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STUDY PROGRAMME: ECONOMICS AND MANAGEMENT OF AN ENTERPRISE

TITLE OF THE THESIS: EFFECTIVENESS OF ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL PROTECTION

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(Supervisor)

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Faculty of Forestry and Wood Sciences

Ph.D. THESIS ASSIGNMENT

Ing. Mathy Sane

Economics and Management

Economics and Management of an Enterprise

Thesis title

Effectiveness of Economic Instruments for Environmental Protection

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Objectives of thesis

The aim is to assess the effectiveness of economic instruments and their role in reducing environmental degradation. The dissertation will primarily focus on the issue of climate change as a key priority of environmental policy. Data collection will be carried out from developing countries so that recommendations are also directed to these regions.

Methodology

Two main approaches will be used to assess the effectiveness of economic instruments. Efficiency and cost effectiveness. Effectiveness (usefulness) means whether and to what extent a given project, program, policy, etc. ensures the goal in environmental protection. Further describe and analyze in detail the economic instruments, aimed primarily at reducing greenhouse gas emissions. Furthermore, the course of application of these economic instruments and the positives and negatives of the practical consequences of the application will be described. Knowledge and data will be drawn from university studies, archival sources and a questionnaire survey. Specifically, the IRD (Institute for Research and Development) database, UNEP, NEPAD, the Ministry of the Environment and expert scientific articles will be used. The research will focus on selected developing countries. Special attention will be paid to economic instruments that achieve the lowest cost targets. The political and social aspects will also be monitored in order to maintain instruments acceptable to the various sectors concerned, including households. Questionnaire interviews will be the basis for the cost-effectiveness of the economic instruments already in use. The questionnaire will focus on the costs and benefits, ie the criteria for the effectiveness of public policies from an economic point of view. These criteria will allow us to secure the cost of public or private interventions, whether in the form of budget expenditures or changes in behavior.

Schedule:

September 2017 – detailed literature search focused on methods of evaluating the effectiveness of economic instruments.

September 2018 – elaboration of a methodical approach to the solution and focus on data acquisition in selected developing countries.

March 2019 – internship in an EU member state and a selected developing country.

September 2019 – data processing and preparation of articles.

March 2020 – preparation for the state doctoral examination and elaboration of the first version of the doctoral thesis.

September 2020 – defense of a doctoral thesis.

The proposed extent of the thesis

80 standard pages

Keywords

environmental policy; climate change; greenhouse gas emissions; developing countries

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Recommended information sources

ALBRECHT, J. Instruments for Climate Policy: Limited Versus Unlimited Flexibility. Edward Elgar Publishing, 2002. ISBN 9781781009604.

BARDE, J. Economic Instruments in Environmental Policy: Lessons from the OECD Experience and their Relevance to Developing Economies. OECD Development Centre Working Papers, 1994, No. 92. Paris: OECD Publishing, https://doi.org/10.1787/754416133402.

ENVIRONMENTAL ECONOMICS, POLICY AND INTERNATIONAL ENVIRONMENTAL RELATIONS (6. : 2004 : PRAHA, ČESKO), – ŠAUER, P. – VYSOKÁ ŠKOLA EKONOMICKÁ V PRAZE. INSTITUT PRO EKONOMICKOU A EKOLOGICKOU POLITIKU, – ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE. LESNICKÁ A DŘEVAŘSKÁ FAKULTA. *Environmental economics, policy and international relations : papers presented at 6th seminar of postgraduate students, young scientists and researchers : October 7-8, 2004 : the University of Economics in Prague, Czech Republic.* Prague: Nakladatelství a vydavatelství litomyšlského semináře, 2004. ISBN 80-86709-05-1.

FISCHER, T B. *Progress in environmental assessment policy, and management theory and practice.* London ; Hackensack, NJ: Imperial College Press, 2016. ISBN 9781783268375.

OECD. Instrument Mixes for Environmental Policy. Paris: OECD Publishing, 2007. ISBN 978-92-64-01780-1.

SENGUPTA, J. *New efficiency theory : with applications of data envelopment analysis.* Berlin ; New York: Springer, 2003. ISBN 3540140131.

STERN, N H. The economics of climate change : the Stern review. Cambridge: Cambridge University Press, 2007. ISBN 0-521-70080-9.

ŠAUER, P. *Introduction to environmental economics and policy : with economic lab experiments and class exercises.* Prague: Nakladatelství a vydavatelství litomyšlského semináře, 2007. ISBN 978-80-86709-10-9.

VEJCHODSKÁ, E. – ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE. PROVOZNĚ EKONOMICKÁ FAKULTA. *Land policy instruments: efficiency and equity : habilitationa thesis (set of serearch papers).* Dissertation thesis. Praha: 2020.

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2022/23 WS – FFWS – Doctoral Thesis Defense

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ABSTRACT

The main aim of this thesis is to examine the use of environmental taxes together with other variables in effectively protecting forest areas among 17 African countries during the period 2001 to 2018. The thesis achieved this goal by applying the Random effects model. The empirical results show that more deforestation and urbanization continue to be a problem to forestry and can lead to the depletion of forest areas, while an increase in environment taxes and improvements in institutions results in forest area conservation. These results vary across different levels of significance. The study also found that an increase in population density results in loss of forest cover and is significant at all levels. Meanwhile, an increase in agriculture land use negatively affects forest cover. Furthermore, the impact of environmental taxes on forest cover is positive and statistically significant. In view of the results, the study recommends that African countries should focus on implementing policies that mitigate deforestation and promote sustainable urbanization and consumption of clean energy. Additionally, they should focus on finding ways to control population growth and agriculture land use so that more forest areas can be preserved. The study further recommends that African countries should use both protection policies such as environmental taxes, fines, enforcement of property rights, laws and regulations, and promotion policies such as good agricultural practices, environmental education, birth control mechanisms, and use of clean, efficient and environmentally friendly energy sources to mitigate deforestation.

Keywords: Environmental taxes, Effectiveness, Deforestation, Conservation, Random effects model

DECLARATION

I hereby declare that this thesis entitled "Effectiveness of economic instruments for Environmental Protection" *is my own work and all the sources have been quoted and acknowledged by means of complete references.*

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Words cannot express my gratitude to my professor Assoc. Prof. Dr. Ing Miroslav Hájek for his invaluable patience and feedback. I could not have undertaken this journey without him. He generously provided knowledge and expertise. He has been supporting me from the beginning until the end and during the difficult times I encountered during this period. You have been a tremendous mentor for me.

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Lastly, I would be remiss in not mentioning my family and friends for their emotional support. Their belief in me has kept my spirits and motivation high during this journey.

List of Contents

ABBREVIATIONS

ACP	-	African, Caribbean and Pacific
ARDL	-	Autoregressive Distributed Lag
BRICS	-	Brazil, Russia, India, China, and South Africa
CO_2	-	Carbon Dioxide
CoP	-	Conference of Parties
DICE	-	Dynamic Integrated model of Climate and the Economy
DOLS	-	Dynamic Ordinary Least Squares
EBC	-	Environmental Brundtland Curve
EDC	-	Environmental Daly Curve
EKC	-	Environmental Kuznets Hypothesis
EU	-	European Union
EUTR	-	EU Timber Regulation
FAO	-	Food and Agriculture Organization of the United Nations
FEM	-	Fixed Effects Model
FLEGT	-	Forest Law Enforcement, Governance, and Trade
FMOLS	-	Fully Modified Ordinary Least Square
GDP	-	Gross Domestic Product
GHG	-	Greenhouse Gas
GtC	-	Gigatons of Carbon
IFS	-	International Forestry Centre
IPCC	-	Intergovernmental Panel on Climate Change
ITTO	-	International Tropical Timber Organization
LCM	-	Land use Change Model

NFP	-	National Forest Programme
NARDL	-	Nonlinear Autoregressive Distributed Lag
OECD	-	Organisation for Economic Co-operation and Development
OLS	-	Ordinary Least Square
POLS	-	Pooled Ordinary Least Square
REM	-	Random Effect Model
REDD	-	Reducing Emissions from Deforestation and forest Degradation in Developing countries
SDGs	-	Sustainable Development Goals
SSA	-	sub-Saharan Africa
UNEP	-	United Nations Environment Programme
UNFCC	-	United Nations Framework Convention on Climate Change
UN-REDD	-	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation
VECM	-	Vector Error Correction Mechanism

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

Contrary to national or regional phenomena, which have caused governments of various nations to express considerable worry due to the potential harm to the environment and its natural resources in the near future, climate change is an international phenomenon. It has had a tremendous impact on the environment of the world as well as the viability of economies and society. Taking quick action to address climate change challenges is now necessary on a global scale. As more lives and assets are lost globally each year, its negative impacts are becoming more pronounced and severe. Despite the suffering and sorrow caused by climate change, countries are taking a very long time to carry out their obligations under the Paris Agreement.

The negative implications of climate change must be understood by policy makers and economic actors (producers, consumers, engineers, scientists, etc.). As a result, study on climate change issues gives them access to empirically supported research, allowing them to examine ongoing developments essential for sustainable development. In this regard, having cutting-edge scientific knowledge about climate change and environmental sustainability is crucial for developing effective adaptation and mitigation mechanisms that are also environmentally friendly, as well as for proposing solutions to lessen and overcome the negative effects of climate change on the planet.

Stern (2006) asserts that "a mountainous body of scientific information now amply demonstrates that climate change is an important and urgent issue. The Earth's climate is rapidly changing, primarily as a result of human-caused increases in greenhouse gases. Although studies on climate change are still in the early stages, there are some well-established key components that earth scientists developed. The release of GHGs exacerbates climate change. Rising greenhouse gas (GHG) emissions therefore result in climate change-related impacts including global warming that eventually endanger both human health and the environment's quality. Carbon dioxide is the main and most rapidly expanding source of GHG emissions (CO_2). Deforestation, Gross Domestic Product (GDP) per capita, and population growth are a few of the causes contributing to the rise in energy-related CO_2 emissions (Fan, Zhang, & Wang, 2017; Z. Liu & Zhao, 2015; X. Xu & Ang, 2014; Yao, Huang, & Song, 2019). Increased demand for goods and services due to population growth will lead to more deforestation and the creation of greenhouse gases (GHGs) (Tamirisa, 2008).

According to the Emissions Gap Report 2022, if global warming continues, emissions must be reduced by 45 percent. Although there are ways to change societies, the moment is now for global cooperation. About 17% of the world's GHG emissions were caused by deforestation and forest degradation (Rogner et al., 2007). Houghton (1991) asserts that deforestation directly affects global warming because it alone is responsible for about a quarter of all anthropogenic carbon emissions worldwide. In developing nations, where the share of deforestation related GHG emissions was projected to be around 25%, a greater proportion of emissions from deforestation and forest degradation occur (Houghton, 2005). According to the Intergovernmental Panel on Climate Change (IPCC, 2001), deforestation has been identified as the second-largest source of GHG emissions (Leplay & Thoyer, 2011). Over the past ten years, it is projected to have contributed two gigatons of carbon (GtC) every year.

In its most thorough evaluation of forests to date, the Food and Agriculture Organization of the United Nations (FAO, 2006) estimates that 12.9 million hectares of land are lost to deforestation year. Additionally, the net loss of forest area is minimized by forest planting, landscape restoration, and natural forest extension. Deforestation is a complicated process that involves numerous factors interacting at various scales. Urbanization and agriculture are often listed as the two main proximate drivers of deforestation in most regions, notably in Africa where population development is requiring more land for settlements and food production (Geist & Lambin, 2002). The main causes of deforestation between 2001 and 2021, according to Hansen et al. (2013), were wildfire, shifting agriculture, forestry, urbanization, and commodity-driven deforestation. However, the major causes of deforestation were identified as urbanization and commodity-driven deforestation. According to FAO (2006), the annual net change in forest area between 2000 and 2005 was expected to be -7.3 million hectares. The predicted 1.1 GtC reduction in annual GHG emissions results from this. In contrast, the use of fossil fuels resulted in emissions of 7.3 GtC in 2003. (Marland, Boden, & Andres, 2008). Governments have found it challenging to combat deforestation because of the complexity of its causes and the fact that many land uses generate better incomes than do those on wooded areas.

A Dynamic Integrated Model of Climate and the Economy, according to Nordhaus (2019), models the fundamental connection between climate change and the economy (DICE). The DICE model's fundamental architecture is depicted in Figure 3. See Nordhaus for a thorough discussion of the DICE model's development (2018).

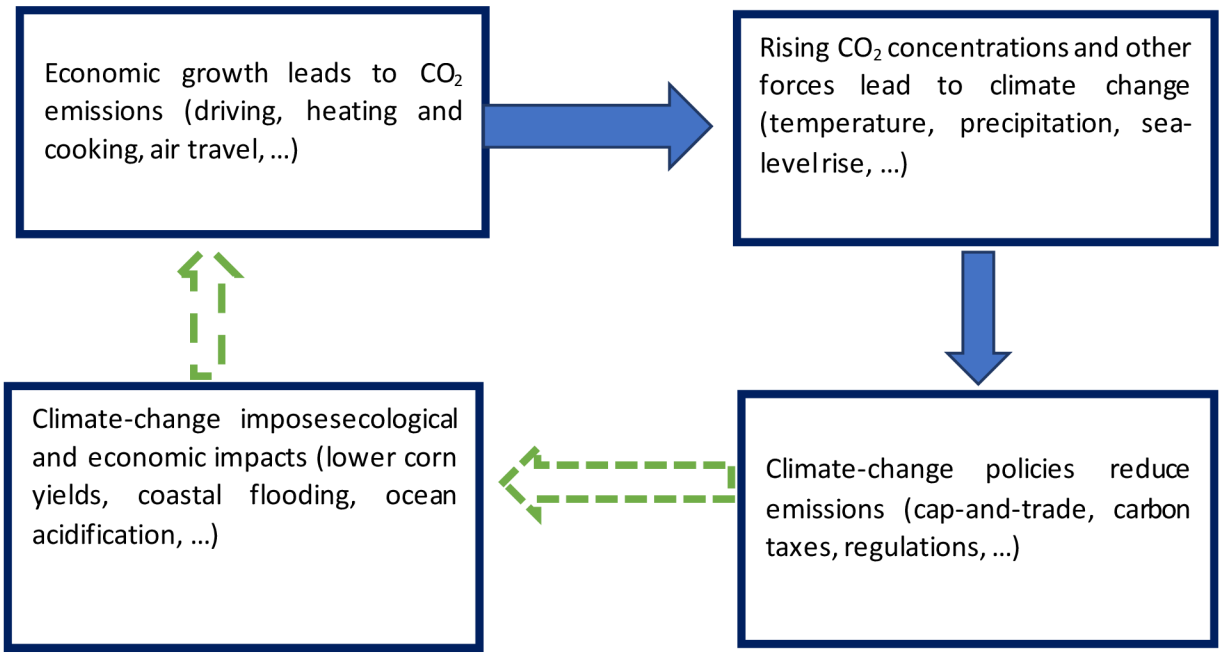


Figure 1. The Circular Flow of Global Warming Science, Impacts, and Policy (adapted from Nordhaus (2019, p. 1995)).

Beginning from the upper left box, where economic expansion skews price signals, increasing CO2 emissions into the atmosphere is the starting point. The upper right box is where CO2 emissions and other factors that can cause significant changes in the climate system are located after this. This leads us to the bottom right box, where we can see how climatic changes have an impact on both natural and human systems. Finally, this leads to the lower left box, where society responds to climate change issues through policies. The arrows depict the connections between the various aspects of the political, economic, and climatic systems. However, the dashed lines indicate that there are currently no reliable international agreements that can be utilized to control GHG emissions, including CO2 emissions (Nordhaus, 2018). These also imply that there are no laws in place to lessen the effects of climate change.

As a result, government institutions now place a high priority on protecting and managing the environment. For instance, Europe uses several economic tools to address environmental challenges, such as environmental taxes, fees, and charges, tradable licenses, deposit-refund systems, and subsidies. Environmental levies are the most successful strategy in the Baltic states for boosting productivity and safeguarding natural resources. The environment is negatively impacted by the cost of activities and the pricing of commodities. Vendiktovien, Pereira, and Erniauskas (2008).

Multiple ways exist for this theory to add to the body of literature. The first step is to investigate how environmental taxes affect GHG emissions as well as forest cover in a few African nations. It also makes use of a quantile regression model, and the results showed that environmental fees had a favorable effect on lowering GHG emissions and deforestation in 17 African nations. And third, it uses the random effect model to evaluate the effectiveness of environmental taxes. Some authors perceive climate policy as a new opportunity to effectively reduce significant sources of GHG and biodiversity loss as well as to increase incomes of many people in rural areas whose livelihood depends on forests. The implementation of measures to reduce deforestation would require innovative financial mechanisms in the context of global climate policies. Before considering enacting policies to conserve the environment and safeguard the climate, it is crucial to understand the nature and causal relationship between GHG emissions, deforestation, and environmental taxation.

The research contributes to the Sustainable Development Goals (SDGs) for the environment, including goals 6 (clean water and sanitation), 7 (affordable and clean energy), 11 (sustainable cities and communities), 12 (responsible consumption and production), 13 (climate action), 14 (life below water), and 15 (life above land) (life on land). Additionally, because all of the SDGs are interconnected—that is, actions in one area have an impact on results in other areas—development must strike a balance between environmental, social, and economic sustainability. In order to achieve the SDGs, national governments or their agencies should *"prioritize SDGs, develop coherent and integrated implementation strategies, and allocate resources, responsibility, and authority taking, into consideration priorities relating to economic development, nature conservation, and social inclusion"*, according to the UN. Katila and others (2019, p. 581).

1.2 OVERVIEW OF ECONOMIC INSTRUMENTS IN FORESTRY SECTOR

In this chapter of the thesis, the focus turns to the overview of the forestry sector and its importance in developing African countries, economic instruments and its contribution to the forestry sector as well as the challenges facing the sector.

1.2.1 FORESTRY SECTOR AND ITS IMPORTANCE

Natural or planted forests offer a wide range of benefits and services to people, animals, and the environment, including carbon storage, biodiversity habitat, water filtering, climate mitigation, timber and non-timber products, tourism, and aesthetic qualities (FAO, 2010; Myers et al., 2013). Despite the immense advantages of forests, human activities have resulted in deforestation, which has negatively impacted natural ecosystems. In addition to the non-timber contributions it makes directly and indirectly to the communities in and around the regions where timber is produced, the forestry sector also contributes by producing timber. The industry makes a considerable contribution to the economy as a source of raw materials, a marketplace for goods and services, and a source of foreign exchange (Chapman, 2020).

1.2.2 ECONOMIC INSTRUMENTS AND CONTRIBUTION TO FORESTRY PROTECTION

Environmental rules could be thought of as tools created for the environmentally sound management of the environment. They are defined as all relevant judicial, administrative, and regulatory decrees, judgments, and orders relating to the protection of human health or the environment as well as all applicable statutes, regulations, rules, ordinances, codes, licenses, permits, orders, approvals, plans, authorizations, concessions, franchises, and similar items from all governmental entities. All requirements, including but not limited to those on reporting, licensing, permitting, investigations, and remediation of emissions, discharges, releases, or threatened releases of hazardous materials, chemical substances, pollutants, contaminants, or dangerous or toxic substances, materials, or wastes whether solid, liquid, or gaseous in nature, into the air, surface water, groundwater, or land, are covered by these without limitation. Chemical substances, pollutants, contaminants, hazardous or toxic substances, materials, or wastes, whether solid, liquid, or gaseous in nature, as well as all requirements

relating to the protection of flora and fauna, including employees, employers, and/or the general public, may be covered by them. Economic tools can, in theory, help to increase the effectiveness and efficiency of environmental policy. By giving polluters more leeway in how they comply with a mandated decrease in pollution levels, they may lower the financial cost of reaching a certain level of environmental protection or allow for further environmental improvements without raising the associated economic costs. Businesses have the option to reduce emissions by another unit if the cost of doing so is less than the emission tax, or to pay the tax if marginal abatement costs are significant. As a result, businesses with the lowest pollution abatement costs reduce pollution the most, whereas businesses that find it expensive to reduce emissions choose to pay the tax. Because they encourage polluters to find ways to cut pollution by more than is necessary to comply with present regulatory criteria, they may promote more rapid innovation in pollution prevention and control technology. Polluters must pay for residual emissions in addition to abatement expenditures because of the specificity of a tax. As a result, there is a constant incentive to cut pollution-related expenses and emissions in order to avoid paying the tax (von Moltke, 2004). Some financial tools generate income that can be applied in many ways. The use of environmental tax revenue or other revenue derived from taxes related to the environment is decided by more general policy considerations or may allow for the reduction of other taxes. Instead, the money might be set aside for specific expenditures, most of which would be environmentally beneficial. Theoretically, earmarking violates the "Polluter Pays" principle (by lowering the net cost of polluters who gain from earmarked expenditures) and could result in the inefficient use of tax dollars. However, by guaranteeing a minimum level of targeted public spending on the environment, earmarking may increase the political acceptability of environmental taxes and guarantees. Additionally, the careful and controlled distribution of subsidies might encourage the growth of a market-based environmental financing sector (OECD, 2003).

1.2.3 CHALLENGES FACING THE FORESTRY SECTOR

Deforestation is the biggest problem the forestry industry is dealing with because it threatens the industry's very existence. According to the Marrakesh Accord, deforestation is the direct human-induced conversion of forested land to non-forested land. According to Murthy et al. (2013), deforestation is the long-term or permanent conversion of land from forest to non-forest. The FAO defined deforestation as either the long-term decline of the tree canopy cover

below the minimum 10% level or the transfer of forest to another land use, according to Murthy et al. (2013). Pimm (2022) defines it as the human-caused clearance or thinning of forests for a variety of uses, such as farming, grazing, building, mining for minerals and wood, and other activities. Overexploitation, overgrazing, illegal encroachments, unsustainable practices, forest fires, and the haphazard placement of development projects in forested areas have been named as the main drivers of declining forest richness (Government of India, 1999). Overexploitation of natural resources, especially forest supply, is always a result of population pressure. Possible contributing factors include population pressure, poverty, corruption, weak institutions, and excessive spending habits. This would have a significant negative impact on the environment. Murthy and co. (2013). Murthy asserts that certain information is crucial for compiling statistics on deforestation or forest loss. These comprise the area of actual forest that was used for non-forest uses during the same time, the area that was afforested and gained 10% tree crown during that time, and the area of forest that was still used for that purpose (Murthy et al., 2013). Over the years, deforestation has increased steadily at significant rates, particularly in the tropical regions of developing countries (Hansen et al., 2013; Vancutsem et al., 2021). One of the main causes of greenhouse gas emissions (CO2, NO2, and methane), biodiversity loss, and limited ecosystem services is deforestation (IPBES, 2019). Although there are many interrelated processes and causes that contribute to deforestation (Geist & Lambin, 2002), the growth of agricultural land use, including cropland, pastures, and tree crops, has been the main remote cause of tropical deforestation (Busch & Ferretti-Gallon, 2017; Curtis, Slay, Harris, Tyukavina, & Hansen, 2018; De Sy et al., 2012). The rapid CO2 emissions that cause deforestation are largely to blame for the atmospheric conditions that, in turn, cause climate change on a worldwide scale. The biggest percentage of tree cover was lost in Russia between 2001 and 2021. Brazil, Canada, the United States, and Indonesia come next. Despite the significant loss of tree cover, Russia experienced the highest increase in tree cover between 2001 and 2012, followed by the United States, Canada, Brazil, and Indonesia. The Democratic Republic of the Congo (rank 11, with 1.3 000 hectares), South Africa (position 13, with 831 000 ha), Madagascar (position 24, with 405, 000 ha), and Tanzania were the African nations that were among those in the world that gained tree cover (position 29 with 304, 000 ha). According to Garzuglia (2018), the FAO projected that there were 3 978 million hectares of forest worldwide in its first forest assessment report, with 2 612 million hectares (or 60%) of that total area) being productive forest. The scale of the fruitful forest ensured a sufficient demand for timber. The world's forest area decreased between 1958 and 1990 (4 405 million hectares in 1958, 4 126 million hectares in 1963, 4 030 million hectares in the 1970s, 3 603

million hectares in 1980, and about 3 442 million hectares in 1990), while it slightly increased between 1995 and 2010 (2000 -3 454 million hectares, 2005 - 3 869 million hectares, and 2010 - about 3 952 million hectares) (Garzuglia, 2018)

According to Hansen et al. (2013), between 2002 and 2021, the world's total tree cover decreased by about 16%. Between 1990 and 2020, forest acreage increased somewhat in Asia and Europe but decreased slightly in Africa and South America. However, although Europe, North America, and Central America saw a tiny increase in carbon stocks, Africa kept its level. In terms of the amount of forest land lost, Africa came in second with 106 million hectares, while South America experienced the most loss (130 million hectares). Policymakers and international environmental activists are concerned about the fact that Africa and South America are losing a significant amount of forest area.

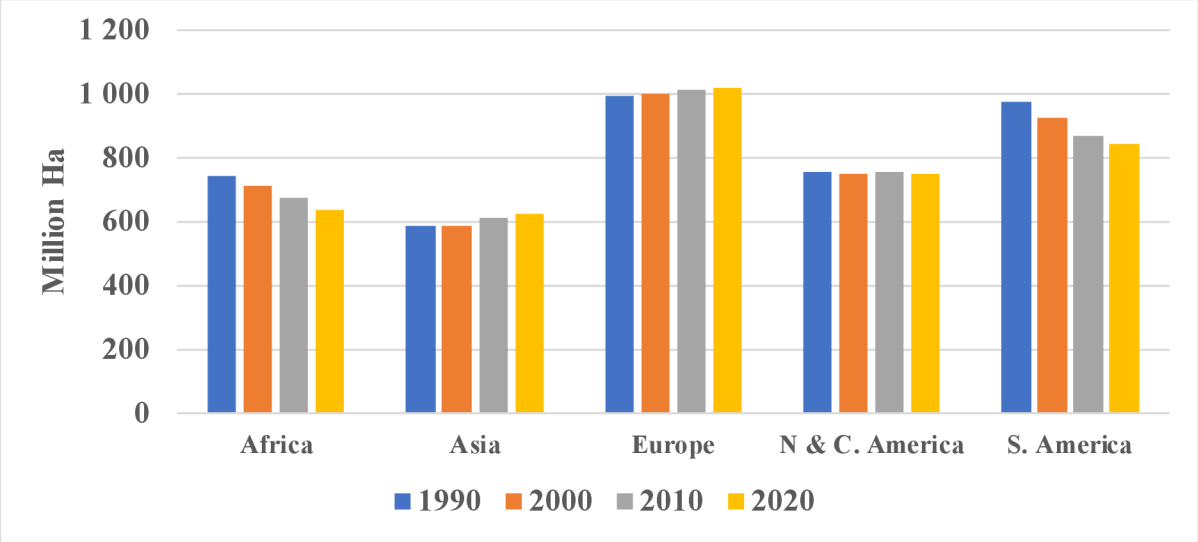


Figure 2: Forest Area cover.
Source: Hansen et al. (2013)

China, Brazil, the EU27 (the other 27 members of the European Union), India, Indonesia, Russia, and the United States of America are the biggest GHG emitters (USA). Together with foreign travel, these nations contributed about 55% of the world GHG emissions in 2020. (UNEP, 2022). Brazil, Russia, and the United States rank among the top countries for global GHG emissions and deforestation, respectively.

Table 2 shows the amount of carbon emissions by regions respectively during the years 1990, 2000, 2010 and 2020. Africa has the lowest levels of carbon stocks during 1990 and 2020.

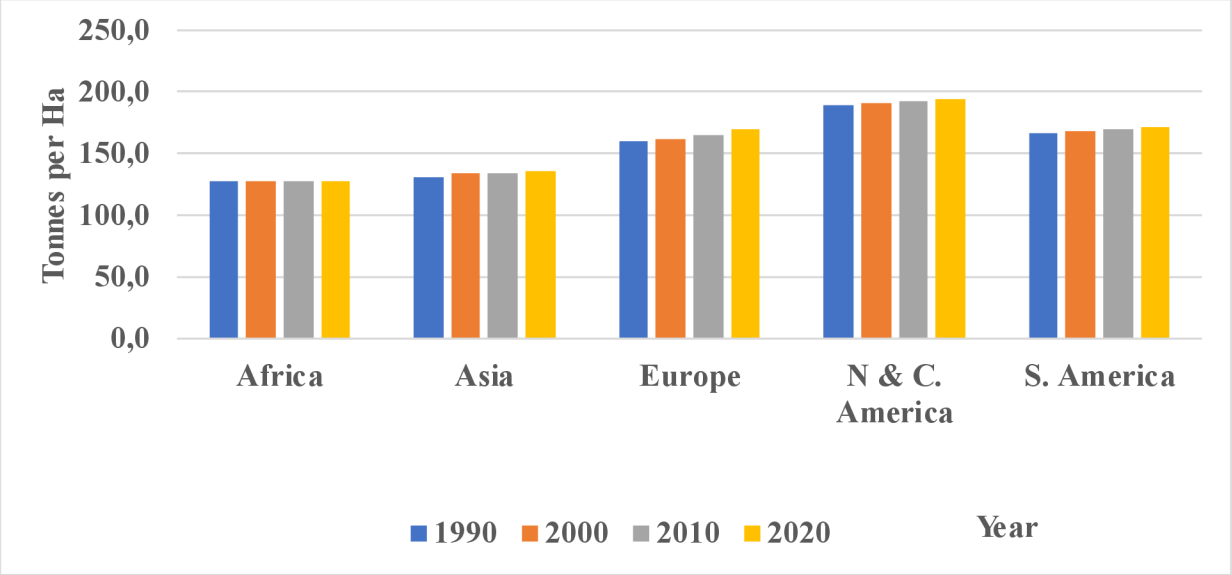


Figure 3: Total Carbon Stocks by Region.

Source: Hansen et al. (2013).

1.3 STATEMENT OF THE PROBLEM

Nearly 43 billion trees could be found on the African continent, with the majority being in South Africa, Ethiopia, and Nigeria. 26% of the continent is classed as forest. In terms of land use, Africa is one of the most diversified continents, having a mix of farmland, forests, grasslands, wetland, and urban areas. Together, grassland and forests cover more than 50% of the entire continent, while 'other land,' which includes deserts and barren, unproductive areas, makes up 32.4% of the overall land area. In terms of total forest area, Africa ranks third in the world. The forests are primarily found in tropical countries in the continent's central and southern regions, including Zambia, Angola, Tanzania, and the Democratic Republic of the Congo (DRC). The latter boasts the second-largest rainforest in the world, covering about 152 million hectares, an area five times the size of France, earning the Congo Basin the moniker "lungs of the globe." Deforestation, however, is still a significant issue (Igini, 2022). According to the UN Food and Agriculture Organization (FAO), nearly 4 million hectares of African forests are being destroyed annually at a rate almost twice as fast as the global average. This is because of various factors, including the expansion of agriculture, human settlements, commercial logging, inadequate government policies,climate change, and global warming, among others (Igini, 2022)

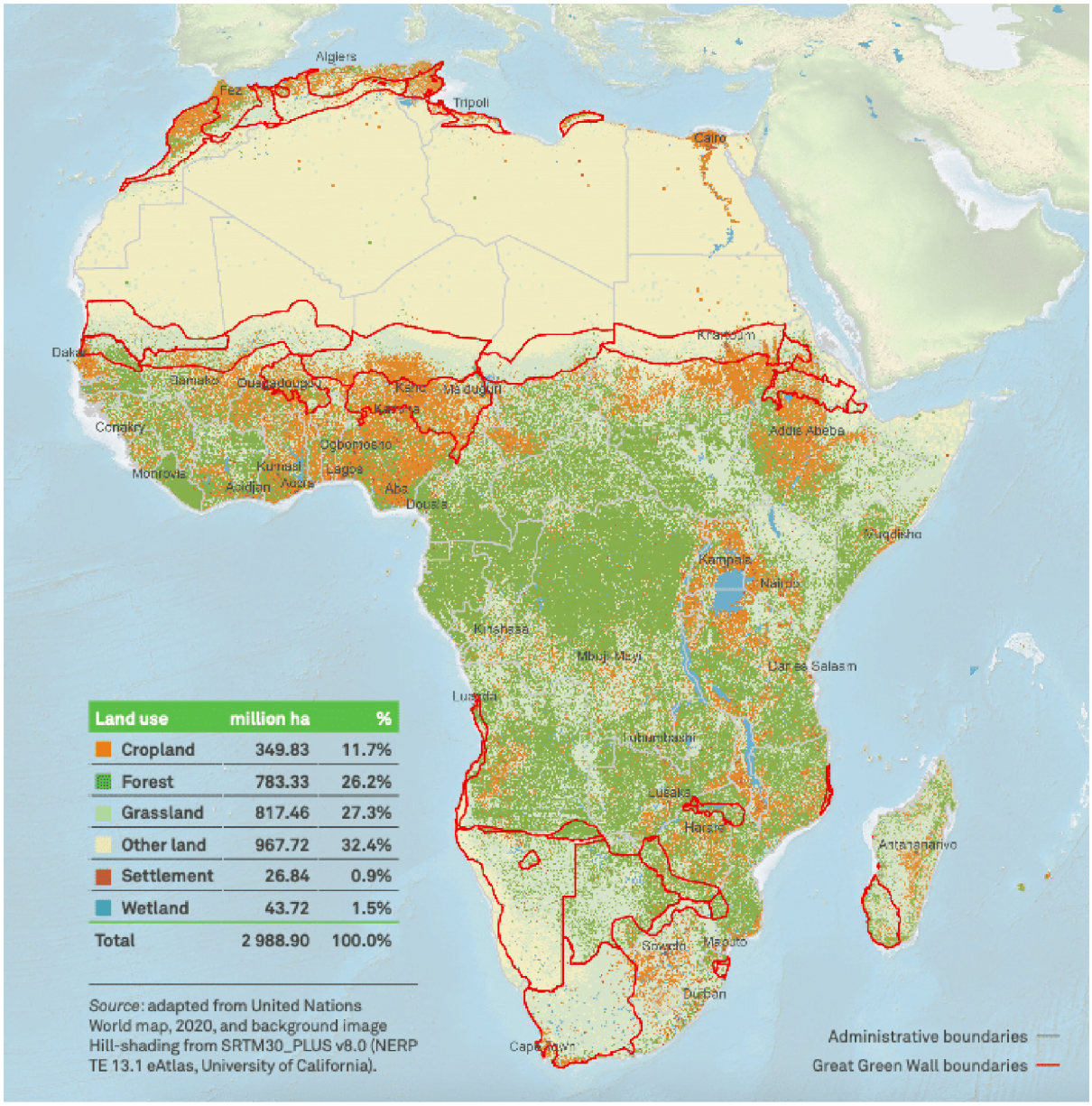


Figure 4. Land use in Africa.

Deforestation has a terrible effect on Africa's ecosystems, biodiversity, and climate. Many of the effects depend on how resilient the continent is to the threat of climate change. Cutting down trees would decrease the forest's capacity to produce rain and absorb carbon dioxide, exposing regions to severe droughts and escalating Africa's continuing water crisis. Kenya in East Africa, one of the nation's most frequently hit by severe droughts, has seen a gradual rise in deforestation rates in recent years. A lack of soil cover would also leave the area vulnerable to erosion and degradation. Additionally, it would increase the severity and frequency of floods. In fact, woods act like sponges, soaking up the rain that tropical storms bring. Flooding is more likely to happen when there aren't enough trees to soak up the water and anchor the

soil during periods of high rainfall. Across the continent, agricultural production and food security are seriously threatened by both flooding and soil erosion (Igini, 2022). This dissertation aims to provide a framework for addressing the issues mentioned in this problem statement and supported by the following objective and research questions.

2 OBJECTIVES AND HYPOTHESIS

The main objective of this dissertation is to assess the effectiveness of economic instruments and their role in environmental protection using data collected from 17 selected developing countries using data. This objective is broken down into primary objectives parts, which is to focus on the issue of climate change as a key to environmental policy implementation. Other fundamental questions we seek to answer, include the following.

1. Does taxation have an effect on deforestation?
2. Will a change in the tax rate lead to a significant change in deforestation across African countries?
3. Are there relationships between GDP, Urbanization, Population growth, Deforestation rates, and other variables in selected African countries?
4. What policy recommendations would help the selected African countries achieve sustainable environmental protection?

RESEARCH HYPOTHESIS

This dissertation focuses on reaffirming the narrative that Environmental taxes are essential in ensuring Sustainable environmental protection in developing African countries. These concepts were over the years developed and supported by proponents and schools of thought including but not limited to: ecological damage theories that include the Environmental Kuznets Hypothesis (EKC) (Kuznets, 1955) and Decoupling Hypothesis (Ruffing, 2007; UNEP, 2016). Based on these, the null hypothesis of the study was tested against the following alternative hypothesis:

Null hypothesis: Taxation is an effective economic instrument to reduce deforestation or conserve forest areas in 17 African countries.

Alternative hypothesis: Taxation is not an effective economic instrument to reduce deforestation or conserve forest areas all 17 African countries.

These hypotheses and their impacts and effectiveness were tested in both the short and long run and explained during the results and discussions section.

It is also worth noting that the theories mentioned above were further developed and discussed in section 3.1.

SIGNIFICANCE AND STRUCTURE OF PAPER

Despite the fact that various authors have conducted studies on the impact and effectiveness of economic instruments, to date, there is still a lack of studies on the effectiveness of environmental taxes on forestry protection, especially in these selected African countries. The novelty of this paper is that it measured the empirical effectiveness of economic instruments on forestry protection, as well as investigated the importance of the forestry sector over the years. It further recommended how environmental taxes can be best or better used to ensure sustainable forestry conservation. The structure of this study is as follows: Chapter 2 covers a brief overview of economic instruments in forestry and their contribution to forest protection, as well as the challenges facing over the years. After that, chapter 3 presents the results of the literature review, which is divided into two parts, namely the theoretical and empirical review. Chapter 4 comprised of data and methodology; under this section, data sources, variables, empirical, and econometric procedures are covered. Chapter 5 and 6 provide results and discussions, respectively. Finally, chapter 7 covers the conclusions and policy recommendations towards ensuring Sustainable forestry protection and solutions to all problems faced prior to this study.

3 LITERATURE REVIEW

In this chapter, the review of literature mainly focusses on two sub-sections; it starts with the conceptual and theoretical framework on the importance of selected economic instruments, especially taxes for forestry protection and concludes with the overview of previous studies. According to the literature, taxes are the most efficient. Taxes are the sub-section conceptual and theoretical framework on the importance of ecological taxes for forestry protection follows.

3.1 CONCEPTUAL AND THEORETICAL FRAMEWORK ON THE IMPORTANCE OF ENVIRONMENTAL TAXES FOR FORESTRY PROTECTION

Some theories and arguments have been developed over the years, emphasizing the role and importance of environmental taxes as a catalyst for sustained forestry protection, particularly for developing countries. Some of those theories and arguments that have stood the test of time include Kuznet's theory on the role of taxes in environmental sustainability, Adam Smith's theory of demand and supply, Thomas Malthus's population theory, The Theory of Reasoned Action (TRA) , theory of planned behavior (TPB) and Gifford's social Dilemma model. The following sections present an overview of these crucial theories.

3.1.1 Kuznets (1955) on the role of GDP on Environmental sustainability

Kuznets described the relationship between inequality and economic growth (Kuznets, 1955). Simon Kuznets finds that economic inequality is related to changes in economic development. literature on environmental economics generally argues that economic growth is among the main determinants of environmental degradation and climate change (McConnell, 1997). Also, the relationship between environmental degradation, deforestation, and economic growth is very complex because at low levels of income or development, deforestation and ecological degradation increase, while, after a certain level of income, they start to improve (McConnell, 1997). This relationship is the EKC. Because the relationship between GDP and environmental damage is generally similar in shape (inverted U) to the relationship between GDP and economic inequality, some economists named it the EKC. The same notion was extended also to describe the relationship between income and environmental problems or degradation. The EKC predicted the relationship between GDP and the environment was an inverted U-shaped.

That is to say, as income (GDP) increases, at low levels of income, environmental problems also increase, but after a certain point, as income increases, environmental drawbacks start to decline. Through product contributions, many commodities are considered lots of food and raw materials which can be used by the citizens in an economy. By means of the factors, forestry is a contributing factor of production, which are essential as supporting inputs for other related industries. Forestry can also provide employment and serve as a means of employment creation for associated industries such as food processing, which rely on forests' natural products. At the same time, several studies acknowledged the importance of these realizations. Bratt (2012) argues that the relationship between GDP and environmental damage can take other non-inverted U forms contrary to the EKC. These are the Environmental Daly Curve (EDC) – which does not have any turning point, and the Environmental Brundtland Curve (EBC) – which takes a U-shaped form. Dinda (2004) posits that if appropriate environmental policies or actions are taken, a rise in GDP or economic growth can be a precondition for environmental and climate improvements. Proponents of the free market, political elites, and those from the corporate world also argue in the same line that higher economic growth translates to higher welfare. They like the 'Business-as-usual' approach in dealing with environmental issues so that their profit motive interests are protected and could appear as if their actions are not harming the environment (Bratt, 2012). Nevertheless, EBC hypothesizes that the relationship between GDP and environmental degradation takes a U-shaped form; that is, low and high GDP are related to high environmental damage (Bratt, 2012). High-income countries contribute to more challenging environmental stress through industrialization, but for developing countries, the reason behind their contribution to environmental damage cannot be specified.

3.1.2 The theory of Demand and Supply

Adam Smith, the father of Economics, in his economic work of 1776, The Wealth of Nations, explained the theory of demand and supply extensively. He stated that demand is what determines supply. To further support his claim, Smith gave a detailed account of a society where the needs and wants of people determine what the bakers and the butchers provide. The main assumption of the theory of demand and supply is the ceteris paribus or holding other things constant assumption". That is, holding all other factors constant; demand should determine supply (Kirzner, 2000)

The theory of demand and supply provides a framework for the demand for forestry products and the ability of the forests to supply these products. The economy, in this case, has two dimensions: demand and supply. The demand side looks at the decisions made by people concerning forest products offered by forests, whereas the supply side has to do with the ability of for the forest to contain this demand. It is important to note that currently, the demand for forest products and services, which is influenced by the need for these services, the nature, and type of services provided.

3.1.3 Malthusian Theory of Population

The Malthusian Hypothesis of Population, developed by Thomas Robert Malthus(2021), is a theory of exponential population expansion and arithmetic growth of the food supply. Malthus thought that by implementing proactive and preventive controls, the supply of food and population expansion could be balanced appropriately. According to the birth rate, he contended, the human population grows exponentially while the food supply expands more slowly. If the population keeps increasing, there will be a limit and a shortage of food. Food shortages are another indication of a growing population. If left unchecked, the infrastructure of many different social institutions, including the government, the economy, and the environment, will all be put under pressure. The family tree will continue to expand if every family member reproduces, for instance. Still, food production develops at an arithmetic rate, which means that it only rises at certain times. The premise was that if a population grew unrestrained, it would outgrow its resources. In this context, a fast expanding population would raise the demand for forest products and the necessity for urbanization, causing people to clear trees in search of new settlement areas and strain the resource (Malthus 2021).

3.1.4 The Theory of Reasoned Action (TRA) and theory of planned behavior (TPB)

In order to accurately forecast behavioral intentions, the theory of reasoned action (TRA) and theory of planned behavior (TPB), respectively created by ((Ajzen, 1985) and (Ajzen, 1991) take into account the individual's attitude, social norms, and sense of control. According to the Theory of Planned Behavior stated that a person's intention to engage in a desired behavior (like cutting down trees) is partially influenced by their perception of how influential others will react to their activities (Venkatesh, Morris, Davis, & Davis, 2003). When used on

behaviors that a person may voluntarily control, TRA is most effective. Even while attitudes and subjective norms may be highly motivating, if behaviors are not totally under the control of the individual, intervening contextual factors may prevent the behavior from being carried out. The TPB was created to forecast actions in which people have only partial voluntary control. The TPB develops the idea of perceived behavioral control by taking into account self-esteem and self-efficacy. According to perceived behavioral control, a person's motivation is determined by how difficult the actions are thought to be, as well as how well they are thought to be able to accomplish the activity. It is simple to understand how this theory might apply to the idea of motivation and adherence to cause deforestation, particularly in the forestry environment. Low levels of perceived control weaken a person's impression and conviction that they can positively impact their own behaviors. This theory is relevant in this situation because individuals may occasionally be persuaded to start chopping down trees for various reasons, which could result in deforestation and a reduction in the amount of forest land.

3.1.5 Gifford's social Dilemma model

Everyone gains from social collaboration, yet some people earn disproportionately from non-cooperative actions, according to Gifford's definition of a social dilemma. In other words, while individuals may benefit from societal collaboration, they may also stand to gain more from acting selfishly or in their own best interests. Real-world social difficulties frequently entail contemporary issues like resource scarcity, pollution, or overpopulation. However, simply social restrictions and laws that encourage self-interested behavior or discredit trust can also lead to social difficulties. Researchers have made attempts to develop solutions to societal problems, but these solutions must take place at various levels in order to persuade people to act in a particular way rather than just changing the rules. The tragedy of the commons, which refers to a situation where some finite resources are available for many people to exploit, is one example of this approach. Everyone is motivated to use or amass as much of the common good as they can. However, excessive use or consumption causes the shared resource in this case forestry to deteriorate or disappear due to deforestation. As a result, everyone will eventually suffer as a result of one's best interests. The problem of public goods is another example. The free-rider paradox is another name for the public goods conundrum. A public goods dilemma is a situation in which social collaboration produces some benefits, yet if an individual does not participate, they still obtain the entire benefit of the product. For instance, people can forgo

paying taxes or ignore them and still benefit from natural resources such as forests. Furthermore, the common benefit is not diminished if one person does not pay taxes or chooses to ignore them. However, the forests will diminish whenever more people start taking advantage of others.(Gifford n.d,1990.)

3.2 Empirical Literature Review

Several empirical studies on the impact and effectiveness of environmental taxes across the world were conducted. Forest fees (or taxes) are assessments made by the concessionaire to the forest owner (i.e., the nation) in exchange for the right to harvest a specific area of land during a specific time period. Taxes and fees have two separate economic purposes. They first help the government. to take advantage of some of the benefits that come with natural forests' economic rents. Second, they influence harvesters' actions, which may contribute to the long-term viability of forest exploitation. Therefore, by internalizing the long-term, non-wood, and off-site values of the tropical forests under exploitation, forest taxes (or fees) may serve as Pigouvian taxes.(Merry and Amacher, 2005)

.It is possible that the first of these two purposes served the initial purpose for which forest taxes were established. Since the early 1980s, this position has become more crucial due to the need for revenue in African countries that were dealing with severe fiscal account imbalances. Government rules have been anticipated to help achieve forest conservation goals. This is indeed one of the primary functions that the State still performs in Central Africa, albeit insufficiently due to the limited institutional capacity and governance that define the majority of the continent's timber producing nations. The requirement to create and implement forest management plans and the choice by governments to administratively set timber output quotas, the latter of which is based on caps on total or per-hectare production, are examples of these rules.(Li and Izlar, 2021) The "role of environmental taxation is precisely to take them into account, to internalize them, either by penalizing practices that should be changed (a high tax rate and a narrow base, typical features of an environmental tax), or by imposing lower tax rates on operations as a whole (but with a broader base, in line with normal taxation logic), and using the funds raised to finance renewal projects and to compensate for environmental degradation.(Hafeez et al., 2020)

The authors of this new school of thought concur that taxes and fees should be modified to account for harmful distortionary incentives. While some suggested making the area tax the

main forest price, others, like (Alain Karsenty, 2010), emphasized the need of "eco-certification." as well as the significance of sector policy harmonization (e.g., with agricultural operations).

On the role of forest taxation in forest management and its potential as a part of public policies, there have been heated discussions. Analysts are evaluating the consequences of some reforms in various ways, such as the controversial adoption of auctions for granting concessions in Cameroon. The level of taxes and the structure of the taxation system, according to empirical analysis and statistics, are two distinct issues that are sometimes conflated but should be taken into account individually. Economic models frequently ignore the diversity of enterprises.(Daly-Hassen et al., 2010)

The precise setting in which the fiscal reform is to be implemented is crucial, and a number of instruments, including fiscal and non-fiscal, economic and regulatory ones, should be developed and put into action simultaneously to have a systemic impact. Rarely is this achievable with just one reform. It is important not to overstate the role that fiscal instruments can play in promoting sustainable forestry management, although there are opportunities if taxation is used in conjunction with other measures and public policies rather than as a stand-alone measure.(Barbone and Zalduendo, 2000; Daly-Hassen et al., 2010)

The "economics" of the environment received more attention in the 1980s and the beginning of the 1990s (e.g. Berck, 1987). Many authors made the case that market forces, as opposed to bureaucrats, may better regulate deforestation, particularly in nations with weak governance. Market-based rewards could assist in reducing deforestation by natural resources have a resource value equivalent to the extra earnings from forest exploitation, much like land has a rent value. Internalizing harmful outside influences. More precisely, it was believed that outmoded forest levies and taxes contributed to the underpricing of timber, which in turn encouraged deforestation. This led to serious waste in the harvesting and processing process by sending out incorrect signals about the worth of forests. In other instances, low taxes and fees induce inefficiencies and skew decisions about how to manage forests, which has a detrimental impact on government revenue.(Susswein, 2003)

Various authors have investigated the impacts of environmental taxes on deforestation in different region, and their results demonstrated that environmental taxes reduce deforestation

(Andersson, 2015; Chen, Zhou, Li, & Li, 2017; Gemechu, Butnar, Llop, & Castells, 2014; Hu & Zhou, 2014; Miller & Vela, 2013; S.-C. Xu & Long, 2014; Yang, Fan, Yang, & Hu, 2014)

In China, Lu, Tong, and Liu (2010) used the dynamic recursive general equilibrium model to model the impacts of an environmental tax on the Chinese economy. They established that the effect of a carbon tax policy on deforestation and GDP is not significant

Others suggested raising forest fees and taxes to address these issues, preferably as near to the value of economic rents as possible while some suggested combining various forest fees and coming up with various ways to raise them. Annual concession fees, for instance, were advised by .(Grut, 1991; Grut et al., 1993) while tumpage fees and profit taxes were suggested by (Barbone and Zalduendo, 2000).

The "increase taxes" narative, which was intended to cut profit margins, received harsh criticism from a number of authors (e.g., (Topa, 2006; Topa and Pendleton, 1998)). This writer made a point of saying that not all taxation and charge structures "support sound forest management." While some can bring in a sizable sum of money for the State without changing the firm's behavior, others might even promote questionable forest management techniques.

(Topa and Pendleton, 1998) argues that simply increasing forest fees may not result in the management of forests in a sustainable manner because fiscal instruments based on output (the number of logs or total timber production in cubic meters) “do not necessarily provide incentives to improve forest management, limit waste and logging damage.” They further acknowledged the fact that some levies are challenging to collect and do not account for the long-term societal consequences of forest exploitation..

(A. Karsenty, 2010; Karsenty et al., 2008) asserts that high taxes (redistribution from loggers to the State) will not have a predictable impact on loggers as a group due to the significant variability among loggers. Additionally, he makes the argument that the objectives of raising tax income for the government and preventing environmental deterioration can be at odds.Further,he argued that the importance of forest taxes as a supporting instrument for sustainable forest management shouldn't be overstated or ignored.

(Hawkins, 2000) in his study takes into account the present and future usage of economic instruments such as taxes by governments as tools for implementing policy. He argues that in many affluent nations, previous overregulation combined with a severe lack of qualified environmental enforcers necessitated the addition of well-targeted economic tools and green levies to regulatory frameworks and that it is also debatable whether they should be applied to nations without sophisticated environmental management systems. Therefore the issue for

policymakers is to create regulations that allow market forces to work in the environmental realm, such as through a system of pollution fees that is primarily meant to encourage higher environmental efficiency.(Hawkins, 2000)

(Lund, 2006)discuss taxation difficulties in regard to the decentralization of forest resources using early empirical data from Tanzania in the form of records of forest taxes from 12 villages that have been given control over the taxation of forest products as a result of a decentralization reform. They argued that taxes on forest products may be progressive or regressive in relation to income distribution, and decentralization of forest resources can significantly increase the effectiveness of taxes. As a result, the effectiveness of increasing forest taxation in reducing poverty is unclear and heavily reliant on the local pattern of forest use.The evidence that suggests forest decentralization can increase the effectiveness of taxing forest products runs counter to some of the general discussion regarding the effects and potentials of decentralization on taxation, and thus supports the idea that natural resource decentralization should continue.(Lund, 2006)

The management and utilization of natural forests in Malawi and Zimbabwe has been impacted by colonial and post-colonial land policies and legislation, according to (Kowero et al., 2001). Customary or tribal trust land designated by colonial governments for settlement and cultivation by indigenous populations, private land primarily taken from local communities for commercial farming and ranching, initially by white settlers and later officially sanctioned by post-colonial governments, and public land appropriated by government for the purpose of establishing national parks and forests are examples of patterns of land ownership shared by the two countries. Private and public land, the first two types of land tenure, not only reduced the amount of land that could be used by indigenous communities for agricultural and non-agricultural purposes, but they also jeopardized the authority and roles of traditional leaders in the management and control of natural resources, such as miombo woodlands. Conflicts over access to land and natural resources between the wealthy and landless groups emerged as a result of growing populations and food demands in both countries, as seen by the rise in encroachment. The native forest cover and several tree species have suffered greatly as a result of bushfires. They concluded that the main causes of the rapid deforestation and land degradation appear to be an increase in population pressure, poverty, and governments' urgent failure to give appropriate policy guidelines on land management and administration for the use of forests and natural resources.(Kowero et al., 2001)

The evolution of land policy in Tanzania and Mozambique during both the pre- and post-independence eras, as well as their consequences for the development of forestry, are also covered by (Kowero et al., 2001) They argued that both nations' pre-colonial land tenure systems relied on common and open access regimes that were governed by customary law and culture. Since there were no land markets and it was thought that there was plenty of land, shifting agriculture was used which promoted the slow clearing of forests and the degradation of the soil.(Kowero et al., 2001)

A review of agricultural policies regarded pertinent to the management of natural forest resources in Malawi, Mozambique, Tanzania, and Zimbabwe is presented by (Kowero et al., 2001) . In order to minimize negative policy consequences, it is necessary to articulate sectoral, extra sectoral, and macroeconomic policies that take into account the rivalry for land between agriculture and forests and the influence of man on the balance between the two. They concluded that governments' ability to close the huge gap between smallholder farmers and estate/commercial farmers in several of these nations will be crucial to successfully reducing deforestation and that when it comes to responding to macroeconomic incentives to lessen their reliance on natural forest resources, smallholder farmers have very limited room for maneuver. In fact, during the structural adjustment programme(SAP) period, such dependence, particularly on income, has expanded noticeably in some of these countries.(Kowero et al., 2001)

In another study conducted in Malawi, Mozambique, Tanzania, and Zimbabwe,(Kowero et al., 2001) used Jumbo chart for the development of these policies and the associated implementation methods. They argue that despite the fact that some countries have had broad policy pronouncements on incorporating local populations in forestry for many years, appropriate resources have not been allocated to make them successful. In southern Africa for example, the forestry industry has generally trailed behind other industries in updating its rules to properly reflect societal and political changes. Furthermore, Policies for the forest sector appear to have fallen behind political and socioeconomic priorities, with serious repercussions for the industry. However, modern forest policies are more thorough in terms of taking stakeholders into account and addressing difficulties.

Ecological tax reform is a top priority on the policy agenda. The main concept is to move the tax burden away from "goods," like productive labor, and toward "bads," such energy use and environmental degradation. The majority of OECD nations have implemented a number of

environmental taxes since the 1980s, and numerous reports evaluate these tools. ETR in developing countries has only recently attracted attention, and there is very little data on their ETRs accessible. Algeria, Benin, Mali, Mozambique, Tanzania, Niger, Senegal, Uganda, and South Africa are among the nine African nations that (Kerckhoven et al., 2015) screen in their study to review the state of the art for environmental taxation using information on environmental taxes gathered from a number of sources. They argue and concluded that all of the chosen African countries have enacted taxes or fees on the exploitation of natural resources, polluting emissions, dangerous products, and utilization of infrastructure, notwithstanding variances in institutional conditions and poverty levels. All nations have enacted laws or levied levies relating to the exploitation of natural resources in the forestry, mining, and/or fishing industries.

Forest policies, according to (Siry et al., 2005), influence how forests are retained, used, and protected. Sustainable forest management has gained widespread acceptance over the past ten years. They argued that forests should be managed in order to promote a variety of economic, ecological, and social goals. Thus, a wide range of multipurpose products and services must be offered as part of forest policies. Furthermore, advances in forest policy instruments for multifunctional forestry are necessary due to the dynamic character of sustainable forestry goals. The new forest policy instruments must, in particular, increase the capacity to offer and safeguard common resources and communal goods, account for and alleviate market imperfections and externalities, and better involve communities and new non-governmental players (Siry et al., 2005). Additionally, they conclude that, because of the increasing limitations imposed by a shortage of public money, policy instruments for multifunctional forestry must rely less on the government and potentially even forest resource specialists. It is crucial to decide when to use public policy tools, which ones to use, and how to fund and mplement them.(Siry et al., 2005)

(Alain Karsenty, 2010) contend that concessions can support sustainable forestry management (SFM) as long as they are bundled with a certain number of specific measures, despite their somewhat poor track record. Similar research has been done in tropical forests (Hansen and Lund, 2018), Indonesia (Nurfatriani et al., 2015),Nepal (Lund et al., 2012), Central Africa (Alain Karsenty, 2010), Ukraine, and Nepal (Garasym et al., 2018). To fill the state and municipal budgets, their goal was to research on how the forestry enterprise's operations affected financial results.(Harrison, 2012) studied the value and efficiency of tax breaks for

forestry businesses. He maintained that tax support programs needed to balance efficiency and equality.

In a different study, (Hansen and Lund, 2018) found that modifications to the forestry taxation structure in various nations result in varying levels of efficiency. They cite the important role played by the national political and economic elements specific to each nation in explaining this. However, (A. Karsenty, 2010) claimed that in order to encourage businesses to engage in woodworking, taxes on raw materials should be implemented in the forestry industry of central Africa rather than on financial outcomes or finished goods ..

(Ferretti-Gallon and Busch, 2014) assessed the impact of numerous factors on the volume of deforestation. They claimed that the influencing factor was local community involvement. (Fortney et al., 2011) conducted research on the items that economically developed nations' forestry taxes are derived from (timber, logging, land, forest rights). In a different study, taxation was taken into account as a benchmark to control deforestation (Chaudhary and Pathak, 2017)

(Zhurakovska et al., 2021) investigate the effect of taxes on forest reproduction and conservation in Ukraine using indices of expansion of forest restoration areas. They come to the conclusion that all government measures to put more financial pressure on forestry firms were irrational and caused the sector to go bankrupt, which has a detrimental effect on the local ecology as forestry harvesting increases. The production of finished wood is processed and manufactured, which adds the most value. That was the intention behind the timber export prohibition. However, because businesses lack the resources to implement forestry, these studies imply that the industry will completely shrink rather than grow. Additionally, they offer a data foundation for critical choices regarding the reform of the taxes of forestry firms.(Zhurakovska et al., 2021). (Rahman et al., 2022) made a comparable case in their research on how government actions affect the condition of the environment, ecology, and forests.

(Heaps and Helliwell, 1985) examine the taxation of natural resources using a Cobb-Douglas function. They contend that as a result of the endogeneity of resource taxation systems and rates, a thorough understanding of the effects of resource taxation relies more on present and predicted future changes in tax systems than on the specifics of a system that is unlikely to

remain in place. Furthermore, as projected future tax hikes may operate to reduce the returns anticipated from delayed development, the impermanence of tax systems presumably tends to speed resource developments when rewards appear to be significant. (Heaps and Helliwell, 1985)

Using annual, time-series data between 1976 and 2018, (Shamshiri et al., 2018) concentrated on empirically examining the long-run impact of fiscal policy on the ecological footprint in Pakistan while taking various socio-economic factors into consideration. They do this with the aid of the ARDL model and other econometric techniques. They came to the conclusion that public development spending, Pakistan's overall population, economic growth, and energy consumption are significant, positively preponderant determinants of ecological footprint, showing that an increase in their values results in an expansion of ecological footprint in Pakistan. Similar to how total public tax and non-tax revenue and current public spending have a long-term negative relationship with the dependent variables, increasing either of them will lessen Pakistan's ecological footprint.(Shamshiri et al., 2018)

The National Action Plan design and implementation in Indonesia are evaluated in a study by (Meehan et al., 2019) evaluating seven of the thirteen activities taken to lower emissions caused by peatland degradation and forestry. They maintained that only two behaviors had a clear, scientifically supported connection to emission sources. Three acts showed some correlation, even though it was reliant on other variables. There was no data to support the clear and targeted implementation of the two remaining initiatives, which were focused on emissions from peatland agriculture. The research reveals that the National Action Plan's metrics were insufficient to demonstrate appreciable emissions reductions. Many of the activities were pre-existing policies with multiple diverse goals that were just rebranded as climate change initiatives, which helps to explain why their design was flawed (Meehan et al., 2019)
While a ban on forest concessions lowered emissions, according to studies like those by (Kim et al., 2016) , (Sloan, 2014), and (Busch et al., 2015), the total reductions were likely to be much lower than projected. Therefore, rather than serving as long-term solutions, regulations like moratoria are best understood as short-term bandages.(Busch et al., 2015; Kim et al., 2016; Sloan, 2014)

To better understand and limit fire emissions from Indonesia, Malaysia, and Papua New Guinea between 2000 and 2006, (van der Werf et al., 2008) combined multiple satellite data sources

with biogeochemical and atmospheric modeling. However, estimates in these studies have been disputed by various authors because they use different data sets, assumptions, and methodologies. They discovered that the region's typical fire emissions were on par with those from fossil fuels. Burning caused highly varied carbon emissions in Borneo, with fluxes during the moderate 2006 El Nio being more than 30 times higher than those during the 2000 La Nia. In dry years, there is a significant nonlinear relationship between fire emissions and drought in southern Borneo due to higher rates of forest loss and bigger areas of peatland becoming exposed to fire. They also contend that it is critical to include deforestation in future climate agreements. Sumatra's fire emissions exhibited a positive linear trend. (Van der Werf et al., 2008)

A study was carried out by (Muttaqin et al., 2019) following objectives: (1) to examine communities' needs for forest products and services; (2) to analyze communities' interests toward REDD+ activities in reducing emission from deforestation and forest degradation activities; and (3) to analyze options to be developed into management plans for reducing emissions from deforestation and forest degradation. Through stakeholder interviews, focus groups, and field observations, they used a qualitative approach to study nine communities in the provinces of Papua, Central Kalimantan. In order to reduce emissions from deforestation and forest degradation that can be anticipated from the use of non-timber forest products and ecosystem services, the study discovered that communities confront several challenges in managing forest ecosystem services. Additionally, they came to the conclusion that while communities have a variety of interests in participating in programs to reduce emissions caused by deforestation and forest degradation, their capacity for planning and systematic forest use, as well as for including carbon conservation programs, is relatively low. (Muttaqin et al., 2019)

(Nurfatriani et al., 2015) investigate the effects of fiscal instruments, such as taxes, on encouraging the private sector to cut back on emissions related to forests, as well as the implications for bettering the governance of the forest sector, in a separate study. The study specifically focuses on the perspectives of a variety of forest sector stakeholders on the role of fiscal instruments that contribute either positively or negatively to reducing emissions from deforestation and forest degradation in Indonesia using a review of the existing instruments in Indonesia, as well as surveys and interviews. They claimed that there were many statutory and informal fiscal devices, as well as incentives and disincentives, at the several levels of

authority. It is also necessary to place more emphasis on cross-sectoral coordination, alternatives to products like palm oil, and ongoing land reform.(Nurfatriani et al., 2015)

Similar to this, (Cadman et al., 2019) investigated the effectiveness of fiscal incentives and key industry and business stakeholder insights to determine whether the private sector may be motivated to participate in REDD+ through such incentives. Despite the fact that their research was presented in terms of participation in REDD+, their conclusions apply to any reduction in emissions and deforestation. They offer a thorough examination of the numerous levies and charges that the government must evaluate in order to encourage sustainable forest management. Additionally, they emphasize that the government ought to take into account offering incentives to companies that deal in carbon trades and environmental services to discourage them from exploiting forests. These could be in the form of corporate investments, public-private partnerships, or involvement by civil society in forestry and land use reform. Incentives like payment for ecosystem services or forest ecosystem restoration may also be included. (Cadman et al., 2019)
(Irawan et al., 2019) examined the REDD+ plan within the framework of the province of Central Kalimantan. A national government may employ a jurisdictional method to meet (part of) its objective for unconditional emission reductions, so even though the research evaluated the jurisdictional approach to REDD+, its significance is greater. They suggested that the implementation of REDD+ involve these three levels of jurisdiction after analyzing the primary land use-based activities occurring at the province, district, and village levels.(Irawan et al., 2019)

(Irawan et al., 2014) argued that the government should take into account using intergovernmental fiscal transfers to provide incentives to regional governments, such as districts, because initiatives that limit land use change to prevent deforestation can result in significant reductions in local government revenues, and the design of incentive schemes at the local government level requires a clear framework for evaluating emissions reductions and determining which level of local government should be responsible for implementing the incentive scheme.(Irawan et al., 2014)

To make sure that they all support the general aim of reducing emissions, or at the very least do not conflict with it, policies within the forestry sector as well as those of other sectors must be carefully reviewed as part of a holistic plan to reduce emissions. According to (Brockhaus

et al., 2012), inconsistent policies, a lack of institutional clarity, and inadequate coordination have dominated Indonesia's land allocation strategy. They also emphasized that a ban on new logging concessions that had just been put in place when they were conducting their research may have provided a chance to reduce emissions caused by deforestation.(Brockhaus et al., 2012)

Similar to this, (Anderson et al., 2016) found that local goals to increase oil palm plantations were at odds with provincial efforts to reduce emissions in the East Kalimantan province where they studied green growth ambitions at the provincial level. They came to the conclusion that poor coordination between the various levels of administration and a political economy that was unfavorable to reforms in the land-based sector represented the principal obstacles to resolving these tensions. (Anderson et al., 2016)

(Ekawati et al., 2019) conducted a thorough examination of national and local government policies and laws relevant to REDD+ while also taking into account their readiness for implementation. They noted that the findings are challenging to summarize due to the fine-grained nature of their research. However, they recommended, as an illustration, that a number of forestry-related legislation be updated, including I Instead of creating incentives for districts to grow or harvest more timber, the method for allocating reforestation money should create disincentives; In addition, the technical specifications for underground mining in protection forests should be tightened to reduce the number of mining permits issued by local governments. ii) The fees for mining in state forests (should be raised so that funds can fully cover reclamation and rehabilitation costs of mined areas). Their effort serves as an example of the comprehensive policy and regulatory assessment necessary to meet the extremely aggressive emissions reduction targets. To meet both unconditional and conditional emission reduction targets, the Indonesian government will need to take into account the private sector's role and potential contributions to decreasing emissions. (Ekawati et al., 2019)

(Meehan et al., 2019) assessed the creation and execution of the Action Plan, they came to the conclusion that just two of the seven emission reduction efforts evaluated had a direct (evidence-based) link to emission sources, while the other three had some evidence of a link—albeit one that depended on a number of other factors. There was no information available for assessment for the other two activities, which were concerned with emissions from peatland agriculture. They discovered that the Action Plan's indicators were insufficient to show

significant environmental change. In essence, the study discovered that there is little proof that any of the forestry-related Action Plan actions have decreased emissions. It may be argued that rather than the reductions given by several activities that might function synergistically, what matters is the total achievement of an emission reduction target.(Meehan et al., 2019) In their study to examine the interests of nine communities in connection to the consumption of forest products and services and their participation in emissions reduction projects, (Muttaqin et al., 2019) came to a similar conclusion.

Using information gathered from a mail survey of program participants and nonparticipants carried out on West Virginia forest landowners in the fall of 2008, (Fortney et al., 2011) evaluate the Managed Timberland program in West Virginia, examining the factors that influence forest landowners' decision to participate in the program, and proposing strategies for increasing enrollment and improving the program. The majority of participants were pleased with the way the Managed Timberland initiative was run, and they frequently heard about it from professional foresters.(Fortney et al., 2011)

(Butler et al., 2022) evaluated the sustainability of forestlands in the USA using the Montreal Process Criteria and Indicators (C&I). They stated that policies like conservation easements and preferential property tax programs that are designed to retain family woods as family forests must be prioritized in order to protect the viability of America's family forest. Additionally, the findings revealed a net loss of family-owned forestland across the nation. While part of this loss was due to transfers to other forest ownership groups, the majority was due to loss to non-forest uses. Furthermore, they acknowledged that there is no easy solution or straightforward metric for evaluating the sustainability of forests because it is unclear whether these are short- or long-term phenomena and long-term monitoring is necessary to thoroughly evaluate consequences.

(Zhang et al., 2022) used the difference-in-differences method and a sample of Shanghai and Shenzhen A-share listed companies from 2015 to 2019 to examine the impact of the 2018 implementation of China's environmental tax on firms' environmental investments. After the tax was put in place, they claimed, businesses invested significantly more in the environment. Additional research looks into changes in the impact according on ownership type, level of regional economic development, and media attention. The beneficial effect is more pronounced for state-owned businesses and businesses that receive a lot of media coverage, but there isn't

a clear distinction between businesses in regions with varying levels of economic development. Additional research demonstrates that government subsidies have a negative impact on businesses' investments in the environment, but that the environmental tax reduces these subsidies and, consequently, their inhibitory effect, enhancing businesses' investments in the environment. They also came to the conclusion that through raising environmental investments, the environmental tax enhances enterprises' performance. Their research offers both empirical proof and theoretical justification for the implementation of the environmental tax policy.

(Frey, 2023)uses a thorough analysis of the literature to assess the weight of the evidence regarding preferential forest property tax programmes' (PFPTP) success in encouraging and retaining active management of private forests. Although the impact appears to be very minor, there is some evidence that PFPTPs decrease forest land-use changes, parcelization, or sales. On the other hand, there is very little proof that PFPTPs promote more active forest management. They claimed that although the impact of PFPTPs on reducing forest land-use change, sale, or parcelization is quite small, there is some evidence for it. Furthermore, they recommended that future research use thoroughly thought-out instrumental variables, propensity score matching, natural experiments, and, to the extent practical, randomized controlled trials to better control for endogenous variables. To better understand the effects of particular policy decisions, research may also compare the results of PFPTPs with various characteristics within or between states.(Frey, 2023).Similarly Binary logistic regression with multiple imputation for missing data was used by (Kilgore et al., 2018) to investigate the characteristics of the landowner, the land, and the program that are associated with the likelihood of enrollment in a PFPTP. They discovered that the majority of landowner goals and worries—including those that might seem to be connected to program enrollment, including worry over tax burden—were generally not correlated with likelihood of enrolment. Higher enrolment likelihood was connected with owning more forest land., According to the relationship between enrolment and population density, enrollment is higher in moderate densities, while it is lower in higher and lower densities, potentially as a result of competing incentives for enrollment as land values rise. Program characteristics, particularly those that limit uses or management, were adversely connected with likelihood of enrollment. The likelihood of enrollment was positively correlated with the owner's desire for the land to remain forested and higher levels of the penalty for program withdrawal, while the average rate of tax reductions was not significantly correlated, indicating that landowners may view programs as

a way of conserving and protecting their forestland in the future rather than just as a way to save money.

(Esen et al., 2021)use the panel smooth transition regression (PSTR) model, a novel non-linear model, to assess the effect of environmentally relevant taxes on environmental performance in the European Nation (EU-15) nations from 1995 to 2016. They contend that there hasn't been enough research done on the possible impacts of these levies on ecological balance sheets, a tool used to reflect human demands on the environment and ecosystem. As a result, their research focuses on the overall ecological balance and its key elements, which are based on the primary categories of ecologically productive areas like cropland, grazing land, forest area, and fishing grounds. The findings show that, after exceeding a certain threshold level, ecological deficits are greatly reduced by tax revenues connected to the environment as a percentage of GDP, but not by farmland balance accounts. If adopted without other measures to mitigate their effects, such as tax exemptions, refunds, or allowances, well-designed environmental taxes could thereby help to address environmental issues and ecological imbalance.

In this study, (Ma et al., 2014) analyze survey data from state preferential property tax program administrators across the United States. They outline the similarities and differences between states' preferential property tax policies, give a general understanding of the relationship between state policies regarding preferential property taxes and changes in the conditions of private forests, and point out problems with the efficiency of state preferential property tax policies in relation to private forest land management and conservation. In addition, they exposed three major disconnects: (1) Program characteristics previously thought to be crucial for preferential property tax programs to be effective in preserving forest land and fostering management did not consistently correlate with program effectiveness as perceived by the administrators of these programs; (2) These program characteristics did not consistently correlate with actual program effectiveness as measured at the state level by forest trend indicators used in this study (i.e., change in pr). (3) Additionally, there was no consistent correlation between the self-assessed and actual program effectiveness. These discrepancies can be explained in part by the different methods that preferential property tax systems' efficacy are identified and evaluated. Before evaluating and comparing programs or proposing reform initiatives, they added that academics and policy makers should be clear about how they define and quantify effectiveness and the scale on which they conduct their analyses.

Analysis of the current Income taxation revenue(demonstrates that distortions may occur even for properties that adopt deforestation in the Amazon by (Fendrich et al., 2022) explicit model that calculates tax income at the property level under various scenarios was also constructed. They claimed that a large group paying low tax rates and another group receiving excessive punishment are the causes of low goal achievement. Furthermore, the conclusion states that the implementation of the suggested revisions could encourage more environmental conservation, boosting the role of taxation as a tool for maintaining Brazil's native vegetation.

When thoroughly thought out, (Taranu and Verbeeck, 2022) contend that property taxes can be a useful instrument for controlling urban sprawl. Furthermore, the location of construction activity, the number of housing units, and density patterns can all be impacted by various tax regimes. For instance, a split-rate tax structure that encourages higher densities may be beneficial in preventing urban sprawl depending on the locality.

Researchers (Sun et al., 2022)looked at how resource taxes alter the resource curse and their effects. They aim to clarify the distinct contributions made by ad valorem tax and special tax in addressing the resource curse. Using data from 114 resource-based prefecture-level Chinese cities, The policy change of the Chinese resource tax from a specific tax to an ad valorem tax significantly slowed the economic growth of pilot cities while increasing their vulnerability to the resource curse through two mechanisms: an output-inhibiting effect and a supply-side Giffen effect. They empirically investigate the impact of resource taxes on economic growth and the resource curse using a difference-in-difference model. These findings have a variety of repercussions for governments in resource-rich economies as they attempt to modify and maximize resource taxes to avoid the resource curse.

(Alola et al., 2023) For the annual period 1995-2020, used the more current Method of Moments Quantile Regression (MMQR) in addition to previous techniques for Europe's biggest agrarian economies (France, Germany, Italy, and Spain). As far as environmental sustainability and value contributed to agriculture are concerned in this panel of the "Big Four" economies, their analysis supports the co-benefit of environmental taxes, driving the nations to assiduously seek the carbon-neutral 2050 target. The analysis supports the hypothesis that the use of renewable energy sources and population density are advantageous elements for achieving a carbon-neutral aim. Finally, they contend that the panel can achieve environmental quality, particularly if income increases beyond a certain point, supporting the environmental

Kuznets curve concept. Above all, the findings offer current policy insight that takes into account the European Union's frameworks for food security and environmental sustainability. The study's findings suggest that the decision-makers in the chosen agrarian economies should increase the prospects for the energy transition through a strong environmental tax structure that encourages credit availability and investment finance in the agricultural sector.

Using the autoregressive distributed lag (ARDL) approach and related intermediate estimators, (Rafique et al., 2022) investigate the impact of environmental taxes and economic growth on the expanding ecological footprint in 29 OECD economies. To test the ARDL estimator's robustness, the two replacement single equation estimators DOLS, FMOLS, and fixed effect are also used. They contend that environmental taxation, economic expansion, FDI, energy consumption, urbanization, renewable energy, and industrialization all have a major impact on the long-term ecological footprint in OECD nations. They came to the conclusion and recommendation that the OECD economies need to closely monitor environmental rules for energy usage policies and cleaner production objectives.

(Filipović and Golušin, 2015) analyze the current method for calculating the financial effects of environmental taxation in the EU27 and use the recently proposed methodology to create a composite ETE indicator that, in addition to the current indicators, also accounts for the environmental taxation effects per capita, an indicator that was unfairly ignored in earlier methods of measurement. By comparing the rankings of all EU-27 countries using the four approaches mentioned, they claimed that there were notable variations, which amply demonstrated the need for more advancements. The ETE technique reduces the GDP's disproportionate influence and adds a social component, which should form the cornerstone of a later, more specialized methodology for establishing effective environmental taxation.

With the electrical sector broken down into 5 technologies and 19 key taxable pollutants included, (Li and Masui, 2019) thoroughly study and build a dynamic country-level Compute General Equilibrium (CGE) model. There are five different scenarios created: the baseline scenario BaU, the low environmental tax scenario LowET, the high environmental tax scenario HighET, the low environmental tax and low carbon tax scenario LowETC, and the high environmental tax and high carbon tax scenario HighETC. The outcomes of the simulation suggest that an environmental tax could cut emissions of most types of pollutants but have detrimental impacts on the GDP (GDP). versus the BaU case scenario. According to their

claims, the GDP losses by 2030 under the LowET, HighET, LowETC, and HighETC scenarios would be 0.10%, 0.21%, 0.32%, and 0.67%, respectively. Carbon dioxide (CO2) emissions will be lowered by 2.21%, 4.62%, 8.91%, and 16.77%, while sulphur dioxide (SO2) emissions would decline by 3.55%, 7.15%, 6.70%, and 13.01%. The outcome also demonstrates that in the policy scenarios, the service sector and clean energy sectors will see output increases while the heavily polluted and energy-intensive sectors will see significant output losses.

(Tan et al., 2022) current study examined scope, tax base, tax rate, tax preferences, monitoring and calculation method of pollutants, collection and management modes, and implementation effects using data retrieved from institutional and governmental websites and related research articles with the aim of providing experiences on establishing environmental taxation systems for developing countries. There was a summary of the tax base structure, commonly utilized economic tools, operational mechanism, and management style. The most important components of implementation were discovered to be governance and management, education and publicity, and legislation and institutional design. Additionally, current development patterns were reviewed. This study helps emerging nations construct environmental taxation systems in accordance with their local conditions based on social and historical background and economic structure by serving as a guide and an inspiration.

In their paper Promoting sustainable logging in Brazil's national forests: Tax revenue for an indemnification fund, (Thurston and Burness, 2006)Stuart Burness recommend giving the increasing severance tax, or stumpage charge, preference over the administrative tax or even using it in conjunction with it.

Researchers (Mahmood et al., 2019)examine how Bangladesh's economic development, use of renewable energy, urbanization, industrialization, technological innovation, and forest area may reduce CO2 emissions and help the country achieve environmental sustainability. The Dynamic Ordinary Least Squares (DOLS) approach was used to evaluate time series data from 1990 to 2019 after the autoregressive distributed lag (ARDL) bounds testing procedure. The usage of renewable energy, technical advancement, and support for forested areas were all suggested to be better ways to achieve environmental sustainability by lowering CO2 emissions in Bangladesh, where economic expansion, urbanization, and industrialization are known to increase CO2 emissions. Furthermore, the pairwise. The Granger causality test was additionally used to identify the causal relationships between the variables.

A number of studies have shown that different types of environmental regulation have different costs and effects on environment (Li and Masui, 2019)(Atkinson & Lewis, 1974; Keohane, 2002; Malueg, 1989). Stavins (1996) stresses that government can address different environmental problems using different environmental regulation. It is generally believed that environmental regulation increases firms' incentives to adopt and develop more efficient technological advancements to control pollution, yet, according to Malueg (1989) they can actually decrease some firms' incentives to adopt new technologies. Whilst according to Arimura et al. (2008) voluntary regulation were effective in reducing pollutants discharge, however, according to Blackman and Kildegaard (2010) high frequent environmental monitoring implementation failed to incentivize enterprises in Mexico to adopt purification techniques. Zhao, Yin, and Zhao (2015) find that market-based environmental regulation plays a significant role as they promote firms' strategic behaviors to shift towards green development while command-and-control regulation strongly and positively impact technological innovation.

A study by Du, Hu, and Song (2016) explored the cap-and-trade system and discovered that the regulation by government through environmental policy which imposes emission cap by applying social credibility to build a philosophy on environment that promotes consumers to prefer low-carbon can help to influence the production decisions of firms of firms that uses techniques with a lot of carbon emissions. Du, Tang, and Song (2016) also revealed that the cap-and-trade approach can promote low-carbon production while at the same time is more profitable that traditional production techniques. Low-carbon production methods can constrain the total amount of carbon emitted into the atmosphere.

In a nutshell, Frondel et al. (2007); Porter (1991) and Wang et al. (2016) stressed that environmental regulation can be a useful instrument that could be used by the government to stimulate technical innovation as well as to improve economic performance and enterprises' performance on environmental related issues. However, an empirical investigation by Zhao et al. (2015) revealed that different environmental regulations have different impacts on production efficiency and carbon emissions. The authors concluded that market-based regulations can significantly enhance improvements in efficiency and reductions in carbon emissions. Additionally, Stavins (1996) stressed that different environmental regulation tools require different mechanisms to solve environmental problems. As a result, when designing

and implementing environmental regulation tools and developing environmental protection system it is necessary to investigate the effectiveness of each mechanism. The reason being, while some industries benefit from environmental regulation, others would otherwise suffer from it. Furthermore, in the case of China environmental regulation promoted upgrading of exports and at the same time decreased the number of heavy polluting industries and promoted green and high value-added manufactured commodities (Wang et al., 2016).

Environmental governance issues are a natural byproduct of economic development, and governments enact environmental legislation to address these issues. Firms must take steps to mitigate the external expenses that strict environmental standards cause. Environmental control can successfully raise environmental quality from a broad perspective. For instance, environmental taxes that place a high price on pollutants can help cut air pollution(Esen et al., 2021), and a healthy environment can help businesses run smoothly and produce more. Environmental taxes have been shown to have an impact on economic growth. More environmental tax revenues come from greater starting GDP levels, which boosts the economy's growth rate (Hassan et al., 2020). The behavior of enterprises is also impacted by macroeconomic changes. According to studies (Berggren, 2014) manufacturing relocation (Chen et al., 2016), and investment (Leiter et al., 2011), environmental rules prevent enterprises from innovating and lead to inconsistent decisions. Environmental regulation is accomplished through tax policies, such as resource and environmental taxes. Standardizing the tax system and the criteria for collection is the main goal of environmental tax design since they have a significant impact on the capital market and businesses. For instance, (Yip, 2018) finds using individual-level data that environmental taxes negatively impact the labor market in places where they are imposed by reducing business profits and having a crowding-out effect on employment. In addition, when businesses attempt to alleviate the operating pressure brought on by environmental fees, high-intensity environmental rules promote stronger political ties between businesses and local governments (Yu et al., 2020). Other researchers discover that environmental taxes influence businesses' disclosures of information, For instance, (Ambec and Coria, 2021) discover that enterprises' emission reduction expenses weren't understood prior to environmental taxes. Environmental taxes boost the quality and amount of information disclosure as they highlight the costs of emission reduction. Environmental rules that are more stringent result in lower export quantities, according to (Shi and Xu, 2018) analysis on the impact of regulations on enterprises' exports. They contend that the lack of access to export markets is what has caused this decrease.

For a very long time, it was thought that taxes discourage both consumers and producers, slowing down environmental deterioration. Individual participant traits related to duty, habit, and attitude have an impact on how environmental taxes are applied. (Bazin et al., 2004). provided a model outlining the relationships between the degree of responsibility, environmental quality, and taxes in connection to the accountability of economic players. It was discovered that a very high level of accountability enhances environmental quality and may take the role of taxation to reach the highest level of environmental quality, responsibilities and taxation should be in harmony (Bazin et al., 2004). Regarding the relationship between habit and green tax reform, a further study was modeled in a dynamic environment with a focus on the efficiency dividend in the double dividend theory. The findings demonstrate how household decisions are impacted by transitional dynamics and habits when household energy excise taxes rise, changing the efficiency dividend. Habits were found to play a less significant role as energy consumption taxes on businesses increased. Here, the reform introduces an efficiency cost (de Miguel and Manzano, 2011). A second modeling research demonstrated that when the best green tax measures are implemented, double dividends can be obtained (Al-Ali et al., 2019) evaluates Public views and approval for environmental taxes using gasoline taxation as an example have been modeled using representative survey data from adults in Norway. Its findings demonstrated that the aforementioned taxes was supported by attitudes on the negative effects of human behavior on the environment, other people, and oneself (Kallbekken and Sælen, 2011). Using microdata from Europe in the late 2000s, environmental tax reform and personal preferences have been empirically studied. Using a partial generalized ordered logit model, individual attitudes toward the environment were discovered to be heterogenic (Ercolano et al., 2014). Furthermore, both industrial and social considerations must be made when implementing environmental taxes. Albrecht proposed excise tax on products as a substitute for green tax reform since it requires less institutional innovations and can be easily distinguished based on environmental impact. The green tax reform was enacted in many European countries in the late 20th century (Albrecht, 2006). An analysis of the effectiveness of packaging fees using a trade gravitation regression model revealed that when enacting new taxes, care should be taken to take commodity features into account (Cela and Kaneko, 2013) According to a study from Denmark, utilizing electricity rather than conventional fossil fuels will be more environmentally friendly when environmental taxes are implemented (Casal, 2012) Reviewing the fundamental theory of environmental taxation, an optimal tax model was developed to explain how environmental taxation and atmospheric externalities, specifically the problem of climate change in relation to global warming from an

environmental economics perspective, relate to one another (Sandmo, 2011). A dynamic general equilibrium model that compares one-step and incremental green tax reform was developed and calibrated to the Spanish economy. The model's results showed that one-step reform results in significant short-term efficiency costs despite producing an efficiency dividend. Meanwhile, a gradual change results in a temporary increase in efficiency that vanishes with time (de Miguel and Manzano, 2011)Politics has a significant impact on how environmental taxation policy is established. According to representative research conducted in Canada, a carbon tax may only be practical if it is supported by a majority of parliament and presented as a campaign issue. Alternatively, a less widespread energy taxation may be suggested (Harrison, 2012). The expansion of environmental taxes also faces oppositional objections, such as economic inequality and disproportionate loads on the poor, which can be mitigated by various forms of green fiscal reform (Casal, 2012). Additionally, where a broad interdisciplinary collaboration is required, obtaining the correct price by using taxation as an instrument is of great importance from both a political and scientific viewpoint. To ensure economic stabilization and the effectiveness of its procedures, the fiscal system needs to evolve and grow more sophisticated (Piciu and Trică, 2012). In contrast, tax evasion is becoming a widespread issue in many emerging nations. The implementation of environmental taxation is helpful in terms of preventing tax evasion and resulting in a decrease in greenhouse gas emissions (Liu, 2013). Economic growth and environmental taxes have a causal relationship from a financial and economic perspective, according to a study utilizing the traditional Granger non-causality technique. The findings indicate that a rise in environmental taxes will not have a long-term negative effect on the economy. The subsidy has some effects in the short term but no long-term influence (Abdullah and Morley, 2014). In order to rank the financial impact of environmental taxation in the European Union (EU), a new methodology approach was proposed, adding environmental taxation efficiency as a new indicator to the traditional approach taking gross domestic product (GDP) and total revenue. This demonstrated the importance of a composite indicator for consideration (Filipović and Golušin, 2015).

As a way to combat alarming rates of environmental degradations, various environment-economic instruments have been implemented by governments of different countries. Economic and Fiscal policy instruments, such as carbon taxes and similar economic instruments established and promulgated as to ameliorate environmental problems are significant in mitigating climate change thus, enhancing the achievement of sustainable development. In this context, pollution or degradation liabilities or levies are the primary

economic-based strategies employed to control environmental degradation including deforestation. Environmental pollution or degradation liabilities cover different taxes or levies with the purpose of controlling producers' and consumers' activities (Statistical Office of the European Communities, 2010).

The purpose of such taxes is to abate environmentally harmful practices and/or encourage incentives for reducing degradation such as deforestation. A recent documentation on the High-Level Commission on Carbon Pricing and Competitiveness reveals that Carbon pricing is a sustainable effective, flexible, and low-cost approach to reducing GHG including CO_2 emissions (Aydin & Esen, 2018; Stern & Stiglitz, 2017). The rapidly global growth in the use of carbon pricing proves the future promising in its effectiveness and reliability in curbing climate change, global warming, and their associated impacts from GHG. Now, there are about 30 carbon taxes and 31 emissions trading schemes world-wide, representing 22% of global emissions (World Bank, 2020). Environmental or Carbon taxes keep a surcharge on gasoline or energy use. It is pertinent to state here that carbon taxation is not basically a domestic climate mitigation policy, but it is a major component of the multilateral regions and countries to cope climate change (Green, 2021). The 2015 Paris Agreement creates an expanded role for carbon pricing.

Taxations (e.g., environmental or carbon taxes) are effective environmental regulations for reducing harmful GHG emissions (Stern & Stiglitz, 2017; Wu, Hao, & Ren, 2020) as they can induce a public response towards efficient use of pollutant energy resources and enhance green innovation (Wu, Xu, Ren, Hao, & Yan, 2020). Carbon taxes are a key policy instrument to stop deforestation. They have been a success in Costa Rica and Colombia, where the revenue from carbon taxes is also used to fund forest restoration efforts (Barbier et al., 2020). More so, carbon taxes can be a source of funding for environmental projects to governments. Nonetheless, carbon taxes are extremely unpopular. By 2019 only 24 countries worldwide had adopted carbon tax policies (World Bank Group, 2019). However, many governments in Africa are reluctant to impose carbon taxes due to their unpopularity, yet taxation may encourage large corporations to keep their emissions low by investing in research and development, new technologies or better innovation, the result of which may bring with it long-term benefits for the environment.

Several studies introduce a carbon price (i.e. tax) associated with land use change, including deforestation (Reilly et al., 2012), and/or reward carbon sequestration (Golub, Hertel, Lee,

Rose, & Sohngen, 2009) in their modelling approach to evaluate the opportunity costs related to the reduction in CO_2 emissions from deforestation. Other studies explicitly examined the behaviour of landowners who receive payments for Reducing Emissions from Deforestation and forest Degradation in developing countries (REDD) (Bellassen & Gitz, 2008). The role of environmental or carbon taxes as economic instruments to reduce environmental degradation including deforestation and CO_2 emissions have been under investigation for many years in different countries. But it is rare to find studies that cover the entire SSA and include many drivers of environmental damage. It is on this background; this study aims at examining the effectiveness of taxation in reducing GHG emissions and deforestation in selected 17 African countries[1]. Based on environmental damage theories that include the Environmental Kuznets Hypothesis (EKC) (Kuznets, 1955) and Decoupling Hypothesis (Ruffing, 2007; UNEP, 2016), the study hypothesizes that taxation is a good economic instrument to reduce deforestation or conserve forest area and consequently GHG/CO_2 emissions in the 17 African countries. Some of the research questions to be answered are (i) does taxation have significant effects on deforestation vis-à-vis GHG/CO_2 emissions? (ii) will a change in the tax rate lead to a significant change in deforestation and GHG/CO_2 emissions across the countries? (iii) Are there any relationships between GDP, urbanization, population growth, deforestation rates and GHG/CO_2 emissions and other variables in selected African countries?

Prohibition, taxation, property rights and many more are generally used to mitigate deforestation, and ultimately GHG or CO_2 emissions. Taxation is among the most effective instrument to reduce GHG or CO_2 emissions and deforestation. Findings by Sathaye, Makundi, Dale, Chan, and Andrasko (2005) show that higher carbon taxes result in carbon gains and reductions in deforestation by 50.9 GtC to 113.2 GtC and 51 to 78 percent respectively by 2100. Environmental taxes can also be used to fund efforts towards investments in natural climate solutions in general and deforestation reduction in particular. A study by Barbier et al. (2020) reveals that Colombia and Costa Rica have implemented carbon tax and as a result they have realized not only a decline in deforestation rates, but a restoration of previously degraded forests which are now generating revenue for the two countries. Barbier et al. (2020) state that economists and scientists generally converge on the idea of using environmental taxes as policy instrument that reduces GHG emissions because the taxes incentivize people to minimize the use of fossil fuels. In addition, environmental taxes are also an effective instrument that can be

[1] These include Cameroon, Congo, Congo Democratic Republic, Cote D'ivoire, Egypt, Eswatini, Ghana, Kenya, Madagascar, Mali, Morocco, Rwanda, Senegal, South Africa, Togo, Tunisia and Uganda.

used to reduce GHG emissions resulting from deforestation, thus they are critical in addressing climate crisis.

Economic instruments such as environmental taxes or Pigouvian taxes are theoretically aimed at overcoming market failures that could lead to excessive deforestation, yet in practice they are determined by the incentives, policies and prices encountered by those who use the land (Amsberg, 1998). Also, some externalities are exterritorial in nature, thus making implementing policies at global level less effective since they give no incentive to individual countries implementing them. This is because the damage to environment is not a problem for the polluting country but affects the whole planet on a global scale, thus giving less incentive to those that comply to environmental protection. According to OECD (2022), "*environmentally related taxes are an important instrument for governments to shape relative prices of goods and services.*" Thus, Nordhaus (2019) stresses that effective climate change policies can only be ensured when countries design, implement and enforce cooperative multinational policies.

The lives of humans are significantly impacted by environmental degradation. The Chinese public came to realize that a narrow concentration on economic development that disregards environmental regulation is a serious issue in 2011 as a result of severe air pollution. Significant environmental issues have also prompted the government to establish environmental restrictions, and businesses have come to the fore as a result. Companies are the biggest users of natural resources and economic resources; hence they are primarily accountable for environmental damage Firms are driven to accomplish a green transformation in order to make up for the social welfare losses brought on by manufacturing and operations. Additionally, environmental investment is a manifestation of corporate social responsibility as it leads to a green transformation (Wang et al., 2018). The government has also enacted a number of punishments against businesses that pollute. To address the huge externalities of environmental contamination, many environmental rules impose social and environmental governance responsibility on businesses. The investment required to eliminate environmental pollution while maintaining output levels to the greatest extent possible is referred to as "environmental investment," according to a novel method to resource allocation. Scholars' opinions on the environmental investments made by businesses vary. According to some academics, environmental spending crowds out other business decisions and raises financial risks for businesses (Hart and Ahuja, 1996). Additionally, approaches toward sustainable development and the formulation of policies were considered in accordance with rules and relative economic

variables(Andreoni, 2019) . A dynamic compute general equilibrium model was used in the field of electricity regarding technologies and pollutants to explore the effects of environmental taxation on socioeconomics and the environment at the national scale. It was discovered that environmental taxes cut pollutant emissions while harming GDP (Li and Masui, 2019). Applying environmental taxes at the national level creates new problems due to regional disparity. A study on the distributional effects of environmental taxes from both an inter-provincial and urban-rural level was conducted using Chinese provinces as examples, and it concluded that a national scale of increasing environmental tax rates and the implementation of a provincially differentiated levy mechanism based on economic and consumption factors are required (Wang et al., 2018). A multi-objective multi-period mathematical modeling was carried out in a case study taking into account changes in carbon emission tax rate and economic loss in a heat exchanger network synthesis in order to find the best method for using energy efficiently. The findings demonstrate that a reasonable taxation rate cuts emissions (Novak Pintarič and Kravanja, 2015). The environmental taxation rate may need to be changed in relation to air pollution taking into account the pollutant transport mechanism. Making tax policy requires taking local and regional effects, environmental responsibility, and fairness into account (Lu et al., 2019). Additionally, a static general equilibrium model was employed to simulate a green tax reform, and the results showed that while the economy's energy intensity decreased, the double dividend, energy-trade balance, and reliance all improved (Rodríguez et al., 2019) . Environmental taxes have replaced pollution levies in many nations, however there is regional variation in different areas. The effectiveness of the environment was assessed using a frontier-based optimization model. The findings demonstrate that environmental productivity increase is dominant in areas where technological advancement is occurring. However, the change slows economic growth while reducing emission intensities (Wang et al., 2018, p. 2). Environmental taxation has recently been the subject of interdisciplinary studies that have shown the need for the introduction and fusion of new technologies and concepts in order to ensure the proper implementation of environmental taxation in the near future. For instance, the fusion of building smart cities with environmental taxation as well as climate policy taking geopolitics, pollution, and energy use into consideration has attracted significant attention. Big data technology can be used to design and integrate smart energy systems to accomplish sustainable growth of the city and society, for example, as sensors with varied functions are widely adopted establishing networks in the construction of smart cities. The introduction of renewable hydrogen as a replacement for fossil fuels may change the global structure of the energy market and have an impact on geopolitics (When implementing carbon pricing, the

relationship between the decrease of carbon dioxide emissions and GDP growth must be fully taken into account and balanced, however climate policies and environmental taxes may also be taken into consideration (Ionescu, 2020).

Till present, the costs of CO_2 emission reduction by using taxation and schemes have been assessed in relatively few studies. The papers use modelling approaches cross-country studies (Golub et al., 2009; Reilly et al., 2012; Strassburg et al., 2009), and others focusing on individual or single countries (Bellassen & Gitz, 2008).

In Japan for example, Nakata and Lamont (2001) affirmed that carbon taxes are an effective tool for ameliorating Japan's carbon emissions. They concluded that such taxes promote a change from activities that increase CO_2 emissions to activities that decrease the use of energy sources with higher CO_2 emissions to sources with lower emissions. In France, Millock and Nauges (2003) investigated the effect of the French tax on air pollution emissions and observed that the tax yielded a significant negative effect on CO_2 emissions.
In contrast, some other studies reported insignificant effects of carbon taxes in reducing CO_2 emissions (Bruvoll & Larsen, 2004; Gerlagh & Lise, 2005; Hotunluoğlu & Tekeli, 2007; K. Li & Lin, 2015; Loganathan, Shahbaz, & Taha, 2014). For instance, Bruvoll and Larsen (2004) found that environmental taxes have a limited impact, and this was attributed to the extensive tax exemptions as well as the relatively inelastic demand in the sectors where these taxes were applied. Similarly, the studies by Gerlagh and Lise (2005) indicated that environmental taxes have inconsequential effect on GHG emissions, and that this result will continue until a necessary technological transformation is achieved.

Other studies also examined the drivers of both deforestation and GHG or CO_2 emissions. For example, in China, Gokmenoglu, Taspinar, and Kaakeh (2019) studied the long-run equilibrium relationship between CO_2 emissions and deforestation by agriculture between 1971 and 2014 using the Autoregressive Distributed Lag (ARDL) approach. The authors established that deforestation through agricultural development is positively associated with CO_2 emissions. In Tunisia, Ben Jebli and Ben Youssef (2017) applied Johansen-Juselius cointegration test and Vector Error Correction Mechanism (VECM) model between 1980 and 2011. Their study revealed that an increase in deforestation induced by agricultural value-added increases CO_2 emissions. By introducing the ARDL model for data from 1961 to 2012, Asumadu-Sarkodie and Owusu (2016) observed that deforestation through agricultural production was responsible for increased CO_2 emissions in Ghana. In Pakistan, Maki

cointegration, Toda-Yamamoto and fully modified ordinary least square (FMOLS) were used to demonstrate the causality tests for CO_2 emissions in the country from 1971 to 2014 (Gokmenoglu & Taspinar, 2018). The authors established that deforestation via agriculture deteriorates environmental quality, and there is bidirectional causality between agricultural-induced deforestation and CO_2 emissions. On the other hand, Naseem et al. (2020) investigated the asymmetrical impacts of agricultural deforestation on CO_2 emissions in Pakistan from 1969 to 2018 by applying the nonlinear Autoregressive Distributed Lag (NARDL) model. Similarly, Ullah, Khan, Khan, and Zheng (2018) conducted ARDL, Johansen cointegration test, and Granger causality test by applying the data from 1972 to 2014. A study by Achuo (2022) on 32 African economies showed that GDP positively contributes to CO_2 emissions.

Ullah et al. (2018) discovered that six distinct types of agricultural activities led to acute deforestation and consequently increase in CO_2 emissions in the middle East country. Thus, a bidirectional causality between deforestation, agriculture and CO_2 emissions was established. In addition, Balsalobre-Lorente et al. (2019) applied Dynamic Ordinary Least Squares (DOLS) and FMOLS methods to examine the long-run effects of agricultural activities of deforestation on CO_2 emissions for the five major emerging economies including Brazil, Russia, India, China, and South Africa (BRICS) over the period 1990–2014. They affirmed through their results that deforestation by agriculture caused a negative impact on the environmental status in the BRICS countries. Similarly, by using the FMOLS and VECM approach with the data from 1990 to 2014, Qiao, Zheng, Jiang, and Dong (2019) observed that deforestation significantly increases CO_2 emissions in the G20 countries.

Applying the Emirmahmutoglu-Kose panel causality test for eleven developing countries in the Central and West African regions, Olanipekun, Olasehinde-Williams, and Alao (2019) ascertained that deforestation from agriculture has a positive impact on CO_2 emissions. A study across the North African countries from 1980 to 2011 utilizing Ordinary Least Squares (OLS), FMOLS, and DOLS techniques concluded that a reduction in deforestation and increase in agricultural value-added decreased CO_2 emissions in the region due to policies geared towards (Ben Jebli & Ben Youssef, 2017). Geographic information systems and remote sensing approaches are tools for the geostatistical and geospatial models which incorporate Land use change model (LCM) and have been considered very effective for deforestation and CO_2 emissions (De Sy et al., 2012). Increased access to remotely sensed data (via the Landsat imageries and archive), allowed for the global production of multiple estimates of data covering human activities and GHG emissions factors (Carter et al., 2018).

To determine the effects of bushland clearing on surface biophysical parameters and its corresponding consequences on surface energy balance and land surface temperature, (Abera et al., 2020)uses high-resolution satellite imagery and land surface flux modeling tools. According to the findings, removing bushland causes an average 0.4 mm per day decrease in evapotranspiration. The components of the surface energy balance were influenced by changes in surface biophysical parameters to varying degrees. The average net increase in daylight land surface temperature (LST) of up to 1.75 K was caused by the decrease in latent heat flux, which was stronger than other surface energy fluxes. These findings reveal increases in LST that are on par with those brought on by forest loss, highlighting the significant influence of bushland to agriculture conversion on the local climate. This research underlined the need of maintaining bushland for controlling East Africa's land surface temperature while also highlighting the adverse climatic effects of destroying bushland for agriculture.

(Daigneault et al., 2020)investigate the potential effects of U.S. tax reform on forest stocks and carbon sequestration using a dynamic global forest model. The implications of changing present policies on investment, area, harvests, and carbon are estimated by scenario analysis. They contend that the industry might be significantly impacted by tax reform because current federal and state levies have a considerable impact on investments in forestry, land use, and forest management.

There is a ton of literature on forest taxation, but most of it concentrates on how taxes might affect investments in, manage, and return forests (e.g., (Amacher and Brazee, 1997; Chang, 1983, 1982; Klemperer, 1982, 1974) These studies often assess "optimal" tax questions, such as how taxes affect investments, rotation duration, and other efficiency-related concerns. Chang (1983) derives the comparative static effects of a wide range of taxes on optimal harvest age management intensity, while (Chang, 1982) exhibits the effects of several types of taxes applied individually on rotation lengths and land values. (van Kooten et al., 1995)summarizes the effects of each of the six forest taxes and concludes that changes to the yield, unit, and timber taxes are likely to have a long-term effect on the availability of timber. (Chang, 2018) examines the effects of five different property taxes on land values using a generalized Faustmann model and finds that an unaltered property tax has the greatest effects on land expectation values and rotation length. Additionally, other research assess how forest taxation affects non-timber goods, amenity, ecosystem services, or biodiversity (e.g., (Koskela and Ollikainen, 1999). For instance, according to (Gamponia and Mendelsohn, 1987), yield taxes are more effective than property taxes at changing the behavior of landowners who manage

their forests to maximize the value of both timber and amenities. In their 1990 study on the effects of taxation on explicit ecosystem services, (Pearce, 2001) made the suggestion that the overall effects of taxation might be different from the implications on particular species. They come to the conclusion that the type of tax enacted has a significant impact on ecosystem services, but the magnitude and direction of the effect vary by species and site class. According to (Uusivuori and Kuuluvainen, 2008) investigation into the effects of forest taxes on consumption and amenity values for a multiple-stand forest, both profit and sales taxes amplify the effects of a landowner's conservation and amenity preferences, lengthening rotations and lowering long-term timber supply. (Koskela et al., 2007). They conclude that the type of tax implemented significantly affects ecosystem services, but the size and direction of the effect differ by species and site class. Profit and sales taxes both amplify the effects of a landowner's conservation and amenity preferences, lengthening rotations and reducing long-term timber supply, according to (Uusivuori and Kuuluvainen, 2008) study into the effects of forest taxes on consumption and amenity values for a multiple-stand forest. Among others, (Koskela et al., 2007) To properly encourage private landowners to extend rotations and leave retention trees in their stand, an evaluation of the impact of five different forest tax options on adjusting the rotation age to take into account the benefits of timber and biodiversity in a commercial boreal forest is conducted. The majority of these studies make the assumption that land supply is inelastic and that prices are exogenous; hence, landowners can only adjust stand management, not forest area, in response to changes in tax policy. Another section of the literature has looked into how forest taxes effect fiscal neutrality, or whether levies have an impact on management choices. Numerous studies show that applying the traditional Faustmann formula to analyze the effects of taxes on rotation age and timber supply indicates that some taxes (such as those on site value, productivity, and profit, for example) have a neutral impact on these variables(Gruver et al., 2017) . However, analytical findings show that nearly all forest property taxes are not fiscally neutral in theory, and that an increase in a variety of forest taxes (such as property, site value, or productivity) will typically reduce the ideal rotation age (Chang, 2018). Additionally, analyses of the ideal design of forest taxation in the presence of timber and amenity services that are considered to be pure public goods find that governments may need to use a neutral tax (such as a site productivity, lump sum property, or profit tax) to raise tax revenue in addition to a corrective tax (such as a yield, unit, or timber tax), to correct the externality caused by excessive private harvesting (e.g., (Amacher and Brazee, 1997), The literature also assesses the factors that lead landowners to sign up for programs that offer favourable forest property taxes. According to several articles, state property taxes can be a

considerable burden for landowners because they must be paid annually even when money from forests may only be received sometimes because of the extensive planning horizons involved in the production of timber (e.g., (Cushing and Newman, 2018; Gruver et al., 2017)).

(Frey et al., 2019) discovered that use limits, total area owned, and long-term management goals are enrollment drivers. In response, (Kilgore et al., 2018) estimate that approximately 4 million landowners managing 85 million hectares (Mha), or roughly 44% of U.S. private forestland area, presently utilize these state programs, collecting a total of over $1.61 billion in property tax savings year, or $19 per ha annually. None of these studies specifically state how much these tax advantages affect 1 the provision of ecosystem services based on forests. According to,(Kilgore et al., 2018) State property tax programs and the fiscal incentives incorporated therein are just one of the numerous strategies that can be used to encourage the availability of ecosystem services from private forestland in the United States. The ecosystem services that were found to be the most consistent as a focus for property tax programs focused on private forest land were the integrity and sustainability of the ecosystem. In the circumstances of decentralization of authority, (Openko et al., 2019)estimates tax receipts from the usage of forest land using a geoinformation technique. In the combined territorial communities, he found that the forest area was mostly located in the Zhytomyrska (788.5 thousand ha), Chernihivska (583.6 thousand ha), Volynska (432.9 ha), Rivnenska (282, 8 thousand hectares), and Sumska (216,0 thousand ha) regions. While the smallest amount of forest land is concentrated in the Kirovohradska, Zakarpatska, Mykolaivska, Zaporizka, Vinnytska, Donetska, Luhanska, Odeska, and Khersonska districts that lie within the boundaries of the united territorial communities.

(Zhurakovska et al., 2021)suggested that it is important to undertake a monetary assessment of forestlands outside of settlements because the results can then be used to determine rates and calculate the amount of land tax.

An official analysis by (Brueckner, n.d.)determined that a split-rate tax raised the "level" of improvements per acre. (DiMASI, 1987) used a general equilibrium model to arrive at the following conclusion: Increasing the land rate relative to the building rate lowers rents and housing costs overall and at each distance from the city center, while increasing population density throughout the entire city. When land was taxed at a rate three times higher than that on improvements, resident welfare in terms of access to cheap housing and wages was found to be at its highest level. When the elasticity of substitution between housing and other items

is strong, a higher property tax leads to denser growth and a smaller city size, according to research conducted by (Brueckner and Kim, 2003).When the elasticity is low, the higher tax reduces density and leads to an expansion of the city area. They also thought about doing away with the property tax in favor of a revenue-neutral move to a land tax, and they came to the conclusion that the city would become smaller under that scenario. A model created by (Song and Zenou, 2006) further demonstrated the effect of property tax increases on the size of urban areas. In their research, they conducted an empirical analysis of a number of American communities, which showed that the cities with greater property taxes had grown more compactly over time.

A significant amount of empirical study has been conducted on the Pennsylvania applications, with Pittsburgh serving as the most prominent and significant example.(Oates and Schwab, 1997)conducted the largest examination of Pittsburgh's split-rate property taxes. According to research, most comparable cities in the area experienced a significant decline in commercial construction during the 1980s compared to the previous two decades. Pittsburgh started increasing its land tax in 1976. Starting off at a rate that was double that of buildings, it eventually increased to over six times that of buildings. However, other cities did not see a significant latent demand for office space, and starting in 1980, a three-year building tax relief was offered for new construction. In view of these elements (Oates and Schwab, 1997) came to the conclusion that while increasing the land tax was a significant enabling factor, it was not the main reason for the increase in development. The main reason for raising the land rate was to make up for a revenue shortfall because raising any other taxes would have created incentives that would have hindered development. Additional studies (Bourassa, 1987; Cord, 1983) discovered a correlation between the split-rate tax and higher development, but they concluded that the effect was not uniform across property kinds and identified other factors that might have contributed to the rise in construction in the city. According to (Cord, 1983), the higher rate on land still equated to a carrying fee that was too low to be taken into account when making development decisions. When (Bourassa, 1990) expanded his research on Pittsburgh to two additional cities, he discovered that while increasing the tax on land had no discernible impact, doing so on buildings showed a significant negative relationship with the quantity of new construction. The tax disparity had a statistically significant impact on construction value and the number of building licenses issued, but not on the value per permit, according to (Plassmann and Tideman, 2000) research. Increasing the tax disparity (either by cutting the rate on buildings or by raising the rate on land) results in greater construction, even

though their model did not examine land and building rates separately. Banzhaf and Lavery (2008) conducted a more current empirical assessment of Pennsylvania applications, separating density from dwelling size and noted that raising the capital-to-land investment ratio could lead to larger housing units rather than more units in a specific region. The development intensity would diminish, and the city would become more dispersed if the dwelling size effect outweighed the density effect. According to their findings, divided tax cities had more rooms per square foot of land, with little to no impact on the size of homes. The researchers came to the conclusion that enacting a split-rate tax would increase the number of dwelling units in a certain location and prevent widespread growth since the density effect was stronger.

The administrative and political effects of split-rate taxation have also been studied. According to Hartzok (1997), the changeover should be gradual, shifting no more than 10 to 20 percent of the tax burden from buildings to land at a time. The public wouldn't mistakenly associate the split rate with a tax increase if the measure were revenue neutral.

Accurate, fast, and fair land value assessments are equally crucial to the effectiveness of a split-rate tax. According to Mills (1998), the government lacks both the motivation and the expertise to forecast the market worth of a piece of land when it is put to its best use. However, as long as estimates of total property value are accurate, economic efficiency improvements with a split-rate tax are still likely, even if significant errors are made in land value assessment (Chapman, 2020). Assessors may be able to estimate accurate land values by making a market-value purchase of the property, demolishing any improvements, and then reselling the vacant parcels (Paris et al., 2022). Zoning and other constraints prevent property owners from using land more extensively if the tax is calculated based on land values under optimal use. Finally, taxing land at a rate that is too high may lead to owners abandoning it outright, and governments often are not interested in taking on the role of landlords. In a life-cycle small open economy with endogenous labor-leisure options, Alberto Petrucci examines the impact of a land rent tax on capital production and foreign investment. In contrast to earlier literature, the effects of land taxes heavily depend on how the government spends the tax revenue. When consumers receive lump-sum compensation for the tax, a land tax reduces capital creation, displaces foreign investment, and boosts national wealth and consumption. Taxation would have little impact on the stock of capital, nonhuman wealth, or labor if the proceeds were utilized to finance wasteful government spending. The land tax produces ambiguous effects when the tax revenue is utilized to lower labor taxes. He contends that wealth accumulation among nonhumans is accelerated by effects on capital stock and labor hours. In order to study the design of taxation

on both land value and development in a competitive real estate market, (Tan et al., 2022) use a real choices framework. We presume that developed areas take up less open space, which is bad for city dwellers. Landowners will nonetheless build homes earlier than is socially ideal if they ignore this unfavorable externality. A regulator can stop this trend by enforcing a tax that is either positive on development or negative on land value. Alternately, the regulator can use both tools at once, in which case a rise in the development tax rate will be accompanied by a rise in the land value tax rate, and vice versa. They believe that urban dwellers suffer as a result of property development. Henry George (1897) , on the other hand, argues that the regulator should impose higher taxes on unused land and lower taxes on construction. Based on Henry George's hypothesis,(Brueckner, 1986) examines the long-term effects of a change to a graded tax system (where the tax rate on land development is reduced and the tax rate on land value is increased). While extending Brueckner's study to a model with perfect foresight, (Anderson et al., 1999)focuses on how this change affects a landowner's decision over when to start developing a property. Both articles make the assumption that when changing the tax code, a regulator will bring in the same amount of tax revenue. Additionally, it has been stated that property taxes act as a motivating factor for municipal governments.

4 DATA AND METHODOLOGY

In this chapter, the dissertation will utilize different econometric tools and software like STATA 14 to assess the effectiveness of economic instruments on forestry protection in the selected 17 African countries. The main tool of assessment will be environmental taxes. This will be done so as to sort out the problem of deforestation that has continued to be persistent over the years as mentioned in the previous chapters. Effectiveness in this regard can be defined as the degree to which something is effective, has an impact. This will be assed using the random effects model as it is preferred due to the fact that it accounts for differential effectiveness through the use of random coefficients models, and it was arrived at after performing various pre-estimation tests. The chapter also covers the data and sources used, and it includes the empirical and econometric steps applied in arriving at the objectives of this dissertation. This first section presents the data used and its sources.

4.1 DATA

The Figure below shows the map of Africa with the location of selected countries.

Figure 5: Map showing the location of the Countries.
Source: Authors' Illustration modified from Vecteezy.com

Secondary panel data for 17 African countries from many data sources (See Table 1) for the period 2001 to 2018 were included in the analysis. Countries were chosen based on the availability of the required data. All the 17 African countries data were used as one pooled data.

The variables of interest included forest areas as a percentage of land area, GDP per capita, the square of GDP per capita, deforestation, Population density (people per square (km) of land area), total energy consumption, environmental taxes as a percentage of total taxes; and the average of world governance index ranking. The thesis used STATA 14 software program to compute all the analysis and results.

4.2 ECONOMETRIC PROCEDURE OF EMPIRICAL ANALYSIS

Several models from econometrics, statistics, geostatistics, and geospatial, including DOLS, ARDL, canonical cointegrating regression, FMOLS, VECM, NARDL, Emirmahmutoglu-Kose panel causality test, Johansen cointegration, Granger causality, and LCM have been used to study the relationships among deforestation, CO_2 emissions, GDP and environmental taxation in various regions (Asumadu-Sarkodie & Owusu, 2016; Balsalobre-Lorente et al., 2019; Ben Jebli & Ben Youssef, 2017; Carter et al., 2018; De Sy et al., 2012; Gokmenoglu & Taspinar, 2018; Gokmenoglu et al., 2019; Naseem et al., 2020; Olanipekun et al., 2019; Qiao et al., 2019; Ullah et al., 2018).

Most papers that used an econometric approach to analyze the possible factors of environmental degradation, particularly deforestation during the start of the 1990s, generally applied a cross-section approach. Nevertheless, cross-sectional data does not account for time-varying effects and fails to control for unobserved individual heterogeneity (Wooldridge, 2002). Because panel data could handle such problems, and moreover, it had more information; hence, it resulted in increased efficiency and variability and provided more degrees of freedom (Baltagi, 2005). According to Damette and Delacote (2012), since the start of the 2000s, most studies have begun to use panel data to investigate climate change and environmental issues. Since literature reveals that ecological degradation through deforestation and GHG emissions can vary from country to country and region to region, it therefore means the determinants of deforestation are strongly heterogeneous. Most studies have however failed to account for the heterogeneity nature of how determinants of environmental variables vary according to country. To the knowledge of the author only Culas (2007); Damette and Delacote (2012); Leplay and Thoyer (2011); Scrieciu (2007) and Van and Azomahou (2007) to mention a few, examine the factors of deforestation but taking into account for the heterogeneous differences in countries.

The fact that patterns of environmental degradation globally are very difficult to identify implies that due care has to be taken (Damette & Delacote, 2011; Scrieciu, 2007). In the case of deforestation, Culas (2007); Damette and Delacote (2012) and Leplay and Thoyer (2011) clustered the sample to suggest that the factors affecting deforestation depend on a country's characteristics. Applying OLS while neglecting the heterogeneity nature of the factors affecting environment variables could lead to biased coefficient estimates (Damette & Delacote, 2012).

Damette and Delacote (2012) and Koenker (2005) suggest that quantile regression could perfectly tackle heterogeneity issues in panel regression. Koenker and Bassett (1978) developed the quantile regression approach. Very few papers, notably Damette and Delacote (2012), apply quantile regression to examine environmental issues. The quantile regression technique allows us to describe the patterns of conditional heterogeneity of factors of deforestation as well as their distribution along different quantiles of deforestation. Most studies use cointegration models to examine the drivers of environmental damage (Dursun, 2022; Pao & Tsai, 2010). Unlike simple OLS, which considers the conditional mean of the independent variable(s) and dependent variable, quantile regression provides the relationship between the independent variable(s) and the conditional quantiles of the dependent variable. It provides a comprehensive picture of how the explanatory variable(s) affect the dependent variable along different quantiles or points of the dependent variable. It is robust to non-normal data and outliers. However, it can only examine the impact and not effectiveness, hence making it difficult to address our objective. Which makes the fixed effects model, or the Random effects model the next best alternative. So then, to analyze the effectiveness of economic instruments for sustainable forestry protection, the study will employ panel data estimation models with either fixed effects modeling or an error components model, also known as a random effects model.

According to (Gujarati and Porter, 2009), the two model regressions used the following function:

Fixed effects model

$$C_{it} = \beta_{1t} + \beta_2 Q_{it} + \beta_3 PF_{it} + \beta_4 LF_{it} + u_{it} \quad (1)$$

i= 1, 2, 3,….17

t= 1,2,3,…,13.

The term fixed effects is such that even though the intercepts are different among entities, they are time invariant.

Random effects model

$$T\,Cit = \beta_{1i} + \beta_2 Q_{it} + \beta_3\, PF_{it} + \beta_4 LF_{it} + u_{it} \quad (2)$$

$$\text{Let } \beta 1i = \beta 1 + \varepsilon i$$

$$T\,Cit = \beta_1 + \beta_2 Q_{it} + \beta_3\, PF_{it} + \beta_4 LF_{it} + \varepsilon i + u_{it} \quad (3)$$

$$T\,Cit = \beta_1 + \beta_2 Q_{it} + \beta_3\, PF_{it} + \beta_4 LF_{it} + \omega_{it} \quad (4)$$

Where $\omega_{it} = \varepsilon i + u_{it}$

In this model, instead of having β_{1i} as fixed, we assume that it is a random variable with mean β_1 while we denote ω_{it} as the idiosyncratic error term.

In order to determine the appropriate model between the two, a Hausman test for model specification shall be performed using the following hypothesis test;

H_0: The random effects model is the appropriate model.

H_a: The fixed effects model is the appropriate model

The thesis adopted the random effects model based on the results from the Hausian test as seen in table 6.

Using the above equation, it was estimated how environmental taxes and other variables affect deforestation and forest areas in general in selected African countries for the period 2001 to 2018. The equations relating these dependent variables are rooted from the EKC hypothesis, which explains what happens to environmental problems when income of a country changes.

Literature cites several socio-economic factors such as economic growth and development, macroeconomic factors and demographics as the causes of deforestation (Angelsen & Kaimowitz, 1999; Damette & Delacote, 2012). Thus, to the equation by Panayotou (1993), the thesis included other variables. Nevertheless, to examine the relationship between deforestation and environmental taxes the equation by Panayotou (1993) was modified. The thesis also followed the work of Culas (2007) and Leplay and Thoyer (2011), who used forest area as the measure of deforestation. The relationship is shown in equation (5) below;

$$\boldsymbol{lnFA_{it} = \beta_0 + \beta_1 lnGDPpc_{it} + \beta_2 lnGDPpc2_{it} + \beta_3 lnALU_{it} + \beta_4 lnPOPd_{it} + \beta_5 TET_{it} + \varepsilon_{it} + \mu_i} \quad (5)$$

The independent variables in the above equation are agricultural land, population density, and environmental taxes. The thesis included GDP per capita and its square in the equation in order to express the equations in line with the EKC hypothesis. The thesis included deforestation because IPCC (2001) and Leplay and Thoyer (2011) state that it is the most contributing cause of forest area depletion. Because deforestation is caused by the expansion of arable land,

increasing demand for fuelwood by the local population and dependence on foreign currency earnings from forest Chomitz (2007), its inclusion in the equation means these other variables are captured so that proper policies to reduce deforestation can be implemented. There are various factors affecting deforestation, and literature cites several socio-economic factors such as economic growth and development, macroeconomic factors and demographics as the causes (Angelsen & Kaimowitz, 1999; Damette & Delacote, 2012). However, Angelsen and Kaimowitz (1999) argue that factors of deforestation range from underlying causes, and immediate causes to sources, thus mixing these variables can result in serious misspecifications in regression models and misleading causal relations between variables.

The variables and their data sources are presented in Table 1 below ande the variables used in the equation.

Table 1: Description of Variables and Data Sources

Variable	Description	Expected Sign	Data sources
FA	Forest area (% of land area).	Dependent Variable	World Development Indicators (WDI).
$GDPpc$	GDP per capita.	±	Feenstra, Inklaar, and Timmer (2015).
$GDPpc2$	The square of GDP per capita.	±	Feenstra et al. (2015).
DEF	Tree cover loss per hectare.	+	Hansen et al. (2013).
ALU	Agricultural land (% of land area).	-	WDI.
$POPgu$	Urban population growth.	+	WDI.
$POPd$	Population density (people per square (km) of land area).	-	WDI.
TEC	Total energy consumption	+	U.S. Energy Information Administration (2022).
TET	Environmental taxes (% of total taxes).	-	OECD (2022).
IST	Average of world governance index ranking.	+	Kaufmann, Kraay, and Mastruzzi (2010)
ln, i, t	Natural logarithm, country and years respectively.		
β, ε, μ	Parameters, error term & individual effects respectively.		

Note: The signs refer to the relationship with the forest area.

The economic tax instrument is represented by environmental taxes, which are the total environmental taxes as a percentage of total taxes in the economy. Environmental taxes are a composite index of energy related taxes, transport taxes, resources taxes, and pollution taxes. Some studies use carbon tax as an economic instrument to reduce environmental degradation, however because of data unavailability and lack of implementation of the tax in most African countries this thesis opted for environmental tax. Based on the authors' knowledge, this is the only available and comprehensive data source on environmental tax.

5 RESULTS

As a basis for determining effectiveness, the methodology was followed, and the following conclusions were found

This section presents results of our regression models. The results from pooled OLS (POLS), quantile regression (i.e. 25th, 50th and 75th quantiles) and fixed effects model (FEM) are compared to those of the random effects model which the thesis adopted. The first column after the variables presents results from POLS model. These are followed by FEM, 25th (Q25), 50th (Q50) and 75th (Q75). Table 2 is a presentation of results for regressions on the impact of environmental taxes on forest cover. Table 2 and 3 represents the same results for regressions on the impact of environmental taxes on forest cover from Fixed effects model and Random effects model respectively.

Table 2: The Effect of Environmental Taxes on Forest Area

VARIABLES	POLS	FEM	Q25	Q50	Q75
lnGDPpc	3.483**	0.551***	2.794***	5.075	6.505***
	(1.669)	(0.200)	(0.606)	(4.278)	(1.143)
lnGDPpc2	-0.267***	-0.0361***	-0.206***	-0.367	-0.419***
	(0.102)	(0.0124)	(0.0369)	(0.260)	(0.0696)
lnALU	1.134***	-0.525***	1.533***	1.503***	-0.102*
	(0.0788)	(0.104)	(0.0286)	(0.202)	(0.0540)
lnPOPd	-0.745***	-0.166***	-0.343***	-0.973***	-0.543***
	(0.0699)	(0.0369)	(0.0254)	(0.179)	(0.0478)
TET	-0.0122	-0.00213**	-0.00171	-0.0329	0.0200**
	(0.0116)	(0.000906)	(0.00422)	(0.0298)	(0.00796)
Constant	-9.011	3.212***	-11.56***	-15.62	-19.04***
	(6.750)	(0.801)	(2.450)	(17.30)	(4.623)
Observations	306	306	306	306	306
Pseudo/R-squared	0.606	0.380	0.467	0.154	0.242
Number of PID		17			

Standard errors in parentheses

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

Source: Authors' Computation

As indicated on the table 2, an increase in population density results in loss of forest cover at all quantiles, while an increase in agricultural land use negatively affects forest cover only at higher quantiles. Furthermore, the impact of environmental taxes on forest cover is positive and statistically significant only at higher quantiles.

Table 3 shows the descriptive statistics for the original data of Forest area, Deforestation, GDP, Agriculture land use, Population density, and Environmental taxes for 2001 to 2018.

Table 3:Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
YEAR	306	2009.5	5.197	2001	2018
FA	306	24.02	18.849	.045	64.958
DEF	306	83251.192	202965.45	31.643	1467956.7
GDPpc	306	4416.452	3466.357	679.901	12912.349
ALU	306	51.634	22.772	3.353	80.809
POPgu	306	3.449	1.43	-.244	9.555
POPd	306	85.767	89.837	9.238	498.661
TEC	306	.636	1.414	.009	5.725
TET	306	8.578	6.091	.04	39.25
IST	306	32.64	15.28	1.516	64.415
COUNTRY1	306	9	4.907	1	17
est fixed	306	1	0	1	1
est random	306	1	0	1	1

Source: Author's computation

As indicated in the table above, the maximum, minimum, mean, and standard deviation values of Forest area were 64.958, 0.045, 24.02 and 18.849 respectively. Then for deforestation, the respective Maximum, minimum, mean and standard deviation was 1467956.7, 31.643, 83251.192 and 202965.45. With regards to GDP, the values 12912.349, 679.901, 4416.452, 3466.357 were the maximum, minimum, mean, and standard deviation, respectively. The maximum, minimum, mean, and standard deviations for population density were 498.661,9.238 ,85.767, 89.837. And finally, Environmental taxes, measured as a percentage of

total taxes, had the values 39.25,0.04,8.578,6.091 for the maximum, minimum, mean, and standard deviation respectively.

The following table 4 and 5 shows the regression analysis from the variables used in the fixed effect model and the random effect model of econometric analysis.

Table 4 : Fixed effects regression analysis

	(1)
VARIABLES	Forest area (FA)
DEF	-3.09e-06***
	(3.90e-07)
GDPpc	-0.000102
	(7.05e-05)
ALU	-0.191***
	(0.0304)
POPgu	-0.0699
	(0.0593)
POPd	-0.00682**
	(0.00282)
TEC	-0.146
	(0.270)
TET	0.0523***
	(0.0116)
IST	-0.0183***
	(0.00672)
Constant	35.68***
	(1.546)
Observations	306
Number of COUNTRY1	17
R-squared	0.601

Standard errors in parentheses

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

Source: Author's computation

Table 5 :The error components or random effects regression results

VARIABLES	(1) Forest area (FA)
DEF	-3.07e-06***
	(3.88e-07)
GDPpc	-0.000101
	(7.01e-05)
ALU	-0.194***
	(0.0300)
POPgu	-0.0696
	(0.0591)
POPd	-0.00675**
	(0.00280)
TEC	-0.163
	(0.268)
TET	0.0523***
	(0.0116)
IST	-0.0186***
	(0.00669)
Constant	35.81***
	(4.970)
Observations	306
Number of COUNTRY1	17

Standard errors in parentheses

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

As earlier stated, in order to determine which one of the two is the best and most suitable model to use, the model adoption criteria suggest that we run what is known as the Hausman specification test, as shown in table 6 below.

Table 6 : Hausman (1978) specification test

	Coef.
Chi-square test value	.645
P-value	.999

Source: Author's computation

From the Hausman specification test, we run the following hypothesis test:

H_0: $The\ random\ effects\ model\ is\ the\ appropriate\ model.$

H_a: $The\ fixed\ effects\ model\ is\ the\ appropriate\ model$

Test method: Hausman specification test

Results: The given chi-square value of 0.645 is greater than the critical values of 0.01, 0.05 and 0.1 respectively

The Hausian test results indicate that we fail to reject the null hypothesis that the random effects model is the appropriate model. This, therefore, justifies our use of the random effects model in our study.

6 DISCUSSION

In analyzing environmental factors, the generally used hypothesis assumes that a rise in income or GDP results in a rise in environmental degradation during the early stages of development. However, as income continues to rise, there comes a point where a rise in income is associated with a decrease in environmental degradation. For the EKC hypothesis to hold the coefficient of GDP per capita should be positive and statistically significant while that of the square of GDP per capita should be negative and statistically significant.

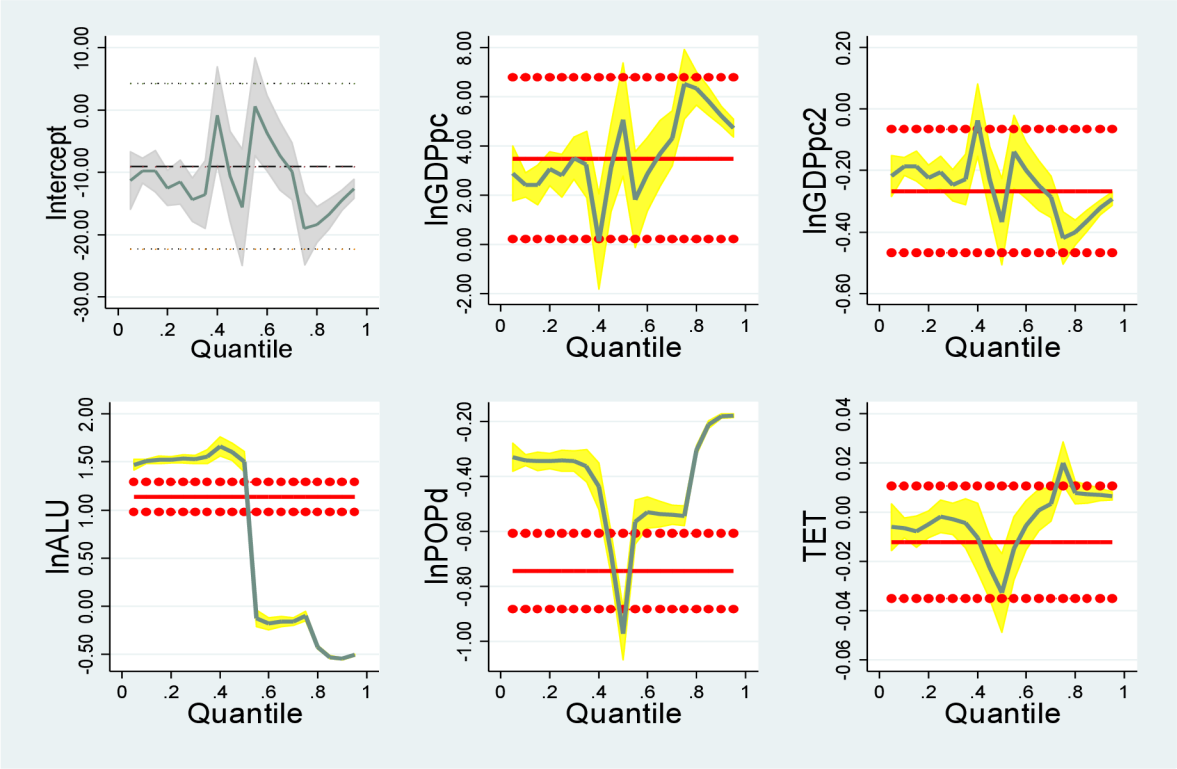
The regression results relating environmental taxes and forest area, the relationship between GDP per capita and forest area follows the EKC hypothesis only at 25^{th} and 75^{th} quantiles. The meaning is that at low levels of economic development, a rise in income is associated with low levels of deforestation. Nevertheless, after a certain level of income, countries with high incomes usually experience high levels of deforestation. The reason could be industrialization and urbanization. The coefficient of agricultural land use is positive and statistically significant at the 25^{th} and 50^{th} quantiles but negative at the 75^{th} quantile of forest area. This means that an increase in agricultural land use does not affect forest area for the 25^{th} and 50^{th} quantiles of forest area. However, at the 75^{th} quantile of forest area, it causes deforestation. Also, our results confirm that at a higher level of forest area, an increase in land for agriculture results in loss of forest cover. According to Dieng et al. (2009), between 1961 and 1999 increase in agricultural output in Africa was attributed to an increase in arable land expansion, which rose from 34% to 66%. This could be explained by the forest transition hypothesis, whose analytical meaning is similar to the convergence hypothesis (Damette & Delacote, 2012). According to Mather (1992), countries with low forest area tend to conserve while those with high forest cover tend to cause more environmental damage. Countries with more forest cover generally experience more loss in forest cover than those with less forest cover, thus contributing to an increase in deforestation. The marginal utility or the value given to forests in areas that have high forest cover is very low, whereas the marginal utility or value given to forests in areas that have low forest cover is high. So, at higher quantiles of forest cover a rise in agricultural land use results in loss of forest cover. The results are similar to that of (Damette & Delacote, 2011, 2012).

Population density has the expected sign and is statistically significant across all three quantiles of forest cover. An increase in the number of people per square kilometer negatively affects forest cover, resulting in deforestation. An increase in population increases demands for more land for agriculture and settlement. These contribute to the loss of forest cover. It is important

to note that the environmental taxes variable is positive and statistically significant only at the 75th quantile of forest cover. This means that countries with high forest cover can effectively use environmental taxes to reduce forest loss or deforestation. The reason could be related to the forest transition hypothesis, which predicts that high forest loss is predominant in countries with high forest cover, thus making enforcement of environmental taxes more effective. Nevertheless, the effectiveness of environmental taxes depends on institutional capacity to conserve the environment. Panayotou (1993) also suggests that developing countries can solve environmental problems by eliminating policy distortions, defining, and enforcing stricter property rights on natural resources, and making those involved in environmental damage pay for their activities, which is internalizing environmental costs by the underlying activities causing them.

The quantile regression technique is applicable when the dependent variable is continuous with no zeros or a lot of repeated values. It is also used when there is heteroskedasticity in the data set. The presence of heteroskedasticity in our data set is evident. This is because the test for heteroskedasticity results in both regression equations are statistically significant, that is, Prob > chi2 = 0.0000. This justifies the use of the quantile regression model. The thesis also checked if the coefficients of the explanatory variables under the quantile regression model are statistically different from those under the POLS regression model. The results are shown in Figure 3.

Figure 6**: Test for Significant Difference Between POLS and Quantile Regression Coefficients**



Source: Authors' Computation

Figure 3 shows results for the test of significant differences between coefficients of explanatory variables under POLS and quantile regression models. Panel (a) shows results for the equation relating environmental taxes and forest cover. Each variable has dotted red lines and a solid red lines parallel to the horizontal axis. The solid red line shows the POLS regression coefficient while the dotted red lines are the respective confidence intervals. The shaded yellow areas on each variable show the confidence interval for the quantile regression coefficients while the solid teal line represents the quantile coefficients. The POLS confidence intervals do not vary across quantiles and are fixed because there is only one regression coefficient for a POLS regression. On the other hand, the coefficients for quantile regression vary across quantiles. Comparing the confidence intervals for the POLS and quantile regression coefficients. For the regression relating to environmental taxes and forest cover, it is evident that there are significant differences between the confidence intervals of POLS and quantile regression coefficients. Furthermore, the graphs show that all the coefficients except the POLS and the 25th and 50th quantiles of environmental taxes are significantly different from zero because their confidence intervals do not cross the horizontal line passing through zero.

It is evident that Environmental taxes truly have an impact on forest area ceteris paribus. However, since our main interest is to determine the effectiveness, we get this from table 5 after conducting the Hausman test in table 6, which proved the random effect model to be the best model for this analysis.

As can be seen from table 5 the calculated regression results from the random effects model show that GDP per capita (GDPpc), Urban population growth (POPgu), and Total energy consumption (TEC) were not significant at 1%, 5%, and 10% significance levels. However, the results indicated that Tree cover loss per hectare (DEF), Agricultural land (ALU), Environmental taxes (TET), and Average of world governance index ranking (IST) were significant at the 1% significance level while Population density [people per square (km) of land area] (POPd) was significant at the 5% significance level. Hence, results from our analysis, which mainly focused on the effectiveness of environmental taxes on maintaining a sustainable forest area showed us that, a 1% increase in the environmental tax has led to 0.0523 square kilometers increase in the forestry area, ceteris paribus. This is indicated by the positive slope coefficient behind the Environmental taxes (TET) variable. Implications of this would suggest that, indeed, environmental taxes give the incentive to preserve lands covered by forests. It can be noted from this that even though environmental taxes have an effect on forestry protection, the effect was minimal, and a such it would be considered that there should be more effort from authorities in the selected 17 countries to improve on their implementation of forest taxation. Meanwhile, the calculated results from Tree cover loss per hectare (DEF), Agricultural land (ALU), Population density [(people per square (km) of land area)] (POPd), and Average of world governance index ranking (IST) show negative relationships with Forest Area. This implies that the ceteris paribus unitary increments in any of these variables would cause a decline in the total forest area. In this case, results from Tree cover loss per hectare (DEF) show that a unit increase in Tree cover loss per hectare (DEF) would cause a reduction in Forest area(FA) by 3.07 square kilometers, ceteris paribus. A unit increase in Agricultural land (ALU) causes a decrease in forest area of 0.194 square kilometers, ceteris paribus. A unit increase in Population density [(people per square (km) of land area)] (POPd) reduces forest area by 0.00675 square kilometers, ceteris paribus. And finally, a unit increase in Average of world governance index ranking (IST) causes a reduction in forest area by 0.0186 square kilometers, ceteris paribus. The results of this research agree with the hypothesis that taxation is a good economic instrument to reduce deforestation or conserve forest area in the 17 African countries, and its conclusions were similar to studies that showed that environmental taxes did affect

forestry conservation. (Busch et al., 2015; Cadman et al., 2019; Ferretti-Gallon and Busch, 2014; Muttaqin et al., 2019). Most developing countries in Africa are still going through the process of urbanization, and as such, issues of deforestation have continued to persist, hence making set up environmental taxes have very little effectiveness to curb these vices as can be seen from the coefficients in the results.
Other things like Agriculture land use have also proved to affect forest areas in most African countries negatively.

Governments have a range of tools at their disposal, including regulations, information programmes, innovation policies, environmental subsidies, and environmental taxes. Taxes in particular are a key part of this toolkit (OECD, 2011).

Environmental taxes have been found to be an effective tool for reducing pollution and encouraging environmental friendly behavior. For example, a study of carbon taxes in Europe found that they have led to a reduction in carbon dioxide emissions, while another study found that a sulfur dioxide emissions trading program in the United States led to a significant reduction in sulfur dioxide emission in power plants.
However, the effectiveness of environmental taxes can depend on a number of factors, such as the level of the tax, the scope of the tax (i.e. which activities are covered by the tax) and how the revenue from tax is used. Additionally, environmental tax could also have other social effects. The effectiveness of taxes can also depend on several factors, including the specific tax being implemented, the design of the tax, and the economic and political context in which it's implemented. Some critics argue that environmental taxes disproportionately impact lower-income households, since they may have fewer resources to invest in more environmentally friendly alternatives. Thus, its effectiveness also highly depends on how it designed and implemented. A well-designed environmental tax program can be effective tool for reducing pollution and promoting environmental friendly behavior, but a poorly designed program may not be as effective and could have united negative consequences.

The strong correlation between socio-economic activities and real-world environmental issues can never be underestimated. Socio-economic activities can make or mar environmental quality, which in turn may facilitate or impede socio-economic operations. Currently, environmental protection and sustainable development have permeated every aspect of human social and economic activities. Environmental problems are usually caused by the negative externalities of socio-economic activities, which means that socio-economic actors add

external costs to society through pollution without paying the corresponding social costs. In the absence of regulation, individuals tend to overexploit the environment at their own advantage. Therefore, environmental problems cannot be solved by simple market mechanisms: most countries implement environmental regulations. Thus, strengthening environmental protection and reinforcing environmental regulations have become key issues, especially in developed countries, while developing nations are still crawling and blind to reality (Sane et al., 2021).

The hypothesis and findings of this paper to some extent, is in line with the conclusions made by most similar studies (Andreoni, 2019; Brockhaus et al., 2012; Gamponia and Mendelsohn, 1987; Liu, 2013; Mahmood et al., 2019; van Kooten et al., 1995) in that economic instruments and regulations are essential and effective in protecting forests and the environment in general which are of great importance and play a role in not only a country's ecological setup but other areas as well as it may support other industries such as those that rely on forest products. Economic history has continued showing that most countries that set up regulations tend to have more forest area conserved and enjoy the benefits that come with it.

7 CONCLUSION AND POLICY RECOMMENDATIONS

The effectiveness of economic instruments was monitored using the example of environmental taxes.

This thesis examined the impact of environmental taxes and other variables on forest cover among selected 17 African countries for the period 2001 to 2018 using data from the world bank database. The study finds that more deforestation and increase environment taxes and improvements in institutions result in less deforestation. However, the study also found that an increase in population density results in loss of forest cover while an increase in agricultural land use negatively affects forest cover. Furthermore, the impact and effectiveness of environmental taxes on forest cover is positive and statistically significant. Generally, some scholars recommend that developing countries can flatten out their EKC curves, that is, reducing the effect of economic growth on environmental degradation through the removal of policy distortions, internalization of environmental costs to the activities that generate them, and having properly defined and enforced property rights over natural resources. Assistance from development partners can also be used to help mitigate environmental degradation. They can do this by ensuring that environmental protection policies are an integral part of their project and policy financing. Furthermore, developed countries can also help developing countries by proving creative financing mechanisms, for instance, they can use Global Environmental Facility, to conserve resources like biodiversity which create global benefits that might be otherwise lost irreversibly during the earlier stages of economic development of developing countries. For further research, analyze the country(ies) individually, because the implementation of environmental taxes might give different response in each country.

In addition to the above, this study recommends that African countries use both protection policies such as environmental taxes, fines, enforcement of property rights, laws and regulations, and promotion policies such as implementing good agricultural practices to increase yield, productivity, and value for poor people without impacting much on forest and environment, revolutionizing, modernizing and mechanizing the agricultural sector in Africa, educating people about the importance of conserving the environment and the negative effects of climate change associated with environmental degradation, educating people about benefits of practicing birth control mechanisms to control population growth, developing urban areas by creating sustainable cities and educating citizens about the benefits associated with environmental protection and of usage of clean, efficient and environmentally friendly energy

sources to mitigate deforestation. Government can also promote the private sector to invest in renewable sources of energy like wind, and solar, and adopt efficient energy technologies in production and manufacturing.

However, most African population lack access to alternative clean sources of energy. In circumstances where alternative energy sources are found, they are not adequate, thus giving a challenging task in making efforts to promote the use of clean energy sources. This can make enforcement of environmental taxes very difficult to use in mitigating deforestation in Africa. Another problem is that most resources in communal areas are shared, and they belong not to an individual thus making it difficult to enforce environmental taxes. Nevertheless, if people in the area where the resources are found are educated about the benefits of environmental protection or are involved in environmental protection processes it can be easier for government to implement environmental taxes without facing resistance from the community. The revenue from environmental taxes can also be used to protect and conserve the environment as well as help the people whose livelihoods depend on forests and nature. Nevertheless, achieving sustainable development does not mean relying on governments alone, but requires active involvement by businesses, capital markets, sub-regional authorities, and other non-state actors.

References:

Abdullah, S., Morley, B., 2014. Environmental taxes and economic growth: Evidence from panel causality tests. Energy Economics 42, 27–33. https://doi.org/10.1016/j.eneco.2013.11.013

Abera, T.A., Heiskanen, J., Pellikka, P.K.E., Adhikari, H., Maeda, E.E., 2020. Climatic impacts of bushland to cropland conversion in Eastern Africa. Science of The Total Environment 717, 137255. https://doi.org/10.1016/j.scitotenv.2020.137255

Adam Smith Economic Theory Summary [WWW Document], n.d. URL https://www.ukessays.com/essays/economics/adam-smith-economic-theory-summary-8545.php (accessed 1.8.23).

AFF, n.d. The State of Forestry in Africa: Opportunities and Challenges – African Forest Forum. URL https://afforum.org/publication/the-state-of-forestry-in-africa-opportunities-and-challenges/ (accessed 1.1.23a).

AFF, n.d. The State of Forestry in Africa: Opportunities and Challenges – African Forest Forum. URL https://afforum.org/publication/the-state-of-forestry-in-africa-opportunities-and-challenges/ (accessed 1.1.23b).

Africa Open D.E.A.L: Open Data for Environment, Agriculture and Land & Africa's Great Green Wall, n.d.

Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes 50, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I., 1985. From Intentions to Actions: A Theory of Planned Behavior, in: Kuhl, J., Beckmann, J. (Eds.), . Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 11–39. https://doi.org/10.1007/978-3-642-69746-3_2

Albrecht, J., 2006. The use of consumption taxes to re-launch green tax reforms. International Review of Law and Economics, Twenty-First Annual Conference of the European Association of Law and Economics 26, 88–103. https://doi.org/10.1016/j.irle.2006.05.007

Alola, A.A., Muoneke, O.B., Okere, K.I., Obekpa, H.O., 2023. Analysing the co-benefit of environmental tax amidst clean energy development in Europe's largest agrarian economies. Journal of Environmental Management 326, 116748. https://doi.org/10.1016/j.jenvman.2022.116748

Altes, W.K.K., 2009. Taxing land for urban containment: Reflections on a Dutch debate. Land Use Policy 26, 233–241. https://doi.org/10.1016/j.landusepol.2008.01.006

Amacher, Gregory S., Brazee, R.J., 1997. Designing Forest Taxes with Varying Government Preferences and Budget Targets. Journal of Environmental Economics and Management 32, 323–340.

Amacher, Gregory S, Brazee, R.J., 1997a. Designing forest taxes with varying government preferences and budget targets. Journal of Environmental Economics and Management 32, 323–340.

Amacher, Gregory S, Brazee, R.J., 1997b. Designing forest taxes with varying government preferences and budget targets. Journal of Environmental Economics and Management 32, 323–340.

Ambec, S., Coria, J., 2021. The informational value of environmental taxes. Journal of Public Economics 199, 104439. https://doi.org/10.1016/j.jpubeco.2021.104439

Anderson, Z.R., Kusters, K., McCarthy, J., Obidzinski, K., 2016. Green growth rhetoric versus reality: Insights from Indonesia. Global Environmental Change 38, 30–40. https://doi.org/10.1016/j.gloenvcha.2016.02.008

Andreoni, V., 2019. Environmental taxes: Drivers behind the revenue collected. Journal of Cleaner Production 221, 17–26. https://doi.org/10.1016/j.jclepro.2019.02.216

Abdulraheem, K. A., Adeniran, J. A., & Aremu, A. S. (2022). Carbon and precursor gases emission from forest and non-forest land sources in West Africa. *International Journal of Environmental Science and Technology, 19*(12), 12003-12018. doi:10.1007/s13762-022-04304-7

Achuo, E. D. (2022). The nexus between crude oil price shocks and environmental quality: Empirical evidence from sub-Saharan Africa. *SN Business & Economics, 2*(7), 1-15. doi:10.1007/s43546-022-00264-9

Adebayo, T. S. (2020). Revisiting the EKC hypothesis in an emerging market: An application of ARDL-based bounds and wavelet coherence approaches. *SN Applied Sciences, 2*(12), 1-15. doi:10.1007/s42452-020-03705-y

Adebayo, T. S. (2021). Testing the EKC hypothesis in Indonesia: Empirical evidence from the ARDL-based bounds and wavelet coherence approaches. *Applied Economics*

Journal, 28(1), 1-23. Retrieved from https://so01.tci-thaijo.org/index.php/AEJ/article/view/242922

Adebayo, T. S., & Beton Kalmaz, D. (2021). Determinants of CO2 emissions: Empirical evidence from Egypt. *Environmental and Ecological Statistics, 28*(2), 239-262. doi:10.1007/s10651-020-00482-0

Agrawal, A., Nepstad, D., & Chhatre, A. (2011). Reducing emissions from deforestation and forest degradation. *Annual Review of Environment and Resources, 36*, 373-396. doi:10.4135/9781452218564.n586

Ahmad, A., Liu, Q.-J., Nizami, S. M., Mannan, A., & Saeed, S. (2018). Carbon emission from deforestation, forest degradation and wood harvest in the temperate region of Hindukush Himalaya, Pakistan between 1994 and 2016. *Land use policy, 78*, 781-790. doi:10.1016/j.landusepol.2018.07.009

Akbota, A., & Baek, J. (2018). The environmental consequences of growth: Empirical evidence from the Republic of Kazakhstan. *Economies, 6*(1), 19. doi:10.3390/economies6010019

Amsberg, J. V. (1998). Economic parameters of deforestation. *The World Bank Economic Review, 12*(1), 133-153. doi:10.1093/wber/12.1.133

Andersson, J. (2015). *Cars, carbon taxes and CO2 emissions.* Working Paper No. 238. London.

Angelsen, A., & Kaimowitz, D. (1999). Rethinking the causes of deforestation: Lessons from economic models. *The World Bank Research Observer, 14*(1), 73-98. doi:10.1093/wbro/14.1.73

Appannagari, R. R. (2017). Environmental pollution causes and consequences: A study. *North Asian International Research Journal of Social Science and Humanities, 3*(8), 151-161.

Arimura, T. H., Hibiki, A., & Katayama, H. (2008). Is a voluntary approach an effective environmental policy instrument?: A case for environmental management systems. *Journal of environmental economics and management, 55*(3), 281-295. doi:10.1016/j.jeem.2007.09.002

Asumadu-Sarkodie, S., & Owusu, P. A. (2016). The relationship between carbon dioxide and agriculture in Ghana: A comparison of VECM and ARDL model. *Environmental Science and Pollution Research, 23*(11), 10968-10982. doi:10.1007/s11356-016-6252-x

Atkinson, S. E., & Lewis, D. H. (1974). A cost-effectiveness analysis of alternative air quality control strategies. *Journal of environmental economics and management, 1*(3), 237-250. doi:10.1016/0095-0696(74)90005-9

Aydin, C., & Esen, Ö. (2018). Reducing CO2 emissions in the EU member states: Do environmental taxes work? *Journal of Environmental Planning and Management, 61*(13), 2396-2420. doi:10.1080/09640568.2017.1395731

Aziz, N., Sharif, A., Raza, A., & Rong, K. (2020). Revisiting the role of forestry, agriculture, and renewable energy in testing environment Kuznets curve in Pakistan: Evidence from quantile ARDL approach. *Environmental Science and Pollution Research, 27*(9), 10115-10128. doi:10.1007/s11356-020-07798-1

Barbone, L., 2000. Forest Taxes, Government Revenues and the Sustainable Exploitation of Tropical Forests.

Barbone, L., Zalduendo, J., 2000. Forest taxes, government revenues, and the sustainable exploitation of tropical forests.

Barde, J.-P., 1994a. Economic Instruments in Environmental Policy: Lessons from the OECD Experience and their Relevance to Developing Economies. https://doi.org/10.1787/754416133402

Barde, J.-P., 1994b. Economic Instruments in Environmental Policy: Lessons from the OECD Experience and their Relevance to Developing Economies. https://doi.org/10.1787/754416133402

Barde, J.-P., 1994c. Economic instruments in environmental policy: Lessons from the OECD experience and their relevance to developing economies.

Bazin, D., Ballet, J., Touahri, D., 2004. Environmental responsibility versus taxation. Ecological Economics 49, 129–134. https://doi.org/10.1016/j.ecolecon.2004.03.015

Berck, P., 1987. Review of The Economics of Forestry and Natural Resources. Land Economics 63, 107–110. https://doi.org/10.2307/3146661

Berggren, C., 2014. Bergek, A. & Berggren, C. 2014. The impact of environmental policy instruments on innovation: a review of energy and automotive industry studies. Ecological Economics 106: 112-123.

Bosquet, B., 2000. Environmental tax reform: does it work? A survey of the empirical evidence. Ecological economics 34, 19–32.

Bourassa, S.C., 1990. Land Value Taxation and Housing Development.: Effects of the Property Tax Reform in Three Types of Cities. Am J Economics & Sociology 49, 101–111. https://doi.org/10.1111/j.1536-7150.1990.tb02264.x

Bourassa, S.C., 1987. Land Value Taxation and New Housing Development in Pittsburgh. Growth and Change 18, 44–56. https://doi.org/10.1111/j.1468-2257.1987.tb00087.x

Bovenberg, A.L., Goulder, L.H., 2002a. Environmental taxation and regulation, in: Handbook of Public Economics. Elsevier, pp. 1471–1545.

Bovenberg, A.L., Goulder, L.H., 2002b. Environmental taxation and regulation, in: Handbook of Public Economics. Elsevier, pp. 1471–1545.

Bovenberg, A.L., Goulder, L.H., 2002c. Environmental taxation and regulation, in: Handbook of Public Economics. Elsevier, pp. 1471–1545.

Bovenberg, A.L., Goulder, L.H., 2002d. Environmental taxation and regulation, in: Handbook of Public Economics. Elsevier, pp. 1471–1545.

Brockhaus, M., Obidzinski, K., Dermawan, A., Laumonier, Y., Luttrell, C., 2012. An overview of forest and land allocation policies in Indonesia: Is the current framework sufficient to meet the needs of REDD+? Forest Policy and Economics 18, 30–37. https://doi.org/10.1016/j.forpol.2011.09.004

Brueckner, J., Kim, H.-A., 2003. Urban Sprawl and the Property Tax. International Tax and Public Finance.

Brueckner, J.K., 1986. A modern analysis of the effects of site value taxation. National Tax Journal 39, 49–58. https://doi.org/10.1086/NTJ41792157

Brueckner, J.K., n.d. A modern analysis of the effects of site value taxation.

Brueckner, J.K., Kim, H.-A., 2003a. [No title found]. International Tax and Public Finance 10, 5–23. https://doi.org/10.1023/A:1022260512147

Brueckner, J.K., Kim, H.-A., 2003b. [No title found]. International Tax and Public Finance 10, 5–23. https://doi.org/10.1023/A:1022260512147

Busch, J., Ferretti-Gallon, K., Engelmann, J., Wright, M., Austin, K.G., Stolle, F., Turubanova, S., Potapov, P.V., Margono, B., Hansen, M.C., Baccini, A., 2015. Reductions in emissions from deforestation from Indonesia's moratorium on new oil palm, timber, and logging concessions. Proc. Natl. Acad. Sci. U.S.A. 112, 1328–1333. https://doi.org/10.1073/pnas.1412514112

Bustamante, M., Robledo-Abad, C., Harper, R., Mbow, C., Ravindranat, N.H., Sperling, F., Haberl, H., Pinto, A. de S., Smith, P., 2014a. Co-benefits, trade-offs, barriers and policies for greenhouse gas mitigation in the agriculture, forestry and other land use (AFOLU) sector. Global Change Biology 20, 3270–3290. https://doi.org/10.1111/gcb.12591

Bustamante, M., Robledo-Abad, C., Harper, R., Mbow, C., Ravindranat, N.H., Sperling, F., Haberl, H., Pinto, A. de S., Smith, P., 2014b. Co-benefits, trade-offs, barriers and policies for greenhouse gas mitigation in the agriculture, forestry and other land use (AFOLU) sector. Global Change Biology 20, 3270–3290. https://doi.org/10.1111/gcb.12591

Butler, B.J., Caputo, J., Henderson, J.D., Pugh, S.A., Riitters, K., Sass, E.M., 2022. An assessment of the sustainability of family forests in the U.S.A. Forest Policy and Economics 142, 102783. https://doi.org/10.1016/j.forpol.2022.102783

Butler, B.J., Catanzaro, P.F., Greene, J.L., Hewes, J.H., Kilgore, M.A., Kittredge, D.B., Ma, Z., Tyrrell, M.L., 2012. Taxing Family Forest Owners: Implications of Federal and State Policies in the United States. Journal of Forestry 110, 371–380. https://doi.org/10.5849/jof.11-097

Baden, J., & Stroup, R. (1981). *Bureaucracy Vs. Environment: The Environmental Costs of Bureaucratic Governance*. Michigan: University of Michigan Press.

Bakaveckas, A., Dziegoraitis, A., Dziegoraitienė, A., Gylys, A., Kalesnykas, R., Pranevičienė, B., . . . Žilinskas, D. (2005). *Lietuvos Administracinė Teisė. Bendroji Dalis*.

Balsalobre-Lorente, D., Driha, O. M., Bekun, F. V., & Osundina, O. A. (2019). Do agricultural activities induce carbon emissions? The BRICS experience. *Environmental Science and Pollution Research, 26*(24), 25218-25234. doi:10.1007/s11356-019-05737-3

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data* (3rd ed.). Chichester ; Hoboken, New Jersey: Springer.

Bano, S., Zhao, Y., Ahmad, A., Wang, S., & Liu, Y. (2018). Identifying the impacts of human capital on carbon emissions in Pakistan. *Journal of Cleaner Production, 183*, 1082-1092. doi:10.1016/j.jclepro.2 018.02.008

Barbier, E. B., Lozano, R., Rodríguez, C. M., & Troëng, S. (2020). Adopt a carbon tax to protect tropical forests. In (Vol. 578, pp. 213--216): Springer Science and Business Media.

Barde, J.-P. (1994). *Economic instruments in environmental policy: Lessons from the OECD experience and their relevance to developing economies*.

Begum, R. A., Raihan, A., & Said, M. N. M. (2020). Dynamic impacts of economic growth and forested area on carbon dioxide emissions in Malaysia. *Sustainability, 12*(22), 9375. doi:10.3390/su12229375

Bellassen, V., & Gitz, V. (2008). Reducing emissions from deforestation and degradation in Cameroon—assessing costs and benefits. *Ecological Economics, 68*(1-2), 336-344. doi:10.1016/j.ecolecon.2008.03.015

Ben Jebli, M., & Ben Youssef, S. (2017). The role of renewable energy and agriculture in reducing CO2 emissions: Evidence for North Africa countries. *Ecological indicators, 74*, 295-301. doi:10.1016/j.ecolind.2016.11.032

Ben Jebli, M., Ben Youssef, S., & Ozturk, I. (2015). The role of renewable energy consumption and trade: Environmental kuznets curve analysis for sub-saharan Africa countries. *African Development Review, 27*(3), 288-300. doi:10.1111/1467-8268.12147

Blackman, A., & Kildegaard, A. (2010). Clean technological change in developing-country industrial clusters: Mexican leather tanning. *Environmental Economics and Policy Studies, 12*(3), 115-132. doi:10.1007/s10018-010-0164-7

Bradley, A., & Ewing, K. (2003). Constitutional and Administrative Law. In. London; New York: Ashford Colour Press Ltd.

Bratt, L. (2012). Three Totally Different Environmental/GDP Curves. In C. Ghenai (Ed.), *Sustainable development-education, business and management-architecture and building construction-agriculture and food security* (pp. 283-312). Rijeka, Croatia: InTech.

Bruvoll, A., & Larsen, B. M. (2004). Greenhouse gas emissions in Norway: Do carbon taxes work? *Energy Policy, 32*(4), 493-505. doi:10.1016/S0301-4215(03)00151-4

Busch, J., & Ferretti-Gallon, K. (2017). What drives deforestation and what stops it? A meta-analysis. *Review of Environmental Economics and Policy, 11*(1), 3–23. doi:10.1093/reep/rew013

Cadman, T., Sarker, T., Muttaqin, Z., Nurfatriani, F., Salminah, M., Maraseni, T., 2019a. The role of fiscal instruments in encouraging the private sector and smallholders to reduce emissions from deforestation and forest degradation: Evidence from Indonesia. Forest Policy and Economics, Assessing policies to reduce emissions from land use change in Indonesia 108, 101913. https://doi.org/10.1016/j.forpol.2019.04.017

Cadman, T., Sarker, T., Muttaqin, Z., Nurfatriani, F., Salminah, M., Maraseni, T., 2019b. The role of fiscal instruments in encouraging the private sector and smallholders to reduce emissions from deforestation and forest degradation: Evidence from Indonesia. Forest Policy and Economics, Assessing policies to reduce emissions from land use change in Indonesia 108, 101913. https://doi.org/10.1016/j.forpol.2019.04.017

Can Environmental Taxes Force Corporate Green Innovation?--《Journal of Audit & Economics》2019年02期 [WWW Document], n.d. URL https://en.cnki.com.cn/Article_en/CJFDTotal-SJYJ201902008.htm (accessed 1.8.23).

"Carbon rights", REDD+ and payments for environmental services, 2014a. . Environmental Science & Policy 35, 20–29. https://doi.org/10.1016/j.envsci.2012.08.013

"Carbon rights", REDD+ and payments for environmental services, 2014b. . Environmental Science & Policy

35, 20–29. https://doi.org/10.1016/j.envsci.2012.08.013

Cai, Y., Sam, C. Y., & Chang, T. (2018). Nexus between clean energy consumption, economic growth and CO2 emissions. *Journal of Cleaner Production, 182*, 1001-1011. doi:10.1016/j.jclepro.2 018.02.035

Carroll, A. (2007). *Constitutional and Administrative Law*. London; New York: Ashford Colour Press Ltd.

Carter, S., Herold, M., Avitabile, V., de Bruin, S., De Sy, V., Kooistra, L., & Rufino, M. C. (2018). Agriculture-driven deforestation in the tropics from 1990–2015: Emissions, trends and uncertainties. *Environmental Research Letters, 13*(1), 014002. doi:10.1088/1748-9326/aa9ea4

Chen, W., Zhou, J.-F., Li, S.-Y., & Li, Y.-C. (2017). Effects of an energy tax (carbon tax) on energy saving and emission reduction in Guangdong province-based on a CGE model. *Sustainability, 9*(5), 681. doi:10.3390/su9050681

Cheng, Z., Li, L., & Liu, J. (2017). The emissions reduction effect and technical progress effect of environmental regulation policy tools. *Journal of Cleaner Production, 149*, 191-205. doi:10.1016/j.jclepro.2017.02.105

Chiroleu-Assouline, M. (2007). Efficacité comparée des instruments de régulation environnementale. Notes de synthèse du SESP (Ministère de l'Ecologie, de l'Energie, du développement durable et de l'Aménagement du territoire). *2*(167), 7-17.

Chomitz, K. M. (2007). *At Loggerheads? Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests*. Washington, D.C: World Bank Publications.

Ciais, P., Sabine, C., Bala, G., Bopp, L., Brovkin, V., Canadell, J., . . . Thornton, P. (2013). Carbon and Other Biogeochemical Cycles. In T. F. Stocker, D. Qin, G. K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, & P. M. Midgley (Eds.), *Climate change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 465-470). Cambridge: Cambridge University Press.

Çıtak, F., Uslu, H., Batmaz, O., & Hoş, S. (2021). Do renewable energy and natural gas consumption mitigate CO2 emissions in the USA? New insights from NARDL approach. *Environmental Science and Pollution Research, 28*(45), 63739-63750. doi:10.1007/s11356-020-11094-3

Cleff, T., & Rennings, K. (1999). Determinants of environmental product and process innovation. *European environment, 9*(5), 191-201. doi:10.1002/(sici)1099-0976(199909/10)9:5<191::aid-eet201>3.0.co;2-m

Craig, P. P. (1999). *Administrative Law*. London: Sweet & Maxwell Limited.

Crippa, M., Oreggioni, G., Guizzardi, D., Muntean, M., Schaaf, E., Lo Vullo, E., . . . Vignati, E. (2019) Fossil CO2 and GHG Emissions of all World Countries. In. Luxemburg: Publication Office of the European Union.

Culas, R. J. (2007). Deforestation and the environmental Kuznets curve: An institutional perspective. *Ecological Economics, 61*(2-3), 429-437. doi:10.1016/j.ecolecon.2006.03.014

Curtis, P. G., Slay, C. M., Harris, N. L., Tyukavina, A., & Hansen, M. C. (2018). Classifying drivers of global forest loss. *Science, 361*(6407), 1108-1111. doi:10.1126/science.aau3445

Casal, P., 2012. Progressive Environmental Taxation: A Defence. Political Studies 60, 419–433. https://doi.org/10.1111/j.1467-9248.2011.00924.x

Cela, E., Kaneko, S., 2013. Understanding the Implications of Environmental taxes: The Case of the Danish Weight Based Packaging Product Charge: Understanding the Implications of Environmental Taxes. Env. Pol. Gov. 23, 274–282. https://doi.org/10.1002/eet.1608

Chang, S.J., 2018. Forest valuation under the generalized Faustmann formula with taxation. Forest Policy and Economics 88, 46–51. https://doi.org/10.1016/j.forpol.2017.12.007

Chang, S.J., 1983. Rotation Age, Management Intensity, and the Economic Factors of Timber Production: Do Changes in Stumpage Price, Interest Rate, Regeneration Cost, and Forest Taxation Matter? Forest Science 29, 267–277. https://doi.org/10.1093/forestscience/29.2.267

Chang, S.J., 1982. An Economic Analysis of Forest Taxation's Impact on Optimal Rotation Age. Land Economics 58, 310–323. https://doi.org/10.2307/3145939

Chapman, J.I., Johnston, R.J., Tyrrell, T.J., 2009. Implications of a Land Value Tax with Error in Assessed Values. Land Economics 85, 576–586. https://doi.org/10.3368/le.85.4.576

Chapman, S., 2020. The role and importance of the forestry sector. SA Forestry Online. URL https://saforestryonline.co.za/articles/the-role-and-importance-of-the-forestry-sector/ (accessed 1.8.23).

Chaudhary, M., Dhar, J., Misra, O.P., 2017a. Analysis of Exploitation of Forestry Biomass by Industrialization: Effect of Harvesting and Taxation. Int. J. Appl. Comput. Math 3, 311–325. https://doi.org/10.1007/s40819-017-0357-x

Chaudhary, M., Dhar, J., Misra, O.P., 2017b. Analysis of Exploitation of Forestry Biomass by Industrialization: Effect of Harvesting and Taxation. International Journal of Applied and Computational Mathematics.

Chaudhary, M., Pathak, R., 2017a. A dynamical approach to the legal and illegal logging of forestry population and conservation using taxation. Adv Differ Equ 2017, 1–23. https://doi.org/10.1186/s13662-017-1439-0

Chaudhary, M., Pathak, R., 2017b. A dynamical approach to the legal and illegal logging of forestry population and conservation using taxation. Adv Differ Equ 2017, 1–23. https://doi.org/10.1186/s13662-017-1439-0

Chen, Z., Kahn, M.E., Liu, Y., Wang, Z., 2016. The Consequences of Spatially Differentiated Water Pollution Regulation in China.

Climate Policies, Carbon Pricing, and Pollution Tax: Do Carbon Taxes Really Lead to a Reduction in Emissions? - Free Online Library [WWW Document], n.d. URL https://www.thefreelibrary.com/Climate+Policies%2C+Carbon+Pricing%2C+and+Pollution+Tax%3A+Do+Carbon+Taxes...-a0593028448 (accessed 1.8.23).

Coleman, A., Grimes, A., n.d. Fiscal, Distributional and Efficiency Impacts of Land and Property Taxes.

Cord, S.B., 1983. Taxing Land More than Buildings: The Record in Pennsylvania, in: Proceedings of the Academy of Political Science. p. 172. https://doi.org/10.2307/3700954

Cushing, T.L., Newman, D., 2018. Analysis of Relative Tax Burden on Nonindustrial Private Forest Landowners in the Southeastern United States. Journal of Forestry 116, 228–235. https://doi.org/10.1093/jofore/fvx013

Daigneault, A.J., Sohngen, B.L., Sedjo, R., 2020. Carbon and market effects of U.S. forest taxation policy. Ecological Economics 178, 106803. https://doi.org/10.1016/j.ecolecon.2020.106803

Daly-Hassen, H., Pettenella, D., Ahmed, T.J., 2010. Economics instruments for the sustainable management of Mediterranean watersheds. 1 141–155. https://doi.org/10.5424/fs/2010192-01310

Damette, O., & Delacote, P. (2011). Unsustainable timber harvesting, deforestation and the role of certification. *Ecological Economics, 70*(6), 1211-1219. doi:10.1016/j.ecolecon.2011.01.025

Damette, O., & Delacote, P. (2012). On the economic factors of deforestation: What can we learn from quantile analysis? *Economic Modelling, 29*(6), 2427-2434. doi:10.1016/j.econmod.2012.06.015

De Sy, V., Herold, M., Achard, F., Asner, G. P., Held, A., Kellndorfer, J., & Verbesselt, J. (2012). Synergies of multiple remote sensing data sources for REDD+ monitoring. *Current Opinion in Environmental Sustainability, 4*(6), 696-706. doi:10.1016/j.cosust.2012.09.013

Dieng, C., Katerere, Y., Kojwang, H., Laverdière, M., Minang, P. A., Mulimo, P., . . . Yemshaw, J. (2009) Making Sub-Saharan African Forests Work for People and

Nature: Policy Approaches in a Changing Global Environment. In. Nairobi: World Forests, Society and Environment (WFSE) of the International Union of Forest Research Organizations (IUFRO)World Agroforestry Centre (ICRAF) the Center for International Forestry Research (CIFOR) the Finish Forest Research Institute (METLA).

Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A survey. *Ecological Economics, 49*(4), 431-455. doi:10.1016/j.ecolecon.2004.02.011

Du, S., Hu, L., & Song, M. (2016). Production optimization considering environmental performance and preference in the cap-and-trade system. *Journal of Cleaner Production, 112*, 1600-1607. doi:10.1016/j.jclepro.2014.08.086

Du, S., Tang, W., & Song, M. (2016). Low-carbon production with low-carbon premium in cap-and-trade regulation. *Journal of Cleaner Production, 134*, 652-662. doi:10.1016/j.jclepro.2016.01.012

Dursun, E. (2022). Investigating the air transport-induced EKC hypothesis: Evidence from NAFTA countries. *International Journal of Energy Economics and Policy, 12*(4), 494-500. doi:10.32479/ijeep.13347

de Miguel, C., Manzano, B., 2011a. Gradual green tax reforms. Energy Economics 33, S50–S58. https://doi.org/10.1016/j.eneco.2011.07.026

de Miguel, C., Manzano, B., 2011b. Green tax reforms and habits. Resource and Energy Economics 33, 231–246. https://doi.org/10.1016/j.reseneeco.2010.05.001

Deo, R.C., 2011. Links between native forest and climate in Australia. Weather 66, 64–69. https://doi.org/10.1002/wea.659

Di Girolami, E., Kampen, J., Arts, B., 2023. Two systematic literature reviews of scientific research on the environmental impacts of forest certifications and community forest management at a global scale. Forest Policy and Economics 146, 102864. https://doi.org/10.1016/j.forpol.2022.102864

DiMASI, J.A., 1987. The effects of site value taxation in an urban area: a general equilibrium computational approach. National Tax Journal 40, 577–590. https://doi.org/10.1086/NTJ41788697

Dixon, R., Challies, E., 2015a. Making REDD+ pay: Shifting rationales and tactics of private finance and the governance of avoided deforestation in Indonesia: Private REDD+ finance in Indonesia. Asia Pac Viewp 56, 6–20. https://doi.org/10.1111/apv.12085

Dixon, R., Challies, E., 2015b. Making REDD+ pay: Shifting rationales and tactics of private finance and the governance of avoided deforestation in Indonesia: Private REDD+ finance in Indonesia. Asia Pac Viewp 56, 6–20. https://doi.org/10.1111/apv.12085

Djezou, W., 2016. Deforestation and Forest land Use in Côte d'Ivoire: Policy and Fiscal Instruments. Journal of Forest and Environmental Science 32, 55–67. https://doi.org/10.7747/JFES.2016.32.1.55

Does environmental tax kill employment? Evidence from OECD and non-OECD countries, 2022. . Journal of Cleaner Production 380, 134873. https://doi.org/10.1016/j.jclepro.2022.134873

Download Amacher G.S., Ollikainen M., Koskela E.A. Economics of Forest Resources [PDF] [WWW Document], n.d. URL https://sciarium.com/file/164647/ (accessed 1.8.23).

Ekawati, S., Subarudi, Budiningsih, K., Sari, G.K., Muttaqin, M.Z., 2019. Policies affecting the implementation of REDD+ in Indonesia (cases in Papua, Riau and Central Kalimantan). Forest Policy and Economics 108, 101939. https://doi.org/10.1016/j.forpol.2019.05.025

Ekoko, F., 2000. Balancing Politics, Economics and Conservation: The Case of the Cameroon Forestry Law Reform. Development and Change 31, 131–154. https://doi.org/10.1111/1467-7660.00149

Environmental protection tax superseded pollution fees, does China effectively abate ecological footprints?, 2023. . Journal of Cleaner Production 135846. https://doi.org/10.1016/j.jclepro.2023.135846

Environmental protection tax superseded pollution fees, does China effectively abate ecological footprints? - ScienceDirect [WWW Document], n.d. URL https://www.sciencedirect.com/science/article/abs/pii/S0959652623000045 (accessed 1.5.23).

Ercolano, S., Gaeta, G.L., Romano, O., 2014. Environmental tax reform and individual preferences: An empirical analysis on European micro data. Journal of Behavioral and Experimental Economics 51, 1–11. https://doi.org/10.1016/j.socec.2014.02.008

Esen, Ö., Yıldırım, D.Ç., Yıldırım, S., 2021. Pollute less or tax more? Asymmetries in the EU environmental taxes – Ecological balance nexus. Environmental Impact Assessment Review 91, 106662. https://doi.org/10.1016/j.eiar.2021.106662

Fan, J.-L., Zhang, Y.-J., & Wang, B. (2017). The impact of urbanization on residential energy consumption in China: An aggregated and disaggregated analysis. *Renewable and Sustainable Energy Reviews, 75*, 220-233. doi:10.1016/j.rser.2016.10.066

Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The next generation of the Penn World Table. *American Economic Review, 105*(10), 3150-3182. doi:10.1257/aer.20130954

Food and Agriculture Organization of the United Nations. (2006). *Global Forest Resources Assessment 2005: Progress towards sustainable forest management* (Vol. 147). Rome: United Nations.

Food and Agriculture Organization of the United Nations. (2010). *Global Forest Resources Assessment 2010: Main Report*. Rome: United Nations.

Frondel, M., Horbach, J., & Rennings, K. (2007). End-of-pipe or cleaner production? An empirical comparison of environmental innovation decisions across OECD countries. *Business strategy and the environment, 16*(8), 571-584. doi:10.1002/bse.496

Fullerton, D., & Wolverton, A. (2002). The case for a two-part instrument: Presumptive tax and environmental subsidy. In *The Economics of Household Garbage and Recycling Behavior* (pp. 175-200): Edward Elgar Publishing.

Fendrich, A.N., Barretto, A., Sparovek, G., Gianetti, G.W., da Luz Ferreira, J., de Souza Filho, C.F.M., Appy, B., de Guedes, C.M.G., Leitão, S., 2022. Taxation aiming environmental protection: The case of Brazilian Rural Land Tax. Land Use Policy 119, 106164. https://doi.org/10.1016/j.landusepol.2022.106164

Fernández, E., Pérez, R., Ruiz, J., 2011. Optimal green tax reforms yielding double dividend. Energy Policy, Special Section: Renewable energy policy and development 39, 4253–4263. https://doi.org/10.1016/j.enpol.2011.04.041

Ferretti-Gallon, K., Busch, J., 2014a. What Drives Deforestation and What Stops it? A Meta-Analysis of Spatially Explicit Econometric Studies. SSRN Journal. https://doi.org/10.2139/ssrn.2458040

Ferretti-Gallon, K., Busch, J., 2014b. What Drives Deforestation and What Stops it? A Meta-Analysis of Spatially Explicit Econometric Studies. SSRN Journal. https://doi.org/10.2139/ssrn.2458040

Features of Taxation of Forestry Enterprises [WWW Document], n.d. . ResearchGate. URL https://www.researchgate.net/publication/325621765_Features_of_Taxation_of_Forestry_Enterprises (accessed 1.3.23).

https://www.researchgate.net/publication/272206338_Forest_Taxation_Regime_for_Tropical_Forests_Lessons_From_Central_Africa (accessed 1.3.23).

Filipović, S., Golušin, M., 2015a. Environmental taxation policy in the EU – new methodology approach. Journal of Cleaner Production, Sustainable Development of Energy, Water and Environment Systems 88, 308–317. https://doi.org/10.1016/j.jclepro.2014.03.002

Filipović, S., Golušin, M., 2015b. Environmental taxation policy in the EU – new methodology approach. Journal of Cleaner Production 88, 308–317. https://doi.org/10.1016/j.jclepro.2014.03.002

Fishbein, M., Ajzen, I., 1975. Belief, attitude, intention and behaviour: An introduction to theory and research.

Forest Taxation Regime for Tropical Forests: Lessons From Central Africa [WWW Document], n.d. . ResearchGate. URL

Forest taxation | 12 | Handbook of Forest Resource Economics | Markku [WWW Document], n.d. URL https://www.taylorfrancis.com/chapters/edit/10.4324/9780203105290-12/forest-taxation-markku-ollikainen (accessed 1.8.23).

Forest use strategies and their determinants among rural households in the Miombo woodlands of the Copperbelt Province, Zambia, 2020. . Forest Policy and Economics 111, 102078. https://doi.org/10.1016/j.forpol.2019.102078

Forestry taxation in Africa: the cases of Liberia and Gabon on JSTOR [WWW Document], n.d. URL https://www.jstor.org/stable/24310468 (accessed 1.1.23).

Fortney, J., Arano, K.G., Jacobson, M., 2011. An evaluation of West Virginia's Managed Timberland Tax Incentive Program. Forest Policy and Economics 13, 69–78. https://doi.org/10.1016/j.forpol.2010.08.002

Foy, T.J., Willis, C.B., 2010a. A Forest Policy for South-Africa: Why. We Should Have One and What Should It Contain. Southern African Forestry Journal.

Foy, T.J., Willis, C.B., 2010b. A Forest Policy for South-Africa: Why. We Should Have One and What Should It Contain. Southern African Forestry Journal.

Frey, G.E., 2023a. Do property tax benefits for forest landowners work? A review of effectiveness at retaining and promoting active management of private forests. Landscape and Urban Planning 231, 104647. https://doi.org/10.1016/j.landurbplan.2022.104647

Frey, G.E., 2023b. Do property tax benefits for forest landowners work? A review of effectiveness at retaining and promoting active management of private forests. Landscape and Urban Planning 231, 104647. https://doi.org/10.1016/j.landurbplan.2022.104647

Frey, G.E., Meier, J.T., Kilgore, M.A., Snyder, S.A., Blinn, C.R., 2019a. Factors associated with family forest landowner enrollment in state preferential forest property tax programs in the United States. Land Use Policy 89, 104240. https://doi.org/10.1016/j.landusepol.2019.104240

Frey, G.E., Meier, J.T., Kilgore, M.A., Snyder, S.A., Blinn, C.R., 2019b. Factors associated with family forest landowner enrollment in state preferential forest property tax programs in the United States. Land Use Policy 89. https://doi.org/10.1016/j.landusepol.2019.104240

Fulginiti, L.E., Perrin, R.K., 1998. Agricultural productivity in developing countries. Agricultural Economics 19, 45–51.

Fullerton, D., Leicester, A., Smith, S., 2008. Environmental taxes. National bureau of economic research.

Gamponia, V., Mendelsohn, R., 1987. The Economic Efficiency of Forest Taxes. for sci 33, 367–378. https://doi.org/10.1093/forestscience/33.2.367

Garasym, P., Klym, N., Khomyak, R., 2018. Features of Taxation of Forestry Enterprises. Economics, Entrepreneurship, Management 5, 55–62. https://doi.org/10.23939/eem2018.01.055

Garzuglia, M. (2018). *1948–2018. Seventy Years of FAO's Global Forest Resources Assessment. Historical Overview and Future Prospects.* . Rome: United Nations.

Geist, H. J., & Lambin, E. F. (2001). What drives tropical deforestation? A meta-analysis of proximate and underlying causes of deforestation based on sub-national case study evidence. In *LUCC Report Series No. 4. CIACO* (pp. 116). Louvain-la-Neuve, Belgium: LUCC Inter-national Project Office, University of Louvain.

Geist, H. J., & Lambin, E. F. (2002). Proximate causes and underlying driving forces of tropical deforestation. *BioScience, 52*(2), 143-150. doi:10.1641/0006-3568(2002)052[0143:PCAUDF]2.0.CO;2

Gemechu, E. D., Butnar, I., Llop, M., & Castells, F. (2014). Economic and environmental effects of CO2 taxation: An input-output analysis for Spain. *Journal of Environmental Planning and Management, 57*(5), 751-768. doi:10.1080/09640568.2013.767782

Gerlagh, R., & Lise, W. (2005). Carbon taxes: A drop in the ocean, or a drop that erodes the stone? The effect of carbon taxes on technological change. *Ecological Economics, 54*(2-3), 241-260. doi:10.1016/j.ecolecon.2004.12.037

Gokmenoglu, K. K., & Taspinar, N. (2018). Testing the agriculture-induced EKC hypothesis: The case of Pakistan. *Environmental Science and Pollution Research, 25*(23), 22829-22841. doi:10.1007/s11356-018-2330-6

Gokmenoglu, K. K., Taspinar, N., & Kaakeh, M. (2019). Agriculture-induced environmental Kuznets curve: The case of China. *Environmental Science and Pollution Research, 26*(36), 37137-37151. doi:10.1007/s11356-019-06685-8

Golub, A., Hertel, T., Lee, H.-L., Rose, S., & Sohngen, B. (2009). The opportunity cost of land use and the global potential for greenhouse gas mitigation in agriculture and forestry. *Resource and Energy Economics, 31*(4), 299-319. doi:10.1016/j.reseneeco.2009.04.007

Government of India. (1999). Economic Survey, 1998-99. In. New Delhi: Ministry of Finance.

Green, J. F. (2021). Does carbon pricing reduce emissions? A review of ex-post analyses. *Environmental Research Letters, 16*(4), 043004. doi:10.1088/1748-9326/abdae9

Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., . . . Smith, P. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences, 114*(44), 11645-11650. doi:10.1073/pnas.17104651

Gondo, P., n.d. FINANCING FORESTRY IN AFRICA.

Goulder, L.H., Parry, I.W., 2008. Instrument choice in environmental policy. Review of environmental economics and policy.

Gray, J.S., 1997a. Marine biodiversity: patterns, threats and conservation needs. Biodiversity & Conservation 6, 153–175.

Gray, J.S., 1997b. Marine biodiversity: patterns, threats and conservation needs. Biodiversity & Conservation 6, 153–175.

Grover, S.P.P., Livesley, S.J., Hutley, L.B., Jamali, H., Fest, B., Beringer, J., Butterbach-Bahl, K., Arndt, S.K., 2012. Land use change and the impact on greenhouse gas exchange in north Australian savanna soils. Biogeosciences 9, 423–437. https://doi.org/10.5194/bg-9-423-2012

Grut, M., 1991. Forest pricing and concession policies : managing the high forests of West and Central Africa.

Grut, M., Gray, J.A., Egli, N., 1993. Forest pricing and concession policies: Managing the high forest of west and Central Africa. World Bank Technical Paper 143; Politique de redevances et de concessions forestires: gestion des futaies en afrique occidentale et centrale (No. WB-0125/XAB). World Bank Group, Washington, DC (United States).

Gruver, J.B., Metcalf, A.L., Muth, A., Finley, J.C., Luloff, A.E., 2017. Making Decisions About Forestland Succession: Perspectives from Pennsylvania's Private Forest Landowners. Society and Natural Resources 30, 47–62. https://doi.org/10.1080/08941920.2016.1180728

Gu, Y., Ho, K.-C., Yan, C., Gozgor, G., 2021. Public environmental concern, CEO turnover, and green investment: Evidence from a quasi-natural experiment in China. Energy Economics 100, 105379. https://doi.org/10.1016/j.eneco.2021.105379

Gujarati, D.N., Porter, D.C., 2009. Basic econometrics, 5th ed. ed. McGraw-Hill Irwin, Boston.

Hansen, C. P., Lund, J., 2018. Forestry taxation for sustainability: theoretical ideals and empirical realities. Current Opinion in Environmental Sustainability.

Hansen, Christian P, Lund, J.F., 2018a. Forestry taxation for sustainability: theoretical ideals and empirical realities. Current Opinion in Environmental Sustainability, Environmental change issues 2018 32, 23–28. https://doi.org/10.1016/j.cosust.2018.03.002

Hansen, Christian P, Lund, J.F., 2018b. Forestry taxation for sustainability: theoretical ideals and empirical realities. Current Opinion in Environmental Sustainability 32, 23–28.

Harrison, K., 2012. A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada. Review of Policy Research 29, 383–407. https://doi.org/10.1111/j.1541-1338.2012.00565.x

Harrison, S.R., 1998. New directions in community and farm reforestation. International Journal of Social Economics 25, 244–260. https://doi.org/10.1108/03068299810193425

Hart, S., Ahuja, G., 1996. Does It Pay To Be Green? An Empirical Examination of the Relationship between Emission Reduction And Firm Performance. Business Strategy and the Environment 5, 30–37. https://doi.org/10.1002/(SICI)1099-0836(199603)5:1<30::AID-BSE38>3.0.CO;2-Q

Hassan, M., Oueslati, W., Rousselière, D., 2020. Environmental taxes, reforms and economic growth: an empirical analysis of panel data. Economic Systems 44, 100806. https://doi.org/10.1016/j.ecosys.2020.100806

Hawkins, R., 2000. The Use of Economic Instruments and Green Taxes to Complement an Environmental Regulatory Regime. Water Air and Soil Pollution 123, 379–394. https://doi.org/10.1023/A:1005294917875

Haberl, H., Erb, K.-H., Krausmann, F., Bondeau, A., Lauk, C., Müller, C., . . . Steinberger, J. K. (2011). Global bioenergy potentials from agricultural land in 2050: Sensitivity to climate change, diets and yields. *Biomass and bioenergy, 35*(12), 4753-4769. doi:10.1016/j.biombioe.2011.04.035

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., . . . Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. *Science, 342*(6160), 850-853. doi:10.1126/science.1244693

Hart, B., & Kane, H. E. (1982). What every real estate lawyer should know about payment and performance bonds. *Real Property, Probate and Trust Journal, 17*, 674-689.

Havlík, P., Schneider, U. A., Schmid, E., Böttcher, H., Fritz, S., Skalský, R., . . . Kraxner, F. (2011). Global land-use implications of first and second generation biofuel targets. *Energy Policy, 39*(10), 5690-5702. doi:10.1016/j.enpol.2010.03.030

Hosonuma, N., Herold, M., De Sy, V., De Fries, R. S., Brockhaus, M., Verchot, L., . . . Romijn, E. (2012). An assessment of deforestation and forest degradation drivers in

developing countries. *Environmental Research Letters, 7*(4), 044009-044020. doi:10.1088/1748-9326/7/4/044009

Hotunluoğlu, H., & Tekeli, R. (2007). Karbon vergisinin ekonomik analizi ve etkileri: Karbon vergisinin emisyon azaltıcı etkisi var mı? *Sosyoekonomi, 6*(6).

Houghton, R. A. (1991). Tropical Deforestation and Atmospheric Carbon Dioxide. In N. Myers (Ed.), *Tropical Forests and Climate* (pp. 99-118). Dordrecht: Springer Netherlands.

Houghton, R. A. (2005). Tropical Deforestation as a Source of Greenhouse Gas Emissions. In P. Moutinho & S. Schwartzman (Eds.), *Tropical deforestation and climate change* (pp. 13-21). Pará, Brazil: Amazon Institute for Environmental Research.

Hu, H., & Zhou, W. (2014). The impact of carbon tax policy on the carbon emission reduction and profit. *International Journal of Smart Home, 8*(5), 175-184. doi:10.14257/ijsh.2014.8.5.16

Huang, J., Yang, X., Cheng, G., & Wang, S. (2014). A comprehensive eco-efficiency model and dynamics of regional eco-efficiency in China. *Journal of Cleaner Production, 67*, 228-238. doi:10.1016/j.jclepro.2013.12.003

Heaps, T., Helliwell, J.F., 1985a. Chapter 8 The taxation of natural resources, in: Handbook of Public Economics. Elsevier, pp. 421–472. https://doi.org/10.1016/S1573-4420(85)80011-2

Heaps, T., Helliwell, J.F., 1985b. The taxation of natural resources, in: Handbook of Public Economics. Elsevier, pp. 421–472.

Henry George [WWW Document], n.d. . Econlib. URL https://www.econlib.org/library/Enc/bios/George.html (accessed 1.9.23).

Hens, L., Boon, E.K., 1999. Institutional, Legal, and Economic Instruments in Ghana's Environmental Policy. Environmental Management 24, 337–351. https://doi.org/10.1007/s002679900237

Hyde, W.F., 2019a. The experience of China's forest reforms: What they mean for China and what they suggest for the world. Forest Policy and Economics, The experience of China's forest reforms: What they mean for China and what they suggest for the world? 98, 1–7. https://doi.org/10.1016/j.forpol.2018.09.009

Hyde, W.F., 2019b. The experience of China's forest reforms: What they mean for China and what they suggest for the world. Forest Policy and Economics, The experience of China's forest reforms: What they mean for China and what they suggest for the world? 98, 1–7. https://doi.org/10.1016/j.forpol.2018.09.009

Intergovernmental Panel on Climate Change. (2001) Climate change 2001. The Scientific Report. In. *Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Integovernmental Panel on Climate Change* (pp. 398). Cambridge, United Kingdom, and New York: Cambridge University Press.

Intergovernmental Panel on Climate Change. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Retrieved from Geneva:

Inyang, M. P., & Esohe, K. P. (2014). Deforestations, environmental sustainability and health implications in Nigeria: A review. *International Journal of Science, Environment and Technology, 3*(2), 502-517.

IPBES. (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Retrieved from Bonn, Germany:

Irfan, M., & Shaw, K. (2017). Modeling the effects of energy consumption and urbanization on environmental pollution in South Asian countries: A nonparametric panel approach. *Quality & Quantity, 51*(1), 65-78. doi:10.1007/s11135-015-0294-x

Isik, C., Dogru, T., & Turk, E. S. (2018). A nexus of linear and non-linear relationships between tourism demand, renewable energy consumption, and economic growth: Theory and evidence. *International Journal of Tourism Research, 20*(1), 38-49. doi:10.1002/jtr.2151

Islam, R., Ghani, A. B. A., & Mahyudin, E. (2017). Carbon dioxide emission, energy consumption, economic growth, population, poverty and forest area: Evidence from panel data analysis. *International Journal of Energy Economics and Policy, 7*(4), 99. Retrieved from

Igini, M., 2022a. Deforestation in Africa: Causes, Effects, and Solutions [WWW Document]. Earth.Org. URL https://earth.org/deforestation-in-africa/ (accessed 1.8.23).

Igini, M., 2022b. Deforestation in Africa: Causes, Effects, and Solutions [WWW Document]. Earth.Org. URL https://earth.org/deforestation-in-africa/ (accessed 1.8.23).

Impacts of forest tax under timber price uncertainty, 2020. . Forest Policy and Economics 111, 102030. https://doi.org/10.1016/j.forpol.2019.102030

Indonesia's moratorium on new forest licenses: An update, 2014. . Land Use Policy 38, 37–40. https://doi.org/10.1016/j.landusepol.2013.10.018

Ionescu, L., 2020. The economics of the carbon tax: Environmental performance, sustainable energy, and green financial behavior. Geopolitics, History, and International Relations 12, 101–107. https://doi.org/10.22381/GHIR121202010

Irawan, S., Tacconi, L., Ring, I., 2014. Designing intergovernmental fiscal transfers for conservation: The case of REDD+ revenue distribution to local governments in Indonesia. Land Use Policy 36, 47–59. https://doi.org/10.1016/j.landusepol.2013.07.001

Irawan, S., Tacconi, L., Ring, I., 2013. Stakeholders' incentives for land-use change and REDD+: The case of Indonesia. Ecological Economics 87, 75–83. https://doi.org/10.1016/j.ecolecon.2012.12.018

Irawan, S., Widiastomo, T., Tacconi, L., Watts, J.D., Steni, B., 2019. Exploring the design of jurisdictional REDD+: The case of Central Kalimantan, Indonesia. Forest Policy and Economics 108, 101853. https://doi.org/10.1016/j.forpol.2018.12.009

Jaffe, A. B., Newell, R. G., & Stavins, R. N. (2005). A tale of two market failures: Technology and environmental policy. *Ecological Economics, 54*(2-3), 164-174. doi:10.1016/j.ecolecon.2004.12.027

Jou, J.-B., Lee, T., 2008. Taxation on Land Value and Development When There Are Negative Externalities from Development. J Real Estate Finan Econ 36, 103–120. https://doi.org/10.1007/s11146-007-9072-4

Junge, J.R., Levinson, D., 2012. Financing transportation with land value taxes: Effects on development intensity. JTLU 5, 49–63. https://doi.org/10.5198/jtlu.v5i1.148

Kallbekken, S., Sælen, H., 2011a. Public acceptance for environmental taxes: Self-interest, environmental and distributional concerns. Energy Policy 39, 2966–2973. https://doi.org/10.1016/j.enpol.2011.03.006

Kallbekken, S., Sælen, H., 2011b. Public acceptance for environmental taxes: Self-interest, environmental and distributional concerns. Energy Policy 39, 2966–2973. https://doi.org/10.1016/j.enpol.2011.03.006

Kallbekken, S., Sælen, H., 2011c. Public acceptance for environmental taxes: Self-interest, environmental and distributional concerns. Energy Policy 39, 2966–2973. https://doi.org/10.1016/j.enpol.2011.03.006

Karsenty, Alain, 2010a. Forest taxation regime for tropical forests: lessons from Central Africa. International Forestry Review 12, 121–129.

Karsenty, Alain, 2010b. Forest taxation regime for tropical forests: lessons from Central Africa. International Forestry Review 12, 121–129.

Karsenty, A., 2010a. Forest taxation regime for tropical forests: lessons from Central Africa. The International Forestry Review 12, 121–129.

Karsenty, A., 2010b. Forest Taxation Regime for Tropical Forests: Lessons from Central Africa [WWW Document]. URL https://www.semanticscholar.org/paper/Forest-Taxation-Regime-for-Tropical-Forests%3A-from-Karsenty/c426b259cb9b04357fd6b87c1db9637aa4839b5a (accessed 1.3.23).

Karsenty, A., Drigo, I.G., Piketty, M.-G., Singer, B., 2008a. Regulating industrial forest concessions in Central Africa and South America. Forest ecology and Management 256, 1498–1508.

Karsenty, A., Drigo, I.G., Piketty, M.-G., Singer, B., 2008b. Regulating industrial forest concessions in Central Africa and South America. Forest ecology and Management 256, 1498–1508.

Kanninen, M., Brockhaus, M., Murdiyarso, D., & Nabuurs, G.-J. (2010). *Harnessing Forests for Climate Change Mitigation through REDD+* (Vol. 25). Vienna: IUFRO (International Union of Forestry Research Organizations) Secretariat.

Kasman, A., & Duman, Y. S. (2015). CO2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: a panel data analysis. *Economic Modelling, 44*, 97-103. doi:10.1016/j.econmod.2014.10.022

Katila, P., Colfer, C. J. P., De Jong, W., Galloway, G., Pacheco, P., & Winkel, G. (2019). *Sustainable Development Goals: Their Impacts on Forests and People*: Cambridge University Press.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2010). The Worldwide Governance Indicators: A Summary of Methodology, Data and Analytical Issues (Working Paper). Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130. from The World Bank http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130

Keohane, N. O. (2002). *Environmental policy and the choice of abatement technique: Evidence from coal-fired power plants.* Paper presented at the 2nd World Congress of Environmental and Resource Economists, Monterrey, CA.

Keohane, N. O., Revesz, R. L., & Stavins, R. N. (1998). The choice of regulatory instruments in environmental policy. *Harv. Environmental Law Rev., 22*, 313. doi:10.4324/9781315194288-10

Kirikkaleli, D., & Kalmaz, D. B. (2020). Testing the moderating role of urbanization on the environmental Kuznets curve: Empirical evidence from an emerging market. *Environmental Science and Pollution Research, 27*(30), 38169-38180. doi:10.1007/s11356-020-09870-2

Kissinger, G. M., Herold, M., & De Sy, V. (2012). *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers.* Retrieved from Vancouver, Canada: https://www.forestcarbonpartnership.org/system/files/documents/DriversOfDeforestation.pdf

Koenker, R. (2005). *Quantile Regression*. Cambridge & New York: Cambridge University Press.

Koenker, R., & Bassett, G. J. (1978). Regression quantiles. *Econometrica: Journal of the Econometric Society*, 33-50. doi:10.2307/1913643

Korhonen, J., Pätäri, S., Toppinen, A., & Tuppura, A. (2015). The role of environmental regulation in the future competitiveness of the pulp and paper industry: The case of the sulfur emissions directive in Northern Europe. *Journal of Cleaner Production, 108*, 864-872. doi:10.1016/j.jclepro.2015.06.003

Kuznets, S. (1955). Economic growth and income inequality. *The American economic review, 45*(1), 1-28. doi:10.4324/9780429311208-4

Kerckhoven, S.V., Bécault, E., Marx, A., 2015. Ecological tax reform initiatives in Africa. IJGE 9, 58. https://doi.org/10.1504/IJGE.2015.067885

Kilgore, M.A., 2014. Do high property taxes influence family forest land Tenure decisions? Journal of Forest Economics 20, 161–173. https://doi.org/10.1016/j.jfe.2014.03.002

Kilgore, M.A., Ellefson, P.V., Funk, T.J., Frey, G.E., 2018a. Private forest owners and property tax incentive programs in the United States: A national review and analysis of ecosystem services promoted, landowner participation, forestland area enrolled, and magnitude of tax benefits provided. Forest Policy and Economics 97, 33–40. https://doi.org/10.1016/j.forpol.2018.08.015

Kilgore, M.A., Ellefson, P.V., Funk, T.J., Frey, G.E., 2018b. Private forest owners and property tax incentive programs in the United States: A national review and analysis of ecosystem services promoted, landowner participation, forestland area enrolled, and magnitude of tax benefits provided. Forest Policy and Economics 97, 33–40. https://doi.org/10.1016/j.forpol.2018.08.015

Kim, Y.S., Bae, J.S., Fisher, L.A., Latifah, S., Afifi, M., Lee, S.M., Kim, I.A., 2016. Indonesia's Forest Management Units: Effective intermediaries in REDD+ implementation? Forest Policy and Economics 62, 69–77. https://doi.org/10.1016/j.forpol.2015.09.004

Kirzner, I.M., 2000. The Law of Supply and Demand | Israel M. Kirzner [WWW Document]. URL https://fee.org/articles/the-law-of-supply-and-demand/ (accessed 1.8.23).

Klemperer, W.D., 1982. An Analysis of Selected Property Tax Exemptions for Timber. Land Economics 58, 293–309. https://doi.org/10.2307/3145938

Klemperer, W.D., 1974. FORESTS AND THE PROPERTY TAX — A RE-EXAMINATION. National Tax Journal 27, 645–651. https://doi.org/10.1086/NTJ41861995

Koshkalda, I., Stupen, N., Anopriienko, T., Stupen, O., 2021. Peculiarities of the forestland taxation system. EEA 39. https://doi.org/10.25115/eea.v39i7.4824

Koskela, E., Ollikainen, M., 2001. Optimal Forest Taxation Under Private and Social Amenity Valuation. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.263118

Koskela, E., Ollikainen, M., 1999. Optimal public harvesting under the interdependence of public and private forests. Forest Science.

Koskela, E., Ollikainen, M., Pukkala, T., 2007. Biodiversity policies in commercial boreal forests: Optimal design of subsidy and tax combinations. Forest Policy and Economics 9, 982–995. https://doi.org/10.1016/j.forpol.2006.09.003

Kosonen, K., Nicodème, G., 2009. The role of fiscal instruments in environmental policy.

Kowero, G., Kaoneka, A.S., Nhantumbo, I., Gondo, P., Jumbe, C.B., Selänniemi, M., 2001. Forest policies in Malawi, Mozambique, Tanzania and Zimbabwe, in: World Forests, Markets and Policies. Springer, pp. 311–328.

Krelove, R., Melhado, O., 2010. Forestry Taxation in Africa: The Cases of Liberia and Gabon [WWW Document]. URL https://www.semanticscholar.org/paper/Forestry-Taxation-in-Africa%3A-The-Cases-of-Liberia-Krelove-Melhado/878f5886e568b363bcaa0cb8b63b229d20d87244 (accessed 1.3.23).

Kurtinaitytė-Venediktovienė, D., Pereira, P., & Černiauskas, G. (2014). Environmental taxes in Northern Europe. The recent evolution and current status in the Baltic Countries. *Societal Studies*, *6*(2), 331-348. https://doi.org/10.13165/SMS-14-6-2-06

Law, B.E., Hudiburg, T.W., Berner, L.T., Kent, J.J., Buotte, P.C., Harmon, M.E., 2018. Land use strategies to mitigate climate change in carbon dense temperate forests. Proc. Natl. Acad. Sci. U.S.A. 115, 3663–3668. https://doi.org/10.1073/pnas.1720064115

Leplay, S., & Thoyer, S. (2011). Synergy effects of international policy instruments to reduce deforestation: A cross-country panel data analysis. In *LAMETA Working Paper, 2011-01*.

Leyland, P., & Anthony, G. (2016). *Textbook on Administrative Law*. Oxford, United Kingdom: Oxford University Press.

Leyland, P., & Woods, T. (2002). *Textbook on Administrative Law* (4th ed.). Gosport, Hampshire: Oxford University Press.

Li, K., & Lin, B. (2015). Impacts of urbanization and industrialization on energy consumption/CO2 emissions: Does the level of development matter? *Renewable and Sustainable Energy Reviews, 52*, 1107-1122. doi:10.1016/j.rser.2015.07.185

Li, Y., Brando, P. M., Morton, D. C., Lawrence, D. M., Yang, H., & Randerson, J. T. (2022). Deforestation-induced climate change reduces carbon storage in remaining tropical forests. *Nature communications, 13*(1), 1-13. doi:10.1038/s41467-022-29601-0

Liu, X., Ekoungoulou, R., Loumeto, J. J., Ifo, S. A., Bocko, Y. E., & Koula, F. E. (2014). Evaluation of carbon stocks in above-and below-ground biomass in Central Africa: case study of Lesio-louna tropical rainforest of Congo. *Biogeosciences Discussions, 11*(7), 10703-10735. doi:10.5194/bgd-11-10703-2014

Liu, Z., & Zhao, T. (2015). Contribution of price/expenditure factors of residential energy consumption in China from 1993 to 2011: A decomposition analysis. *Energy Conversion and Management, 98*, 401-410. doi:10.1016/j.enconman.2015.04.008

Loganathan, N., Shahbaz, M., & Taha, R. (2014). The link between green taxation and economic growth on CO2 emissions: Fresh evidence from Malaysia. *Renewable and Sustainable Energy Reviews, 38*, 1083-1091. doi:10.1016/j.rser.2014.07.057

Lu, C., Tong, Q., & Liu, X. (2010). The impacts of carbon tax and complementary policies on Chinese economy. *Energy Policy, 38*(11), 7278-7285. doi:10.1016/j.enpol.2010.07.055

Leiter, A.M., Parolini, A., Winner, H., 2011a. Environmental regulation and investment: Evidence from European industry data. Ecological Economics 70, 759–770. https://doi.org/10.1016/j.ecolecon.2010.11.013

Leiter, A.M., Parolini, A., Winner, H., 2011b. Environmental regulation and investment: Evidence from European industry data. Ecological Economics 70, 759–770. https://doi.org/10.1016/j.ecolecon.2010.11.013

Leruth, L., Paris, R., Ruzicka, I., 2001. The complier pays principle: the limits of fiscal approaches toward sustainable forest management. IMF Staff Papers 48, 397–423.

Leruth, L.E., Paris, R., Ruzicka, I., 2001. The Complier Pays Principle: The Limits of Fiscal Approaches Toward Sustainable Forest Management. IMF Staff Papers 2001. https://doi.org/10.5089/9781451974256.024.A008

Li, G., Masui, T., 2019a. Assessing the impacts of China's environmental tax using a dynamic computable general equilibrium model. Journal of Cleaner Production 208, 316–324. https://doi.org/10.1016/j.jclepro.2018.10.016

Li, G., Masui, T., 2019b. Assessing the impacts of China's environmental tax using a dynamic computable general equilibrium model. Journal of Cleaner Production 208, 316–324. https://doi.org/10.1016/j.jclepro.2018.10.016

Li, P., Lin, Z., Du, H., Feng, T., Zuo, J., 2021. Do environmental taxes reduce air pollution? Evidence from fossil-fuel power plants in China. Journal of Environmental Management 295, 113112. https://doi.org/10.1016/j.jenvman.2021.113112

Li, Y., Izlar, R.L., 2021. The Forest Land Protection Act program (FLPA) and conserving forestland in Georgia. Forest Policy and Economics 124, 102399. https://doi.org/10.1016/j.forpol.2021.102399

Liu, A.A., 2013a. Tax evasion and optimal environmental taxes. Journal of Environmental Economics and Management 66, 656–670. https://doi.org/10.1016/j.jeem.2013.06.004

Liu, A.A., 2013b. Tax evasion and optimal environmental taxes. Journal of Environmental Economics and Management 66, 656–670. https://doi.org/10.1016/j.jeem.2013.06.004

Liu, G., Yang, Z., Zhang, F., Zhang, N., 2022. Environmental tax reform and environmental investment: A quasi-natural experiment based on China's Environmental Protection Tax Law. Energy Economics 109, 106000. https://doi.org/10.1016/j.eneco.2022.106000

Liu, L., Zhao, Z., Zhang, M., Zhou, D., 2022. Green investment efficiency in the Chinese energy sector: Overinvestment or underinvestment? Energy Policy 160, 112694. https://doi.org/10.1016/j.enpol.2021.112694

Lund, J., Chhetri, B., Nielsen, O., 2012. Lund, J.F., Chhetri, B.B.K. and Ø.J. Nielsen 2012. The Public Finance Potential of Community Forestry – Evidence from Nepal. Forest & Landscape Development Briefs Policy 15. January 2012.

Lund, J.F., 2006a. Taxation issues in Tanzanian forest decentralisation. Presented at the Scandinavian Forest Economics: Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics, pp. 69–78.

Lund, J.F., 2006b. Taxation issues in Tanzanian forest decentralisation. Presented at the Scandinavian Forest Economics: Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics, pp. 69–78.

Ma, Z., Butler, B.J., Catanzaro, P.F., Greene, J.L., Hewes, J.H., Kilgore, M.A., Kittredge, D.B., Tyrrell, M., 2014. The effectiveness of state preferential property tax programs in conserving forests: Comparisons, measurements, and challenges. Land Use Policy 36, 492–499. https://doi.org/10.1016/j.landusepol.2013.09.016

Malthusian Theory of Population: Elements, Importance and Criticism [WWW Document], 2021. . Collegedunia. URL https://collegedunia.com/exams/malthusian-theory-of-population-elements-importance-and-criticism-articleid-1194 (accessed 1.7.23).

Mamkhezri, J., Muhamad, G.M., Khezri, M., 2022. Assessing the spatial effects of economic freedom on forest-products, grazing-land, and cropland footprints: The case of Asia-Pacific countries. Journal of Environmental Management 316, 115274. https://doi.org/10.1016/j.jenvman.2022.115274

Marland, G., 2003. The climatic impacts of land surface change and carbon management, and the implications for climate-change mitigation policy. Climate Policy 3, 149–157. https://doi.org/10.1016/S1469-3062(03)00028-7

Mahapatra, K., & Kant, S. (2003). Tropical deforestation: A multinomial logistic model and some country-specific policy prescriptions. *Forest policy and Economics, 7*(1), 1-24. doi:10.1016/S1389-9341(03)00064-9

Mahmood, H., Alkhateeb, T. T. Y., & Furqan, M. (2020). Industrialization, urbanization and CO2 emissions in Saudi Arabia: Asymmetry analysis. *Energy Reports, 6*, 1553-1560. doi:10.1016/j.egyr.2020.06.004

Malhi, Y., Baldocchi, D. D., & Jarvis, P. G. (1999). The carbon balance of tropical, temperate and boreal forests. *Plant, Cell & Environment, 22*(6), 715-740. doi:10.1046/j.1365-3040.1999.00453.x

Malueg, D. A. (1989). Emission credit trading and the incentive to adopt new pollution abatement technology. *Journal of environmental economics and management, 16*(1), 52-57. doi:10.1016/0095-0696(89)90045-4

Marland, G. H., Boden, T. A., & Andres, R. J. (2008). Global, Regional, and National Fossil Fuel CO2 Emissions. In *Trends: A Compendium of Data on Global Change*. Oak Ridge, Tennessee, U.S.A.: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy.

Mather, A. S. (1992). The forest transition. *Area, 24*(3), 367-379. Retrieved from http://www.jstor.org/stable/20003181

McConnell, K. E. (1997). Income and the demand for environmental quality. *Environment and development Economics, 2*(4), 383-399. doi:10.1017/S1355770X9700020X

Miller, S., & Vela, M. (2013). Are environmentally related taxes effective? *SSRN Electronic Journal*. doi:10.2139/ssrn.2367708

Millock, K., & Nauges, C. (2003). The French tax on air pollution: Some preliminary results on its effectiveness. *SSRN Electronic Journal.* doi:10.2139/ssrn.419082

Mokany, K., Raison, R. J., & Prokushkin, A. S. (2006). Critical analysis of root: shoot ratios in terrestrial biomes. *Global change biology, 12*(1), 84-96. doi:10.1111/j.1365-2486.2005.001043.x

Murthy, I. K., Sharma, N., & Nijavalli, R. H. (2013). Harnessing REDD+ opportunities for forest conservation and carbon stock enhancement in the Northeastern States of India. *Natural Science, 5*(3), 349-358. doi:10.4236/ns.2013.53048

Musa, K. S., Maijama'a, R., & Yakubu, M. (2022). Deforestation, Sectoral Co2 Emissions and Environmental Pollution Nexus: Evidence from Nigeria. *Asian Research Journal of Current Science, 4*(1), 161-181.

Myers, S. S., Gaffikin, L., Golden, C. D., Ostfeld, R. S., Redford, K. H., Ricketts, T. H., . . . Osofsky, S. A. (2013). Human health impacts of ecosystem alteration. *Proceedings of the National Academy of Sciences, 110*(47), 18753-18760. doi:10.1073/pnas.1218656110

Meehan, F., Tacconi, L., Budiningsih, K., 2019a. Are national commitments to reducing emissions from forests effective? Lessons from Indonesia. Forest Policy and Economics 108, 101968. https://doi.org/10.1016/j.forpol.2019.101968

Meehan, F., Tacconi, L., Budiningsih, K., 2019b. Are national commitments to reducing emissions from forests effective? Lessons from Indonesia. Forest Policy and Economics 108, 101968. https://doi.org/10.1016/j.forpol.2019.101968

Merry, F.D., Amacher, G.S., 2008. Forest Taxes, Timber Concessions, and Policy Choices in the Amazon. Journal of Sustainable Forestry.

Merry, F.D., Amacher, G.S., 2005. Forest taxes, timber concessions, and policy choices in the Amazon. Journal of Sustainable Forestry 20, 15–44.

Miceikiene, A., 2018a. Assessment of the effect of environmental taxes on environmental protection.

Miceikiene, A., 2018b. Assessment of the effect of environmental taxes on environmental protection.

Mohammed, J., Osei-Fosu, A.K., Yusif, H., 2017a. Factors influencing households' participation in forest management in the northern region of Ghana. Ind. Jour. Manag. & Prod. 8, 1324. https://doi.org/10.14807/ijmp.v8i4.631

Mohammed, J., Osei-Fosu, A.K., Yusif, H., 2017b. Factors influencing households' participation in forest management in the northern region of Ghana. Ind. Jour. Manag. & Prod. 8, 1324. https://doi.org/10.14807/ijmp.v8i4.631

Møller, N.F., 2017. Energy demand, substitution and environmental taxation: An econometric analysis of eight subsectors of the Danish economy. Energy Economics 61, 97–109. https://doi.org/10.1016/j.eneco.2016.10.004

Muttaqin, M.Z., Alviya, I., Lugina, M., Hamdani, F.A.U., Indartik, 2019a. Developing community-based forest ecosystem service management to reduce emissions from deforestation and forest degradation. Forest Policy and Economics, Assessing policies to reduce emissions from land use change in Indonesia 108, 101938. https://doi.org/10.1016/j.forpol.2019.05.024

Muttaqin, M.Z., Alviya, I., Lugina, M., Hamdani, F.A.U., Indartik, 2019b. Developing community-based forest ecosystem service management to reduce emissions from deforestation and forest degradation. Forest Policy and Economics 108, 101938. https://doi.org/10.1016/j.forpol.2019.05.024

Nakata, T., & Lamont, A. (2001). Analysis of the impacts of carbon taxes on energy systems in Japan. *Energy Policy, 29*(2), 159-166. doi:10.1016/S0301-4215(00)00104-X

Naseem, S., Guang Ji, T., & Kashif, U. (2020). Asymmetrical ARDL correlation between fossil fuel energy, food security, and carbon emission: Providing fresh information from Pakistan. *Environmental Science and Pollution Research, 27*(25), 31369-31382. doi:10.1007/s11356-020-09346-3

Nondo, C., & Kahsai, M. S. (2020). The impact of energy intensity, urbanisation, industrialisation, and income on CO2 emissions in South Africa: An ARDL bounds testing approach. *African Journal of Economic and Sustainable Development, 7*(4), 307-330. doi:10.1504/ajesd.2020.106826

Nordhaus, W. D. (1991). The cost of slowing climate change: A survey. *The Energy Journal, 12*(1), 37-64. doi:10.5547/issn0195-6574-ej-vol12-no1-4

Nordhaus, W. D. (2018). Evolution of assessments of the economics of global warming: Changes in the DICE model, 1992–2017. *Climatic Change, 148*(4), 623-640. doi:10.1007/s10584-018-2218-y

Nordhaus, W. D. (2019). Climate change: The ultimate challenge for economics. *American Economic Review, 109*(6), 1991-2014. doi:10.1257/aer.109.6.1991

Ndoye, O., Tieguhong, J.C., 2010. Forest Resources and Rural Livelihoods: The Conflict Between Timber and Non-timber Forest Products in the Congo Basin. Scandinavian Journal of Forest Research. https://doi.org/10.1080/14004080410034047

Nellor, D.C., 1987. Sovereignty and natural resource taxation in developing countries. Economic Development and Cultural Change 35, 367–392.

Netzer, D., 1998. Land Value Taxation: Can It and Will It Work Today?

Nguyen, C.P., Nguyen, B.Q., 2023. Environmental foe or friend: The influence of the shadow economy on forest land. Land Use Policy 124, 106456. https://doi.org/10.1016/j.landusepol.2022.106456

Novak Pintarič, Z., Kravanja, Z., 2015a. A methodology for the synthesis of heat exchanger networks having large numbers of uncertain parameters. Energy 92, 373–382. https://doi.org/10.1016/j.energy.2015.02.106

Novak Pintarič, Z., Kravanja, Z., 2015b. A methodology for the synthesis of heat exchanger networks having large numbers of uncertain parameters. Energy 92, 373–382. https://doi.org/10.1016/j.energy.2015.02.106

Nurfatriani, F., Darusman, D., Nurrochmat, D., Yustika, A.E., Muttaqin, M.Z., 2015a. Redesigning Indonesian forest fiscal policy to support forest conservation. Forest Policy and Economics.

Nurfatriani, F., Darusman, D., Nurrochmat, D., Yustika, A.E., Muttaqin, M.Z., 2015b. Redesigning Indonesian forest fiscal policy to support forest conservation. Forest Policy and Economics.

Nurfatriani, F., Darusman, D., Nurrochmat, D., Yustika, A.E., Muttaqin, M.Z., 2015c. Redesigning Indonesian forest fiscal policy to support forest conservation. Forest Policy and Economics.

Nurfatriani, Fitri, Darusman, D., Nurrochmat, D.R., Yustika, A.E., Muttaqin, M.Z., 2015. Redesigning Indonesian forest fiscal policy to support forest conservation. Forest Policy and Economics 61, 39–50. https://doi.org/10.1016/j.forpol.2015.07.006

Oates, W.E., Schwab, R.M., 1997. The Impact of Urban Land Taxation: The Pittsburgh Experience. National Tax Journal 50, 1–21.

Openko, I., Stepchuk, Y., Tsvyakh, O., 2019. Estimation of tax receipts from the use of forest land in the conditions of decentralization of authority. ees 3, 65–72. https://doi.org/10.31520/2616-7107/2019.3.3-8

Obiri, B. D., & Damnyag, L. (2011). Socio-economic contribution of illegal chainsaw milling to the Ghanaian rural economy. *Ghana Journal of Forestry, 27*, 50–67. Retrieved from http://csirspace.csirgh.com/bitstream/handle/123456789/2246/illegal_milling.pdf?sequence=1&isAllowed=y

Odugbesan, J. A., & Adebayo, T. S. (2020). The symmetrical and asymmetrical effects of foreign direct investment and financial development on carbon emission: Evidence from Nigeria. *SN Applied Sciences, 2*(12), 1-15. doi:10.1007/s42452-020-03817-5

Olanipekun, I. O., Olasehinde-Williams, G. O., & Alao, R. O. (2019). Agriculture and environmental degradation in Africa: The role of income. *Science of the Total Environment, 692*, 60-67. doi:10.1016/j.scitotenv.2019.07.129

Olorunfemi, I. E., Fasinmirin, J. T., Olufayo, A. A., & Komolafe, A. A. (2020). GIS and remote sensing-based analysis of the impacts of land use/land cover change (LULCC) on the environmental sustainability of Ekiti State, southwestern Nigeria. *Environment, Development and Sustainability, 22*(2), 661-692. doi:10.1007/s10668-018-0214-z

Olorunfemi, I. E., Komolafe, A. A., Fasinmirin, J. T., & Olufayo, A. A. (2019). Biomass carbon stocks of different land use management in the forest vegetative zone of Nigeria. *Acta Oecologica, 95*, 45-56. doi:10.1016/j.actao.2019.01.004

Olorunfemi, I. E., Olufayo, A. A., Fasinmirin, J. T., & Komolafe, A. A. (2022). Dynamics of land use land cover and its impact on carbon stocks in Sub-Saharan Africa: an overview. *Environment, Development and Sustainability, 24*, 1-37. doi:10.1007/s10668-021-01484-z

Organisation for Economic Co-operation and Development. (2003). *The Use of Economic Instruments for Pollution Control and Natural Resource Management in EECCA*. Retrieved from Paris: http://www.oecd.org/environment/outreach/26732337.pdf

Organisation for Economic Co-operation and Development. (2006). *Alternatives to Traditional Regulation*. Paris.

Organisation for Economic Co-operation and Development. (2016). *OECD Policy Instruments for the Environment*.

Organisation for Economic Co-operation and Development. (2022). Environmental tax (indicator) (Publication no. 10.1787/5a287eac-en). Retrieved 03-11-2022

Pan, Y., Birdsey, R. A., Fang, J., Houghton, R., Kauppi, P. E., Kurz, W. A., . . . Canadell, J. G. (2011). A large and persistent carbon sink in the world's forests. *Science, 333*(6045), 988-993. doi:10.1126/science.1201609

Panayotou, T. (1993). *Empirical tests and policy analysis of environmental degradation at different stages of economic development*. Technology and Employment Programme. Geneva.

Pao, H.-T., & Tsai, C.-M. (2010). CO2 emissions, energy consumption and economic growth in BRIC countries. *Energy Policy, 38*(12), 7850-7860. doi:10.1016/j.enpol.2010.08.045

Parajuli, R., Joshi, O., & Maraseni, T. (2019). Incorporating forests, agriculture, and energy consumption in the framework of the Environmental Kuznets Curve: A dynamic panel data approach. *Sustainability, 11*(9), 2688. doi:10.3390/su11092688

Peuckert, J. (2014). What shapes the impact of environmental regulation on competitiveness? Evidence from Executive Opinion Surveys. *Environmental Innovation and Societal Transitions, 10*, 77-94. doi:10.1016/j.eist.2013.09.009

Pimm, S. L. (2022). Deforestation. In: Encyclopedia Britannica.

Porter, M. E. (1991). America's green strategy. *Scientific American, 264*, 168.

Pearce, D.W., 2001. The Economic Value of Forest Ecosystems. Ecosystem Health 7, 284–296. https://doi.org/10.1046/j.1526-0992.2001.01037.x

Petrucci, A., 2003. Taxing Land Rent in an Open Economy. SSRN Journal. https://doi.org/10.2139/ssrn.447481

Piciu, G.C., Trică, C.L., 2012a. Trends in the Evolution of Environmental Taxes. Procedia Economics and Finance, International Conference Emerging Markets Queries in Finance and

Business, Petru Maior University of Tîrgu-Mures, ROMANIA, October 24th - 27th, 2012 3, 716–721. https://doi.org/10.1016/S2212-5671(12)00219-5

Piciu, G.C., Trică, C.L., 2012b. Assessing the Impact and Effectiveness of Environmental Taxes. Procedia Economics and Finance, International Conference Emerging Markets Queries in Finance and Business, Petru Maior University of Tîrgu-Mures, ROMANIA, October 24th - 27th, 2012 3, 728–733. https://doi.org/10.1016/S2212-5671(12)00221-3

Pielke, R.A., Mahmood, R., McAlpine, C., 2016. Land's complex role in climate change. Physics Today 69, 40–46. https://doi.org/10.1063/PT.3.3364

Plassmann, F., Tideman, T.N., 2000. A Markov Chain Monte Carlo Analysis of the Effect of Two-Rate Property Taxes on Construction. Journal of Urban Economics 47, 216–247. https://doi.org/10.1006/juec.1999.2140

Policy instruments to enhance multi-functional forest management, 2007. . Forest Policy and Economics 9, 833–851. https://doi.org/10.1016/j.forpol.2006.03.010

Property rights and liability for deforestation under REDD+: Implications for 'permanence' in policy design, 2011. . Ecological Economics 70, 571–576. https://doi.org/10.1016/j.ecolecon.2010.10.011

Qiao, H., Zheng, F., Jiang, H., & Dong, K. (2019). The greenhouse effect of the agriculture-economic growth-renewable energy nexus: Evidence from G20 countries. *Science of the Total Environment, 671*, 722-731. doi:10.1016/j.scitotenv.2019.03.336

Rafique, M.Z., Fareed, Z., Ferraz, D., Ikram, M., Huang, S., 2022. Exploring the heterogenous impacts of environmental taxes on environmental footprints: An empirical assessment from developed economies. Energy 238, 121753. https://doi.org/10.1016/j.energy.2021.121753

Raihan, A., Muhtasim, D.A., Farhana, S., Pavel, M.I., Faruk, O., Rahman, M., Mahmood, A., 2022. Nexus between carbon emissions, economic growth, renewable energy use, urbanization, industrialization, technological innovation, and forest area towards achieving environmental sustainability in Bangladesh. Energy and Climate Change 3, 100080. https://doi.org/10.1016/j.egycc.2022.100080

Ramadhani, D.P., Koo, Y., 2022. Comparative analysis of carbon border tax adjustment and domestic carbon tax under general equilibrium model: Focusing on the Indonesian economy. Journal of Cleaner Production 377, 134288. https://doi.org/10.1016/j.jclepro.2022.134288

Raihan, A., Begum, R. A., Mohd Said, M. N., & Abdullah, S. M. S. (2019). A review of emission reduction potential and cost savings through forest carbon sequestration. *Asian Journal of Water, Environment and Pollution, 16*(3), 1-7. doi:10.3233/AJW190027

Raihan, A., Begum, R. A., Nizam, M., Said, M., & Pereira, J. J. (2022). Dynamic impacts of energy use, agricultural land expansion, and deforestation on CO2 emissions in Malaysia. *Environmental and Ecological Statistics, 29*, 477–507. doi:10.1007/s10651-022-00532-9

Reilly, J., Melillo, J., Cai, Y., Kicklighter, D., Gurgel, A., Paltsev, S., . . . Schlosser, A. (2012). Using land to mitigate climate change: hitting the target, recognizing the trade-offs. *Environmental science & technology, 46*(11), 5672-5679. doi:10.1021/es2034729

Reimann, M., & Zimmermann, R. (2006). *The Oxford Handbook of Comparative Law*: Oxford University Press.

Ren, S., Li, X., Yuan, B., Li, D., & Chen, X. (2018). The effects of three types of environmental regulation on eco-efficiency: A cross-region analysis in China. *Journal of Cleaner Production, 173*, 245-255. doi:10.1016/j.jclepro.2016.08.113

Ribeiro, F. d. M., & Kruglianskas, I. (2015). Principles of environmental regulatory quality: A synthesis from literature review. *Journal of Cleaner Production, 96*, 58-76. doi:10.1016/j.jclepro.2014.03.047

Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. Retrieved from https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions. Retrieved 03-11-2022, from Our World In Data https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

Rogner, H.-H., Zhou, D., Bradley, R., Crabbé, P., Edenhofer, O., Hare, B., . . . Yamaguchi, M. (2007). Introduction. In B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, & L. A. Meyer (Eds.), *Climate Change 2007: Mitigation contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Intergovernmental Panel on Climate Change* (pp. 94-116). Cambridge, United Kingdom/New York: Cambridge University Press.

Ruffing, K. (2007). Indicators to Measure Decoupling of Environmental Pressure from Economic Growth. In T. Hák, B. Moldan, & A. L. Dahl (Eds.), *Sustainability indicators: A scientific assessment* (Vol. 67, pp. 211-222). Washington: Island Press.

Regulating industrial forest concessions in Central Africa and South America, 2008a. . Forest Ecology and Management 256, 1498–1508. https://doi.org/10.1016/j.foreco.2008.07.001

Regulating industrial forest concessions in Central Africa and South America, 2008b. . Forest Ecology and Management 256, 1498–1508. https://doi.org/10.1016/j.foreco.2008.07.001

Rodríguez, M., Robaina, M., Teotónio, C., 2019. Sectoral effects of a Green Tax Reform in Portugal. Renewable and Sustainable Energy Reviews 104. https://doi.org/10.1016/j.rser.2019.01.016

Sandmo, A., 2011. Atmospheric externalities and environmental taxation. Energy Economics, Supplemental Issue: Fourth Atlantic Workshop in Energy and Environmental Economics 33, S4–S12. https://doi.org/10.1016/j.eneco.2011.07.021

Sandmo, A., 1975. Optimal Taxation in the Presence of Externalities. The Swedish Journal of Economics 77, 86–98. https://doi.org/10.2307/3439329

Sane, M., Hajek, M., Nwaogu, C., & Purwestri, R. C. (2021). Subsidy as an economic instrument for environmental protection: A case of global fertilizer use. *Sustainability, 13*(16), 1-20. doi:10.3390/su13169408

Sathaye, J., Makundi, W., Dale, L., Chan, P., & Andrasko, K. (2005). GHG Mitigation Potential, Costs and Benefits in Global Forests: A Dynamic Partial Equilibrium Approach. In: Lawrence Berkeley National Lab.

Scrieciu, S. S. (2007). Can economic causes of tropical deforestation be identified at a global level? *Ecological Economics, 62*(3-4), 603-612. doi:10.1016/j.ecolecon.2006.07.028

Seo, S. N. (2016). Modeling farmer adaptations to climate change in South America: A micro-behavioral economic perspective. *Environmental and Ecological Statistics, 23*(1), 1-21. doi:10.1007/s10651-015-0320-0

Shah, A., & Larsen, B. (2014). Carbon taxes, the greenhouse effect, and developing countries. *Annals of Economics and Finance, 15*(1), 353-402.

Shittu, W. O., Musibau, H., & Hassan, S. (2018). Revisiting the environmental Kuznets curve in Malaysia: The interactive roles of deforestation and urbanisation. *International Journal of Green Economics, 12*(3-4), 272-293. doi:10.1504/ijge.2018.097872

Statistical Office of the European Communities. (2010). *Environmental Statistics and Accounts in Europe*. Luxembourg: Publications Office of the European Union.

Stavins, R. N. (1996). Correlated uncertainty and policy instrument choice. *Journal of environmental economics and management, 30*(2), 218-232. doi:10.1006/jeem.1996.0015

Stern, N. (2006). Stern Review: The economics of climate change. Retrieved from https://www.osti.gov/etdeweb/biblio/20838308

Stern, N., & Stiglitz, J. E. (2017). *Report of the High-Level Commission on Carbon Prices.* Retrieved from Washington, D.C:

Strassburg, B., Turner, R. K., Fisher, B., Schaeffer, R., & Lovett, A. (2009). Reducing emissions from deforestation—The "combined incentives" mechanism and empirical simulations. *Global Environmental Change, 19*(2), 265-278. doi:10.1016/j.gloenvcha.2008.11.004

Schwidrowski, A., Thomas, S., n.d. Forestry Taxation in Africa: The Case of Liberia.

Schwidrowski, S.T., Arnim, n.d. Forestry Taxation in Africa: The Case of Liberia [WWW Document]. IMF. URL https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Forestry-Taxation-in-Africa-The-Case-of-Liberia-18424 (accessed 1.1.23).

Sensor-based Big Data Applications and Computationally Networked Urbanism in Smart Energy Management Systems, 2020. . Geopol. Hist. Int. Relat. 12, 52. https://doi.org/10.22381/GHIR12120203

Shahzad, U., 2020. Environmental taxes, energy consumption, and environmental quality: Theoretical survey with policy implications. Environmental Science and Pollution Research 27, 24848–24862.

Shi, X., Xu, Z., 2018. Environmental regulation and firm exports: Evidence from the eleventh Five-Year Plan in China. Journal of Environmental Economics and Management 89, 187–200. https://doi.org/10.1016/j.jeem.2018.03.003

Sierra, R., Russman, E., 2006. On the efficiency of environmental service payments: A forest conservation assessment in the Osa Peninsula, Costa Rica. Ecological Economics 59, 131–141. https://doi.org/10.1016/j.ecolecon.2005.10.010

Siry, J.P., Cubbage, F.W., Ahmed, M.R., 2005. Sustainable forest management: global trends and opportunities. Forest Policy and Economics 7, 551–561. https://doi.org/10.1016/j.forpol.2003.09.003

Sloan, S., 2014a. Indonesia's moratorium on new forest licenses: An update. Land Use Policy 38, 37–40. https://doi.org/10.1016/j.landusepol.2013.10.018

Sloan, S., 2014b. Indonesia's moratorium on new forest licenses: An update. Land Use Policy 38, 37–40. https://doi.org/10.1016/j.landusepol.2013.10.018

Social Dilemma Overview & Examples | What is a Social Dilemma? [WWW Document], n.d. . study.com. URL https://study.com/academy/lesson/social-dilemma-overview-examples.html (accessed 1.7.23).

Soil erosion in developing countries: a socio-economic appraisal, 2003. . Journal of Environmental Management 68, 343–353. https://doi.org/10.1016/S0301-4797(03)00082-3

Song, X.-P., Hansen, M.C., Stehman, S.V., Potapov, P.V., Tyukavina, A., Vermote, E.F., Townshend, J.R., 2018. Global land change from 1982 to 2016. Nature 560, 639–643. https://doi.org/10.1038/s41586-018-0411-9

Song, Y., Zenou, Y., 2006. Property tax and urban sprawl: Theory and implications for US cities. Journal of Urban Economics 60, 519–534. https://doi.org/10.1016/j.jue.2006.05.001

Sterner, T., 1994a. Environmental tax reform: the Swedish experience. European Environment 4, 20–25.

Sterner, T., 1994b. Environmental tax reform: the Swedish experience. European Environment 4, 20–25.

Sterner, T., 1994c. Environmental tax reform: the Swedish experience. European Environment 4, 20–25.

Sterner, T., 1994d. Environmental tax reform: the Swedish experience. European Environment 4, 20–25.

Streck, C., 2020. Who Owns REDD+? Carbon Markets, Carbon Rights and Entitlements to REDD+ Finance. Forests 11, 959. https://doi.org/10.3390/f11090959

Strengthening forest protection policies in West Africa through improved capacities and commitments [WWW Document], n.d. . Tropenbos International. URL https://www.tropenbos.org/news/strengthening+forest+protection+policies+in+west+africa+through+improved+capacities+and+commitments+ (accessed 1.1.23).

Sun, X., Ren, J., Wang, Y., 2022. The impact of resource taxation on resource curse: Evidence from Chinese resource tax policy. Resources Policy 78, 102883. https://doi.org/10.1016/j.resourpol.2022.102883

Susswein, P.M., 2003a. The Use of Market Based Economic Instruments for Sustainable Environmental Management in Africa: A Case Study of the SADC Region. International Environmental Law and Policy in Africa 297–325. https://doi.org/10.1007/978-94-017-0135-8_14

Susswein, P.M., 2003b. The Use of Market Based Economic Instruments for Sustainable Environmental Management in Africa: A Case Study of the SADC Region. International Environmental Law and Policy in Africa 297–325. https://doi.org/10.1007/978-94-017-0135-8_14

Tacconi, L., Muttaqin, M.Z., 2019. Policy forum: Institutional architecture and activities to reduce emissions from forests in Indonesia. Forest Policy and Economics, Assessing policies to reduce emissions from land use change in Indonesia 108, 101980. https://doi.org/10.1016/j.forpol.2019.101980

Tan, Z., Wu, Y., Gu, Y., Liu, T., Wang, W., Liu, X., 2022. An overview on implementation of environmental tax and related economic instruments in typical countries. Journal of Cleaner Production 330, 129688. https://doi.org/10.1016/j.jclepro.2021.129688

Tang, G.P., Li, L.H. and Wu, D.J. (2013) Environmental Regulation, Industry Attributes and Environmental Protection Investment of Enterprises. Accounting Research, 6, 83-89 + 96. - References - Scientific Research Publishing [WWW Document], n.d. URL https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=2670771 (accessed 1.8.23).

Taranu, V., Verbeeck, G., 2022. Property tax as a policy against urban sprawl. Land Use Policy 122, 106335. https://doi.org/10.1016/j.landusepol.2022.106335

Tax evasion and optimal environmental taxes - ScienceDirect [WWW Document], n.d. URL https://www.sciencedirect.com/science/article/abs/pii/S0095069613000454 (accessed 1.5.23).

Tamirisa, N. (2008). Climate change and the global economy. *Finance & Development, 45*(1), 18-22. doi:10.5089/9781451922349.022

The Economic Efficiency of Forest Taxes | Semantic Scholar [WWW Document], n.d. URL https://www.semanticscholar.org/paper/The-Economic-Efficiency-of-Forest-Taxes-Gamponia-Mendelsohn/f682d327937013d47f666f5d6642830a6a976e28 (accessed 1.8.23a).

The Effect of Taxation on Available Resources of Forest Enterprises [WWW Document], n.d. . ResearchGate. URL https://www.researchgate.net/publication/280489534_The_Effect_of_Taxation_on_Available_Resources_of_Forest_Enterprises (accessed 1.3.23).

The Economic Efficiency of Forest Taxes | Semantic Scholar [WWW Document], n.d. URL https://www.semanticscholar.org/paper/The-Economic-Efficiency-of-Forest-Taxes-Gamponia-Mendelsohn/f682d327937013d47f666f5d6642830a6a976e28 (accessed 1.8.23b).

The Geopolitics of Renewable Hydrogen in Low-Carbon Energy Markets, 2020. . Geopol. Hist. Int. Relat. 12, 7. https://doi.org/10.22381/GHIR12120201

The role of fiscal instruments in encouraging the private sector and smallholders to reduce emissions from deforestation and forest degradation: Evidence from Indonesia, 2019. . Forest Policy and Economics 108, 101913. https://doi.org/10.1016/j.forpol.2019.04.017

The role of fiscal instruments in encouraging the private sector and smallholders to reduce emissions from deforestation and forest degradation: Evidence from Indonesia | Semantic Scholar [WWW Document], n.d. URL https://www.semanticscholar.org/paper/The-role-of-fiscal-instruments-in-encouraging-the-Cadman-Sarker/1ba754f96c062dafc7011043e5227027369b174f (accessed 1.4.23).

Thomas, S., Schwidrowski, A., 2005. Forestry Taxation in Africa: The Case of Liberia. IMF Working Papers 2005. https://doi.org/10.5089/9781451861754.001.A001

Thomas, S., SThomas@imf.org, Schwidrowski, A., ASchwidrowski@imf.org, 2005. Forestry Taxation in Africa: The Case of Liberia. IMF Working Papers 05, 1. https://doi.org/10.5089/9781451861754.001

Thurston, H.W., Burness, H.S., 2006. Promoting sustainable logging in Brazil's national forests: Tax revenue for an indemnity fund. Forest Policy and Economics 9, 50–62. https://doi.org/10.1016/j.forpol.2005.02.003

Topa, G., 2006. The role of development partners in Africa: a forestry perspective on benefits, problems and trends, in: International Forestry Review. pp. 145–152. https://doi.org/10.1505/ifor.8.1.145

Topa, G., Karsenty, A., Megevand, C., Debroux, L., 2009. The Rain Forests of Cameroon: Experience and Evidence from a Decade of Reform. World Bank Publications.

Topa, G., Pendleton, L., 1998a. Policy and fiscal instruments for production forestry in humid tropical Africa. mimeo.

Topa, G., Pendleton, L., 1998b. Policy and fiscal instruments for production forestry in humid tropical Africa. mimeo.

Uchiyama, Y., Kohsaka, R., 2016. Analysis of the Distribution of Forest Management Areas by the Forest Environmental Tax in Ishikawa Prefecture, Japan. International Journal of Forestry Research 2016, e4701058. https://doi.org/10.1155/2016/4701058

Uusivuori, J., Kuuluvainen, J., 2008. Forest taxation in multiple-stand forestry with amenity preferences. Can. J. For. Res. 38, 806–820. https://doi.org/10.1139/X07-123

U.S. Energy Information Administration. (2022). Total Primary Energy Annual. from U.S. Energy Information Administration

Uddin, R., Philipsborn, R., Smith, D., Mutic, A., & Thompson, L. M. (2021). A global child health perspective on climate change, migration and human rights. *Current Problems in Pediatric and Adolescent Health Care, 51*(6), 101029. doi:10.1016/j.cppeds.2021.101029

Ullah, A., Khan, D., Khan, I., & Zheng, S. (2018). Does agricultural ecosystem cause environmental pollution in Pakistan? Promise and menace. *Environmental Science and Pollution Research, 25*(14), 13938-13955. doi:10.1007/s11356-018-1530-4

United Nations Environment Programme. (2016) Global Material Flows and Resource Productivity. An Assessment Report for the UNEP International Resource Panel. In, (pp. 200). Paris: United Nations Environment Programme.

United Nations Environment Programme. (2019) Emissions Gap Report 2019. In, (pp. 108). Nairobi: United Nations Environment Programme,.

United Nations Environment Programme. (2022) Emissions Gap Report 2022. In. *The Closing Window Climate Crisis Calls for Rapid Transformation of Societies* (pp. 132). Nairobi: United Nations Environment Programme,.

United Nations Framework Convention on Climate Change. (2015). *Adoption of the Paris Agreement.* Paper presented at the 21st Conference of the Parties, United Nations Framework Convention on Climate Change, Paris.

van der Werf, G.R., Dempewolf, J., Trigg, S.N., Randerson, J.T., Kasibhatla, P.S., Giglio, L., Murdiyarso, D., Peters, W., Morton, D.C., Collatz, G.J., Dolman, A.J., Defries, R.S., 2008a. Climate regulation of fire emissions and deforestation in equatorial Asia. Proceedings of the National Academy of Science of the United States of America 105, 20350–20355. https://doi.org/10.1073/pnas.0803375105

van der Werf, G.R., Dempewolf, J., Trigg, S.N., Randerson, J.T., Kasibhatla, P.S., Giglio, L., Murdiyarso, D., Peters, W., Morton, D.C., Collatz, G.J., Dolman, A.J., Defries, R.S., 2008b. Climate regulation of fire emissions and deforestation in equatorial Asia. Proceedings of the National Academy of Science of the United States of America 105, 20350–20355. https://doi.org/10.1073/pnas.0803375105

van Kooten, G.C., Binkley, C.S., Delcourt, G., 1995. Effect of Carbon Taxes and Subsidies on Optimal Forest Rotation Age and Supply of Carbon Services. American Journal of Agricultural Economics 77, 365–374. https://doi.org/10.2307/1243546

Van, P. N., & Azomahou, T. (2007). Nonlinearities and heterogeneity in environmental quality: An empirical analysis of deforestation. *Journal of Development Economics, 84*(1), 291-309. doi:10.1016/j.jdeveco.2005.10.004

Vancutsem, C., Achard, F., Pekel, J.-F., Vieilledent, G., Carboni, S., Simonetti, D., . . . Nasi, R. (2021). Long-term (1990–2019) monitoring of forest cover changes in the humid tropics. *Science Advances, 7*(10), 1-21. doi:10.1126/sciadv.abe1603

Vo, A. T., Vo, D. H., & Le, Q. T.-T. (2019). CO2 emissions, energy consumption, and economic growth: New evidence in the ASEAN countries. *Journal of Risk and Financial Management, 12*(3), 145. doi:10.3390/jrfm12030145

von Moltke, A. (2004). *The Use of Economic Instruments in Environmental Policy: Opportunities and Challenges*: United Nations Publication.

Vejchodská, E., Pelucha, M., 2019. Environmental charges as drivers of soil sealing? The case of the Czech charge for agricultural land loss. Land Use Policy 87, 104071. https://doi.org/10.1016/j.landusepol.2019.104071

Viszlai, I., Hajdúchová, I., 2015. The Effect of Taxation on Available Resources of Forest Enterprises. https://doi.org/10.5593/SGEM2015/B53/S21.084

Vojtech, V., 2010. Policy measures addressing agri-environmental issues.

Wang, K., Zhang, H.-M., Tsai, S.-B., Wu, L.-D., Xue, K.-K., Fan, H.-J., Zhou, J., Chen, Q., 2018. Does a Board Chairman's Political Connection Affect Green Investment?—From a Sustainable Perspective. Sustainability 10, 582. https://doi.org/10.3390/su10030582

Wang, Y., Yu, L., 2021. Can the current environmental tax rate promote green technology innovation? - Evidence from China's resource-based industries. Journal of Cleaner Production 278, 123443. https://doi.org/10.1016/j.jclepro.2020.123443

Waheed, R., Chang, D., Sarwar, S., & Chen, W. (2018). Forest, agriculture, renewable energy, and CO2 emission. *Journal of Cleaner Production, 172*, 4231-4238. doi:10.1016/j.jclepro.2017.10.287

Walls, M. (2011). Deposit-refund systems in practice and theory. *Encyclopedia of Energy, Natural Resource, and Environmental Economics*(11-47). doi:10.1016/b978-0-12-375067-9.00035-8

Wang, Z., Zhang, B., & Zeng, H. (2016). The effect of environmental regulation on external trade: Empirical evidences from Chinese economy. *Journal of Cleaner Production, 114*, 55-61. doi:10.1016/j.jclepro.2015.07.148

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, Massachusetts: Massachusetts Institute of Technology Press.

World Bank. (2020). *State and Trends of Carbon Pricing 2020*. Washington, D.C: World Bank.

World Bank Group. (2019). *State and Trends of Carbon Pricing 2019*. Washington, D.C: World Bank.

Wu, H., Hao, Y., & Ren, S. (2020). How do environmental regulation and environmental decentralization affect green total factor energy efficiency: Evidence from China. *Energy Economics, 91*, 104880. doi:10.1016/j.eneco.2020.104880

Wu, H., Xu, L., Ren, S., Hao, Y., & Yan, G. (2020). How do energy consumption and environmental regulation affect carbon emissions in China? New evidence from a dynamic threshold panel model. *Resources Policy, 67*, 101678. doi:10.1016/j.resourpol.2020.101678

Whiteman, A., 2001. An Appraisal of the Licensing and Forest Revenue System in Zambia. Forest Finance Working Paper FSFM/MISC/04, Food and Agricultural Organization, Rome. ftp://ftp. fao. org/docrep/fao/003/X6824E/X6824E00. pdf.

William R. Hawkins [WWW Document], n.d. . U.S. Naval Institute. URL https://www.usni.org/people/william-r-hawkins (accessed 1.9.23).

Xu, J., Hyde, W.F., 2019. China's second round of forest reforms: Observations for China and implications globally. Forest Policy and Economics, The experience of China's forest reforms: What they mean for China and what they suggest for the world? 98, 19–29. https://doi.org/10.1016/j.forpol.2018.04.007

Xu, S.-C., & Long, R.-y. (2014). Empirical research on the effects of carbon taxes on economy and carbon emissions in China. *Environmental Engineering & Management Journal (EEMJ), 13*(5). doi:10.30638/eemj.2014.112

Xu, X., & Ang, B. (2014). Analysing residential energy consumption using index decomposition analysis. *Applied Energy, 113*, 342-351. doi:10.1016/j.apenergy.2013.07.052

Yang, M., Fan, Y., Yang, F., & Hu, H. (2014). Regional disparities in carbon dioxide reduction from China's uniform carbon tax: a perspective on interfactor/interfuel substitution. *Energy, 74*, 131-139. doi:10.1016/j.energy.2014.04.056

Yao, X., Huang, R., & Song, M. (2019). How to reduce carbon emissions of small and medium enterprises (SMEs) by knowledge sharing in China. *Production Planning & Control, 30*(10-12), 881-892. doi:10.1080/09537287.2019.1582096

Yang, M., Fan, Y., Yang, F., & Hu, H. (2014). Regional disparities in carbon dioxide reduction from China's uniform carbon tax: a perspective on interfactor/interfuel substitution. *Energy, 74*, 131-139. doi:10.1016/j.energy.2014.04.056

Yao, X., Huang, R., & Song, M. (2019). How to reduce carbon emissions of small and medium enterprises (SMEs) by knowledge sharing in China. *Production Planning & Control, 30*(10-12), 881-892. doi:10.1080/09537287.2019.1582096

Yip, C.M., 2018. On the labor market consequences of environmental taxes. Journal of Environmental Economics and Management 89, 136–152. https://doi.org/10.1016/j.jeem.2018.03.004

Zhao, X., Yin, H., & Zhao, Y. (2015). Impact of environmental regulations on the efficiency and CO2 emissions of power plants in China. *Applied Energy, 149*, 238-247. doi:10.1016/j.apenergy.2015.03.112

Zmami, M., & Ben-Salha, O. (2020). An empirical analysis of the determinants of CO2 emissions in GCC countries. *International Journal of Sustainable Development & World Ecology, 27*(5), 469-480. doi:10.1080/13504509.2020.1715508

Zhurakovska, I., Sydorenko, R., Fuhelo, P., Khomenko, L., Sokrovolska, N., 2021. THE IMPACT OF TAXES ON THE REPRODUCTION OF NATURAL FOREST RESOURCES IN UKRAINE. Independent Journal of Management & Production 12, 108–122. https://doi.org/10.14807/ijmp.v12i3.1511

Гарасим, П.М., Клім, Н.М., Хом'як, Р.Л., 2022. Особливості оподаткування лісогосподарських підприємств. Економіка, підприємництво, менеджмент 55–62.