Transdisciplianry Journal of Education and Sustainable Development Studies, Vol. 1, No. 1, April 2025
A publication of the Department of Education Geography & Sustainable Development Studies, ISSN: 1595-8051
University of Calabar, Nigeria.

Assessing the Impact of Sustainable Forest Management Practices on Climate Change Mitigation in Cross River State: An Evaluation of Selective Exploitation and Reafforestation Efforts

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ABSTRACT

The study is on Assessing the Impact of Sustainable Forest Management Practices on Climate Change Mitigation in Cross River State: An Evaluation of Selective Exploitation and Reafforestation Efforts. This study specifically examined the relationship between selective exploitation, reafforestation and climate change mitigation in Cross River State. Two research questions and two hypotheses were raided in line with the objectives of the study. The population of the study consists of 9018 residents consisting of 4397 adult males and 4621 females. The design employed was survey research design. The sample of this study was eight hundred and sixty-five (865) respondents. The instrument for data collection was a 35-item questionnaire titled "Sustainable Forest Resources Management and Climate Change Mitigation Questionnaire" (SFRMCCMQ). The instrument was face and construct validated by two experts from Educational Foundation (Measurement and Evaluation and one from Environmental Education Department, University of Calabar, Calabar Cross River State. The reliability coefficient ranges between 0.72 and 0.85 was obtained using Cronbach Alpha reliability method statistics and was high enough to accept that the instrument was reliable. The simple regression analysis was employed to analyze the five hypotheses in the study. The findings revealed that: there is a significant relationship between selective exploitation, reafforestation on climate change mitigation Cross River State. It was recommended that the farmers should form a formidable and strong association who in conjunction with the Cross River State government to promote selective exploitation as a sustainable forest management practice to mitigate climate change. This can be achieved by providing incentives to forest concessionaires who adopt selective exploitation methods and the farmers should establish a reafforestation program to restore degraded forests and promote carbon sequestration. They should include local communities who then pull their resources/funds together to provide them with economic benefits for participating in reafforestation efforts.

Keywords: Sustainable Forest Management Practices, Climate Change, Mitigation, Selective Exploitation, Reafforestation Efforts.

Introduction

The main cause of climate change has been attributed to anthropogenic (human) activities. For example, the increased industrialization in many nations has led to the introduction of large quantities of greenhouse gases (GHGs), including carbon (IV) oxide (CO2), methane (CH4) and nitrous oxide (N2O) into the atmosphere. Climate change refers to any change in

climate over time, whether due to natural variability or as a result of human activity (Nnaji, 2012). It refers to a change in weather which is attributed directly or indirectly to human activities, that alters the composition of the global atmosphere in addition to natural variability observed over comparable time periods (Intergovernmental Panel on Climate Change IPCC (2007)

Climate change has become a global issue in recent times manifesting in variations of different climate parameters including cloud cover, precipitation, temperature ranges, sea levels and vapour pressure (Ministry of Environment of the Federal Republic of Nigeria, 2003). The variations in climate parameters affect different sectors of the economy such as agriculture, health, water resources, energy among others. According to the Intergovernmental Panel on Climate Change (2007) effects that scientists had long predicted would result from global warming, such as, sea ice loss, accelerated sea level rise and longer, more intense heat waves. Climate change according to Courtney (2022) is our planets' greatest existential threat, making events like droughts, hurricanes and floods more intense and unpredictable and results to, melting sea ice, sea level rise, flooding, droughts and so on.

Mitigating climate change means reducing the flow of heat-trapping greenhouse gases into the atmosphere. This involves cutting greenhouse gases from main sources such as power plants, factories, cars, and farms. Forests, oceans, and soil also absorb and store these gases, and are an important part of the solution. Reducing and avoiding our emissions requires us to reshape everything we do from how we power our economy and grow our food, to how we travel and live, and the products we consume. Climate change is a pressing issue with far-reaching consequences, affecting communities worldwide. Over the past few decades, the European Union has taken decisive action to mitigate its impact. Notably, EU emissions decreased by more than 31% in 2022 compared to 1990 levels. This significant reduction can be attributed to the increased adoption of renewable energy sources and a decline in the use of carbon-intensive fossil fuels. Additionally, enhancements in energy efficiency and structural changes within the economy have contributed to achieving these goals (Morghadiya & Smarden, 2019)

Climate change mitigation deals with actions that are designed to reduce or prevent emissions of GHG causing human-induced climate change. Mitigation of climate change can be attained by harnessing new technologies, promoting renewable energies, improving efficiency of older energy systems, or changing management practices or consumer behavior. According to the Intergovernmental Panel on Climate Change (IPCC, 2017), mitigation is the

effort to control the human sources of green house gases and their cumulative impacts, notably the emission of GHGs and other pollutants, such as black carbon particles, that also impact the planet's energy balance.

Mitigation also includes efforts to enhance the processes that remove GHGs from the atmosphere, known as sinks. Mitigation of climate change is delineated as human intervention to reduce the sources or enhance the sinks of GHGs. This report also assesses human interventions to reduce the sources of other substances which may contribute directly or indirectly to limiting climate change, including the reduction of PM emissions that can directly alter the radiation balance (e.g., black carbon) or measures that control emissions of carbon monoxide, nitrogen oxides (NO_x), volatile organic compounds (VOCs) and other pollutants that can alter the concentration of tropospheric ozone (O_3) which has an indirect effect on the climate" (Angelsen &Wunder, 2023).). Owing to mitigation's potential in lowering the projected impacts of climate change along with the risks of extreme weather impacts, mitigation constitutes part of a broader policy strategy that encompasses adaptation to already occurring climate change impacts; therefore, adaptation and mitigation are often considered holistically as two faces of the same effort to combat the negative impacts of climate change.

In the southern region of Nigeria, Cross River State is home to over 50% of the remaining forest of the country, comprising vast areas of tropical high forest, montane forest, savannas, and saltwater swamps. Nigeria has the largest mangrove ecosystem in Africa. The Cross River Forest is recognized as one of the world's 25 biodiversity hotspots, where three quarters of the state population (4.5 million) is largely dependent on the forest for every-day life. Despite this, the region has faced one of the globe's highest deforestation rates, increasing at 2.7% between 1990-2000, rising to 2.95% between 2007-2014 (Nnaji, 2012). This is mainly due to illegal logging, expansive agriculture, both smallholder and commercial agriculture, unsustainable fuelwood harvesting, oil and mineral exploration, as well as infrastructure development. As a result, climate change mitigation and adaptation are mainstreamed in the state's sustainable forest management plans and development strategies, and form an essential part of Cross River State's Climate Action Plan (Government of Cross River State, 2020).

Cross River State, Nigeria, is home to a vast array of forest resources that provide essential ecosystem services and support local livelihoods. However, these forests face numerous threats, including deforestation, over-exploitation, and climate change. Sustainable

forest resource management offers a solution, balancing the economic, social, and ecological values of forests to ensure their long-term health and productivity. This approach prioritizes responsible land-use practices, biodiversity conservation, and community engagement, ultimately contributing to a more climate-resilient future for Cross River State. By adopting sustainable forest management strategies, the state can protect its natural heritage while promoting economic development and improving the well-being of its citizens (Kolawole, 2015)

It is against this background that the researcher was poised to study the relationship between sustainable forest resource management activities and climate change mitigation in Cross River State, Nigeria, to ascertain the applicability of climate change mitigation and ensure the sustainability of the forests. The researcher considers variables such as selective exploitation and reafforestation as factors of sustainable forest resource management activities that could have relationship with climate change mitigation in Cross River State, Nigeria.

Putz, Zuidema, Synnott, Pena-Claros, Pinard, Sheil and Vanclay (2018) conducted a study on the impacts of selective logging on tropical forest ecosystems. The study concludes that selective logging can be compatible with biodiversity conservation, but only if best management practices are employed. Additionally, the study highlights the importance of considering the long-term impacts of selective logging on tropical forest ecosystems. The findings of the study have significant implications for forest management and conservation policy in tropical regions. Overall, the study provides valuable insights into the impacts of selective logging on tropical forest ecosystems.

Roberto, Simona, Jeremy, David, Marco, Ariannm Francisco and Riccardo (2017) carried out a study on the impact of selective logging and clearcutting on forest structure, tree diversity and above-ground biomass of African tropical forests. The authors show that the effects of selective logging are greater than those expected simply from the removal of commercial species, and can persist for decades. Selective logging, unless it is practiced at very low harvest intensities, can significantly reduce the bio- mass of a tropical forest for many decades, seriously diminishing aboveground carbon storage capacity, and create opportunities for weeds and vines to spread and slow down the ecological succession and therefore affection potential food security.

Angelsen and Wunder (2018) stated that reafforestation consists in recovering forested areas destroyed in recent times by planting new trees and sowing seeds from tree

species, among other strategies. According to the authors reafforestation is the major solution to two of the phenomena that most impact the deterioration of the earth: desertification and deforestation. Reforestation is therefore the process of planting trees in a forest where the number of trees has been decreasing. Afforestation is when new trees are planted or seeds are sown in an area where there were no trees before, creating a new forest. There has been a significant shift in focus from encouraging natural forest extraction to forest plantation establishment in many parts of the tropics (Angelsen & Wunder, 2018). Promotion of forest plantation establishment has included smallholder tree growing on-farms

Purpose of the Study

1. ascertain the extent to which selective exploitation relates to climate change mitigation in Cross River State.
2. examine the relationship between reafforestation and climate change mitigation in Cross River State.

Statement of the problem

Cross River State faces significant challenges in balancing sustainable forest resource management with climate change mitigation efforts. Despite being home to diverse ecosystems and critical biodiversity hotspots, the region's forests are under increasing pressure due to deforestation, unsustainable logging practices, and land-use changes driven by a growing population and economic activities. These activities not only threaten the ecological integrity of the region but also contribute to greenhouse gas emissions, thereby exacerbating the impacts of climate change.

The current management practices in Cross River State often lack the necessary integration of sustainable forest management principles and climate change mitigation strategies. This disconnect hinders the state's ability to maximize the potential of its forests as a crucial carbon sink and natural climate solution. Furthermore, inadequate policies, weak enforcement mechanisms, limited stakeholder engagement, and insufficient funding further compound the challenges of effectively managing forest resources in a sustainable manner while mitigating climate change impacts.

The interplay between unsustainable forest management practices and climate change in Cross River State calls for a comprehensive and integrated approach that addresses the complex interactions between environmental conservation, community livelihoods, and

climate resilience. Without urgent intervention and targeted strategies that reconcile the dual objectives of sustainable forest resource management and climate change mitigation, the state risks losing its invaluable forests, compromising biodiversity, and exacerbating the adverse impacts of climate change on both ecosystems and local communities.

The government of Cross River State had taken several steps to address the issue of deforestation and promote sustainable forest management. The government established the Cross River State Forestry Commission to oversee the management of forests in the state. The state government has also created the Cross River National Park, which covers an area of over 4,000 square kilometers and is home to a diverse range of flora and fauna. Additionally, the government has implemented policies to prevent deforestation, including the prohibition of logging in certain areas and the introduction of sustainable forest management practices. The state government has also partnered with international organizations, such as the United Nations Development Programme (UNDP), to support sustainable forest management and biodiversity conservation efforts. Furthermore, the government has established community-led forest management initiatives, which empower local communities to take ownership of forest management and conservation efforts. Despite these efforts, the rate of deforestation and forest degradation in Cross River State remains high, and the state's forests continue to face significant threats. Therefore, this study aims to investigate the current state of sustainable forest resource management practices and climate change mitigation in Cross River State, with a view to identifying strategies for improving the effectiveness of these efforts

Theoretical framework

Abraham Maslow's Hierarchy of Needs Theory (1954)

The Hierarchy of need theory was propounded by Abraham Maslow's (1954). Maslow's hierarchy of needs is a theory of psychology explaining human motivation based on the pursuit of different levels of needs. The theory states that humans are motivated to fulfill their needs in a hierarchical order. This order begins with the most basic needs before moving on to more advanced needs. The ultimate goal, according to this theory, is to reach the fifth level of the hierarchy: self-actualization. These needs make up five basic needs which are the major reasons for environmental resource depletion and degradation and subsequent climate change.

These needs are physiological needs, safety needs, social needs, esteem needs and self-actualization needs. Our concern is on the physiological needs which represent basic needs such as food, water, clothing, shelter, oxygen, sex and elimination of waste products. These are also called biological biogenic or survival needs. Safety needs come in once physiological needs are satisfied. Safety needs include danger, economic security and job security. So, when physiological need has been satisfied to a certain extent, safety needs become the most dominant controller of human beings These two needs become the most paramount to living organisms. As earlier stated, there are five main levels to Maslow's hierarchy of needs. These levels begin from the most basic needs to the most advanced needs. Maslow originally believed that a person needed to completely satisfy one level to begin pursuing further levels. A more modern perspective is that these levels overlap. As a person reaches higher levels, their motivation is directed more towards these levels. However, though their main focus is on higher levels, they will still continue to pursue lower levels of the hierarchy but with less intensity.

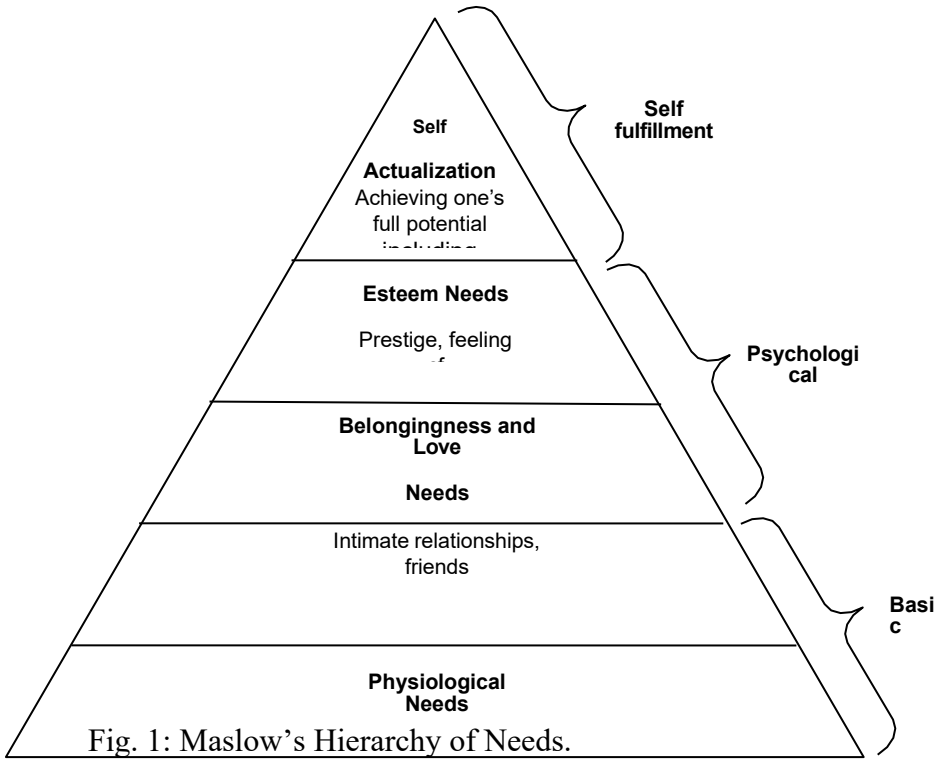

Fig. 1: Maslow's Hierarchy of Needs.

The implication of Maslow's needs theory to this study is that, since man according to Maslow is a wanting being, and there are always some needs he will always want to satisfy, and he sees forest resources as free gift for exploitation, this simply implies that once a

particular resource is exploited to his satisfaction, that resource no longer motivates him, he turns to another resource seeking for satisfaction, and the quest to exploit other resources continues and will lead to overexploitation of forest resources and subsequently lead to climate change as a result of much removal of plant species that help control global warming.

Research Questions

1. To what extent do male and female students differ in Mathematics phobia among students in senior secondary school in Nnewi Education Zone of Anambra State, Nigeria?
2. To what extent do male and female students differ in their willingness to study sciences in senior secondary school in Nnewi Education Zone of Anambra State, Nigeria?

Research Hypotheses

1. To what extent does which selective exploitation relate to climate change mitigation in Cross River State?
2. How does reafforestation relate to climate change mitigation in Cross River State?

Methodology

Survey research design was adopted for this study. Isangedighi, Joshua, Asim and Ekuri (2004) asserted that" Survey research design involves the collection of data to accurately and objectively describe existing phenomena. Studies that make use of this design, employed it to obtain a picture of the present condition of a particular phenomenon. The population of the study consists of 9018 residents consisting of 4397 adult males and 4621 females. The design employed was survey research design. The sample of this study was eight hundred and sixty-five (865) respondents. The instrument for data collection was a 35-item questionnaire titled "Sustainable Forest Resources Management and Climate Change Mitigation Questionnaire" (SFRMCCMQ). The instrument was face and construct validated by two experts from Educational Foundation (Measurement and Evaluation and one from Environmental Education Department, University of Calabar, Calabar Cross River State. The reliability coefficient ranges between 0.72 and 0.85 was obtained using Cronbach Alpha reliability method statistics and was high enough to accept that the instrument was reliable. Multistage sampling procedure was adopted in the selection of sample for the study. First the

purposive sampling technique was used to select various local government areas within Cross River state with tropical high forest, this is because there is concentration of forest in some areas than others in the study area. After selecting the local government areas, the next step was the choice of one village from each of these densely forested areas. The selected villages, nestled deep within the forest, served as a representative of the local government areas, The simple regression analysis was employed to analyze the five hypotheses in the study.

Results

Hypothesis 1

There is no significant relationship between selective exploitation and climate change mitigation in Cross River State.

TABLE 1: Simple regression analysis of relationship between selective exploitation and climate change mitigation in Cross River State (N=.865)

Source of variation	SS	Df	MS	F-ratio	p-value
Regression	44.793	1	44.793	10.247	.001[b]
Residual	2461.023	863	4.371		
Total	2505.816	864			

*Significant at .05 level. R = .134; R^2 =.018; Adj R^2=.016

To test this hypothesis, simple regression statistical analysis was used and the result as presented in Table 6. The analysis in Table 6 showed that the Adj R^2 is 0.016. This implies that 1.6% of the variance in the dependent variable (climate change mitigation) could be accounted for by selective exploitation. Though the percentage contribution is small, a cursory look at the table showed that the F=0 10.247 (p<.001) is significant at .05 level of significance and 1 and 863 degrees of freedom. And since p (.001) is less than p (.05), it implies that there is a significant relationship between selective exploitation and climate change mitigation in Cross River State. Hence the null hypothesis is rejected and alternative hypothesis upheld

.Hypothesis 2: There is no significant relationship between reafforestation and climate change mitigation in Cross River State.

TABLE 2: Simple regression analysis of relationship between reafforestation and climate change mitigation in Cross River State (N=.865)

Source of variation	SS	Df	MS	F-ratio	Sig.

Regression	19.247	1	19.247	4.358	.037[b]
Residual	2486.569	863	4.417		
Total	2505.816	864			

*Significant at .05 level. R = .088; R^2 =.008; Adj R^2=.006

To test this hypothesis, simple regression statistical analysis was used and the result as presented in Table 8. The analysis in Table 8 showed that the Adj R^2 is 0.014. This implies that 1.4% of the variance in the dependent variable (climate change mitigation) could be accounted for by agroforestry. However, though the percentage contribution is small, a careful observation of the table indicated that F-value of 8.73 ($p<.05$) is significant at .05 level of significance and 1 and 863 degrees of freedom. Equally, since p (.003) is less than p (.05), it implies that there is no significant relationship between agroforestry and climate change mitigation in Cross River State. Therefore, the stated null hypothesis is rejected

Discussion of findings

Selective exploitation and climate change mitigation

The result of hypothesis one showed that there is significant relationship between selective exploitation and climate change mitigation in Cross River State. The conclusion among other result the p-value of $p<001$ is less than $p<.05$. Therefore, the null hypothesis which stated that is no significant relationship between selective exploitation and climate change mitigation in Cross River State was rejected.

The present result is in line with Putz, Zuidema, Synnott, Pena-Claros, Pinard, Sheil and Vanclay (2018) that conducted a study on the impacts of selective logging on tropical forest ecosystems. The study concludes that selective logging can be compatible with biodiversity conservation, but only if best management practices are employed. Additionally, the study highlights the importance of considering the long-term impacts of selective logging on tropical forest ecosystems. The findings of the study have significant implications for forest management and conservation policy in tropical regions. Overall, the study provides valuable insights into the impacts of selective logging on tropical forest ecosystems.

This study equally affirmed the study of Roberto, Simona, Jeremy, David, Marco, Ariannm Francisco and Riccardo (2017) who carried out a study on the impact of selective logging and clearcutting on forest structure, tree diversity and above-ground biomass of African tropical forests. The authors show that the effects of selective logging are greater than those expected simply from the removal of commercial species, and can persist for decades. Selective logging, unless it is practiced at very low harvest intensities, can significantly reduce the bio-mass of a tropical forest for many decades, seriously diminishing aboveground carbon storage

capacity, and create opportunities for weeds and vines to spread and slow down the ecological succession and therefore affection potential food security.

Reafforestation and climate change mitigation

The result of hypothesis two showed that there is a significant relationship between reafforestation and climate change mitigation in Cross River State. This assertion was based on the fact that p(.035) is less than p(.05), it implies that there is a significant relationship between reafforestation and climate change mitigation in Cross River State. Therefore, null hypothesis that states there is no significant relationship between reafforestation and climate change mitigation in Cross River State a was rejected and alternative hypothesis upheld forthwith.

The present conclusion is in line with Angelsen and Wunder (2018) that stated that reafforestation consists in recovering forested areas destroyed in recent times by planting new trees and sowing seeds from tree species, among other strategies. According to the authors reafforestation is the major solution to two of the phenomena that most impact the deterioration of the earth: desertification and deforestation. Reforestation is therefore the process of planting trees in a forest where the number of trees has been decreasing. Afforestation is when new trees are planted or seeds are sown in an area where there were no trees before, creating a new forest. There has been a significant shift in focus from encouraging natural forest extraction to forest plantation establishment in many parts of the tropics (Angelsen & Wunder, 2018). Promotion of forest plantation establishment has included smallholder tree growing on-farms.

Conclusion

This study has conclusively established that selective exploitation, reafforestation, agroforestry, are effective strategies for mitigating climate change in Cross River State. The findings of this study provide robust evidence that these practices can significantly reduce greenhouse gas emissions and promote carbon sequestration. Overall, this study demonstrates that sustainable forest management can be a win-win strategy for both climate change mitigation and sustainable development in Cross River State. By adopting these practices, policymakers and stakeholders can make a significant contribution to reducing the state's carbon footprint and promoting a more sustainable future

Recommendations

The researcher made the following recommendations

1 The farmers should form a formidable and strong association who in conjunction with the Cross River State government to promote selective exploitation as a

sustainable forest management practice to mitigate climate change. This can be achieved by providing incentives to forest concessionaires who adopt selective exploitation methods.

2 The farmers should establish a reafforestation program to restore degraded forests and promote carbon sequestration. They should include local communities who then pull their resources/funds together to provide them with economic benefits for participating in reafforestation efforts

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