. Adams, Against Extinction: The Story of Conservation (Earthscan, London, 2004).
51. Wangui EE (2003). Links between Gendered Division of Labour and Land Uses in Kajiado District, Kenya. LUCID Working paper No. 23.Int. Livestock Res. Institute. Nairobi. www.lucideastafrica.org. Maitima et al. 325
52. Wells M, Brandon K (1992). People and Parks: Linking Protected Area Management and Local Communities. Washington D.C.; The World Bank.

53. Western D (1976). “Amboseli; Integration of people, land and wildlife seeks to end the conflicts which threaten this national park.” Parks, 1, 2:1-4.
54. Wilson CJ, Reid R, Stanton NL, Perry BD (1997). Effects of land use and tsetse fly control on bird species richness in southwestern
55. Working paper No. 36. Int. Livestock Res. Institute. Nairobi.
56. World Bank Group. GDP (current US$) - Kenya, Tanzania, Rwanda, Uganda, Ethiopia, South Sudan, Burundi, Somalia, Eritrea, Djibouti. World Bank data (2020). Available at:https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=KE-TZ-RW-UG-ETSS-BI-SO-ER-DJ. (Accessed: 20th July 2024)