Journal of Sustainable Development in Africa (Volume 14, No.6, 2012)
ISSN: 1520-5509
Clarion University of Pennsylvania, Clarion, Pennsylvania

CLIMATE CHANGE, ENVIRONMENTAL RESOURCES AND POVERTY REDUCTION IN NIGERIA

Ben E. Aigbokhan
Department Of Economics, Ambrose Alli University, Ekpoma, Nigeria

ABSTRACT

Poverty reduction has been a major policy thrust of the government of Nigeria since the 1980s. Following the millennium development goal declaration in 2000, the target is to achieve poverty rate of 21.4% by 2015. Report of poverty assessment for 2004 records poverty rate of 54.4%.By 2010, this had risen to 69%. This is despite the fact that Nigerian economy has recorded an average annual growth rte of 6.5% since 2004. There obviously is a major challenge of poverty reduction in Nigeria. There appear to a major conceptual shortcoming in the approach to poverty measurement in Nigeria. Poor households, particularly rural households depend heavily on freely-provided environmental goods to sustain their welfare. Conventional standard household income/expenditure surveys have typically omitted these resources. Such omission has tended to limit our understanding of the extend of poverty in Nigeria, the role of environmental resources, and what should be the direction of poverty reduction policies. Climate change has added another dimension to the challenges of poverty reduction in the country. Its effects on environmental resources have immense implications for poverty reduction. There is evidence of climate change in Nigeria in the form of changes in weather patterns and carbon dioxide emission. This has negatively impacted on the environmental resources. The study used a purpose-collected data set to demonstrate the potential impact of environmental resources on household income. From the survey conducted in June-December 2005 simultaneously in three states, it was found that environmental resources income contributed on average 4.3 percent to total household income. Results of poverty measures show that environmental resource income reduce poverty by between 0.73 and 6.5 percent, and income inequality by between 0.23 and 6.7 percent, even from a small, exploratory sample size. These results suggest the potentials for environmental resource management as a strategy in poverty reduction, and also the need to systematically integrate the use and value of environmental resources with standard household economic activities if we are to have better understanding of poverty dynamics.

Keywords: Climate Change, Sustainable Development, Household Livelihoods, Poverty reduction, Environmental resources, Income inequality, Economic Growth, Niger Delta

INTRODUCTION

"In the long-run climate change is a massive threat to human development and in some places it is already undermining the international community's efforts to reduce extreme poverty" (UNDP-Human Development Report 2007/2008:3)

The above quotation underscores the potential implication of climate change to the challenges of poverty reduction**.** Yet poverty reduction has been a major policy thrust of the government of Nigeria since the 1980s. This got greater impetus from the MDGs declaration in 2000 which seeks to achieve halving the poverty level by year 2015. Starting with poverty level of 42.7% in 1992, Nigeria would have to achieve poverty rate of 21.4% by 2015. Report of poverty assessment for 2004 records poverty rate of 54.4%. Results of the 2010 survey indicate that poverty rate had risen to 69%. This is despite the that fact that the economy recorded an average annual growth rate of 6.5% since 2004.

There appears to be a major conceptual shortcoming in approach to poverty measurement in Nigeria, which, unless addressed, may mean that our understanding on the extent of poverty and impact of poverty reduction efforts of government as well as what should be the direction on poverty reduction policies may be somewhat limited. The shortcoming relates to measurement of household income and consumption.

It has been established that poor households, particularly rural households, depend heavily on freely-provided environmental goods to sustain their welfare, through provision of both productive inputs and consumption goods. Such dependence tends to even be higher in periods of economic downturn. Cavendish (1999), based on a sample size of 213 households, estimated that rural households in Zimbabwe derive as much as 35% of their income/consumption from environmental resources. There is empirical evidence of such dependence among Nigerian households. For example, in a study on demand for fuelwood, it was concluded that 'the indication is that if household income increase and the price of fuelwood increases, the household demand for fuelwood will fall' (Ayodele, Falokun, Chete & Fasheun, 1996:103). In other words, the poor depend more of fuelwood consumption for energy supply. The authors estimated that daily fuelwood consumption in sampled households ranged from 2.6kg to 48kg.

Since these environmental resource uses are typically omitted from conventional standard household income/expenditure surveys, it has been suggested that there is a substantial gap in the quantitative understanding of poverty dynamics (Dasgupta 1993:273, Dasgupta & Mater 1994). Due to lack of data sets that systematically integrate the use and value of environmental resources with standard household economic activities, it has not been possible to address this gap with respect to Nigeria.

This paper attempts to address this gap through a purpose-collected data set. This was in a household survey that explicitly integrated quantitative environmental resources data on a small range of environmental goods such as wild fruits, wild animal/fish, wild medicinal herbs, fuelwood and wild resources like tooth chewing sticks, drinking liquids and leaves as insect repellant[1].

These survey data were used to estimate poverty and income inequality levels in Edo, Delta and Bayelsa states, based on two measures of income, namely, total household income, excluding environmental resources income, or total non-environmental income (TNEY); and the total household income including environmental resource income (TY).

Since the essence of the paper is to demonstrate the potential impact the environmental resource on household income, the paper further demonstrates the potential impact of climate change on environmental resources, and thus the implications for poverty reduction. Evidence from the paper also highlights the importance of sustainable utilization of environmental resources in sustainable development and sustained poverty reduction strategy.

The rest of the paper is structured as follows. Following this introductory section, the second section discusses the concept of sustainable development and its link with poverty reduction; the third section discusses the nexus between environmental resources and household livelihoods; the fourth section discusses the impact of climate change on the environment, highlighting the incidence of climate change in Nigeria; the fifth section discusses the study area, the data used and the results; and the sixth section concludes the paper, with policy options for sustained poverty reduction.

SUSTAINABLE DEVELOPMENT AND POVERTY REDUCTION

Poverty reduction has been a major development policy goal of governments in the past four decades. A widely held view is that economic growth is central to any poverty reduction strategy. Without doubt, rapid economic growth is necessary for poverty reduction. However, growth will be unsustainable in the long run unless it is also environmentally sustainable, by which is meant that the growth process ensures that the earth's natural assets are able to adequately provide the resources and environmental services on which humans depend. In other words, when growth comes at the expense of the environment, it is not sustainable. The concept of sustainable development emerged from anxieties that accompanied the impressive rise in living standards enjoyed in developed countries during the 1960s and 1970s. It became clear that life-sustaining role of the biosphere was at risk from unfettered consumption of natural resources. These anxieties culminated in The Club of Rome's Limits of Growth published in 1972.

The most widely accepted definition of the concept of sustainable development is "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:43).

Sustainable development is normally assessed by reference to parallel progress in economic growth, human development and environmental protection. These can be examined at local, national, regional or global levels. A range of sustainable development indicators include enhanced energy efficiency, technology, improved local environment, boosted employment rate, improved health conditions and increased living standards and poverty alleviation (Huang et al, 2012). The objective of this paper is to demonstrate the potential of environmental resources in engendering improved living standard and poverty reduction through sustained environmental resources income, if the environmental resources are properly maintained. This is also to call to attention the need to ensure that while pursuing growth through rapid extraction of petroleum resources in the Niger Delta region of Nigeria, the need to ensure environmental sustainability should be of close attention.

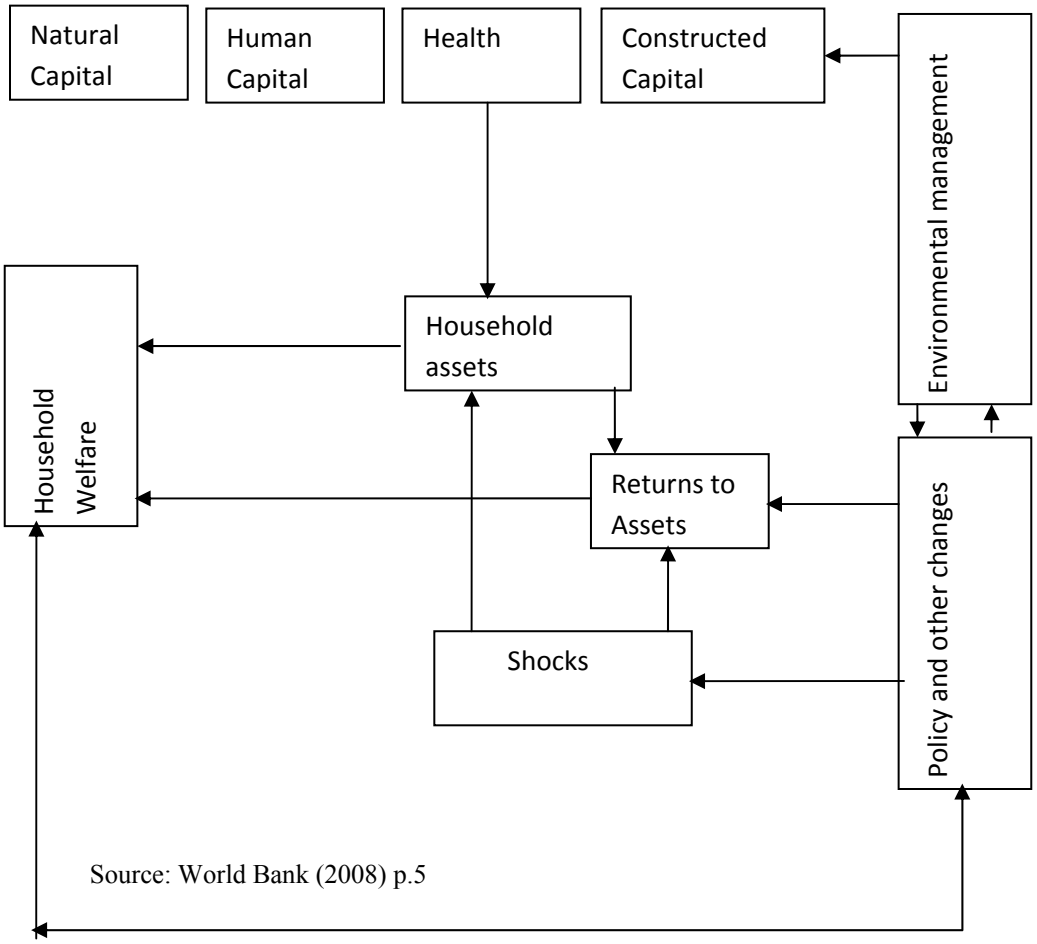
ENVIRONMENTAL RESOURCES AND HOUSEHOLD LIVELIHOODS

Poverty reduction has three dimensions. The first dimension requires stemming the fall of households into deeper poverty; second entails enabling the poor to move out of poverty; and third requires preventing non-poor from becoming poor. In each of these, there is a role of environmental management. Household welfare depends on assets the household own or has access to. These assets include biophysical, human, environmental, and constructed capital, as can be observed in Fig.1. Changes in welfare can thus result from four types of changes, namely, changes in asset holdings, changes in return to these holdings, changes in uncertain component of return (due to weather, health, and other factors such as human economic activity induced environmental degradation known as anthropogenic emission of greenhouse gases) and changes in exogenous income.

The link between environmental resources and livelihoods of poor households has been recognized for quite some time. However, there has been little attempt to integrate this into poverty analysis. According to Dasgupta and Maler (1994), in their work on Central and West Africa, Falconer and Arnold (1989) showed how vital are forest products to the lives of rural dwellers. Haripriya (1998) notes that conventional income measures do not capture all aspects of human well being, because they ignore the non-marketed services produced by natural resources such as forests. Similarly, Shyamsunder (2001) suggests that from a policy perspective, it is important to understand how environmental quality and natural resources affect the wellbeing of the poor. Dasgupta and Maler (1994) summarized the viewpoint thus: "the dependence of poor countries on their natural resource, such as soil and its cover, water, forests, animals and fisheries should be self-evident. Ignore the environmental resources-base, and we are bound to obtain a misleading picture of productive activity in rural communities there. Nevertheless, if there has been a single thread running through forty years of investigation into poverty countries, it has been the neglect of this resources base". A notable exception to this observation is Cavendish (1999).

Cavendish (1999) demonstrates that environmental resources make a significant contribution to average rural incomes. Poorer households also depend heavily on these resources, which contribute about 40% to their incomes. However, richer households were also found to use greater quantities of environmental resources in total. Thus, studies which ignore them miscalculate rural incomes and welfare. Cavendish, therefore, used purpose-collected data to demonstrate the contribution of environmental resources incomes to poverty and income inequality measurement. He estimated that environmental resources income contributes as much as 30% reduction in measured inequality and as much as 50% reduction in measured poverty based on income as conventionally measured. This paper drew inspiration from Cavendish's work.

Fig 1 : Poverty- Environmental linkages at the household level



Source: World Bank (2008) p.5

Table 1 shows evidence on other countries on the contribution of environmental resource to household income, ranging from 2 to 44 percent for the poor and 1 to 30 percent for the rich.

Table 1 : Environmental Income as % of Total Income

	Resource-rich countries		Resource-poor countries		Average	
	poor	rich	poor	rich	poor	rich
Jodha (1986)	-	-	-	-	9-26	1-4
Cavendish (1999)	-	-	44	30	-	-
Vedeld et.al (2004)	-	-	-	-	32	17
Nrviain et.al (2005)	41	23	18	18	-	-
Challushhalhi (2008)	20	14	2	1	-	-

Source : World Bank (2008) p.15

CLIMATE CHANGE AND ENVIRONMENTAL RESOURCE INCOME

Climate change is broadly defined as the change in the state of the climate that can be identified by changes in the mean temperature and that persists for an extended period (IPCC, 2007). Climate change is attributed directly or indirectly to human activities (anthropogenic factors) that alter the composition of the global atmosphere and are in addition to natural climate variability, observed over a comparable period of time (Terfa, 2011).

Climate change can cause an increase in the variability of returns to assets. For example, greater variation in rainfall patterns is likely to increase the variability of crop yields. Exogenous shocks such as floods and human economic activity-induced pollution and environmental degradation can wipe out household assets and contribute to loss of incomes. Climate change is now accepted as the most immediate and far-reaching threat to the environment (Mearns and Norton, 2010:12). IPCC (2007) shows that greenhouse gas emissions from human activity, particularly burning fossil fuels for energy, are changing the earth's climate. Also, it is recognized that generally, poor people in developing countries tend to depend directly on climate-sensitive sectors such as agriculture, forestry and fishing for their livelihoods. Therefore, they are more exposed to the impacts of climate change than people in the developed world (Mearns and Norton, 2010:14).

There is evidence to suggest that Nigeria has been experiencing climate change in recent decades. First is the prevalence of changing weather pattern. As Terfa (2011) has shown, annual temperature has been rising since the 1970s. The trend in the period 1970 – 2009 has a positive slope with an R-square value of 8.03%. This is an indication of rising mean annual temperature in Nigeria. Second is the incidence of flooding, which has devastated many communities. For example, Okun

Alfa village, a fishing village located 20 kilometers from Lagos city, was visited by selected African Journalists who were monitoring the problem of climate change and its impact on Nigeria and how people are adapting to the threat. The community head (Baale) told the team that the warming which has resulted in climate change has been responsible for massive flooding that has adversely affected the village and neighboring communities[2].

Asked how he knew that their problem in recent years was related to climate change, the Baale retorted:

"We know that ice cap is melting in the polar region and that is pushing water into low lying areas. We watch the news about all the development in the polar region on DSTV cable television" [3]

Investigation revealed that the means of livelihood of the men and women in the village have been affected. The coconut trees which supply the means of livelihood for the women have been wiped off by the advancing sea. When the village was visited on September 19, 2010, over 50 coconut trees were standing at the site, but they had vanished by last visit two weeks ago – less than a year, according to the report.

Third, and more importantly in the context of the climate change literature is carbon dioxide emission. The trend of carbon dioxide emission in Nigeria in the period 1991 - 2007, as shown by Terfa (2011), has a positive slope with R-square value of 34.2%, which indicates that carbon dioxide emission is increasing in Nigeria.

The essence of the foregoing is to show that climate change in Nigeria due to natural and anthropogenic factors has impacted on the environment. To demonstrate the implication of this for poverty reduction, in the next session the paper presents the extent to which environmental resources income is capable of raising income and contributing to poverty reduction, if properly managed.

As mentioned in section 2, agriculture productivity is one of the channels through which climate change affects households livelihoods in developing countries. Studies have attempted to examine the impact of climate change on Nigerian agriculture and food security. Terfa (2011) estimated a food supply model, relating total staple foods to annual rainfall and temperature variations over the period 1970-2009. The author found food supply to be negatively associated with changes in temperature; that is, high temperatures are accompanied by low crop yields. He thus concluded that variations in rainfall patterns and rise in annual mean temperature are potential impact channels of climate change on food supply in Nigeria.

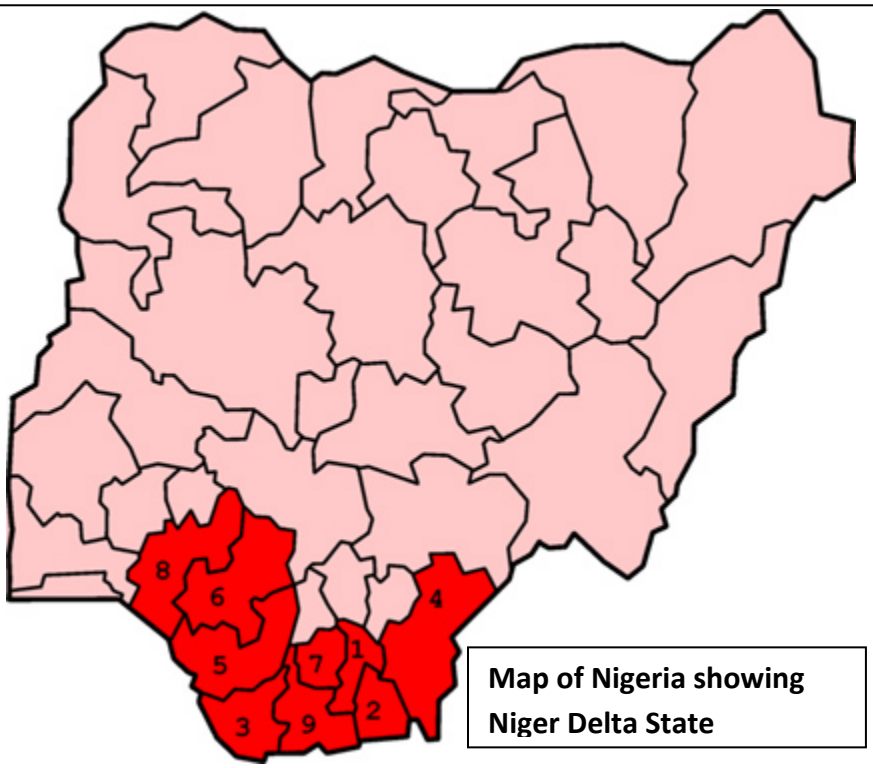
ENVIRONMENTAL RESOURCE INCOME AND POVERTY AND INEQUALITY IN NIGERIA

The Study Area

The Niger Delta region comprises nine oil-producing states in Nigeria, namey Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers states, with a total land of about 75,000 square kilometers and 185 local government areas. In population is estimated to be 30, 554,800 million by 2006 national population census.

The region produces the oil wealth that accounts for the bulk of Nigeria's export earnings. Oil and gas accounts for over 40% of Nigeria's national GDP, about 80% of total government revenue and 90%of foreign exchange earnings. Yet, it has been noted that "paradoxically, however, these vast revenues from an international industry have barely touched the Niger Delta's

pervasive local poverty; this has spurred formidable challenges to sustainable human development in the region" (UNDP 2006:1). Also, the links between the environment and sustainable livelihoods have been highlighted, demonstrating that environmental degradation and poverty are mutually reinforcing, (and thus) "underscores the urgency of proactive steps to conserve natural resources" (UNDP 2006:7). This is understandable, as "over sixty percent of the people in the Niger Delta region depend on the natural environment, living and non-living, for livelihoods" (UNDP 2006:73).



Map of Nigeria showing Niger Delta State

1. **Abia**
2. **Akwa Ibom**
3. **Bayelsa**
4. **Cross River**
5. **Delta**
6. **Edo**
7. **Imo**
8. **Ondo**
9. **Rivers states**

Source*: www.anaijaforum.com/myforum/niger-delta/map-of-the-area-called-niger-delta/ map of niger delta nigeria*

For this paper, three of the nine states are covered. These are Delta, Bayelsa and Edo States. The first two are two of the three core Niger Delta and leading oil producing states (Delta, Bayelsa and Rivers). Edo State contributes the least to Nigeria's oil output. Delta is the largest oil producing state, followed by Bayelsa and Rivers.

The economy of Bayelsa state was estimated to be N2.17 trillion in gross state product (GSP) in 2007. This accounted for 9.8% of the nation's economy and the fourth largest state economy in the country, behind Rivers state with N3.25 trillion, Lagos state with N2.65 trillion and Delta state with N2.35 trillion. Edo state has GSP of N0.25 trillion oil accounts for 96% of Bayelsa state GSP, and with a population of 1.8 million, its per capita GSP is estimated to be 1207.5 its population is predominantly rural, accounting for 92.3% and urban ratio being 7.7%. The average for oil producing states is 18.4% urban and 81.6% rural (BYSG 2008:14). Between 1999 and 2005, total revenue from statutory federation account to Bayelsa was N285.64 billion; in 2007-2009 it was N338.96 billion.

To appreciate the importance of environmental resources to its people, it is relevant to note that more than three-quarters of its (Bayelsa) total areas of 21,110 square kilometers is covered by water, with a moderately low land stretching from Ekeremor to Nembe towns. With total forest area of 3801.06 square kilometers or 27.98% of total land cover, there is a rich variety of biological communities of plant and animal species. The state lies almost entirely below sea level with a maze of meandering creeks and mangrove swamps. The main occupations of its population are fishing, palm wine tapping, carving and weaving.

Edo State with a population of 3.233,366 million, has the smallest oil producing base in Nigeria. It accounts for less than 5% of Nigeria's crude oil output. It has a total forest area of 4,330 square kilometers or 22.09% of total land area. The main occupations of its population are farming lumbering, fishing, solid mineral mining and craft making.

Delta state, with a population of 4.112,445 million, produces about 25% of Nigeria's crude oil. Over the period 1999-2005, it received N387.43 billlion from the statutory Federation Account. In 2008, it received N147.71 billion. It has a total forest area of 3,686 square kilometers or 21.75% of total land area. The main occupations of its population are fishing, farming, palm oil milling, lumbering and palm wine tapping. Thus, on the basis of their occupations, the bulk of the population in the region depends on the environment for their livelihood.

The Survey Data

The survey was conducted in June-December 2005 simultaneously in three of the nine oil producing states of the Niger Delta region namely, Bayelsa, Delta and Edo states. The survey instrument is a conventional household income and expenditure questionnaire that explicitly integrated quantitative environmental resources data on range of environmental goods such as wild fruits, wild animals herbs, fuelwood, tooth chewing stick, drinking liquid. Information was collected on both quality and value of resources use. These were verified against local prices to authenticate the resources values.

A sample frame obtained from the National Bureau of Statistics was used to select sample areas. In Bayelsa, three of the eight Local Government Areas (LGAs) in the state were covered. In Edo state, nine of the twenty four LGAs were covered,

with three from each senatorial zone. In Delta state, nine of twenty five LGAs were covered, with three from each senatorial zone.

Five hundred and fifty households were selected in each state, with a minimum of 50 households in each LGA. The survey covered both urban and rural households. The response rate was high (82.75 and 87 per cent respectively), with useable sample size of 450 in Bayelsa, 412 in Delta and 480 in Edo states.

Two measures of income were derived from the responses. Total household income excluding environmental resources income (conventional or standard income measure), and total household income including environmental resources income.

RESULTS

The Mean Procedure

Table 2 presents mean income for various types of income that constitute total household income in each of the three states. It is observed that consumption from own produced goods accounts for 26 to 28 per cent of total income across the states. Environmental income accounts for a little over 4 per cent of total income.

Table 2: Mean Income of States, 2005

Delta	N	Minimum	Mean	Maximum
Cash income	412	6000	61110	240800
Own-produced goods		2400	21575	62400
Environmental income		1200	3694	14400
Total non-environmental income		2400	76547	270400
Total income, incl. environmental income		3600	77760	274000
Bayelsa				
Cash income	450	6000	85707	1256800
Own-produced goods		2400	27738	69600
Environmental income		1200	4431	15600
Total non-environmental income		2400	105876	319600
Total income, incl. environmental income		3600	106806	331200
Edo				
Cash income	480	6000	60846	226000
Own-produced goods		2400	22193	69600
Environmental income		1200	3701	15600
Total non-environmental income		2400	79989	245600
Total income, incl. environmental income		3600	83304	54800

Exchange rate in 2005 N/$ = 131.66

Source: Survey data 2005

Poverty Measures

There is the debate as to the appropriateness of consumption over income as a measure of welfare. It is argued that consumption better approximates individual welfare. For this study, income is chosen as a measure of welfare principally because it was observed that respondents seem to recall more accurately how much income was earned from sale of environmental resources than how much was consumed. Since emphasis in this study is on environmental resources income, to demonstrate its impact on measure poverty, it is felt this may satisfy the purpose at hand.

Also, there is the debate over absolute versus relative poverty line. If absolute poverty line is of chosen, the issues become that of what bundle of goods should be considered for basic needs basket, and what the ratio should be between food and non food consumption as well as what should be the appropriate costing of the bundle (Aigbokhan, 2000).

Since the emphasis in the study is lesson point estimate of poverty, but more on demonstrating the robustness of poverty measures to different poverty lines, based on different income definitions, it is appropriate to chose poverty lines fixed with reference to standard income distribution.

Lastly, is the choice of poverty indices. The popular indices in the literature are derived from the standard three measures from the Foster-Greer-Thorbecke class of poverty measures (Pα), derived as.

$$P\alpha = \int_0^z \frac{(z-x)}{z}^{\alpha} f(x)dx \qquad (1)$$

$$\alpha = 0, 1, \text{and } 2$$

Where z is the poverty line, and f(x) is the population density function of income, α=0, I and 2 in the estimation of P_0, P_1 and P_2 which respectively are the headcount index, the poverty gap index, and the poverty sensitivity index. Each of these indices captures different aspects of poverty (Aigbokhan, 2000; Foster, Greer and Thorbecke, 1984). Table 3 presents the estimates of poverty lines for each state, based on per capita income value per month. Interestingly, defined poverty lines are close to the international line of one dollar per day.

Table 3: Poverty Lines by State, 2005

Bayelsa		Delta		Edo	
TNEY	TY	TNEY	TY	TNEY	TY
N5876	N5928	N4248	N4316	N4439	N4623
$44.63	$45.03	$32.27	$32.78	$33.92	$35.11
$1.49	$1.50	$1.08	$1.09	$1.12	$1.17

N/$ = 131.66

Table 4 presents results of poverty estimates based on two measures of income[4]. The results provide interesting insight to the influence of environmental resources income on poverty. Take Edo state, with standard income measure (non-environmental income, TNEY), 35.4% of households would be classified as poor, while with total income, adjusted for environmental income (TY), the proportion is 33.5%, a fall of almost 6%. The poverty gap and poverty sensitivity indices both also record a decline, and sensitivity index, records an even higher decline and, given the normative property of the index, it suggests that the reduction in headcount poverty may have been brought about by transfer of income from the richer to poorer households.

For Bayelsa state, headcount poverty declined by 1.1% and for Delta state it declined by 1.7%. However, for both states, poverty gap and poverty sensitivity indices both increased. This seems to suggest that the decline in headcount poverty may not have been accompanied with transfers from richer to poorer households.

Taken together, these tend to lend support to the central contention of this study that environmental resources income contributes to household income and if taken into account, is capable of reducing measured poverty. Though the level of reduction may be small, due partly to the limited coverage of environmental resources in this study, it is of interest to note in table 3 that standard errors of the estimations are lower for total income incorporating environmental income (TY). This thus gives us grounds for confidence in the results.

Table 4: Poverty Indices

State	Z		Measure Poverty	Income Aggregate		% Reduction	Standard Errors	
	TNEY	TY		TY	TNEY	(TY-TNEY)/TY*100	TY	TNEY
Bayelsa	5876	5928	Head Count	0.436	0.440	-1.10	0.02337	0.02377
			Poverty Gap	0.197	0.191	3.27	0.01876	0.01882
			Square Poverty Gap	0.126	0.114	9.55	0.01564	0.01522
Delta	4248	4316	Head Count	0.388	0.395	-1.71	0.02401	0.02444
			Poverty Gap	0.170	0.163	3.82	0.01849	0.01847
			Square Poverty Gap	0.106	0.093	11.56	0.01514	0.01455
Edo	4439	4623	Head Count	0.335	0.354	-5.59	0.02155	0.02183
			Poverty Gap	0.114	0.120	-5.23	0.01450	0.01482
			Square Poverty Gap	0.060	0.064	-6.49	0.01084	0.01117

Environmental Resources and Inequality

The study also examines the influence of environmental resources on measured inequality. Reducing inequality is of policy concern, especially given the inequality poverty nexus (Aigbokhan, 2008a). Table 5 presents quintile income shares by state. It is observed that in Bayelsa, for TNEY, the lowest quintile share 4.43% while the fifth quintile share 41.2% in Delta the respective shares at 5.0% and 44.9%, and in Edo these are 6.5% and 39.1%.

However, for total income incorporating environmental income (TY) the share of the lowest quintile decline in the three states, while the shares of the third and fifth quintiles increased, only in Delta state did the share of the fifth quintile decline marginally. It would seem that environmental resources may not be equalizing in the case of Bayelsa and Delta, while it is equalizing in the case of Edo state. Inequality indices would shed more light on the nature of inequality in the states.

Table 5: Quintile Shares

	Bayelsa		Delta		Edo	
	TNEY	TY	TNEY	TY	TNEY	TY
1	4.43	3.81	5.00	4.45	6.48	7.39
2	9.85	9.92	11.64	10.95	12.59	12.33
3	16.67	16.83	15.12	16.58	17.37	17.31
4	27.87	27.38	23.32	23.43	24.44	24.50
5	41.18	42.06	44.91	44.59	39.12	38.47

Source: Survey Data 2005

Inequality Measures

The increasing number of measures of inequality and the fact that almost each of them has some properties which render it potentially useful for such analysis, means that there is need to define rigorous criteria for choosing among them. A number of axioms or properties have been defined which should be satisfied by a given index to make it acceptable for the analysis of inequality. The properties include income scale-independence (value of the measure should not depend on the level of income), population size-independence (value should be independent of the number of income recipients). Weak and strong principles of transfers are another set of axioms. Most measures satisfy the first two, and satisfy one dimension or the other third axiom (Cowell, 1977).

A criterion more relevant in the context of this paper was suggested by Champernowne (1974), relying on the sensitivity of the measures to various aspects of inequality. This aids in understanding the specific nature of inequality. Champenowne suggested three types of inequality: Pareto's alpha inequality (inequality due to inequality among less extreme incomes within the distribution); beta inequality (inequality due to inequality among less extreme incomes within the distribution); and gamma inequality (inequality due to the presence of extreme poverty within the distribution).

On the basis of these properties, alpha – type inequality is captured by Coefficient of Variation (CV), and Theils' index, because each attaches equal weight to transfers at all levels of income. Beta – type inequality is captured by Gini Coefficient (G), standard deviation of logarithms of income (SDLY), and Atkinson's index when degrees of inequality aversion, €, equals unity (€ = 1). Gamma – type inequality is captured by SDLY and Atkinson's index when € = 2 (Champenowne, 1974 and Aigbokhan, 1988). For the formula for these indices, see Cowell (1977) and Cavendish (1999a). These five indices are used in this study. It might be necessary to note that measure inequality (Gini coefficient) for the states covered in this study in 2004 were 0.459, 0.465 and 0.476 for Edo, Delta and Bayelsa states (see footnote 4). Though not strictly comparable with our study's, given differences in income measures, welfare measure (expenditure versus income) and sample size, the results nonetheless indicated that our results may be considered credible.

The focus of the study is the comparison between inequality measured by standard income (TNEY) against that by environmental resources – adjusted total income (TY), to highlight how far environmental resources income could be equalizing. Table 6 presents results of the estimation.

Table 6: Measure of Inequality

State	Inequality Measure	Sample Size	Income Aggregate TY TNEY	% Reduction (TY-TNEY)/TY*100	Standard Error TY TNEY
	Coefficient of Variation	450	0.702	2.08	0.02155 0.02219
	Standard deviation of logs	450	0.688	12.06	#NUMI 0.01133
	Gini coefficient	450	1.069	2.17	0.02305 0.02333
Bayelsa	Theil enthropy measure	450	0.940	5.74	0.02061 0.02054
	Atkinson inequality measure	450	0.396	11.83	0.02190 0.2146
	Relative mean deviation	450	0.387	-1.03	0.02180 0.02157
			0.258		
			0.243		
			0.315		
			0.278		
			0.293		
			0.296		
	Coefficient of Variation	412	0.745 0.745	0.09	0.02146 0.02180
	Standard deviation of logs	412	0.976 0.872	10.60	0.00759 0.01669
Delta	Gini coefficient	412	0.369 0.393	0.08	0.04209 0.02442
	Theil enthropy measure	412	0.260 0.252	2.91	0.02161 0.02172
	Atkinson inequality measure	412	0.290 0.262	9.69	0.02235 0.02259
	Relative mean deviation	412	0.285 0.286	-0.23	0.02224 0.02259
	Coefficient of Variation	480	0.579 0.596	-2.89	0.02253 0.02240
	Standard deviation of logs	480	0.679 0.712	-4.94	0.02132 0.02067
	Gini coefficient	480	0.320 0.329	-2.80	0.02129 0.02144
Edo	Theil enthropy measure	480	0.165 0.174	-5.74	0.01693 0.01731
	Atkinson inequality measure	480	0.176 0.188	-6.66	0.01739 0.01783
	Relative mean deviation	480	0.232 0.240	-3.47	0.01926 0.01949

We discuss first the underlying features of measured inequality. On the basis of alpha, beta and gamma properties of inequality, it is observed that CV and Theil indices suggest that there is extreme wealth in income distribution in Bayelsa and Delta states than what obtains in Edo state. Also, there is the presence of extreme poverty in the distribution, as suggested by higher SDLY and Atkinson indices in both Bayelsa and Delta state than Edo state. And on the basis of estimates of Gin coefficient, there is inequality among less extreme income in the distribution, given the inequality – poverty nexus.

There seems to be mixed evidence of the influence of environmental resources income on inequality. Results for Edo state indicate that environmental resources has an equalizing effect, as measured inequality on the six indices recorded reduction, ranging from 2.8 to 7.4 per cent.

Results for Bayelsa and Delta states seem to suggest that environmental resources may be having non-equalizing effect on household income. On the basis of five inequality measures, inequality increased with inclusion of environmental resources income. Only on account of relative mean deviation index did inequality decline. Results for Bayelsa and Delta states could reflect the observation made by Cavendish (1999:2) that though "poorer households depend heavily on these resources, however richer households use greater quantities of environmental resources in total".

CONCLUSION

Evidence from this study suggests that environmental resources contribute to household incomes. Considering the limited depth in coverage of range of environmental resources, results still suggest that as much as 4% increase in household income derives from environmental resources.

There is evidence, also, that environmental resources income contributes to poverty reduction. In the case of Edo state reduction of 5 to 7 per cent is brought about, while in the case of Bayelsa and Delta states over 1 per cent reduction results. This may not be considered insignificant, especially if viewed in the context of the observation by Ravi Kabur (2009:33) that consider an economy in which the incidence of poverty has been falling by 1 percentage point a year. This is a good rate of decline, especially for an African country. At any rate, depending on the initial poverty level, an economy would be well on its way to achieving the first Millennium Development Goal, which is focused on reducing the incidence of poverty".

Also, there is evidence that environmental resources income has equalizing effect as demonstrated by the evidence for Edo state on all six indices of inequality, and for Bayelsa and Delta on relative mean deviation measure of inequality. Again, the level of reduction may not be considered insignificant, given the importance of inequality reduction to poverty reduction.

The study demonstrates that there is evidence of changing climate in Nigeria. Given the observed impact of climate change on the environment on one hand, and the potentials environmental resources income hold for poverty reduction.

Three important implications derived from the results of this study. First is the implication for income measurement in household income and consumption surveys. Our results show that failure to incorporate environmental resources income to standard survey questionnaire would over estimate poverty and inequality levels. This is important as it would give better understanding of poverty dynamics and the extent of poverty reduction. Second is the implication for poverty reduction strategy. With the evidence that poor households depend heavily on environmental resources, appropriate environmental management, particularly of the commons would be of great value in a strategy to promote the welfare of these households. It is observed that more distributionally-sensitive index (Atkinson index) records the highest reduction in inequality as a result of incorporation of environmental resources income, for example in Edo state. Given the inequality-poverty nexus, this could be a root to more rapid poverty reduction, that is, inequality-averse policies. This linkage also suggests that a sustained reduction in poverty would require a sustainable consumption and exploitation of environmental resources. However, we do

not pretend that focus on environmental resources income alone would ensure rapid reduction in poverty through the reduction in inequality. There are other inequalities that would need to be addressed simultaneously. For example, conventional surveys and the environmental resources adjusted ones like this study often do not capture the value of public services such as health and education consumed. Richer households do consume higher proportion of these services. If quantified, this would result in much higher inequality than is often reported. Also, intra-household inequality is often glossed over, even when per capita income/expenditure is used. Yet, it has been found that ignoring intra-households inequality could understate true inequality and poverty by as much as 30 per cent (Kabur, 2009:33). Poverty reduction, therefore, requires a multi-pronged focus.

In the context of the rising incidence of climate change, the policy options should aim at:

- Reduction in anthropogenic factors in climate change. Specifically, for oil-producing countries like Nigeria, oil production resulting in oil spillage and the resultant environmental degradation, as well as gas flaring which exacerbate carbon dioxide emissions should receive more committed attention.
- Pricing to the true cost of energy consumption and revitalisation of rail road projects would be highly desirable.
- Reforestation, to reduce CO_2 emissions and regenerate the environment would be a desirable strategy.
- Social transformation from carbon-intensive lifestyles would contribute to reduction in CO_2 emissions.

All these ensure sustainable utilization of environmental resources, and contribute to reduction in the rising incidence of climate change, and thus stem its degradation impact on the environment.

And third is the issue for future work. Admittedly, this study has been largely exploratory, the scope and depth having been limited by funding. It would be useful to expand in future work the scope and depth of coverage of the range of environmental resources income and consumption for further investigation of the central contention of this paper that exclusion of environmental resources income overstates poverty and inequality levels, and therefore tends to underestimate progress on poverty reduction. It would also be useful to examine why environmental resources income could be poverty reducing on the one hand, but be inequality-increasing on the other in some locations.

FOOTNOTES

1. Cavandish (1999) covered a range of twenty-five environmental goods and resources in 8 broad categories namely, wild vegetables, wild fruits, other wild foods, firewood, grass and woven goods, environmental fertilizers, pottery, and small and large carpentry items. The depth of the survey for the present study was severely limited by fund, as it was self-financed.
2. The journalists visited on the platform of the Africa Adaptation Programme Capacity Development Project, organized by the UNDP/International Centre for Journalists, based in the USA/Ghana Journalists Association and the Government of Japan, to support 20 African countries, including Nigeria, to adapt to the problem of climate change.
3. “Climate change and flooding”, Special Feature in The Guardian on Sunday (Lagos) October 30, 2011 pp. 10-11.
4. Table 4.1 below shows poverty and inequality 2004 in the states, based on household expenditure per capita.

5. Table 4.1: Poverty and Inequality in Bayelsa, Delta, Edo States, and Nigeria, 2004.

	P_0	P_1	P_2	Gini Coefficient
Bayelsa	19.98	0.0994	0.0557	0.4757
Delta	45.35	0.2222	0.1157	0.4650
Edo	33.09	0.1568	0.0804	0.4585
Nigeria	54.41	0.218	0.1191	0.4882

Source: National Bureau of Statistics, Poverty Profits of Nigeria, Abuja, 2005.

REFERENCES

Aigbokhan, B. E. (1988) *Planning, employment and income distribution in Nigeria,* Lagos, Kristal Publishers.

Aigbokhan, B. E. (2000) Poverty, growth and inequality in Nigeria: Case study, *African Economic Resources Consortium Research Report* No. 102.

Aigbokhan, B. E. (2008a) Growth, inequality and poverty in Nigeria; UNECA, ACGS/MPAMS Discussion Paper No. 3 (June).

Aigbokhan, B. E. (2008b) Trade Policy, Growth, Inequality and Poverty: Evidence on Nigeria and Lessons for EU-Nigeria EPA, 20th Anniversary Oxford Round Table Conference, St. Anne's College, Oxford, 3-8 August.

Ayodele, O; G.O Falokun; L.N Chete & F.E. Fasheun (1996) "Population Environment and Sustainable Development in Nigeria", in A. Philips and D.O Ajakaiye, eds, *Population-environment interactions in Nigeria, Ibadan: Nigerian Institute of Social and Economic Research*, pp. 95-106

Bayelsa State Government (BYSG): Bayelsa Facts, Yenogoa, 2008 (September).

Cavendish, W. (1999) "Poverty, inequality and environmental resources: Quantitative analysis of rural households". *Centre for the study of African Economic (CSAE)* WPS 99-9 (February)

Champenowne, D. G. (1974) "A Comparison of Measures of Income Distribution", *Economic Journal* (December) pp. 787-816

Cowell, F.A (1977) *Measuring Inequality* (Oxford: Philip Allan)

Dasgupta, P. and K-G Maler (1994) Poverty, institutions and the environmental resources-base; *World Bank Environmental Paper* No. 9, Washington D.C.

Ekbom. A. and J. Bojo (1991) Poverty and environment: Evidence of links and integration into the country assistance strategy process; Discussion Paper No. 4, Environment Group Africa Region, World Bank, Washington D. C. (January)

Foster, j. , Greer and E. Thorbecke (1986) "A Class of Decomposable Poverty Measures" , *Econometrical*, 52, 3(May) pp 761 - 766

Haripriya, G. S. (1998) " Forest resource accounting: Preliminary estimates for the State of Maharashtra" *Development Policy Review* 16, pp 131-151

IPCC (2007) 4th Assessment Report, Climate Change 2007, Cambridge, UK: Cambridge University Press for Intergovernment Panel on Climate change

Jones, B. and M. Keen (2009) "Climate policy in hard times" , *Finance and Development*, International Monetary Fund, Washington D. C.,(December) pp. 7-9

Laderchi, R. C. , R. Saith and F. Stewart (2003) 'Does it matter if we do not agree on the definition of poverty?: A comparison of four approaches" , *Oxford Development Studies* 31, 3 (September) pp. 243-274

Kabur, Ravi (2009) " Poverty, disconnected" , *Finance and Development* (December) pp. 32-34

Leach, M. and R. Means (1991) Poverty and environment in developing countries: An overview study", Institute of Development Studies, Sussex, United Kingdom

Mearns, R. and A. Norton (2010) Equity and vulnerability in a warming world: Introduction and overview, in *Social dimensions of climate change*, World Bank: Washington

Reardon, T. and S.A Vost (1995). "Links between rural poverty and the environment in developing countries: Asset categories and investment poverty", *World Development*, 23, 9 (September) 1495-1506

Shamsundar, P. (2001) "Poverty – environment indicators", World Bank Environment Department Paper No. 84 (November)

Terfa, W. Abraham (2011) "Climate change and food security in Nigeria" , *Nigerian Economic Society Conference Paper Proceedings*

United Nations Development Programme(UNDP, 2006) Niger Delta Human Development Report

United Nations Development Programme(UNDP,2007) Fighting climate change: Human solidarity in divided world, Human Development Report 2007/2008 Summary, New York

World Bank (2008) Poverty and the environment :Understanding linkages at the household level, Washington D. C.

World Bank (2010) Development and climate change, *World Development Report*, Washington D. C.

World Commission on Environment and Development (WCED 1987) *Our Common Future,* Oxford: Oxford University Press.

ABOUT THE AUTHOR:

Ben E. Aigbokhan is a Professor of Economics at Ambrose Alli University, Ekpoma, Nigeria.