CPED Monograph Series 2011

POVERTY AND ENVIRONMENTAL QUALITY IN THE NIGER DELTA REGION: DEPENDENCE ON BIOMASS FUELS AS THE SOURCE OF HOUSEHOLD ENERGY

Gideon E.D. OMUTA

This Publication is supported by the Think Tank Initiative Programme initiated and managed by the International Research and Development Centre (IDRC)

Published by

Centre for Population and Environmental Development (CPED)
BS-1 and SM-2 Ugbowo Shopping Complex,
Ugbowo Housing Estate
P.O. Box 10085, Ugbowo Post Office
Benin City, Nigeria

First published in 2011

Series Editor:
Professor Andrew G. Onokerhoraye
Executive Director, CPED, Benin City

Printed in Nigeria by:

AMBIK PRESS LTD.
#4, Otike-Odibi Avenue, Isiohor,
Via Ugbowo Old Lagos Road,
P.O. Box 5027,
Benin City, Edo State.
052-880527 & 08074009192

PREFACE

This policy research monograph is part of the on-going research of the *Centre for Population and Environmental Development (CPED)* on the theme titled "Conflict and Development in Nigeria's Niger Delta region" in the current strategic plan (2010-2014) of the Centre. One major component of the natural environment of the Niger Delta region that has been a constant receptor of the unrelenting pressure and assault is the ecosystem, particularly, the forests and forest resources has been the pervading and deepening poverty in the region. In be absence of affordable and sustainable alternatives, the vast majority of the people, particularly in rural and even urban settlements depend on biomass fuel sources for their domestic energy, especially for cooking. In the global literature, however, the debate about the linkage between poverty and environment appears inconclusive. This study examines the relationship between poverty and environmental quality in the Niger Delta Region. It focuses on determining how population growth has affected forest and non-forest resource exploitation in the Niger Delta Region; establishing the relationship between poverty and the source of domestic energy consumption; establishing the relationship between poverty, biomass or wood energy demand and environmental quality; determining the rural and urban dimensions of the observed relationships and any conflicts that could arise or have arisen there from; and outlining the major policy challenges.

We are particularly grateful to the *Think Tank Initiative* for the Institutional support provided for CPED which has enabled the Centre to carry out the study that led to publication of this policy monograph.

ACKNOWLEDGEMENT

The cover design was adopted from Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007), *Cooking Energy: Why it really matters if we are to halve poverty by 2015;* p. 3.

LIST OF ACRONYMS

ARC	Aprovecho Research Centre
ASL	Above Sea Level
BATN	British-American Tobacco Nigeria
BEIU	Biomass Energy Improvement Unit
CBO	Community –Based Organization
CPED	Centre for Population and Environment Development
CPR	Common Property Resource
DFID	Department for International Development
EMCA	Environmental Management and Coordination Act (Kenya)
ERML	Environmental Resources Management Limited
FAO	Food and Agricultural Organization
FEPA	Federal Environmental Protection Agency (Nigeria)
FGN	Federal Government of Nigeria
FLN	Laws of the Federation of Nigeria
GHG	Green House Gas
GIS	Geographic Information Systems
GTZ	Duetsche Gesellschaft fur Technische Zusammenarbeit
HDI	Human Development Index
HIV/AIDs	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
IBT	Improved Biomass Technology
IEA	International Energy Agency
IEF	International Energy Forum
IHSN	International Household Survey Network
IUCN	International Union for the Conservation of Nature
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goal

Mtoe	Million Tons of Oil Equivalent
MW	Megawatts
NBEIA	National Biomass Energy Improvement Agency
NDDC	Niger Delta Development Commission
NDES	Niger Delta Environmental Survey
NDR	Niger Delta Region
NEMA	National Environmental Management Act (South Africa)
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGO	Non-Governmental Organization
NPC	National Population Commission
OAU	Organization of Africa Unity
OECD	Organization for Economic Co-operation and Development
PRS	Poverty Reduction Strategy
SPM	Suspended Particulate Matter
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFPA	United Nations Fund for Population Activities
WCED	World Commission on Environment and Development
WCFSD	World Commission on Forests and Sustainable Development
WEO	World Energy Outlook
WHO	World Health Organization
WWF	World Wildlife Fund

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

1. INTRODUCTION

Maintaining a sustainable balance between basic human needs and the exploitation of natural resources, on the one hand, and the regenerative capacities of the environment, on the other, could be a very huge challenge. Dealing with environmental issues requires a good knowledge and understanding of the relationships between and among man, his physical habitat and ecosystem, his soci0economic status and wherewithal and, the processes that produce peculiar environmental challenges. This is so because given groups of populations tend to have peculiar needs and so make equally peculiar demands, and correspondingly create peculiar impacts, on their given environments. In other words, environmental challenges are the results of the interplay between and among the physical, social, economic and political factors of the human processes of production, consumption and social reproduction (Lowe and Bowlby, 1992). Since the late 1960s, African leaders have recognized the very significant importance of the environment and its diversified resources to the development of their economies. Consequently, they have taken steps to protect and conserve their environments. Some of these steps include the adoption of:

- ♣ The African Convention on the Conservation of Nature and Natural Resources; the so-called ***Algiers Convention***, in 1968 (OAU, 1968);
- ♣ The 1991 ***Bamako Convention*** on the Ban of the Import into Africa and the Control of Trans-boundary Movement and Management of Dangerous Wastes within Africa (Amechi, 2009);
- ♣ The ***Nairobi Convention*** for the Protection, Management and Development of Marine and Coastal Environment of the East African Region (www.unep.org/Nairobi Convention/docs/English_Nairobi_ Convention_Text.pdf); and
- ♣ The Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (http://www.opeworg/chemica-weapons-covention/related-international-agreements/toxic-chemica-weapons-and-the environment/marine-and-coastal-environment-west-and-central-africa/).

At the individual national levels, a myriad of environmental instruments have also been adopted to protect the environment so that it can stimulate, enhance and continue to sustain socio-economic development. These include:

- ♠ South Africa's National Environmental Management Act (NEMA), No. 107 of 1998,
- ♠ Kenya's Environmental Management and Coordination Act (EMCA), No. 8 of 1999, and
- ♠ Nigeria's Federal Environmental Protection Agency (FEPA) Act, Cap F10 *LFN* 2004, now superseded by National Environmental Standards and Regulations Enforcement Agency

(Establishment) (NESREA) Act, No. 25 of 2007.

Apart from these continental and national environmental instruments, Amechi (2009) has also noted that various environmentally-inclined human rights instruments aimed at the promotion of socio-economic development in Africa have been established. He specifically cited article 24 of the African Charter on Human and People's Rights; known as the ***Banjul Charter***, which provides that "all peoples shall have the right to a generally satisfactory environment, favourable to their development" (OAU, 1982, in Amechi, 2009: 109). Twenty-seven (27) African countries have followed the Banjul Charter by explicitly enshrining environmental protection and conservation clauses in their constitutions. A sample will suffice.

- The 1992 constitution of Angola states that "all citizens shall have the right to live in a healthy and unpolluted environment". Part II, Article 24(1) directs the state to "take the requisite measures to protect the environment and natural species of flora and fauna throughout the national territory and maintain ecological balance" (Earth Justice Report, 2005: 86),
- The 1990 Constitution of the Republic of Benin states that "everyone person has the right to a healthy, satisfying and lasting environment" (Molb, *et al* (Earth Justice Report, 2005: 88)),
- The 1992 Constitution of the Republic of Congo states that each citizen shall have right to a healthy, satisfying and enduring environment. Title II, Article 46 directs the state to "strive for the protection and conservation of the environment" (Molb, *et al* (Earth Justice Report, 2005: 91)),
- The 1996 Constitution of the Republic of South Africa states that "everyone has the right to an environment that is not harmful to their health or wellbeing", while Chapter 2, Article 24 directs the state "to have the environment protected for the benefit of present and future generations, through reasonable and other measures that secure ecologically sustainable development and use of natural recourses while promoting justifiable economic and social development" (Molb, *et al* (Earth Justice Report, 2005: 104)).
- ***The 1999 Constitution of the Federal Republic of Nigeria*** recognizes the importance of improving and protecting the environment and makes copious provisions for it. Particularly:

  Section 20 makes it an objective of the Nigerian State to protect and improve the environment and safeguard the water air and land, forest and wildlife**.**

  Section 12 establishes, though impliedly, that international treaties (including environmental treaties) ratified by the National Assembly should be implemented as law in Nigeria.
- ***Sections 33 and 34*** guarantee fundamental human rights to life

and human dignity, respectively, which have also been argued to be linked to the need for a healthy and safe environment, in order to give effects to these rights (Amokaye, 2004).

This review shows that the stubborn persistence and escalation of environmental challenges cannot be wholly attributed to the lack of regulatory policy instruments. Rather, the executive ability and capacity of individual operators in the environment have been implicated in the outcome of the quality of interactions. More specifically, it is becoming clearer that the ability of communities to reduce or economically liberate their populations from putting pressure on environmental resources can be directly related to the degree of stress that is transferred to, and the consequent quality of, their environment. There is, therefore, a relationship between poverty (and of course, affluence) and the quality of the environment. In this Report, we have synthesized the relationship between poverty and environmental quality in the Niger Delta Region of Nigeria.

Pursuant to achieving the objective of the Report, the rest of it divided into the following eleven sections:

- Materials and methods,
- The Niger Delta Region,
- The Poverty Complex: A conceptual framework,
- Poverty in the Niger Delta Region,
- Energy need of the poor,
- Energy-Millennium Development Goals (MDGs) linkages,
- Poverty-environment indicators,
- Rural-urban context of poverty-energy linkages,
- Environmental impact of the energy consumption in the Niger Delta Region,
- Matters arising,
- Policy challenges, and
- Concluding remarks.

Methods and Materials

The Niger Delta Region (NDR) has a naturally fragile, vulnerable, delicate and sensitive environment. The balance between man and nature is, therefore, so precariously insecure that even the slightest unguided external interference could cause serious upsets with equally grievous environmental consequences. However, as a result of its rich hydrocarbon bearing status, natural, pristine innocence of region has been progressively and massively invaded and violated. The region has now become home to unprecedented and very intense human activities for over five decades. Consequently, the population has increased remarkably and human activities have put more pressure on the environment than its natural capacity can carry and sustain, without adverse consequences.

One major component of the natural environment that has been a constant receptor of this unrelenting pressure and assault is the ecosystem, particularly, the forests and forest resources. As a result of the pervading and deepening poverty in the region, and in be absence of affordable and sustainable alternatives, the vast majority of the people, particularly in rural and even urban settlements depend on biomass

fuel sources for their domestic energy, especially for cooking. In the global literature, however, the debate about the linkage between poverty and environment appears inconclusive.

The goal of the Report, therefore, is to ascertain whether or not, the relationship between poverty and environmental quality in the Niger Delta Region is really inconclusive and indeterminable. Our operational postulation, however, is that ***it is poverty which causes environmental degradation in the Niger Delta Region***. In this Report, biomass is used in a generic sense to include all wood or vegetation-based energy sources. Furthermore and consequently, fuel wood, wood fuel and biomass are used interchangeably.

Pursuant to its goal, the Report seeks to achieve these objectives, namely to:

- ♣ Determine how population growth has affected forest and non-forest resource exploitation in the Niger Delta Region,
- ♣ Establish the relationship between poverty and the source of domestic energy consumption,
- ♣ Establish the relationship between poverty, biomass or wood energy demand and environmental quality,
- ♣ Determine the rural and urban dimensions of the observed relationships and any conflicts that could arise or have arisen there from,
- ♣ Outline the major policy challenges and
- ♣ Proffer away forward.

The Niger Delta Region is defined in the next section. However, we wish to quickly point out that for the purpose of this Report, the Niger Delta Region is defined for political expediency as the nine oil-producing states identified for the purpose of the operations of the Niger Delta Development Commission (NDDC).

The materials used for, and in, this study were sourced primarily from the most current data and information on:

- ❖ population (rural-urban distribution and settlement sizes),
- ❖ type and sources of predominant energy,
- ❖ household energy sources,
- ❖ among others.

The Report is executed through desk top sourcing of information and an extensive review of materials from the following, among other sources:

- ➢ Niger Delta Development Commission (NDDC),
- ➢ Niger Delta Environmental Survey (NDES),
- ➢ United Nations Development Programme (UNDP) Annual Reports,
- ➢ UNDP Niger Delta Human Development Report (Achieving Growth with Equity),
- ➢ UNDP Human Development Report: Nigeria (Achieving Growth with Equity),
- ➢ Publications by researchers on the subject matter, and
- ➢ Socio-Economic surveys by the member states.

The Report stands on a broad and robust literature base of globally-established and widely-accepted linkages between poverty and environmental quality in developing countries, with particular reference to biomass energy consumption in these countries and the African continent, in general. Particular attention is paid to the studies of those countries which share similar socio-economic characteristics with Nigeria, in general, and the Niger Delta Region, in particular.

2. THE NIGER DELTA REGION

This section of the Report draws substantially from the definition of the region used by the ***UNDP/Niger Delta Human Development Report (2007).*** The Niger Delta Region is discussed under following topics: location; geology, relief, drainage and ecological zones; climate; the people; settlements and their size distribution.

Location

We reiterate that this Report adopts the definition of the Niger Delta that has been officially adopted for the purpose of dealing with the practical challenges that have been associated with the exploitation of hydrocarbon resources in the region. Consequently, the Niger Delta Region is defined as comprising the area drained by the natural delta of the Niger River and the areas to the east and west, which also produce oil. The natural limits of the Niger River Delta can be defined by its geology and hydrology. Its approximate boundaries are located close to the bifurcation of the Niger River at Aboh, to the north, around the Benin River, to the west and the Imo River, to the east. The area covers approximately 25,900 square kilometres (ERML 1997). The geographic co-ordinates are between Aboh (050 33′ 49”N; 060 31′ 37”E) in the north and Palm Point (040 16′ 22”N; 060 05′ 27”E) in the south; the east-west limit stretches from Benin River estuary (050 44’ 11”N, 050 44′49”E) in the west to Imo River estuary (040 27′ 16”N, 050 35′ 27′”E) in the east (NDES, 1997).

However, the Niger Delta Region for policy and planning purposes is broader and considerably larger. It includes all oil producing communities and other areas considered relevant for reasons of administrative convenience, developmental objectives and political expediency. This extends and triples the land area to approximately 75,000 square kilometres. This is the definition used by the Niger Delta Development Commission (NDDC). Thus defined, the Niger Delta consists of nine states, namely:

- Abia,
- Akwa Ibom,
- Bayelsa,
- Cross River,
- Delta,
- Edo,
- Imo,
- Ondo, and
- Rivers (Figure 1); and their 185 local governments divided into 800 communities of 12 major ethnic groups.

Geology, Relief, Drainage and Ecological Zones

The natural delta of the Niger River is a vast sedimentary basin. The deltaic deposits comprise mainly medium-to-coarse unconsolidated sands, silt, clay, shale and peat. The delta is generally a flat, low-lying swampy region, dissected by a dense network of meandering rivers and creeks.

The Region has four broad ecological zones, distinguished on the basis of relief and hydrological characteristics. These are, from the coast inland, the:

- coastal sandy barrier ridge zone,
- mangrove swamp zone,
- freshwater swamp zone, and
- lowland rainforest zone.

The coastal sandy barrier zone: It is made up of a chain of sandy barrier islands, which are separated by numerous estuaries and inlets. The islands are generally less than one (1) metre above sea level (ASL) at high tide. They extend along the outer coastline from the Benin River, in the west, to the Imo River, in the east. Typically, they are 16 to 20 kilometres wide. Because of their relatively higher topography, which keeps them from the tidal influence of the marine and brackish waters, the coastal barrier islands support freshwater forests and associated fauna. These islands are also often flooded during the year when rainfall is heavy (UNDP, 2007).

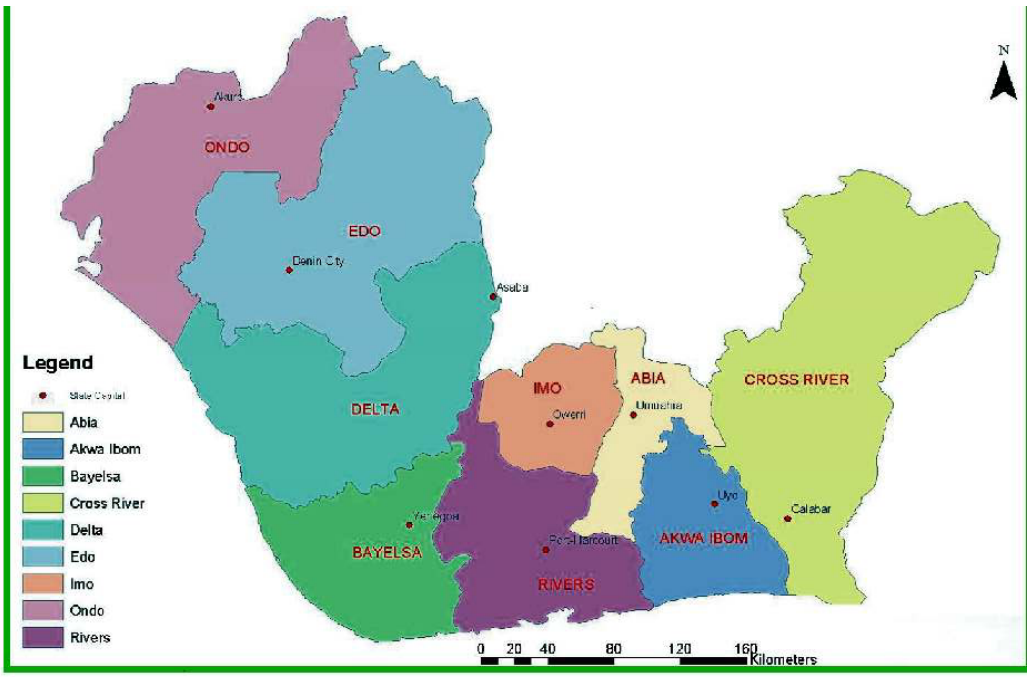

Figure 3: Niger Delta Region

The mangrove swamp zone: This zone occurs immediately after the barrier islands, inland. It is the swampiest of the ecological zones, being essentially a massive swamp, dotted with islands of dry land covering about 10,240 square kilometres (Mosunmolu, 1998). Most of the zone is less than one (1) metre above sea level (ASL), and it is generally muddy and under tidal influence. Within the zone are feeder channels that move tidal waters into the swamp, connecting channels and inter-fluves (UNDP, 2007).

The freshwater swamp zone: It is characterized by seasonal flooding, especially during the rainy season, at which time its swampy characteristics are most vividly obvious. It has the most distinct subdivisions. It is the most diverse in terms of biology and supports an ecology similar to the one in the coastal barrier islands. The zone's three subdivisions are the:

- flood forest sub-zone or 'upper delta',
- marsh forest sub-zone, and
- eastern flank (UNDP, 2007).

The flood forest subdivision has large sand river channels, both permanent and seasonal flood creeks, and is inundated annually by the Niger River flood. Flood-free levees are common, while back swamps and cane forests help give the zone a highly diverse habitat.

The marsh forest subdivision is also referred to as the transition zone. It is permanently swampy and under flooding from freshwater. Muddy swamp channels and raffia swamps can be found in the zone, and its species of wildlife are usually different from those of the flood forest zone.

The eastern flank is thought to have been a flood forest when the Orashi River was a major tributary of the Niger Delta (Powell 1995, in UNDP, 2007).

***The lowland rainforest zone*:** This is in the northern most part of the Niger Delta Region, beyond the areas of dense river and creek networks. It is not located within the area defined by the natural limits of the *geographic* Niger Delta, but falls within the broader, *political* Niger Delta area. It is the least swampy part of the region. It has a varied geology and terrain, but sedimentary rock formations, mostly sandstone with some shale and limestone, underlie most areas. The rock formations present a ridge-and-valley topography. In some parts of Akwa Ibom, Cross River and Ondo States, the terrain is characterized by advanced gully erosion. In Edo, Cross River and Ondo States, there are areas of old, crystalline basement complex rocks, mainly granites, gneisses and granodiorite. These areas are characterized by rugged, rocky terrain with massive rock domes and inselbergs. Apart from the Niger River, the other major rivers in the region include the Cross, Imo, Qua Iboe and Orashi, in the east; and the Benin, Oluwa and Siluko, in the west (UNDP, 2007).

Climate

The Niger Delta Region has a semi-hot, humid equatorial climate with wide internal variations from one part of the region to the other. It is characterized by:

- ♣ temperatures that are high and fairly constant throughout the year. Average monthly temperatures for the warmest months (February to April) range from 28^0C to 33^0C, while the average monthly temperatures for the coolest months (June to September), range from 21^0C to 23^0C.
- ♣ high relative and specific humidity, and
- ♣ intense rainfall, which occurs almost throughout the year in the core delta, but becomes markedly seasonal further inland, with increasing distance from the coast.

Copious rainfall, coupled with the low relief and high water table, produce frequent flooding. The mean annual rainfall in the Niger Delta Region varies from 4,000 mm in the coastal towns of Bonny (Rivers State) and Brass (Bayelsa State), to about 3,000 mm in the central Niger Delta towns of Ahoada (Rivers), Yenagoa (Bayelsa) and Warri (Delta), and about 2,400 mm in the more northern Abia and Imo States. In the more interior locations in the northern parts of Cross River and Ondo States, mean annual rainfall is much less, ranging from 2,000 mm nearer the coast to 1,500 mm, farther inland (UNDP, 2007).

Table 1: Rainfall Distribution in Selected Niger Delta Communities

Community	Number of years covered	Average total annual rainfall (mm)	Average number of rain days
Nembe	5	3419	128
Ahoada	4	1989	121
Ndele	5	2285	124
Port Harcourt	31	2286	180
Calabar	63	2651	190
Warri	64	2842	183

Source: NDDC, 2003.

The UNDP Report presents a composite picture of the climate of the Niger Delta Region as follows:

> The Niger Delta has a humid, semi-hot equatorial climate. The region experiences heavy rainfall, leading to floods in urban areas and communities along the rivers. Due to the heavy and frequent rainfalls, soils consisting mainly of silt and clay become saturated, reducing infiltration to the barest minimum and

encouraging run-off. Rainfall induced run-off is directed mainly to the back swamps in the upper and middle parts of the delta. In the coastal zone, there is an even smaller topographic gradient that makes run-off difficult. Precipitation frequently results in flooding. On average, about 10 per cent of the total annual rainfall occurs during the dry season months of November to March (UNDP, 2007).

The People

The Niger Delta Region is extremely heterogeneous, with respect to culture and ethnicity. There are, however, five major linguistic and cultural groups, namely the:

- Ijoid,
- Edoid,
- Delta Cross,
- Yoruboid, and
- Igboid. Each of these major groups is composed of numerous sub-groups.

The Ijoid: Acclaimed to have the longest settlement history in the Niger Delta Region, the group is the most complex, linguistically. Each of the numerous clans of this group has some linguistic and cultural distinctiveness. In certain cases, villages in the same clan have linguistic differences. This group, which occupies virtually the whole of Bayelsa State, is also found in Rivers, Akwa Ibom, Delta, Edo and Ondo States (UNDP, 2007).

The Edoid: Made up mainly of the Isoko and Urhobo of Delta State, the Edo of Edo State, the Engenni and Apie-Atissa of Bayelsa State, and the Degema of Rivers State. Like the Ijoid, but to a far lesser degree, within these groups, several sub-groups exist; many claiming to have their own individual identity. The groups within the Urhobo are good examples. Typical cases are the Okpe and Uvbie. Among the Edoid groups, the Urhobo is the largest. Although the Edoid is a larger group overall, most of them are found outside the Niger Delta Region. The Edoid in Bayelsa and Rivers States are considered largely within the Ijoid group because of the cultural impact the latter has had on the former (UNDP, 2007).

The Delta Cross: Comprises mainly the Ogoni, Ogba, Abua, Odual and Obolo/Andoni in Rivers State and the Ibibio, Oron and Ibeno of Akwa Ibom State. The Ibibio is the largest of these groups. However, the most well known internationally, is the Ogoni because of its celebrated agitation for resource control and autonomy. The ethno-cultural complexity of the Niger Delta Region is vividly illustrated by the fact that even a small ethnic group like the Ogoni (about 500,000 people) is made up of at least four cultural groups: the Khana, Gokama, Tai and Eleme (UNDP, 2007).

The Yoruboid: They are the Itsekiri of Delta State, and the Ilaje and Ikale in the borderlands of Ondo State.

The Igboid: They are the Ikwerre, Ndoni, Egbema, Ogba and Ekpeye in

Rivers State and the Ukuwani in Delta State.

It is noteworthy that in spite of the fact that the Yoruba and the Igbo are two of the largest ethnic groups in Nigeria, the groups that bear affinity with them in the Niger Delta are some of the smallest.

Before modern times, there was considerable interaction among the groups of the Niger Delta Region, especially those of the core Niger Delta. This interaction has always been in terms of trade and intergroup marriages. One major system of exchange is the trade between the Ijaw, who fish, on the one hand, and the Urhobo, who farm, on the other. Until recently, Itsekiri female traders were important facilitators of this trade. Intergroup marriages have been so significant, particularly among the Urhobo, Itsekiri and Western Ijaw, that a large proportion of families in some areas are multi-cultural (UNDP, 2007).

Population

According to the National Population Commission's (NPC) census returns for 2006, the population of the Region is 31.2 million, distributed among the consistuent states as shown in Table 2.

The estimated total population for 2010 was 33.8 million, rising to 39.2 million by 2015 and 45.7 million by 2020 (Table 3). The states with the highest population sizes are Rivers, Delta, Akwa Ibom and Imo, each being above three million. Bayelsa was the least populated state, with a population of below two million in 2006. With the possible exception of Bayelsa and Cross River States, there are probably no significant differences in population sizes among the states. There are, however, differences in population densities. The overall population density for the

Table 2: Population of the Niger Delta Region by States

State	Land Area (Square Kilometers)	Population (NPC, 2006)	Capital City
Abia	4,877	2,833,999	Umuahia
Akwa Ibom	6,806	3,920,208	Uyo
Bayelsa	11,007	1,703,358	Yenegoa
Cross River	21,930	2,888,966	Calabar
Delta	17,163	4,098,391	Asaba
Edo	19,698	3,218,332	Benin City
Imo	5,165	3,934,899	Owerri
Ondo	15,086	3,441,014	Akure
Rivers	10,378	5,185,420	Port

			Harcourt
TOTALS	**112,110**	**31,224,587**	**N/A**

***Source*:** National Population Commission (NPC), 2006

Niger Delta Region based on the 1991 population was 182 persons per square kilometer (UNDP, 2007). However, the following states have above the regional population density as shown against them:

- Imo (481 per square kilometre),
- Abia State (478 per square kilometre),
- Akwa Ibom (354 per square kilometre), and
- Rivers (307 per square kilometre).

Population distribution within each state is characteristically uneven, particularly in the states in the core Niger Delta, where the fragmented, swampy landscape constrains human settlements.

Table 3: Projected Population of Niger Delta States

States	Land Area	Male	Female	Both	1996	2002	2005	2010	2015	2020
Abia	4,877	1,123,754	1,210,013	2,333,567	2,667,762	3,026,623	3,230,000	3,763,000	4,383,000	6,106,000
Akwa Ibom	6,806	1,167,829	1,241,784	2,409,613	2,746,748	3,131,230	3,343,000	3,895,000	4,537,000	6,285,000
Bayelsa	11,007	584,117	537,576	1,121,693	1,327,488	1,571,540	1,710,000	1,992,000	2,320,000	2,703,000
Cross River	21,930	1,271,932	1,318,569	2,590,491	2,952,900	3,365,881	3,694,000	4,186,000	4,877,000	5,681,000
Delta	17,163	1,271,932	1,318,559	2,590,491	2,952,900	3,365,881	3,594,000	4,186,000	4,877,000	5,681,000
Edo	19,698	1,085,156	1,086,849	2,172,005	2,475,352	3,150,050	3,342,000	3,894,000	4,535,000	5,283,000
Imo	5,165	1,166,448	1,319,187	2,485,635	2,798,238	3,150,050	3,342,000	3,894,000	4,535,000	5,283,000
Ondo	15,086	1,121,898	1,127,650	2,249,548	2,532,535	2,851,293	3,025,000	3,524,000	4,105,000	4,782,000
Rivers	10,378	1,655,441	1,532,423	3,187,864	3,772,738	4,466,293	4,858,000	5,659,000	6,592,000	7,679,000
Niger Delta Region	112,110	10,132,711	10,329,200	20,461,711	23,469,866	26,934,302	28,856,000	33,616,000	39,157,000	45,715,000

Source: *Centre for Population and Environment Development (CPED), 2003; 421.*

Settlement Patterns

Settlement patterns in the delta are influenced by topography and drainage. In the coastal beach ridge zone, dry land is readily available, though in narrow strips. Settlements in this area are typically linear. Various wide estuaries separate settled areas. A number of sizeable settlements, such as Bonny, Akassa and New Forcados, are located here. Given the fact that the mangrove swamp zone is a massive swamp with scattered islands, population is correspondingly discontinuous and sparsely distributed. The mangrove swamp is virtually uninhabited except for fishing camps; some settlements exist in dry islands.

Settlement size is dependent on the size of a given island. The large settlements include Buguma, Nembe and Burutu. Land is more or less continuous in the fresh water swamp region,

notwithstanding the numerous creeks. Since much of the land is swampy, habitation is usually in areas of high land. The levees along the rivers and creeks are the favoured sites, and often densely populated. Other areas are very sparsely settled. Major settlements include Sagbama, Oleh and Patani. Of all the zones, the lowland rain forest zone is best suited for settlement. Most of the large settlements are found here, although the largest towns in the Niger Delta: Port Harcourt and Warri, are found in the transition zone between swampland and the more solid land of the lowland rainforests.

Size Distribution of Settlements

Small settlements with less than 1,000 people dominate in the Niger Delta, followed by settlements in the range of 1,000 to 5,000 people. The NDDC Regional Master Plan established that there are 13,329 settlements in the region, with 94 per cent of them having populations of less than 5,000. Indeed, only 98 settlements, or about one per cent, can be classified as urban centres based on population size (Table 3 and Figure 2). The prevalence of small settlements is explained by a number of factors.

- First, the environment provides limited space for human settlement, given the fragmentation of land into islands and the occurrence of dry land in isolated pockets. Most settlements are small and dispersed.
- Second, fishing communities all over the world characteristically dwell in small fishing villages close to their fishing grounds.
- Third, as indicated above, the Niger Delta is home to many small minority groups, each of which is composed of numerous clans. Each clan cherishes its own private space (UNDP, 2007).

Given this preponderance of small settlements, the task of promoting sustainable human development in the Niger Delta Region is a major challenge. Size or threshold population, plays an important role in the promotion of development, whether human or economic. In many parts of the world, the human development agenda have revolved mainly around large settlements. Developmental artifacts usually involve large capital outlays and great elements of risk, and are, therefore, more likely to be located in areas where the risks are low and profit or potential use can be

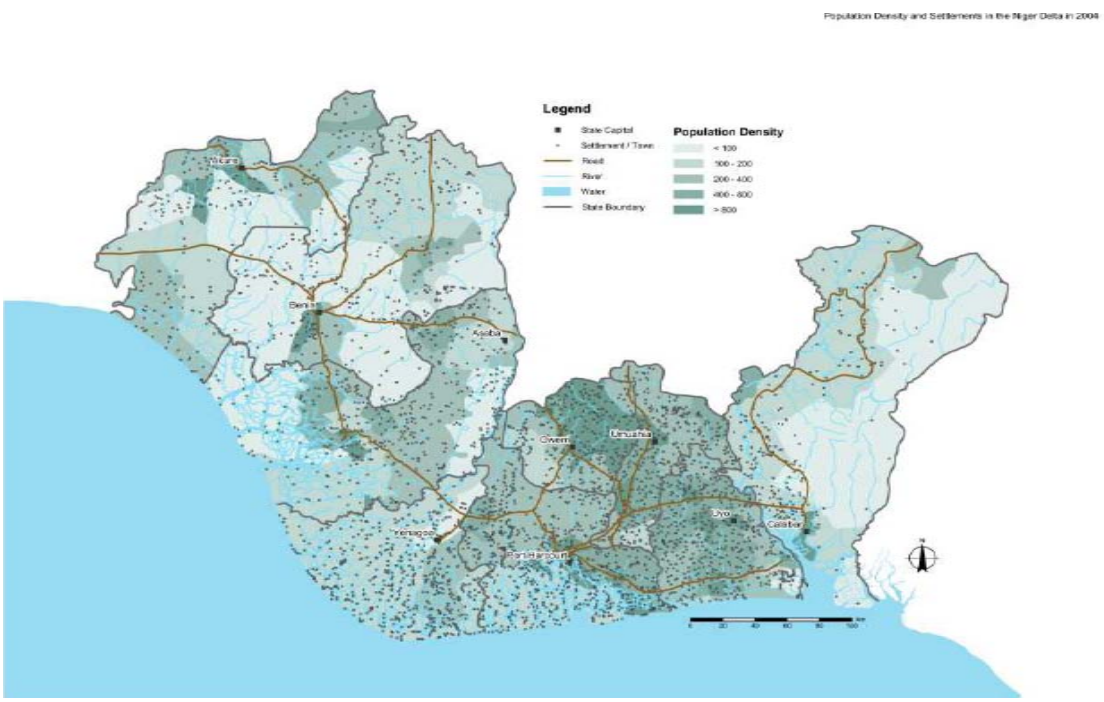

Figure 4: SIZE DISTRIBUTION OF SETTLEMENTS

maximized. Typically, human organizations require a certain minimum support threshold to sustain its existence. This is because many products and services can only be produced or provided economically at a certain scale; many innovations are adoptable by production units of a certain size, or critical mass; and so on and so forth. All of these factors point to large settlements as generators of growth and as engines of human and economic development (Mabogunje, 1965; Abumere, 2000, 2004; Omuta, 2005). Unfortunately, this phenomenon has often fostered inequality in development between urban and rural areas, especially in developing countries. This is especially true in the Niger Delta Region, where many of the cities are parasitic; absorbing resources without commensurately spreading development to surrounding rural areas that sustain them. Table 4 shows the size distribution of settlements in the NDR.

Table 4: Size Distribution of Settlements in the Niger Delta

NDDC States	Less than 1,000 people	1,000-5,000 people	5,001-20,000	20,001 people and above
Abia	393	494	52	11
Akwa Ibom	1,236	1,098	46	7
Bayelsa	290	317	85	4

Cross River	117	500	56	8
Delta	1,o16	307	104	22
Edo	903	264	70	11
Imo	788	925	81	2
Ondo	1,463	278	57	16
Rivers	428	598	213	17
Niger Delta Region	**7,686**	**4,781**	**764**	**98**

***Source**: Centre for Population and Environment Development (CPED), 2003, p. 236.*

The Table shows that less than half of the states, namely: Delta, Rivers, Ondo, Abia and Edo have reasonable numbers of such settlements. If we use the number of urban settlements (generally accepted as those with 20,000 people and above) as our measure of urbanization, then Table 4 shows that Delta State is the most urbanized in the region, with twenty-two urban centres, followed by Rivers and Ondo States, with seventeen and sixteen centres, respectively. Contrastingly, the least urbanized (most rural) is Imo, with only two urban centres, followed by Bayelsa and Akwa Ibom with four and seven centres, respectively.

3. THE POVERTY COMPLEX: A CONCEPTUAL OUTLINE

The way we define and use poverty is critical to any public policy on matters pertaining to the concept. The debate about the poverty-environment nexus dates back to the 18th century, when Thomas Malthus argued that because of burden of their inherent economic handicap and disadvantage, the poor "seldom think of the future" (Malthus, 1798) and consequently continually and heedlessly degrade their natural recourse base and put their environment under perpetual jeopardy, pressure and stress. Mahatma Gandhi has been reported to have echoed Malthus's assertion by concluding that "poverty is the greatest cause of environmental harm" (Amokaye, 2004; 24). In contemporary context, Ostrom, Burger, Field, Norgerd, and Policansky (1999) are of the opinion that people living in poverty are almost always forced to deplete their local natural resources to survive; and that this degradation of their environment further impoverishes them in a vicious circular, self-reinforcing manner. Of particularly direct concern is the argument by Holden, Bekele and Pender (2004) and Agrrey, Wambugu, Karugia and Wanga (2010; 84) that poverty-constrained options may, and do often, induce the poor to deplete environmental resources at rates that are incompatible with long-term sustainability.

However, in order to properly understand the connections and linkages; and adequately deal with the issues pertaining to them, the concepts of poverty and environment must be isolated and discussed.

The first set of questions is: What is poverty? Is it a single attribute? Or is it multifaceted? If it is multifaceted, what are its dimensions and components? In this section, we shall explore and characterize the concept of poverty. The concept of the environment will be discussed later.

Economists have traditionally defined poverty on the basis of household incomes or consumption capacities, and have adopted this as the best proxy for welfare (Bucknall, Kraus and Pillai, 2000). This perspective limits the definition of poverty to "those areas of life where consumption and or participation are determined primarily by command over financial resources" (Nolan and Whelan, 1996: 193). In the view of Nolan and Whelan (1996), the utility of the definition of poverty lies in whether its conceptualization is rooted in the individual's personal resources, especially income, or in terms of living standards and activities; while Ringen (1987: 146) believes that both could be combined. Consequently, Ringen (1987) has defined a condition of poverty as one of "a low standard of living, meaning deprivation in way of life because of insufficient resources to avoid such deprivation".

Consequently, using this composite approach, people are considered poor if their levels of consumption fall below a given income (poverty) line, which is currently globally set at one US dollar per person per day. However, Langmore (2009) has been cited as arguing that even this approach is a narrow perspective to the definition of poverty because it implicitly excludes the non-material elements included in the broader United Nations definitions. These non-material elements include 'lack of participation in decision making', 'violation of human dignity', 'powerlessness', 'susceptibility to violence' and 'humiliation', among others (www.policy.co.uk/key concepts/samples/lister-chapter.pdf).

In other words, and according to a recent view from the World Bank, "Poverty is a multi-dimensional phenomenon, extending from low levels of health and lack of education, to other 'non-material' dimensions of well-being, including gender gaps, insecurity, powerlessness and social exclusion". From the point of view of human development, the United Nations Development Programme (UNDP) defines human poverty to mean situations where "opportunities and choices most basic to human development are denied: to lead a long, healthy, creative life and to enjoy a decent standard of living, freedom, dignity, self-respect and the respect of others" (UNDP, 2006).

Given the multi-dimensional nature of poverty, not only must the precise measurement of who is poor not be restricted to the measurement of income-based poverty, but it must also define social categories such as gender, ethnicity, location, livelihood status, etc. A distinction can also be drawn between people in chronic (long-term) poverty and those suffering from temporary vulnerability or transitory

poverty. The latter may be as a result of natural or macro-economic shocks.

Households in chronic poverty can also be disaggregated according to their specific characteristics and causal factors. One category of the chronically poor may experience poverty in several dimensions, for example socially excluded groups, people with disabilities, refugees and displaced persons, people suffering from HIV/AIDs, etc. Another category is those who suffer chronic poverty primarily as a result of inadequate access to productive assets (OECD, 2001; IV-9). It is from this point of view that Chukwu (2008) has defined poverty as "a condition of lacking the necessary ingredients that make life worth living", to the extent that these ingredients could be many and quite varied; material and non-material.

In other words, it is difficult to find a single measure or indicator for the interrogation and analysis of poverty. Therefore, contemporary definitions of poverty are moving away from single dimensional investigations towards and including utility- and capability-based concepts. These include inequality (both within a country or region and within a household), health, education, security, energy use, political voice, and discrimination (Sen, 1981; Putnam, Leonardi and Nanetti, 1993). It must be noted that not all of these indicators are necessarily applicable in every particular investigation, but generally, each is relevant in capturing an aspect of the global, composite concept of poverty (Ravallion, 1996).

The definition of poverty has also been dichotomized into 'absolute' and 'relative'. In this regard, absolute poverty has been defined in terms of an individual's lacking the needed (sufficient) resources to meet his or her basic physical needs. It is translated ultimately into survival or more commonly, subsistence; linked to basic standards of the physical capacity necessary for production (paid work) and reproduction (the bearing and nurturing of children) (Joseph and Sumption, 1979: 27). According to the United Nations Fund for Population Activities (UNFPA) absolute poverty is "a condition of life so limited by malnutrition, illiteracy, disease, squalid surrounding, high infant and low life expectancy as to be beneath any reasonable definition of human decency" (1991; 65).

Relative poverty, on the other hand, derives from Townsend's monumental work: "***Poverty in the United Kingdom***", and puts poverty within its social context and consequently declares that:

> "Individuals, families and groups in the population can be said to be in poverty when they lack the resources to obtain the type of diet, participate in the activities and have the living conditions and amenities which are customary, or are at least widely encouraged and approved, in the societies to which they belong. Their resources are seriously below those commanded by the average individual or family

> that they are, in effect, excluded from ordinary living patterns and activities" (Townsend, 1979: 31).

Consequently, Townsend has asserted that relative poverty is a multi-dimensional concept that embraces all major spheres of life (Townsend, 1993; 36). Moreover, it is historically and spatially dynamic. Thus, according to Donnison (1982), as general living standards improve, and new technologies throw up new modes of consumption, standards of living are pushed constantly forward and upward, such that those who cannot catch up are also constantly pushed down the ladder into poverty. Examples include evolving methods of household cooking. As technology manufactures more sophisticated and invariably more expensive methods and gadgets, new levels of poverty are either created for those that are left behind, or the ranks of those who were already classified as poor, increase.

Surveys by Townsend (1979), Mack and Lansley (1985, 1992) and Gordon *et al.* (2000) initiated a new trend in the poverty discourse. This was labeled as "consensual poverty" in which respondents were asked to name items the lack of which would constitute poverty according to them.

Arising from its multi-dimensionality is the fact that poverty could also be defined at the level of the individual's capacity to meet the needs along a given dimension. In other words, there is a needs dimension to poverty. It is in this regard that Dowler and Leather (2000; 208) have identified ***"food poverty"*** and made the distinction that while the poor consume 'food', the more affluent consume 'nutrients'. They maintain that food is an expression of who a person is, his worth and his ability to provide for basic needs. (Dowler and Leather, *ibid*). Thus, the poor, in a given society, in the name of meeting basic needs, often shops for cheap food items in well-stocked grocery-shops; always tries to maintain a conventional eating habit; and usually afraid to experiment with new foods, since there is no margin for waste and error, should the family (especially where there are children) reject them (Dowler *et al,* 2001).

The point being made is that the discourse of the poverty burden has become very robust and more dynamic and has been broadened to include investigations of the various parameters of its various indicators that can be loaded into it.

4. POVERTY IN THE NIGER DELTA REGION

Poverty makes far more meaning when it is put within a localized context. It is in this context that the UNDP (2007) has confirmed that the incidence of poverty in Nigeria has increased since 1980 (Table 5). According to the Federal Office of Statistics (1999), poverty incidence rose from 28.1 per cent in 1980, to 46.3 per cent in 1985; declined slightly to 42.7 per cent in 1992, before soaring dramatically to 65.6 per cent in 1996. Estimates from the Central Bank of Nigeria (1999) were

even higher, putting the overall poverty rate for the country at 69 per cent in 1997. Aigbokhan (1998), using food energy intake as a measure, determined the incidence of national poverty as 38.0 per cent in 1985, 43.0 per cent in 1992 and 47.0 per cent in 1996. Data from the National Bureau of Statistics also using the food energy intake measure gave a figure of 34.9 per cent in 2004. Thus, the trend of the incidence of relative poverty rose from 28.1 per cent in 1980 to 46.3 per cent in 1985; declined to 42.7 per cent in 1992; rose again to 65.6 per cent in 1996; before declining to 54.4 per cent in 2004 (National Bureau of Statistics, 2005).

Table 5: Incidence of Poverty in the Niger Delta, 1980-2004

Niger Delta Region States	**1980**	**1985**	**1992**	**1996**	**2004**
Edo/Delta	19.8	52.4	33.9	56.1	Delta: 45.35 Edo: 33.09
Cross River	1o.2	41.9	45.5	66.9	41.61
Imo/Abia	14.4	33.1	49.9	56.2	Imo : 27.39 Abia: 22.27
Ondo	24.9	47.3	46.6	71.6	42.15
Rivers/Bayelsa	7.2	44.4	43.4	44.3	Rivers : 29.09 Bayelsa: 19.98
Nigeria	**28.1**	**46.3**	**42.7**	**65.6**	**54.4**

***Source**: National Bureau of Statistics, 2004.*

Available evidence shows that the Niger Delta Region, mimics national trend and pattern, to a large extent. Hence, Higgins (2009) has concluded that the analysis of poverty and human development indicators paints a dismal picture for the Niger Delta. For instance, except for Rivers and Bayelsa States, where poverty incidence seems to have stabilized at around 44 per cent after an initial jump from seven (7) per cent, the poverty level in the region increased between 1980 and 1996 (Table 2.1); declining between 1996 and 2004, for the other states, like the national pattern (UNDP, 2007).

The region's human development index (HDI) is 0.564. While this is slightly higher than the Nigerian HDI of 0.448, the Niger Delta rates far below other regions or countries with similar gas or oil reserves. For instance, in Venezuela, the index is significantly higher at 0.772, while in Indonesia it is also very impressive, at 0.697 (UNDP, 2006: 15). Perhaps more interesting is the observation that when disaggregated at the local government level, the ***Niger Delta Human Development Report*** shows that state and regional HDI scores mask inequalities in human development among the oil producing communities.

Thus, paradoxically, and rather intriguingly, local government areas without oil facilities appear to have fewer poor people than those with oil facilities (UNDP, 2006: 15). The report also concludes, also paradoxically, that decline in the HDI has been steeper for the Niger Delta states than the rest of Nigeria (UNDP, 2006: 137). In other words, Niger Delta states descend into poverty faster and more easily than non-Niger Delta states.

In addition, and to further complicate the poverty syndrome of the region, the significantly higher earnings of some oil and gas industry workers leads to sharp, localised price distortions, which drive up prices, thereby constraining the purchasing power of ordinary people and making it difficult for many to meet the costs of basic needs such as housing, healthcare, environmentally friendly and clean energy, transportation, education and making poverty more pervasive than conventional measures reveal (UNDP, 2006: 57).

The critical issue in the Niger Delta Region is not only the increasing incidence of poverty, but also the intense feeling among the people of the region that they ought to be doing far better than they presently are. This is based on the considerable level of resources they see in their midst, and the unmitigated and flagrant display and celebration of wealth, especially by the political elite in Nigeria; most of which derives from the crude oil and gas resources in their local communities. This largely explains much of the frustration, indignation and sometimes open defiance in the region (UNDP, 2007).

The UNDP Report claims that the poverty rate based on self-assessment of the Niger Delta indigenes is much higher than the 74.8 per cent officially indicated for South-South zone (which accounts for six of the nine states in the region). This is vividly captured by the difference in the 'subjective' definitions of poverty by Niger Deltans during the UNDP field work, on the one hand, and the 'objective' definition by the World Bank, on the other, as presented below.

Two Definitions of Poverty by the People of the Niger Delta

Below is a sample of the definitions or perceptions of poverty that emerged from the engagement of the locals in focus group discussions by the UNDP study team.

- "The poor person is one who cannot pay school fees for his children; cannot meet any needs, including food; has no farm land and cannot farm well; cannot take part in age-grade activities (responsibilities that are specifically designated to some age groups in communities); cannot afford to send his children to school; wears tattered clothes; is very lean; and has no house to live in. In short, a poor person is one who has nothing. Consequently, he has no voice in the community".

- "When you wake up hopeless as to where the next meal is coming

from. When you cannot attend certain functions because you don't have clothes. When your roof leaks and you cannot change it. When you cannot travel because the transport fares are high and when the school fees and allied demands are too much to bear. Then poverty is the cause" (*ERML Fieldwork 2005, in UNDP, 2007).*

Poverty as Defined by a Multilateral Organization

On the other hand, in the perception of the World Bank, "Poverty is hunger. Poverty is being sick and not being able to see a doctor. Poverty is not having access to school and not knowing how to read. Poverty is not having a job, is fear for the future, living one day at a time. Poverty is losing a child to illness brought about by unclean water. Poverty is about powerlessness, lack of representation in decision making in the society and lack of freedom to express oneself. Poverty has many faces, changing from place to place and across time, and has been described in many ways. Most often, poverty is a situation people want to escape. So poverty is a call to action; for the poor and the wealthy alike. A call to change the world so that many more may have enough to eat, adequate shelter, access to education and health, protection from violence, and a voice in what happens in their communities" (*The World Bank 2006, Poverty Net (http://web.worldbank.org/, in UNDP, 2007).*

As alluded earlier, while discussing poverty in this region, it is important to appreciate that price regimes for goods and services can be, and are usually, different from those of most other regions. Prices are often higher in remote oil-producing communities, where they are tied to the pricing of services in the oil and gas industry; and the much higher earnings of oil sector workers. This grossly undermines, erodes and further weakens the already weak purchasing power of the ordinary Niger Delta person; thereby heightening inflation in the costs of basic needs, including conventional household energy.

The operationalization of the concept, therefore, shows that poverty is pervading in all its ramifications in the Niger Delta Region. In other words, whether it is defined in *absolute* terms, as the lack of the means to access basic human needs such as food and shelter; or in *relative* terms, from the societal comparative point of view; or in the *administrative* context of the failure of the state to protect and provide for those who are (even temporarily) vulnerable; or c*onsensually*, in terms of public perception; or *contextually* in terms of relating it to different socio-cultural and economic levels; poverty finds its very eloquent and bold expression in the Niger Delta Region (Omuta, 2011: 228).

A critical and realistic assessment of poverty in the Niger Delta Region should, therefore, focus attention on core considerations such as access to health care, education, water, transportation, fuel/energy and other basic amenities of life, as well as the

extent to which people are involved in decisions that affect them.

5. ENERGY CONSUMPTION BY THE POOR

Following from the earlier summary of the debate on, and interrogation of, the concept of poverty, is the logic that just as there is "food poverty", so also there is ***"energy poverty".*** Energy poverty has been defined as the lack of adequate modern energy for the basic needs of cooking, warmth and lighting, (practicalaction.org.com/…/energy_poverty_hidden_crisis.pdf). It is the basic lack of access to modern energy services necessary for human development (IEF, 2009); the inability to cook with modern cooking fuels and the lack of bare minimum of electric lighting to read, or for other household and productive activities after sunset (Modi, McDade, Lallement and Saghir, 2005; 9). Indeed, one of the indicators that could be, and has been, used to measure poverty in developing countries is the household's affordability, or otherwise, of environmentally-friendly sources or types of energy (or 'clean' or 'modern' energy) for domestic use. In this context, clean or modern energy may be defined to include any energy that either does not pollute at all, or the one that, while reducing the amount of pollutants put into the world, also comes from a source that does not compromise the ability of future generations to meet their energy needs (or what has been called 'environmental debt') (www.tinygreenbubble.com/livegreen/…/546-clean-energy-definition; dictionary.reference.com/browse/clean + energy; www.wisegeek.com/what-is-clean-energy.htm; ODI, 2006). Clean energy is needed to save the world from global warming, climate change and ensure future energy security (file///C:Users/Owners/Desktop/clean_energy_definition.html). Common forms of clean energy include: solar energy, wind energy, hydro energy, even rain energy (www.Twitter.com/TinyGreenBubble; www.wisegeek.com/what-is-clean-energy.htm).

However, one thing that is common to all forms of clean energy is that the technologies needed for their production and commercialization processes are invariably alien to the vast majority of the population of most developing countries because they tend to be very sophisticated and or complex and above all, capital intensive. Consequently and expectedly, they are either not commonly or easily available, or where they are available, are usually very expensive and unaffordable to the poor. There is, therefore, a strong relationship between household income, the most common parameter for measuring poverty, on the one hand, and the type of energy consumed, on the other. Indeed, Yahaya (2002) has concluded that the poorer a country (or a community) is, the greater its dependence on fuel wood (or inefficient energy sources), and *vice versa*.

In this connection, for instance, studies by Gundimeda and Kohlin (2003) have shown that while wood fuel is accepted as a "normal good" for the poor, it is considered an "inferior good" for the

high income households. In the context of Nigeria, Adeoti, Idowu and Falegan (2003) have found that the relationship is such that the use of fuel wood contributes to poverty because the vulnerable, poor households spend almost twice as much on fuel wood for cooking as the mean national income. In Lesotho, Wason and Hall (2004) and Scott (2006) observed that when the government increased the price of oil-based (clean, modern) fuels, most Basotho decided to economize, by sliding down the energy ladder and reverting to using traditional (dirty) fuels, despite the fact that fuel wood was already becoming very difficult to find.

The poverty-energy connection could also be approached from the demographic angle. Here, we note the truism that population growth is faster among the poor than among the rich. Hitherto, it has been established that population growth among the poor invariably translates to pressure on the local environmental resources base. As Osei-Hwedie (1995) puts it, as population expands and the number of the poor increases and demands on resources will also increase. For example, the demand for food, cooking fuel and wood would put greater pressure on agricultural land as well as the stock of a number of environmental resources, especially biomass, the traditional sources of energy.

Biomass is the composite name for the energy from sources such as: wood energy or wood fuel or fire wood; animal dung; agricultural wastes and farm residues; and charcoal. They constitute the bulk of the energy sources for the poor. From our earlier categorization and classification, they are the ones usually known as 'dirty' energy (file///C:Users/Owners/Desktop/clean_energy_definition.html)

It must be noted at this point that the collection and processing of biomass energy supply and demand statistics are very complex. This is because of the great diversity of consumption patterns, differences in the units of measurement, the lack of regular surveys and the variation in the heat or energy content of different types of biomass, among others.

In terms of the global scenario, and according to the best available data (WEO, 2006; www.worldenergyoutlook.org/docs/weo2006/cooking.pdf), household energy use in developing countries totaled 1,090 Mtoe (million tons of oil equivalent) in 2004, which is almost 10 per cent of the world primary energy demand. While in the Organization for Economic Cooperation and Development (OECD) countries, the bulk of the energy demand comes from the power generation and industry sector, in the developing countries, these sectors represent only 12 per cent.

According to the World Energy Outlook (WEO, 2006; 420), although there are enormous variations in the levels of consumption and the types of fuels used; and although a precise breakdown is usually difficult, the main uses of energy in households in

developing countries are as follows, in this descending order:

1. Cooking,
2. Heating, and
3. Lighting.

Table 6 shows the distribution of the people depending on biomass for cooking among the major region of developing countries.

Table 6: Number of people relying on traditional biomass for cooking and heating in developing countries, 2000

REGION	Million	Percentage of Total Population
China	706	56
Indonesia	155	74
Rest of East Asia	137	37
India	585	58
Rest of South Asia	128	41
Latin America	96	23
North Africa and Middle East	8	0.05
Sub-Saharan Africa	575	89
Total Developing Countries	**2,390**	**52**

Source: IEA 2002b

The Table shows that while across all the developing countries, on the average, 52 per cent of the total population uses biomass energy for cooking and heating, the figure for sub-Saharan Africa is 89 per cent; which incidentally is the highest. This is to be compared to 0.05 per cent of the population of North Africa and the Middle East, on the one hand, and 23 per cent in Latin America, on the other. According to the Aprovecho Institute of Germany, the average poor family in developing countries uses about four (4) tons of fuel wood annually for cooking, which is about twice as much wood as each family in the developed world uses for construction, paper, furniture and fire wood, combined. The Institute concludes that up to 70 per cent of all the wood used on earth ends up under someone's cooking pot (Aprovecho Institute, 1984; 5). This is why this Report focuses on cooking, being the main energy demand item of households in Nigeria, in general and the Niger Delta Region, in particular.

The Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ, 2007) has confirmed that "in developing counties, and especially in the rural areas, 2.5 billion people rely on biomass sources of energy, such as fuel wood, charcoal, agricultural waste and animal dung, to meet their energy needs for cooking", and they account for over 90 per cent of the aggregate household energy consumption (WEO, 2006; 419;

www.gtz.de/de/dokumente/en-cooking energy-2007.pdf; 3; IEA. 2006). Indeed, biomass fuels are often the only available energy sources, especially in rural areas. And in most developing countries, it has been confirmed that not only is it preferred now, more than 80 per cent of the population use, and will continue to use biomass fuels for their daily cooking (www.gtz.de/de/dokumente/en-cooking energy-2007.pdf; 3). In fact, it has been projected that in the absence of new strong and responsive policies, the number of people that will rely on biomass to meet their energy need for cooking will increase to over 2.6 billion by 2015, and to 2.7 billion by 2030, due largely to population growth and stagnant or sluggishly responding per capita income (WEO, 2006; 431).

Having established that cooking is the main use of energy by the poor in developing countries, the above scenario helps us to understand its strategic place in the development of such regions.

Generally, in developing countries, households use a combination of energy sources for cooking. These can be categorized into:

- Traditional, including: dung, agricultural wastes, farm residues and fuel wood (wood energy),
- Intermediate, such as charcoal, and
- Modern, including: liquefied petroleum gas (LPG), biogas and electricity.

In these countries, electricity, biogas and liquefied petroleum gas (LPG), together, represent a very insignificant proportion of total household energy consumption. In fact, Practical Action (practical action.org/…/energy_ poverty_hidden_crisis.pdf) has claimed that only 15 per cent of the population in Africa has electricity compared to 40 per cent in South Asia. This is because, being largely either unavailable or unaffordable, they are mainly used for lighting (and, where appropriate, for powering light appliances), rather than for domestic or any other type of cooking. Bearing in mind also, that our concern is with the poor, electricity and other modern sources of energy are not and cannot be considered relevant and so will not be our focus, because where the poor are able to afford electricity connection, it is never used for cooking. Considering further, the very close affinity between charcoal, being from forest resources, on the one hand, and agricultural residues and fuel wood, which make up the bulk of the traditional energy source, on the other, this Report does not make a distinction between traditional and intermediate sources of energy.

Concerns over consumption of biomass energy (fuel wood, wood fuel, fire wood, etc,) around the world, and in developing countries in particular, came to public attention with the 1975 publication of Erik Eckholm's paper, ***"The Other Energy Crisis."*** In the paper, Eckholm called attention to the growing use of wood for fuel in less-developed countries and the commensurate concerns of environmental degradation through deforestation, soil erosion, loss of soil nutrients, and loss of

biodiversity, among other manifestations. It also noted a connection between poverty and unsustainable fuel wood harvesting; and the difficulty in breaking the cycle of unsustainable harvest, resource depletion, and deepening poverty.

In stating the importance of traditional biomass sources of energy in many developing countries, Ouedraogo (2005) has argued that the high cost of modern cooking energy (such as liquefied petroleum gas (LPG) and electricity) and their specially designed cooking gadgets and stoves are major constraints for household fuel preferences. Similarly, Fawehinmi and Oyerinde (2002) have used descriptive statistics to confirm that massive increases in the costs of modern sources of energy have resulted in increasing levels of relative poverty in Nigeria. Consequently, they concluded that wood energy has remained, and would continue to remain, the fuel of choice for most homes. In this regard, Chavin (1981)cited in Ouedraogo (2005) and Arnold, Kohlin Presson and Shephard (2003) have confirmed that in spite of several public policies designed by the government of Burkina Faso, to discourage the continued dependence on wood energy, "a certain inertia is observed for household cooking fuel preferences". In his study of Burkina Faso, Ouedraogo (2005) confirmed that more that 90 per cent of the population of the country use wood energy as the main source of cooking energy and that even in urban Ouagadougou, the national capital, only a dismal 29 per cent of the population has access to electricity, which is used exclusively for lighting. The study further confirmed that the poorest segments of the society, which characteristically have the largest families and households, and cook more food and more frequently, are the main users of fire wood. Figure 3 locates the poor at, or towards the base of the energy ladder.

Studies by Tolba, El-Kholy, Holdgate, McMicheal and Munn (1992) have confirmed that in Kenya, 78 per cent of the population depend on fuel wood for cooking, while in Ethiopia and Tanzania, the figure rises to 95 per cent. In rural Botswana the proportion of households that use fuel wood for cooking is three times that of urban areas (IEA, 2006; 422). In Nigeria, Aina and Salau (1992; 212) have asserted that "of all traditional fuels, fuel wood is the most important. The vast majority of rural Nigerians depend on fuel wood, for cooking and heating for both domestic and non-domestic

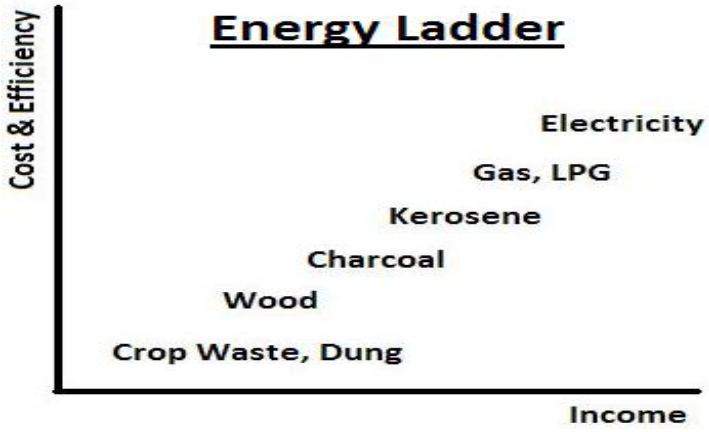

Figure 3: The Energy Ladder: The Relationship Between Income, the Cost and Efficiency of Type of Household Energy

purposes; domestic consumption represents the largest share of the total consumption. In many rural areas of Nigeria, fuel wood supplies over 80 per cent of the total energy consumed for all purposes". This figure was recently upheld by Onuche (2010; 212). In fact, the use of fuel wood as the source of cooking energy has been confirmed as an endemic rural habit.

With specific reference to the Niger Delta Region, data from the Federal Office of Statistics show that across the area, the general sources of household fuel are firewood, charcoal, kerosene, gas, electricity, crop residues, animal waste and others. The modal fuel or primary energy source for cooking in the region is fire wood (a mean of 73 per cent), followed by kerosene (24.8 per cent) and gas (1.2 per cent) (UNDP, 2007).

With crises and shortages already manifesting in many biomass energy (fuel wood-) dependent countries and communities, Duraiappah (1996) has expressed serious concern for the energy security of the poor, who depend solely on biomass as the main source of energy for cooking and warming. Probably of equally, if not more, significant concern are the implications of these pressures and the attendant consequent shortages for the ecosystems and environmental resources from which the cooking energy is sourced and in which it is used.

6. THE ENVIRONMENT: ENERGY CONSUMPTION OF THE POOR

The foregoing section clearly and emphatically shows that there is a strong linkage between the energy consumption of the poor and the environment. In this section, we shall discuss the concept of the environment and further explore, interrogate and try to establish the relationship between the two.

Because of the fluid nature of its content, a plethora of definitions of the concept of the environment exist in the literature, ranging from the sweeping and general, to the sophisticated and specific. Hence, Comim (2008; 6) posits that "controversies exist about the concept of environment" because it covers a wide range of ecological aspects. In colloquial usage, the environment is defined as our surroundings, especially the material and spiritual influences which affect the growth, development and existence of a living being (The Concise Oxford Dictionary, 1995). This is in consonance with Wilkinson and Wyman's (1986) definition of the environment as all the interacting factors and circumstances that surround, influence and direct the growth and behavior of individual beings, groups, species and communities. Earlier, Detwyler and Marcus (1972) had defined the environment as the aggregate of the external conditions that influence the life of an individual or a population.

The environment is usually characterized and classified into two, namely: physical and cultural. The physical environment is the natural environment, consisting of the biosphere, atmosphere, hydrosphere and lithosphere and their inherent resources. The cultural environment, on the other hand, generally encompasses the way of life of the people of a particular geographic domain or location, including the settlements, cultural, historical and religious aspects of human activities (Rau and Wooten, 1980). This dichotomy notwithstanding, the International Union for the Conservation of Nature (IUCN) has been cited as perceiving the environment, holistically, as the totality of nature and natural resources; which include the cultural heritage and the infrastructure essential for socio-economic activities (Amokaye, 2004; 24). In the same vein, Rau (1980) has defined the environment as "the whole complex of physical, social, cultural, economic and aesthetic factors which affect individuals and communities and ultimately determine their form, character, relationships and survival".

According to Amokaye (2004), the legal definition of the environment is extensive and integrative in nature and incorporates the natural, human and non-living inhabitants of the planet. Thus, in Nigeria, for instance, the Federal Environmental Protection Agency (FEPA) Act (FGN/FLN, 1990) defines the environment to include the water, air, land, and all plants and human beings or animals living therein and the relationship between and among them. Similarly, Amokaye (2004) has cited the International Convention on Civil Liability for Environmental Damage (ICCLED) as defining the environment to include both biotic and abiotic (non-living) resources.

Thus, the definition of the environment could be extended to include not only the natural environment but also the man-made environment which accommodates man-made landscapes, buildings, and objects which form part of man's cultural heritage. In the opinion of Kofi Anan, from whatever

perspective we define the environment, it is the source of sustenance that humanity depends on; for food, fuel, medicines and materials (Amokaye, *ibid*; 5). A logical extension of these definitions is that since the mix of physical and man-made conditions almost always varies from place to place, the character and quality of the environment will correspondingly vary from place to place (Omuta, 1988; 418). At this juncture, we reiterate that African countries have long been concerned about protecting and conserving their environmental resources, as demonstrated by their various declarations in the African Charter on Human and Peoples Rights. For instance, countries like Angola, Benin and South Africa have enshrined in their various constitutions, their commitment to protecting the health and well being of their people (even the flora and fauna) and guaranteeing an unpolluted environment.

From the above sample of definitions, we cannot over emphasize the fact that we should and must be concerned about the environment, because within its definition are embedded the linkages with energy consumption, especially, when the type of energy consumed comes directly from nature, such as biomass energy. More explicitly, the environment is significant to energy consumption because:

- ♣ it is the life-support system for planet earth, including its sources of energy supply,
- ♣ it is the ecosystem within which all living organisms (including man who uses its resources as energy) interact with the physical elements (Oladapo, 2001, p. 340),
- ♣ as the global life-support system, it drives a number of ecological processes that control the climate, cleanse the air and water, regulate water flow, recycle essential elements, create and regulate soils and keep the earth perpetually fit for life and living (IUCN/UNEP/WWF,1991),
- ♣ as a dynamic life-support system, its capacity to sustain human life and support the development of human cultures depends on the extent to which the effects of human activities (including energy consumption) are kept, and remain, within safe bounds,
- ♣ uncontrolled effects of human activities (including man's demand for and supply of energy) can destroy the diversity, complexity and function of the global ecological life support system (Contanza, 1991),
- ♣ in his interaction with nature, man faces a number of challenges and threats, which have been summarized in terms of some ecological laws. Sada (1988, pp. 28, 29) has distilled the over twenty such ecological laws identified by Dausereau (1966) into four major ones, namely; that:
  - ➢ "no species encounter in any given habitat, the optimum condition for all its function". This is otherwise known as the ***law of inoptimum,*** which suggests that because of man's original

ineptitude, changes, challenges and adjustments are inevitable in man-environment interactions. Consequently, inadequacies and less-than-satisfactory options, like "energy poverty" will always be with humanity,

- "on the average, organic evolution is slower than environmental change". This is the ***law of aphasy*** which implies that the rate at which human activities (including the dependence on biomass energy) degrade the environment is faster than the rate at which the environment regenerates itself,
- "a specie is ecologically and geographically confined by the extremes of environmental adversities that it can withstand". This is the ***law of tolerance***, which suggests that there is an ultimate limit to human (organic) survival, and
- "although living beings react holocenotically (to all factors of environment in their peculiar conjunction), there frequently occurs a discrepant factor that has controlling power through its excess or deficiency". This is the ***law of factorial control*****,** which stresses that uncontrolled concentrations of polluting agents and substances (like indoor cooking smoke), on the one hand, and/or the depletion of essential elements (such as biomass exploitation), on the other, could threaten the environment,

- humanity's development depends on it in a number of ways. Among those identified by Morvaridi (1996), are that the environment is:
  - a source of raw materials and energy,
  - a provider of services for the maintenance of climatic systems and ecological cycles, including forests, agricultural lands, water, and so on, and
  - a sink for the waste by-products of development.

In linking the three, Kozulj (2010; 65) has asserted that the dependence on biomass energy, through the use of fuel wood for cooking is almost invariably a clear indicator of the poverty that is associated with lack of access and ability to afford clean and modern sources of energy for such purposes. Consequently, and for such households, the only option left is to assault unprotected, vulnerable natural resources. The environment becomes the receptor of the burden and brunt of energy poverty.

If we accept the warning that unless there are new strong and responsive policies, the number of people that will rely on biomass to meet their energy need for cooking will increase to over 2.6 billion by 2015 and to 2.7 billion by 2030, due largely to population growth and stagnant or sluggishly responding per capita income (WEO, 2006; 431), then the poor should be expected to continue to put pressure on the environment in order to meet their basic household energy needs.

The general consensus is that the functions of the ecosystem are under threat and are being stressed. In this regard, Oladipo (2001; 341, 342) argues that "human activities are radically altering the ecological processes that make the planet (earth) fit for life (and living), through global pollution and the destruction or degradation of the ecosystems". He concludes by warning that "within the development context, there is a general realization that if the present rate of human-induced resource depletion continues unchanged and unmitigated, the limits to growth on the earth could be reached in less than 100 years, irrespective of our faith in technology". Contemporary trends seem to be indicating that dependence on biomass energy could be pushing developing countries speedily towards that dreaded limit.

7. ENERGY-MILLENNIUM DEVELOPMENT GOALS (MDGs) LINKAGES

At the Millennium Summit in September 2000, the largest gathering of world leaders in history adopted the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets, with a deadline of 2015. These targets have become known as the Millennium Development Goals (MDGs).

The Millennium Development Goals (MDGs) are the world's time-bound and quantified targets for addressing extreme poverty in its many dimensions: namely: income poverty, hunger, disease, lack of adequate shelter, and exclusion; while promoting gender equality, education, and environmental sustainability. They are also targeted at basic human rights, namely: the rights of each person on the planet to health, education, shelter, and security. The goals are stated as follows:

- Goal 1: Eradicate Extreme Poverty and Hunger
- Goal 2: Achieve Universal Primary Education
- Goal 3: Promote Gender Equality and Empower Women
- Goal 4: Reduce Child Mortality
- Goal 5: Improve Maternal Health
- Goal 6: Combat HIV/AIDS, Malaria and other diseases
- Goal 7: Ensure Environmental Sustainability
- Goal 8: Develop a Global Partnership for Development

However, a very strong opinion is currently being formed that the exclusion of ***energy poverty*** or its specific mention appears to be a major omission. Indeed, Weatherbee (2010) has called energy poverty "the missing MDG." Even the United Nations had in fact earlier signified this by acknowledging that "although there is no specific MDG relating to energy, the MDGs ***cannot*** be met without affordable, accessible and reliable energy services. Higher quality and larger quantities of energy services than current approaches provide are required to meet the MDG challenge" (UN, 2005; 6). For the avoidance of doubt, the eight MDGs and their energy linkages are presented in Table 7.

Table 7: The MDG-Energy Linkages

GOAL	MDG	ENERGY LINKAGE
1	**Eradicate extreme poverty and hunger**	❖ Saving time spent being ill or having to care for sick children will cut health care expenses and increase earning capacities. ❖ Where fuels are purchased, increasing fuel efficiency and thus cutting down on the quantity of fuel needed will ease constraints on already tight household budgets. ❖ Improved household energy technologies and practices will open up opportunities for income generation. ❖ Access to electricity will provide a source of light for economic activities in the evening and a source of energy for operating, for example, a sewing-machine or refrigerator.
2	**Achieve universal primary education**	❖ With less time lost in collecting fuel and due to ill health, children will have more time available for school attendance and homework. ❖ Better lighting will allow children to study outside of daylight hours and without putting their eyesight at risk.
3	**Promote gender equality and empower women**	❖ Alleviating the drudgery of fuel collection and reducing cooking time will free women's time for productive endeavours, education and child care. ❖ Reducing the time and distance that women and girls need to travel to collect fuel will reduce the risk of assault and injury, particularly in conflict situations. ❖ Involving women in household energy decisions will promote gender equality and raise women's prestige.
4	**Reduce child mortality**	❖ Reducing indoor air pollution will prevent child morbidity and mortality from pneumonia. ❖ Protecting the developing embryo from indoor air pollution can help avert stillbirth, perinatal mortality and low birth weight. ❖ Getting rid of open fires and kerosene wick lamps in the home can prevent infants and toddlers being burned and scalded.

5	**Improve maternal health**	❖ Curbing indoor air pollution will alleviate chronic respiratory problems among women. ❖ A less polluted home can improve the health of new mothers who spend time close to the fire after having given birth. ❖ A more accessible source of fuel can reduce women's labour burdens and associated health risks, such as prolapse due to carrying heavy loads.
6	**Combat HIV/AIDS, malaria and other diseases**	❖ Lowering levels of indoor air pollution levels can help prevent 1.6 million deaths from tuberculosis annually.
7	**Ensure environmental sustainability**	❖ Where biomass is scarce, easing the reliance on wood for fuel through more efficient cooking practices will lessen pressures on forests. ❖ Moving up the energy ladder and using improved stoves can increase energy efficiency and decrease greenhouse gas emissions.
8	**Develop a global partnership for development**	❖ Recognition in development agendas and by partnerships of the fundamental role that household energy plays in economic and social development will help achieve the Millennium Development Goals by 2015.

Source: WHO, *Fuel for Life*, p. 17.

It would seem that the underlying assumption of the Millennium Summit and the relationships established above is that a shift from traditional to modern energy sources and services would be a major catalyst to the achievement of the MDGs. More specifically, the presumption is that ***electricity*** will be the global source of household energy. However, progress reports from most developing nations confirm that this anticipated shift is either not taking place, or it is doing so at a pace that is slower than is needed to meet the expectations of the Millennium Declaration. This is summarized recently by a UN (2010; 8) document, when it confirmed that a large number of households still do not have access to modern fuels for cooking; and that when they do, it accounts for a disproportionate share of their incomes, which further exacerbate social inequality and ultimately poverty.

Nigeria, in general and the Niger Delta Region, in particular, is one of the areas where the UN observation can be confirmed; implying that the anticipated shift to modern energy services cannot be expected to be completed by 2015. The challenges facing the shift in Nigeria and the Niger

Delta Region are well known and include:

- inadequate capacity (where less than 4,000MW of electricity is generated, compared to the minimum of 10,000MW needed), and
- high tariffs (which, although are already a heavy burden to most consumers, are claimed to be highly subsidized).

Consequently, modern energy services, and particularly, electricity, are largely either not available, especially in the rural areas, or where they are available, are not affordable to the poor, whether they live in rural or urban areas.

Among others, what this points to is the fact that perhaps, energy poverty might be with the region for some time. In other words, eliminating energy poverty by shifting from traditional biomass to modern energy sources can only be pursued as a long term policy objective, which will take some time to achieve. However, given the infallible linkages between energy poverty, on the one hand, and natural environmental resources and human health, on the other, as well as between energy poverty and the achievement of the MDGs, on the other, short-term, realistic and affordable ways of meeting the household energy needs of the poor, while mitigating the negative impacts, must sought and pursued, and should be on the front burners of policy makers.

8. POVERTY-ENVIRONMENT INDICATORS

According to Osuntogun (2002, 9), one of the main challenges for the study of the relationship between poverty and environmental quality is the choice of indicators or parameters. Given the diversity of the manifestations of environmental problems, the variety of contexts in which they arise, and the numerous possible solutions to them, there can be no "correct" set of indicators. Consequently, there is no universal set of indicators that is equally applicable in all cases. Two separate, but largely overlapping sets of suggestions are presented here to demonstrate the flexibility or even subjectivity of environmental indicators.

Segnestam (1999: viii) has suggested a generic framework within which to consider what may be relevant for adaptation in a particular investigation. These include:

- Direct relevance to the emphasis of investigation,
- Relevance to the target population,
- Unambiguity,
- Clear cause and effect linkages,
- Reliability,
- Appropriate spatial scale, among others.

However, in the opinion of Prennushi, Rubio and Subbarao (2001), a good indicator:

- Is a direct and unambiguous measure of progress,
- Is relevant, i.e., it measures factors that reflect the goals/objectives of the program/project,

- ❖ Varies across areas, groups, over time,
- ❖ Is sensitive to changes in policies, programs and institutions,
- ❖ Is transparent and cannot be manipulated to show achievement where none exists, and
- ❖ Is cost-effective to track.

Against this background, two major areas where energy poverty has been confirmed to affect the environment are:

- ♣ Environmental resources management, and
- ♣ Health (Shyamsundar, 2001).

Thus, for instance, with regard to the former, indicators such as time spent, or distance traveled, to collect biomass energy relate quite directly to household incomes and opportunity, which are in turn, manifestations of poverty. With regard to health, on the other hand, one of the most significant ways in which environmental quality has been negatively impacted is through the prolonged exposure of the poor to indoor air pollution from the smoke from incomplete combustion of biomass energy. Accordingly, some of the indicators that are used to capture the linkage between poverty and environment are: the quality of ventilation in poor households; children sleeping in cooking areas; and the types of cooking stoves and fuel; which are in turn used to assess vulnerability to respiratory infections (Shyamsundar, *ibid*).

The core significance of the poverty-environment linkage is further confirmed by the number of indicators that are directly or indirectly related to access to the type of domestic energy that is affordable to the household. Osuntogun (2002) has suggested that if Nigeria is to achieve the goal of her Poverty Reduction Strategy (PRS), the following should be included in the poverty-environment indicators package:

1. Prevalence of and deaths caused by malaria,
2. Prevalence of and death caused by diarrhea and vector-borne diseases,
3. Infant mortality rate,
4. Under 5 mortality rate,
5. Kind of toilet/latrines provided for the community,
6. Coverage of safe water supply,
7. Time spent/distance involved in collecting water and fuel wood,
8. Prevalence of and death caused by acute respiratory infections,
9. Proportion of households using coal, wood or dung as primary fuel,
10. Proportion of households using improved stoves or cleaner fuel,
11. Persons per room of housing,
12. Amount of Public Health Expenditures, and
13. Percentage of rural population below poverty line.

It is particularly instructive to note that four (7, 8, 9, 10), or about one-third, of the thirteen suggested poverty-environment indicators are directly related to the source of domestic energy that the household can access. The

concern for the environmental implications of biomass fuels was recently echoed by a national weekly newspaper which carried the photograph of three girls returning from a fire wood sourcing trip, with the caption: "*Creating more problems while trying to solve another*: ***Sequel to kerosene scarcity, young women in Lekki, Lagos, take to firewood gathering for domestic purposes, oblivious of the effects of fuel wood on human and the environment"*** (Sunday PUNCH, 2011; 64).

In the rest of this segment, we have synthesized some of the effects of the demand for biomass energy on the quality of the physical surroundings (the macro environment) of the source regions, on the one hand, and how the activities associated with traditional methods of converting biomass fuels into energy, on the one hand, and how the use of the resultant energy, on the other, affects the immediate domain (micro environment) of the user (Omuta, 2004; 7), on the other. These two levels of resolution capture the physical and cultural dimensions of the environment as characterized in the above definitions.

Subsequently, the following nine (9) poverty-environment indicators are used to measure the relationships between the relevant dimensions of the environment, and dependence of households on biomass fuels in the NDR:

- ♣ Relative (%) significance of household dependence on various types of energy sources,
- ♣ Projected (descriptive) relationship between population and dependence on biomass fuels,
- ♣ Relative (mean and standard deviation) significance of the various forest products exploited in the NDR,
- ♣ Relative (%) contribution of major sources of income to total rural household income by income group,
- ♣ Relative (%) extent of household dependence on forest resources by income groups,
- ♣ Relative (%) affordability and availability of various sources of biomass fuels,
- ♣ Relative (%) awareness of the environmental impact of biomass utilization,
- ♣ Relative (%) awareness of the health implications of biomass utilization
- ♣ Relative (%) significance of the involvement of various activities in household livelihoods.

Macro Environmental Effects of Biomass Energy Consumption

The way energy is produced, distributed, and consumed affect the local, regional, and global environment (Modi, McDade, Lallement and Sghir, 2005; 29). Consequently, inefficient and unsustainable cooking practices can, and do in fact, have serious implications for the physical environment. These impacts could manifest in various forms, including land degradation, as well as local and regional air pollution. Tolba, El-Kholy, Holdgate, McMicheal and Munn (1992) have claimed that in 1980, 1.3 billion people were already facing fuel wood

shortages because the rate of consumption had become unsustainable. Furthermore, they raised an alarm that if the (then) rate of deforestation continued, the shortages would escalate and the figure would have reached 2.7 billion by the year 2000. These projections are an early indication that the world now faces catastrophic levels of fuel wood shortages. Figure 4 uses the scenario for the Shinyanga District of Tanzania, to illustrate the typical and deepening disparity between the supply of, and demand for, biomass energy in developing countries.

However, the debate as to how much pressure the balance between wood fuel demand and supply places on forest resources appears to be inconclusive. Indeed, some of the positions that have been taken are poles apart. In this regard, some are of the opinion that the unsustainable preference for biomass energy portends a great threat to the environment generally, the forest, the users and the economy, and indeed that the depletion of resources has resulted in an increase of direct and indirect costs (Ouedraogo, 2005; FAO, 2003). For instance, Kramer (http://solarcooking.org/crisi.htm) has argued that because of the high and still rising cost of alternative forms of household fuel, the link between poverty and biomass resource base is obvious. Categorically, Somaratne (2005) and Babanyara and Saleh (2010) have argued that urban residents' demand for fire wood as energy source leads to indiscriminate cutting down of trees, even wet woods, which has resulted in rural deforestation and subsequent land degradation. The need for traditional biomass energy places a high burden on forest resources in many developing countries.

The World Health Organization has estimated that worldwide 2 billion tonnes of wood go up in smoke every day for cooking, heating or charcoal production (WHO, 2006). Wiskerke (2009) argues that while, forest clearing for agricultural expansion, shifting agriculture and livestock are the main drivers, unsustainable consumption of fuel wood is still an important driver for forest degradation and deforestation in many developing countries.

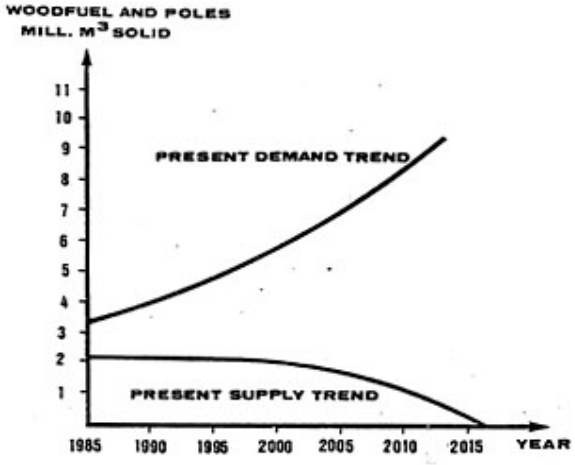

Figure 4: Wood demand and supply projections in Shinyanga in 1985 (Wiskerke, 2009; 34)

Furthermore, and relatedly, FAO (2003, 2004) and Mbwambo (2004) assert that deforestation leads to severe degradation of soils.

Contrastingly, DFID (www.ucl.ac.uk /dpu-project/21st Century/myths), in calling it a "myth", has argued that there is very little evidence that there is a link between poverty, (by whatever parameter it is measured, including the total dependence of the poor on fuel wood as cooking energy) and environmental degradation on a global scale, either in rural areas or in urban areas. Consequently and in the same vein, others have also argued that national intervention is not necessary because it has not been established that wood fuel demand is a major cause of deforestation (Arnold, Kohlin Presson and Shephard, 2003). The argument of the latter group is hinged on the claim that as much as two-thirds of the fuel wood used for domestic cooking is usually gathered from the road side and trees outside the forests, rather than from natural forests (IEA, 2006).

The inconclusive debate notwithstanding, some strong and emphatically vehement positions have emerged. For instance, GTZ (www.gtz. de/de/dokumente/en-cooking energy-2007.pdf; 5) claims that in the many cases where the demand for biomass fuels far exceeds sustainable supply, the inevitable result is "massive deforestation, land degradation and desertification". Sow (1990) has also noted that many people today, do not have enough wood to cook more than one meal per day, and for such people, the real energy crisis is the lack of wood energy. And a number of case studies have confirmed this longstanding and persisting crisis.

Ouedraogo's (2005) study shows that in Burkina Faso, the urban population of Ouagadougou have known wood energy crisis since the 1970s, especially during the rainy season, when fuel wood scarcities are frequently experienced. With a projected probability of the adoption of fuel wood as the major source of cooking energy put at 92.2 per cent, Ouedraogo (*ibid*) was lead to conclude that "wood fuel will remain the primary source of energy for households in Ouagadougou for a long time to come". Another study of Burkina Faso established that although on the average 90 per cent of the wood in the country is used as fuel, the rate of consumption is higher in the urban than in rural areas (Kramer, http://solarcooking.org/crisi.htm). The implication is that under the circumstances of projected accelerated urbanization, the longstanding shortages will not only persist but should be expected to escalate and lead to corresponding accelerated deforestation.

Babanyara and Saleh (2010; 19) have observed that in Nigeria, urban demand for fuel wood can no longer be met by harvesting dead woods, dry branches and twigs, as is done in rural areas, but by cutting down wet woods as well. Their conclusion is that with continuous growth of urban population, the trend portends great threat to environmental resources, particularly, in the rural areas from where these fuel woods are now being harvested. Furthermore, the poor rural dwellers, in their bid to increase and or supplement their incomes resort to indiscriminate

deforestation to meet urban fuel wood demand. And, given that regeneration rates are far slower than consumption rates, they are ultimately reducing, and in some critical regions, actually eliminating the possibility of renewing this otherwise renewable source of energy. This is to say that unsustainable fuel wood exploitation not only degrades the rural environment, it indirectly increases rural poverty.

Amechi (2009) has tried to establish a more direct relationship between the energy need of the poor and environment. In this regard, he argues that the poor is often forced to rely heavily on the ecosystem for his energy needs, which in most cases leads to its degradation. Similarly, Johnson (1993; 145) argues that the poor are driven to destroy the environment because they have no other viable possibilities to explore. For them, it is a question of sheer survival. And, as the World Commission on Environment and Development states in ***Our Common Future***, otherwise known as the Brundtland Report, "poverty pollutes the environment, creating environmental stress in a different way. Those who are poor and hungry will often destroy their immediate in order to survive" (WCED, 1978). In the context of Nigeria, Amechi (2009), therefore, concludes that the challenge of deforestation "exemplifies the effect of income poverty (as manifested in 'energy poverty') on the environment", where the rising demand for fuel wood and charcoal for energy needs has been identified as one of the major causes of deforestation. He attributes the rising demand to the inability of the poor to access modern and cleaner energy sources because of their lack of income.
In Nigeria, as early as 1988, Mabogunje (1988) had warned that "the forest resources of Nigeria are not capable of meeting the fire wood demand", estimated by the FAO at 54 million cubic metres in 1985. By 2005, the figure was claimed to have risen to 80 million cubic meters (43.4 x 109 kg) (Sambo, 2005). Mabogunje (1988*)* then concluded that "the fire wood crisis is going to stay with the rural population for a long time to come". Equally pointedly but more directly related to the natural environment, Choji (2005) has claimed that more than half of 9.5 million hectares of rain forest in the south of Nigeria has been lost to the demand for biomass cooking energy by rural and urban poor. In a milder and more general context, Aina and Salau (1992; 36, 79) also implicated the rising demand for fire wood as one of the sources of pressure on the Nigerian high forest timber resources. At a lower level of resolution, and using data from the Central Bank of Nigeria (2006), the National Bureau of Statistics (2007), and the Food and Agricultural Organization (FAO) (2007), Onuche (2010; 213, 214) established that was a positive Spearman's correlation coefficient (*r*) of +0.771 between poverty prevalence and pressure on biomass energy for cooking, among the six geo-political regions of Nigeria, and concluded that poorer geopolitical zones tended to use more wood fuel for domestic (cooking) requirements and consequently, experienced more deforestation.

IEA (2006) has established that while fuel wood may not be gathered directly from the forest, charcoal, which is also a major component of the cooking energy used by the poor, is usually produced from forest resources. Furthermore, it has been argued that unsustainable production of charcoal in response to urban demand has placed serious strain on biomass resources. It is also argued that because charcoal production is often inefficient, it has lead to localized deforestation and land degradation around some urban areas. For instance, charcoal production for urban and peri-urban households has resulted in the devastation of biomass resources over a radius of 200 to 300 kilometers around Luanda, the capital of Angola (*ibid*; 427). Babanyara and Saleh (2010), Cline-Cole, *et al,* (1998) and Nancy (1994) have similarly observed that improved transportation has made it possible to import large quantities of fuel wood from rural areas over distances of up to 400km into Nigerian urban centres, such as Kano. With the number of urban centres of over 20,000 people in Nigeria estimated at 450 in 2000, and the proportion of total population living in urban centres projected to be 60 per cent in 2050 (Babanyara and Saleh, 2010; 20,21) and with more than 70 per cent of these being migrants from the rural areas, who are used to cooking with fuel wood as a matter of "habit" and who cannot afford clean energy due to income poverty, it is, therefore, expected that the pressure on fuel wood energy would be two-pronged:

- Though now dislocated from the rural areas, poor rural-urban migrants will continue to depend on the accustomed rural natural resources for their energy needs, and
- The increase in urban population is expected to proportionately swell the ranks of the urban poor, who like their rural-urban immigrant counterparts, also depend on biomass fuels because they cannot afford cleaner and more environmentally friendly energy; thereby also indirectly extending the ecological footprint of the city farther afield into the rural natural resource base.

In their study of Zambia, Liberty and Hongjuan (2008; 373) established that the need for fuel wood "is one of the major causes of the reduced tree cover in Magoye West", where excessive lopping and felling, combined with the poor regeneration capabilities of trees and the increasing commercialization of the fuel wood and the charcoal economy have accelerated the rate of deforestation.

Given the low level of technology adoption and patronage in Nigeria, in general, and the Niger Delta Region, in particular, one of the ways that small scale and peasant farmers have regenerated their farm lands over the years is to allow animal dung and farm residue to decompose *in situ.* However, since their incomes either limit or prevent their access to cleaner energy sources, the poor are constrained to resort to the use of these *natural fertilizers* as cooking fuel. When animal dung and farm residue are used for fuel rather than left in the farm or ploughed back

into the fields, soil fertility is reduced and propensity to soil erosion is correspondingly increased. The end result is general land and forest degradation (Schubert, Blasch and Hoffmann, 2007; 4).

Within the bigger deforestation picture are some other equally important aspects or sub-sets of environmental resource degradation due to unsustainable biomass energy demand. These include biodiversity loss as well as regional atmospheric pollution. Regarding regional atmospheric pollution, it has been reported that in Kenya, charcoal production and consumption emit more green house gases (GHGs) than the industries and transportation sectors put together (RK, 2002). In Nigeria, Aina and Salau (1992; 201) have also confirmed that the loss of vegetation cover also means reduction in wild plant products that have often provided nutritional supplements and traditional medicine for the entire family.

From the above, the following relevant truisms have emerged:

- ***Poverty and environmental degradation are causally interlinked***
  Poverty and environmental degradation are obviously and closely associated and causally interlinked, therefore, they should of necessity be addressed together. The international goal of halving the number of people living in extreme poverty and hunger by 2015 and reversing environmental degradation will require addressing all relevant dimensions of poverty, whether they are manifested in rural or urban areas.

- ***Poverty-environmental linkages take different forms in rural and urban contexts***
  Poverty-environment linkages manifest differently in rural and urban contexts. In rural areas, the critical concern is the harvesting of the biomass directly from nature. In the urban areas, on the other hand, the poverty-environment nexus is manifested in the dependence of the poor on the biomass that is sourced from the rural areas, because the former is more removed from nature than the former.

- ***Urban and rural environments cannot be considered in isolation from each other***
  Related to, and following from, the above is the fact that any rigid distinction between rural and urban environments will distort the linkages between biomass usage and environmental quality. For example, because of the proximity of the rural population to natural environmental resources (especially forest resources) they harvest their biomass energy directly from nature. Urban populations, especially, the poor, transfer the burden of their demand for biomass energy to the neighboring rural environments by overexploiting neighboring forests through the collection of fuel wood. Usually, the larger the urban centre, the greater the pressure it puts on the environs and the greater the

distance over which biomass is sourced.

In other words, urban areas do not have only local environmental impacts but also large so-called 'ecological footprints'. An ecological footprint is "the area of productive land (and or aquatic ecosystems) required to support, produce and supply the resources used, and to assimilate the wastes produced, by a defined population, at a specified material standard of living, wherever that land may be located" (WWF, 2000).

In their immediate vicinities, cities have a variety of impacts: conversion of agricultural or forest land for urban uses and infrastructure, reclaiming of wetlands, quarrying and excavation of sand, gravel and building materials in large quantities and, in some regions, deforestation to meet fuel (wood) demand.

❖ ***Gender disparities in the sourcing and use of domestic energy should be noted***

Men and women have different roles in society. In order to fulfill these roles, they use environmental resources differently. To be effective, strategies to sustain the environment must, therefore, pay close attention to the impact of disparities between women and men in the sourcing of domestic cooking energy.

Micro Environmental Effects of Biomass Energy Consumption

Our concern in this section, is with the environment in which biomass fuel is converted into energy and used for cooking; namely, the home or house or compound environment. For the average poor in the Niger Delta Region of Nigeria, the home is usually a small space, which could be as small as one poorly ventilated and over-occupied room for the entire family. The housing of the poor is usually also characterized by the absence of kitchen facilities, or where there are kitchens, they are shared and are characteristically without cooking gadgets, except the ubiquitous three-stone (open) fire stove. In a recent study of the housing conditions of the poor in Akure, the capital of Ondo State, in the Niger Delta Region, Omole (2010; 284) confirmed that only 5.2 per cent of the houses had self-contained kitchen facilities. The overwhelming 94.8 per cent of them are spread among:

- ♣ those that do not have kitchen facilities at all, and consequently have to cook either in the open or in their living spaces, and
- ♣ those that share indoor facilities.

In the most common cases where there are no kitchens, cooking is done indoors; which could be inside the same room that the family sleeps in, or along the corridor that leads to many rooms. This is particularly common in the verandahs. In both cases: whether it is done along corridors or inside the living room, the conversion of biomass fuel into cooking energy by the poor results

in indoor air pollution, which Oni and Durodola (2010; 666) have identified as one of the commonest causes of disputes among households in houses and compounds that have inadequate facilities, such as kitchens. The air pollution is as a result of either incomplete combustion of the biomass fuels or the non-dissipation of the smoke produced, due to poor ventilation, or both (Figure 4).

Figure 5: Inefficient, (smoky) unhealthy use of fuel wood.
Source: Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007; 15).

The most important negative environmental externality arising from air pollution due to indoor cooking, using biomass, is the health deterioration of the people who are directly exposed (Ezzati and Kammen, 2001). In fact it has been asserted that "cooking with fuel wood, crop residues, and dung is associated with a significantly higher disease burden than other forms of cooking, due to indoor air pollution" (Modi, McDade, Lallement and Saghir, 2005; 9). More specifically, Smith, *et al,* (2000) have established that biomass fuels produce

very high emissions of carbon monoxide, hydrocarbons and suspended particulate matter (SPM). Furthermore, it has been well established that indoor air pollution arising from the use of biomass-based fuels for indoor cooking is a primary contributor to respiratory problems, particularly in developing countries (Ezzati and Kammen, 2001; Niringiye, Wambugu, Karugia and Wanga (2010). Indeed, UNEP (2006; www.unep.org/pdf/annualreport/UNEP_AR_2006_English.pdf) has estimated that indoor air pollution causes about 36 per cent of lower respiratory infections and 22 per cent of chronic respiratory diseases. The World Bank (2006) has also estimated that there are about 40,000 new cases of chronic bronchitis yearly as a result of exposure to soot and smoke inhalation. In another study, the World Bank (1992) has also asserted that between 300,000 and 700,000 deaths can be prevented yearly if the victims are removed from unsafe levels of indoor smoke, or if suspended particulate matter (SPM) concentrations can be held to WHO standards.

The impacts of indoor and outdoor air quality on welfare are of widespread concern, and according to a joint study undertaken by the Universities of Harvard and Berkeley, smoke from wood fires for cooking will result in 10 million premature deaths in Africa by 2030 (Kammen, 2005). What is more, it is the poor that will be predominantly affected, because as has been abundantly established, they are more dependent on biomass energy sources. A study in South Africa on poor household fuel impacts indicated that externalities mainly from fires, burns and air pollution increased the economic cost of fuel wood by over 78 per cent.

Access to cleaner and or more efficient energy services is a critical element for overcoming poverty and also for ensuring environmental sustainability. In their study of Uganda, Niringiye, Wambugu, Karugia and Wanga (2010) used regression analysis to test whether districts with high percentages of households living in absolute poverty are significantly greater users of wood fuel than districts with higher-income households. They confirmed a positive finding that supported the case for a joint environment/poverty strategy. Their conclusion was that enhancing access of the poor to more efficient modes of even biomass energy consumption would greatly reduce indoor air pollution and improve the welfare of the poor, by reducing health damage from indoor air pollution.

The most vulnerable groups that suffer from indoor air pollution (population at risk) are the women and children, who invariably and traditionally do most of the cooking and other household chores and are consequently exposed for long hours to smoke inhalation (DFID, 2000). In the circumstances that we are considering, suspended particulate matter concentrations are higher than permissible levels because biomass fuels are usually converted into cooking energy by burning in inefficient open fires and traditional stoves. In fact, it has been claimed that every year, the

smoke from open fires and traditional stoves kills 1.5 million people. In other words, every 20 seconds, a woman or child is dying due to inefficient use of biomass fuels (www.gtz.de/de/dokumente/en-cookingenergy-2007.pdf; 5). An equally alarming scenario was painted by the World Bank (2001) which explained that smoke inhalation results in severe health problems and that it contributes to about 4 million deaths per year among infants and children in developing countries.

In another investigation, the World Health Organization (WHO) has estimated that more than 4,300 deaths of children below five years of age per day are due to inefficient biomass energy usage. According to the International Energy Agency, this means that indoor air pollution associated with biomass energy use is directly responsible for more deaths than malaria; almost as many as tuberculosis and almost half as many as HIV/AIDS (IEA, 2006; 425). Also in connection with the negative health externalities of inefficient use of biomass fuels, UNEP (2006) has established that a child exposed to indoor air pollution is two to three times more likely to catch pneumonia, which is one of the world's leading killers of young children. Furthermore, IEA (2006) asserts that there is evidence to link indoor smoke inhalation to low birth weight, infant mortality, tuberculosis, cataracts, blindness and asthma

Among the indirect social and economic negative externalities of the health implications of cooking indoors with biomass fuels is the low productivity among adults and mental retardation among children. In this regard, it has been estimated that urban centres which have suspended particulate matter (SPM) levels above the WHO standards lose an equivalent of 0.6 to 2.1 working days per year for every adult in the labour force due to respiratory related illnesses (World Bank, 1992). Although no confirmatory studies have been done, it is estimated that the medical cost burden on the economy could be staggering, with consequential implications for overall economic development, especially for the lean resources of developing countries.

In addition to time-loss due to ill health, it has also been argued that dwindling biomass fuel resources leads to additional workload for the women and children. The distances covered continue to increase, as the energy sources become increasingly scarce, with the implication that they spend correspondingly increasingly more time searching for fuel wood. This means less and less time for other productive, income-earning activities, even including the education of the children. For instance, in Tanzania, a national survey of 22,178 households showed that in the central region of Singida, people travel an average of 10.4 kilometers daily (one direction) to collect fuel wood (IHSN, 2006). The heavy loads of fire wood carried over such long distances, in turn, have implications for the health and productivity of women and children.

Depending on the richness of the ecosystem, similar or even longer distances can be replicated in the Niger Delta Region.

9. THE POVERTY-ENVIRONMENT LINKAGE AND THE URBAN CONTEXT

Urban areas usually account for a disproportionately large share of national economic production and are the main generators of economic growth. The same pattern is often replicated in major geo-political regions within national settlement and economic systems. However, the concentration of economic growth in and around major cities often contributes to inequitable, spatially unbalanced growth patterns which may in fact have negative impact on poverty reduction efforts, while aggravating environmental problems. However, while the focus of attention is often on relatively large or mega-cities, the majority of urban households in most developing countries actually live in intermediate cities (with populations of 20,000 to 250,000) and smaller rural settlements (with less than 20,000 inhabitants). Indeed as stated earlier, in the Niger Delta Region, only about one (1) per cent of the all the settlements are urban centres. For the purpose of designing a responsive policy, therefore, it must be appreciated that the scale and nature of problems faced by poor households vary with the size of the urban area and nature of economic activity located there.

Rapid urbanization was one of the most significant demographic and social changes in the 20th century and will continue in this one. About half of the world's people were estimated to be living in cities in the year 2000 (2.9 billion out of a total of 6.1 billion), a figure expected to rise to 59 per cent by 2025 (United Nations, 1998, cited in OECD, 2000). It is now well known that developing countries are urbanizing at faster rates than OECD countries. In the past, this was primarily driven by the migration of rural population to urban areas in search of better opportunities. Today, however, as recent rural-urban migrants arrive the city with their rural tendencies (including high birth rates), increasing chunks of urban population growth are resulting from natural growth as from migration.

The retention of rural habits (including almost total dependence on biomass sources of household energy) by migrants and the income limitations of others, lead to a rural-urban energy crisis or conflict, where large quantities of fire wood are required to be supplied from the rural areas to meet urban needs. Although urbanization is associated with lower dependence on biomass energy, the use of fuels such as gas and kerosene in towns and cities is not always as widespread as should be expected or is presumed. Indeed it has been estimated that almost half a billion people in urban areas also rely on wood fuel resources (IEA, 2006). In other words, heavy dependence on biomass fuels may be concentrated in, but by no means confined to, rural areas. Urban-

rural linkages with respect to environmental impacts must, therefore, be recognized because in the long run, urban areas can have, and have indeed had strongly negative ecological footprints on their hinterlands, through the energy demand of their poor populations.

With specific regard to the Niger Delta Region, it has been confirmed that the energy alternatives for many of the urban population are restricted by factors such as cost of procurement of modern fuels and their accessories, as well as inadequate infrastructure. Consequently, wood fuel is the main energy source for well over half of the population in the urban areas of Delta (Achi, 2006).

10. ENERGY CONSUMPTION OF THE POOR AND THE ENVIRONMENTAL QUALITY IN THE NIGER DELTA REGION

We recall that our postulation in this Report is that poverty has affected the quality of the environment in the Niger Delta Region. We will also recall that having accepted that poverty is a multi-dimensional phenomenon, we limited our investigation to ***energy poverty*** or the ***energy dimension*** of poverty. We need to also note that we decided to use as our indicator of energy poverty, the degree of dependence on biomass fuels, or more specifically, ***wood fuel*** as the major source of household energy. Furthermore, we have limited our investigation to two dimensions of the environment, namely: natural environmental resource exploitation and human health. We can, therefore, restate our postulation as follows:

> ***Dependence of poor households on biomass sources of energy has affected the quality of the environment of the Niger Delta Region through natural environmental resource over exploitation and the health of the people.***

Finally, we need to reiterate that in order to justify this postulation, we looked at the following poverty-environment indicators: relative (%) significance of household dependence on various types of energy sources; projected (descriptive) relationship between population and dependence on biomass fuels; relative (mean and standard deviation) significance of the various forest products exploited in the NDR; relative (%) contribution of major sources of income to total rural household income by income group; relative (%) extent of household dependence on forest resources by income groups; relative (%) affordability and availability of various sources of biomass fuels; relative (%) awareness of the environmental impact of biomass utilization; relative (%) awareness of the health implications of biomass utilization; and relative (%) significance of the involvement of various activities in household livelihoods. They are examined below.

Relative (%) Significance of Various Type of Energy in the Niger Delta Region

The overall pattern of dependence of households on the various types of alternative fuels in the Niger Delta Region is presented in Table 8. The Table shows that energy use in the Niger Delta Region is similar to the national pattern. However, although the regional average dependence on wood fuel as the major source of household energy is slightly lower than the national situation (74.4 per cent as against 77.9 per cent), there are noteworthy differences both within the region and between the region and the nation. Thus, within the region, the Table shows that while in the Niger Delta Region 74.4 per cent of the households depend on wood fuel as the major source of energy, the corresponding figures are higher in two thirds (six) of the states, namely: Akwa Ibom (88.3 per cent), Imo (85.3 per cent), Edo (85.1 per cent), Ondo (84.6 per cent), Cross River (81.5 per cent) and Abia (75.1 per cent). Only Delta, Bayelsa and Rivers States have lower figures. Similarly, while nationally, 77.9 per cent of the households depend on wood fuel, the corresponding figures are higher in more than half of the states in the Niger Delta Region. They are: Akwa Ibom (88.3 per cent), Imo (85.3 per cent), Edo (85.1 per cent), Ondo (84.6 per cent), and Cross River (81.5 per cent).

Table8: Relative Significance of Types of Fuel Used by Households

State	Fuel wood	Char-coal	Kero-sene	Gas	Elect-ricity	Crop Residue	Animal Wastes	Others	Total
Akwa Ibom	88.3	0.5	9.4	1.3	0.4	0.0	0.1	0.0	100.0
Bayelsa	59.2	1.3	38.0	0.6	0.4	0.1	0.4	0.0	100.0
Cross River	81.5	0.6	15.6	1.5	0.7	0.1	0.0	0.0	100.0
Delta	59.3	0.6	34.6	4.5	0.6	0.1	0.2	0.1	100.0
Edo	85.1	1.1	11.9	1.6	0.3	0.0	0.0	0.0	100.0
Rivers	52.4	1.5	38.7	6.0	1.0	0.2	0.2	0.0	100.0
Ondo	84.6	0.9	12.7	1.0	0.1	0.2	0.5	0.1	100.0
Imo	85.3	1.4	10.0	2.3	0.5	0.4	0.1	0.0	100.0
Abia	75.1	1.5	19.2	3.7	0.3	9.2	0.0	0.0	100.0
Niger Delta Region	**74.4**	**1.9**	**20.8**	**2.9**	**0.5**	**0.2**	**0.2**	**0.0**	**100.0**
Nigeria	**77.9**	**0.8**	**19.8**	**0.6**	**0.4**	**0.1**	**0.1**	**0.4**	**100.0**

Source: Centre for Population and Environmental Development (CPEC), 2003; 173,174

Within the region, the Table further shows that the percentage of household dependence on wood fuel varies from as low as 52.4 per cent in Rivers State, followed by Bayelsa State (59.2 per cent), to as high as 88.3 per cent in Akwa Ibom State, followed very closely by Rivers State, with 59.3 per cent.

Also worthy of note is the observation that only 0.4 per cent of all households, nationwide, depend on the use electricity as household fuel. The corresponding figure for the Niger Delta Region is 0,5 per cent. This very low level of access to electricity has serious implications for the achievement of the MDGs (Table 6) which are implicitly predicated on access to electricity.

Also noteworthy is the observation that dependence on kerosene is about the same for the average Nigerian household as for those in the Niger Delta Region (19.8 per cent, compared to 20.8 per cent, respectively). The intra-regional details show that the figures are lower than the national and regional averages in Akwa Ibom State (9.4 per cent), Imo State (10.0 per cent), Edo State (11.9 per cent), Rivers State (12.7 per cent), Cross River State (15.6 per cent) and Abia State (19.2 per cent). However, the Table shows that in Delta, Bayelsa and Rivers States, more than one-third (34-38 per cent) of the households use kerosene, which are higher than both the national and regional averages.

Again these figures have implications for the eventual magnitude of the dependence on biomass fuel. This is so because it is a well-known fact that the use of kerosene is very sensitive to price changes. Consequently the slightest price increase causes a very disproportionately large shift from the product down the energy ladder to biomass sources (Figure 3). This was recently confirmed by Aboluwade (2011), who observed that the most recent kerosene crisis in Nigeria which resulted in price increases from the approved ₦50.00 (Fifty Naira) per litre, to ₦ 250.00 (Two hundred and fifty Naira) per litre, had "prompted a major shift by many kerosene users to fire wood". The implication, therefore, is that in the worst case scenarios of such protracted shortages and corresponding high kerosene prices, all or the bulk of the households using kerosene at any particular point in time could switch to wood fuel. This means that depending on the price and availability of kerosene, the percentage of households using wood fuel could be the combination of those who always use wood fuel plus those who will shift from the use of kerosene. For instance, in the very extreme scenario presented above, the percentage of households using wood fuel in Edo State could be as high as 97. 0 per cent; made up of the 85.1 per cent that always use wood fuel plus the 11.9 per cent that could switch from kerosene.

Below, we shall discuss the four sets of relationships that were presented as the objectives of the Report, seeking thereby, to establish the veracity or otherwise of our central postulation. The four sets of relationships are:

- ♣ Population growth, household incomes and forest resource exploitation (degradation),
- ♣ Poverty and choice of domestic energy consumption,
- ♣ Wood energy demand and environmental quality, and
- ♣ Rural and urban dimensions and conflicts in poverty-environment linkages

Population growth, household incomes and forest resource exploitation

Forest resources are a very key component of the natural environmental resource base of any community, region or country. They play a fundamental role in the socio-economic well-being of the people (Inoni, 2009; 20). With specific regard to fuel wood, the basic assumption repeated throughout studies of supply and demand of this forest resource is that there is a fixed, or nearly fixed, ratio between population and fuel wood demand. With particular reference to developing nations, Eckholm (1975) puts it explicitly and directly thus: "The fire wood needs of the developing countries cannot be massively reduced. The energy system of the truly poor contains no easily trimmable fat…. The unfortunate truth is that the amount of wood burned in a particular country is almost completely determined by the number of people who need to use it." We reiterate our earlier conclusion that depending on the prevailing price behavior and availability of the next most affordable alternative, the proportion of households use wood fuel could be as high as 98 per cent for Abia State!

Hradsky (1981) has also echoed these sentiments by concluding that: "Fuel wood energy demand will continue to grow at rates similar to those of population." Specifically in the Nigerian context, Sambo (2005; 14) confirms that excessive fuel wood consumption arises due to population growth, low technical efficiency of the traditional three-stone open fire stoves and the lack of adoption of other sustainable cooking methodologies; and concludes that the result of these factors is overexploitation of natural resources, and eventual deforestation. In impliedly relating them, Woodwell (2002) has asserted that fuel wood supplies in natural woodlands are two-to-five times greater than the estimates of the 1960s and 1970s (due to corresponding population increases).

The World Commission on Forests and Sustainable Development (WCFSD) (1998) has confirmed that fuel wood and charcoal (which is a derivative of forest resources), make up 56 per cent of global wood production, and approximately 90 per cent of this is produced in developing countries. Roper and Roberts (1999) and IEA (2002) have further confirmed the literature on the subject by observing that firewood is the most important source of energy for developing countries and the only source of energy for most of the world's rural areas.

What these findings have established is that as population grows, rural

households as well as their poor urban counterparts will tend to put more and more pressure on common pool resources (CPR), such as forest resources, because in almost all cases, they depend on them to meet their daily economic and social needs (Jodha, 1995). Common pool resources are resources whose characteristics make them costly, but not impossible, to exclude potential beneficiaries from obtaining and exploiting the benefits from their use. In cases of extreme pressure, common pool resources have been converted to open access resources (OARs). An open access resource is one where it is impossible to control the access of individuals who want to use it. A common example is a fishery. In other words, due to population pressure, forests as CPRs and fishing grounds as OARs often face the challenges of congestion and overuse or overexploitation.

Studies have shown that these scenarios are applicable to the Niger Delta Region, where, Table 9 shows that the population is projected to grow steadily at about the rate of 3.2 per cent annually. In order to fully appreciate the implications of the population growth of the Niger Delta Region for the exploitation of its natural resources and eventual environmental consequences, three things are particularly noteworthy and should be emphasized:

- First, is the pervasive poverty incidence of this rapidly growing population, as was established in Table 4. From our conceptual framework, this means equally growing demand for biomass fuels as well as growing pressure on natural resources for their household energy.
- Second, in spite of the expected increase in urbanization, most of the communities will continue to have large rural populations (as shown in the size distribution of settlements in Table 3) that habitually and endemically depend on natural environmental resource exploitation both for household fuels and indeed for their very livelihood.
- Third, usually, rural population grows faster than urban populations, and depend more on biomass energy sources.

Table 9: Projected Population Growth in the Niger Delta Region up to 2020

States	Land Area	2005	2010	2015	2020
Abia	4,877	3,230,000	3,763,000	4,383,000	6,106,000
Akwa Ibom	6,806	3,343,000	3,895,000	4,537,000	6,285,000
Bayelsa	11,007	1,710,000	1,992,000	2,320,000	2,703,000
Cross River	21,930	3,694,000	4,186,000	4,877,000	5,681,000

Delta	17,163	3,594,000	4,186,000	4,877,000	5,681,000
Edo	19,698	3,342,000	3,894,000	4,535,000	5,283,000
Imo	5,165	3,342,000	3,894,000	4,535,000	5,283,000
Ondo	15,086	3,025,000	3,524,000	4,105,000	4,782,000
Rivers	10,378	4,858,000	5,659,000	6,592,000	7,679,000
Niger Delta Region	**112,110**	**28,856,000**	**33,616,000**	**39,157,000**	**45,715,000**

Source: *Culled from Centre for Population and Environment Development (CPED), 2003; 421.*

If the present population of about 34 million people is said to have exceeded the energy carrying capacity of the biomass resources of the Region, and it is consequently claimed that the demand far exceeds supply, and furthermore, that the rate of use is not commensurate with the rate of regeneration, then an additional 11 million people by the year 2020 means an unimaginable pressure on the region's environmental energy resources.

Relative significance (mean and standard deviation) of the various forest products exploited in the NDR

A recent study of 306 households in twelve rural communities in Ughelli Local Government Area of Delta State by Inoni (2009) has confirmed that as a result of its increasing commercialization, people who exploit forest resources concentrate more on the collection of wood fuel.

In Table 10, Inoni's study revealed that fire wood was certainly the most exploited forest non-timber product (by weight) by the poor rural communities of Ughelli, with the mean figure of 439.69 kg compared to other forest non-timber resources such as rattan cane with a mean of 62.83 kg and wild fruits/nuts (56.69 kg). In corroboration of the literature and as confirmed by the study, the prominence of wood fuel can be attributed to two things:

- Fuel wood is the major source of energy for cooking and heating among rural households, and the urban poor, in the surveyed communities, as it is indeed in all of the Niger Delta Region. In fact, fire wood is the principal source of energy for practically more than 80 per cent of the households he surveyed,
- As will be confirmed latter it is also a major source of supplementary income to poor households.

Table 10: Descriptive Statistics on Quantity (kg) of Forest Products Exploited

Activity	Mean	Standard Deviation	Minimum	Maximum	Number
Fire Wood	439.69	197.55	120	950	306
Wild Fruits/nuts	56.69	17.12	30	105	306

Ruttan Cane	62.83	18.8	135	122	306

Source: Culled from Inoni, 2009.

Relative (%) contribution of major sources of income to total rural household income by income group

As should be expected, even among the poor, the degree of dependence on biomass fuel varies with income levels. Thus, the poorest of the poor depend more on common pool resources, especially, forest resources, than their relatively more affluent counterparts. Table 11 summarizes Inoni's findings regarding the contribution of various forest products to the total incomes of different income groups among the poor in the rural communities in Ughelli. The survey shows that on the whole, forest resources account for 47.2 per cent of all the incomes of the rural poor. This result corroborates the finding of other studies where common pool resources were observed to contribute a substantial part of the income of the rural poor. (Jodha, 1995; Cavendish, 1999; Kerapeletswe and Lovett, 2001). However, among the various income brackets of the poor, these resources account for 67.2 per cent of the poorest first quintile (20 per cent), compared to 63.6 per cent of the second quintile (21-40%), 57 per cent of the third quintile (41-60%), 57.1 per cent of the forth quintile (61-80%) and 41 per cent of the top quintile (81-100%). There is, therefore, an evident inverse relationship between the proportion of household income that comes from forest resources and total household incomes and level of poverty.

Table 11: Relative Contribution of Major Sources of Income to Total Rural Household Income (October, 2006–September, 2007)

Sources of Income	**Income Quintiles**					
	Lowest 20%	**21-40%**	**41-60%**	**61-80%**	**Top 20%**	**All Households**
Wild Fruits/nuts	21.2	24.0	14.4	9.1	4.9	13.4
Rattan	21.1	21.8	9.7	16.9	17.0	10.6
Fire Wood	24.9	24.3	33.4	24.5	19.4	18.2
Farming	20.0	17.8	28.5	19.9	21.5	30.5
Others	12.8	12.1	14.0	29.6	37.3	27.3
Total Income (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Income from Forest Products (%)	**67.2**	**63.6**	**57.1**	**50.5**	**41.3**	**47.2**

Source: Culled from Inoni, 2009

Furthermore, among the various forest resources, biomass fuel stands out prominently. For instance, among the poorest first, second and third quintiles, fuel wood is the first, most major contributor to household incomes, accounting for 24.9 per cent, 24.3 per cent and 33.4 per cent, respectively. For the forth quintile it came second (24.5 per cent) and occupies the third position (19.4 per cent). Again, we find that, as with all forest resources, the contribution that income from biomass fuel makes to total household income is inversely related to the income bracket of the household. Accordingly, the lower the income bracket, the more significant the share that comes from fuel wood (forest) sources and *vice versa.*

Relative (%) extent of household dependence on forest resources by income groups (poverty and choice of domestic energy consumption)

Our conceptual framework and literature review have demonstrated clearly that apart from income generation, rural households also depended first and foremost, on common pool forest resources for firewood supply; as well as employment. This extended employment dimension also means an additional dimension of pressure on natural environmental resources with consequent implications for overall environmental quality

Like income, the share of fuel wood (as a proportion of total fuel) used decreases with increasing income. They are inversely related. Inoni's survey corroborates this proposition and findings are summarized in Table 12.

Table 12: Extent of Household Dependence on Forest Resources by Income Groups

Parameter	Income Quintiles					All Households
	Lowest 20%	21-40%	41-60%	61-80%	Top 20%	
Fuel supply (%)	87.3	84.0	76.7	71.6	66.0	78.2
Employment (man days)	178.6	163.1	137.0	123.6	96.2	139.8
Income from Forest Resources as % of Total Household Income	67.2	63.6	57.1	50.5	41.3	47.2

Source: Culled from Inoni, 2009.

The Table shows that on the whole, 78.2 per cent of the households depend on forest resources, particularly fuel wood as the household energy. The first observation is that the proportion of households that depends on fuel wood is higher in the rural communities in Ughelli (78.2 per cent) than the Nigerian (77.0 per cent) and Niger Delta Region (73.0 per cent) averages (Table 8). However, among the rural poor, again, there are differences in the degree of dependence on wood fuel. For instance, while 87.3 per cent of the households in the poorest, lowest quintile depend on forest resources for fuel, the corresponding figure is 84.0 per cent for the second quintile (21-40%); 76.7 per cent for the third quintile (41-69%); 71.6 per cent for the fourth quintile (61-80%) and 66.0 per cent for the top quintile. Again, the inverse relationship between income levels and dependence of wood fuel for household energy is thereby confirmed.

The Table also shows that the number of man-days that members of the household put into employment in sourcing fuel from forest resources is related to the income of the household. For instance, on the average the poor rural households in Ughelli put 139.8 man-days of employment in sourcing wood fuel for energy and to supplement family incomes. However, among the various income groups the figures vary from as high as 178.6 man days for the poorest 20 per cent of the poor to as low as 96.2 man days for the top 20 per cent. All things being equal, therefore, the lower the income group, the more man-days they devote to employment relating to forest resources and *vice versa.*

Again the recurring inverse relationship between poverty and dependence on natural environmental resources is further confirmed. Inoni's findings, therefore, corroborate other studies that have established that poor households with little income-earning alternatives tend to spend more time and effort exploiting forest resources both for fuel and income; thereby creating or aggravating environmental stress (Lopez, 1998; Durraiappah, 1998; Baland, *et al*, 2004).

Relative (%) affordability and availability of various sources of biomass fuels

Wokocha's (2010) survey of four communities of Ogba/Egbema/Ndoni Local Government Area of Rivers State provides further evidence of the poverty-environment linkages in the Niger Delta Region. The information in response to the question of which of the biomass sources of fuel is considered most affordable and readily available to the household are summarized in Table 13. The study shows that as a result of poverty, rural communities in Rivers State depend overwhelmingly on the direct combustion of biomass fuels; such as wood, crop residues and cow dung for cooking as well as other activities that require heating or lighting.

Table 13: Relative Affordability and Availability of Various Sources of Biomass Fuels.

Cheap and Readily Available biomass fuel	Yes	No	Yes %	No %	TOTAL
Saw Dust	130	20	87	13	100
Fire Wood	98	52	65	35	100
Charcoal	54	96	36	64	100
Dried Grass	124	26	83	17	100
Wood Residues/chippings	100	50	67	33	100
Cow Dung	10	140	67	93	100
Prefer Biomass to Oil and Gas	39	111	26	74	100
Can only afford Biomass Fuel	101	49	67	33	100

Source: Culled from Wokocha, 2010.

The details show that on the whole 67 per cent of the surveyed respondents claim that they resort to biomass energy sources because that is what they could afford, while 74 per cent reject modern fuels such as oil and gas derivatives as their sources of household energy, again because they are unaffordable. In terms of the rating of their preferred biomass fuel, saw dust was first, followed by dried grass, wood residue/chippings and cow dung tied for the third place and wood fuel came fourth. The least preferred was charcoal. The poverty element is reflected in the fact that of all the types of biomass-related fuels available to the surveyed communities, charcoal is the most expensive; hence it is the least preferred. Thus, like in the cases of all the indicators considered so far, the inverse relationship between household incomes and the choice of domestic energy is again confirmed.

Wood energy demand and environmental quality

This sub-section is discussed under the physical environment from which biomass energy is sourced and the health environment of biomass energy users.

Relative (%) awareness of the environmental impact of biomass utilization

We reiterate that opinion seemed to be divided in the literature review as to the impact of poverty on the environment. Consequently, and as we stated earlier, one of the objectives of the study was to seek to confirm (or refute) if indeed there is evidence to support the argument that energy poverty degrades the environment in the Niger Delta Region. The data on some communities in Rivers State are presented in Table 14, relating to the effects of dependence on biomass

energy on the physical environment from which biomass fuels are sourced.

In seeking to establish the relationship between poverty and environmental quality, we reaffirm two things, namely, the fact that:

- Recent data (UNDP, 2006; National Bureau of Statistics, 2004) show that the incidence of poverty in the Niger Delta Region is paradoxically and worrisomely high. We reiterate that the situation is made worse by local price distortions, caused by the comparatively very high incomes of very few workers, particularly in the oil and gas sectors, which drive up general prices, thereby reducing the actual purchasing power of the poorly paid ordinary people in the Region. This further aggravates the poverty of the poor.
- Biomass is the most major source of energy for most of the households in the Niger Delta Region.

Table 14: Relative Awareness of the Environmental Impact of Biomass Fuel Utilization

Items	**Yes**	**No**	**Yes %**	**No %**	**TOTAL**
Burning of biomass causes more air pollution than oil and gas	69	81	46	54	100
The ashes obtained from burning biomass is useful to farmers	84	66	56	44	100
The ashes, smoke and soot can make the environment dirty	124	26	83	17	100
Biomass fuel utilization does not adversely affect soil fertility and food productivity	40	110	27	73	100
Water cannot easily be polluted when using biomass fuel	60	90	40	60	100

Source: Culled from Wokocha, 2010

Against this background, Table 14 shows that, with respect to natural resources and the physical environment, households are not ignorant of the negative environmental impacts of their dependence on biomass fuels. Indeed they not only know, but also confirmed that they have been affected by some of the negative impacts. Rather, their constraint is poverty which is manifested in the lack of access to safer and more environmentally friendly alternative fuels to choose from. This is a practical confirmation of Malthus's earlier-cited claim that the poor is mostly concerned with present survival. In order words, the Table shows that apart from acknowledging the fact that biomass usage may be less polluting to water sources, users of biomass fuels know that:

- ♣ the smoke from the inefficient conversion processes causes both regional and indoor air pollution,
- ♣ the bye products, such as smoke, sooth and ashes degrade the general environment and make it dirty,
- ♣ the harvesting of biomass fuels from the forest could lead to:
  - ♠ deforestation, by removing plant cover,
  - ♠ biodiversity loss, by removing a wide range of organisms,
  - ♠ lower soil fertility, by removing the natural fertilizers produced by decomposition,
  - ♠ poor agricultural yields, as a result of poor soil quality, and eventually,
  - ♠ further accentuating poverty.

However, as earlier confirmed from Table 6, in spite of the awareness of these negative externalities, the poor are constrained to use biomass energy for domestic purposes.

Relative (%) awareness of the health implications of biomass utilization

Again, with respect to the awareness of the impact of biomass energy dependence on human health, Table 15 summarizes the findings from Wokocha's (2010) study of some communities in the Rivers State.

The Table shows that biomass users are aware of the global correlates between dependence on this source of energy and their potential health status, namely, that:

- ♣ Smoke and soot form burning biomass fuels cause respiratory complications, such as asthma, cough, pneumonia and chronic bronchitis.
- ♣ Bye products (suspended particulate matter) cause chronic pulmonary disease, including those associated with smoke and soot, and eye problems such as cataracts, as has also been confirmed by Smith, (2006),

Table15: Relative Awareness of the Health Impact of Biomass Fuel Utilization

Items	Yes	No	Yes %	No %	TOTAL
Burning of biomass causes more air pollution than oil and gas	69	81	46	54	100
The ashes obtained from burning biomass is useful to farmers	84	66	56	44	100
The ashes, smoke and soot can make the environment dirty	124	26	83	17	100
Biomass fuel utilization does not adversely affect soil fertility and food productivity	40	110	27	73	100
Water cannot easily be polluted when using biomass fuel	60	90	40	60	100

Source: Culled from Wokocha, 2010

- ♣ Inefficient modes of conversion, especially the traditional three-stone open fire stove, could result in fire outbreaks, with very high collateral damages, considering the low quality of local building materials,
- ♣ Combustion products could also cause blood disorder,
- ♣ Biomass fuels cause heat rashes and other skin diseases,
- ♣ Wood combustion products can include toxic and carcinogenic substances which contribute to human health challenges and increase hospital admissions for asthma and heart disease patients, as has also been confirmed by Warwick and Doig (2004), and
- ♣ The health risk of biomass fuel is less than that of oil and gas.

Our conclusion is that in the Niger Delta Region, as far as household energy use is concerned, there is a direct and strong linkage between poverty and the quality of the environment. Poorer households depend almost entirely on biomass, which is harvested wholly from natural environmental resources and usually without replacement; thereby degrading the macro environment. Furthermore, the use of biomass produces pollutants that degrade the immediate micro environment, where they are used.

Rural and urban dimensions and conflicts in poverty-environment linkages

The rate of urbanization in the Niger Delta Region far exceeds both the Nigerian and the Third World averages. This is due to the large volume of activities, especially those associated with oil and gas operations. Consequently, new urban centres have emerged and the older ones have become larger. A survey by the Centre for Population and Environmental Development (CPED) showed that in 2003, there were 98 urban settlements with populations of at least 20,000. This was, however, only 1.0 per cent of the 13,327 settlements identified in the region. They were unevenly distributed; with Delta State having the largest number of twenty-two (22), while Imo State was the least urbanized with only two (2) urban centres. However, four other states, namely; Abia, Edo, Ondo and Rivers had more than ten urban centres, each. Granting the continued attraction of region, it is projected that the number of urban centres in the Niger Delta Region will exceed 150 by the year 2020. This paints the Niger Delta Region as a rapidly urbanizing sub-region. That notwithstanding, over 70 per cent of the region will continue to live in the rural settlements.

Because many of the people who move into the urban centres from rural communities retain their rural habits, as regarding energy use, the phenomenon of energy poverty transcends the rural-urban sectors of the region. In other words, and as has been severally stated elsewhere, economic constraints compel most urban poor to depend on biomass energy sources, like their rural poor counterparts.

Most biomass fuels, especially wood fuel, are generally bulky and heavy products. Consequently, all things being

equal, wood fuel cannot be transported economically over a long distance. This is the thesis of the classical von Thunen model of land use. Johann Heinrich von Thunen, a German land owner and economist, in his book, ***The Isolated State***, written in 1826, had theorized that given certain assumptions, land use and economic activities would be directly related to variations in transportation costs, which are in turn dependent on such factors as the distance to points of consumption (markets), the bulk, weight and perishability of goods (Chisholm, 1968). Accordingly, land uses are arranged in concentric zones around settlements, such that goods involving high transportation costs come from the inner-most zones next to the market and consumption points. The expectation, therefore, is that the wood fuel that the urban poor consume, being 'bulky and heavy', can only come from around the urban settlements. Consequently, if wood fuel supply will cause deforestation, its intensity will be localized around urban areas and will decrease with increasing distance from the towns.

However, the present day settlement system in the Niger Delta Region has violated virtually all the expectations of von Thunen's village-type of settlement system, with characteristically rudimentary modes of transportation, such as the ox-drawn wagon. Instead, we now have a variety of transportation modes, including highways that have broken distance barriers and made the long-distance movement of 'bulky and heavy' goods more cost-effective than hitherto. Consequently, the fuel wood consumed in the urban centres now comes from distant sources.

Long-distance haulage of wood fuel is further encouraged by the commercialization of the operations and the quantities that are transported. In the past, the collection of wood fuel was essentially a subsistent activity; each household fetching just what it needs for its cooking, by using bare hands to break off the dry branches or at best using cutlasses to cut them, and carrying them home on the head. Today, however, wood fuel processing has become a major 'mechanized' business; involving major entrepreneurs and middlemen; using motorized saws and heavy duty trucks for the transportation of large quantities over long distances from rural sources to urban markets. While rural communities run into 'paradoxical' circumstances, where fuel wood is in short supply (and, therefore takes more time to collect), the problem of scarcity is generally perceived to be more acute around urban areas, where well organized networks of collectors, procurers, transporters, and distributors bring in fuel wood from sources that are becoming farther afield, than hitherto. Although estimates are rather rough and sometimes contradictory, Woodwell (2002) has cited Food and Agricultural Organization (FAO) sources as asserting that for large urban markets, fuel wood harvesting can be as far away as 150 km to 400 km in the West African sub-region in which the Niger Delta is located.

Relative (%) significance of the involvement of various activities in household livelihoods

Moss and Morgan (1981) have confirmed that in Nigeria fuel wood not only provides energy for rural households, but also employment and income for rural farmers, who process biomass for 'export' to meet part of the energy requirement for cooking in urban areas. It could, therefore, be a viable source of livelihood for some families. Based on the Ughelli survey cited earlier, Inoni (2009) puts it thus: "Although, the exploitation of fire wood is done primarily as a source of energy to the rural households in Nigeria, it has a great deal of effect on their economic wellbeing. This is so because fire wood collectors do not gather fuel wood only for their own domestic use, but for sale in nearby peri-urban and urban areas to generate income". Indeed, Onakuse and Lenihan's (2003) study has shown that wood fuel harvesting has become a relatively major occupation in the Niger Delta Region (Table 16, also see Figure 6).

Table 16: Distribution of Respondents According to Levels of Involvement in Livelihood Activities

Livelihood Activities of Households	**Level of Involvement**					
	Rarely		**Often**		**Very Often**	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Civil Service	-	-	-	-	9	4.5
Fishing	60	30.0	21	10.5	26	13.5
Processing	16	8.0	15	7.5	95	47.5
Gathering non-fish aquatic products	30	15.0	25	12.5	38	19
Sea Food Collection	24	12.0	29	14.4	65	32.5
Crop Farming	29	14.5	21	10.5	7	3.5
Livestock Rearing	9	4.5	4	2.0	5	2.5
Trading	10	5.0	11	5.5	25	12.5
Hired Labouring	6	3.90	1	0.5	1	0.5
Fuel Wood collection	59	29.5	28	14.0	25	12.5
Timber and non-timber Forest Products	9	4.5	15	7.5	1	0.5

Source: Culled from Onakuse and Lenihan (2003)

Onakuse and Lenihan's study shows that in the Niger Delta Region, among the people who indicated the sources from which they 'very often' derive their livelihoods, trading and wood fuel collection were equally significant at 12.5 per cent each); and that wood fuel collection was even more significant than civil service (4.5 per cent), crop farming (3.5 per cent), livestock rearing

(2.5 per cent); casual daily hired laboring and timber and non-timber forest products (0.5 per cent, each). Even more remarkably, among those who indicated the sources from which they 'often' derive their livelihood, sea food collection and fire wood collection were almost equal as the most significant (14.5 per cent as against 14.0 per cent, respectively. All other livelihood activities were less significant.

Because of its rural origin and common association with rural communities, it is generally assumed that rural households in the humid forest zone of Nigeria do not suffer from fuel wood scarcities (Oguntala, 1986). However, Achi (2006) has concluded that recent trends of exploitation show that this assumption can no longer be sustained. This is because wood fuel processing has become a significant source of employment and income. Furthermore, because the urban markets are more lucrative, many rural areas are being emptied of biomass fuels and are beginning to experience a paradoxical scarcity. This is the basis of the rural-urban wood fuel crisis and conflict. The increasing population of urban poor means increasing demand for wood fuel in the urban areas. This puts additional pressure on the rural areas to meet the urban demand, beyond the pressure to meet local demand. The generally higher incomes in the urban centres tend to distort the prices for fuel wood between urban and rural markets. Consequently, wood fuel fetches more money in the urban than rural markets and the normal rational response to the higher urban prices is to move most wood fuel from rural to urban centres. The result is the emerging scarcity of biomass fuels in the rural areas, from where wood fuel is harvested. Figure 6 represents the common sight along highways leading to the region's urban centres.

Figure 6: Heaps of freely-cut firewood from the forest, on display for sale and transfer to urban centres.
Source: Chokor, 2004, p. 8.

Achi's (2006) study of Delta State confirms that the deforestation associated with wood fuel supply to urban areas did not decline with distance. Rather he found out that wood vendors harvested wood fuel from distances of up to 45 km from Ogwashi-Uku, from largely uncontrolled lands. He observed that contrary to expectation, the lands around the urban centres tended to be protected from indiscriminate deforestation because they have clear tenure and rules governing tree use and exploitation (Achi, 2006; 24). Consequently, the ecological footprint or wood fuel hinterland of urban centres has greatly widened; taking advantage of improvements in the transportation infrastructure and intensifying motor traffic (Achi, 2006; 25). It is in attempt to exploit the profitable wood fuel market that large scale operations by urban-based entrepreneurs have emerged in distant places of low population and extensive wood lands.

If it is appreciated that Ogwashi-Uku is only a medium-sized settlement in the Niger Delta Region, then, the wood fuel ecological footprints of the state capitals, and such other large urban centres as Warri, Sapele, among others, will be far larger.

Ikurekong, Esin and Mba's study of Akwa Ibom State (2009) provides another evidence of the transformation of the fuel wood operations in Akwa Ibom State. They observed that fuel wood supply that used to be by head porterage has now been commercialized and the volume of operation greatly increased in response to external (urban) demand. The transportation of wood fuel to urban markets is now through both land routes and waterways. They observed that canoes and flying boats are now used to move fuel wood from the creeks to the beaches enroute to the city. Large scale commercial suppliers use pick-up van and trucks.

Gender and the Poverty-Environment Nexus

Chinweze, and Abiola-Oloke, (2009; 9) have asserted that the Niger Delta Region, women are the principal custodians of the environmental resources, just as they make copious contributions to home management. They bear the burden of raising and nurturing their families, sometimes as the breadwinner of their family unit, especially within a polygamous setting. They provide the basic needs of their household, especially household fuel and energy. In other words, the pressure to meet the energy needs of the household is transferred directly to the women of this region who, in turn, come under pressure to over-exploit the slim natural resources.

11. MATTERS ARSING

The Report so far shows that among the negative externalities associated with the consumption of biomass fuels by the poor are that:

- Biomass fuels are converted into cooking energy by burning, using very inefficient and very ineffective and very environmentally unfriendly methods, such as the three-stone open fires and traditional stoves. They are inefficient because, more than 80 per cent of the heat or energy generated while cooking with wood on a traditional three-stone fire does not end up 'in the pot,' (Modi, McDade, Lallement and Saghir, 2005; 36),
- Every day, over 4,000 people, mostly women and children, die as a result of long exposure to indoor air pollution, resulting from the inhalation of smoke from the inefficient conversion and use of biomass fuels,
- In almost all the cases in the Niger Delta Region, the demand for biomass fuels far exceeds sustainable supply. Among the resulting environmental impacts are varying degrees of deforestation, general land degradation, soil erosion, loss of soil fertility and declining agricultural (food) produce.
- Dwindling biomass fuel resources has led to additional workload for women and children, as they spend longer hours sourcing cooking energy, at the expense of other economically productive endeavors, including education of the latter.

However, in spite of these and other negative externalities, and in the light of

the reality of their economic situations, the use of biomass fuels by the poor has been identified with some advantages that cannot be ignored. Among these are, that:

- To a large extent, and granted a sustained proactive policy, in the long term, biomass fuel can be a renewable source of energy,
- Biomass fuels are available in some form (farm residue, dung, fuel wood) virtually ubiquitously, and can be easily and cheaply converted to energy (usually by burning) without further processing,
- Biomass fuels are affordable to the poor because they are cheaper than such other alternative fuels as electricity or liquefied petroleum gas or kerosene. Indeed some consider it a free commodity,
- Technologies and techniques for the sustainable production and use of biomass energy are either available or can be readily made available.

Against this background, the International Energy Agency has cautioned that without strong new policies to expand access to cleaner fuels and technologies, it is projected that up to one-third of the world's population would still be relying on biomass fuels in the next few decades. Furthermore, the Agency asserts that there is evidence that, in areas where local prices have adjusted to recent high international energy prices, the shift to modern, clean and more efficient use of fuel for cooking has seen very sharp reversals (IEA, 2006). A number of matters arise from this scenario. They include:

1. The overwhelming dependence of the poor on the use of biomass fuels for cooking ought not be an issue of grave concern, if the base resources are harvested in a sustainable manner, on the one hand, and if the harvested biomass is converted to cooking energy in an efficient and environmentally friendly manner, on the other. The major issue is the very low conversion efficiency, which has been put at a very dismal 7-12 percent (Kaale, 2005).
2. Following logically from the above, is the need to explore ways and means of improving the processes of biomass fuel supply, conversion and subsequent use for cooking. This is so because from the surveys of biomass fuel users it does not appear feasible to switch from traditional sources of cooking energy, at least in the short term.
3. The projected and continued dominance of biomass as the predominant source of cooking energy is based on the assertion that "owing to stagnation or slow growth of the economy, sub-Saharan Africa is the only region where the absolute number of the poor is expected to rise by the 2015" (Shiferaw, 2005; 3). This automatically applies to the Niger Delta Region.
4. The conclusion by the World Energy Outlook that in Africa, biomass will account for 80 per cent of residential energy use in 2030, compared to 50 per cent in Eastern Asia, excluding China (WEO, 2002; 390).
5. Logically following from the above is the fact that, while the

consumption of fuel wood has been declining in a developing country like South Africa (15 per cent) and the countries of North Africa (5 per cent) (Karekezi, Lata and Coelho (2004), it is actually rising in countries like Nigeria (Olusegun, 2009). The outlook of the global scenarios of energy use is presented in Table 17.

Table 17: Projected Final Biomass Consumption in Relation to Total Energy Use, 2000 and 2020

Country or Region	2000				2020			
	Biomass (Mtoe)	**Conventional Energy (Mtoe)**	**Total (Mtoe)**	**Share of Biomass (%)**	**Biomass (Mtoe)**	**Conventional Energy (Mtoe)**	**Total (Mtoe)**	**Share of Biomass (%)**
China	214.48	943.4	1,157.9	18.50	224	1,524	1,748	13.00
Asia	343.20	467.74	810.94	42.30	394	1,336	1,730	22.80
Latin America	69.34	284.96	354.30	19.57	81	706	787	10.00
Africa	**221.10**	**157.37**	**378.47**	**58.40**	**371**	**260**	**631**	**59.00**
Total non OECD	859.65	2,417.86	3,277.51	26.23	1,097	5,494	6,591	17.00
OECD countries	126.17	3,551.32	3,677.49	3.40	96	3,872	3,968	2.00
World	**985.2**	**5,969.18**	**6,955**	**14.20**	**1,193**	**9,365**	**10,558**	**11.00**

Source: Karekezi, Lata and Coelho, 2004; 6.

It is particularly note worthy that while globally, dependence on biomass energy is projected to decrease significantly (from 14.20 per cent to 11.00 per cent), by the year 2020, it is only in African Region that the share of biomass energy is expected to increase (even if it only marginally) in relation to total energy use. Equally worthy of note is that while some other developing regions, like Asia and Latin America are projected to reduce their dependence on biomass energy by almost half (from 42.30 per cent to 22.80 per cent; and from 19.57 per cent to 10.00 per cent, respectively) by the year 2020, Africa's dependence will actually rise! This, and the preceding point, must be viewed seriously with respect to the Niger Delta Region.

6. It should be recognized, however, that the technology for the use of biomass energy can be categorized into three (3), namely; traditional, improved and modern, depending on the amount of biomass needed, their capacity to retain heat, the amount of resultant indoor air pollution, combustion efficiency and heat transfer, among others. Thus, while ***traditional biomass energy technologies*** like the three-stone open fire needs a large amount of biomass for any

purpose, loses most of the heat produced, generates a lot of indoor pollution and is inefficient in heat transfer, at the one end, ***modern biomass energy technologies*** which convert biomass energy into advanced fuels, such as liquid fuels, gas and electricity, at the other end, are more environmentally friendly and more efficient in heat production and transfer, thereby requiring less quantity of biomass. In between two extremes are the ***improved traditional biomass energy technologies***. However, modern biomass energy technologies are very expensive.

7. Based on the advantages of modern methods, a joint Harvard and Berkeley study (Kemman, 2005), has argued that the best situation in Africa would be the transition from biomass fuels to petroleum-based fossil fuels, such as kerosene and liquefied petroleum gas, which could prevent 1.3 million to 3.7 million premature deaths, depending on the speed of the transition. The Report, however, concluded by rightly acknowledging that granting the economic cost of these modern methods, such a transition is 'unachievable'.
8. This scenario is not peculiar to Nigeria, or the Niger Delta Region. For instance, in Lesotho, where the country is not extensively electrified and other 'modern' energy sources such as solar power are far too expensive to install, Basotho have resorted to economizing by using traditional fuels, despite the fact that fuel wood is becoming difficult to find (Wason and Hall, 2004). Lessons from such places may be useful for the Niger Delta Region.
9. The syllogism above implies that in the interim it would not be possible to stop the use of biomass fuels by fiat, regardless of the challenges associated with their use. Rather, ***the short term solution is the adoption of an intermediate technology based on efficient wood-burning methods and facilities, together with the widespread establishment of fast growing trees.***
10. The quality of any policy on the regulation and control of the use of biomass fuels will be greatly influenced by the quality of the information on which it is based. In other words, detailed and accurate statistics on energy supply and consumption are essential for proper policy and market analyses.

12. POLICY CHALLENGES

Although dependence on biomass fuels as the major source of cooking energy by the poor may be considered rational, it is clear that this preference is unsustainable, due to some of their serious negative environmental impacts, including those highlighted in this Report. However, as we have seen, the facts that have emerged from both the global literature and the various local studies of the Niger Delta Region show that changing the cooking habits of the poor has never been, and will never be, an easy task. First, users of biomass fuels must be convinced that there are

better methods than the known traditionally entrenched ways. Secondly they understand how to use these better technologies. Thirdly, they should be able to afford them. As we approach the eve of the target (2015) set by the United Nations Millennium Project, and considering the very close links between energy and each of the Millennium Development Goals (MDGs), on the one hand, and the need to address the macro and micro environmental challenges associated with the use of biomass fuels as cooking energy, on the other, it becomes extremely urgent and imperative that we look closely at and explore some of the policy implications of the issues raised and discussed in this Report.

In doing so IEA (2006; 419) has proposed two complementary approaches that are perceived to be capable of closing some of the observed gaps in the energy needs of the poor. These are:

- promoting more efficient and sustainable use of traditional biomass; and
- encouraging people to switch to modern cooking fuels and technologies.

The mix that is appropriate will depend on local circumstances such as household incomes and the availability of a sustainable biomass supply, among others. In this regard and considering the local realities in the Niger Delta Region, we reiterate that while pursuing the second option as a longer-term policy, the first, namely; promoting more efficient and sustainable use of traditional biomass, should be our priority and short-term policy thrust. In order to achieve this short-term goal, it is considered that as an irreducible minimum, a responsive policy on the cooking energy needs of the poor in the Niger Delta Region, must include the following, albeit interrelated and sometimes over lapping items: environmental education; attributes of the improved biomass technology (IBT); the improved biomass cook stove; economic affordability; sustainability of biomass energy supply; capacity building, tooling up and implementation.

The outline presented in this Report leverages on Modi, McDade, Lallement and Saghir's (2005; 3) recommendation that efforts should be made to develop and adopt the use of sustainable biomass and biomass-derived fuels, improved stoves, and practices that reduce exposure of the environment and users to harmful emissions, as well as increasing the efficiency of conversion of biomass to more environmentally friendly household cooking energy.

Environmental Education: Sensitization and Awareness

If, as it has been confirmed by several investigations and assessments, switching from traditional biomass fuels to modern sources cannot be feasible in the short run, for many households, then the success of any proposed alternative aimed at that switch will depend strongly on its ***social acceptability***. Social acceptability, in turn, will depend on how much the

prospective users of the new, improved methods of biomass conversion are persuaded about the disadvantages of the old and the advantages of the new. Massive and aggressive environmental education must, therefore, be a strong component of any sustainable long term policy and strategy for redressing the stresses that result from biomass energy consumption. Awareness about the environmental implications of dependence on traditional biomass sources of cooking energy can be heightened and sustained through public and private agencies, grassroots institutions; through changes in school curricula and by creative use of the local media. Every perceived opportunity must be explored to sensitize, mobilize and educate biomass-energy-dependent poor households on why the change in the technology of conversion of cooking energy must be considered, and an improved alternative embraced.

Considering that the vast majority of the target populations reside in rural areas, and considering the enormity of the power they wield, and the control they have over their subjects in the Niger Delta Region, environmental education should leverage on local institutions built around influential local leaders and rulers. Local institutions built around traditional rulers and royal fathers, such as the obas (Edo and Ondo States), obis, igwes, ezes, nzes (Delta, Imo and Abia States), ivie, edion (Delta), amanyanabors (Rivers and Bayelsa States), obongs, etuboms, nsoboms (Cross River and Akwa Ibom States), and their hierarchy of chiefs, etc, constitute very potent platforms for grassroots mass sensitization and mobilization for the social acceptability of new energy technology and schemes. For instance, the effects of a simple taboo against a perceived unsustainable energy consumption practice by local institutions could produce unimaginably greater results than laws and bye laws. Similarly, considering the great influence and followership of clerics, religious institutions such as churches and mosques can also be veritable outlets for the dissemination of environmental information. Environmental education should be made a mandatory subject in the curricula of primary and secondary education.

Considering also that the majority of producers and users of biomass fuels are illiterate, environmental education must be reduced or translated into the local languages and dialects of the communities (with the active sponsorship of all levels of government and international donor agencies) for maximum dissemination and assimilation. Policy makers and designers of environmental education must ensure that information to be disseminated must be rendered in very simple and easily understandable language, completely devoid of all confusing technicalities.

In addition, professional groups, non-governmental organizations (NGOs) and community –based organizations (CBOs) should be encouraged and indeed commissioned, sponsored and supported by various levels of

government and donor agencies to organize environmental awareness and sensitization programmes (workshops, seminars, symposia, etc) for biomass fuel suppliers and consumers. Because of its national significance and importance, it is suggested that even political parties should be compelled to include environmental education in their manifestoes.

However, environmental education must recognize that although the rural poor are most directly implicated in the use of biomass fuels, the impact often goes far beyond their immediate communities. For instance, urban consumers of fuel wood are scarcely aware of, or concerned about the consequences (even if only indirect) of increased demand for soil fertility and eventually food supply.

The overall goal of environmental education is to ensure consultation and enroll the cooperation of key stakeholders, so as to engage and carry them along. Consultation ensures a bottom-up policy process that makes the resultant outcome 'our own', rather than 'their own'.

Attributes of the Alternative Technology

The second policy issue is to articulate the 'specifications' of the alternative technology for which the sensitization programme is building patronage support. The presumption here, is that the introductory part of the environmental education programme would have addressed the negative externalities of the present form of biomass energy consumption. This becomes the basis for advocating a switch to an improved technology. In other words, current users of the present inefficient methods of cooking energy must understand those attributes of the proposed alternative that make it better and preferred. Essentially, these attributes should be those that address all the perceived negative environmental impacts of the present methods.

In order to appreciate their global relevance and national significance, so as to make a strong case for the improved biomass energy technology, it would be appropriate to link its expected 'deliverables' to the United Nations Millennium Project. Consequently, the proposed policy must ensure that the attributes of the improved alternative include, but by no means limited to the following:

- ***A remarkable saving in the quantity of biomass energy used*** for the same amount of cooking. This saving would come from greater energy content per unit weight of biomass fuels, and the increased efficiency of energy conversion, thereby contributing to the achievement of MDG 7,
- ***A remarkable reduction in indoor air pollution***, arising principally from a complete (or near complete) combustion process of the conversion of biomass fuels to energy, thereby reducing (or eliminating) suspended particulate matter (SPM). This would in turn, reduce the risk of respiratory diseases and of eye infections, and thereby reducing child mortality,

improving maternal health and combating pollution-triggered diseases. Together, these would ultimately contribute to achieving MDGs 4, 5, 6 and 7,

- **A remarkable improvement in the design and ventilation of kitchens**, such that even with the existing form of biomass fuel use, the particulate levels in the homes using fuel wood could be remarkably reduced. This has been claimed to have reduced particulates to levels even lower than in poorly ventilated homes using liquefied petroleum gas (LPG) (IEA, 2006),
- ***An appreciable reduction in health risks*** (such as burns, eye infections, asthma, bronchitis, tuberculosis and cough, among others) and ***time-loss by women and children,*** which could then be used for productive, income earning activities. These would in turn reduce child mortality, empower the women, improve maternal health and combat diseases. Again, together, these ultimately contribute to achieving MDGs 1, 4, 5 and 6,
- ***An unambiguous reduction in emissions:*** of suspended particulate matter, carbon monoxide and other green house gases into the atmosphere, thereby contributing to the achievement of MDGs 4, 5, 6 and 7,
- ***Employment opportunities*** that would arise from the jobs and small scale businesses (cottage industries) that would be set up for the production and commercialization of improved forms of biomass energy use (cook stoves), thereby contributing to the achievement of MDGs 1 and 3,
- ***Overall economic empowerment*** would arise from the improved incomes that would be earned from the production and commercialization of improved forms of biomass energy use, on the one hand, and from the income yielding activities that women would divert their wood-fetching time to. These would contribute to the eradication of extreme poverty and hunger, and ultimately partly achieving MDGs 1, 3 and 8.
- ***The reduced use of dung and agricultural residue will, with time, improve soil fertility and contribute to a reduction of land degradation.*** In the same vein, a reduction of the demand for, and consumption of, wood fuel will in turn reduce pressure on forest resources. This will in turn result in savings of resources that would have been used for afforestation. Ultimately, both will ensure environmental sustainability, thereby contributing to the achievement of MDG 7.

The Alternative: The Improved Biomass Cook Stove

There is a wide range of technologies for modern cooking. They vary from artisanal or factory-made clay and metal stoves to solar cookers. Others include heat retainers as well as stoves using modern bio-fuels, such as plant oil, ethanol or biogas (IEA, 2006; 6). Considering the confirmed pervasive poverty in the Niger Delta Region, most of these technologies are only relevant

for intellectual and academic debate and interrogation, but not practical adoption. This is because all indicators have confirmed that they are totally and absolutely unaffordable.
Caution must, therefore, be exercised in recommending an alternative; considering that household incomes in the region are not expected to rise very remarkably in the very near future, and also that cooking energy choice and consumption have been confirmed to be very sensitive to price changes in alternative energy forms, especially kerosene, therefore, tending towards inertia.

It is against this background that the ***improved biomass cook stove*** is recommended as a replacement for the traditional and ubiquitous three-stone open fire cookers. This recommendation is in consonance with Modi, McDade, Lallement and Saghir's (2005; 48) suggestion supporting a three-fold approach to tackling the energy need of the poor with a focus on achieving the MDGs, namely;

- ♣ increasing efforts to develop and adopt the use of improved cook stoves,
- ♣ devising measures to reduce the adverse health impacts from cooking with biomass fuels, and
- ♣ articulating measures to increase sustainable biomass fuel production.

It is noteworthy that all three are linked and revolve around the first. This is because, as will be evident later, improved cook stoves have the capacity to improve the health of the population at risk (women and children) and by reducing the quality of biomass fuel needed to produce a given amount of heat, make the biomass that is available go farther and hence become more sustainable.

In this Report, the ***Rocket Stove***, designed by GTZ in conjunction with the Aprovecho Institute of Germany is used s a ***very good example*** of an efficient and improved biomass cook stove. ***Its principles are basic, versatile and very easily adaptable to local situations,*** as shown in this Report. It must, however, be emphasized, here, that it is ***THE TECHNOLOGY*** and ***NOT NECESSARILY THE PRODUCT*** that is recommended in this Report. The product is only used to illustrate how the technology works and demonstrate its advantages. Locally customized products can be fabricated, aiming eventually at 100 per cent local content.
The Rocket Stove was invented by Dr. Larry Winiarski, the present Director of the Institute, in 1982 (http://www.ashdenawardsorg/winners/trees). It won the Ashden Award for sustainable energy in 2005, in the "Health and Wealth" category (http://www.stovesource.com/mambo/index.php?option=comcontent&task=category&sectioned=5&id=20&Itemid=51). It also won the Special Africa Award at the Ashden Award in 2006 for their work with rocket stoves for institutional cooking in Lesotho, Malawi, Uganda, Mozambique, Tanzania and Zambia (http://www.ashdenawards.org/winners/aprovecho). Furthermore, the Aprovecho Research

Centre (ARC) was awarded the 2009 Ashden International Energy Champion Award for its groundbreaking achievements in creating affordable and reliable mass produced improved cook stoves, including the Rocket Stove (ARC, 2009). There is quite a wide variety of stoves, based on the basic technological structure, but made from a variety of materials, ranging from metal (Figure 6) to clay (Figure 7) to burnt bricks (Figure 8) and even mud (Figure 19). Furthermore, they could be stationary; in fixed positions in kitchens (Figures 7) or outdoor (Figure 8); but could also be portable and easy to move around, either within the kitchen space or in the outdoors (Figures 6 and 10). Since the materials used will determine the price of the cook stove, it means the user-households can have an equally wide range of choices, depending on their degree of affordability. We re-emphasize that the underlying principle is, however, the same. The cook stove has a unique fire chamber, where all the gases that are produced when the fire is lit are completely burnt up and the heat generated is transferred efficiently, effectively and directly to the cooking pot.

Figure 7: The Prototype Rocket Stove
Source: Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007; 6),

The technology combines air-intake with the fuel feed slot. It is made up of four components as follows:

- ***The Fuel Magazine***: into which the raw, unburned fuel (e.g. wood or dried grass) is loaded, fed or placed, and from where it feeds into the combustion chamber,
- ***The Combustion Chamber***: located at the end of the fuel magazine, where the raw fuel (wood, etc) is burned,
- ***The Chimney***: a vertical channel above the combustion chamber, to

provide for the updraft of air needed to maintain the fire,

- ***The Heat Exchanger***: to transfer the heat to where it is needed, that is, the base of the cooking pot (en.wikipedia.org/wiki/Rocket_ stove).

Figure 8: More efficient and healthier use of fuel wood (metal type, portable, outdoor); compared to Figure 4.
Source: Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007; 6).

Figure 9: More efficient and healthier use of fuel wood (clay type, fixed, indoor kitchen); compared to Figure 4.
Source: Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007; 8),

If the biomass fuel (wood) that is fed into the fuel magazine is thoroughly dried, the improved stove ensures almost complete combustion, thereby reducing (and possibly eliminating) the emission of suspended particulate matter as well as reducing (or eliminating) all the attendant smoke- or soot-triggered health risks. Since none of the energy converted from the wood escapes or is lost, the stove saves energy, retains and maximizes heat, thereby, reducing waste and shortening cooking time. Reduced cooking

Figure 10: More efficient and healthier use of fuel wood (burnt brick-type, fixed, indoor/outdoor;
Source: Wiskerke, (2009; 117)

time impliedly also as reduces the biomass fuel (fire wood) needed to generate the energy required for a particular cooking. The reduction in the wood energy fed into the stove in turn, reduces the environmental pressures on vegetation and soils; reduction of green house gasses, among the other attributes listed earlier.

Figure 11: More efficient and healthier use of fuel wood (clay type, mobile,outdoor); compared to Figure 4.
Source: Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007; 12),

Figure 12: More efficient and healthier use of fuel wood (mud type, mobile, outdoor);
Source: Wiskerke, (2009; 117)

The improved biomass cook stove has been successfully deployed in more than 100 projects in over 60 countries, including many in East Africa, especially Uganda, Ethiopia and particularly in Rwanda, where it was used in mass cooking in large refugee camps (www.cd3wd.com/cd3wd_40/JF/425/20-228.pdf; www.aprovecho.org/).

There are clear and specific multi-level benefits of the improved biomass cook stove, ranging from the individual family, the local community, the nation, to the global community. They have been summarized to include:

- ***Potential benefits to the family***
  - Less time spent gathering wood or less money spent on buying fuel, since less will now be needed,
  - Saved time could be used for other economically productive (income-earning) activities,
  - Saved money could be used to improve the general quality and standard of living,
  - Less smoke in the kitchen, since combustion is greatly enhanced,
  - Lessening of respiratory problems associated with smoke inhalation,
  - Less manure used as fuel,
  - Releasing more natural *in situ* fertilizer (agricultural residue) for agriculture,
  - Little initial cost, compared to most other kinds of cookers, since most, if not all the materials are locally sourced (100 per cent local content)
  - Improved hygiene, especially with models that raise cooking off the floor to a table,
  - Greatly enhanced safety: fewer burns than are associated with open flames;
  - Less chance of children falling into the fire or boiling pots, especially, if raised from the ground,
  - If pots are securely set into the stove, less chance of children pulling them down on themselves,
  - Enhanced cooking convenience: since stoves can be customized to, or placed at, any height and can have work space on the surface,
  - The fire requires less attention, as stoves with damper control can be easier to tend.

- ***Potential benefits to the local community***
  - Stove building or fabrication creates new jobs,
  - Potential for 100 per cent local content (materials),
  - Potential for local innovations, to maximize the use of local materials,
  - Money and time saved can be invested elsewhere to improve household living standard, as well as in the community at large.

- ***Potential benefits to the nation***
  - Lowered rate of deforestation improves climate, wood supply and hydrology,
  - Decreases soil erosion,
  - Potential for reducing dependence on imported fuel,
  - Potential for short-range solution to deforestation, while long-range reforestation programmes get underway,
  - Cost of providing improved biomass cook stove is much lower, compared with other means of fighting deforestation.

- ***Potential benefits to the global community***
  - Improved biomass cook stoves can slow down the rate of

climate change, deforestation and desertification,

- They allow time for reforestation projects to gain a foothold and help to change the balance toward extending forested areas once again (Aprovecho Institute, 1984; 12).

The appeal of the improved biomass technology (IBT) is, therefore, not debatable. It has been tried. It has been tested. It has been confirmed to work. It provides the short run solution to the impending 'other energy crisis in developing countries', namely; the shortage of wood fuel.

Economic Affordability

The rising demand for biomass fuels in urban areas is the result of the rising cost of alternative energy sources, especially kerosene. For instance, Momah and Soaga (1999) claim that between 1991 and 1994, the cost of kerosene and liquefied petroleum gas (LPG) rose by about 900 per cent, while Babanyara and Saleh (2010) are of the opinion that the current rise is in the order of 1,000 per cent. Such astronomic hikes correspondingly push more and more households down the energy ladder (Figure 3). Within two weeks the challenge of the economic affordability of cooking fuel featured twice in a Nigerian national daily newspaper. On Friday, January 28, 2011, The PUNCH carried the picture of a man processing traditional biomass fuel (fire wood) for sale; with the caption: "***Fire wood business booms as scarcity of kerosene persists in Abuja*** (the national capital)" (PUNCH, 28.01.11; 13). Again, on Friday, February 11, 2011, the newspaper carried a related picture, captioned: "***Man hawking Fire wood, as scarcity of kerosene persists in Abeokuta*** (capital of) ***Ogun State … on Wednesday***" (PUNCH, Friday, February 11, 2011; 13). These images can be replicated in the major urban areas in the Niger Delta Region, such as Port Harcourt, Benin City, Warri, Calabar, Asaba and indeed, all the other state capitals. Similarly, IEA (2006; 441) reported of Brazil, that "biomass consumption per capita has stopped declining and even started to increase, as many poor households switch back to fuel wood, in the face of higher liquefied petroleum gas prices". These reports confirm that the issue of affordability of cooking energy is a global one. The bottom line of any policy aimed at persuading the poor to switch from the traditional forms of biomass consumption to a cleaner and more efficient form, therefore, is to ensure that the new alternative is affordable.

The most major anticipated barrier to the acceptance, adoption and subsequent penetration of improved biomass energy use methods is the cost of fabricating and or buying the basic unit; the cook stove. If per capita incomes are not expected to rise appreciably, and poor households do not normally have the required collateral to grant them adequate access to orthodox bank facilities to help upgrade their economic status, then governments must set up structures to assist them. In this regard, it is commonly complained that, compared

to the international response to hunger, HIV/AIDS, dirty water, poor sanitation and malaria, energy use for cooking, especially from the point of view of the poor, has received very woeful funding support and political backing. Yet considering the direct and indirect collateral environmental damages that traditional biomass energy consumption has caused and will continue to cause, the need for the urgent extension of funding assistance cannot be overemphasized and is strongly advocated.

In this regard, one of the pro-poor approaches is to encourage the development of ***energy micro financing***. Microfinance institutions provide for poor households and village communities to mobilize and access the capital needed to make small energy investments by the managers of cooking in the home; the women. Energy micro financing should be targeted particularly at the women folk because as IEA (2006; 443) has established, worldwide, four out of every five micro-borrowers are women. Because the amounts involved are usually small, no collaterals are needed and the repayment terms are often very liberal, micro financing is attractive even in the rural areas, where biomass energy consumption is highest. Governments at all levels, non-governmental organizations (NGOs), community based organizations (CBOs) and international donor agencies should be encouraged to partner with households and village communities to address the perennial cooking energy needs of the rural and urban poor.

Furthermore and in order to make poor households (especially in the rural areas) embrace the micro financing scheme, they must be made to realize that the improved biomass technology is a worthwhile investment. Why are rural households reluctant to invest in improving their cooking efficiency and decrease the burden of fuel wood collecting and the collateral burden on their health? One explanation is related to social differences in the perception of need for fuel wood. Wood fuel is not regarded as an economic resource, because it can be harvested 'free of charge' from public forests and common pool resources. Likewise, time spend by women is not regarded as an economic resource, since household tasks of women are traditionally regarded as 'free time', as it is the men who usually make most of the decisions in the home and they might rate women's labour low (Wiskerke, 2009). In other words, both wood fuel and the time spent to source for it, are not perceived as economic commodities.

Furthermore, it could be that women have become so accustomed to the activity that they now enjoy fuel wood gathering more than their other tasks, which can be quite enjoyable, as it is often done in groups. Consequently, they may not feel that the hours devoted to this should be shortened (Wiskerke, 2009). Additionally, many poor people have no cash for even relatively small investments and if they would have, they would not easily think of spending it on an imprved cooking stove, since they would not earn their investment back directly and since they

have not avoided any direct costs (Wiskerke, 2009). Finally, there is simply a lack of knowledge in rural areas of how to effectively improve rural household cooking efficiency (Kaale 2005).

These are some of the issues that the proposed education and sensitization programme should be designed to handle. When women become convinced and persuaded that fire wood and fire wood-sourcing time are indeed vital economic commodities, and that any savings made on them will contribute to their overall empowerment, especially, in terms of having more time to participate in income earning activities that can enable them make more meaningful contribution to the management of the home, they will be more willing to embrace the technology and all schemes design for its success. Furthermore, by embracing the improved technology, they shall be closing the gap between them and their male folks, thereby promoting gender equality and women empowerment (MDG 3). From the point of view of the children who are encumbered by biomass energy sourcing, investment in the improved biomass technology will translate into more time available for them to pursue the United Nation's goal of universal primary education (MDG 2) and reducing child mortality (MDG 4).

Sustaining Biomass Fuel Supply

Abundant evidence is now available, both in the Niger Delta Region and in all other areas where biomass (wood) fuel is the major source of household energy, that its demand far exceeds it supply. Evidence can also be adduced to the effect that the gains that are expected from the reduction in the amounts of wood fuel used and reduction in the amount of heat loss, through the adoption and use of more efficient, improved biomass cook stoves, on their own, will never be enough to eliminate the gap between supply and demand. This means that dependence of the poor on biomass energy cannot be sustained without a strong policy intervention. Deliberate efforts are, therefore, needed to accelerate the rate of replacement of consumed wood fuel. Consequently, a policy must be put in place to initiate and sustain the systematic cultivation of fast growing trees needed to facilitate the regeneration and restoration of forests. They are called ***energy crops*** (Bringezu, *et al,* 2007) and for the purpose the sustainability of biomass fuels, are usually grown in dedicated farms. They include trees and shrubs and could, with the appropriate expertise, be planted together with other crops, especially ***food crops,*** in what is called agro-forestry.

Perhaps the first direct benefit of such a policy, beyond afforestation, is that it would also provide additional income for the farmers involved in the scheme, thus contributing towards the eradication of extreme poverty (MDG 1). Furthermore, beyond replacing the biomass collected and used, such a policy will also bring collateral compensation in the forms of restoring soil fertility and eliminating soil erosion. Furthermore, the regenerated

forests will serve as sinks for carbon dioxide, maintaining diverse plants and animal life and also regulating the flow of water, thereby, reducing overall environmental degradation. In addition, with the guided choice of trees, the policy will provide a reservoir or stock of raw materials for other economic activities such as construction, furniture and paper making, among others.

Because of the long term impact of biomass harvesting on soil quality and food production, it would be necessary to identify soils that are not, or hardly, suitable for food crops and food production, for dedication to the growth of energy crops. By so doing, environmental sustainability would be assured, directly or indirectly (MDG 7); through soil conservation and or recovery. In addition, the programme is expected to stimulate rural development, improvement of agricultural efficiency and increase of the economic prosperity and the social well-being of the local households, thereby contributing to the eradication of extreme poverty and hunger (MDG 1). In order to achieve this, however, care must be taken to ensure that the production of biomass for energy purposes does not lead locally to, or aggravate, competition with the production of food, building materials, local herbal medicines and other wood-based products. This is because biomass production involves competition for the same production factors, such as raw materials, land, water and labour. This is why the production of energy crops on marginal soils (not or hardly suitable for food production) is perhaps to be preferred, even if it means that the energy return is lower.

However, if the energy crop programme of regenerating biomass fuel is to succeed and be responsive the objective of closing the gap between the supply of, and demand for, fuel wood, a ***sound needs-assessment research*** needs to be conducted to identify, among others, the most vulnerable and disadvantaged communities, and to determine the quantity of wood that needs to be supplied to meet their present and projected energy needs. This information requires that we know the quantity of fuel wood consumption per household and the projected population of various communities. Furthermore, seasonal variations in the yield and consumption patterns of biomass must be known. This will help plan for the management of surpluses in the bumper, dry season and deficits during the lean, raining season.

The sustainable supply of biomass energy can leverage on the tree planting programmes which have a common original objective, namely, to replace the wood we remove for food production, energy and other uses, thereby checking desertification and its degrading environmental effects (Sanni, 2009). The fact that multinationals like the British-American Tobacco Nigeria (BATN) have not only shown interest, but actually partnered with the government by committing huge resources, is an indication of the great prospects of integrating the tree-planting programme into the biomass sustainability campaign. It also means

that the programme offers opportunity for further development of global partnership for development (MDG 8). However, the full potentials of the tree planting programmes, in terms of their effectiveness and delivery, have not been fully realized because of the absence of the needed proper follow up, monitoring and evaluation. The biomass sustainability programme, therefore, provides an opportunity to realize these potentials. To produce the needed result, the evaluation process should, among others, review issues like the species of tress to be planted, from one ecosystem to the other; where they should be planted, in relation to patterns of biomass shortages; the energy content of the tree species; their maturity period; and feasibility of combining energy tree planting with agro-forestry. Because the tree planting programmes have become rather ritualistic, ceremonial and symbolic, pertinent questions have not been raised as to the guidelines for the choice of the locations where the trees are planted. Consequently, most trees are planted in the wrong places: government residential premises or offices. In the new approach, the energy trees must be planted in relation to the need assessment and the locations of biomass fuel shortages. Moreover, because of the political gains expected from them, the publicity of the present programme emphasizes on announcing an impressive number of trees to be planted. However, if the exercise is integrated into the biomass energy sustainability campaign, the emphasis will necessarily shift from the number of trees planted to the number of trees actually raised over a period of time. On the contrary, we have never heard announcements of how many of the trees intended to be planted were actually planted and how many of those actually planted over the years have matured. In the new approach, there must be periodic auditing and declaration of the survival status of the planted trees.

Capacity Building

Given the disproportionately large population that depends on biomass energy for cooking in the Niger Delta Region, a successful sensitization programme and wide-spread social acceptability is expected to produce a huge demand for the proposed alternative improved and more efficient form of converting biomass fuels into cooking energy. There would, therefore, be the need to build the capacity required to cope with and manage this expected huge response.

A responsive policy would, therefore, require governments at all levels to make, or improve, provision for the training of locals for the purpose of preparing the people to receive the new concept and the associated technology, as well as developing the needed skills and expertise. Capacity needs to be built at, at least three levels, namely: supply, infrastructure and consumption. At the ***supply level***, the overall objective is to build capacity for setting up a sustainable biomass resource base. Potential growers or farmers of energy crops need to be trained on the setting up and management of biomass wood plantations, especially, if this has to be

combined in some way with the production of food, without jeopardized either of them.

At the ***infrastructure level***, capacity needs to be built to fabricate the biomass energy facilities. People would also be needed to be trained on how to set up cottage industries to mass produce the improved biomass energy stoves. They also need to be trained on how to commercialize (advertize and sell) them. The major beneficiary is expected to be the very accessible, receptive and robust informal sector.

Figure 13: A woman entrepreneur with a collection of finished improved biomass cooking stoves
Source: Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007; 11),

At the ***consumption level***, the capacity of the end user of the improved biomass technology (especially the women and children who do most of the cooking) also needs to be enhanced. The objective here is to ensure a more efficient use of available wood fuel energy. For instance, letting biomass energy users know that drying fuel wood thoroughly before feeding it into the fuel magazine of the stove can reduce smoke levels, is an aspect of capacity building. Similarly, letting people know that placing the lid on the pot during cooking can reduce cooking time, thereby reducing the amount of energy needed to cook a particular food, as well as the amount of smoke that would be released during cooking, are aspects of capacity building. Furthermore, letting people know that increasing the number of window openings in the kitchen, or providing gaps between the roof and wall, as well as moving the cooking stove, if it is the mobile type, away from the living area of the house, preferably towards the window, can enhance environmental quality and reduce the health risks associated with cooking, are all aspects of capacity building.

Tooling for the Policy

Lack of information and data is the bane of most policies. The quality of a policy is as good as the integrity of the data on which it is based. Without data that reflect the realities of a policy domain, the resultant policy cannot respond to the challenges that need to be addressed. No effort should, therefore, be spared to build a robust information and data base for the biomass energy policy of the Niger Delta Region.

In this regard, it must be appreciated that the challenges facing poor

households in terms of meeting their cooking energy consumption vary from state to state and even from community to community within the states in the Niger Delta Region. There is need, therefore, for policies to be locally customized to reflect such uniqueness, differences and peculiarities. One of the major challenges in this task is the lack of quality data in terms of geographic (spatial) comprehensiveness and temporal currency. The information that exist are at best of doubtful integrity because they are discontinuous in time and or space. Their utility in terms of spatial and temporal comparison and analyses is very limited. A responsive biomass energy policy for the Niger Delta Region will require as the irreducible minimum, information on the following:

- ♣ population to be served,
- ♣ rural and urban distributions of the population,
- ♣ projected population and its distribution for the given plan periods of say ten (10) years,
- ♣ household sizes,
- ♣ common local meals,
- ♣ cooking frequencies of certain meals,
- ♣ time needed to cook different meals,
- ♣ household incomes,
- ♣ sources of the potential fuels locally available,
- ♣ amount of time needed to source biomass for daily/weekly/monthly cooking,
- ♣ cost of biomass fuels needed for daily/weekly/monthly cooking,
- ♣ amount of biomass energy needed for cooking per day,
- ♣ proportion of household incomes spent on wood fuels,
- ♣ proportion of household depending on natural resources to supplement incomes,
- ♣ common diseases,
- ♣ health statistics,
- ♣ hospital records of certain diseases,
- ♣ death rates of women and children,
- ♣ dropout rates of children of school age,
- ♣ man-hours devoted to collecting biomass fuels,
- ♣ baseline vegetation and soil conditions of sources of local biomass fuels,
- ♣ types of stoves and other cooking devices,
- ♣ available infrastructure and prospective producers,
- ♣ cost-benefit and market analyses,
- ♣ estimates of the ability and willingness to pay for improved facilities as a function of incomes, among others.

These information could be distilled into community-based feasibility studies. In order to make such data relevant for environmental planning, they must reflect local differences. They, therefore, must be geo-referenced and converted to geographic information systems (GIS) formats. This will ensure their comprehensiveness and ease of retrieval. In order to guarantee the integrity of the data on biomass energy, non-governmental organizations (NGOs) may be commissioned to do sector surveys, guided by, but not limited to, the suggested items.

Implementation

In spite of the manifest importance of biomass energy in Nigeria, in general, the Niger Delta Region, in particular, and indeed the entire developing world, biomass energy policy planning neither exists and nor is it taken seriously. Where there appears an action plan, it is often undertaken in an *ad-hoc* manner. This is partly due to the absence of a recognized structure charged with the specific responsibility for biomass energy and related matters (Karekezi, Lata, Coelho, 2004). Consequently, we find elements and issues 0f biomass energy scattered in a wide range of institutions, usually without an explicit specific mention and linkage. These range from the Ministries of Power and Energy; Environment; Agriculture; Science and Technology; to a myriad of national and sub-national agencies responsible for land tenure policy and rural development.

Therefore, whatever tangential efforts may have been made are at best disjointed and uncoordinated. A manifestation of its insignificance in policy planning is further reflected in the fact that there are no explicit budgetary allocations to biomass energy, in spite the huge and overwhelming dependence on biomass by the majority of the population. It is rather interesting, if not intriguing, that while the National Assembly is considering a National Tobacco Bill to ban smoking because of the effects of second hand smoke on non-smokers, no thought has been given to the control of biomass energy smoke that does far more damage to far more people. This is to say that although it is expedient and indeed belated, designing and establishing an appropriate and effective institutional and associated legal and regulatory framework for biomass energy is a key challenge that decision makers and analysts must consider.

Against this background, and for the purpose of accountability, and considering its national and even global importance, it is proposed that an autonomous unit, to be called the ***Biomass Energy Improvement Unit (BEIU),*** should be set up within the Ministry of Niger Delta Affairs, to coordinate and manage the proposed improved biomass energy project. It should be structured into the following sections, to be driven by relevant experts with core competences in:

- Administration,
- Finance,
- Information Management,
- Fabrication and Quality Control,
- Marketing,
- Research and Training.

Because of its national and strategic significance, staff of the Unit could be seconded from the Ministries of Environment; Science and Technology; Education; Power and Energy; Agriculture; Commerce and Industry; specialized institutions in forestry, tree crops, and technocrats from the private sector. The Unit should be funded under a special dedicated vote in the Ministry. It should be headed by an officer of the rank of a Director. It should have offices in all states in the

Niger Delta Region to be able to effectively coordinate and monitor its projects and activities. It will start as a ***pilot project***. However, considering that biomass fuel shortages are not limited to the Niger Delta Region, it is proposed that when its anticipated success has been confirmed, it should be upgraded to a ***National Biomass Energy Improvement Agency (NBEIA)***, directly under the Presidency, and given the status and prominence commensurate to that of National Orientation and Trafficking in Persons.

13. CONCLUDING REMARKS

In this Report, we have established that since the late 1960s, African leaders have recognized the importance of the environment and its resources to the development of their economies. Consequently, they have signed and adopted a number of conventions to protect and conserve their environments. We have also established that at the level of individual nations, myriads of environmental instruments have also been adopted to protect the environment so that it can stimulate, enhance and continue to sustain socio-economic development. However, in spite of these continental and national instruments, environmental challenges have not only persisted, they have even deteriorated in certain cases.

Although the direction and strength of the factors operating within the nexus do not appear to be very clear, the fact that there are very strong linkages between economic status and environmental quality is no longer in doubt. Within the nexus, the strong linkages between poverty and the environment have also been well established. At a lower level of resolution, the strong linkages between cooking energy consumption and the environment are also no longer controvertible. The very core significance of cooking energy to the prosecution of the United Nations Millennium Project has been demonstrated by the close linkages between the former and each of the goals set by the latter. However, the presumed and expected shift from traditional to modern energy sources has been recognized as a major omission in the Millennium Project. As a result of widespread and persistent poverty, it has been projected that household cooking energy preferences will almost certainly experience inertia in the next several years. This scenario has been confirmed by several studies of the Niger Delta Region.

In other words, poor households are expected to continue to depend on biomass sources for their cooking energy, since per capita incomes in Nigeria, in general, and the Niger Delta Region, in particular, are not expected to witness a quantum leap in the near future. It would be unrealistic, therefore, to expect or recommend a revolutionary switch from traditional forms of energy consumption to the cleanest but most expensive forms of energy. While we prepare to embrace new technologies in cooking energy, even marginally improved, acceptable and affordable facilities will suffice for now.

However, any recommended short-term or intermediate technology (product) must be such that is capable of reasonably addressing most of the perceived challenges of the traditional forms and methods. Consequently, it should be able to appreciably reduce the quantity of wood fuel used through, a more efficient conversion process; reduce indoor pollution considerably, as a result of a more complete combustion process; improve the design and ventilation of kitchens so as to dissipate and neutralize smoke and fumes; reduce health risks associated with indoor pollution; reduce time-loss by women and children as a result of a reduction of the quality of wood fuel needed; reduce heat loss; reduce suspended particulate matter, and the emission of carbon monoxide, and other green house gases into the atmosphere; create employment opportunities; result in economic empowerment; reduce land degradation by leaving dung and farm residue on the field, and above all make optimal contribution to the achievement of the United Nations Millennial Development Goals (MDGs).

In the Niger Delta Region of Nigeria, as in most developing countries, it has become clear that only an intermediate technology would be appropriate, realistic and affordable in the present circumstance: the technology of improved and more efficient wood fuel cook stove. The technology has proven to be a robust and immense stop-gap in many African countries with similar socio-economic characteristics as the Niger Delta Region. One of the prototype products of the technology is the Rocket Stove; and its operational principles are recommended for adoption, initially in the Niger Delta Region, but later, nationally.

The product combines all the attributes required in the conversion of biomass energy to make them more environmentally friendly, by producing and retaining more heat from a given quantity of biomass. It has been widely accepted and adopted for use in many developing nations, including some East and Southern African countries, and the results have been very impressive. For instance, within two years of its introduction and adoption, the rocket stove has reached over 200,000 households, generated over 290 jobs, which in turn, generated incomes of about 261,000 Euros per annum, in Uganda. Furthermore, with the use of improved stove over 200,000 tons of wood are saved every year, which is the equivalent of spending almost eight million Euros in afforestation (GTZ, 2007). It, therefore, holds great prospects, especially a country like Nigeria that is under the pressure of a large and fast growing population. The Niger Delta Region, whose naturally fragile and vulnerable environment is put under pressure of increasing population and intensive industrial activities in the oil and gas sectors, is a good place to consider the adoption of the improved technology and more efficient cooking stoves.

However, in order to popularize it, an aggressive environmental education is needed. Local capacity also must be

built to both produce and commercialize it. Furthermore, in order to sustain the supply of biomass energy, without further threat and damage to the environment, it is proposed that a programme of cropping fast growing energy trees be instituted immediately, leveraging on the existing tree-planting programmes. It is also proposed that a strong energy micro financing structure must be established to support the scheme and assist those who may have initial difficulty in embracing the new, improved biomass cooking energy technology. Finally, for the purpose of accountability and focused responsibility, it is proposed that a special biomass improvement unit be set up in the Ministry of Niger Delta Affairs, charged with the implementation of the proposals in the Report. Since biomass energy shortage is not peculiar to the Niger Delta Region, it is hoped that the anticipated success of the proposed pilot biomass improvement unit can be replicated at the national level with the eventual creation of a National Biomass Improvement Agency in the Presidency.

REFERENCES

Aboluwade, A. (2011), "Kerosene Scarcity: The Pains and Dashed Hope", *SUNDAY PUNCH*, June 5, p. 69.

Achi, C.N. (2006), "Forestry and Sustainable Rural Development in Delta State, in Wall, S. (ed.) *Small Scale Forestry and Rural Development: The Intersection of Ecosystem, Economics and Society,* Galway-Mayo: Ireland, pp. 24-31.

Adeoti, O., Idowu, D. O. O. and Falegan, T. (2003), "Could Fuel Wood Contribute to Household Poverty in Nigeria?" *Biomass and Energy,* Vol. 21, pp. 205-210.

Aggrey, N., Wambugu, S., Karugia, J and Wanga, E. (2010), "An Investigation of the Poverty-Environment Degradation Nexus: A Case Study of Katonga Basin in Uganda" *Research Journal of Environmental and Earth Sciences*, Vol. 2, No. 3, pp. 82-88.

Aina, T.A and Salau, A.T. (eds.) (1992), The Challenge of Sustainable Development in Nigeria, Ibadan: Nigerian Environment Study/Action Team (NEST).

Amechi, E. P. (2009), "Poverty, Socio-Political Factors and Degradation of the Environment in sub-Saharan Africa: The Need for a Holistic Approach to the Protection of the Environment and Realization of the Right to Environment", *Law, Environment and Development (LEAD) Journal*, Vol. 5, No. 2, pp. 109-129.

Amokaye, O. G. (2004), *Environmental Law and Practice in Nigeria*, Lagos; University of Lagos Press.

Anderson, D. (1987), *The Economics of Afforestation: A Case Study in Africa*. The Johns Hopkins University Press; Baltimore Maryland, USA.

Aprovecho Institute (1984), *Fuel-Saving Cook Stoves*, A German Appropriate Technology Exchange (GATE) Publication, 129 pp.

Aprovecho Research Centre (ARC) (2006), *Rocket Stoves for Sustainable Cooking*, South Africa: Ashden Awards.

Aprovecho Research Centre (ARC) (2009), *Applying Appropriate Technology to Improve Lives and the Environment*, South Africa: Ashden Awards.

Aprovecho Research Centre (ARC) (2009), *Applying Appropriate Technology to Improve Lives and the Environment.* www.aprovecho.org/,

Arnold, M. Kohlin, G. Persson, R. and Shepherd, G. (2003), "Fuel Wood Revisited: What has Changes in the last Decade" Centre for International Forest Research (CIFR), *Occasional Paper, No 39*.

Babanyara, Y.Y. and Saleh, U.F. (2010), "Urbanization and the Choice of Fuel Wood as a So*urce of Energy in Nigeria", Journal of Human Ecology, Vol. 31, No. 1, pp. 19-26.*

Baland, J.M., Bardhan, P., Dass, S., Mookerjee, D. and Rinki, S. (2004), "The Environmental Impact of Poverty: Evidence from Firewood Collection in Rural Nepal", *Paper Presented at the Tenth Biennial Conference of the International Association for the Study of Common Property (IASCP),* Oaxaca Mexico, 9–13 August, 2004.

Borchers, M. and Annecke, W. (ND), "Poverty-environment-energy linkages in Rwanda", *Policy Brief*, Prepared for UNEP by Sustainable Energy Africa.

Bringezu, S., Ramesohl, S., Arnold, K., Fischedick. M., von Giebler, J., Liedtke, C. and Schutz, H. (2007), "What we Know and What we should know: Towards a Sustainable Biomass Energy", *A Discussion Paper of the Wuppertal Institute: Wuppertal Papers No. 163*, June.

Bucknall, J., Kraus, C. and Pillai, P. (2000), *Poverty and the Environm*ent, The World Bank, (April).

Cavendish, W. (1999): Empirical Regularities in the Poverty-Environment of African Rural Households. World Bank Policy Research Working Paper, WPS 1299.

Chavin, H. (1981), *Une Ville Africaine en Crise d'Energie: Ouagadougou*, Edition Unasylva.

Chinweze, C. and Abiola-Oloke G. (2009),"Women Issues, Poverty and Social Challenge of Climate Change in the Nigerian Niger Delta Context", *A Paper Presented at IHDP Open Meeting*, 2009, At the 7th International Conference on the Human Dimension of Global Environmental Change, 26-30, April, 2009, UN Campus, Bonn, Germany.

Chisholm, M. (1968), *Rural Settlement and Land Use*, London: Hutchinson University Press.

Choji, I.D. (2005), "The Impact of Government Policies on Fuel Prices on the Environment", *International Journal of Business and Common Markets Studies*, Vol. 3, No. 2, pp. 94-100.

Chokor B. A. (2004) "Perception and response to the challenge of poverty and environment the Niger Delta", *Journal of Environmental Psychology,* (Article in press).

Chukwu, G. U. (2008), "Poverty-Driven Causes and Effects of Environmental Degradation in Nigeria", *The Pacific Journal of Science and Technology*, Vol. 9, No. 2, pp. 599-602.

Clime_Cole, R.A, Falola, J.A., Manin, H.A.C, Mortimore, M.J, Nichol, J.E. and O'Reilly, F.D (1988), "Wood Fuel in Kano, Nigeria: The Urban-Rural Conflict", *Social Forestry Network*, Paper 7b.

Comim, F. (2008), *Poverty and Environment Indicators*, UNDP/UNEP: Capability and Sustainability Centre.

Costanza, R. (1991), "The Ecological Economies of Sustainability" in Goodland, et al, (eds.), *Environmentally Sustainable Economic Development: Building on Bruntland,* UNESCO, 93-98.

Department for International Development (DFID), (2000), *Achieving Sustainability: Poverty Elimination and the Environment: Strategies for Achieving the International Development Targets*, DFID Plans.

Department for International Development (DFID), "The Links Between Poverty and Environmental Degradation: Myth 9", *The 21st Century Urban Scenario*, (Retrieved March 11, 2011).

Detwyler, T.R. and M.G. Marcus, (1972), Urbanization and Environment in Perspective" in T.R. Detwyler and M.G. Marcus (eds.), *Urbanization and Environment*, Bermont, California: Duxbury Press, pp. 3-26.

dictionary.reference.com/browse/clean + energy.

Donnison, D. (1982), *Poverty and the State: An Historical Sociology*, London: The Open University Press.

Dowler, E. and Leather, S. (2000), "Spare some change for a bite; From Primary Poverty to Social Exclusion: The Role of Nutrition and Food" in Bradshaw J. and Sainsbury, R. (eds.), *Experiencing Poverty 2000,* Canada: Ashgate Aldershot, pp. 200-218.

Dowler, E., Rex, D., Blair, A., Dunkin, A., Grundy, C. (2001), *Measuring Accessibility of Healthy Food in Sandwell*, Sandwell: Sandwell Health Authority.

Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (1979), *Helping People in Poor Countries Develop Fuel-Saving Cook Stoves*, Germany: A German Appropriate Technology Exchange (GATE) Publication, 148 pp.

Duetsche Gesellschaft fur Technische Zusammenarbeit (GTZ), (2007), *Cooking Energy: Why it really Matters if we are to Halve Poverty by 2015*, 23 pp.

Duraiappah, A. (1996), *Poverty and Environmental Degradation: A Literature Review and Analysis*, London: International Institute for Environment and Development.

Duraiappah, A.K. (1998), "Poverty and Environmental Degradation: A Review and Analysis of the Nexus". *World Development*, Vol. 26, No. 12, pp. 2169– 2179.

Eckholm, E. (1975), *The Other Energy Crisis: Firewood.* Worldwatch Paper 1. Washington, DC, Worldwatch Institute**:** 22.

en.wikipedia.org/wiki/Rockect_stove.

Ezzati, M. and Kammen, D. (2001), "Indoor Air Pollution from Biomass Combustion as a Risk Factor for Acute Respiratory Infections in Kenya: An Exposure-Response Study", *Lancet,* Vol. 358(9281), pp. 619-624.

Fawehinmi, A. S. and Oyerinde, O. O. (2002), "Household Energy in Nigeria: The Challenge of Pricing and Poverty in Fuel Switching", *Journal of Energy and Development*, Vol. 27, No. 2, pp. 277-284.

Federal Republic of Nigeria (1990), Federal *Environmental Protection Agency (FEPA) Act, Cap 131, FLN, s.38.*

Federal Republic of Nigeria (2004), *Niger Delta Regional Development Master Plan,* Nigeria: NDDC.

Federal Republic of Nigeria (2004/2007), *Federal Environmental Protection Agency (FEPA) Act, Cap F10, FLN, 2004*, now superseded by *National Environmental Standard and Regulations Enforcement Agency (Establishment) Act, No. 25 of 2007.*

File///C:Users/Owners/Desktop/clean_energy_definition.html.

Food and Agricultural Organization (FOA), (2002), *Forestry Outlook Study for Africa: West Africa Sub-Regional Report.* Rome: Food and Agriculture Organization of the United Nations.

Food and Agricultural Organization (FAO), (2003), "Forestry Outlook Study for Africa: Regional Report-Opportunities and Challenges Towards 2020 Food and Agricultural Organization of the United Nations", *Forestry Paper 141*.

Food and Agricultural Organization (FAO), (2003), Forestry Outlook Study for Africa; *Sub-Regional Report East Africa,* Food and Agriculture Organization of the United Nations, ftp://ftp.fao.org/docrep/fao/005/y8693e/y8693e00.pdf,

Food and Agricultural Organization (FAO), (2004), *Carbon Sequestration in dry Land Soils*, Food and Agriculture Organization of the United Nations, ftp://ftp.fao.org/agl/agll/docs/wsrr102.pdf.

Global Vision (2001). Sustainable City, http://www.global-vision.org/city/footprint.html,

Gordon, D., Levitas, R., Pantazis, C., Patsios, D., Payne, S., Townsend, P., Adelman, L., Ashworth, K., Middleton, S., Bradshaw, J., and Williams, J. (2000) *Poverty and Social Exclusion in Britain.* (York: Joseph Rowntree Foundation) Halleröd, Björn,

Gundimeda, H. and Kohlin, G. (2003), *Fuel Demand Elasticities for Energy and Environmental Studies: Indian Sample Survey Evidence*. Environmental Economics Unit,

Department of Economics, Goteborg University, Sweden.
Haluzan, N. (2010), *Clean Energy Definition*, www.wisegeek.com/what-is-clean-energy.htm.
Higgins, K. (2009), *Regional Inequality and the Niger Delta, Policy Brief No 5*. Prepared for the World Development Report.
Holden, S., Bekele, S. and Pender, J. (2004), "Non-farm Income, Household Welfare and Sustainable Land Management in less-favoured Areas in Ethiopia", *Food Policy*, Vol. 29, No. 4, pp. 369-392.
Hradsky, J.A. 1981. *Fuel wood: A Regional Appraisal of West African Needs in Energy, Ecology, and Forest Cover.* Bangkok, USAID.
http://www.ashdenawards.org/winners/trees, *just stove wins award.*
http://www.opeworg/chemica-weapon-convention/related-international agreements/toxic-chemica-weapons-and-the-environment/marine-and-coastal-environment-west-and-centra-africa/,
http://www.stovesource.com/mambo/index.php?option=comcontent&task=category&sectionid=5&id=20&Itemid=51.
Ikurekong E.E., Esin J.O. and Mba,A.C., (2009) "Rural Fuel wood Exploitation in Mbo Local Government Area: A Nigerian Coastal Settlement", *Ethiopian Journal of Environmental Studies and Management*, Vol.2 No.3, pp. 44-56.
Inoni, O. E. (2009), "Effects of Forest Resources Exploitation on the Economic Well-being of Rural Households in Delta State, Nigeria*", Agricultura Tropica et Subtropica* Vol. 42, No. 1, pp. 20-27.
International Energy Agency (IEA), (1998), World Energy Outlook 1998, IEA Paris.
International Energy Agency (IEA), (2002a), *Energy and Poverty*. in: World Energy Outlook 2002, pp. 365–406.
International Energy Agency (IEA), (2002b), *World Energy Outlook 2002*. Chapter 10, Energy and Development. Organisation for Economic Co-operation and Development (OECD)/IEA: Paris, France.
International Energy Agency (IEA), (2003), *World Energy Outlook 2003,* IEA Paris.
International Energy Agency (IEA) (2006), "Energy for Cooking in Developing Countries", in OECD/IEA (2006), *World Energy Outlook 2006: Focus on Key Topics*, (Chapter 15), pp. 419-445.
International Energy Forum (IEF), (2009), "Reducing Energy Poverty through Cooperation and Partnership", *Background Paper for IEF Symposium on Energy Poverty,* Symposium on Energy Poverty, 8-9 December 2009 8-9, Johannesburg, South Africa.
IUCN/UNEP/WWF, (1991), *Caring for the Earth: A Strategy for Sustainable Living,* Gland: Switzerland.

Johda, N.S. (1995): Common Property Resources and the Dynamics of Rural Poverty in India's dry Regions. *Unasylva,* 180, 46(1): 23–29.

Johnson, S. P. (ed.) (1993), *The Earth Summit: The United Nations Conference on Environment and Development, (UNCED)*. London: Graham and Trotman.

Joseph, K. and Sumption, S. (1979), *Equity,* London: J. Murray Publications.

Kaale, B. K., (2005) "Baseline study on biomass energy conservation in Tanzania", *SADC Programme for Biomass Energy Conservation (ProBEC),* Ministry of Energy and Minerals, Tanzania, www.ecoventures.org/files/Briquetting%20docs/tanbaselinestudy.pdf,

Karekezi, S., Lata, K. and Coelho, S.T., (2004), "Traditional biomass Energy: Improving its use and Moving to Modern Energy Use" *A Thematic Background Paper,* International Conference for Renewable Energies, Bonn, January.

Kammen, D. (2005), "Africa: Cleaner Cooking Fuels cut Gree House Gas, Saves Lives", *Environmental News Service*, www.ens-newswire.com/ens/apr2005-04-06-04.html (Retrieved May 10, 2011).

Kerapeletswe, C.K. and Lovett, J.C. (2001), "The Role of Common Pool Resources in Economic Welfare of Rural Households", *Environment Department Working Paper 2001–2004*, University of York.

Kozulj, R. (2010), "Contribution of Energy Services o the Millennium Development Goals and to Poverty Alleviation in Latin America and the Caribbean", *Paper Prepared for the Economic Commission for Latin America and the Caribbean (ECLAC),* Under the auspices of the UN, ECLAC Project Document Collection.

Kramer, J. *The Solar Cooking Archive*, http://solarcooking.org/Crisis.htm (Retrieved March 12, 2011).

Lopez, R.E. (1998), Where Development Can and Cannot Go: The Role of Poverty-Environment Linkages, in Pleskovic B. and Stiglitz, J.E. (eds.), *Proceedings of the Annual World Bank Conference on Development Economics*, 1997. The World Bank, Washington, D.C.

Lowe, M. S. and Bowlby, S. R. (1992), "Population and Environment" in Mannion, A. M. and Bowlby, S. R. (eds.) *Environmental Issues in the 1990s*. New York: John Wiley and Sons.

Mabogunje, A.L. (1988), "The Debt to Posterity: Reflections on a National Policy on Environmental Management" in Sada, P.O. and Odemerho, F.O. (eds.) *Environmental Issues and Management in Nigeria*, Ibadan: Evans Brothers.

Mack, J. and Lansley, S. (1985), *Poor Britain.* (London: George Allen and Unwin).

Mack, J. and Lansley, S. (1992), *Breadline Britain* (London: London Weekend Television).

Malthus, T. R. (1798), *An Essay on the Principle of Population*, Penguin Classics (Reprinted 1985).

Mbwambo, L. (2004). "Status of Arid and Semi-arid Lands of Tanzania". *Paper Presented at the Dry Lands Agro-Forestry Workshop*. ICRAF Headquarters, Nairobi, Kenya, Tanzania Forestry Research Institute (TAFORI). www.worldagroforestry.org/eca/downloads/ASAL_ASAL%20Country%20Strategy-%20Tanzania.doc,

Modi, V., McDade, S., Lallement, D. and Saghir (2005), "Energy Services for the Millennium Development Goals", New York: UNDP: *Achieving the Millennium Development Goals.*

Molb, M., Johl, A., Wagner, J. M., Popovic, N., Lador, Y., Hoenniger, J., Seybert, E. and Walters, M. (eds.) (2005), *Earth Justice, Environmental Rights Reports: Human Rights and the Environment.* Oakland: Earth Justice (Because the Earth needs a Good Lawyer), (Appendix), pp. 86-108.

Momah, S. and Soaga, J. (1999), *"Biomass Energy Consumption in Nigeria: Integrating Demand and Supply", Nigerian Journal of Renewable Energy,* Vol. 71, pp. 78-83.

Morvaridi, B, (1996), "Sustainable Development: The Environment and Development Debate", in Egbon, P.C. and B. Morvaridi (eds.), *Environmental Planning Policy,* Ibadan: NCEMA, pp. 5-28.

Moss, l. and Morgan, W. (1981), *Fuel wood and rural energy production and supply in the humid tropics,* UN University. Tycool International Pblication, LTD, Dublin Ireland.

Mosunmolu Limited (1998*), Flooding Study of the Niger Delta*.

Nancy, C. (1994), "Fuel Wood Issues Revisited", *Boiling Point*, Vol. 32, pp. 44-50.

Niger Delta Environmental Survey (NDES), (1997).. *Environmental and Socio-economic Characteristics.* Phase 1 Report. Vol. 1.

Niringiye A., Wambugu, S., Karugia, J. Wanga, E. (2010), "An Investigation of the Poverty-Environmental Degradation Nexus: A Case Study of Katonga Basin in Uganda", *Research Journal of Environmental and Earth Sciences* Vol. 2, No. 2, pp. 82-88.

Nolan, B. and Whelan, C. T. (1996*), Resources Deprivation and Poverty, Oxford*: The Clarendon Press.

Oguntala A . B. (1986), "The challenge of deforestation in Nigeria*", Paper Presented at the Annual Conference of the Forest Association of Nigeria,* Held at the Federel University of Technology, Minna. Nigeria.

Oladipo, E.O. (2001), "Key Elements of Environmental Impact Assessment in Nigeria", in Abumere, S.I and A Soyinbo, (eds), *Development Policy and Analysis,* Ibadan, Development Policy Center, pp. 339-369.

Olusegun, K.A. (2009), "Threats to Nigerian Environment: A Call for Positive Action", *A Paper Presented*

at the Chief S.L. Edu Memorial Lecture, Held at the Ondo Town Hall, (August 13).

Omole, K. F. (2010), "An Assessment of Housing Condition and Socio-Economic Life Styles of Slum Dwellers in Akure, Nigeria" *Contemporary Management Research,* Vol. 6, No. 4, pp. 273-290.

Omuta, G.E.D. (1988), "The Quality of Urban Life and the Perception of Livability: A Case Study of Neighbourhoods in Benin City, Nigeria", *Social Indicators Research*, 20, pp. 417-440.

Omuta, G.E.D. (2004), *The Good, the Bad and the Ugly: Man-Nature Interfaces*, The Seventy-fourth Inaugural Lecture, University of Benin, Benin City.

Omuta, G.E.D. (2011), "Poverty in Plenty: The Paradox of Governance Failure in the Niger Delta Region", *Proceedings of the Workshop on Confronting the Challenge of Development, Environmental Management and Peace Building in the Niger Delta: Beyond the Amnesty,* Organized by the Centre for Population and Environmental Development (CPED) and the International Development and Research Centre (IDRC), Benin City, Nigeria, (July 28 and 29), pp. 219-238.

Onakuse, S. and Lenihan, E. (2003), "Livelihood Systems and Rural Linkages in Niger Delta Region of Nigeria", www.nuigalway.ie/.../44_stephen_onakuse_and_eamon+lenihan;pdf .

Oni, A. O. and Durodola, O. D., (2010), "Disputes Resolution Amongst Residents of Tenement Properties in Lagos, Nigeria", *Global Journal. of Engineering. & Technology*. Vol. 3, No. 4, pp. 661-670,

Onuche, U. (2010), "Impact of Poverty on the sustainability of Forests in Nigeria: Implications for Sustainable Forests and Reduction of Global Warming", *Journal of Sustainable Development in Africa*, Vol. 12. No. 6, pp. 208-215.

Organisation for Economic Co-operation and Development (OECD), (2001), "Poverty-Environment-Gender Linkages" *Pre-print of the DAC Journal,* Volume 2, No. 4.

Organization of African Unity (OAU), (1968), *African Convention on the Conservation of Natural and National Resources*, Algiers: September 15, (Doc. No. CAB/LEG 24.1).

Osei-Hwedie, K. (1995), "Poverty and Environment: Dimensions of Sustainable Development Policy", *PULA: Botswana Journal of African Studies*, Vol. 9, No. 2, pp. 1-10.

Ostrom, E., Burger, J., Field, C. B., Norgerd, R. B. and Policansky, D. (1999), "Sustainability: Revisiting the Commons; Local Lessons, Global Challenges", *Science*, Vol. 284, pp. 278-282.

Osuntogun, A. (2002), "Applied Poverty-environment Indicators: the case of Nigeria", *Report submitted to the Environment Department*, World Bank, Washington, DC.

Ouedraogo, B. (2005), "Household Energy Preferences for Cooking in Urban Ouagadougou, Burkina Faso", Elsevier: *Article in Press in Energy Policy.*

Pernnushi, G., Rubio, G. and Subbarao, K. (2001), "Monitoring and Evaluation," Draft for Comments, in Chapter 1, *Poverty Reduction Strategy Papers Source Book.* <www. worldbank.org/Poverty/Strategies />. Washington, DC: World Bank.

Practical Action (practical action.org/…/energy_poverty_hidden_crisis.pdf).

PUNCH (Nig) Ltd (2011), *The PUNCH*, Friday, January 28, 2011, p. 13.

PUNCH (Nig) Ltd (2011), *The PUNCH,* Friday, February, 11, 2011, p. 13.

PUNCH (Nig) Ltd (2011), *SUNDAY PUNCH*, Sunday, September 18, 2011, p. 64.

Putnam, R. D., Leonardi, R. and Nanetti, R. Y. (1993), *Making Democracy Work: Civic Traditions in Modern Italy*, Princeton: Princeton University Press.

Rau, J. G. (1980), "Concepts of Environmental Impact Analysis" in Rau, J. G. and Wooten, D. C. (eds.) (1980), *Environmental Impact Assessment Handbook*, New York: Mc-Graw Hill Publishers, pp. 1-59.

Rau, J. G. and Wooten, D. C. (eds.) (1980), *Environmental Impact Assessment Handbook*, New York: McGraw Hill Publishers.

Ravallion, M. (1996), "Issues in Measuring and Modeling Poverty", *The Economic Journal*, Vol. 106 (September), pp. 1328-1343.

Rees, W. (1996). Revisiting Carrying Capacity: Area-Based Indicators of Sustainability. *Population and Environment: a Journal of Interdisciplinary Studies, Vol.* 17, No. 2. January.

Republic of Kenya (1999), *Environmental Management and Coordination Act (EMCA), No. 8*

Republic of South Africa (1998*), National Environmental Management Act (NEMA), No. 107.*

Ringen, S. (1987), *The Possibility of Politics*, Oxford: The Clarendon Press.

Roper J., and Roberts, R.W. (1999), *Deforestation: Tropical Forests in Decline. Forestry Issues No.1999–2001*, CIDA Forestry Advisers Network (CFAN). Canadian International Development Agency, Canada.

Sada, P.O. (1988), "Development and the Environment: A Conceptual Framework for Environmental Management" in Sada, P.O. and Odemerho, F.O. (eds.), *Environmental Issues and Management in Nigerian Development,* Ibadan: Evans Brothers, pp. 27-37.

Sambo, A.S. (2005), "Renewable Energy for Rural Development: The Nigerian Perspective", *ISESCO: Science and Technology Vision*, Vol. 1, pp.12-22.

Sanni, T., (2009) "Aggressive Tree Planting Will Check Desertification", *THIS DAY*, July 29.

Schubert, R., Blasch, J. and Hoffmann, K. (2007), *Environmental Protection, Energy Policy and Poverty Reduction:*

Synergies of an Integrated Approach, Zurich: Swiss Federal Institute of Technology. Institute for Environmental Decision (IED) Working Paper 1, (April).

Scott, L. (2006), *Chronic Poverty and the Environment: A Vulnerability Perspective.* London: Overseas Development Institute (ODI), (August).

Segnestam, L. (1999), "Environmental Performance Indicators", *Environmental Economic Series Paper No.71*, 2nd Edition, World Bank, Washington, D.C., 50 pp.

Sen, A. K. (1981), *Poverty and Famines: An Essay on Entitlement and Deprivation*. New Delhi: Oxford University Press.

Shiferaw, B. (2005), "Poverty and Natural Resources in Semi Arid Tropics: Revisiting Challenges and Conceptual Issues", *SAT e.Journal: An Open Access Journal by ICRISAT,* Vol. 2, No. 1, pp. 1-21.

Shyamsundar, P. (2001), *Poverty-Economic Indicator,* Environment Department, World Bank, Washington, D.C.

Smith, K.R. (2006). *Update on the health and climate impacts of household solid fuels,* Practical Action, Boiling Point No 52.

Smith, S. D., Huxman, T. E., Ziter, S. F., Charlet, T. N., Housman, D. C., Coleman, J. S., Fenstermaker, L. K., Seemann, J. R. and Nouak, R. S. (2000), "Elevated CO2 increases Productivity and Invasive Species Success in an Arid Ecosystem", *Nature*, Vol. 408 pp. 79-83.

Somaratne, W. G. (2005), "Globalization, Poverty Alleviation and the Environmental Governance: The Strategic Policy and Operational Options for South Asia", *SAARC Journal of Human Resource Development,* pp. 55-71.

Sow, H. (1990), *Les bois-Energie au Sahel*, Paris: ACCT-ATC-KARTHALA.

The Concise Oxford Dictionary (1995).

Tolba, M. K. El-Kholy, O. A., Holdgate, M. W. MacMicheal, D. F. and Munn, R. E. (1992), *The World Environment: 1972-1992; Two Decades of Challenge*, London: Chapman and Hall.

Townsend, P. (1979) *Poverty in the UK: A Survey of Household Resources and Standards of Living*. Berkeley and Los Angeles: University of California Press.

Townsend, P. (1993), *International Analysis of Poverty,* London and New York: Harvester Wheatsheaf.

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

United Nations Development Programme (UNDP) (2010), *Contribution of Energy Services to the Millennium Development Goals and to Poverty Alleviation in Latin America and the Caribbean,* ECLAC Project Documents Collection.

United Nations Fund for Population Activities (UNPFA), (1991), *Population, Resources and Environment: The Critical Challenges*. London: Banson Productions.

United Nations, (2005), *UN Energy Paper,* June 22.

Warwick,, H and Doig A (2004). *Smoke: The Killer in the Kitchen Indoor, Air Pollution in Developing Countries,* ITOG (Practical Action).

Wason, D. and Hall, D. (2004), "Poverty in Lesotho: 1993-2002; An Overview of Household Economic Status and Government Policy", *Critical Poverty Research Centre Working Paper, No. 40,* London: Overseas Development Institute (ODI).

Weatherbee, M. (2010), *The Missing MDG*, www.policyinnovations.org/ideasbriefins/data/000188 (April 25, 2011).

Wikpedia, The Free Encyclopedia: *Rocket Stove*, http://www.ashdenawards.org/winners/aprovecho.

Wilkinson, F.F and M. Wyman (eds.), 1986, *Environmental Challenge:Learning for Tomorrow's World*, London: Althouse Press.

Wiskerke, W. (2009), "Towards a Sustainable Biomass Energy Supply for Rural Households in Semi-Arid Shinyanga, Tanzania A Cost-Benefit Analysis", *A Study in Partial Fulfillment of the Master of Science Program Sustainable Development, Track Energy and Resources* at the Utrecht University, Utrecht, the Netherlands, Second Periodic Activity Report.

Wokocha, G.A. (2010), "Impact of Biomass Fuel Utilization in Rivers State", *European Journal of Scientific Research* Vol. 48, No. 1, pp. 29-34.

Woodwell, J.C, (2002), "Fuel wood and Land Use in West Africa: Understanding the Past to Prepare for the Future," *Paper Prepared for: A Joint Workshop in Ouagadougou*, Burkina Faso, July 16–19, 2002, Under a Contract with International Resources Group, Washington, DC.

World Bank (1992), *World Bank Report-1992 Development and the Environment*, Washington D.C: The World Bank.

World Bank (2001), *Word Bank Report-2001 Attacking Poverty*, Washington D.C: The World Bank.

World Bank (2006), *Energy, Poverty Issues, and G8 Actions*. From http://sitesources.worldbank.org/INTRUSSIANFEDERATION/Resources/Energy_Poverty_Issues_Paper_Russia_G8_eng_summary.pdf (Retrieved May 21, 2007).

World Commission on Environment and Development (WCED) (1978), *Our Common Future,* Oxford: Oxford University Press.

World Commission on Forests and Sustainable Development (1998), *Our Forests, our Future.* March Report, WCFSD Secretariat, Winnipeg.

World Energy Outlook (WEO) (2002), "Energy and Poverty", in *WEO 2006: Focus on Key Topics,* (Chapter 13), pp. 365-393.

World Energy Outlook (WEO) (2006), "Energy for Cooking in Developing Countries", in *WEO 2006: Focus on Key Topics*, (Chapter 15), pp. 419-445.

World Health Organization (WHO), (2006) "Household Energy and the

MDGs," *Fuel for Life: Household Energy and Health,* pp. 16-25.

World Health Organization (WHO), (2006). *Fuel for Life; Household Energy and Health*, World Health Organization, http://www.who.int/indoorair/publications/fuelforlife.pdf.

World Wildlife Fund (WWF) International, (2000), *Living Planet Report 2000.*

www.bm.kbase.com/articles/LPGsdarticles(15).pdf.

www.cd3wd.com/cd3wd_40/JF/425/20-448.pdf.

www.gate-International.org/documents/publications/webdocs/.../g14fue.pdf.

www.gtz.de/de/dokumente/en-cooking-energy-2007.pdf

www.policy.co.uk/key concepts/samples/lister-chapter.pdf.

www.tinygreenbubble.com/livegreen/../546-clean-energy-definition.

www.Twitter.com/TinyGreenBubble.

www.unep.org/Nairobi Convention.docs/English Nairobi ConventionText.pdf.

www.worldenergyoutlook.org/docs/weo2006/cooking.pdf.

Yahaya, S.B. (2002), "The Development and Adoption of Local Alternative Sources of Energy Against Fuel Wood", *Proceedings of a Two-Day Training Workshop on Agro Forestry Management for Sustainable Agricultural Production.* Manpower Development Centre. Office of the Head of Service, Kano State, Nigeria, pp. 129-130.