ISSN: 2288-2766 © 2014 EABEA. http://www.eabea.or.kr
doi: http://dx.doi.org/10.13106/eajbe.2014.vol2.no4.1.

Population growth and carbon dioxide emission: An investigation of the Africa perspective

[1] **Abdulrasaki Saka**

1 First Author & Corresponding Author Department of Economics and International Development, Middlesex University, London, United Kingdom. Tel: +44-740-460-6703; +44-777-426-8097. E-mail: A.Saka@mdx.ac.uk; A.Saka@live.mdx.ac.uk

Received: July 28, 2014., Revised: December 01, 2014., Accepted: December 15, 2014.

Abstract

This study examines the relationship between population growth and carbon dioxide emissions in the context of Africa perspective. Population growth and carbon dioxide emissions helped identify the key driving forces of environmental impacts by including other predictors in all the different income levels of all sampled countries in Africa. To explore the role of population growth in the emissions of carbon dioxide, this research employed a panel data set of 52 Africa countries from 1960 to 2012 using fixed effects, random effects and GLS/FGLS estimators to estimate the modified STIRPAT model. The results found that a 1% increase in population growth suggests an increase in carbon dioxide emission loads by about 0.33%, 1.08%, 0.57% and 2.32% on the average, controlling for all other anthropogenic driving forces, for LICA, LMICA, UICA and HICA respectively. There is a significant relationship between population growth and carbon dioxide emissions in all the national income levels in Africa.

Keywords: Population, Investigation, Africa, Perspective.

1. Introduction

The population trends in Africa continent have generated concerns in the scientific community leading to the suspicion that it may have influenced recent increased in carbon dioxide emissions in the last few years. However, Africa continent still accounts for the lowest carbon dioxide emissions when compared with other continents and/or regions of the world, yet the carbon dioxide emissions trend have been on an increasing trend since 1960 according to the World Bank data sheet (http://data.worldbank.org/indicator). For example, in 1960 the total carbon dioxide emitted was 145,972.275 kilo-tonnes (kt) and this increased to 1,170,521.068 kilo-tonnes (kt) in 2010. In terms of population, Africa accounts for the fasted rate of human population growth (United Nations Population Fund 2013) and the biggest number of extra people in absolute terms (Haub 2012) between 1960 and 2012, and this will continue (United Nations Population Fund 2013). The projection for future growth in 2005 confirmed that the largest percentage growth in world population will be in Africa, "whose population can be expected to at least double from 1.1 billion to about 2 billion" (Haub 2012). This estimate is based on the assumptions that the average number of children per woman- total fertility rates (TFR) will reduce from "5.1 to approximately 3.0 by 2050". Thus, both of these trends have increased since 1960, and these have fuelled our motivation to investigate the relationship between population and carbon dioxide emissions in Africa.

As population pressures increases, the demand for energy increases to meet the essentials of life such as food, water, shelter, transportation; the suspicion is that population growth is largely responsible for increasing energy demand, and both of these trends have accelerated since 1960 according to statistical estimates, fuelling the debate on the interactions between population growth and environmental problems in Africa.

In addition, population growth in Africa has generated a surge in the demand for more farm land leading to more cultivation of forest lands, extensive and intensive agricultural practices in most countries in the continent. The population pressures have also engendered rapid infrastructure developments (road constructions have increased tremendously to cope with increasing vehicular movements; hospitals, schools, recreational facilities, etc. have all increased in line with the size of the population), cement factories are rising with the scale of the demand. All these mean an encroachment into the forest areas and an increase in fossil fuel emissions. Furthermore, increasing prices of oil and removal of subsidy on oil have accentuated the drive to turn to forest areas for fire -wood for cooking and other essentials of life.

Previous studies have attempted to examine population-environment nexus in developing countries, but pay little attention to the relationship between Africa population dimensions and carbon dioxide emissions as a specific study. Recent works have also assumed that negative linkages exist between population and carbon dioxide emissions in Africa. This study test the validity of these assumptions, and our main goal is to investigate the relationship between population growth and carbon dioxide emissions in Africa among different income groups. The countries in Africa are classified into four different income levels according to the World Bank: low income countries in Africa (LICA-26 countries), lower middle income countries in Africa (LMICA-15 countries), upper income countries in Africa (UICA-10 countries) and high income countries in Africa (HICA- 1 country).

This study is organised as follows: Section 2 presents the literature review on the linkages between population growth and carbon dioxide emissions in Africa according to the income levels. Section 3 presents Methodology: the samples, the construction of the variables, and the models specification. Section 4 presents the findings. Section 5 presents the conclusion.

2. Literature Review

While supporting a more empirical investigation between population growth and Co_2 emissions, Shi (2001) studies underscore the importance of this consideration: the research pointed out that previous studies paid more attention to the link between Co_2 emissions and affluence (per capita GDP) than between the Co_2 emissions-population growth nexus. Furthermore, the so-called affluence is motivated and influenced by population. This finds theoretical support in the Malthusians tradition (Shi 2001, 2003; Diet & Rosa 1997; Neumayer 2004). The findings for the period 1975-1996, suggest that population growth is one of the key drivers behind rising emissions globally over the 20-year period. The estimated results show that half of the rise in Co_2 emissions by 2025 will be attributed to future growth in population alone, whereas affluence has been linked with monotonically upward shift in Co_2 emissions. Neumayer (2004) used a more robust estimation technique and investigated two different types of air pollutant simultaneously. The study claimed to be the first to use sulphur dioxide (So_2) and Co_2 emissions to investigate the relationship between population size, other demographic factors and pollution, at cross national level. It also considered the urbanization rate and average household (family) size not accounted for by many prior cross-sectional econometric studies. The estimated results show that for Co_2 emission population increases are matched by proportional rising in emissions (this is consistent with Dietz & Rosa (1994)), and a higher urbanization rate and lower average family size increase emissions. This also found support with previous studies that shows concern for Africa countries with high population growth rates and a trend towards rapid urbanization and smaller household sizes. Meyer & Turner II (1992) consider population growth as the proximate sources of change (the human actions) that directly alter land cover. The study noted that the role and importance of these drivers notwithstanding, works on the anthropogenic forces of world climate change is in considerable disarray. It states that "many studies in the literature are either weakly connected (shopping lists of 'causes' unrelated to one another) or unduly hypothetical (plausible arguments unsupported by case-specific data)," Meyer & Turner II (1992, p. 51). The research called these two syntheses "extreme approaches" (ultra-empiricism and ultra-theoreticisms). In the case of ultra-empiricism, a correlation of +0.9985 exist between world population growth and tropospheric Co_2 levels since the 1950s proof and evidence of population growth's fundamental role (Newell & Marcus 1987). The Neo-Malthusian arguments that population growth is the primary driving force of resource depletion was countered, as Harvey (1974) deprecated the supposition as politically founded. Harvey was also critical of the former as it is apt to mistake correlation for cause or "absence of correlation for causal unimportance" in a complex global environment; and the latter is apt to narrow excessively the scope of examination in the absence of recourse to data. The study stated that fundamental theories need to be drawn upon. Further still, the drivers of environmental change may vary with types of change involved, Meyer & Turner II (1992) argue that forces that drive some may reduce or lessen others. For example, increasing interest rates or rising agricultural prices will increase deforestation because they provide incentive for further clearing; simultaneously such practices prevent soil erosion on cultivated land since they provide incentive to adopt soil conservation measures. Hughes, et al. (2003) investigates the relationship between human impacts and coral reefs, the report stated that diversity, frequency, and scale of population on coral reefs are rising to the extent that reefs are threatened worldwide. The projected increment in Co_2 emissions and temperature over the next five decades is greater than the conditions under which coral reefs have flourished over the past half-million years. However, some reefs are changing with variation in climate, with some species showing greater tolerance while others may be endangered. The study suggested support in the form of vigorous implementation of international management strategies for reef resilience, complemented by strong policy measures to mitigate carbon dioxide emissions. The literatures by Jorgenson & Kick (2004) observe a gap in the mounting global literature on population-environment interaction. It noted that what is lacking is a focus on the theoretical foundation with parallel empirical investigations of world structures and their environmental impacts (consequences). The study investigates the global economy and related non-economic forms (factors) of world structuring impact the natural environment and quality of life of human population globally. The report presented environmental dynamics dated back to the Ancient Egypt and the Modern Amazon based on world-system approach, and linked environmental outcomes and antecedents to global processes (see Jorgenson & Kick 2004). The work of Alam, et al. (2007) analyse the effects of population growth, economic growth, energy intensity growth and urbanization growth on environmental degradation in Pakistan. In this study, environmental degradation was held constant in order to ensure sustainability of economic development, as increases in environmental degradation indicates moving away from sustainability path and a decrease suggests moving closer to sustainability. The estimated results indicate that both increased population growth and rapid urbanization showed a statistically positive association with environmental degradation. Overall the literature found significant evidences that population growth and carbon dioxide emissions are strongly related. In the literature of Ehrhardt-Martinez (1998), the investigation of social determinants of deforestation which induces carbon dioxide emissions in developing countries was carried out, and applied to a cross-national comparison of 51 LDCs.

The Malthusian and Boserupian traditions form the foundation upon which our theories are rested, and we derived our models from the theoretical underpinnings of these two perspectives: For instance, Malthus (1798) conceives that population growth is limited by the means of subsistence, whereas Boserup (1965, 1981) argues that population density is the cause of agricultural intensification in Europe, which triggered technological breakthrough. Thus, Boserup maintained that agriculture is not the cause of population growth, but the reverse, that is, population is the cause of agricultural growth and technological development. Furthermore, a small society with a small population may remain economically stagnant because population pressures drive economic growth.

3. Methodology

3.1. Data Source

We constructed an unbalanced data set of 52 African countries for the period 1960-2012, with a sample of 2764 observations. However, the actual sample size depends on the specification of the models. The research excluded South Sudan because she got her independent 2 years ago; other countries excluded are mostly Island countries whose data on carbon dioxide emissions are scant or not available at the time of this study. Out of the 54 Africa countries, our samples of 52 countries are fairly large enough and satisfactory for our investigation. Among the 52 Africa countries, 26 are low income countries, 15 are lower middle income countries, 10 are upper income countries and 1 is a high income country (these groups are in line with the World Bank 2014 classification).
The data used are derived from the World Bank data set (see http:// data.worldbank.org/indicator, 2014). The information on carbon dioxide emissions collected includes emission from total fossil fuel consumption and cement manufacture. The study actually used per capita carbon dioxide emissions defined as the aggregate emissions from total fossil fuel consumption and cement manufacture deflated by population size. The population growth rate is also gathered from the World Bank. The affluence (final consumption expenditure (annual % growth) data is gathered from the same source. The technology was disaggregated into economic structures: manufacturing sector value added as a percent of GDP and services sector value added as a percent of GDP, permitting comparisons across the different countries and over time (sees Shi, 2003).

3.2. Model specifications

We address these concerns by adopting the STIRPAT (stochastic impacts regression on population, affluence and technology) model formulated by Dietz and Rosa (1994), but modified.
Beginning with the challenge of

$$In\left(I_{it} \right) = In\left(aP_{it}^{\alpha} A_{it}^{\beta} T_{it}^{\varphi} e_{i} \right) \qquad (1)$$

We estimate the following models on which our findings are reported:

$$lnI_{it} = a + \omega\left(C^{C}\right) + \Omega\left(y^{C}\right) + \alpha\left(lnP_{it}\right) + \beta\left(lnA_{it}\right) + \varphi\left(lnT_{it}\right) + \theta\left(lnM_{it}\right) + \psi\left(lnS_{it}\right) + e_{it} \quad (2)$$

$$a_i = a + \omega\left(C^{C}\right) + \Omega\left(y^{C}\right) \quad (3)$$

In models (2) we applied fixed effects estimator.

$$ln\left(I_{it}\right) = a + \alpha ln\left(P_{it}\right) + \beta ln\left(A_{it}\right) + \varphi ln\left(T_{it}\right) + \theta ln\left(M_{it}\right) + \psi ln\left(S_{it}\right) + e_{it} \quad (4)$$

In models (4) we used random effects estimator.

$$ln\left(I_{it}\right) = \alpha ln\left(P_{it}\right) + \beta ln\left(A_{it}\right) + \varphi ln\left(T_{it}\right) + \theta ln\left(M_{it}\right) + \psi ln\left(S_{it}\right) + e_{it} \quad (5)$$

In models (5) used GLS/FGLS estimator

$$ln\left(I_{it}\right) = a + \alpha ln\left(P_{it}\right) + \beta ln\left(A_{it}\right) + \varphi ln\left(T_{it}\right) + \theta ln\left(M_{it}\right) + \psi ln\left(S_{it}\right) + e_{it} \quad (6)$$

In models (6) we used OLS estimator for high income country in Africa (HICA), this is so because only one country (Equatorial Guinea) is classified as the HICA. This study adopt STIRPAT model, but modified and expanded the models to permit suitability to Africa situation. This is because Africa countries possess some characteristics peculiar to the continent which are crucial for any investigation regarding economic and environmental analysis, which previous studies did not take into account.

Furthermore, this research investigates the magnitude impacts of population dimensions (population growth) in order to determine population growth impacts on carbon dioxide emissions (environment) in Africa for policy adjustment. This gap is crucial because previous studies are convoluted in debates and argument and counter argument over whether population growth is the right population dimension to employ as the key driving force of environmental impact or population density or population size or population structure. Previous studies have used each of these population dimensions at a time, while the controversy on the potency of each of these impacts of population dimensions on emissions still remains inconclusive. This study, therefore, investigates all these population growth and shows its relationship withcarbon dioxide emissionsin Africa.

4. Findings

The findings in the panel regression analyses are presented in the tables below. Our findings are presented from fixed effects, random effects and FGLS (this is due largely to the autocorrelation errors- AES). We carried out diagnostic test using Hausman test to determine the appropriate estimator. The test found support with previous literature which checked for the robustness between emission-population nexus by testing for a higher order of autocorrelation of the error terms (Shi, 2003). Our test indicates mixed results, but favour the fixed effects, and this is consistent with Hossain (2013) and Lambert (2013) who argue that Hausman test is notorious for testing in-favour of fixed effect. Hence, we employed the techniques of regression with correlated disturbances and regression with panel-corrected standard errors (PCSE) in order to correct for spatial correlations of the errors (SCE) and contemporaneous correlation of the errors (CCE). And the unit heterogeneity problem was solved by including the country-specific and year-specific dummies in our models and applied the fixed effects regression.

For HICA, Equatorial Guinea is the only country classified as high income given the per capita income in Africa according to World Bank classification. Thus, a panel data analysis is not appropriate; we used OLS estimator and employed Prais-Winsten regression and/or regression with Newey-West standard error to adjust for serial correlation.

We investigate the relationship between the impact of population dimensions: growth, density, size and structure), manufacturing sector value added as a percent of GDP, services sector value added as a percent of GDP, final consumption expenditure, etc. (annual % growth) and carbon dioxide (Co_2) emissions in our sample of Africa countries according to per capita income levels- Low Income Countries in Africa (LICA), Lower Middle Income Countries in Africa (LMICA), Upper Income Countries in Africa (UICA) and High Income Countries in Africa (HICA).

The Tables below presents the findings, per capita carbon dioxide emissions are first regressed on the basic STIRPAT anthropogenic driving forces (i.e population dimensions- PG, PD, PS and PT), final consumption expenditure, etc. (annual % growth), manufacturing sector value added expressed as percentage of GDP (M) and services sector value added expressed as percentage of GDP (S), while at the same time we controlled for country-specific and year-specific dummies. The coefficients of both dummies are not reported because they are of no significance to our findings; some packages do not even report them.

4.1. Population Growth as a Predictor of per capita Carbon dioxide emissions

The GLS/FGLS estimator provides an informative contrast to fixed effect and random effect estimators to the carbon dioxide emission analyses. The FGLS results show subtle and precise findings possible with our basic model and the concepts of elasticity coefficients. Therefore, we concentrate our interpretation of the results on GLS/FGLS estimator. However, for population growth, the fixed effect for LICA is more robust than GLS/FGLS, we interpret fixed effect for LICA. The impact of population growth on carbon dioxide emissions is positive for low income countries in Africa (LICA). The manufacturing sector value added as a percent of GDP and services sector value added as a percent of GDP are also positive, and all these magnitude impacts are less than one. Whereas the final consumption expenditure growth (FCEG) is not statistically significant, implying that FCEG is not a significant variable to explain. According to Jorgenson and Clark (2013), theses additional predictors are well established in the existing literature on the human drivers of greenhouse gas emissions. The implication is that they are expected to contribute to increase in carbon dioxide emissions during the period under investigation. The coefficients of our explanatory variables are less than one, but greater than zero (< 1.0, but >0), indicative of an inelastic interaction, where impact is less responsive to variations in the predictors. Thus, a 1% increase in population growth rate raises emissions by about 0.33% on the average holding all other drivers constant. Furthermore, a 1% increase in manufacturing increases emissions by about 0.17%, and a 1% rise in services sector value added as a percent of GDP leads to an increase in emissions by 0.16% (see Table 1).

For LMICA (we present the results in Table 3), the estimated results suggest that population growth and manufacturing sector value added as a percent of GDP are positively related to increases in Co_2 emission loads. The findings suggest that population growth has a positive impact on emissions (carbon dioxide emissions), and this indicates a positive linkage between emissions and population growth. The findings further reveals that a 1% increase in population growth rate increases emission loads by about 1.08% on the average controlling for all other explanatory variables, indicating that population growth is responsible for emission reduction by about 1.08% as shown in the Table 3 below. A 1% increase in services sector value added as a percent of GDP indicates that emission decreases by about 0.49%, when all other variables are controlled, ceteris pari bus. In the case of final consumption expenditure, it is not significant.

The estimated results (see Table 3) of the combined samples of UICA show that population growth rate plays a significant role in increasing emission loads. This indicates that population growth rate have a positive relationship with increased emissions during the period investigated. In other words, a 1% increase in population growth rate increases emission loads by about 0.31% on the average when all other predictors are held constant. A 1% rise in manufacturing sector value added as a percent of GDP suggests an increase in emission impacts by about 0.57% controlling for other driving forces. The service sector value added as a percent of GDP indicates that a 1% increase leads to a reduction in emissions by about 0.09% when other drivers are constant.

In the case of HICA, the ordinary least squares (OLS) is not robust (see Table 1), but after correcting for serial correlation using Prais Winsten Regression (PWR) in Table 2, the findings show that population growth rate has a more than proportionate impacts on emissions increase. The results indicate that a 1% increase in population growth rate suggests an increase in emission loads of about 2.32% controlling for are other anthropogenic driving forces. In this income group, population growth is very crucial in influencing emissions rise. However, a 1% increase in final consumption expenditure growth rate ameliorates emissions by about 0.09% holding all other variables constant.

Table 1. Baseline Model- Regress per capita Co_2emissions-In (I) on population growth- In (PG), manufacturing sector value added as a percent of GD- In (M), services sector value added as percent of GDP-In (S) and final consumption expenditure (annual % growth) In(FCEG).

<Table 1> Dependent Variable: In(I) Fixed Effect

Variable		LICA		LMICA		UICA		HICA(OLS)
Intercept	-9.53***	(0.669)	3.999	(2.407)	-13.02**	(1.603)	1.533	(3.375)
In(PG)	0.339***	(0.058)	-323*	(0.152)	0.138	(0.115)	0.764	(2.950)
In(M)	0.178**	(0.067)	-.64**	(0.145)	0.464***	(0.129)		
In(S)	0.166*	(0.073)	0.389*	(0.177)	0.160	(0.158)		
In(fceg)	0.0004	(0.014)	-.068*	(0.033)	0.015	(0.026)	-.074	(0.117)
Sample		332		163		178		6
R-sq		0.33		0.15		0.5		0.16
DW Stat.								
Wald Chi2								
log likelihood								

***P < 0.001; **P < 0.01; *P < 0.05.
*The coefficients are asterisk according to their levels of significance (coefficient not asterisk are not significant), and the standard errors are in parenthesis.
*Our dependent variable and all the explanatory variables are in logarithmic forms.
*The FE indicates fixed effects
*The OLS means regression with ordinary least squares.
*For HICA, a panel regression analysis is not possible because we have only one country as the high income country in Africa. We therefore applied OLS method

Table 2. Baseline Model- Regress per capita Co_2 emissions-In (I) on population growth- In (PG), manufacturing sector value added as a percent of GD- In (M), services sector value added as percent of GDP-In (S) and final consumption expenditure (annual % growth) In(FCEG).

<Table 2> Dependent Variable: In(I) Random Effect

Variable		LICA		LMICA		UICA		HICA (PWR)
Intercept	-9.20***	(0.675)	-0.216	(2.223)	-12.46**	(1.507)		
In(PG)	0.334***	(0.058)	0.006	(0.163)	0.124	(0.110)	2.329***	(0.025)
In(M)	0.152*	(0.066)	-.51**	(0.156)	0.434**	(0.126)		
In(S)	0.173*	(0.073)	0.439*	(0.175)	0.171	(0.152)		
In(fceg)	-0.00003	(0.014)	-0.062	(0.038)	0.014	(0.026)	-0.094**	(0.006)
Sample		332		163		178		4
R-sq		0.33		0.12		50		1.0000
DW Stat.								1.49
Wald Chi2		144.39		15.27		169.56		
log likelihood								

***P < 0.001; **P < 0.01; *P < 0.05.
*The coefficients are asterisk according to their levels of significance (coefficient not asterisk are not significant), and the standard errors are in parenthesis.
*Our dependent variable and all the explanatory variables are in logarithmic forms.
*The RE shows random effects
*For HICA, a panel regression analysis is not possible because we have only one country as the high income country in Africa. We therefore applied Cocharne-Orcutt AR(1) regression-iterated estimates, otherwise called Prais-Winston regression.

Table 3. Baseline Model- Regress per capita Co_2 emissions-In (I) on population growth- In (PG), manufacturing sector value added as a percent of GD- In (M), services sector value added as percent of GDP-In (S) and final consumption expenditure (annual % growth) In(FCEG).

<Table 3> Dependent Variable: In (I) GLS/FGLS

Variable		LICA		LMICA		UICA	HICA
In(PG)	0.381**	(0.133)	1.088***	(0.203)	0.316*	(0.137)	
In(M)	0.080	(0.078)	0.432***	(0.121)	0.573***	(0.151)	
In(S)	-.195**	(0.074)	-.498***	(0.118)	-0.501**	(0.144)	
In(fCEG)	-0.032	(0.034)	-0.026	(0.056)	-0.099	(0.058)	
Sample		332		163		178	
R-sq		0.92					
DW Stat.							
Wald Chi2		3892		313.27		302.19	
log likelihood				-185.19		-203.80	

***P < 0.001; **P < 0.01; *P < 0.05.
*The coefficients are asterisk according to their levels of significance (coefficient not asterisk are not significant), and the standard errors are in parenthesis.
*Our dependent variable and all the explanatory variables are in logarithmic forms.

*The GLS/FGLS indicates Generalized Least Squares/ Feasible Generalized Least Squares.
*For HICA, a panel regression analysis is not possible because we have only one country as the high income country in Africa.

5. Conclusions

Throughout this study, we focused exclusively on carbon dioxide emissions as a major contributor to greenhouse gas emissions and as the primary indicator of the environmental impacts. Given that the increasingly sustained opinion identified carbon dioxide emission to be responsible for the major components of greenhouse gas emissions in the ongoing global warming and ambient air pollution progress, the growing concern about the production of carbon dioxide (Co_2) emissions by various activities of mankind, this research belief that it is vital to pay more attention on this relatively understudied and debatable environmental indicator.

Overall, in all the income groups, the estimated results indicate mixed results (both positive and negative relationships between population dimensions and emission impacts, and these are consistent with an increasingly sustained divergent opinion from previous and recent studies). The findings of a disproportionate association between population growth and emissions found evidence in Boserupian tradition (1965, 1981) which argued that population has a non proportional relationship with environmental change. This is further reinforced by the neoclassical economists who argued that an increasing population is a major cause of economic change, and not environmental change (Satterthwaite 2009). This is also consistent with the findings of Jorgenson & Clark (2013), that the two-way fixed effects panel regression elasticity models of national-level carbon dioxide emissions shows that the estimated elasticity exponents for population is much smaller for countries in Africa than for other countries in other regions of the world. In contrast to what is mentioned in Boserup (1965, 1981), the Malthus (1798) and Neo-Malthusians traditions (Ehrlich & Holdren 1971, 1972) perspectives are also consistent with our findings indicative of positive relationship between populations and carbon dioxide emissions. The Malthus and Neo-Malthusians traditions maintained that the means of subsistence determine population growth, and therefore suggested the need to control population growth through different methods. The Neo-Malthusian also maintained that population growth, density, size and/or structure is the cause of environmental problems through its various activities and land use pattern. For example Dietz & Rosa (1994, 1997); Shi 2003; Ehlirch & Holdren (1971, 1972) study found a positive association between population growth, size and environmental impacts. The positive relationship between population growth and emissions further found evidence to support the environmental impacts in Dietz & Rosa (1994, 1997); Shi 2003; Ehlirch & Holdren (1971, 1972) empirical studies. The empirical works of Dietz & Rosa (1994, 1997) found evidence to support an increasingly sustained opinion that an increasing population growth leads to an upward increase in emissions impact. However, the findings of this study suggest that non-proportional and absolute impact relationship were not correlated with the unitary elasticity population impacts on emission in the empirical studies of Dietz & Rosa (1994, 1997), and that population impacts on emissions are not the same across all income groups. The non-proportionate impact of population
growth found additional support in Shi (2003) works which argued that the disproportionate impact of population pressures on resources, energy, and the environment is as a result of the per capita consumption of energy and of resources, and the associated per capita impact on carbon dioxide emissions are themselves a function of population dimensions. In addition, the study of Holdren (1991) supports this assertion as it contends that energy consumption per person rises with population if variations in settlement patterns necessitated by population pressures leads to more transport, per individual, of resources, goods, and people.

The manufacturing sector as a major contributor to environmental impacts is reinforced and consistent with the findings of Shi (2003) that countries with a large manufacturing sector as a major component of GDP contributes higher emissions than countries with a larger service sector as a major component of GDP.

The findings reinforced by this study suggest that population growth is one of the most important drivers of environmental impacts. It appeared that an exponentially growing population may lead to further increase in emissions given the breathing out of carbon dioxide by human kinds which increases with the size of population (although the breathing by humans have not been empirically investigated by this study). The population growth is robust and statistically significant in all the different income groupings.

In this study, some of the coefficients of determination are not correctly signed. Almost all the elasticity exponents are significant at 1%, 5% and 10% significance levels. Our results show that both national and global communities have to encourage better population control through family planning and greening of the environment in less developed countries particularly in Africa. It is further suggested that emphasis should be focused on the "development of environmentally friendly practices" in Africa continent, despite divergent results. There is a significant relationship between population growth and carbon dioxide emissions across the national income level in all Africa countries.

References

Alam, S. et al. (2007).Sustainable development in Pakistan in the context of energy consumption demand and environmental degradation.*Journal of Asian economics*, *18*(6): 825-837.

Boserup, E. (1965). *The conditions of agricultural growth*. London: Allen and Unwin. Expanded and updated in population and technology. Oxford: Basil Blackwell, 1980, Pp. 118.

Boserup, E. (1981). *Population and Technological Change: A study of Long-term trends.* Chicago: University of Chicago press.

Dietz, T. and Rosa, E. A. (1997). Effects of population and affluence on CO_2 emissions.*Proceedings of the National Academy of Sciences USA*, *94*:175-179.

Dietz, T. and Rosa, E. A. (1994). Rethinking the environmental impacts of population, affluence, and technology. Human ecology review 1: 277-300.

Ehrlich, P. and Holdren, J. (1971).Human population and the global environment. *American scientist*, *62*: 282-292.

Ehrlich, P. and Holdren, J. (1972). A bulletin dialogue on the closing circle: one-dimensional ecology. *Bulletin of the Atomic Scientists 28* (5): 16-27.

Ehrhardt-Martnez, K. (1998). Social determinants of deforestation in developing countries: A cross-national study. *Oxford journals*, *77*(2): 567-586.

Harvey, D. (1994). Population, resources and the ideology of science.*Economic geography*, *50*:256-77.

Haub, C. (2012). World population data sheet 2012. Fact sheet: World population trends 2012. Population Reference Bureau. Retrieved in September 15, 2013, from http://www.prb.org/publications/Datasheets/2012/world-population-data-sheet/fact-sheet-world-population.aspx.

Hossain, S. (2013). Lecture: Panel data: Fixed Effects and Random Effects, model one STATA. Retrieved on January 19, 2014 from www.youtube.com/watch?v=IrMCRYk9jh8.

Hossain, S. (2013). Model Three-Stata: Panel data. Fixed and random effects. Retrieved on September 28, 2013 from 21www.youtube.com/watch?V=PFI2SCWYJ-M&hd=1.

Hughes, T. P. et al. (2003). Climate change, human impacts, and the resilience of coral reefs.*Science*, *301*(5635): 929-933. Doi.10.1126/science.1085046.

Jorgenson, A. and Kick, E. (2004).*Globalization and environment.*Haymarket Books. USA.

Lambert, B. (2013). Video lecture: A comparison between Random Effects and Fixed Effects estimators. Retrieved on February 21, 2014 from www.youtube.com/watch?v=weylnmScboA.

Malthus T. R., (1798).*Essay on the Principle of Population, seventh ed.* (1967). Dent, London, UK

Meyer, W. B. and Turner II, B. L. (1992).Human population growth and global land-use/cover change.*Annual review of ecology and systematics*, *23*: 39-61.

Neumayer, E. (2004). Examining the impact of demographic factors on air pollution.*Population and environment*, *26*(1): 5—21.

Newell, N. D. and Marcus, L. (1987).Carbon dioxide and people.*Palaios 2*: 101-3.

Shi, A. (2001). Population growth and global dioxide emissions.*Paper to be presented at IUSSP conference in Brazil/session-s09*.

Shi, A. (2003). The impact of population pressure on global carbon dioxide emissions, 1975-1996: evidence from pooled cross-country data. *Ecological economics 44*:29-42.

United Nations Population Fund (2013). World population review: Africa population 2013. Retrieved in November 25 from www.worldpopulationreview.com/Africa-population-2013.