

# Rural Poverty and Environmental Degradation: Evidence from Selected Countries in Sub-Saharan Africa

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**Abstract-** This paper investigates the inter-relationship between rural poverty and environmental degradation, relies on secondary data of 21 of Sub-Saharan African countries for year 2021 as compiled by the World Bank. A recursive model made up of five behavioral equations has been built, the functional equations expressed in an economic and social terms. Carbon dioxide emissions and deforestation as facets of environmental degradation. The results reveal that rural poverty lends itself to be readily explainable on the basis of prevalent macro socio-economic variables and some aspects of environment degradation by no means a consequence of the spread of poverty.

**Keywords-** Rural Poverty; Carbon Dioxide Emission; Deforestation; Environmental Degradation; Environmental Awareness; Sub-Saharan Africa

## I. Introduction

Poverty as envisaged by the study is a multifaceted process, which impacts on the economic and social aspects of household, communities and nations at large. Low incomes, which fall short of subsistence requirements; inequitable access to factors of production and inadequacy or sheer lack of health care and education services are viewed as salient features of poverty as an appalling socio-economic phenomenon.

More people today live healthier and more productive than at any time in history. But the gains have been inadequate and uneven, as for instance, during the peak of the covid-19 crisis in the second quarter of 2020 The incomes of the poorest 40 percent of the world's population likely fell by 4 percent in 2020. As a result, the number of people living in extreme poverty likely increased by 11 percent in 2020 from 648 million to 719 million. This increase pushed the extreme poverty rate 1.2% higher than projections going into the year. Given current trends, it became clear that the global goal of ending extreme poverty by 2030 would not be achieved. Of the world's 8.2 billion people, that is, 574 million people live on less than US\$2.15 a day in 2030, with most in Africa. In 2020 alone, the number of people living below the extreme poverty line rose by over 70 million. That is the largest one-year increase since global poverty monitoring began in 1990 [1].

The rise in poverty in poorer countries reflects economies that are more informal, social protection systems that are weaker, and financial systems that are less developed. This highlights the magnitude of poverty, which overwhelms despite the immense technological progress the world has made following World War II. low-income countries have yet to see a full recovery, poverty in the study area –which is on the whole rural- is measurable and discernible using both monetary and non-monetary indicators. The forty-seven countries comprising Sub-Saharan Africa depend more on their natural resource base for economic and social needs than any other region in the world.

Energy Information Administration [2] reported that, two-thirds of Sub-Saharan Africa's people live in rural areas and rely on agriculture and other natural resources for income. However, the environmental resource base of the region is shrinking rapidly.

Various gatherings, declarations and conventions such as Stockholm conference on human development of early 1972s, the world environment strategy of early 1980s and the world conference on environment and development of mid 1980s were held to address the poverty related issues. Temporal and spatial spread of poverty would be dealt with in this study by way of defining the nature and scale of the problem.

Out of the debate on the "Limits to Growth" the concern over environmental degradation emerged to become a highly prioritized developmental concern. Such a concern has revealed the pressing need to manage global resources in a way, which would cater for human, ecological and economic considerations. Pre-occupation with economic growth as a sole and over-riding objective of economic activity in both the developed and the developing countries has dominated since World War II for over three decades.

However, since then, evidence started to accumulate that unrestrained economic growth in the developed world and the dominance growth in the developing countries had negative repercussions on the natural environment. The Paris Agreement on climate change started during 2016, to combat climate change and adapt to its effects. Such repercussions, which are generally referred to as environmental degradation, would highly reduce the ability of the environment to provide its indispensable services. Environmental services encompass a wide range which can be summed up as: provision of production factors and inputs in the form of renewable and non-renewable resources; acting as a sink tank whereby the wastes produced as a result of biological, physical and economic activities can be disposed of.

Africa is home to the second largest rainforest on the, hosts 17 percent of the world's forests and 31 percent of woodlands across the Sahel and other regions. These landscapes deliver numerous products and services, including food, fuel, shelter and freshwater, protect against hazards and provide habitats for wildlife. As much as 65% of productive land in Africa is degraded, while desertification affects 45% of the continent's land area. Every year, nearly 3 million hectares of Africa's forests are lost, leading to a 3% loss of Gross Domestic Product (GDP) associated with soil and nutrient depletion. As a result of degraded forests and croplands and the associated loss of land productivity and desertification [3].

Environmental degradation in the developing countries has been thought of as a major contributing factor to the pervasive spread of poverty. Indeed, the two have been conceived as reinforcing and reciprocally inter-related. In Africa, however, deforestation and forest degradation are still major concerns, and are depleting the region's wealth, environmental problems of Sub-Saharan Africa include pollution of air and water supplies, massive deforestation, loss of soil and soil fertility and a dramatic decline in biodiversity throughout the region (EIA, 2000).

World Bank [4] highlighted, at the global level, environmental degradation has unequivocally been recognized as a major factor breeding and aggravating poverty. In response to this, the concept of sustainable development has come into being. Sustainable development as a philosophy and policy-guiding framework is based upon three integrative and interactive components namely, economic efficiency, social equity and environmental conservation. On the one hand, alleviation of poverty will be instrumental in the way of realizing sustainable development while on the other, the role of poverty as a counter force and process to environmental conservation will be widely accepted. As such, reduction and alleviation of poverty has been central to the operationalization and hence achievement of sustainable development. The problems of poverty and environmental degradation in Sub-Saharan Africa are highly stereotyped. The conventional wisdom is that environmental resources in Sub-Saharan Africa are being rapidly degraded and the poor, rural peasants are the agents of this change. It is also held that rural households use environmental resources quite extensively. Rural poverty-environment relationship stated that, environmental resources make a significant contribution to average rural incomes and poorer households also depend heavily on these resources. Hence, degradation of natural resources would hurt the poorest most [5].

The relationship between humans and forests is subject to complex, dynamic and sometimes opposing forces [6]. Identifying the causal pathways between social and economic variables and environmental outcomes is a formidable challenge [7]. Studies in Mexico [8] and in the Gambia [9] to determine the causal impact of income growth on deforestation showed that income growth induced by a conditional cash transfer programme and a community-driven development programme, respectively, increased forest loss. By contrast, other studies in Mexico and Uganda suggest that programmes offering payments in compensation for conservation activities have successfully reduced rates of deforestation [10, 11].

Africa has the highest net loss of forest area at 3.9 million hectares per year followed by South America at 2.6 million hectares. Since 1990, Africa has reported an increase in the rate of net loss, from 3.28 million hectares in 1990–2000, to 3.40 million hectares in 2000–2010, to 3.94 million hectares in 2010–2020 [12]. Environmental management is instrumental to sustained poverty alleviation. Therefore, the problem statement of the present paper emphasized rural poverty and environmental degradation as a reinforcing process. Then, the rural poor are expected to be the most affected by diminishing environmental quality. Moreover, the dual role of the poor as agents and victims of environmental degradation will be raised as a research question, that must be attended to analyses and comprehend the linkage between poverty and environmental degradation.

The question is how environmental health problems such as emissions of carbon dioxide affect the health of the poor, what causes the emissions, what are the factors that contribute to the level of education of poor people to enhance environmental awareness especially in rural area. On equal footing –but even more significant to poverty alleviation is provision of an objective understanding to deforestation. The latter which is widely spread in the study area is a major threat to sustainable livelihoods and hence to the aggravation of poverty.

The main objective of the research is to investigate the inter-relationship between the spread of rural poverty and pervasiveness of environmental degradation in selected countries from Sub-Saharan Africa. To pursue the above objectives, several secondary objectives are considered, which are as follows: to analyze the effect of macro-economic factors on poverty, to study how socio-economic factors affect poverty, to examine the factors contributing to environmental degradation as expressed in terms of emissions of carbon dioxide and deforestation and to investigate environmental awareness –a major prerequisite to the promotion of environmental quality- as functionally related to

poverty, adult illiteracy rate (IR), carbon dioxide emission (CD), share of agriculture in the GDP (AS) and public expenditure on health (EXPH). Ultimately, such an investigation is meant to shed light on environmental awareness as a crucial input to environmental promotion.

Regarding the interrelationship between rural poverty and environmental degradation, there have been many debates on its hypothesis. Up until now, researchers and policy-makers still give their recommendations of the relationship. Hence, the researcher puts forward the following as its working hypotheses: economic poverty (PE) measured in terms of number of poor people living in poverty is functionally related to key macro-economic variables such as GDP per capita (GDPC), AS, deforestation per capita (DFC), food production index (FPI) and Gini index (GI). Social poverty measured in terms of adult illiteracy rate (IR) is functionally related to both socio and macro-economic variables such as PE, GDPC, share of manufacturing in the GDP (MS) and EXPH. Environmental degradation measured in terms of carbon dioxide emissions (CD) is affected by PE and number of factors namely, IR, GDPC and energy use (EU). Whereas, deforestation as environmental degrading parameter is explainable by a set of socio-economic variables such as PE, IR, CD, net enrolment in secondary school (NER) and GDPC. Environmental awareness is functionally related –and hence explainable contingent on– to socio-economics variables such as PE, IR, AS, EXPH, MS, EU and GDPC. A set of parallel null hypotheses each corresponding to each of the working hypothesis will also be discussed.

The research focuses mainly on rural poverty and environmental degradation and development in 21 countries from Sub-Saharan Africa namely, Botswana, Burkina Faso, Cote d'Ivoire, Ethiopia, Kenya, Lesotho, Madagascar, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. The rationale for this stems from the fact that Sub-Saharan Africa has been selected to represent the under developed countries.

In order to explore the inter-relationship between rural poverty and environmental degradation, secondary data on poverty and the environment for year 2021, the data available at World Bank Open Data (WBOD) [13] website will be used. The term poverty is defined as the number of poor people living below poverty line (less than US \$1.9 a day 2017 purchasing power parity [PPP]). For the purpose of this article, environmental degradation is peroxided by carbon dioxide emissions and deforestation. The research will also have scope for environmental awareness among poor people through improvement in the level of education. The findings and conclusions of the study can help in understanding the link between rural poverty and the degradation of their environmental resources.

The significance of the study due to environmental problems require serious and urgent attention. World Summit on Sustainable Development (WSSD) specified, tackling environmental degradation is an integral part of effective and lasting poverty reduction, moreover, environmental degradation harms human health and reduces economic productivity [14].

This article is organized in the following form. Section one provides the link between rural poverty and environmental degradation, problem statement, objectives, hypothesis, scope and the significance of the study. Section two provides a description of the features, population, socio-economic development and state of environment of Sub-Saharan Africa, the area of the study. Section three dwells on the theoretical framework and methodology. Section four outlines the results and discussion of the study in Section five. Finally, the conclusion the research is provided in section six.

## II. Review of literature

This paper investigates the inter-relationship between rural poverty and environmental degradation taking Sub-Saharan Africa as the study area and hence as a provider of case material. The criteria upon which this selection has been made are two-fold. First, taken collectively as a region, Sub-Saharan Africa with slightly FAO (2020) valued, 252 million people living in forests and savannahs had incomes of less than US\$1.25 per day. Overall, about 63% of these rural poor lived in Africa.

Secondly, this region for the last three decades or so has been experiencing massive environmental degradation, close to a fifth (17%) of the world's forests can be found in Africa. The planet continues to lose forests at a rate of 4.4 million hectares per year. Up to 65% of productive land in Africa is degraded [15]. An important report by Sahara and Sahel Observatory (OSS) knowledgeable, the Sahel and West Africa region is one of the areas on the planet which is most severely affected by aridity, land degradation and desertification. Although the twelve countries in this atlas have very different environmental characteristics, we can still find many similarities between them, particularly with regard to climate and the diversity of the landscape. These forests and tree-based landscape are teeming with products that are essential to everyday life and livelihoods of the majority of Africa's people [16]. The role of forests in poverty alleviation is also increasingly well implicit [17].

According to WBOD (2023), there are 42 countries located on the Sub-Saharan Africa mainland, in addition to 6 island nations, with total population for year 2022, 1.21 billion, annual population growth 2.5%, poverty headcount ratio at US\$2.15 a day (2017 PPP) for year 2019 equal to 35.4% of population. GDP (US\$) 2.05 trillion, GDP per capita 1,690.4 for year 2022, annual GDP growth 3.6%. Adult literacy rate (% of people ages 15 and above) 68% for year 2022. Carbon dioxide emissions (metric tons per capita) 0.7 for year 2020, forest area (% of total land area) 26.1 for year 2021.

Forests contribute directly to the GDP of many countries in Africa, with estimates of the contribution of forests to GDP for example at up to 6 percent in the Republic of the Congo [18]. Environment refers to the living and non-living components of the natural world, and to the interactions between them, which together support life on earth. The environment provides goods and services used for food production, the harvesting of wild products, energy, and raw materials. The environment is also a recipient and partial recycler of waste products from the economy and an important source of recreation, beauty, spiritual values, and other amenities (WSSD, 2002).

Moreover, population pressure and poverty are the main threats to forest conservation, driving poor farmers to convert forests to cropland in Africa [19, 20] and to harvest wood fuel at unsustainable levels. An estimated result [21] using time series data from 1981 to 2015 examines the impact of poverty, population density, and trade openness on deforestation in Nigeria, it implies that when income per capita increases, deforestation experiences an increasing trend up to a certain point, after which it reverts with a continuous increase in income per capita.

African Development Bank (AfDB) Sub-Saharan Africa has experienced some promising developments. Africa's economic growth for 2020 is anticipated to have been close to 4%, in 2019, the world's 10 fastest growing economies included six African countries: Rwanda at 8.7%, Ethiopia at 7.4%, Cote d'Ivoire at 7.4%, Ghana at 7.1%, Tanzania at 6.8% and Benin at 6.7% [22].

A special report on the issue on access to energy in Sub-Saharan Africa by the United Nations of Development Programme (UNDP) detailed, energy consumption in Sub-Saharan Africa varies dramatically, however, "non-commercial" fuels such as wood and animal waste dominate fuel consumption. Africa is the world's largest consumer of biomass energy, calculated as a percentage of overall energy consumption. access rates to energy in Sub Saharan African remains the lowest in the world [23].

### III. Methodology

#### *Data source and description of variables*

The study relies on secondary data on poverty and the environment for year 2021, the data available at WBOD (2023). Poverty is measured as the number of people living below the international poverty line of \$1.90 a day (PPP 2017), and its indicators include such variables as health and education. The study uses data in the GDPC, AS, DFC, MS and GI. The state of the environment is measured in terms of CD and indices of agricultural productivity and human health. Given hereby definitions for the variables employed by the empirical model both as dependant and explanatory variables.

The PE: is measured by the number of population living below \$1.90 per capita per day level of consumption or income at 2017 prices, total population: includes all residents regardless of their legal status or citizenship and excluding the refugees not permanently settled in their country of asylum; GDP: is measured by gross value added, at purchase prices, by all resident producers in the economy plus any taxes and minus any subsidies not included in the value of the products; GDPC: is calculated by divided GDP and total population mention above; AS: corresponds to the International Standard Industrial Classification (ISIC) divisions 1-5 and includes forestry and fishing. Due to the difficulties in collecting, recording and compiling of data, a combination of methods is used to estimates the outputs, yields and area under cultivation to predict the agricultural production; DFC: is calculated by dividing annual deforestation per one thousand square kilometres by total population.

Annual deforestation is the permanent conversion of forest area to other uses, including shifting cultivation, permanent agriculture, ranching, settlements and infrastructure development; FPI: covers food crops that are considered edible and that contain nutrients; GI: measures the deviation of income distribution among individuals or households with respect to a perfectly equal distribution; IR: number of people age 15 and above who cannot read and write in an effective way; MS: is the net output of manufacturing sector after adding up all outputs and subtracting intermediate inputs.

EXPH: consists of governmental spending, external borrowings and grants and social health insurance funds; CD: refer to those stemming from the burning of fuels and the manufacturing. These emissions include carbon dioxide produced during consumption of solid, liquid and gas fuel and from gas flaring; EU: it is apparent consumption measured by adding the indigenous production to imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transportation. Commercial energy use is designed as the domestic primary energy use before transformation to other end-use energy sources; NER: is the ratio of the number of children of official school age who are enrolled in school to the population of the corresponding official school age.

#### *Theoretical framework*

Theoretical framework which provides for the arena as covered by the research topic is given as Figure 1. The schematic model as represented in the model gives variables which combine to give rise to environmental degradation. Among others, these include parameters such land quality, deforestation and carbon dioxide emissions. On the other hand, the model outlines contributing factors to environmental degradation such as provision of essential social services. Moreover, the model highlights the impacts of environmental degradation both at the sectoral and macro levels in the



form of declining agricultural productivity and hence incomes. This ultimately implicates at the macro level breeding declining economic growth and subsequently dwindling GDPC.

Figure 2 depicts the association between economic growth, rural poverty and environmental degradation. It meant to further scrutinize the reciprocal interactive causation between components and consequences of economic growth such as agricultural and manufacturing development and energy consumption, on one hand, and facets of environmental degradation and rural poverty on the other.

Figure 3 on environmental degradation and health impacts on the poor highlights the consequences of air and water pollution and scarcity, deforestation and soil degradation as a major aspects of poor environmental quality in Sub-Saharan Africa. The figure pin-points the socio-economic implications of environmental degradation.

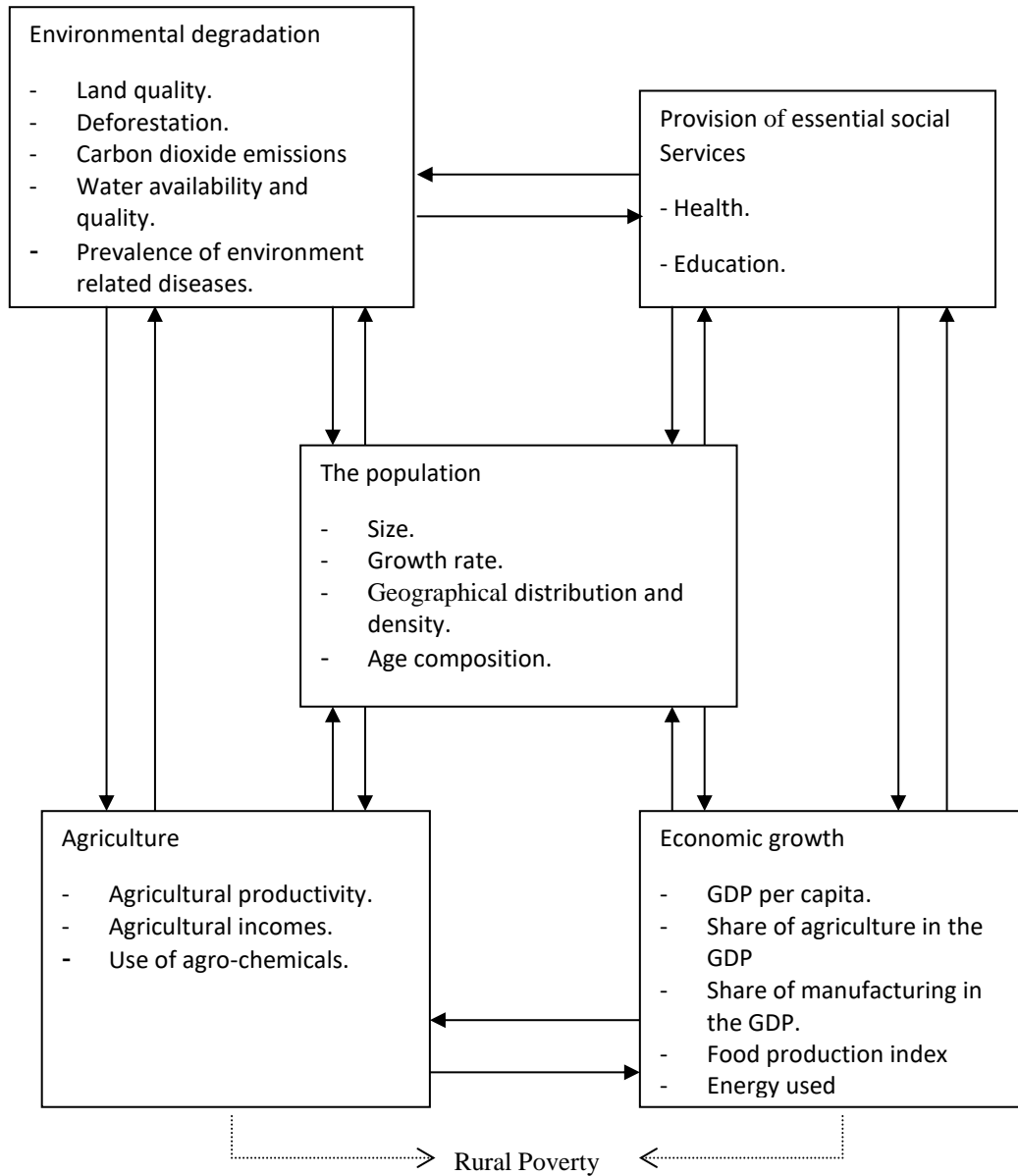


Figure 1. Linkages rural poverty and environmental degradation

Legend:

Reciprocal interaction between variables implying two-way cause-effect relationships.

Dotted arrows indicate physical and financial flows of income

(Source: Compiled by the researcher)



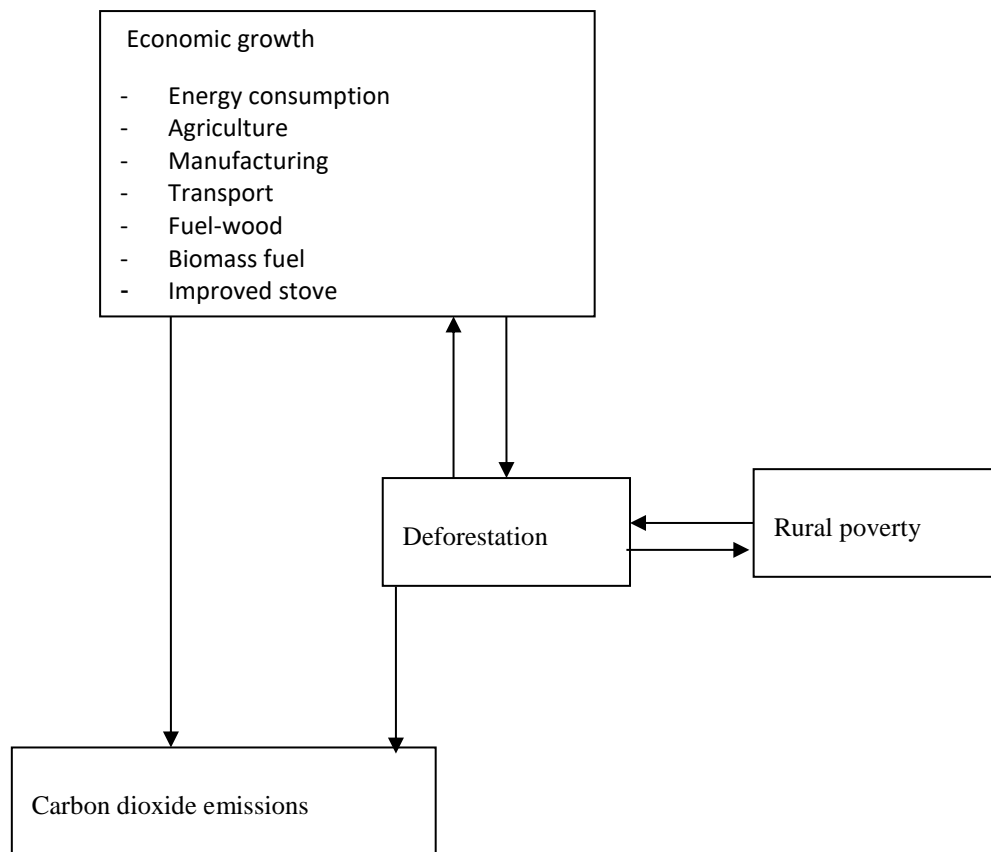


Figure 2. Economic growth, rural poverty and environmental degradation nexus

Legend:

Direct linkage

(Source: Compiled by the researcher)



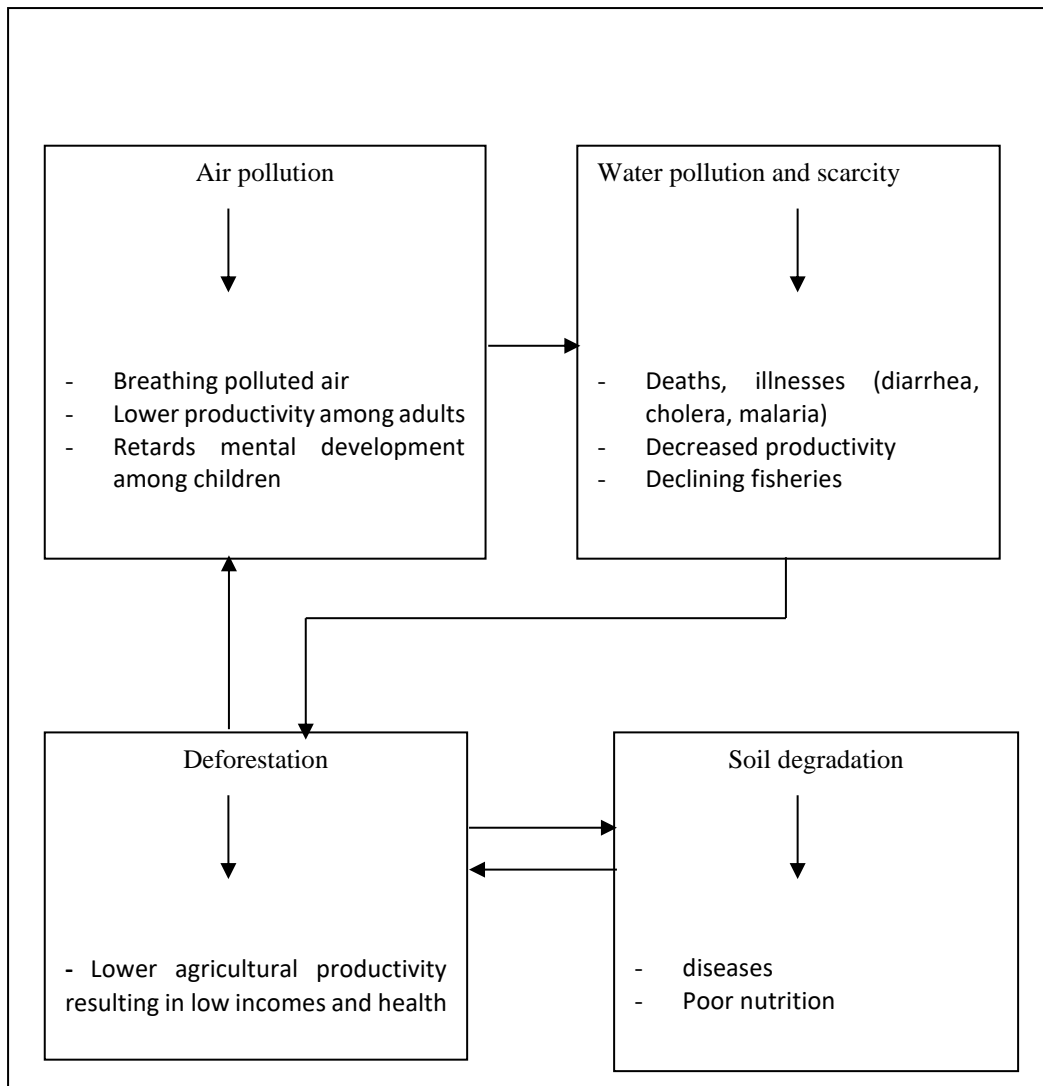


Figure 3. Environmental degradation and health impacts on the poor people  
Legend:

↓  
Direct relation between environmental degradation and health  
(Source: Compiled by the researcher)

**Empirical model**

A recursive regression model has employed as a means of analysing the data and hence arriving at results, findings and conclusions with regard to the inter-relationship between rural poverty and environmental degradation. A resort to the recursive has been made to avoid the problems following the analysis when we used Ordinary Least Square (OLS) method namely, bias, inconsistent and the interdependent between the explanatory variables. The model which has been designed to analyse the rural poverty-environmental degradation nexus is made up of five behavioural equations as follows:

PE as a function of macro-economic variables: This equation depicts poverty as an outcome of explanatory variables made up from macro-economic variables. We would expect that negative relationship between PE and GDPC, the higher GDPC, the lower PE. Also negative relationship between PE and AS, the higher AS, the lower PE would be expected. Positive relationship would be anticipated between PE and DFC, the higher DFC, the higher PE. Negative relationship would be expected between PE and FPI, the higher FPI, the lower PE. GI can be positive or negative from the fact that inequality worsens at first with development and improved only later (World Bank, 1990). Thus, this equation shall take the following structure:

$$PE = F(GDPC, AS, DFC, FPI, GI). \tag{1}$$

Social poverty as a function of macro-economic and macro-social factors: This equation investigates social poverty as a reflection of selected macro, social and human development indicators. Poverty is viewed as an expression of the adequacy or otherwise inadequacy of the access of the population to basic social services, for example the level of





degradation variable embedded into this equation which mainly seeks an explanation for poverty from a macro-economic perspective. FPI and GI were in the equation have been found to be insignificant.

Equation 2 models poverty expressed in social terms as illiteracy rate as a function of a set of socio-economic factors. The estimation of equation 2 is presented as follows:

$$\text{IR} = 0.778 + 0.701\text{PE} + 0.001\text{GDPC} + 0.007\text{MS} - 0.04\text{EXPH}$$

$$(0.766) \quad (12.797) \quad (0.937) \quad (3.494) \quad (-3.420)$$

$$R^2 = 0.964 \quad \text{D-W} = 1.713$$

Good fit and high explanatory power for equation has been obtained as evidenced by  $R^2$  at 0.964. All the independent macro-social variables are significantly related to social poverty, as indicated by the F value significant at 0.000. All coefficients were found to be significant different from zero as indicated by the t-values in the parentheses. Furthermore, EXPH bears an expected negative sign. The result confirms the hypothesis that social poverty is functionally related to socio-macro economic factors, and that expenditure on health services impacts positively on reduction of poverty measured in terms of a major social indicator such as illiteracy. The result points out that scaling up expenditure on health on its own would be reflected in better literacy. Intuition tells us that good health is a pre requisite for enhancing the educational standing of individuals and hence communities.

On the other hand, it has been found that, poverty expressed in economic terms as persons living on less than US \$1.9 a day has been statistically significant at 0.05 level and positively related to poverty expressed in social terms (IR), this result reveals that social deprivation expressed in terms of illiteracy underlies poverty as economic phenomena. This gives evidence to the effect that both aspects of poverty are not anything but two faces of one coin; human deprivation. GDPC has been found to be insignificant at 0.05 level and possess a positive sign. The relationship between IR and GDPC as revealed upon estimation of equation two shows a direct proportionality between the two variables. This implies an increase in poverty as GDPC improves. Similar tendency between share of manufacturing sector and illiteracy has been substantiated by estimation of equation two. Such a result proves that growth of the manufacturing sector in Sub-Saharan Africa rather than making contribution to social development, in the way of reduction of social deprivation, as a manifestation of poverty, it has rather being reliant on a pool of cheap rural labourers who are mostly illiterate.

Equation 3 models environmental degradation expressed as CD, as a function of PE, IR, GDPC and EU. The estimation of equation 3 is as below:

$$\text{CD} = 0.179 - 0.053\text{PE} - 0.0028\text{IR} + 0.0003\text{GDPC} + 0.0001\text{EU}$$

$$(1.241) \quad (-2.360) \quad (-0.105) \quad (2.030) \quad 10.155)$$

$$R^2 = 0.931 \quad \text{D-W} = 1.628$$

Good fit and high explanatory power for equation has been obtained as evidenced by  $R^2$  at 0.931. All the independent variables are significantly related to carbon dioxide emissions, as indicated by the F value significant at 0.000. The PE variable is negatively related to carbon dioxide emissions. However, such a finding is plausible on the basis that increased carbon dioxide emissions is in general a consequence of high rates of urbanization and manufacturing which reflect conditions prevalent in the developed countries and least in the developing ones. The coefficient of EU has been found to be statistically significant at 0.05 level and positively related to environmental degradation. This implies that an increase in energy use automatically leads to environmental degradation.

Equation 4 models secondary school enrolment –as a proxy for environmental awareness- as explainable by a set of socio-economic variables. The estimation of 4 four is as follows:

$$\text{NER} = -24.894 + 0.577\text{PE} + 0.785\text{IR} + 19.082\text{CD} + 0.007\text{AS} + 0.206\text{EXPH}$$

$$(3.436) \quad (-0.123) \quad (-5.097) \quad (-2.781) \quad (8.351) \quad (4.470)$$

$$-0.038\text{MS} - 0.002\text{EU} + 0.046\text{GDPC}$$

$$(-1.727) \quad (-0.970) \quad (4.941)$$

$$R^2 = 0.834 \quad \text{D-W} = 1.854$$

Generally, a good fit and high explanatory power for equation has been obtained as evidenced by  $R^2$  at 0.834. All the independent variables are significantly related to secondary school enrolment, as indicated by the F value significant at 0.001. The estimation results indicate that an increase in the number of poor people leads to lower the level of education, the causation is direct, poverty makes education beyond the reach of the poor as it entails costs. The latter would stem from both of availing schooling expenditure as well as depriving poor families from the economic rewards to be availed by their children either in kind or in cash.

Estimation of equation four indicates that the coefficient of environmental degradation has been found to be statistically significant at 0.05 level and negatively related to level of education of poor people. Such a negative relationship between environmental awareness is explainable along a premise as follows. High carbon dioxide emissions are conducive to poor health. Bearing in mind, the prevalence of malnutrition and poor health standing and services in Sub-Saharan Africa. Poor health is highly likely to be associated with poor education services. This stems from the nature of poverty as multifaceted phenomena.

The coefficient for the share of agriculture in the GDP has been found to be statistically significant at 0.05 level and positively related to net enrolment in secondary schools. This finding indicates that an increase in agriculture investment is required as a means of raising the profile of environmental awareness. The estimation results for equation four also show that better health leads to high level of education as indicated by the positive sign between public expenditure on health and net enrolment in secondary school. It is widely believed that many of the economic problems in the developing countries can be attributed to excessive or inappropriate government intervention in the way of availing social services.

Equation 5 of the empirical model, analyses environmental degradation measured as per capita deforestation as a function of selected socio-economic variables and single environmental quality variable. The estimation of equation 5 is as follows:

$$DFC = 39.089 + 2.830PE - 3.681IR - 44.664CD - 0.131NER + 0.098GDPC$$

$$(1.998) \quad (1.101) \quad (-0.961) \quad (-2.548) \quad (0.205) \quad (2.323)$$

$$R^2 = 0.634 \quad D-W = 1.790$$

The estimation results indicate a good explanatory power and goodness of fit as it can be concluded from  $R^2$  with a magnitude of 0.634, and F value, which is significant at 0.005 points out that all of the explanatory variables are functionally related to – alternatively associated with DFC as a dependent variable. Carbon dioxide emissions show a negative coefficient; this implies that higher rates of carbon dioxide emissions are associated with less deforestation. In other words, less rates of carbon dioxide emissions are associated with high rates of deforestation. Such a result based on estimation of equation five of the empirical model- is a reflection of the economic structure predominant in Sub-Saharan Africa.

Agricultural production is a major economic activity and income generator. However, because of the significant of traditional farming –which virtually uses no fossil fuel- in relation to modernized and such contributes to carbon dioxide emissions. GDPC proves to be statistically significant with a positively signed coefficient. This would reveal a direct relationship between economic growth measured in terms of GDPC and deforestation a principal indicator of environmental degradation in the study area. This entails that economic growth, particularly at the early stages of development, would result in higher rates of deforestation.

## V. Discussion

The findings are then discussed in the light of the study research and the body of literature as it relates to the research topic. This implies that affecting development at the national level is a necessary condition for alleviation of poverty. However, it is significantly relevant to point out the well-known shortcomings of GDPC as a measure of social welfare in general and as an indicator of income distribution as amongst the various socio-economic group which make up every society.

Impressive gains in GDPC may materialize, yet the lot of the poor might well go down, however the result as it applies to this study on the association between poverty alleviation and economic growth expressed as per capita gross domestic product is encouraging as well as the positive prospects for national development programmes as a means of poverty reduction.

However, the negative relation between income poverty and share of Agriculture in GDP signifies the predominance of agricultural development programmes plagued by recruitment bias and therefore a bias against the interests of the poor when it comes to the distribution of the benefits of such agricultural development programmes.

The result reveals that a reduction in poverty rates would be a positive contributing factor to environmental quality promotion. The finding is far – reaching as an indication of the two-way interaction of poverty and the environment. The result points out clearly to the role of sound environmental management as a vehicle of easing the grip of poverty on rural population. Plans and programmes aimed at conserving the vegetative cover in Sub-Saharan Africa would prove to be effective stimuli of equitable income distribution and an efficient booster of poverty reduction.

From one hand, expenditure on health could be helpful for better education as poor health would only result on poor educational performance. Government spending on health usually rises with economic development. Through training medical personnel, investing in clinics and hospitals, licensing practitioners, testing drugs and running subsidy and insurance schemes, in addition to directly providing medical care, the public sector would be dominant player in the development of the health sector.

From other hand, a paradoxical role for increased GDPC on poverty is readily explainable on the grounds that GDPC as macro-economic indicators is a measure which weights GDP by population size without giving what–so–ever attention to actual income distribution as amongst various socio-economic strata that make up every society. This reveals that whilst per capita GDP increases, not parallel allocations to education are made to the extent which result in per capita GDP improvements being a cause for deteriorated poverty measured in social terms.

Valuable contribution by International Monetary Fund (IMP), an improving living standards and potential growth, particularly in resource intensive countries, boosting income per capita will require wide-ranging structural reforms, including investment in education, better natural resource management, improved business climate and digitalization,

and a commitment to trade integration. The region is expected to rebound by 2024, with growth increasing to 4.0% in 2024 from 3.3 in 2023 [24]. Structural reforms can help to ensure broad-based and durable improvements in living standards, reducing divergence in Sub-Saharan Africa and reducing inequality more generally.

Orientation of UNDP (2023) about energy issue, the low levels of access to energy in sub-Saharan Africa and the negative impact of the types of energy dominating supply requires concerted efforts by all stakeholders to seek sustainable solutions to improve access to modern energy services. For example, exploiting the vast array of renewable energy sources available on the continent could present an opportunity to transition from the heavy polluting fuels that dominate the current energy mix to low-carbon or zero-emission energy sources. This would reduce the adverse health effects associated with the use of dirty fuels, introduce efficient fuels in the energy mix, and build a climate-resilient energy sector.

The most recent data for carbon dioxide emissions in 2021 clearly show a rebound in emissions compared to 2020, which was strongly affected by covid-19 globally. Global carbon dioxide emissions in 2021 increased by 5.3% compared to 2020 and were just 0.36% smaller than in 2019. The covid-19 crisis slowed down the global economy in the first half of 2020, resulting in an interruption in the global growth in Carbon dioxide emissions.

As such, the poor were found to be less aware of environmental problems which are bound to affect their lives. This suggests a positive role for raising the profile of environmental awareness –expressed as availing more educational opportunities- as a means of improving environmental awareness. Carbon dioxide emissions -a measure of environmental degradation- proves to be negatively associated with environmental awareness. This would lead to the inference that environmentally degraded environments would perhaps contribute to less environmental awareness. The linkage here can be thought of in the way how specific modes of development would be expected to affect the lives of the poor.

To drive this point home, national development plans and actions which prioritizes manufacturing though are expected to speed up economic growth, yet such development programmes by relying more on intensive labour technologies as opposed to capital intensive ones, would not affect a parallel expansion in social services which ultimately raises the capacity and capability of the population in question. As such, it is highly likely that imbalanced development which does not attend to promote the production base of the economy as well as raising the profile of social services availability will adversely affect environmental awareness.

To sum up, the two share of agriculture in the GDP as well as expenditure on health reveals a positive impact on environmental awareness as judged by their positively signed coefficients. This would stem from the impact of services such as agricultural extension and community health services as a means of enlightening rural communities as to the misgivings of environmental degradation and the potential opportunities inherent in environmental conservation and quality promotion.

Agricultural expansion in Sub-Saharan Africa –in general- contributes less to carbon dioxide emissions. The negative association between carbon dioxide emissions and deforestation stems from the nature of agricultural growth in these countries, which relies on encroaching on forest lands rather than improving resource use efficiency. Data compiled by FAO (2020) evident that given that agricultural expansion is the main driver of deforestation.

Deforestation in the study area dramatizes environmental degradation in Sub-Saharan Africa. These countries due to the prevalence of brief rainy season and long dry ones coupled with cyclic dry spells and drought are at the immediate threat of deforestation which degrade soils, result in low and declining incomes and as such in the predominance of low standards of living and hence the spread of poverty. Deforestation, as the study result show, taken as a dependent factor is positively related to the incidence of poverty.

This highlights the ways by means of which the rural poor may turn out to be environment degraders. The explanation for the positive proportionality between deforestation as environment degrading factor and prevalence of poverty is the poor in their quest to earn living would be inclined on what-so-ever forest or other vegetative cover lands. This would spawn deforestation which would accelerates over time to result in desertification. The latter which is indiscriminately affects Sub-Saharan Africa at varying magnitudes is a principal factor which underlies diminishing productive capacity of agricultural land which ultimately result in the spread of poverty.

Similar findings have been concluded on the inter-relationship between deforestation and economic growth. Along similar lines conclude to what they have referred to as an inverted Kuznets curve, such a curve is a sort of an inverted U. With per capita GDP measured on the horizontal axis, and deforestation on the vertical one, deforestation would increase as GDP increases up to a point of deflection after which increases in GDP would result in less deforestation. This would take place at a later stage whereby the manufacturing sector becomes the leader and pace-setter of economic growth [25].

The analysis also concludes that, deforestation as an environmental hazard has been found to be negatively associated with literacy rate, carbon dioxide emissions and environmental awareness. Such a finding is explainable on the following grounds. Literate people would be expected to be more aware of the consequences of environmental degradation and hence of preserving the environment intact. Carbon dioxide emissions are likely to be on the high level as countries venture more towards manufacturing. Such state of affairs would bring into play less dependence on

agricultural expansion and as thus less deforestation. The link between environmental awareness and deforestation is direct, the more the population is oriented towards environmental conservation as a result of them being well aware of the significance of the natural environment to their well-being, the less will be deforestation.

Actions to combat deforestation have gathered pace over the past decade, primarily because of awareness that the loss of forests and the use of fire to clear land is having negative impacts on the global carbon cycle. In order to reduction of emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries as a recommended action in the Paris Agreement. A recent analysis of 31 national strategies and action plans [26] highlights priority actions to reduce deforestation and forest degradation.

A number of international initiatives have provided support to these efforts, including the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation, programme jointly operated by FAO, the UNDP and UNEP, the Forest Carbon Partnership Facility and the Forest Investment Program of the World Bank. The New York Declaration on Forests, a voluntary and non-binding international declaration to take action to halt global deforestation launched in 2014, now has over 200 endorsers, including national and subnational governments, multinational companies, groups representing indigenous communities and NGOs.

The new FAO estimates, based on a simple carbon stock change approach, update published information on net emissions and removals from forests in relation to net forest conversion and forest land. Results show a significant reduction in global emissions from net forest conversion over their study period, from a mean of 4.3 in the 1991–2000 to 2.9 in 2016–2020, at the same time, forest land was a significant carbon sink globally. Moreover, the findings indicate that in the decade just concluded the net contribution of forests to the atmosphere, representing the combination of emissions from net forest conversion and removals on forest land, was very small.

Sub-Saharan Africa is significantly behind many other regions in terms of human capital accumulation, enrollment rates in the region's secondary schools is 54% fall far below the rates seen in other regions under study estimated at 89%. Greater focus on education and training can help boost productivity for the millions of workers now entering the workforce, ensuring they are better able to participate in the global economy. Investing in girls' education, in particular, can have multifaceted returns adding to productivity gains, boosting savings, improving health outcomes and ensuring that the opportunities and benefits of economic growth are passed on to future generations. As a priority, therefore, authorities should both widen the access and improve the quality of education. For example, abolishing school fees (recently implemented in Zambia) and providing school lunches and stipends can help attract and retain students, while hiring and training new teachers is critical to ensure that quality standards do not slip as the school population grows (IMF, 2023).

## VI. Conclusions

This paper has concluded that the rural poverty measured either in economic terms as persons living on less than US \$1.9 a day or in social terms as illiteracy rate is well explained by socio-economic variables at the macro level. For instance, the variables like per capita GDP, share of agriculture and manufacturing in the GDP and public expenditure on health. On other hand, the study concludes that carbon dioxide emissions and deforestation as aspects and manifestation of environmental degradation are functionally related more or less to the same set of socio-economic variables. This leads to the conclusion that rural poverty and environmental degradation are inter-related in the sense that both are causally related and hence explainable in the light of macro-socio economic variables such as the ones incorporated by the study. Moreover, environmental awareness, a crucial factor for initiation and fostering of rural populations in environment conservation and quality promotion bears strong functional relationship with socio-economic factors. This would make plausible the inference that socio-economic factors at the macro level as made by this study provide for sound investigation of the inter-relationship between rural poverty and environmental degradation. Besides the macro socio-economic factors as identified by the study are capable of promoting environmental awareness these factors are appropriate policy manipulation.

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