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RECALIBRATING THE CORRELATION BETWEEN CLIMATE CHANGE MITIGATION POLICY AND ENVIRONMENTAL PERFORMANCE IN SUB-SAHARAN AFRICA: IMPLICATIONS FOR BIOSPHERE RESILIENCE AND RENEWABLE ENERGY TRANSITION

Hayatullah Boladale Hassan* and Idris Olawale Raimi**

ABSTRACT

As the world transits from primitive sources of energy generation to renewable and sustainable energy, the impact of climate change and biosphere resilience to this innovative transition cannot be over-emphasized. The study analysed the correlation between Climate Change Mitigation Policy (CCMP) and Environmental Performance (EP) in Sub-Saharan Africa (SSA) using a linear regression statistical tool. The study leveraged integrative review and relied on secondary data. It found a positive correlation between CCMP and EP, indicating that focusing on climate change mitigation policies can enhance the SSA region's environmental performance (EP). The findings of this study posited that effective governance and strong institutional policies are crucial for implementing climate change mitigation policies, while, promoting sustainable development. The study concluded that implementing climate change mitigation policies effectively can positively affect the biosphere resilience, and drive the renewable energy transition in Sub-Saharan Africa. Furthermore, the findings offer noteworthy lessons for policymakers and practitioners working to address the challenges of climate change, environmental degradation, and energy poverty in SSA.

Keywords: Climate Change Mitigation Policy, Environmental Performance, Sub-Saharan Africa, Biosphere Resilience, Renewable Energy Transition.

1. INTRODUCTION

Climate change is one of the most pressing issues of all time, with far-reaching impacts on the environment, human health, and the economy. Sub-Saharan Africa (SSA) is particularly vulnerable to the impacts of climate

change,[1] with countries facing challenges in reducing greenhouse gas emissions and transitioning to renewable and sustainable energy sources. The SSA's vulnerability to climate change is worsened by several factors, including limited institutional capacity, lack of access to finance and technology, and dependence on fossil fuels. Sub-Saharan African countries experience harsh temperatures than other countries and are more exposed to extreme weather conditions due to factors such as nearness to the equator pole, desert encroachment, and desertification among others.[2] Scholars have found out that the climate underlying SSA heavily depends on rainfall for basic livelihood, and the weak capacity of such weather exacerbates the situation leading to a negative impact on people's health and national economies.[3] Sub-Saharan African countries suffer more persistently from severe Gross Domestic Product (GDP) losses than other countries as a result of climate problems because their underlying fragilities amplify the impact of shocks, in particular on EP and agriculture.[4] In addition, the shocks from climate change worsen the underlying environmental fragilities; hence, there is a critical need for the assessment of mitigation policies to facilitate the immediate response to climate problems and to build climate resilience with a special focus on public policies over time.

Sub-Saharan Africa is a region particularly vulnerable to the impacts of climate change, with countries facing challenges in reducing greenhouse gas

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1 Bedeke Belay, 'Climate change vulnerability and adaptation of crop producers in sub-Saharan Africa: a review on concepts, approaches and methods.' (2023) 25(2) Environment, Development and Sustainability 1017

2 Omotoso Babatunde, and Others, 'Climate change and variability in sub-Saharan Africa: A systematic review of trends and impacts on agriculture.' (2023) 414 Journal of Cleaner Production 137487

3 Jaramillo Carlos, 'The evolution of extant South American tropical biomes.' (2023) 239(2) New Phytologist 477

4 Lahai John, and Isaac Koomson, 'State fragility and resilience in sub-Saharan Africa: Indicators and interventions.' (2020) Routledge < https://www.routledge.com/State-Fragility-and-Resilience-in-sub-Saharan-Africa-Indicators-and-Interventions/Lahai-Koomson/p/book/9781032174181

emissions and transitioning to renewable energy sources.[5] Studies have examined the development and implementation of climate change mitigation and sustainable practices as a key driver for biosphere resilience and renewable energy transition success.[6] Additionally, the region's rapid urbanisation and uncontrolled population growth are exerting enormous pressure on natural resources, infrastructures, and services and these are among the leading candidates resulting in resource depletion.[7] In recent years, there has been an increase in the need for climate change mitigation and adaptation efforts in sub-Saharan Africa. Governments, international organizations, and civil societies have begun to develop and implement policies and programs aimed at reducing greenhouse gas emissions and enhancing resilience to climate change impacts.[8]

Despite these efforts, the region still faces significant challenges in addressing climate change-related issues. The development and implementation of effective climate change mitigation policies remain the key to assuaging the complications around climate change issues. Furthermore, the transition to renewable (greener) energy sources is critical for reducing greenhouse gas emissions and enhancing energy security in sub-Saharan Africa. Meanwhile, the SSA's energy systems are still largely dominated by fossil fuels, and the transition to renewable energy faces significant challenges, including infrastructure development, policy and regulatory frameworks, and financing mechanisms.

Climate change has the potential to do environmental harm that negatively impacts the economy. This is a global externality in that one country's emissions affect all countries by adding to the stock of heat-warming gases in

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5 Bedeke Belay, 'Climate change vulnerability and adaptation of crop producers in sub-Saharan Africa: a review on concepts, approaches and methods.' (2023) 25(2) Environment, Development And Sustainability 101

6 Critchley William, and Others, 'Sustainable land management and climate change adaptation for small-scale land users in Sub-Saharan Africa.' (2023) 12(6) Land 1206.

7 Kassouri Yacouba, 'Monitoring the spatial spillover effects of urbanization on water, built-up land and ecological footprints in sub-Saharan Africa.' Journal of Environmental Management 300 (2021): 113690.

8 Kuramochi Takeshi, and Others 'Beyond national climate action: the impact of region, city, and business commitments on global greenhouse gas emiss ions.' (2020) 20(3) Climate Policy 275

the atmosphere from which warming arises.[9] The process of climate change has a significant environmental impact on many countries, with a large number of lower-income countries especially those in the SSA region mostly vulnerable. Climate change mitigation policies aim to reduce the severity of climate change by lowering greenhouse gas emissions and removing carbon dioxide from the atmosphere.[10] Some key policies include transitioning to renewable energy sources (for example, solar, wind); improving energy efficiency in buildings and industries; electrifying transportation and promoting sustainable land use; and carbon pricing (for example, carbon taxes, cap-and-trade systems). Other key policies are to phase down hydrofluorocarbons (HFCs)[11] and other potent greenhouse gases; protect biodiversity and reforestation efforts; promote sustainable agriculture practices (for example, agroforestry, and permaculture); and encourage sustainable consumption and production patterns.[12]

A climate change policy will also seek to support climate-resilient infrastructure development and encourage research, development, and deployment of new low-carbon technologies.[13] CCPMs are implemented at various levels, including International (such as the Paris Agreement), National (country-specific targets and laws), subnational (state or provincial policies), and local (city-level initiatives). However, climate change policies in SSA countries will need to be recalibrated to accommodate more frequent weather shocks (climate changes), including building policy space to respond to the shocks. Infrastructure will need to be upgraded to enhance biosphere resilience and renewable energy transition.

Historically, efforts to mitigate climate change have occurred at a multinational level including at the 1992 – UN Conference on the

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9 www.imf.org/en/Topics/climate-change/climate-and-the-economy#:~:text=Climate%20change%20has%20potential%20to,atmosphere%20from%20which%20warming%20arises.

10 Fawzy Samer, and Others 'Strategies for mitigation of climate change: a review.' (2020) 18 Environmental Chemistry Letters 2069

11 Purohit Pallav, and Others 'Electricity savings and greenhouse gas emission reductions from global phase-down of hydrofluorocarbons.' (2020) 20(19) Atmospheric Chemistry and Physics 11305

12 Xiaopu SUN, and Others, 'Fast Action on Short-Lived Climate Pollutants and Nature-Based Solutions to Help Countries Meet Carbon Neutrality Goals.' (2022) 13(4) Advances in Climate Change Research 564

13 Mosadeghrad Mohammad, and Others 'Strategies to strengthen a climate-resilient health system: a scoping review.' (2023) 19(1) Globalization and Health 62

Environment and Development held in Rio de Janeiro. It resulted in the Framework Convention on Climate Change (UNFCCC) among other agreements. In 1995, parties to the UNFCCC met in Berlin to map out specific targets for the reduction of carbon and greenhouse gas emissions. In December 1997, the parties concluded the Kyoto Protocol in Kyoto, Japan, and in 2004 Canada and Russia ratified the Kyoto Protocol to the UNFCCC, and implemented the treaty on 16 February 2005.[14] From this time, the Climate Change Mitigation Policy has been evaluated and re-evaluated regularly, and even recently at the United Arab Emirates 2023 United Nations Climate Change Conference.[15]

Climate action is a concern to all and sundry because it is susceptible to complexities and central to Environmental Performance (EP). No country in the world is immune from the impact of climate change, because some effects of climate change are not easily discernible. The cost of climate change on the world is 16 million US Dollars (USD16m) per hour and this cost includes damage to human health, agriculture, infrastructure, and property.[16] The situation could become worrisome for the SSA countries if left at the status quo. In light of this, Sub-Saharan African countries are already facing harsh temperatures than other countries and are more exposed to extreme weather conditions.[17] Researchers have found out that the climate underlying SSA heavily depends on rainfall for basic livelihood, and the weak capacity of such weather exacerbates the situation leading to a negative impact on people's health and national economies.[18] SSA suffers more persistently from severe Gross Domestic Product losses than other countries as a result of climate problems because their underlying fragilities amplify the impact of shocks, in particular on EP and agriculture.[19] In addition, the shocks from climate change worsen the underlying environmental fragilities; hence, there is a

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14 Gupta Joyeeta, 'A history of international climate change policy.' (2010) 1.5 Wiley Interdisciplinary Reviews: Climate Change 636

15 https://unfccc.int/cop28

16 https://www.weforum.org/videos/16-million-per-hour-climate-related-damage/

17 Omotoso Babatunde, and Others 'Climate change and variability in sub-Saharan Africa: A systematic review of trends and impacts on agriculture.' (2023) 414 Journal of Cleaner Production 137487

18 Jaramillo Carlos, 'The evolution of extant South American tropical biomes.' (2023) 239(2) New Phytologist 477

19 Lahai John, and Isaac Koomson, 'State fragility and resilience in sub-Saharan Africa: Indicators and interventions.' (2020) Routledge < https://www.routledge.com/State-Fragility-and-Resilience-in-sub-Saharan-Africa-Indicators-and-Interventions/Lahai-Koomson/p/book/9781032174181

critical need for the assessment of mitigation policies to facilitate the immediate response to climate problems and to build climate resilience with a special focus on public policies over time.

Though extant literature exists on Climate Change Mitigation Policy and Environmental Performance, little is done concerning SSA with the primary objective of correlating the variables with a specific explanation of its implications on the biosphere resilience and renewable energy transition. Hence, a study that analyses the correlation between CCMP and performance in this regard becomes an exigency.

2. THEORETICAL FRAMEWORK AND CONCEPTUAL MODEL

This study used a theoretical framework and conceptual model to further explain the variables understudied. To succinctly capture the concept of this current study, variables connecting sustainable development with climate change realities and other externalities with biosphere resilience as elucidated by other researchers are evaluated. The theory of sustainability, also known as the sustainability framework is considered, and this formed the basis for a conceptual model outlining the three inter-connected pillars of sustainable development.[20] These pillars are environmental sustainability (conservation and management of natural resources, protection of the environment, and mitigation of climate change); social sustainability (promotion of social justice, human rights, community development, and cultural diversity); and economic sustainability (economic growth, poverty reduction, and sustainable consumption and production patterns). The theory of sustainability posits that these three pillars must be in balance for sustainable development to occur.[21] It maintains that economic development must be separated from environmental degradation and social injustice and that all three pillars are interdependent and mutually reinforcing. The theory has its roots in the 1987 United Nations report tagged 'Our Common Future,'[22] also known as the Brundtland Report, which defined sustainable development as

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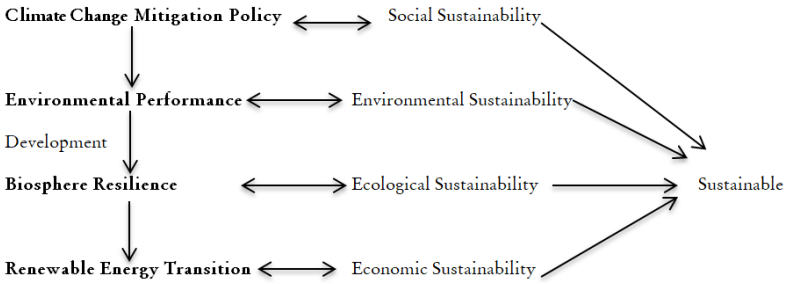
[20] Purvis Ben, Yong Mao, and Darren Robinson, 'Three pillars of sustainability: in search of conceptual origins.' (2019) 14 Sustainability Science 681

[21] Pohoață Ion, Delia Diaconaşu, and Vladimir Crupenschi, 'The sustainable deve lopment theory: A critical approach' (2020) 1 The discourse of the founders. Springer Nature.

[22] Duncan Kirsty, 'Environment and Health: Protecting Our Common Future.' (2008) WIT Press

'meeting the needs of the present without compromising the ability of future generations to meet their own needs.'[23] The sustainability framework has since been widely adopted by governments, businesses, and civil society organizations as a guiding principle for decision-making and policy development. However, the conceptual model for the interconnectivity of the variables understudied and other ecological determinants are presented below:



Source: Authors

The above model illustrates the relationships between CCMP and EP; EP and biosphere resilience; biosphere resilience and renewable energy transition; and renewable energy transition and sustainable development with each component corresponding to another sustainability dimension including social, environmental, ecological, and economic sustainability. This confirmed that climate change mitigation policies (CCMP) are associated with improved EP. This supports the notion of advantage scenarios in sustainability, where environmental protection and economic development can be mutual. Inferably, by transitioning to renewable energy sources and promoting sustainable land use practices, countries in Sub-Saharan Africa can reduce their carbon generation while driving economic growth and development. These concepts are interconnected and interdependent, these terms represent different facets of sustainability, all of which are essential for creating a resilient, equitable, and prosperous future. The model is inclusive

[23] Borowy Iris, 'Defining sustainable development for our common future: A history of the World Commission on Environment and Development (Brundtland Commission).' (2013) Routledge < https://www.routledge.com/Defining-Sustainable-Development-for-Our-Common-Future-A-History-of-the-World-Commission-on-Environment-and-Development-Brundtland-Commission/Borowy/p/book /9780415825511

as Climate Change Mitigation policy aims to achieve environmental sustainability and sustainable development; social sustainability and economic sustainability are important for achieving sustainable development; environmental performance and ecological sustainability are necessary for maintaining biosphere resilience; and renewable energy transition supports climate change mitigation policy and environmental sustainability.

3. METHODOLOGY

This study combined an integrative review of existing literature with a quantitative research design to explore the relationship correlation between climate change mitigation policy and environmental performance in sub-Saharan Africa in order conceived a comprehensive understanding of the topic. The integrative review provided a broad perspective on the subject,[24] while the quantitative approach enabled the author to analyse secondary data from the Environmental Performance Index (EPI). This data-driven analysis revealed correlations between policy and environmental outcomes. The complementary nature of these approaches enhanced methodological rigour, as each compensated for the limitations of the other. Specifically, the integrative review contextualised the quantitative findings, while the quantitative analysis validated and refined the insights from the literature review.[25] This hybrid approach allowed for a more robust understanding of the complex relationships between climate change mitigation policies and environmental performance in sub-Saharan Africa.

3.1 Study Area and Sample Size

The study area includes all SSA countries with available data on climate mitigation policy and environmental performance index. These countries include Angola, Benin, Botswana, Burkina Faso, Cameroon, Burundi, Central African Republic, and Chad. Others are Comoros, Cote d'Ivoire, Dem. Rep. Congo, Djibouti, Eritrea, Eswatini, Ethiopia, Gabon, and Gambia. Others are Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. A total of forty-four (44) countries in Sub-Saharan Africa whose data on CCMP and EP was published over a consistent

[24] Whittemore Robin, and Kathleen Knafl. 'The integrative review: updated methodology.' (2005) 52(2) Journal of advanced nursing 546

[25] Ibil.

ten-year period was used for this present study and correlation analysis was done on the data using SPSS Version 23.0.

3.2 Data Source and Data Collection

The source of the data used is the 2024 Environmental Performance Index (EPI).[26] These are reports and datasets published by the Yale Centre for Environmental Law and Policy. It is data-driven by the State's summary on sustainability around the world using 58 performance indicators across 11 issue categories. The Environmental Performance Index scores and ranks 180 countries on climate change performance, environmental health, and ecosystem vitality. Data were extracted and compiled into a spreadsheet for analysis before being exported to the SPSS.

3.3 Data Variables

There are two main variables understudied. The Climate Change Mitigation Policy is measured using the EPI's scores on Climate Change Mitigation, and Environmental Performance is measured using the EPI's scores.

3.4 Data Quality

The EPI is a widely recognised and reputable source of environmental data, and the data is regularly subjected to rigorous quality control and assurance processes. The data was carefully reviewed and checked for errors or inconsistencies before analysis.

3.5 Ethical Considerations

This study used secondary data, which does not require ethical approval. Proper citations and credits were given to the original data sources. By using secondary data from the EPI, this study was able to leverage existing research and data to investigate the correlation between CCMP strength and EP in Sub-Saharan Africa.

3.6 Data Analysis

Descriptive statistics was used to summarize the data and provide an overview of CCMP and EP in Sub-Saharan Africa. Correlation analysis (Pearson's r) was conducted to examine the strength and direction of the relationship between CCMP strength and EP. While regression analysis was also used to establish the relationship between the variables understudied, the choice of Pearson Correlation is justified because the study presented enough

[26] https://epi.yale.edu/

sample size of more than 30 recommended for such statistical operation to ensure reliability.[27]

4. RESULTS AND DISCUSSION

The data presented in Table 1 showed the Climate Change Mitigation Policy (CCMP) and Environmental Performance (EP) scores for various countries understudied in the SSA region in percentages. The CCMP scores range from 16.5 (Mali) to 53.5 (Zimbabwe), with higher scores indicating more effective climate change mitigation policies. EP scores range from 28.6 (Eritrea) to 53.1 (Gabon), with higher scores indicating better environmental performance. The data suggests that some countries in SSA have strong climate change mitigation policies (high CCMP scores) but may not necessarily have good environmental performance (lower EP scores). On the other hand, some countries in the region may have good environmental performance but weaker climate change mitigation policies. Furthermore, Zimbabwe has the highest CCMP score (53.5) as well as a high EP score (51.7), indicating strong performance in both areas. Countries like Mali, Malawi, and Niger have lower scores in both CCMP and EP, indicating areas for improvement in both climate change mitigation and environmental performance.

Table 1: Climate Change Mitigation Policy (CCMP) and Environmental Performance (EP)

Countries	CCMP (%)	EP (%)
Angola	49.4	39.7
Benin	22.9	37.4
Botswana	25.1	49.0
Burkina Faso	24.9	41.5
Burundi	26.6	33.0
Cameroon	39.4	38.1
Central African Republic	31.0	38.3
Chad	21.0	35.2
Comoros	25.2	37.9
Cote d'Ivoire	40.9	42.5
Dem. Rep. Congo	40.1	39.0
Djibouti	47.9	32.2

[27] Lakens Daniël. 'Sample size justification.' (2022) 8(1) Collabra: psychology 33267

Eritrea	38.1	28.6
Eswatini	52.9	38.5
Ethiopia	28.9	35.8
Gabon	52.8	53.1
Gambia	37.2	37.1
Ghana	24.7	36.6
Guinea	22.2	36.2
Guinea-Bissau	41.8	41.6
Kenya	26.5	36.9
Liberia	38.4	34.1
Madagascar	36.1	29.9
Malawi	17.7	34.9
Mali	16.5	33.9
Mauritania	24.8	34.2
Mauritius	45.8	47.3
Mozambique	35.7	38.6
Namibia	30.3	43.8
Niger	19.4	39.2
Nigeria	43.9	37.5
Republic of Congo	29.3	41.2
Rwanda	32.3	33.4
Sao Tome and Principe	38.6	35.9
Senegal	32.0	43.3
Seychelles	27.3	48.2
Sierra Leone	46.8	39.7
South Africa	48.0	42.9
Sudan	36.2	38.6
Tanzania	32.5	43.1
Togo	28.5	35.2
Uganda	35.7	35.4
Zambia	39.4	46.1
Zimbabwe	53.5	51.7

Source: The 2024 Environmental Performance Index (EPI) – Yale University[28]

Table 2 below revealed that the Mean score of CCMP was 34.27, and the EP was 39.00 with a standard deviation of 9.99 and 5.40 respectively. Table 3 below revealed that the correlation between EPI and CCMP is positive and significant ($r = 0.325$, $p = 0.016$), indicating a moderate positive relationship between the two variables. Table 4 revealed that the regression model is

[28] Ibid.

significant F(1,16) = 4.969, p = 0.031, indicating that CCMP is a significant predictor of EPI. However, Table 5 revealed that the coefficient for CCMP is positive and significant (B = 0.176, p = 0.031), indicating that for every unit increase in CCMP, EPI increases by 0.176 units. Further, Table 6 revealed that the R-squared value is 0.106, showing that about 10.6% of the variation in EPI can be explained by CCMP and that the Durbin-Watson statistic is 1.487, maintaining that there is no autocorrelation in the residuals. In addition, the residual statistics obtained showed that the residuals are normally distributed and have a mean of zero, indicating that the assumptions of linear regression are met. Hence, this output suggests that there is a significant positive relationship between CCMP and EP in the SSA.

Table 2

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
EPI	39.0068	5.40101	44
CCMP	34.2773	9.99393	44

Source: Authors' Computation

Table 3

Correlations			
		EPI	**CCMP**
Pearson Correlation	EPI	1.000	.325
	CCMP	.325	1.000
Sig. (1-tailed)	EPI	.	.016
	CCMP	.016	.
N	EPI	44	44
	CCMP	44	44

Source: Authors' Computation

Table 4

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	132.710	1	132.710	4.969	.031[b]
	Residual	1121.638	42	26.706		
	Total	1254.348	43			
a. Dependent Variable: EPI						
b. Predictors: (Constant), CCMP						

Table 5

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	32.981	2.813		11.725	.000	27.305	38.658
	CCMP	.176	.079	.325	2.229	.031	.017	.335
a. Dependent Variable: EPI								

Table 6

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.325[a]	.106	.085	5.16775	1.487
a. Predictors: (Constant), CCMP					
b. Dependent Variable: EPI					

Considering the theoretical framework engaged by this current study, it is observed that the relationship between CCMP and EP in Sub-Saharan Africa is moderate, with a focus on biosphere resilience and renewable energy transition in the case of environmental sustainability. The results of this study also corroborated the Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action) and SDG 15 (Life on Land), which emphasize the need for urgent action on climate change and environmental conservation.[29] By focusing on climate change mitigation policies, countries in Sub-Saharan Africa can make significant progress towards achieving these SDGs and promoting sustainable development.[30]

[29] Salmon Angela, and Others 'Climate Stewards for the World: SDG 13 Climate Action SDG 15 Life on Land NEW.' Children's Literature Aligned with SDGs to Promote Global Competencies: A Practical Resource for Early Childhood Education. (2024) Cham: Springer Nature Switzerland 239

[30] Adenuga Kayode, and Others 'Climate change adaptation and mitigation in sub-Saharan African countries.' (2021) Energy and Environmental Security in Developing Countries 393

Furthermore, the findings of the study supported the concept of sustainable development as a framework for achieving human well-being while protecting the environment. By implementing climate change mitigation policies effectively, countries in Sub-Saharan Africa can perform better, especially in the areas of biosphere resilience, poverty reduction, and improved human well-being. Likewise, the outcome of the study provided some insights into the concept of environmental justice, which gives reasons for the equitable distribution of environmental costs and benefits. It holds that countries in Sub-Saharan Africa can achieve so much in their environment if the focus of the state actors will always resonate with climate change policy to promote environmental well-being and ensure that the costs and benefits of environmental protection are shared equitably. This reiterates that the main aim of CCMP is to reduce greenhouse gas emissions and environmental degradation, hence promoting environmental sustainability in Sub-Saharan Africa.

However, in terms of social sustainability, the authors argue that only effective policies can enhance biosphere resilience, ensuring the long-term health and well-being of ecosystems and human communities, and promoting social sustainability. Further, the authors maintain that policy is a key to climate adaptation in terms of economic sustainability, and transitioning to renewable energy sources can drive economic growth, create jobs, and reduce energy poverty in the region.

The results of the study corroborated the fundamental principles of sustainability, which emphasizes the interdependence of environmental, social, and economic dimensions.[31] By promoting climate change mitigation policies, countries in Sub-Saharan Africa can reduce their environmental issues, promote sustainable development, and enhance biosphere resilience. The moderate relationship between CCMP and EP reiterates the concept of environmental governance, which moderates the importance of effective policies and institutions in achieving environmental sustainability. Strengthening climate change mitigation policies can enhance environmental governance, leading to improved environmental performance in Sub-Saharan Africa as stated previously in this current study.

In addition, the authors argue that the moderate relationship obtained for CCMP and EP could have some considerable implications for biosphere

[31] Purvis Ben, Yong Mao, and Darren Robinson, 'Three pillars of sustainability: in search of conceptual origins.' (2019) 14 Sustainability Science 681

resilience, and renewable energy in Sub-Saharan Africa, particularly in the context of climate change. By engaging climate change mitigation policies, Sub-Saharan African countries can reduce their greenhouse gas emissions, and improve energy efficiency, thereby enhancing biosphere resilience and renewable energy transition. Investing in renewable energy infrastructure following this policy route can drive the transition to a low-carbon economy, reducing dependence on fossil fuels and enhancing energy security, which is critical for biosphere resilience. This can also increase energy access, reducing energy poverty and promoting sustainable development for the over 600 million people in Sub-Saharan Africa who lack access to electricity.[32,33]

Implementing climate change mitigation policies correctly in the right direction will reduce climate vulnerability, as Sub-Saharan Africa is highly vulnerable to climate change, with rising temperatures and extreme weather events already affecting agricultural productivity, water resources, and human health. The authors however posit that policy offer great benefits for climate change mitigation. To reinforce this argument, it is important to note that a fundamental duty of government includes formulating environmental policies that are effective enough to stop or mitigate global externalities. One of the means to ensure this is through efficient public policy; which is the action or inaction of the government in response to issues affecting the public, especially climate change-induced disasters such as flooding, earthquakes, whirlwind stones etc. Public policy has various targets; one of such seeks to mitigate the impact of climate change. Hence, Climate Change Mitigation Policy (CCMP) - this is a cardinal framework to direct the affairs of States in a way that will reduce environmental damages and risks. To mitigate the effect of climate change on the earth, there is a need for every government to take climate action to avert the inherent danger associated with it. Climate Change Mitigation Policy (CCMP) would readily help reduce if not obliterate potential threats from climate change effects that could be so devastating if left unattended.

In SSA, studies have examined the development and implementation of climate change mitigation policies in the region, highlighting the importance of effective policy frameworks in achieving emissions reduction and

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[32] Ulsrud Kirsten, 'Access to electricity for all and the role of decentralized solar power in sub-Saharan Africa.' (2020) 74(1) Norsk Geografisk Tidsskrift-Norwegian Journal of Geography 54

[33] Avila Nkiruka, and Others 'The energy challenge in sub-Saharan Africa: A guide for advocates and policy makers.' (2017) Part 1 Generating Energy for Sustainable and Equitable Development 1

sustainable development goals[34] prompting a need to empirically test the CCMP and other variables such as EP, and researchers (interdisciplinary) have assiduously worked in the area of CCMP and EP. For instance, a study used a dynamic-panel model based on twenty SSA countries in Sub-Saharan Africa with a special focus on the policy responses (mitigation).[35] To this extent, the fabric of the SSA poses deep challenges to EP as a result of additional damage done to the environment following conflict regimes. This situation cast higher disruption on the economic performance of SSA as a result of some 24.9 million weather-related displacements[36]. To foster pathways from climatic changes to good environmental performance and peace within national governments of SSA, there is a need to create appropriate global performance measurements.

Biosphere resilience is also a critical component of EP, determining the ability of ecosystems to withstand and recover from climate change impacts. Studies have shown that biosphere resilience is declining in sub-Saharan Africa[37,38] with significant implications for ecosystem services and human well-being. For example, a study on the impact of climate change on savannas in East Africa found that declining biosphere resilience is affecting ecosystem services and human livelihoods.[39]

Furthermore, the transition to renewable (greener) energy sources is a critical strategy for reducing greenhouse gas emissions and enhancing energy security in sub-Saharan Africa. Research has shown that the region (SSA) has significant potential for solar, wind, and hydroelectric power, with some countries such as Nigeria already making significant progress in renewable

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[34] Acheampong Alex, Mary Amponsah, and Elliot Boateng, 'Does Financial Development Mitigate Carbon Emissions? Evidence from heterogeneous financial economies.' (20200 88 Energy Economics 104768

[35] https://www.imf.org/en/Publications/WP/Issues/2022/03/18/Climate-Change-in-Sub-Saharan-Africa-Fragile-States-Evidence-from-Panel-Estimations-515159

[36] https://www.brookings.edu/articles/climate-change-development-and-conflict-fragility-nexus-in-the-sahel/

[37] Pausata, Francesco, and Others 'The greening of the Sahara: Past changes and future implications.' (2020) 2(3) One Earth 235

[38] Lenton Timothy, and Others 'A resilience sensing system for the biosphere.' (2022) B 377(1857) Philosophical Transactions of the Royal Society 20210383

[39] Mkala Mbandi, and Others 'Modeling impacts of climate change on the potential distribution of three endemic Aloe species critically endangered in East Africa.' (2022) 71 Ecological Informatics 101765

energy deployment.[40] In South Africa's renewable energy transition, it was found that the country has made significant progress in deploying solar and wind power, with significant reductions in greenhouse gas emissions.[41]

While this study hinged on the theory of sustainability, it provided an overview of the current state of knowledge on climate change mitigation policies and EP in Sub-Saharan Africa using the integrative review method. From the foregoing, the study examined the development and implementation of climate change mitigation policies in the SSA, with a focus on renewable energy transition and energy security. The review of literature explored the correlation between policy strength and EP indicators, including air and water quality, ecosystem health, and biodiversity. Additionally, the study considered the implications of climate change mitigation policies on biosphere resilience and ecosystem services in Sub-Saharan Africa. The literature review in the study contributed to the ongoing efforts to address climate change in sub-Saharan Africa by providing a comprehensive insight into the current state of knowledge on climate change mitigation policies and EP in the SSA.

Despite the progress made in understanding climate change mitigation policies and environmental performance in Sub-Saharan Africa, significant gaps remain in the literature. Future research should focus on the correlation between policy strength and EP indicators. Additionally, research should explore the impact of renewable energy transition on energy security and sustainable development in the region. The development of effective policy frameworks and financing mechanisms for renewable energy deployment should also be a priority for future research. Furthermore, research should investigate the impact of climate change mitigation policies on biosphere resilience and ecosystem services in Sub-Saharan Africa.

Climate change mitigation policies in Sub-Saharan Africa are critical in reducing greenhouse gas emissions and transitioning to renewable energy sources. However, the effectiveness of these policies varies across countries, with some facing challenges in implementation and enforcement.

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[40] Ogunjo Samuel, Adeyemi Olusola, and Christiana Olusegun, 'Potential of using floating solar photovoltaic and wind farms for sustainable energy generation in an existing hydropower station in Nigeria.' (2023) 25(6) Clean technologies and environmental policy 1921

[41] Mutezo G, and Mulopo J, 'A review of Africa's transition from fossil fuels to renewable energy using circular economy principles.' (2021) 137 Renewable and Sustainable Energy Reviews 110609

Environmental Performance (EP) indicators are critical in assessing the impact of climate change mitigation policies in the region. Biosphere resilience is also a critical component of EP, determining the ability of ecosystems to withstand and recover from climate change impacts. The transition to renewable energy sources is a critical strategy for reducing greenhouse gas emissions and enhancing energy security in Sub-Saharan Africa. However, significant challenges remain, including the need for infrastructure development, policy and regulatory frameworks, and financing.

Ultimately, the authors considered the study to be timely and relevant, given the urgent need for climate change mitigation and adaptation efforts in Sub-Saharan Africa. Climate Change Mitigation is critical to better EP due to the associated risks, which need more robust and comprehensive attention within the context of SSA, because of the conflict peculiarity of the countries.[42] The literature also has shown that climate change mitigation policies in Sub-Saharan Africa vary in strength and effectiveness, with some countries facing challenges in the implementation and enforcement,[43] For example, a study on South Africa's CCMP found that while the policy framework is robust, implementation challenges hinder its effectiveness.[44] Another study on Nigeria's climate change policy found that lack of political will and limited institutional capacity hinder policy implementation,[45] but few studies have investigated the correlation between CCMP strength and EP in Sub-Saharan Africa. However, research outcomes still showed that there is a positive correlation between policy strength and greenhouse gas emissions reduction in some countries in the region.[46] Another research has found a negative correlation between policy strength and deforestation rates in the Congo

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42 Gilmore Elisabeth, and Halvard Buhaug, 'Climate mitigation policies and the potential pathways to conflict: Outlining a research agenda.' (2021) 12(5) Wiley Interdisciplinary Reviews: Climate Change e722

43 Ofori Appiah, Samuel Cobbina, and Samuel Obiri, 'Climate change, land, water, and food security: Perspectives From Sub-Saharan Africa.' (2021) 5 Frontiers in Sustainable Food Systems 680924

44 Todd Iain, and Darren McCauley, 'Assessing policy barriers to the energy transition in South Africa.' (2021) 158 Energy Policy 112529

45 Adelaja Adesoji, 'Barriers to national renewable energy policy adoption: Insights from a case study of Nigeria.' (2020) 30 Energy strategy reviews 100519

46 Karim Sitara, and Others 'Modelling the role of institutional quality on carbon emissions in Sub-Saharan African countries.' (2022) 198 Renewable Energy 213

Basin,[47] highlighting the importance of effective policy frameworks in protecting biodiversity and ecosystem services.

However, the transition to renewable energy also poses significant challenges, including the need for infrastructure development, policy and regulatory frameworks, and financing mechanisms.[48] To buttress the above-stated facts about the challenges in renewable (greener) energy, a study on the challenges facing renewable energy deployment in Nigeria found that lack of infrastructure and policy frameworks is the major hindering factor impeding the transition to renewable energy in the country[49]. By improving EP, countries can reduce the environmental impacts of climate change including deforestation, water pollution, and land degradation. Additionally, climate change mitigation policies and renewable energy investments can in turn generate considerable economic benefits, including reducing climate-related disasters, improving energy efficiency, and creating employment in the renewable energy sector. Optimizing these implications, Sub-Saharan African countries can build a more sustainable and resilient future, promote economic development, and reduce climate vulnerability in line with the Paris Agreement's goal to limit global warming to well below 2°C.[50]

5. CONCLUSION

This study has demonstrated a positive correlation between climate change mitigation policies and Environmental Performance in Sub-Saharan Africa. The findings suggest that implementing climate change mitigation policies effectively can enhance biosphere resilience, facilitate the transition to renewable energy, and promote sustainable development in the region. The result of the study underscores the critical role of effective governance and institutions in implementing climate change mitigation policies and

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47 Brandt Jodi, Christoph Nolte, and Arun Agrawal, 'Deforestation and timber production in Congo after implementation of sustainable management policy: A response to Karsenty et al. (2017).' (2018) 77 Land use policy 77 375

48 Bishoge Kyetuza, Godlisten Kombe, and Benatus Mvile, 'Renewable energy for sustainable development in sub-Saharan African countries: Challenges and way forward.' (2020) 12(5) Journal of Renewable and Sustainable Energy

49 Adelaja Adesoji, 'Barriers to national renewable energy policy adoption: Insights from a case study of Nigeria.' (2020) 30 Energy strategy reviews 100519

50 Meinshausen Malte, and Others 'Realization of Paris Agreement pledges may limit warming just below 2 C.' (2022) 604 (7905) Nature 304

promoting sustainable development. By strengthening environmental governance and institutions, incentivizing sustainable land-use practices and renewable energy sources, and promoting public-private partnerships, policymakers can unlock the potential for sustainable development and biosphere resilience in sub-Saharan Africa. As the region continues to grapple with the challenges of climate change, environmental degradation, and energy poverty, the findings of this study offer a beacon of hope. Formulating and implementing climate change mitigation policies efficiently and investing in renewable energy infrastructure in sub-Saharan African countries can build a more sustainable and resilient future for future generations. Finally, this study maintains that there is an urgent need to recalibrate climate action and sustainable development in sub-Saharan Africa. It is observed that synergy to prioritise climate change mitigation policies and renewable energy transition will support a more sustainable, equitable, and prosperous future.