Environmental Degradation and Economic Growth in Kenya: An ARDL Rounds Testing Approach

Kingori Sarah V/

X50/61870/2010

Research Paper Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Arts in Economics of the University of Nairobi

July, 2012

DECLARATION

This research paper is my original work and to the best of my knowledge has not been presented for the award of a degree in any other university.

Signed: . . . . . Date:.....kd .I. .".v.v. I .'iv.....

Kingori Sarah W ^
£50/61870/2010

his research paper has been submitted, for examination with our approval as university ipervisors.

tgned:_____Date:..... .....

r. Gor Setfa

»ned:. . . . . / . ^ Q j x

. Nyademo Samuel

DEDICATION

I dedicate this research work to my late father, Benson Kingori for giving me the inspiration to pursue further studies my mum, Teresa Gathoni for her support and encouragement and all my brothers and sisters for their love and support all through my studies.

ACKNOWLEDGMENT

[thank the almighty God for the blessings of life, health, guidance, direction and love during my entire masters program. I owe gratitude and thanks to my supervisors Dr. Seth Gor and Dr Samuel Nyademo. I would like to particularly express my profound gratitude to Dr. Gor for tirelessly reading my drafts *and guidance while doing this project, despite his many other academic and professional commitments.

There is an endless list of friends, relatives and colleagues who contributed either directly or indirectly to the success in my studies to whom I will be forever grateful. Whereas great care has been taken in preparing this paper, I remain solely responsible for any errors and mistakes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This study set out to determine the nature of the relationship between environmental degradation and economic growth in Kenya over the period 1970-2008. The objectives were to determine the impact of economic activities on the environment and to establish whether economic growth is detrimental or beneficial to the environment in Kenya.

A structural model was formulated by employing carbon dioxide emissions as the environmental indicator, per capita GDP as a proxy for the scale effect, the-share of manufacturing, agricultural and services sectors as proxies for the composition effect and polity as a proxy for the technique effect. The ARDL approach to cointegration was adopted to establish the long-run relationship amongst variables.

The findings reveal that there is an inverted N- shaped relationship between economic growth and environmental degradation. The share of agricultural and manufacturing sectors and polity variables are insignificant in the model, implying that changing them does not significantly cause a change in environmental degradation. However, the services sector is a significant contributor to degradation probably due to the tremendous growth reported in the sector and the high potential for degradation in its sub-sector activities.

One of the core policy implications that can be drawn from the findings is that in order Tor the government to realize its development objectives there is need for environmental policies to be pursued alongside developmental policies. In addition a change towards enhanced democratization is expected to have beneficial effects on the environment through effective policies and institutions.

CHAPTER ONE

INTRODUCTION

1.1 Background

The environment is one of the pillars of sustainable growth and development since it fulfills developmental needs such as increasing the asset base and their productivity and also provitling various goods and services. In addition the environment empowers women, the poor and marginalized communities thus playing a crucial role in enhancing intra- and intergenerational equity (Bass 2006).

In the process of economic development, physical, natural and human capitals all contribute to overall wellbeing by supporting the production of goods and services. Natural capital provides raw materials for production and is the backbone of core sectors such as agriculture, tourism and manufacturing. Natural capital also provides various ecological services (Fisher 2002).

According to the Millennium Ecosystem Assessment (MEA) there are four core beneficial ecosystem services provided by natural resources. Provision of food, fiber, timber and water; regulation of climate and floods; supportive services which includes nutrient recycling and the provision of cultural services which provide aesthetics and recreational benefits (MEA 2005).

Therefore, in order to make development sustainable, these resources must be utilized in such a way that there is enough for the present as well as the future generation.

Evidence from literature suggests that the relationship between economic growth and the environment is controversial. Traditional economic theory posits a trade-off between economic growth and environment (Bennett *et al.* 2008; Hediger 2006; Sawmill 1993 and Scherr 1999).

Since the early 1990s, however, the rapidly expanding empirical and theoretical literature on the Environmental Kuznets Curve (EKC) has tended to suggest that the relationship between economic growth and the environment could be positive and hence growth is a prerequisite for environmental improvement (Kuznets 1955). The EKC depicts the empirical pattern that at relatively low levels of income per capita, pollution level (and intensity) initially increases with rising income, then reaches a maximum and falls thereafter.

Panayotou (1993) and Arrow *et al.* (1995) argue that the implied inverted-U relationship between environmental degradation and economic growth also implies that at low income levels environmental degradation is attributed to subsistence activities as well as plant and animal wastes. As agriculture and resource extraction intensifies and industrialization takes off, both resource depletion and waste generation accelerate (Rowstow 1960). According to the EKC hypothesis as a nation attains higher levels of development degradation slows down and eventually declines with further growth in income (Kamande 2007).

However, De Bruyn *et al.* (1998) and Vincent (1997) argue that the inverted U shape does not hold in the long run as it would only hold at the initial stage of the relationship between economic growth and environmental degradation. They argue that above a certain income level, there would be a new turning point when environmental degradation would increase at higher growth levels leading to an N shaped curve.

1.1.1 An Overview of the Kenyan Situation

Kenya experienced rapid economic growth with Gross Domestic Product (GDP) expanding by 5.6% in 2010 after suppressed growth of 1.5% and 2.6% in 2008 and 2009 (Republic of Kenya 2011). Over this period, most sectors in the economy experienced increased productivity and growth in job opportunities. The agricultural sector reported a 6.3% real growth rate compared to the contractions of 4.1% in 2008 and 2.6% in 2009 and the manufacturing sector grew by 4.4% compared to the marginal growth of 2.6% in 2009. The agricultural and forestry sectors continued to be the key contributors to GDP with their contributions being unparalleled by other sectors. In 2010 the two sectors contributed 21.5% of the GDP a decline from 24.4% contribution in 2009. While the manufacturing and wholesale and retail trade sectors remained the second highest contributors to the GDP.

The wholesale and retail trade sector contributed 10.3% and 9.8% of the GDP in 2010 and 2009 respectively while the manufacturing sector contributed 10% and 9.9% of the GDP in 2010 and 2009 respectively (Republic of Kenya 2011).

Over the same period however, environmental degradation became more severe. Forest plantation stock decreased from 112.7 thousand hectares in 2009 to 111.8 thousand hectares in 2010. In addition natural resource mining also increased from 1,399 thousand tonnes in 2009 to 1,497 thousand tonnes in 2010 (Republic of Kenya 2011). Wetlands and wildlife numbers also declined while other renewable and non-renewable resources became increasingly exploited and therefore depleted.

Environmental degradation of this magnitude leads to economic and social costs, both now and in the future. These costs include direct ones in terms of production and consumption

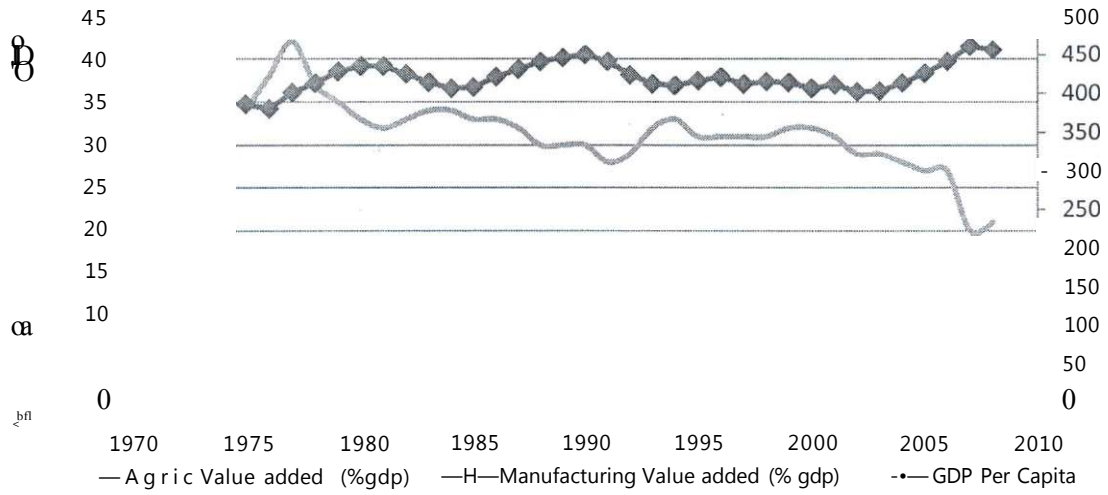
opportunities foregone, direct costs in terms of abatement and replacement expenditure, indirect costs to other production and consumption activities and costs in terms of future opportunities foregone. Social costs include stress on the community social structures, increased possibility of completion and conflict on resources amongst other costs (Emerton *et al.* 2001).

From the foregoing, it is evident that environmental problems constitute an important challenge in Kenya and focus should gradually shift from politics and poverty to environmental issues. In Kenya, the quality and richness of terrestrial, freshwater, and marine environments have been grossly interfered with due to pollution and this has subsequently led to a decline in the establishment of industrial and manufacturing sectors (Republic of Kenya 2012). This has been exacerbated by rapid population growth, urbanization, energy consumption, overgrazing and over-cultivation of lands. The socioeconomic impact of environmental deterioration in Kenya therefore continues to pose a major problem to development, stability, and even to the attainment of national goals. The future challenge for Kenya is to continue to achieve economic growth and to generate employment and income while at the same time conserving the natural resource base.

1.1.2 Trend Analysis of Environmental Degradation and Economic Growth in Kenya

Natural resource dependent sectors such as the agricultural and manufacturing sectors are major contributors to GDP in Kenya. While the GDP trend has been steady, the contribution of the agricultural sector to GDP was significantly high in 1977 when it was the highest contributor. The sector experienced a steady decline until 1991. This was followed by a short increase in its contribution in 1994 after which it has been on downward trend. The manufacturing sectors contribution to GDP has been fluctuating over the same period with very little upward growth as shown by Figure 1.1.

Figure 1.1: Trend of Agriculture and Manufacturing Value Addition (% GDP) and GDP per Capita for the Period 1975 to 2010

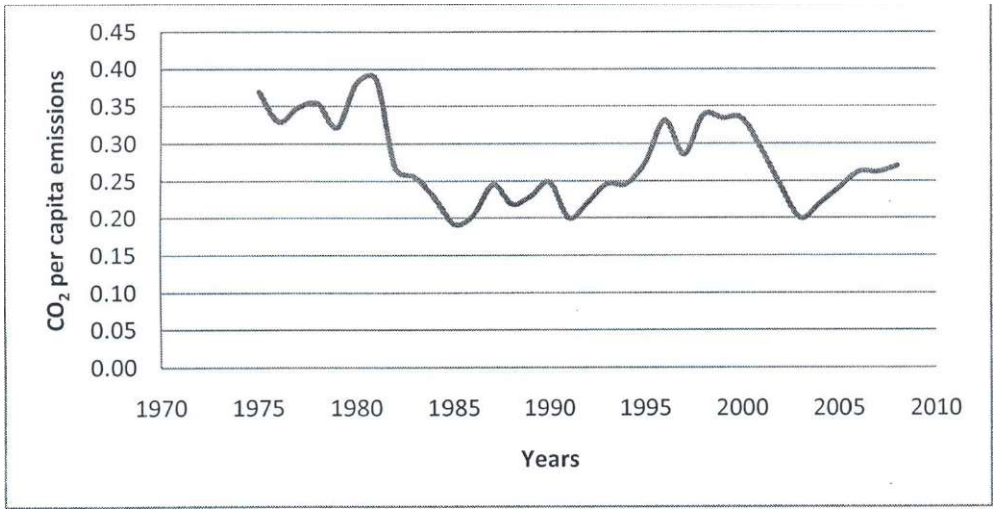


Source: The World Bank (2011)

The pattern of GDP per capita and agriculture value addition between 1970 and 2010 indicates that they had a uniform trend with agriculture initially growing faster than per capita GDP and later being surpassed with per capita GDP growing very fast with the agricultural value addition declining significantly. The manufacturing value addition has maintained a steady trend characterized by stagnant growth within the same period.

There has been no uniform trend in CO2 emissions in Kenya. Between 1980 and 1985 there was a downward trend in the levels of CO2 emissions followed by fluctuating increases in the level of emissions until 2000. A sharp decline in CO2 emissions occurred from 2000 to 2003 followed by a sharp increase as shown in Figure 1.2.

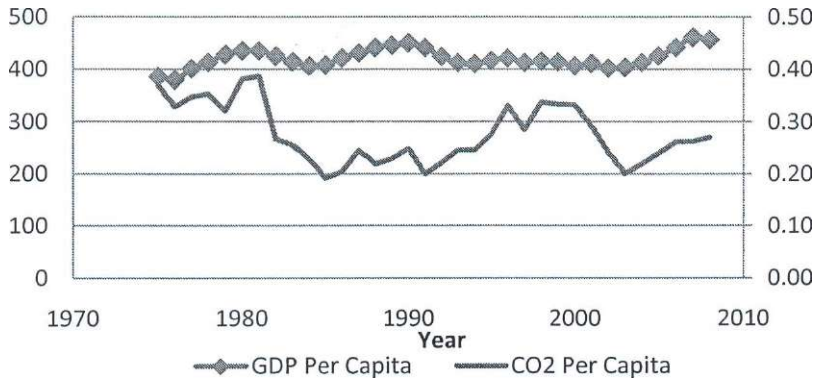
Figure 1.2: Trends of CO2 Emissions per Capita for the Period 1975 to 2010



Source: The World Bank (2011)

The EKC argues that at low levels of income, emissions rise with income and when income rises above a certain level emissions decrease as income rise. In Kenya however, this systematic trend between $C0_2$ emissions and GDP does not hold as shown in Figure 1.3.

Figure 1.3: Trend of CO2 Emissions per Capita and GDP per Capita for the Period 1975 to 2010

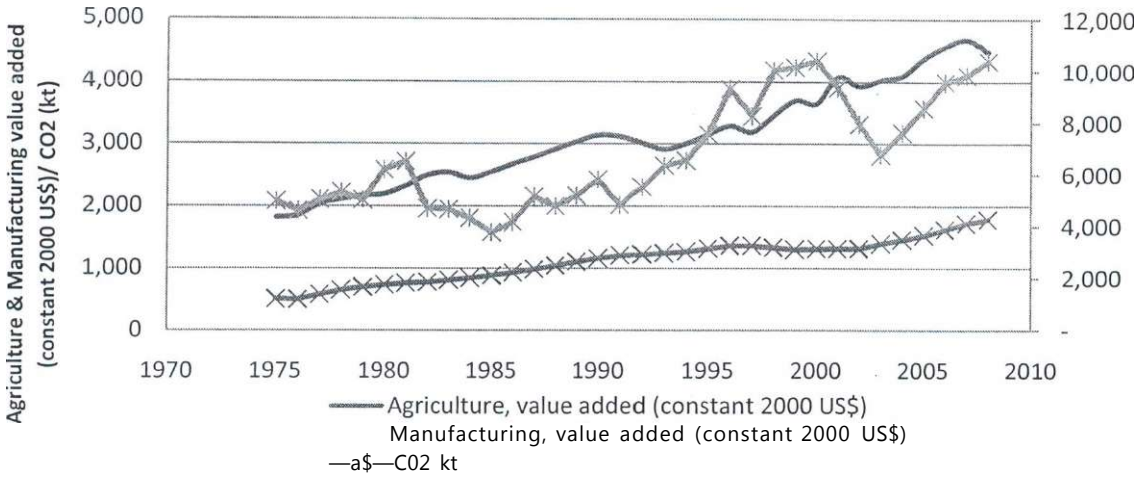


Source: The World Bank (2011)

Figure 1.3 shows there was a sharp rise in $C0_2$ emissions in 1980 accompanied by relatively high levels of GDP followed by a fall in GDP and a decline in the levels of CO_2 emissions before 1990. There is also an observed rise in the levels of $C0_2$ emissions in 2000 which was accompanied by a steady state trend of GDP in Kenya.

Between 1975 and 1980 as the levels of CO2 emissions increased this coincided with rapid growth in both the agricultural and manufacturing sectors. This may be attributed to associated pollution from the two sectors. A downward trend in CO2 emissions is observed from 1981 to 1984 which coincides with a steady trend in the two sectors. However, even though $C0_2$ emission levels are fluctuating they are on an upward trend. When value addition from the manufacturing sector reaches its peak in 1997 the levels of CO2 emissions are also shown to be at their highest levels as seen in Figure 1.4.

Figure 1.4: Trend of Agriculture and Manufacturing Value Addition and $C0_2$ Emissions for the Period 1975 to 2010



Source: The World Bank (2011)

Even as the agricultural sector contribution to GDP declined from 1995 to 2001 the levels of $C0_2$ emissions rapidly increased from 1996 to 2000. During the same period GDP trend rises gradually reaching its peak in 1990. Increases in the levels of CO2 emissions and GDP can be attributed to growth of the manufacturing sector. From 2000 the decline in the levels of CO2 emissions coincides with a decline in the manufacturing sector. But as the manufacturing sector is revived from the period 2002 to 2010 the levels of CO2 emissions increase drastically. This can be attributed to the rapid growth experienced in both the agricultural and manufacturing sectors which resulted into increases in GDP over the same period.

The graphical and trends analysis are insufficient in establishing the nature of the relationship between environmental degradation and economic growth in Kenya thus the need to conduct an econometric analysis.

1.1.3 Environmental Conservation Initiatives in Kenya

The Government of Kenya is cognizant of the critical role environmental resources play in the economy and has developed guidelines to integrate environmental concerns into its national development plans. The primary objective of the economic pillar of the country's economic blue print Vision 2030, is to improve prosperity of all Kenyans through economic development programmes aimed at achieving an average GDP growth rate of 10% per annum. In addition, the vision aims to ensure that the country has a clean, secure and sustainable environment by 2030. This is to be attained by increasing forest cover from less than 3% to 4% and by promoting environmental conservation in order to provide better support to the economic pillar flagship projects and for purposes of achieving the Millennium Development Goals (MDGs).

Kenya is signatory to several international conventions, protocols, agreements and treaties that aim to ameliorate or contain environmental degradation. Kett^a. Nations on Climate Change (UNFCC) in 1944 thus committing itself to stabilizing green house gas concentrations in the atmosphere to levels that prevent dangerous anthropogenic interference with the climate system. In addition in 1969 Kenya ratified the African Convention on the Conservation of Nature and Natural Resources, thus committing itself to conservation, utilization and development of natural resources with due regard for its citizens.

In addition several national laws, legislations and bodies have been established and mandated to address environmental issues. The core legislation that governs all activities affecting the environment is the Environmental Management and Coordination Act (EMCA 1999). EMCA guides coordination, planning and management of the environment and natural resources. It also stipulates guidelines on environmental impact assessment that determine potential impacts of

project activities and the necessary mitigation measures. Its implementation is coordinated by the Ministry of Environment and Mineral Resources through the National Environment Management Authority (NEMA). Development partners, non-governmental organizations and private sector actors have also undertaken several initiatives aimed at reducing environmental degradation.

However, enforcement challenges and the lack of strict compliance to the Act has been a major challenge in addressing environmental concerns in Kenya. In addition, some developers are also evasive and hesitant to comply with the Act thus several activities have been undertaken that do not fully comply with EMCA's requirements thereby contributing to environmental degradation in Kenya.

Given the ambiguous relationship between environmental degradation and economic growth as summarized above, and also given the primary objective of the Kenya government of sustaining economic growth as envisaged in the vision 2030, this study aims to examine and explain the nature of the relationship between environmental degradation and economic growth in Kenya.

1.2 Statement of the Problem

Economic growth is partially dependant on exploitation of natural resources for the generation of economic rents. While people have to exploit the environment and natural resources to alleviate poverty and raise their standards of living, such exploitation is not without cost. These costs which are the unintended outputs of natural resource exploitation may reduce the options for economic growth and development available currently and for future generations.

The degradation of natural resources directly affects household food security as it has an impact on food production. A decline in soil nutrients and fertility leads to decline in grain harvest while

rangeland depletion results in reduction in livestock production and loss of biodiversity while the deterioration of water quality adversely affects fish stock and catch. These shortages in food production may lead to lower nutrition levels and thus affect the overall productive population composition. Environmental degradation can also lead to health related illnesses through prolonged exposure to toxic substances which negatively affects labour productivity through reduction in both the labour force and productive labour hours and thus negatively affecting output. Overexploitation and abuse of natural resources could not only lead to environmental degradation, but also increase in food insecurity, health and nutrition challenges and could thus exacerbate the very poverty people seek to alleviate.

In addition, extreme environmental degradation can lead to permanent loss or reduction in the volume of natural resources which can lead to the closure of resource dependent industries which are core contributors to national output and this would be detrimental to the overall economy.

Environmental degradation therefore if not addressed results in both economic and social challenges that hinder the attainment of national goals and deter economic growth. There have been no exhaustive studies that have been undertaken to determine the relationship between environmental degradation and economic growth in Kenya. This study intends to add to existing literature on environmental matters with respect to development and also tobprovide policy measures that can be adopted to address the problem.

1.3 Objective of the Study

The primary objective of this study is to determine the nature of the relationship between environmental degradation and economic growth in Kenya.

1.3.1 Specific Research Objectives

The specific objectives of the study are:

1. To determine the impact of economic activities on the environment in Kenya
2. To establish whether economic growth is detrimental or beneficial to the environment in Kenya.
3. Based on 1 and 2 above, recommend policy interventions for improving environmental conservation in Kenya towards sustainability.

1.3.2 Hypothesis

The hypothesis of the study is that environmental degradation does not influence per capita growth. The hypothesis can be formulated as follows:

H_0 = a =0: environmental degradation does not influence per capita growth

Hi = *a* =1: environmental degradation influences per capita growth

1.4 Justification of the Study

The interaction of the economy and the environment is unique in that the economy relies and uses natural resources for the generation of economic rents through production and trade. This depletes and degrades natural resources. However, these economic activities are beneficial and provide critical benefits and services which can be invested in the physical and human capital necessary to increase production and conserve the environment. This would in turn increase the net wealth of the nation and the well-being of its people (Fogel, 2004).

In practice, however, resource-rich poor countries remain poor and polluted because these resource rents are inefficiently captured, imprudently spent, poorly reinvested, or wasted in rent-seeking conflicts (Pearce *et al.* 1990; Barbier 2005).

At present the Kenyan government is under tremendous pressure to pursue environmental conservation and economic growth, but there exists no empirical evidence which shows the nature of the relationship between environmental degradation and economic growth within the perspective of the Kenyan economy. The uniqueness of this study is that it situates this relationship within the Kenyan context and sectors thereby providing empirical evidence upon which macroeconomic policies can be formulated. Additionally, stakeholders in various sectors, and civil society organizations, will utilize the findings of this study to understand and target priority factors that would enhance economic growth and environmental sustainability.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Literature Review

There are two distinct sets of theoretical approaches that investigate the interrelationship between economic growth and the environment namely; the objective and subjective valuation approaches (Fankhauser *et al.* 1995 and Dixon *et al.* 1994). The two approaches are derived from the extension of the neoclassical welfare economics. Neoclassical economics addresses the total welfare of the society and evaluates alternative actions on the basis of social welfare (Pigou 1920). In the neoclassical models (Stern 2004), the environment is either an input or a by-product of the production of commodities used as material inputs for industries and household goods. The two approaches extend the neoclassical theory to include all environmental benefits and costs.

The subjective approach is based on subjective assessments of possible damage expressed in real or hypothetical market behaviour (Dixon *et. al* 1994). This approach entails the examination of the real market of goods and services affected by environmental impacts for instance, analyzing the health impacts of pollution based on the incurred medical expenses. However, in some instances environmental impacts cannot be valued and thus a hypothetical scenario has to be developed to value them. This entails asking individuals directly their willingness to pay for reduction in environmental impacts through a contingent valuation method.

The objective valuation approach is based on physical relationships that describe the cause effect relationships and provide objective measures of damage resulting from various causes (Dixon *et. al* 1994). This approach uses damage estimates which relate the level of an activity such as the

level of toxic waste emissions to their degree of physical damage to resources. For instance, by determining the number of residents who have been affected by the toxic water reveals the damage estimates. Thus the objective approach captures the changes in productivity which leads to output changes which are measureable.

Since the subjective valuation approach is based on individuals expressed preferences, information constraint may introduce a bias in the valuation process (Fujiwara, D. and R. Campbell 2011). Information bias arises when people have inadequate information on which to base their perceptions or when they over estimate or underestimate actual environmental damage costs. Objective valuation approach on the other hand is based on objective knowledge of the cause and effect relationships relating activities to expected environmental damages.

This study is premised on the objective valuation approach with a view to determining the relationship between environmental degradation and economic growth in Kenya. The objective valuation approach is employed since it not only eliminates the information constraint bias associated with the subjective valuation approach but also allows for the analysis of the impacts as reflected by changes in sector productivity.

2.2 Empirical Literature Review

Several studies on economic growth -environment relationship have been undertaken with mixed results. A number of studies (Grossman and Krueger 1991; Panayotou 1993, Selden and Song 1994; Galeotti 2003 and Lucena 2005) have confirmed the existence of an EKC for different measures of environmental degradation while others report a monotonically increasing or decreasing relationship between pollution and per capita income.

Grossman and Krueger (1993) undertook the pioneering work in hypothesizing the nature of the interaction between income and the environment. They argued that at the initial stages of growth there was increased environmental deterioration followed by an improvement phase. Their work popularized and led to the wide acceptance of the EKC hypothesis. A study on the income environment relationship for countries at various income levels by Shafik and Bandyopadhyay (1992) revealed that this relationship differs amongst the developed and developing nations. Therefore, the EKC hypothesis cannot be generalized across countries.

Ghosh and Dutta (2003) re-examined the economic growth-environment relationship for high, medium and low income countries. A structural model using panel data from a cross-section of countries was estimated. The study decomposed the scale, composition and technique effect of the environmental impact. The study found that the decline in the environmental quality during the initial stages of growth is attributed to the increase in economic activities. However, technological advancements and policy changes address the emerging environmental issues. One of the core findings of their study was that the process is not across all countries.

Day (2003) investigated the relationships between growth and environment in Canada using per capita GDP and several environmental indicators. The core study finding is that both environmental and income changes influence the relationship in Canada.

In Kenya, Kamande (2007) investigated the relevance of the EKC for environmental conservation. The relationship was modeled using per capita carbon emissions, population growth, per capita GDP and technology data from 1960 to2006. The study did not find that an EKC exists in Kenya.

Apart from the Ghosh and Dutta (2003 and 2004) studies few other empirical studies have included variables that decompose the income environment relationship. Hettegi *et al.* (1997) investigated the relationship between industrial water pollution and economic development. The study found that pollution increases with income per capita and thus a linear relationship existed as opposed to the inverted U-shaped relationship. Their study also revealed that industrial water pollution was highest at the middle income stage. However, the composition of pollution from the manufacturing sector had higher toxic intensity while the sectoral composition of toxicity declined with income.

Torras and Boyce (1999) analyzed the relationship between several pollution indicators and income growth. They extended their model to capture political and social aspects. Their Iindings reveal that education levels and basic freedoms all have a stronger influence on the environmental quality as compared to per capita income especially in low income countries. One of the core challenges to economic development in medium and low income countries is corruption. According to Lopez and Mitra (2000) this also has a negative impact on pollution

levels. Their study revealed that the existence of bribery amongst various key players leads to higher pollution levels and thus the existence of a higher EKC.

A few studies have investigated the income- environment relationship using the bounds testing approach. Shahbaz...e/ *al.* (2010) investigated the EKC in Portgual using an ARDL framework using annual data from 1971 to 2008. The findings showed that the EKC exists, thus environmental degradation increases with trade growth, urbanization and energy consumption and then eventually declines. Usenobong and Chuku (2011) also undertook a study on environmental degradation in Nigeria using an autoregressive distributed lag (ARDL) framework with data from 1960 to 2008. Their model was also extended to include trade openness and key sectors in Nigeria's economy. The study found that there was no evidence of an EKC model but rather an N-shaped relationship.

2.3 Overview of Literature Review

The empirical studies reveal mixed findings where for some specific countries and some selected indicator, environmental degradation reportedly decreases with growth in income. An inverted-U shaped relationship is reported in most cross country studies while the within-country studies do not provide evidence of an inverted-U shaped relationship but rather an inverted-N shape, linear or cubic relationship.

In addition most of the studies are cross-country studies which have only provided a broad understanding of how the variables interact. Thus they have not been able to capture the country-specific historical experiences and exogenous shocks that are unique to each country. It can therefore be argued that the cross-country study recommendations cannot be generalized for all countries. This is particularly due to the fact these effects differ amongst the developed and developing nations.

Even fewer studies have decomposed the income environment relationship and extended their models to capture the scale, composition and technique effect on the relationship using a bounds testing approach. Amongst the developing nations, Kenya in particular this relationship has not been decomposed and the only relevant empirical study has been undertaken to determine only the existence of the EKC. This study adds to existing literature by highlighting the effect of the scale, composition and technique effect in Kenya.

CHAPTER THREE

METHODOLOGY

3.1 Theoretical Framework

Grossman and Krueger, (1995) state that economic growth can be linked to the environment through three different mechanisms: the scale effect, the composition effect, and the technique/abatement effect. Ghosh and Dutta (2003) decomposed the economic growth environment relationship by incorporating variables that capture the underlying causes of the relationship. The scale effect refers to the situation where economic growth requires more input and thus more natural resources are used up in the production processes. More output also implies more waste and emissions as by-products which contributes to environmental degradation.

The composition effect refers to the situation when economic growth generates structural transformation in economic activities. As income grows, the structure of the economy shifts from primary activities which are pollution-intensive to activities which are environment friendly (Copeland and Taylor 2004). The economy changes as a country aims to increase trade and development. As a result, energy and resource use increases at an increasing rate with increase in manufacturing and industrial activities and environmental degradation is likely to increase at an increasing rate with economic growth. Thus, the state of natural resources changes with structural transformations driven by economic growth.

Advancements in the extraction and use of natural resources leads to reduced environmental degradation through increased access to environmentally friendly services and technological

advancements (Panayotou 1997). The decline in degradation arises from. In addition the increase in incomes from enhanced economic growth leads to increased demand for environmental services.

The income environment relationship comprises of the scale, composition and the technique effects (Stern, 2002). The framework is expressed as:

$$Et = fifl t, {}^{x}t,z_t) \qquad (3.1)$$

Where;

$E,$ = A measure of environmental degradation through total $C0_2$ emissions,

q_t = A vector of industrial outputs; scale effect

x_t = A vector of inputs/resource use; composition effect and,

z_t = A vector of abatement measures; technique/abatement effect.

3.2 Empirical Model

The changes in production and abatement with changes in income as derived from the scale, composition and the technique effects derives the income environment relationship (Panayotou 2000). The changes in economic activities are captured by GDP. The, scale effect function is considered to be linear and quadratic in GDP per capita expressed as:

$$ED_t = a_0 + a_1 y_t + a_2 Y^2_t \qquad ({}^{3}\text{-}{}^{2})$$

Where;

ED_t = A measure of environmental degradation,

F_t = Per capita GDP, and

a =Parameters to be estimated

The composition effect is captured through the use of variables on the share of different sectors in GDP of the economy. The study uses manufacturing, agricultural and services sectors as proxies for structural changes to capture the composition effect. As the economy changes from agrarian to industrial, environmental degradation is expected to increase thus the coefficients of the manufacturing and agricultural sectors are expected to be positive while the services sectors coefficient may be negative since the sector is not pollution intensive.

The composition effect function is expressed as:

$$ED_t = /?_x \, man + /?_2 \, agric + /?_3 \, serv \qquad (3.3)$$

Where;

EDt = A measure of environmental degradation,

man = share of the manufacturing sector in GDP,

agric = share of the agricultural sector in GDP,

serv = share of the services sector in GDP, and

/? =Parameters to be estimated

Higher incomes result in increased demand for better environmental quality and it also provides resources for investment in environmentally friendly technology. Therefore, people express their desire for environmental conservation based not only on their income levels but also on their rights and freedoms (Eriksson and Persson 2002).

Changes in people's preferences influence policy formulation in any governing system. Polity has been used in previous studies as a measure of how democratic the structure of government is ranging from -10 (strongly autocratic) to +10 (strongly democratic) Marshall and Jugger (2000).

The overall study model that relates the level of environmental degradation to a flexible function of per capita income which captures the scale, composition and technique effect, following Grossman and Kruger (1995) and Grafton (2001), is specified as:

$$ED_t = a_0 + a_1 y_t + a_2 y^2_i + a_3 y^3_t + a_4 x_t + E_t \quad (3\ 4)$$

Where;

ED_t = Proxy measure of environmental degradation; CO2 emissions,

Y_t = Per capita GDP,

a =Parameters to be estimated

x =A vector of other variables that often affect the environment, and

G =is the error term

$$C_t = a_0 + a_x Yt + {}^a2\ Y^2_t + {}^a3\ Y^3_t + cc\hat{}M_t + a_5 A_t + a_e S_t + a_7 P_t + E_t \quad (3.5)$$

Where;

M_t =represents the manufacturing sector, value added as a share of GDP,

A_t =represents the agricultural sector, value added as a share of GDP,

St represents the services sector, value added as a share of GDP, and

P_t represents polity; a measure of how democratic the structure of government is.

3.2.1 Data Types and Sources

This study employs annual time series data covering the period 1970-2008. In this study $C0_2$ emissions (measured in metric tons per capita), GDP per capita (measured in 2000 constant U.S. $), share of the manufacturing, agricultural and services sectors in GDP were sourced from World Development Indicators, World Bank (WDI), (2012).

The democratic rights data provides annual, cross-national time-series data based on the democratic and autocratic patterns of authority and regime changes in all independent countries. Polity data is sourced from Polity IV (Political Regime Characteristics and Transitions), data (Marshall and Jaggers 2010).

3.2.2 Definition of Variables

The data set was sourced from a variety of sources and its core characteristics are summarized below:

co_2	Emissions measured in metric tons per capita.
GDP per capita	Measured in 2000 constant U.S. $
A_t	Value added as a percentage of GDP. It includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.
M	Value added from sector activities. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.
St	Value added as a percentage of GDP. It includes value added in wholesale and retail trade transport, and government, financial, professional, and personal

	services such as education, health care, and real estate services. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.
Pt	A measure of the regime based on the degree of democracy and autocracy. The polity score is a combination of the democracy and autocracy score indices thus a single regime indicator. The polity score captures the regime authority spectrum ranging from a 21-point scale from -10 (hereditary monarchy) to +10 (consolidated democracy).

CHAPTER FOUR

EMPIRICAL RESULTS

4.1 Introduction

In this chapter findings of the study are presented. First, the OLS estimation results and the model estimation results are discussed. The ARDL and ECM results are then discussed in the last part of this chapter.

4.2 Empirical Findings

Before proceeding with the econometric analysis, diagnostic tests of integration and cointegration on all the series were undertaken to determine the nature of the variables in the model and to avoid the likelihood of obtaining spurious regressions.

Stationarity tests were conducted using two different procedures: the Augmented Dickey Fuller test (Dickey and Fuller, 1974), and the Phillips-Perron (PP) test. The results indicate that polity, the share of agricultural and services sector variables are non-stationary but become stationary after taking first difference while all the other variables are stationary. The unit root test results on the data are presented in Table 4.1 and 4.2.

Table 4.1: Differencing of Non-Stationary Variables

Variable	ADF Test Statistic				P-P Test Statistic	
		^evel	First Di	Terence	Level	First Difference
	Intercept	Trend & intercept	Intercept	Trend & intercept		
Agricultural sector	-1.405	-4.02 ***	-5.778	-5.867	-1.22	-5.786
Services sector	-0.854	-3.990***	-6.743	-6.723	-0.883	-6.963
Polity	-0.067	-1.626	-6.206	-6.339	-1.640	-6.221

*Note: *** **, * denotes significance at the 1%, 5%, and 10% levels respectively.*

Table 4.2: Unit Root Tests of $C0_2$, GDP and Manufacturing sector

Variable	ADF Test Statistic		P-P Test Statistic
	Level		Level
	Intercept	Trend & Intercept	
Per capita $C0_2$	-3.474	-6.024	-4.567
Per capita GDP	-2 911** *	-3.329 **,*	-4.66
Per capita GDP_2	-3 00***	_3 414*** *	-3.955
Per capita GDP_3	-3.075***	-3.476** *	-3.956
Manufacturing sector	-4.093	-4.096	-4.431

*Note: ***, **, * denotes significance at the 1%, 5% and 10% levels respectively.*

4.2.1 Causality Testing

In order to establish whether a unidirectional or bidirectional causality relationship exists, Granger causality tests between per capita GDP and per capita $C0_2$ emissions were conducted. The optimal lag length was determined using the Akaike information criterion of (AIC) and two lags were determined as optimal. Table 4.3 presents the results of the Granger causality tests.

Table 4.3: Pair Wise Granger Causality Tests $C0_2$ and GDP

Null Hypothesis:	P-Value	Results
GDPPC does not Granger Cause $C0_2PC$	***0.01124***	***Reject Ho***
$C0_2PC$ does not Granger Cause GDPPC	0.22674	Do not Reject Ho
$GDPPC^2$ does not Granger Cause $C0_2PC$	***0.02396***	***Reject H_0***
$C0_2PC$ does not Granger Cause $GDPPC^2$	0.19206	Do not Reject Ho
$GDPPC^3$ does not Granger Cause $C0_2PC$	***0.04692***	***Reject H_0***
$C0_2PC$ does not Granger Cause $GDPPC^3$	0.17263	Do not Reject H_0

Only the P-values tests between per capita GDP and per capita $C0_2$ emissions are significant (less than 0.05) while all the other P-values are insignificant (greater than 0.05). From these results, a uni-directional causal relationship exists between per capita carbon dioxide emissions and per capita GDP and its squared and cubic transformations.

The causality tests provide evidence that the relationship between income and environmental degradation in Kenya is one of unidirectional causality with income causing environmental changes and not vice versa, both in the short-run and long-run. This implies that emission reduction policies accompanied by more investment on environmental degradation abatement expense will be beneficial to economic growth and can be a practical tool to achieve economic development.

Furthermore, causality tests indicate that the hypothesis that environmental degradation does not influence per capita income is rejected since unidirectional causality from income to environment is observed.

4.2.2 Cointegration Analysis

The unit root tests results on the variables based on the ADF and PP tests reveal that 3 variables are non-stationary while 5 are stationary thereby necessitating the bounds test approach using the ARDL model. The ARDL approach to cointegration or the bounds testing approach was developed by Pesaran and Shin (1999) and later extended by Pesaran, *et al.,* (2001). The use of the bounds technique is based on several validations. The approach is flexible and can be applied irrespective of whether the underlying regressors are integrated of order zero *[I* (0)], *one [I* (I)] or whether they are mutually cointegrated.

The bound testing does not depend on pretesting the order of integration of the variables. It eliminates the uncertainty associated with pretesting the order of cointegration (Narayan and Narayan, 2004). Pesaran *et al.* (2001) argue that the ARDL model can also be estimated by OLS. In addition the technique is suitable for small or finite sample size.

The ARDL bounds testing approach has been adopted in similar studies (Iwata *et ah,* 2009; Shahbaz *et ah,* 2010; Usenobong and Chuku, 2011). The bounds test approach involves two steps. The first step is to investigate the existence of a long-run relationship among the variables.

The model is adopted from Pesaran *et al* (2001) and is expressed as follows;

$$AC_t = S_Q + <*! \; AC_{t\_i} + a_2 \; AY_{t\_x} + a_3 \; AY^2_{t\_i} + «4 \; AY^3_{t\_i} + a_5 \; AM_{t\_x} + a_6 \; AA_{t\_x}$$

$$+ a_7 \; AS_{t\_i} + a_8 \; AP_{t\_!} + \sum_{t=1}^{p} a_t \; AC_{t\_x} + \sum_{t=o}^{q} a_y \; AY_{t\_x}$$

$$+ \sum_{t=o}^{r} Y_j{}^a k \; AY^2_{t\_!} + \sum_{t=o}^{s} a_t \; AY^3_{t\_!} + \sum_{t=0}^{t} Y_J{}^a m \; AM_{t\_!} + \sum_{t=0}^{u} a_n \; AA_{t\_x}$$

$$+ \sum_{t=0}^{v} T \; a_0 \; AS_{t\_i} + \sum_{t=0}^{w} a_p \; AP_{t\_i} + \qquad (3.5)$$

Where 5 and G are the drift component and white noise operators. The *a* denotes the long term multipliers while the summation are the short run dynamics of the relationship. The results of the analysis indicate that the model passes all the diagnostic tests; the variables are not serially correlated since the Lagrange Multiplier (LM) test and F-tests are 0.862 and 0.889 respectively. The LM test for normality and heteroscedasticity are 0.918 and 0.684 respectively as shown in Table 4.4.

Table 4.4: ARDL Diagnostic Tests

Test Statistics	LM Version	F Version
Serial correlation	0.862	0.889
Functional form	0.021	0.055
Normality	0.918	-
Heteroscedasticity	0.864	0.694

Equation (3.5) was estimated using ordinary least square (OLS) method and the null hypothesis of no cointegration or no long-run relationship against the alternative hypothesis of an existing long-run relationship. The test statistics for cointegration is greater than the Engle and Granger critical value at 10% (-3.04). Thus, the residual is stationary and therefore an error correction model (ECM) is applicable.

The ECM tests results presented in Table 4.5 reveal that there exists a strong cointegration relationship among the variables in the model because the coefficients of the Error Correction term; u (-1) is statistically significant and has the expected sign. The short run coefficient of per capita GDP is -2.44 and is statistically significant, while the coefficient of u (-1) is -0.6234 indicating that any deviation from the long-run equilibrium between variables is corrected by 62.34% annually.

Table 4.5: ECM Tests

Regressor	Coefficient	t-Statistic
A Per capita GDP	-2.4406	-2.0224
A Squared per capita GDP	.0050421	1.7235
A Cubic per capita GDP	-.3931E-5	-1.6663
A Manufacturing sector share of GDP	-.054228	-.92741
A Services sector share of GDP	2.3720	57.8788
A Agricultural sector share of GDP	-.075613	-1.9583
Constant	381.9165	2.2122
A Polity	.026130	1.2340
Error Correction term)	-0.62338	-6.4408
R-squared	0. 99945	0.000
Durbin-Watson stat	1.8698	

The long run coefficients of the model are presented in Table 4.6. The negative coefficient of per capita GDP, positive coefficient of squared per capita GDP and the negative coefficient of cubic per capita GDP reveal the existence of an inverse N-shaped relationship between economic growth and environmental degradation. The income turning point (ITP) is found to be Ksh 220.25 from the coefficient estimates. This value lies within the range of the per capita GDP data set employed in this analysis, implying that the ITP has already been attained.

Table 4.6: Long Run Coefficients

Regressor	Coefficient	Prob.
Constant	612.6582	0.009
Per capita GDP	-3.9151	0.019
Squared per capita GDP	.008878	0.027
Cubic per capita GDP	-.7221E-5	0.025
Manufacturing sector share of GDP	-.086991	0.372
Services sector share of GDP	2.3720	0.000
Agricultural sector share of GDP	-.1230	0.067
Polity	.041917	0.237

From Table 4.6, only three coefficients; agriculture, manufacturing and polity are insignificant in explaining the relationship between environmental degradation and economic growth in Kenya. The share of agricultural and manufacturing sectors and polity variables are insignificant, implying that changing them does not significantly cause a change in environmental degradation. The negative and positive coefficients of per capita GDP (-3.92) and squared per capita GDP (0.0089) indicate that carbon dioxide emissions initially decline then reaches a turning point when it starts increasing with higher levels of income and then finally declines with even higher levels of income (cubic per capita GDP (-0.722E-5)).

Our results further show that environmental degradation has a positive but insignificant (0.237) effect on democratic rights. This is possibly due to the fact that better democracy is expected to result into better policies which would in effect reduce degradation.

The services sector is a significant contributor to degradation probably due to the fact that the sector is the core contributor to GDP and has registered tremendous growth as compared to manufacturing and agricultural sectors. In addition, some of its sub-sector activities have a high potential in pollutant emissions especially through transportation, dumping of waste and deforestation.

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Summary

The objective of this paper was to investigate the relationship between environmental degradation and economic growth in Kenya, over the period 1970-2008. This was because earlier (Stern *et al.,* 1996 and Lindmark, 2002) cross-country studies had recommended country specific investigations as an area warranting further research. The analysis improves on the conventional analysis by not only employing the level, square and cubic transformations of per capita GDP but also by incorporating additional explanatory variables such as polity as a proxy of the technique effect and the share of manufacturing, agriculture and services sectors in GDP as proxies of the composition effect and carbon dioxide emissions as a proxy for environmental degradation.

Rationalized against the details provided in the introduction and the review of literature a structural model is formulated. The model is analyzed using the ARDL bounds testing approach to check for the existence of a long-run relationship between carbon dioxide emissions, per capita GDP, polity and the shares of the agricultural, manufacturing and services sector in GDP .

The ADF and PP unit root tests reveal that polity, the share of agricultural and services sector variables are non-stationary however, none of the variables are integrated beyond order one. The bounds tests provide evidence of long-run cointegration among the variables. In addition employing the ECM helped to uncover an economically meaningful relationship since the error correction term; u (-1) is found to be not only statistically significant but also correctly signed.

5.2 Conclusion

The empirical tests reveal that a uni-directional causal relationship between per capita carbon dioxide and per capita GDP and its squared and cubic transformations was observed implying that changes in income causes changes in environmental degradation and not vice versa. The derived ECM reveals that there exists a strong cointegrating relationship amongst the variables. The short run coefficient of per capita GDP is -2.44 and any deviation from the long-run equilibrium between variables is corrected by 62.34% annually.

In addition, an N-shaped curve between income and the environment is observed which differs from the inverted U-shaped curve proposed by the EKC hypothesis. The results also indicate that the share of agricultural and manufacturing sectors and polity variables are insignificant, implying that changing them does not significantly cause a change in environmental degradation. However, the services sector is found to be a significant contributor to degradation probably due to the tremendous growth experienced in the sector and also due to its sub-sector activities.

5.3 Policy Implications

From the study findings the following policies on environmental degradation abatement in Kenya are implied. Economic growth is significantly associated with increased environmental degradation both in the short run and the long run. The finding of an inverted N-shape curve implies that at very high income levels, the scale of economic activity becomes significantly large such that its negative impact on the environment cannot be counterbalanced by the positive impact of the composition and technology effects. Therefore, any beneficial effect that economic growth may have on the environment is transitory.

The finding of an inverted N- shaped relationship also suggests that Kenya cannot out-grow its environmental problems by simply emphasizing economic growth. There is need for special attention to the environment. This suggests that in order to realize sustainable development environmental policies should be pursued alongside developmental policies. Some of the core environmental policies that should be adopted are those that address; the need for intensified environmental preservation, adoption of clean production methods, reforms to improve the signals received by economic agents and provision of the right incentives for protecting the resilience of ecological systems and the adoption of ecologically friendly means of economic growth.

Environmental degradation and economic growth relationship shows unidirectional causality running from income to pollutant emissions growth in the long-run. It is important for the government to formulate emission reduction policies and increase investment on abatement since this will be beneficial towards attaining economic development.

The recent political changes towards enhanced democratization is expected to have beneficial effects on the environment through effective policies and institutions which should significantly reduce environmental degradation at low income levels while at the same time speeding up improvements at higher income levels, thereby reducing the environmental cost of growth. This would also lead to implementation and adherence to environmental regulations. In addition greater democratic rights are expected to positively influence the demand and lobbying for better environmental policies.

5.4 Limitations of the Study

The study encountered various limitations. First, environmental degradation indicators do not include quality-type measures such as water quality because such data is unavailable. In addition, the use of only per capita carbon dioxide emissions to proxy environmental degradation may differ from the results that would be obtained using a wide range of other environmental proxies such as air, noise and water pollutants.

Second due to limited data availability on policy variables particularly environmental policies for instance, the quality of institutions in general; respect/enforcement of contracts, efficiency of bureaucracy, the rule of law and the extent of government corruption the study does not capture the impact of environmental policies.

Due to data restriction, it was not possible to use provincial data in this study. The use of provincial data would have provided a more valuable insight since it captures region specific effects. The addition of such variables would facilitate the drafting of region specific policies that can reduce environmental degradation.

5.5 Areas for Further Research

This study concentrated on the environment and economic growth relationship in Kenya. Even though the study has achieved its objectives we cannot claim to have addressed all aspects of this topic. Other researchers can explore the following areas to extend the frontiers of knowledge in this topic:

1) Undertake sector specific studies to determine the presence and impact of technical innovations in subsector activities. The benefit of this in terms of policy prescriptions is that one can be able to propose sectoral policies that address sector specific issues.

2) Even though $C0_2$ emissions are significant contributors to greenhouse gasses and thus to environmental degradation the relationship with other proxies of environmental degradation and economic growth may vary. Therefore there's need to investigate the nature of the relationship between economic growth and other environmental variables such as gaseous emissions, noise and water pollutants.

3) Examine the distribution of costs and benefits of natural resources as distributed in order to determine; the willingness to pay for reduction in specific pollutants and develop relevant strategic interventions.

REFERENCES

Almeida, E., Carvalho, R. (2009). The Global Environmental Kuznets Curve and the Kyoto Protocol, viewed 10 February 2012, <http://www.ub.edu/sea2009.com/Papers/! 19.pdf>

Andreoni, J. and A. Levinson (2001). The Simple Analytics of the Environmental Kuznets Curve. *Journal of Public Economics* 80: 269 - 286.

Antweiler, W., R. Copeland and M. Scott Taylor (1998), Is Free Trade Good for the Environment? *American Economic Review,* 91:877-908.

Arrow, K., B. Bolin, R. Costanza, P. Dasgupta, C.Folke, C. S. Holling, B.O. Jansson, S. Levin, K.G. Maler, C. Perrings and D. Pimentel (1995). Economic Growth, Carrying Capacity and the Environment. *Ecological Economics 15(2): 91-95.*

Auffhammer, M. (2002). *Forecasting China's Carbon Dioxide Emissions: A View Across Province.,* Job Market Paper, University of California San Diego, Department of Economics.

Barrett, S. and K. Graddy (2000). Freedom, Growth and the Environment. *Environment and Development Economics* 5: 433-456.

Barro> R. (2000). Inequality and Growth in a Panel of Countries. *Journal of Economic Growth,* 5, 5-32

Chakraborty, R (2003). Short and Long Run Effects of Environmental Degradation: A Structuralist Approach, Metro*economica* 54 (2 &3): 263-300.

Chuku, A.C. (2011). Economic Development and Environmental Quality in Nigeria: Is there an Environmental Kuznets Curve? Unpublished Thesis, University of Uyo, Nigeria.

Copeland, B.R. and M.S. Taylor (2004). Trade, Growth, and the Environment, *Journal of Economic Literature* 42(1): 7-71.

Dasgupta, Susmita, B. Laplante, H. Wang and Davi Wheeler (2002). Confronting the Environmental Kuznets Curve. *Journal of Economic Perspective,* 16(1): 147-168.

Day, K. and Grafton, R. (2003). Growth and the Environment in Canada: An Empirical Analysis. *Canadian Journal of Agricultural Economics* (51): 197-216.

De Bruyn, S. M. (1997). Explaining the Environmental Kuznets Curve: Structure Change and Intenational agreements in Reducing Sulphur Emission. *Environmental and Development Economics* 2:485-503.

De Bruyn, S.M., J.C.J.M. van den Bergh, and J.B. Opschoor (1998). Economic Growth and Emissions: Reconsidering the Empirical Basis of Environmental Kuznets Curves, *Ecological Economics* 25: 161-175.

Deacon, R.T. and C.S. Norman (2006). Does the Environmental Kuznets Curve Describe how Individual Countries Behave? *Land Economics* 82: 291-315.

Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics 49(4):431-455.*

Dinda, S. Condoo, D and Pal, M. (2000). Air Quality and Economic Growth: An Empirical Study. *Ecological Economics 34(2); 409-423.*

Dixon, J., Fallan Scura, L., Carpenter, R. and Sherman, P. (1994). *Economic Analysis of Environmental Impacts.* London: Earthscan.

Emerton, L., Karanja F. and Gichere, S. (2001). Environment, Poverty and Economic Growth in Kenya: What Are the Links, and Why Do They Matter? Policy Brief 2, IUCN.

Engle, R.F., and Granger, C, (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica* (55); 251-276.

Eriksson, C. and Persson, J. (2002), Economic Growth, Inequality, Democratization, and the Environment, *FIEF Working Paper Series,* No 178

Fankhauser, S. (1995). *Valuing Climate Change: The Economics of the Greenhouse.* London: Earthscan

Fisherl, J. (2002). The Role of Natural Resources in Economic Development: Adelaide University, Adelaide, University Press.

Fogel, R. (2004). The Escape from Hunger and Premature Death, 1700-2100: Europe, America, and the Third World. 4th ed. Cambridge: Cambridge University Press.

Fujiwara, D. and R. Campbel (2011), Valuation Techniques for Social Cost-Benefit Analysis: Stated Preference, Revealed Preference and Subjective Well-Being Approaches. A Discussion on Current Issues, The National Archives, Kew, London.

Greene, W.H. (2003). Econometric Analysis. 5th ed. New York: Prentice Hall, USA

Grossman, G. M. and A.B. Krueger (1995). Economic Growth and the Environment, *Quarterly Journal of Economics* 110(2): 353-377.

Grossman, G.M. and A.B. Krueger (1991). Environmental Impacts of a North American Free Trade Agreement, NBER Working Paper 3914.

Grossman, G.M. and A.B. Krueger (1993). Environmental Impacts of a North American Free Trade Agreement, in P. M. Garber, (ed.). The U.S.-Mexico Free Trade Agreement, Cambridge, MA: MIT Press, pp. 13-56.

Harbaugh, W. T., A. Levinson, and D.M. Wilson (2002). Reexamining the Empirical Evidence for an Environmental Kuznets Curve, *Review of Economics and Statistics* 83: 541-551.

Hettige, H., Mani, M. and Wheeler, D. (1997). Industrial Pollution in Economic Development: Kuznets Revisited. Policy Research Working, Paper 23, The World Bank. Geneva.

Iwata, H., Okada, K., and Samreth, S. (2009). Empirical Study on Environmental Kuznets Curve for C02 in France: the Role of Nuclear Energy. *Energy Policy*, 38, 4057-4063.

Johansen, S. (1995). Likelihood-Based Inference in Cointegrated Vector Autoregressive Models. Oxford University Press, Oxford.

Kamande, W. (2007). Environmental Conservation as an Engine for Economic Growth: Testing the Validity of Environmental Kuznets Curve on Carbon Emissions for Kenya. Unpublished MA Thesis, University of Dares Salaam.

Kuznets, S. (1955). Economic Growth and Income Inequality, *American Economic Review* 45(1): 1-28.

Lindmark, M. (2002). An EKC-Pattern in Historical Perspective: Carbon Dioxide Emissions, Technology, Fuel Prices and Growth in Sweden, 1870-1997. *Ecological Economics Journal, 42(3): 33-47.*

Lopez, R., and Mitra, S. (2000). Corruption, Pollution and the Kuznets Environment Curve. *Journal of Environmental Economics and Management,* 27:163-184.

Martino D., and Zommers, Z. (2007). Environment for Development. World Commission on Environment and Development (WCED), Oxford University Press, Oxford

Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis.* Island Press, Washington, DC.

Monty G. Marshall and Keith Jaggers. 2010. Polity IV Project: Political Regime Characteristics and Transitions, 1800-2010. Version p4v2010. College Park, MD: Center for International Development and Conflict Management, University of Maryland.

Olusegun, O.A. (2009). Economic Growth and Environmental Quality in Nigeria: Does Environmental Kuznets Curve Hypothesis Hold? *Environment Research Journal, 3 (1): 14-18.*

Panayotou, T. (1997). Demystifying the Environmental Kuznets Curve: Turning a Black Box into a Policy Tool, *Environment and Development Economics* 2: 465-484.

Panayotou, T., A. Peterson, and J. Sachs (2000). Is the environmental Kuznets curve driven by structural change? What extended time series may imply for developing countries, CAER II Discussion Paper 80.

Panayotou,T. (1995). Environmental Degradation at Different Stages of Economic Development', in I. Ahmed and J.A. Doeleman (eds.), Beyond Rio: The Environmental Crisis and Sustainable Livelihoods in the Third World, London: Macmillan, pp. 13-36.

Paritosh, C., Ghosh and Dilip, D. (2003). Re-examining Economic Growth-Environment Relationship: Evidence from High, Medium and Low-Income Countries: Sydney University Press.

Pearce, D., Barbier, E and Markandya, A. (1990). Sustainable Development: Economics and Environment in the Third World. London: Edgar Elgar.

Perman, R. and D. I. Stern (2003). Evidence from Panel Unit Root and Cointegration Tests that the Environmental Kuznets Curve Does Not Exist, *Australian Journal of Agricultural and Resource Economics* 47: 325-347.

Pesaran, M.H. and Y. Shin (1999), An Autoregressive Distributed Lag Modelling Approach To Cointegration Analysis. In: Storm, S. (ed.), *Econometric and Economic theory in 20th Century,* The Ragnar Frisch Centennial Symposium. Cambridge: Cambridge University Press.

Pesaran, M.H., Y. Shin and R. Smith (2001), Bounds Testing Approaches to the Analysis of Level Relationships, *Journal of Applied Econometrics,* 16: 289-326.

Raymond, L. (2004). Economic Growth as Environmental Policy? Reconsidering the Environmental Kuznets Curve, *Journal of Public Policy* .24 (3): 327-348.

Republic of Kenya (RoK), National Environment Policy, 2012 . Government Printer. Nairobi.

Shafik, N. (1994). Economic Development and Environmental Quality: an Econometric Analysis, *Oxford Economic Papers* 46: 757-773.

Shafik, N. and S. Bandypadhyay (1992), Economic Growth and Environmental Quality: Time series and Cross Sectional Evidence. Background paper for World Development Report, World Bank, Washington D.C.

Shahbaz, M., Jalil, A., and S. Dube (2010). Environmental Kuznets Curve (EKC): Times Series Evidence from Portugal, University, Islamabad, Pakistan, California State University, Sacramento (CSUS),Sacramento, CA, USA.

Stern, D.I. (2002). Explaining changes in Global Sulfur Emissions: An Econometric Decomposition Approach, *Ecological Economics* 42: 201-220.

Stern, D.I. (2004). The Rise and Fall of the Environmental Kuznets Curve, *World Development* 32(8): 1419-1439.

Stern, D.I. and M.S. Common (2001). Is There an Environmental Kuznets Curve For Sulfur? *Journal of Environmental Economics and Management* 41 (2): 162-178.

Stern, D.I., M.S. Common, and E.B. Barbier (1996). Economic Growth and Environmental Degradation: The Environmental Kuznets Curve and Sustainable Development, *World Development* 24(7): 1151-1160.

Taylor, M.S. and W. Brock (2004). Economic Growth and the Environment: A Review of Theory and Empirics, Department of Economics Discussion Paper 2004-14, University of Calgary.

Torras, M. and Boyce, J. K., (1999). Income, inequality, and pollution: A Reassessment of the Environmental Kuznets Curve. *Ecological Economics (25):* 147-160.

Usenobong F., A. and A.C. Chuku (2011). Economic Growth and Environmental Degradation in Nigeria: Beyond the Environmental Kuznets Curve, University of Uyo, Nigeria

Vincent, J.R. (1997). Testing for Environmental Kuznets Curves within a Developing Country. *Environmental and Development Economics (2):417-431*

Wooldridge, J.M. (2002). Econometric Analysis of Cross Section and Panel Data. 7th ed. Massachusetts Institute of Technology: Massachusetts.

World Bank World Development Indicators: World Bank. World Development Indicators 2012 [CD-ROM], Washington, DC: World Bank [Producer and Distributor], 2012.

APPENDIX

	Polity	Agric	Man	Serv	GDPpc	GDPpc2	GDPpc3	C02pc
1970	-7	33	12	47	291	84,681	24,642,171	161.51
1971	-7	31	13	48	343	117,649	40,353,607	139.94
1972	-7	35	11	44	388	150,544	58,411,072	113.40
1973	-7	35	12	44	396	156,816	62,099,136	111.11
1974	-7	35	13	44	397	157,609	62,570,773	110.83
1975	-7	34	12	46	386	148,996	57,512,456	119.17
1976	-7	38	11	43	380	144,400	54,872,000	113.16
1977	-7	42	11	40	401	160,801	64,481,201	99.75
1978	-7	37	12	43	413	170,569	70,444,997	104.12
1979	-6	35	12	46	428	183,184	78,402,752	107.48
1980	-6	33	13	47	435	189,225	82,312,875	108.05
1981	-6	32	12	47	435	189,225	82,312,875	108.05
1982	-7	33	12	47	425	180,625	76,765,625	110.59
1983	-7	34	12	46	414	171,396	70,957,944	111.11
1984	-7	34	12	47	406	164,836	66,923,416	115.76
1985	-7	33	12	48	408	166,464	67,917,312	117.65
1986	-7	33	12	48	421	177,241	74,618,461	114.01
1987	-7	32	12	50	431	185,761	80,062,991	116.01
1988	-7	30	12	51	441	194,481	85,766,121	115.65
1989	-7	30	12	51	446	198,916	88,716,536	114.35
1990	-7	30	12	51	450	202,500	91,125,000	113.33
1991	-5	28	12	52	441	194,481	85,766,121	117.91
1992	-5	29	11	53	424	179,776	76,225,024	125.00
1993	-5	32	10	52	412	169,744	69,934,528	126.21
1994	-5	33	11	49	410	168,100	68,921,000	119.51
1995	-5	31	10	53	416	173,056	71,991,296	127.40
1996	-5	31	13	51	421	177,241	74,618,461	121.14
1997	-2	31	13	51	412	169,744	69,934,528	123.79
1998	-2	31	12	51	415	172,225	71,473,375	122.89
1999	-2	32	11	51	414	171,396	70,957,944	123.19
2000	-2	32	12	51	406	164,836	66,923,416	125.62
2001	-2	31	11	51	411	168,921	69,426,531	124.09
2002	8	29	11	53	402	161,604	64,964,808	131.84
2003	8	29	11	53	403	162,409	65,450,827	131.51
2004	8	28	11	54	413	170,569	70,444,997	130.75
2005	8	27	12	54	426	181,476	77,308,776	126.76
2006	8	27	12	55	441	194,481	85,766,121	124.72
2007	7	25	12	56	461	212,521	97,972,181	121.48
2008	7	26	12	54	456	207,936	94,818,816	118 42