Faculty of Environmental Sciences and Process Engineering. International Study Course:

Environmental & Resource Management

DOCTORAL THESIS

MEASURING PROGRESS TOWARDS SUSTAINABLE FOREST MANAGEMENT AND POLICY IMPLICATIONS:

A CASE STUDY OF THE HIGH FOREST ZONE IN GHANA

A thesis approved by the Faculty of Environmental Sciences and Process Engineering, Brandenburg University of Technology (BTU), Cottbus-Germany in partial fulfillment of the requirements for the award of the degree Doctor of Philosophy (Ph.D.) in Environmental Sciences

by

Edward Kweku Nunoo
M.Sc, BA(Hons), DipEd

(Born in Winneba, in the Central Region of the Republic of Ghana)

Supervisors:
Prof. Dr.Dr. *hc* Michael Schmidt
Prof. Dr. Daniel Baier

Date of Defense:
30.06.2010

DECLARATION

I hereby declare that this PhD thesis is the result of research work carried out by myself at the Brandenburg University of Technology (BTU)-Cottbus, within the confines of the International Doctorate Programme, ´Environmental and Resource Management` at the Department of Environmental Planning under the supervision of Prof. Dr. Dr. *h.c* Michael Schmidt and Prof. Dr. Daniel Baier, at the Chair of Marketing and Innovations Management. Except for references cited, which serve as sources of secondary information (for which I have duly acknowledged), it is not a reproduction in part, or in whole of any work ever presented for the award of a degree. I am therefore solely responsible for any omissions, errors of reasoning and presentation of facts.

Edward Kweku Nunoo

…….....

BTU, Cottbus (Germany)

DEDICATION

To God be the Glory!

This thesis is dedicated to my brother, the late Francis Kobina Nunoo, whose financial support saw me through up to this level. May his soul rest in perfect peace.

ACKNOWLEDGEMENT

My sincerest appreciation, with a joyful heart, goes to all and sundry who contributed to making this PhD research a reality.

Special thanks go to my family (Hagar and Michael), Isaac, John, Grace and Joe, who supported me whole heartily towards the realization of this academic goal. It was a difficult decision to make. Nevertheless, having braved all odds, another hurdle has been bridged. May God richly bless you. I should also put on record the immense help I received from the universities in both countries, Ghana (University of Cape Coast, Legon and KNUST) and Germany (BTU-Cottbus, Freiburg, and Stuttgart) who furnished me with some valuable information needed for this study. The list is endless. To the Ghana Government Ministries of Environment, Science and Technology, Lands and Forestry, the Environmental Protection Agency, the Resource Management Support Centre of the Forestry Commission, the Forestry Commission secretariat in Accra, and the Ministry of Tourism, I say kudos.

I am also grateful to my indefatigable lecturers and the supervisory team, Professor Dr. Dr. *h.c* Michael Schmidt and Professor Dr. Daniel Baier, at the Chair of Marketing and Innovations Management, who patiently and meticulously, supervised this work and without whose suggestions and guidance this study would not have been possible.

However, I must emphasis that any short comings, marginal or substantial, which may be found in the text to this work are solely mine.

Edward Kweku Nunoo

.....
BTU, Cottbus
Germany

TABLE OF CONTENTS

List of Tables

List of Figures

ABSTRACT

Sustainable forest management in 1992 was recognized by the United Nations Conference on Environment and Development as the most important contribution the forestry sector can inject into any sustainable development initiative. The author's extensive literature review established this as the premise on which Ghana's quest for sustainable economic growth and development strategies is being implemented. Since embarking on this endeavour, conscious efforts have been made to define essential components of forest resources against which sustainability assessments could be performed in Ghana.

The conceptual framework of the present research rests on FAO's concept on criteria and indicators as useful tools in monitoring progress towards sustainable forest management and resource-use. In addition, an empirical approach seeks to elicit answers from staffs involved in the management of natural resources as well as from other stakeholder groups in order to address four pertinent questions as; *i.* the specifics of forest management practices and policies that exist in Ghana's high forest zone, *ii.* interactive forces that come into play with the identification and development of national level criteria and indicators for sustainable forest management, *iii.* who constitute the stakeholders and lastly, *iv.* the extent to which progress towards sustainable forest management has been achieved and in which direction it is moving.

First a quantum of forest management policy documents were reviewed out of which applicable criteria and measurable indicators, specific to the high forest zone of Ghana, were identified. Together with stakeholder's involvement, performance scores were established for indicators identified within the trio-sectors *(forest ecosystem, forest communities and the economy)* for sustainability assessments. Based on actual performance scores, measures of successes towards sustainable forest management operations were quantitatively performed with estimated maximum and minimum thresholds levels at which resource-use would be sustainable using the *measure of forest resource-use sustainable scale-MoFRUSS.*

Outcomes of these measurement operations, as depicted on the scale, revealed the actual extent to which stakeholder's initiatives, towards sustainable forest management have progressed and in which direction they are moving. The study also offers optional policy baskets for resource management interventions from which the *Socio-eco-Economy* bundle is the most recommendable if the environmental aspect of Ghana's Vision 2015 *(sustainable development)* is to be achieved; with improved societal well-being, improved environmental health and vitality and improved economic growth and development.

The study concludes with recommendations to both policy makers and the other vested stakeholders a viable opportunity which could be harnessed to improve on management's performance through avoided deforestation.

Keywords: *Sustainable forest management, performance indicators, progress towards SFM, measures of successes, policy implications, avoided deforestation, climate change mitigation, sustainable development, vision 2015.*

Zusammenfassung

Die Konferenz der Vereinten Nationen über Umwelt und Entwicklung (UNCED) erklärte bereits 1992 *nachhaltige Waldbewirtschaftung* zum wichtigsten Beitrag, den die Forstwirtschaft im Kontext nachhaltiger Entwicklung leisten könne. Wie das eingehende Studium der relevanten Fachliteratur zeigt, ist dies auch das Leitbild, an dem sich Ghanas Streben nach einer nachhaltigen ökonomischen Wachstums- und Entwicklungsstrategie orientiert. Seither sind in Ghana gezielte Bemühungen feststellbar, durch das Identifizieren entscheidender forstlicher Ressourcen ein Referenzystem für Nachhaltigkeitsprüfungen zu schaffen.

Das Rahmenkonzept der vorliegenden Forschungsarbeit beruht auf dem Grundgedanken, bestimmte Kriterien und Indikatoren als Maßstab zur Erfolgskontrolle für nachhaltige Wald- und Ressourcenbewirtschaftung heranzuziehen. Durch den empirischen Ansatz der Untersuchung werden relevante Fragen direkt von Vetretern des zuständigen Managements sowie sonstigen Interessengruppen („Stakeholdern") beantwortet. Dies betrifft Themen wie: *i.*die für Ghanas Hochwaldregionen spezifischen Waldbewirtschaftungskonzepte und -praktiken, *ii.* die Wechselwirkungen, die bei der Festlegung und Entwicklung von landesweit gültigen Kriterien und Indikatoren für nachhaltige Waldbewirtschaftung auftreten, *iii.* wer die Interessengruppen im Einzelnen sind sowie letztlich, *iv.* welche Fortschritte hinsichtlich nachhaltiger Waldbewirtschaftung gemacht wurden und in welche Richtung die Entwicklung geht.

Zunächst wurden verfügbare Dokumente zu Forstmanagementkonzepten analysiert, aus denen heraus speziell für die ghanaischen Hochwaldregionen geeignete Kriterien und meßbare Indikatoren abgeleitet werden konnten. Bezogen auf Indikatoren für drei Sektoren – Waldökosysteme, betroffene (Wald-)Gemeinden und wirtschaftliche Aktivitäten – wurden Bewertungsskalen für eine Nachhaltigkeitsprüfung entwickelt. Dieser Arbeitsschritt geschah in Kooperation mit Stakeholdergruppen. Auf Grundlage der so entstandenen „Measure of Forest Resource-use Sustainability Scale" (Skala zur Bewertung von nachhaltiger Waldnutzung – kurz MoFRUSS) wurden daraufhin tatsächliche Aktivitäten zur nachhaltigen Waldbewirtschaftung quantifizierend bewertet, einschließlich der geschätzten oberen und unteren Schwellenwerte, ab wann Ressourennutzung als nachhaltig gelten kann.

Die unter Anwendung vom MoFRUSS erzielten Untersuchungsergebnisse offenbaren den Umfang, in dem Initiativen zur nachhaltigen Waldbewirtschaftung mittlerweile Fortschritte gemacht haben sowie die Richtung, in der sie sich bewegen. Desweiteren verweist die Studie auf mögliche Optionen für politische Maßnahmen im Rahmen von Ressourcenmanagement, von denen das so genannte sozial-ökologisch-ökonomische Paket nahe gelegt wird, damit die Umweltziele von Ghanas „Vision 2015" (Förderung des Gemeinwohls, der Umwelt und der wirtschaftlichen Entwicklung) erreicht werden können.

Die Arbeit schließt mit Handlungsempfehlungen für die Politik wie auch für andere maßgebliche Interessengruppen und bietet so einen potentiell aussichtsreichen Ansatzpunkt, um Managementleistungen durch die Vermeidung von Waldzerstörung weiter zu verbessern.

Schlüsselbegriffe: *Nachhaltiges Forstmanagement, Leistungsindikatoren, Fortschritt hin zu SFM, Erfolgsindikatoren, Implikationen für Strategien, vermiedene Rodung, Klimawandel Minderung, nachhaltige Entwicklung, vision 2015*

LIST OF ABBREVIATION

ATO	African Timber Organization
CSCE	Conference on Security and Cooperation in Europe
CSD	Commission for Sustainable Development
DPSIR	Driving Force State Impact Response
ERP	Economic Recovery Programme
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GIS	Geographic Information Systems
ITTO	International Tropical Timber Organization
IUCN	International Conservation Union
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MLF	Ministry of Lands and Forestry
NGO	Non Governmental Organization
SFM	Sustainable Forest Management
MCA	Multi-Criteria Analysis
MoFRUSS	Measure of Forest Resource-Use Sustainability Scale

1.0 INTRODUCTION

1.1 AN OVERVIEW

The concept of sustainability, although cumbersome to actually define, has been accepted globally by forest resource managers and policy makers as an appropriate medium for the fight against the fast eroding resource base vi-sa-vis its multi-facet functions. Use of forest resources and assessment of progress towards its sustainability, over the years by conventional forest management practices, has not yielded successful results. Outcome of credible reports such as the forest resources assessment of the Food and Agriculture Organisation (FAO, 2005b), International Tropical Timber Organisation's report (ITTO, 2005) on tropical forest management and the Millennium Ecosystem Assessment (MEA, 2005) all indicate that global forest cover continue to dwindle on a daily bases at a rate of 25,000 hectares[1] with the magnitude weighing more on tropical forests.

The present condition of forest resources in developing countries couldn't have been any much better situation as degradation is even more pronounced. However, with inception of the criteria and indicators processes (Rebugio, 2000; 1998) which digress from conventional forest management practices and majors on resource-use in perpetuity involving stakeholders from the trio sectors[2], some emerging progress on resource sustainability in this direction has been recorded.

Several basic sets of criteria and indicator processes have been hierarchically (global, regional, national, forest management unit) developed for the management of all type of forests (appendix 10.1a, 10.1b). Ghana has participated in a number of such processes, notably, within the International Tropical Timber Organisation and Africa Timber Organization initiatives with some credible achievements although the new paradigm is still in its infancy and an on-going process. This research is intended to assess Ghana's progress of performance over the last two decades towards sustainable forest management by way of the criteria and indicators prognosis.

[1] Toure Moctar, Global Environmental Facility team leader on land & water resources of the World Bank, USA.
[2] The trio sector refers to the ecosystem, economy and social fabric.

1.2 CRITERIA AND INDICATORS FOR SFM AND POLICY IMPLICATIONS

Sustainable forest management (SFM) is recognized by the United Nations Conference on Environment and Development (UNCED) as the most important contribution the forestry sector can inject into sustainable development objectives of any country (UNED, 1992). The role of SFM as a key element in sustainable development equations has already been identified and enshrined by UNCED under its forest policy provisions. Subsequent action plans developed by this body thereafter, according to CAB International (2001), have all been vociferously explicit on such forest management approach with chapter eleven (11) of the blueprint, *'Combating Deforestation'* specifically addressing it. Section 22b of the above mentioned document entreats all governments, at the national level, to pursue in cooperation with special interest groups and international organizations, "the formulation of scientifically sound criteria and guidelines for the management, conservation and sustainable development of all forest types" (UNCED, 1992).

Since such awareness the right to use natural resources in Ghana has been equally challenged by a high sense of eco-stewardship, not only to the appeasement of international organizations in order to score global political points, but also to the enhancement of her socio-economic growth and development indicators and raise the well-being of forest communities. Accessions from political podiums as well as documents emanating from natural resource management related ministries, the forestry commission, non-governmental bodies and independent studies, over the last two decades, all seem to suggest that Ghana has clocked some successes in defining essential components of her forests resource base against which its sustainability could be assessed. Translating this into achievable and measurable management targets policies have been periodically reviewed to ensure that the resource base is maintained or enhanced but not to be further eroded.

The study agrees with the underlying principles of the new forest management paradigm which sees the wisdom in the collective use of criteria and indicators as a tool in tracking performance progress (FAO, 2001) towards a nationwide sustainable forest management program. It also subscribes to the numerous proliferations of conventions and treaties on biodiversity, conservation and environmental care (appendix 10.1c) with the understanding that arriving at appropriate criteria and indicators will present a formidable and an efficient system by which scientifically based and reliable data on the state of the forest (Cook et.al, 1999) could be

identified, analysed and disseminated. Such information would be deemed useful to decision makers in devising strategic policy framework towards achieving sustainable forest management.

1.3 PROBLEM FORMULATION AND RESEARCH QUESTIONS

Formal forest management practices in Ghana date as far back as the early 1900s with the colonial masters[3]. In 1927 administration of the forest was backed by legal tender (Munasinghe et al., 1994) and since then policies consistent with selection of tree species, demarcation and creation of reserves have been vigorously pursued. These over the years have tested the times and revised to meet evolving forest resource management expectations.

Since the 1980s the sector has been under a ministerial portfolio with a comprehensive master plan rolled out for wildlife and forests resources and an institutional framework that demands for policy analysis, evaluation and monitoring. The process with time has generated into stakeholder management initiatives under a collaborative effort that succumbs to active participation by forest communities. Today meticulous standards and threshold limits exist for major forest resource-use harvesting. A certification scheme also applies for timber products making exports of round logs a thing of the past. This puts Ghana on the world map as one of the emerging countries in the World to be making headway towards sustainable forest management.

However, no quantitative criteria and indicator measurements has been performed in Ghana, at the national level, to determine actual extent to which sustainable forest management has progressed so far, in which direction it is moving and policy implication for sustainable development. The central question posed by this study thus turn to reflect the main goal which is expressed in the objectives of the research. It has it that quest for a progressive economic growth and development, land access and tenure systems, socio-cultural factors and market pressures, directly or indirectly, dictate the pace of deforestation and its related environmental degradation problems in Ghana.

With a shift in paradigm from the traditional forest management principles towards a more participatory approach (sustainable forest management) there is the need therefore, according to Clark et al (2000), to pursue strategic programs that give flesh to bare policies, mainstream management institutions and physical capacity buildings to be able to handle data collection and

[3] The British colonised and ruled Ghana (Ghana was then called the *Gold Coast*) until her independence in 1957.

analysis with minimum subjectivity. Thus, the research investigations are guided by the following questions which unfolded with the development of postulating a hypothesis as;

1. **What type of forest management practices exist in Ghana?** These synergies guided investigations into forest management systems and policies that have been pursued since colonial times until now. The essence is to look at lessons learnt and implications for collaborative forest management by stakeholders as well as opportunities for improvement.

2. **What are the forces that come into play with the identification and development of national level criteria and indicators for sustainable forest management?** According to the United Nations Commission on Environment and Development (UNCED, 1992) the environment, economy and society's jux-ta-positions cannot be compromised with such an exercise. This question gave insight into the interconnections or inconsistencies within the ecosystem's integrity, economic gains and dynamics of the social fabric.

3. **To what extent and in which area(s) has progress towards sustainable forest management been achieved?** A prognosis on measures of success, using criteria and indicators was performed. Its significance relates to appropriate policy formulations which will accelerate the drive towards achieving the overall environmental aspects of sustainable development (Ghana's version of agenda 21 implementation is called *Vision 2015*) objective in the case study region.

1.4 BOUNDARY CONDITIONS

A number of assessment options exist which are also acceptable for a research design and development of this nature. However, the focus of this exercise is directed towards an analytical assessment of sustainable forest management that see ecological enhancement, economic gains and societal well-being as intertwined, and a combined catalyst in the new forest management paradigm relevant to the achievement of the environmental aspects of Ghana's vision 2015 objectives.

The boundary conditions are a sort of controlled environment under which the study is carried out and therefore the outcome(s) of this research is (are) indicative of such conditions. The

specifics are categorised into two and confined within the criteria and indicator hierarchical subject matter and the Brandenburg University of Technology Cottbus Environmental and Resource Management International Programme as outlined below;

I. Content specifics:

The content limitations are subject related to;

a. The identification of applicable and measurable national scale criteria and indicators for Sustainable Forest Management.
b. Measures of success operations towards pursuing sustainable forest management goals.
c. Appropriate forest management policies to combat land degradation and climate change.

II. Procedural framework:

Procedural framework is confined to conditions governing the PhD International Programme *'Environmental and Resource management'* at Brandenburg University of Technology (BTU) in Cottbus, Germany. These include;

a. The PhD research time frame: a six academic semester (3 years) period.
b. Field-work: a three to six month period field exercise for data collation.
c. Research seminars, colloquiums and workshops
d. Conference(s) and internship(s).
e. Examination and oral defence of PhD thesis.

1.5 JUSTIFICATION OF STUDY

There is a need to sustain the dwindling natural forest resources since according to Kotey et al. (1998) they satisfy a lot of our basic necessities. These include shelter and fuel-wood utilization, provision of medicinal plants, erosion control, scenic protection, global warming control and foreign exchange earnings. Ghana has basically an agrarian economy. About 70 % of all economic activities, according to Armstrong (2008), are directly related to extractions from natural resources, making interactions with the forest a way of life for majority of Ghanaians (Larsen, 2006) living in the peripheries.

The original 8,525,063 million hectares of forested lands as estimated by the Forestry Services Department of the Forestry Commission of Ghana a century ago have been reduced to a mere 1,578,990 million hectares (FSDFC, 1999). The resource base in Ghana continues to dwindle at an alarming rate of 1.7% every year (FAO, 2005a). As an attempt at arresting the situation several initiatives aimed at 'best practices' for taking care of the forest ecosystem have been undertaken. Rectification of a host of treaties and conventions (appendix 10.1c) on environmental protection has also taken place. This re-thinking on natural resource-use and a paradigm shift in management options open up the desire for fringe forest community's participation in the decision making process to become complete.

Since the actual extent of sustainable forest management in Ghana still remains elusive it is envisaged that this research will be a medium through which informed decisions on criteria and indicator methodology, appropriate sustainable forest management policy pathways, implementation, monitoring and evaluation gaps could be bridged. The study also show collaboration between all stakeholders, the relationship between socio-economic and ecological indicator perspectives in the drive towards sustainable development and assess the actual extent to which sustainable management of the forest resource have been achieved.

1.6 RESEARCH GOAL AND OBJECTIVES

The main goal of this thesis is to perform a measure of successes assessment on progress made towards achieving sustainable forest management. It investigated mechanisms (working documents) and policies in place for managing forest resources in perpetuity, and extent to which resources are been managed on sustainable basis and in which direction it is moving. Additionally it assessed and evaluated government's involvement and institutional framework to support management of the forestry sector towards resource-use sustainability. Specifically, the study;

a. Evaluated the socio-economic dynamics involved with the flow of resource utilization in order to account for changes in the resource base vis-à-vis management strategies.
b. Identified and assessed appropriate criteria and indicators for sustainable forest management, specific to forest resource use in Ghana.
c. Performed a measure of successes operation on progress made towards sustainable forest management over the last two decades and assessed its implications for policy direction in Ghana.
d. Made recommendations to policy makers and resource persons other optional policy interventions necessary to put forest management on a desired sustainable path.

1.7 RESEARCH DESIGN AND STRATEGY

The research is designed to dwell on in-depth literature review involving desk studies on forest policy mechanisms, institutional setups and frameworks on criteria and indicator initiatives aimed at achieving sustainable forest management globally and welfare economics. However the specifics were narrowed down to tropical countries in order to investigate the possibilities of applying findings in Ghana to other tropical countries where multiple uses of forest resources also have significant impact on environmental degradation. The research is structured to identify and select appropriate criteria and indicator sets to test conclusions reached in the study towards sustainable forest management in the High Forest Zone of Ghana.

1.7.1 Data Base Sources

Two main data sets were investigated; data from the case study region and from the rest of the world. The database, which was generated from a wide array of sources, emanated from government ministries and agencies, timber companies, forest communities, non-governmental organizations (NGOs), universities and research institutions, books and publications in specialized magazines and from the general media. Other documents from the rest of the world examined came from;

- Official texts of other country´s government policies, legislations, executive instruments and framework on sustainable forest management.
- International conventions and treaties on sustainable forest management in tropical countries including UNCED and ITTO.
- Monitoring and evaluation reports on sustainable forest management from international bodies such as ITTO, ICUN and UNO.
- Progress reports and analysis of current forest management practices undertaken by the Food and Agricultural Organization, African Development Bank and the World Bank.

1.7.2 Methodology

The research mainly employed the following methods: desktop studies (literature review), interviews, questionnaires, and field assessments. The theoretical base of the research is centered on review of copious literature texts bordering on forest management practices, sustainability issues, welfare economics, identification and development of criteria and indicators for sustainable forest management, deforestation and climatic change. Structured questionnaire (appendices 10.2a, 10.2b, 10.2c, 10.2d, 10.2e), in both opened and closed forms, were administered to five leading institutional setups responsible with forest resource-use sustainability in Ghana to collate data. These are the Ministries of Lands and Forestry, Science, Environment & Technology, the Environmental Protection Agency, Forestry Commission and opinion leaders in Fringe Forest Communities. Sector and Departmental heads of Agencies and Non-Governmental Organizations who deal with related issues were also solicited for working documents, data and their views on forest resource-use and the necessary measures needed to

sustain them. Field exercises were undertaken to ascertain primary information on site-specific projects related to harvesting standards and forestry projects in the northern and southern sectors of the high forest zone.

Data generated from the survey were analyzed and synthesized, quantitatively and qualitatively, to fulfill objectives of the study using the latest micro-soft word processor. Micro-soft excel and mathematical equation data were used in analysing quantitative information.

Geographic Information System (GIS) spatial outlay maps were also obtained for the analysis. Interrelations between elements in the forestry sector and stakeholders were determined using stakeholders participatory hierarcharization matrix and the resultant graphically presented.The findings have been analytically documented and visualized in different steps useful for sustainable forest management policy inventories, analysis and strategic decision-making. It is expected that at the end of this exercise, the research findings will; *a.* play a useful role in enhancing adaptive management policies needed in tropical forest resource-use, *b.* contribute to managing the multi-facet usage of Ghana's forest resources in perpetuity, *c.* serve as a useful guide to the government ministries and agencies, consultants, environmental and resource management students, environmentalists and fringe forest community opinion leaders and d. would be useful in setting up a globally accepted framework for assessing natural resource values, goals, reporting as well as monitoring appropriate actions for achieving SFM.

1.7.3 Instruments

Three internationally recognized decision support tools were employed. These are;

1. The Biomass growth function: The biomass growth function is used to model dynamics associated with species population capable of renewing themselves over a given period of time (US DOE & USDA, 2005). Its relevance for this thesis dwells on Schaefer´s approach (1957) to the subject in predicting extent of intact forest cover in the high forest zone over time. The biomass growth function is established as biomass growth (timber stock increment) depends on the volume of biomass stock at any given time**.** The growth function is assumed to exhibit the following properties;

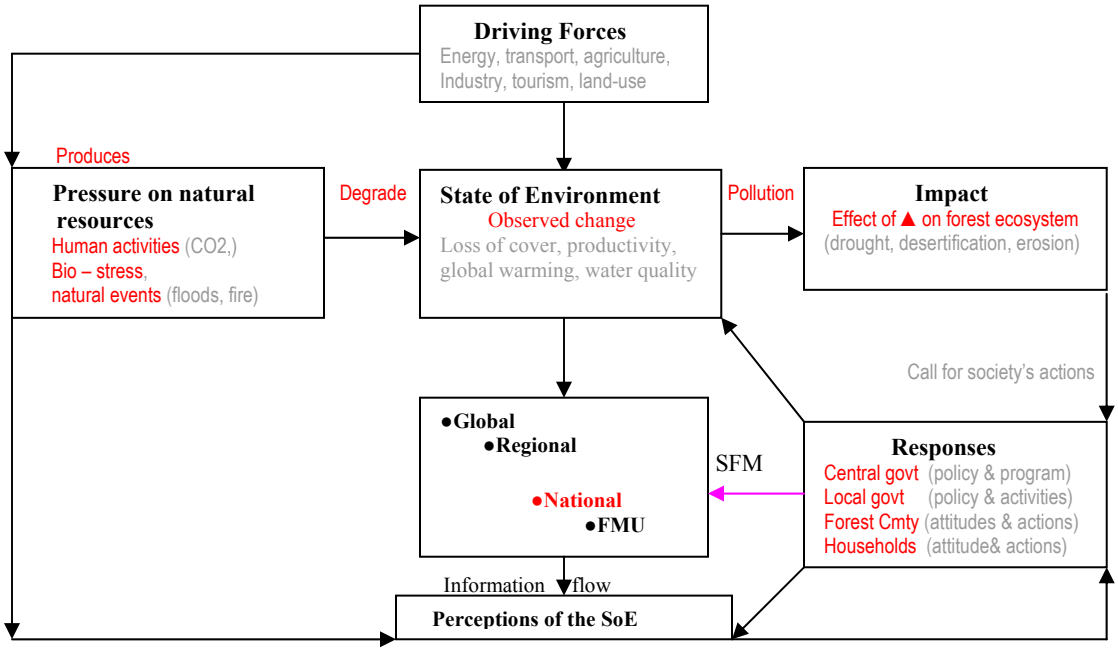
i. Timber stock will continue to grow over the given period of time as long as the volume of biomass stocks are maintained and does not approaches *depletion limits* or completely depleted.

ii. If the first condition is true then, all things being equal, timber stock will ceases to grow over time when the population size of biomass stock become completely depleted or is equal to zero.

iii. The marginal rate of timber stock growth (additions to timber stock) will be monotonous assuming conditions *(i)* and *(ii)* are satisfied.

2. The DPSIR Framework: The driving force, pressure, state, impact, response (DPSIR) is used here as a tool to identify and analyze relationships (Hass et al., 2002) that exist between socio-economic dynamic inter-play in the forest ecosystem. The following scenario persist (figure 1.1); drivers of forest resources (agriculture, energy, land-use, wood industry, transport) mounts pressure (rapid population growth forces people to clear the land for their livelihood) on the environment and degrade the state of the forest environment (loss of cover, productivity, global warming, quality of water) at the national level This impacts the forest ecosystem negatively (drought, desertification, erosion) calling for society to respond.

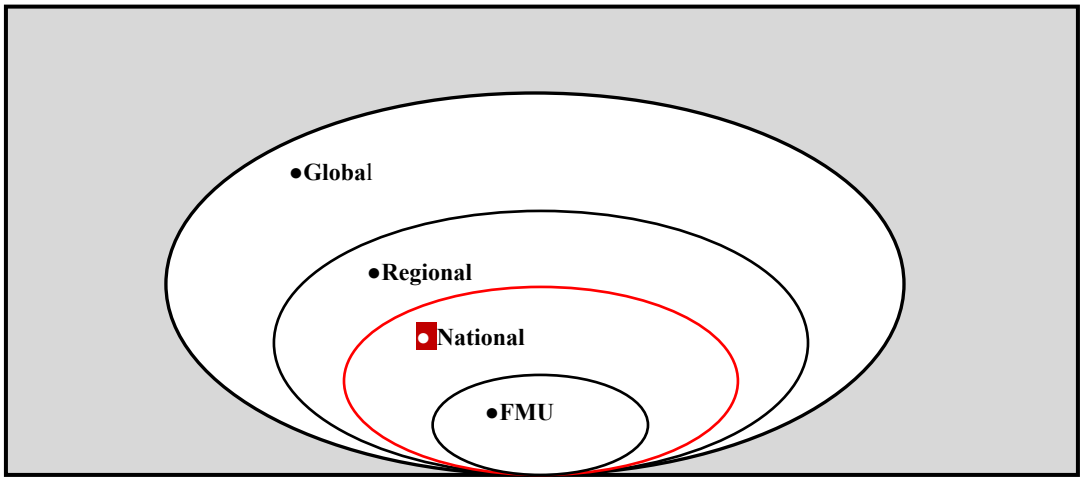
Figure 1.1 A schematic DPSIR framework of natural resources in Ghana



Source: Based on Hass et al, 2002

3. The Hierarchical frame-work of criteria and indicators for SFM: A major breakthrough in finding a solution to the standardization of forest management at the global level is assumed to be found within the hierarchical framework of criteria and indicator processes (FAO, 2005b) as illustrated by figure 1.2. The framework provides critical information to forest managers and other stakeholders for making forest related decisions at the various levels; the forest management units (FMU), national, regional and the global level. With regards to this thesis the dynamic situation at the national level is of importance because specific indicator sets identified will be helpful in measuring the extent of sustainability of forest management in the high forest zone of Ghana.

Figure 1.2 Hierarchical framework of Criteria and Indicators for SFM



Source: Based on FAO, 2005b; FMU=forest management units

1.8 DEFINITION OF KEY TERMS

Sustainable Development (Sd): is the ability to maintain something over time. However, following discussions on the limits of growth in the 1970s, the Brundtland Report in 1987, and the Earth Summit at Rio de Janeiro on Environment and Development in 1992, sustainable development is widely accepted within the confines as development that meets the needs of the present inhabitants without compromising the ability of future generation to meet their own needs" (WCED, 1987).

Sustainable Forest Management (SFM): is a management system that maintains forest's critical ecological functions and biological diversity, and minimizes the adverse impacts of human activity so as to ensure the availability of forest goods and services in perpetuity for the use of present as well as future generations (Rebugio L., 2000).

Biological Diversity (Bd): hitherto referred to as biodiversity is the viability among living organisms from all sources including, *inter alia* terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part: This include diversity within species, between species and of ecosystems (Norton, 2001).

Forest Management Unit (FMU): is a clearly defined forest area, managed to a set of explicit objectives and according to a long-term management plan.

Criterion: is a set of conditions by which sustainable ecosystem management is assessed. Criteria define the essential components of forest management against which sustainability may be assessed in a given country or in a specified forest area in time and space. Emphasis is however put on the productive, protective and socio-economic roles of forests and forest ecosystems (FAO, 2005b). Each criterion identified will relate to a key element of sustainability and will be described by one or more quantitative, qualitative, or descriptive indicators.

An indicator: is a measurable aspect (parameter) of the criterion that is monitored periodically to assess change. In otherwise are quantitative, qualitative or descriptive parameters, which when periodically measured, may indicate the direction of change in a forest resource or forest

ecosystem. They correspond to a particular criterion and help to monitor the status and changes of forests values as they relate to specific forest ecosystems and definition of each criterion.

Criteria and Indicators: are tools collectively used to describe the systematic approach in measuring, monitoring, evaluating and reporting on sustainable forest management over time at both national and local levels.

Monitoring: is the periodic and systematic movement, and assessment of change with regard to an indicator.

Principle: is a fundamental law or rule as a guide to action; a rule of conduct (e.g. the fundamental role of forests in maintaining global ecological processes must be maintained).

Criterion: is a distinguishing characteristic of a thing by which it can be judged. Criteria provide the basic framework for policy formulation (e.g. protection of biodiversity and maintaining productive capacity of forest ecosystems).

Indicator: is any variable that can be measured in relation to a specific criterion (e.g. percentage area of unique forest types legally protected).

Extinct (Ex): a taxon is extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed extinct when exhaustive surveys in known and or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form (Conservation International, 2005a).

Extinct in the Wild (EiW): a taxon, according to Conservation International (2005a), is extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual) throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR): a taxon is critically endangered when the best available evidence indicates that it meets any of the specified in the *IUCN Red List Categories and Criteria* for critically endangered and is therefore considered to be facing an extremely high risk of extinction in the wild (Conservation International, 2005a).

Endangered (EN): a taxon is endangered when the best available evidence indicates that it meets any of the criteria specified in the *IUCN Red List Categories and Criteria* for endangered and is therefore considered to be facing a very high risk of extinction in the wild (Conservation International, 2005a).

Vulnerable (VU): a taxon is vulnerable when the best available evidence indicates that it meets any of the criteria specified in the *IUCN Red List Categories and Criteria* for vulnerable and is therefore considered to be facing a high risk of extinction in the wild (Conservation International, 2005a).

Sustained yield: the production of forest products in perpetuity, ensuring that the harvesting rate does not exceed the rate of replacement (natural and, or artificial) in a given area over the long term.

Stakeholders: persons or group of individuals who are directly or indirectly affected by, or interested in, a given resource and therefore have a stake in it.

Annual allowable cut: the amount of timber that is permitted to be harvested annually from a given managed forest.

Primary forest: is forest which has never been subject to human disturbance, or has been so little affected by hunting, gathering and tree cutting that its natural structure, functions and dynamics have not undergone any changes that exceed the elastic capacity of the ecosystem.

Environmental vitality: improved ecosystem's ability to support healthy organisms whilst maintaining its productivity, adoptability and capability for renewal.

Societal well-being: use of resources must conform to social norms lead to improved living standards of fringe forest community and at the same time does not stretch beyond a community's tolerance for change.

Economic growth and development: resource-use benefit leads to improved economic well-being of the nation as a whole and could be sustained and handed down to future generations.

1.9 STRUCTURE OF THESIS

The study is organized into a ten (10) - chapter report. It is expected that hopefully, in this way, it will guide the reader methodically towards the main concerns raised, attempt at addressing the issues, conclusion and recommendations made. An introduction to the study is outlined in details as chapter one (1). It gives readers insight into the schematic content of the report, research goal and objectives, steps and tools employed, database management, and expected result of the study.

In chapter two (2) a conceptual framework on natural resource-use and sustainable development is presented along the peripheries of environmental economics. Based on the conceptual framework five (5) theoretical constructs were proposed from which sustainable forest management indifference curves are derived. This paved way for a conceptual module to be postulated under the basic underlying principles of welfare economics. It formed the building blocks for the thesis and has three imperatives; a successful sustainable forest management as a means to achieving a key sustainable development objective (environmental aspect) in Ghana; enabling and or reinforcing policies, programs and strategies and appropriate tools for assessment modeled on Ghana`s millennium development goals (vision 2015).

A review of literature is presented in chapter three (3). After a concise synopsis on nature`s most bountiful but versatile green resources sustainable forest management is defined from a 3-tier dimensional perspective; forest ecosystem (environment), societal well-being and economic growth and development. It gives vivid account of the paradigm shift in forest management from the conventional approach, which has not achieved desired management result, to sustainable forest management which is filling in the gabs and summarized main differences between the old and new management systems. It probes further at attempts on measuring sustainable forest management using the criteria and indicators, prior to and during the Rio declaration and the post Rio era. It also brings to bear on Ghana`s attempt at managing her natural resources on sustainable basis. Highlights of major interventions captured include restoration of degraded lands, conservation and preservation of forest resources, establishment of standards and thresholds for harvesting. The use and importance of criteria and indicators are also stressed.

Using Ghana as a case study, chapter four (4) deals with the geographic location and situation, socio-economic indicators and justifies why the selected region under consideration was chosen for the research. A comprehensive look at the state of forest resources, their characteristics and type of management system in Ghana to ascertain evolution of management policies are outlined. Measures for the implementation of sustainable forest management in Ghana are also evaluated.

Chapter five (5) presents research methodology. First a quantum of forest management policy documents were reviewed out of which applicable and measurable criteria and indicators specific to the high forest zone of Ghana were identified. Together with stakeholder's involvement, performance scores were established for indicators identified within the trio-sectors *(forest ecosystem, forest communities and the economy)* for sustainability assessments. Based on actual performance scores, measures of successes towards
sustainable forest management operations were quantitatively performed with estimated maximum and minimum thresholds levels at which resource-use would be sustained using the Measure of Forest Resource-Use Sustainable Scale.

In chapter six (6) data analysis and presentation of results are summarized. It entails calibration of the measure of forest resources-use sustainability scale, determination of which position each indicator will occupy on the scale and its cumulative effects. Outcome of the measurement operations, as depicted by the scale, revealed actual extent to which stakeholder's initiatives towards sustainable forest management has progressed and in which direction it is moving. It also offered optional policy baskets for resource management interventions from which the *Socio-Eco-Economy* bundle is recommended if the environmental aspect of Ghana's Vision 2015 *(sustainable development)* is to be achieved; with improved societal well-being, improved environmental health & vitality and improved economic growth & development.

Chapter seven (7) brings to bear on the likelihood implications of such quantitative measurements on decision making at the policy level. Here opportunities for improvement on management policies associated with the outcome of the research which policy makers could explore to effectively achieve stated objectives, were discussed under the concept of avoided deforestation. Its prospects on climate change mitigations, degradation of forest cover and

income generation were further probed. Whereas chapters eight (8) outlines conclusion reached and recommendations made, chapter nine (9) and ten (10) chronicles all references and appendices.

2.0 "SUSTAINABLE FOREST MANAGEMENT" AND "KNOWN CRITERIA AND APPROACHES FOR MEASURING SUSTAINABILITY"

2.1 BACKGROUND

Forests and its ecosystem dynamics constitute nature's most bountiful and versatile natural resources (Nunoo, 2008). Tropical forests epitomise its diversity as they contributes to a wide range of environmental, economic and socio-cultural benefits. While forests resources play important economic role in developing countries by way of employment, income generation and foreign exchange earnings, its significance in industrialized nations cannot also be overemphasized. According to Nunoo (2008), they satisfy a wide range of basic human needs such as food, energy, fodder, shelter, fibre and medicine. Forests play essential social roles in the area of sport and recreation, meet aesthetic, cultural and spiritual needs in diverse fields and also fulfil an important function as the abode to some indigenous people such as the Pygmies of Congo and Aborigines of Australia. Furthermore, they perform important ecological roles with regard to soil and water conservation, wildlife sanctuary, the hydrological, oxygen and carbon cycles, and micro-climate protection. Their global values include carbon sequestration, tourism and future genetic resource-use. These multi-faceted functions and values all need to be recognized as important in the forest ecosystem dynamics in order to synthesize material well-being, societal welfare and environmental health & vitality on equal pedestals.

Nevertheless, the same cannot be said of the once much revered rich natural resources today in terms of abundance and functionality. The world's forest resources are endangered[4] largely at the mercy of human induced activities and to a lesser extent by natural disasters. Some school of thought (Bryant et al, 1997; Laarman & Rodger, 1992) envisages that about 40% of the original 6,000 million hectares of the worlds forest cover has been lost. The United Nations (UN) confirmed this assertion through the Food and Agricultural Organization's assessment report (FAO, 1997) that by the close of the 20th century what remained of the resources was estimated at approximately 3,500 million hectares. Though the FAO of the UN in the state of the world's forest assessment document (2007) reported a slight increase in the figure from 3,500 million

[4] Here thereof referred to as threatened

hectares to 3,952 million hectares between year 2000 and 2005 this can be attributed to good forest management practices. As the obvious seems to be the case, the decline in quantity[5] is accentuated by a reduction in forest quality retarding its ability to carry out its purported functions in the complex web of forest ecosystem.

Decline in forest cover is more pronounced in developing countries. FAO (1998b) estimated that about 65.1 million ha of forests were destroyed between 1990 and 1995 alone. The destruction of forest cover continue in spite of the fact that sustainable development has became a key objective in many national forest policy frameworks (Lee et al, 2001) in the face of global and regional initiatives aimed at retarding forest degradation. An appropriate adjective to qualify this phenomenon in tropical countries, as expressed by one authority (Andreas Obser, 1998), is that 'tropical forests are simply shrinking rapidly'. The most commonly cited causes of deforestation range from land conversion for crops and grazing, from logging to fuel-wood collection, as well as the multiple dimensions of poverty effects (Andreas Obser, 1998). In the case of Ghana, more than ninety percent (90%) of the forest resources have been logged since the 1940s (Asibey and Owusu 1982). Literature review suggests that primary forest might have disappeared over two decades ago and the extent of remaining forest cover was estimated at 1.7 % of the original (Sayer, 1992). These renewable natural resources are today scattered throughout the southern part of the country in small isolated fragments (Keeling, 1991).

While Principle 21 of the Stockholm Declaration (UNCED, 1992) see the need for Sovereign States to exploit resources relevant for their economic growth as recognized by international environmental law and other non-binding forest principles, any forests and forest ecosystem management that is made devoid of popular participation[6] will amount to a no action alternative. This is because the resource's multifaceted use, as already outlined above, include shared public goods to neighbouring countries like watersheds and protection of the earth's biosphere as a whole through their function as carbon sinks. Furthermore, the following school of thought (Schlager, 1995; Sabatier, 1988; Sabatier and Jenkins-Smith, 1993; Ostrom, 1990; Ostrom et al, 2002; Meyers Norman, 1992) have also observed that the international timber trade has come under serious criticism as harvesting and export of timber is seldom in violation of national laws

[5] Conversion into grassland or deserts
[6] Involving the people and forest communities

and often with significant impact on the customary rights of indigenous people. Collective action, according to Cook & Laughlin (1999), is thus required for sustainable forest management.

2.2 DEFINING SUSTAINABLE FOREST MANAGEMENT

Cook and Laughlin (1999) see "Sustainability" and "sustainable development" as terms frequently used in the context of natural resource management. Their assertion is collaborated by Paehlke (2000) that since the beginning of the 1990s the idea of establishing sustainable patterns of resource use has become one of the three core values of an environmental perspective, along with minimization of negative impacts on human health and protection of biological diversity, ecosystems and wilderness. Though defining sustainability itself has not fitted into any straight forward jacket, the concept has succeeded in creating a deep sense of global environmental stewardship awareness, inter-connections and purposeful deliberations (McCool and Stankey, 2001) among decision makers, foresters, government agencies, non – government institutions, forest communities and individuals.

Meddling its way up to the global political ladder the concept of sustainability has received widespread acceptance as an ethically laudable goal with respect to the use of natural resources (Shearman, 1990). Over 201 definitions of sustainability have been proposed and according to Heuveldop (1994) the numbers will continue to increase in future. My literature review clearly established the figure to a little over 220. Following discussions on the limits of growth in the 1970s, the Brundtland Report (WCED, 1987) and the Earth Summit at Rio de Janeiro on Environment and Development (UNCED, 1992), the concept has been approached from the perspective of development that meets the needs of the present without compromising the ability of future generation to meet their own needs" (WCED, 1987).

What then will SFM imply? Sustainability, in the context of forest resources, caught the eye of Parties to the Conference in the statement of Forest Principles and Chapter 11 of Agenda 21 at the 1992 UN Conference on Environment and Development. According to Upton and Bass (1995) the non-legally binding authoritative statement of Principles were aimed at contributing to

the management, conservation and sustainable development of forests which also called for the need to setting relevant harvesting standards and thresholds for their use.

Early attempt at defining sustainable forest management was equated to the principle of sustained yield (Wiersum, 1995). This perception, according to Schmutzenhofer (1992), may have persisted over the past 200 years and it is only in the recent past that definitions have sought to hammer home the environmental and socio-economic aspects (Wiersum 1995). With this development, Rebugio (2000), McRae (1997) and Ober (1998), Gale and Cordray (1991); and ITTO (1992) see SFM as a management system that maintains forest's critical ecological functions, biological diversity, and minimizes the adverse impacts of human activity so as to ensure the availability of forest goods and services in perpetuity for the use of the present as well as future generations.

In addition several other studies (Revilla et al., 1999; Sors et al., 2001; IUCN, 1999; Norton, 1992, Poore, 1989) seems to link it to a system, aimed at satisfying the needs of society for various forest goods and services through the application of forest, environmental management, ecological, social, economic and business principles and methods in the wise utilization, renewal and development of forest resources without significant degradation of the inherent capacity of the forest to provide goods and services on an uninterrupted basis.

Implicit from the various attempts at sustainable forest management definitions examined above are the following imperatives;

i. The fast shrinking forests as a natural resource base is of global concern not only to environmental scientists but has now become a matter of public concern. Putting it in its right perspective in recent times, it has become a bone of contention between prospective users, resource managers, politicians and environmental activists (Evans, 1995).

ii. Issues dealing with its judicious utilization and conservation cannot be dealt with effectively in an insular manner because of its multifaceted functions and complexities that arises with the socio-economic and human dynamics interplay.

iii. A participatory approach, with forest communities, government involvement and the international community's blue prints, are needed to address management successes to ensure that these resources continue to exist at some acceptable levels for the benefit of current and future generations (Jollands & Harmsworth, 2006).

Inferring from the expositions above and in consonance with sustainable development goals, sustainable forest management is hereby defined along the lines of the 1994 Ghana`s forest and wildlife policy focal point as forest management that is ecologically sound, economically viable and socially acceptable. This approach, as collaborated by Szaro et al (2005), seeks to value forest ecosystem in its totality and treat all its functions (economic, environmental, and social) as equally significant. From this 3-tier dimensional definition the conceptual imprint is that a state of equilibrium is established when progress made in one dimension (sector) does not compromise progress in any other dimension, but all working progressively towards achieving a sustained economic growth and development, and ecosystem health and vitality, with the spill over felt in the pockets of the ordinary people (forest community). For example, activities that enhance the productive function of forests should not deny forest communities their source of livelihood nor hinder registering higher gross domestic product (GDP) indicators and vice visa.

Thus Upton and Bass (1995) hypothesized three sustainability principles which must interplay to establish such equilibrium as;

a. Environmental sustainability: this entails an ecosystem that is able to support healthy organisms, whilst maintaining its productivity, adaptability and capability for renewal; it advocates for forest management to respect and build on natural processes as much as possible.

b. Societal sustainability: this reflects the relationship between development and social norms, and that an activity becomes socially sustainable if it conforms to social norms, or does not stretch them beyond a community's tolerance for change.

c. Economic sustainability: this requires that benefits or gains to the group(s) in question exceed the costs incurred, and that some form of equivalent capital is also handed down from one generation to the next.

2.3 PARADIGM SHIFT IN FOREST MANAGEMENT

Sustainable forest management, popularly referred to by its abbreviation, sustainable forest management, emerged as a priority item on the international agenda in the early 1990's. Although the concept is not a new one early attempts at its definition and practice were based on the conventional principle of 'harvesting the interest and not the capital of the forest stock' (Dawkins & Philip, 1998).

In other words it was all about harvesting wood at sustained yields (CAB International, 2001). However the multi dimensional nature of resource-use, coupled with intricacies of the web of forest ecosystem and forest cover disappearance has led to a complete paradigm shift from this conventional principle of sustained yields to a much broader perspective of forest management. The essential objective of such shift is reflected in the concluding chapter of the Pan European Ministerial Conference on the Protection of Forest (Helsinki, 1993) and captioned here as;

"Stewardship and use of forest and forest lands in a way, and at a rate that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic, and social functions, at local, national and global levels, and that does not cause damage to other ecosystems".

This re-thinking of resource management has become relevant due to changes or a complete shift in the way academicians and professionals value the resource, see the forestry profession and regard forestry practices as well as see forestry on the whole as a discipline (Rebugio, 2000; Williams et al 1997; Williams & Duinker, 1997).

Comparative analyses of salient points between the old and new paradigms are enumerated below (table 2.1) under the following thematic categories; forest resources, resource managers, management systems, forestry disciplines and harvesting methods. The differences further justify the need for the shift in management paradigm as outlined below.

Table 2.1 Paradigm shift in forest resource management

Thematic Category	Management Objective	
	Conventional Paradigm (Sustained Yield)	New Paradigm Shift (SFM)
1. Forest Resources	• specialized industry with limited products (timber)	• open industry with multiple products and services
2. Resource Managers	• forestry authority • limited other technical experts • manage resources by themselves	• forestry authority • other technical experts • in partnership with socio-economic practitioners, leaders in resource management, forest communities
3. Management System		
i. publics	• limited	• plurality or unlimited
ii. problem	• technical	• technical and socio-economic
iii. goal	• sustained yield	• equity and sustainability
iv. objective	• limited	• multiple
v. strategy	• conventional	• diversified
vi. program	• specialized	• integrated
vii. administration	• rigid hierarchical organized structure, centralized power, authority and decision making, communication is one way	• flexible open organized structure, developed power and authority, participatory decision making & communication is dual way
4. Forestry Discipline	• biological and physical sciences	• bio-physical and social sciences
	• use least cost regeneration techniques	• use techniques that maintain productivity of forest and by avoiding, soil degradation and impoverishment of eco-system
5. Harvesting Methods	• considered outside preview of forest managers	• considered within the preview of forest managers • maintain wildlife populations and maintain species

Source: Based on field data analysis, 2008

2.4 MEASURING SUSTAINABLE FOREST MANAGEMENT

Sustainable forest management is about managing forest to achieve a multiplicity of clearly specified objectives of forest management. With regard to producing a continuous flow of desired forest products and services, care must be taken to conserve and enhance its inherent

values and future productivity without undue undesirable effects on the physical and social environment. This cannot be achieved through policy instruments and tools alone but in collaboration with other stakeholders. Since sustainable development, according to IUCN (2002), has now become almost a universally accepted concept any attempt at sustainable forest management assessment will be an effort directed at measuring sustainable development in both quantitative and qualitative terms.

2.4.1 Development of Criteria and Indicators for Sustainable Forest Management

A number of initiatives are being undertaken to measure and identify sustainability in forest resource-use globally. Specific processes that are of particular interest in recent times include criteria and indicators, certification schemes and related standards and thresholds. With reference to sustainable forest management, criteria and indicators are more generic as compared to certification schemes in the sense that whilst certification requires agreed-on criteria and indicators, the former do not necessarily invoke any formal certification system per se. Certification schemes has also invoked controversial debates as it has created platforms for some countries to pursue initiatives on criteria and indicators agreements yet actively campaign against certification (IISD, 2003).

Based on issues raised in some academic corridors about which aspects of forest should be sustained, Gale & Cordray (1994) and Sheil et al, (2004) advocates strongly for the trio generic sectors (economic growth and development, societal-wellbeing, ecosystem). Criteria and indicators are thus seen to offer some clues to the specificities of sustainable forest management as a useful natural resource assessment tool. Several fora on the subject (criteria and indicators) evolved in the 1990s. At the national level they were intended to provide a common understanding of the intricacies associated with Sustainable Forest Management reporting (Write et al, 2002) and its relationship with forest management units (Castaneda, 1998; FAO, 2001). Prior to and after the United Nations Commission on Environment and Development's roundtable conference in 1992 a number of initiatives have emerged to prescribe guidelines, principles, criteria and indicators for sustainable forestry in all types of forests. Guidelines for the sustainable management of natural tropical forest, first, were elaborated under the auspices of the International Tropical Timber Organization.

Based on this, the International Tropical Timber Organization published a set of criteria for monitoring sustainability in tropical moist forests in 1992. Later in the same year, the need to reconcile productive functions of forests with protective functions, and environmental and socio-economic roles were strongly stressed by United Nations Commission on Environment and Development's (1992) Agenda 21 in chapter 11 (Combating Desertification).

Thereafter, harmonization of internationally agreed on set of criteria terminology which is characteristic of sustainable forestry was also recognized and enshrined in the forest principles negotiated at Rio de Janeiro. Although the global guiding principles for managing natural tropical forest resources are based on convictions, guidelines and conventions, on the national scale they are guaranteed in legal constitutional documents, environmental policies and action plans specific to individual countries (NDPC, 1994) as exemplified by the case of Ghana.

2.4.2 Harmonising key terms and working definitions

Literature reviewed (Gale & Cordray, 1991; Elliot, 2000; CAB International, 2001; Aaron Cosbey, 2004; Sheil et al, 2004; ITTO, 2005; FAO, 2007) show that over the past two decades 50 different criteria and indicator schemes, worldwide, have been identified and according to the Canadian Wood Council (2005) more are brewing in the pipeline. Sometimes criteria and indicators are simply viewed as a mere political process (Rametsteiner & Simula, 2001) primarily to guide and facilitate certification (Elliot, 2000). Most of these standards reflect a multi-stakeholder approach and therefore the range and balance of stakeholder groups represented during the criteria and indicators standard setting process, according to Gullison (2003), may vary considerably. As a result, differences exist in approach to conservation methodology, social and environmental standard's terminologies that are considered to work towards achieving sustainability. These evolving concepts and definitions, related to sustainable forest management at the various hierarchical levels, as noted by Elliot (2000) have polarize harmonisation of key terms and working definitions at the international front.

In order to articulate global dialogue on sustainable forest management, a number of significant attempts have been made to define and harmonize terminology intricacies associated with the criteria and indicators aspects of sustainable forest management (Olympia, 1994). The furthest advanced of these is the work of the International Tropical Timber Organization in 1990 which

outlined criteria for sustainable tropical forest management. Its objective was that by year 2000 progress was to be made towards trade in tropical timber products from sustainably managed sources. These were followed by other initiatives which include the ministerial conference on the protection of forests in Europe (Helsinki, 1993), the conference on security and cooperation in Europe (CSCE), seminar of experts on the sustainable development of the temperate and boreal forests (Montreal, 1995), the Food and Agricultural Organisation (1993), the forest stewardship council (1993) and the Pan-European round table meetings on sustainable forestry in Brussels and Geneva in 1994. Related terms and definitions used for this research work have been subsequently enumerated above under the caption *'definition of key terms'*.

2.4.3 Global Dimensional Characteristics of Criteria and Indicators for SFM

2.4.3.1 Introduction

International processes on criteria and indicators for sustainable forest management started with a national level focus directed at providing a common understanding of what is meant by the concept (Sustainable Forest Management) itself. With time this has been extended to complement forest management unit level indicators that address concerns at the local forest communities.

Criteria and indicator processes and initiatives (appendix 10.1a) towards adopting a concrete sustainable forest management system, at the international scene, took off under the auspices of the international tropical timber organization (ITTO). The international tropical timber organization's pioneering work was soon embraced as a challenge by the Euro-Zone countries in protecting their forests in a follow-up to their ministerial conferences on the protection of forests in Europe (MCPFE). In the Non-European Temperate and Boreal countries it came as a follow-up to the Conferences on Security and Cooperation in Europe and seminars of experts on the sustainable development of temperate and boreal forests held in Montreal. Signatories to the Amazon Cooperation Treaty (ACT) pulled in countries from the Amazon forest regions whiles joint sponsorships by the United Nations' Environment Programme (UNEP), Food and Agricultural Organization (FAO), Central American Commission for Environment and Development (CCAD) propelled the Near East, the Dry Africa Zone, the Central America and the Asian processes (appendices 10.1a, 10.1b). Additionally, international environmental

protection organizations and inter-governmental forum on forest have been instrumental in this course. In all these broad initiatives, four criteria set under the thematic groupings: forest reserves, functions of forest, socio-economic needs, and legal & institutional framework emerged common to all processes as illustrated by table 3.2. Details of these global initiatives with their dimensional characteristics are further enumerated under appendices 10.1a and 10.1b.

2.4.3.2 The International Tropical Timber Organization Initiative

The International Tropical Timber Organization issued the first guidelines, which were later adopted internationally for sustainable forest management in spite of concerns raised by Colchester (1990) that timber trade interests prevailed in its activities. Nevertheless in 1991 the International Tropical Timber Council (ITTC) adopted a 'year-2000 ambitious objectives' which committed member countries to trade in tropical timber products emanating from sustainably managed forest by the year 2000. The criteria and indicators were kept simple as checklist oriented towards sustainable forest management practices. Thereafter a legally binding International Tropical Timber Agreement (ITTA) was renegotiated in 1994 and concluded at the United Nations Conference on Tropical Timber under the auspices of United Nations Commission on Trade and Development in Geneva. It is in this agreement which included the non-binding promise that forest products should come from sustainably managed forest by the year 2000. Until now date this is been adhered to by member countries.

2.4.3.3 The Rio Declaration and UNCED's Agenda 21

Soon after the International Tropical Timber Organization criteria and indicator process the United Nations Conference on Environment and Development, in trying to find solutions to forest resource-use and its sustainability, noted with grieve concern the role played by forests to the long term well-being of local populations, national economies, and the earth's biosphere as a whole (UNCED, 1992). The conference also adopted a non-legally binding authoritative statement of forest principles and chapter 11 of this document is what has become known as Agenda 21 (combating deforestation). The blue print hinted on the need to develop criteria and indicators to manage all types of forests in a sustainable manner in order to meet the needs of the present and future generations.

2.5 THE POST RIO INITIATIVES

After the well acclaimed Rio declaration on sustainable development in Brazil (UNCED, 1992), the cry to formulate criteria and indicators necessary to measure sustainable forest management was heeded to. Sooner than later several processes at the international, regional and national levels emerged on the scene. They have contributed immensely to the paradigm shift in forest management. The major globally inter-governmental framework on criteria and indicator initiatives and processes (appendix 10.1a) are briefly discussed below.

2.5.1 The Helsinki Process (Hels)

Development of criteria and indicators in the Helsinki process, also known as the Pan European C&Is Process, was initiated in 1993 as a follow up to the forest principles agreed on at Rio de Janeiro (UNCED, 1992) by the second Ministerial Conference on the Protection of Forests in Europe (MCPFE), held in Helsinki.

The process involved 41 countries which resulted in the development and adoption of a core set of criteria and indicators in 1994. Pan-European C&Is majored on ecological aspects and paid minimum attention to socio-economic considerations. Particular emphasis was placed on the effect of acid rain and global warming. At the third MCPFE (2003) experts-level follow up meetings in 1998 a number of criteria and quantitative indicators for Boral and Temperate forests were agreed on. Six (6) national level criteria and a corresponding 27 indicators (appendix 10.1a) were officially adopted and endorsed in 1998.

2.5.2 The Montreal Process (Mont)

The Montreal criteria and indicators process, also known as the Santiago Declaration, involved 12 countries. The countries formed working groups to advance the development of criteria and indicators for the conservation and management of temperate and boreal forests outside Europe. It started as a Seminar of Experts on Sustainable Development of Temperate and Boreal Forests, held in Montreal in 1993. Two years later (1995), the Montreal Process issued a declaration (Santiago Declaration) containing a set of 7 non-legally binding national level criteria and 67 indicators for sustainable forest management (appendix 10.1a). Although it bears a resemblance to the Helsinki process and limited to temperate and boreal forests outside Europe, the Santiago

Declaration (the Montreal Process) is seen as the most comprehensive set of criteria and indicators, national in focus and assumes an ecosystem oriented approach characteristics.

2.5.3 Tarapoto Proposal (Tara)

The Central America criteria and indicator initiative commenced in 1995with countries signatory to the Amazon Cooperation Treaty (ACT) on the definition of criteria and indicator for managing the Amazonian Forests on sustainable basis in Tarapoto, Peru. The 8 signatory countries identified and agreed on 7 national level criteria and 47 indicators. At the FMU 4 criteria and 22 indicators were identified whilst on a regional level 1 criterion and 7 indicators were advocated for (appendix 10.1b) to measure Amazon forest sustainability in 1995. This initiative is considered to be the most comprehensive set of criteria and indicator for tropical forests since it addresses in particular socio-economic issues and is also unique in its emphasis on global services provided by tropical forests (Compensation for avoided deforestation).

2.5.4 Dry Zone Africa Initiative (D-zoa)

In 1995 at an expert meeting in the capital of Kenya (Nairobi), which was jointly organized by the UNEP and FAO, the Dry Zone Africa process towards use of criteria and indicator for sustainable forest management was initiated. The 28 participating countries identified 7 national level criteria and 47 indicators (appendix 10.1b) to be used within the confines of Sub Sahara Africa. The African Forestry and Wildlife Commission and the Secretariats of three sub regional groupings - the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), the Intergovernmental Authority on Development (IGAD) and the Southern African Development Community (SADC) subsequently endorsed the work of this process. Following a number of such experts meetings at the national and regional workshops and expert meetings to review applicability of the criteria and indicator in the region, to discuss the availability of information and national capacities for collection and analysis of data, and to elaborate a plan of action for implementation, practical guidelines for the assessment and measurement of criteria and indicators for sustainable forest management in Dry Zone Africa was published in 2000.

2.5.5 The Near East Region Initiative (N-est)

Similar to the United Nations Environment Programme and the Food and Agriculture Organisation`s initiatves above a Regional Expert Meeting (REM) on criteria and indicator for sustainable forest management in the Near East was held in Cairo, Egypt. The Near East Process involves 30 countries which identified 7 national level criteria and 65 indicators that focused mainly on the management of dry-zone forests and woodlands in the region for sustainable forest management in October, 1996. The proposal were immediately endorsed by the Near East Forestry Commission (NEFC) and accepted as a good working document to be tested by individual countries of the region. This was also followed by a number of regional workshops and expert meetings to review applicability of the criteria and indicator in countries concerned and to discuss the availability of information and national capacities for collection and analysis of data. Subsequently guidelines for assessment and measurement were published in 2000.

2.5.6 The Asian Dry Forest Initiative (D-asi)

Initiative in the Asian Region started with an international workshop as a follow-up of one of the recommendations of the 17th Session of the Asia-Pacific Forestry Commission in February 1998. The process became known as the "Regional Initiative for Development and Implementation of criteria and indicator for Sustainable Management of Dry forests in Asia". It originated in a workshop on National Level Criteria and Indicators for the Sustainable Management held in December 1999 and supported by the Food and Agricultural Organization, the United Nations Environment Programme (UNEP) and the International Tropical Timber Organization (ITTO), the United States Forest Services (USFS) and India Institute of Forest Management (IIFM) in Bhopal, India. The nine (9) participating countries identified eight (8) national level criteria and 49 indicators for the sustainable management of dry forests in the Dry Zone of Asia and South Asia region. Guidelines for assessment and measurement were published in 2001.

2.5.7 The African Timber Organization Process (Ato)

The African Timber Organization (ATO) initiated development of Principles, Criteria and Indicators for sustainable management of African natural tropical forests in 1993 and adopted by its Ministerial Conference in 1996.

In accordance with recommendations made at the international level, 'especially by the Intergovernmental Panel on Forests' its 13 member countries identified five principles, two 'sub-principles,' 28 criteria and 60 indicators for sustainable forest management, for application at the regional, national and forest management unit levels. In 2001, the 14 African Timber Organization member countries harmonized its principles, criteria and indicators with the International Tropical Timber Organization's criteria and indicators for African tropical forests management.

2.5.8 The Lapaterique process (C-am)

An expert meeting on criteria and indicators for sustainable forest management in Central America organised by the Food and Agricultural Organisation, in collaboration with the Central American Commission for Environment and Development (Comision Centro Americana de Ambiente y Desarrollo) in Teguciagalpa, Honduras resulted in what is today referred to as the Lapaterique criteria and indicator process. The meeting, involving 7 countries in 1997 drafted a declaration containing a set of criteria and indicator 4 criteria and 40 indicators at the regional level and; 8 criteria and 42 indicators at the national hierarchy (appendix 10.1b) related to sustainable management of the region's forests. Cuba attended the meeting as an observer.

Table 2.2 A common platform for global criteria and indicator initiatives and processes

Criteria and Indicators	Major C&I Initiatives and Processes								
	ITTO	D-ZOA	MONT	TARA	HELS	C-AM	N-EST	D-ASI	ATO
Hierarchy									
1. Global Level	No	No	No	Yes	No	Yes	No	No	No
2. National Level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Forest Mgt. Units	Yes	No	No	Yes	No	No	No	Yes	Yes
Thematic Group									
A. Forest Reserves									
1. Forest Resource Extent	Yes	Yes	-	-	Yes	No	Yes	Yes	Yes
2. Global Carbon Cycle	No	-	Yes	No	Yes	-	No	No	No
3. Ecosystem health, vitality	No	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes
4. Biological vitality	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B. Forest Functions									
1. Productive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Protective & Env't.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
C. Devt. & Social Needs									
1. Socio-economic needs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D. Inst'nal framework									
1. Policy, legal framework	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Analysis based on FAO of UNO data, 2005b.

2.6 INTER-GOVERNMENTAL FORUM ON FOREST

The Inter-governmental Forum on Forest (IFF) management processes has also been considering several interrelated issues out of which 'scientific research, forest assessment and development of criteria and indicators for sustainable forest management' has been high on the agenda. The third session of the Commission for Sustainable Development (CSD) considered the issue of criteria and indicator for sustainable forest management as one of the priority areas of work of the Inter-governmental Forum on forest. The process, however, could not generate an alternative on consensual approach by the end of the IPF's last accountable four years. As a result a more general international position on criteria and indicators, and certification were formulated. The Inter-governmental Panel on Forest efforts is still on-going and continues in the new Intergovernmental Forum on Forest sessions (IFF, 2000).

2.7 THE GHANA INITIATIVE

Although environmental concerns in Ghana were awakened from the Stockholm United Nations Conference, working towards sustainable forest management, which has underpinnings of the country's vision of sustainable development (Nunoo, 2008) is a post *Rio de Janeiro* endeavour. The dilemma among resource users and managers has been whether to use forests for short term economic gains or view them as an invaluable part of the system-environment. The challenge then is how to reconcile these conflicting priorities, taking into account how forests affects and are influenced by policies within and without the forestry sector.

Environmental policies promulgated so far, with regards to forest management, to salvage degradation have been described by some school of thought as one of the best in developing countries. Highlights of major interventions captured include restoration of degraded land, conservation and preservation of forest resources which constitute the major natural resource management problem (Nunoo, 2008). Unsustainable logging rates which were in excess of annual allowable cuts (AAC) have been lowered down through establishment of standards and thresholds for harvesting to sustainable rates. The standards, according to Musah (1995), cover a broad spectrum of stakeholder's perspectives that considers among other issues the socio-

economic well-being of the people and communities, and the resources' health and vitality as can be gleaned from table 3.3. Notwithstanding the many set of criteria and indicators for measuring sustainable forest management that have been developed and expatiated above (appendix 10.bb), Ghana is also a party to the African Timber Organization (ATO) and the International Tropical Timber Organization's (ITTO) processes (appendix 10.1a) which have played major roles in the fight for forest resource use accountability (Johnson, 2001). As echoed by Tang (2001), pursuing a national hierarchy criteria and indicators initiative "must be supplemented by standards of performance and management prescriptions" specific to a particular forest type (s).

Table 2.3 Underlying principles towards SFM in Ghana.

Principles	Objectives
1. Principle one	Compliance with laws and regulations
2. Principle two	Land tenure, stakeholders and resource rights
3. Principle three	Conservation and maintenance of biological diversity
4. Principle four	Rights and responsibilities of workers
5. Principle five	Forest proceeds, equitable distribution of benefits and cost
6. Principle six	Maintenance and enhancement of ecosystem productivity
7. Principle seven	Forest management system

Source: NCFC, 1996

This was the case in Ghana as by the close of 1994 a more responsive policy towards collaborative and sustainable forest management (The 1994 Forest and Wildlife Policy) had been rolled out which had as its core objective to strengthened national commitment towards SFM based on its national standards and thresholds limits. In 1996, a two-day national workshop under the theme "Forest Certification and other Market-Based Instruments in Ghana" was organized (NCFC, 1996) in Kumasi under the auspices of the Ministry of Lands and Forestry (MLF) and the Forestry Research Institute of Ghana (FORIG) with assistance from the International Institute of Environment and Development (IIED) and the United Kingdom Department for International Development (DFID). Stakeholder's consensus at the end of the workshop concluded on the need for a certification scheme as one of the tools for ensuring SFM. Consensus reached at the workshop constitutes the bed rock of what is enshrined as the underlying principles towards achieving sustainable forest management (table 3.3).

Thus in harmonizing the two processes, the Africa Timber Organization and the International Tropical Timber Organization settled on 1 principle, 5 criteria and 33 indicators for national level assessments (ITTO, 1999), whereas this study concluded on 7 principles (table 2.3), 11 criteria (figure 5.1) and 52 indicators (tables 5.1a, 5.1b, 5.1c, 5.1d, 5.1e) relevant for measuring progress towards sustainable forest management in the high forest zone of Ghana.

2.8 IMPORTANCE OF CRITERIA AND INDICATORS

a. The principle underlying criteria and indicators at the policy level, although cumbersome, is useful in that a common understanding of what sustainable forest management entails is brought to the limelight. It also provides the baseline framework for describing, monitoring and evaluating progress towards sustainable forest management. More-so it will help provide the necessary feedback channels in making adjustments in policy synergies and prescriptions for ensuring sustainable natural resource-use.

b. Since criteria and indicators define sustainable forest management as a multiple objective management of the ecological, economic and socio-cultural dimensions of forest resource it could be an effective tool to evaluate and implement sustainable forest management. When well pursued, criteria and indicators could provide a full picture of the state of the resources, indicate the direction of change and suggest optional ways to enhance the process.

c. Criteria and indicators also provide a cost effective information system for facilitating sustainable forest management. Since criteria and indicators can be used for resource change assessment they could be better placed as tools to facilitate purposive management policies thus setting up the foundation of adaptive co-management. Furthermore the tool could prove to be an efficient framework in Ghana to collect, store and disseminate reliable and scientifically based information on forests in order to monitor and assess the state of forests. Also as an effective communication and reporting tool it could help build bridges between stakeholders in the forestry domain and inform policy makers on matters related to resource-use management in communicating to the public with the public.

d. Due to the common understanding of sustainable forest management, criteria and indicators are also of significance for reporting in international fora. They are directed at providing a reference base for national policy makers on the formation of forestry programmes (NFPs). The tool foster more holistic thinking when planning forest management activities, bring about greater rigour, openness, transparency and accountability in forest management planning, monitoring and reporting towards sustainable development.

3. CONCEPTUAL FRAMEWORK

3.1 INTRODUCTION

Measuring progress towards forest resource-use and sustainability is discordant to the conventional scientific process as observed in other State of the Environment Assessments (Rees & Wackernagel, 1994; Knetsch**,** 2005). Sustainable forest management appears to be in a less tangible aspect and selecting indicators for such assessment proves to be a more challenging task. This is because a spectrum of potential indicators, according to Macgregor (2000), could be generated for this kind of exercise. As a normative objective the researcher need to be cautious and decisive on exactly what need to be examined, and what type of data, with minimum subjectivity, will contain the results.

3.2 THEORETICAL ASSUMPTIONS

An economic theoretical construct is thus deemed appropriate to ensure that selection of applicable indicator sets is not done haphazardly (Prabhu et al, 1999, Wolfslehner and Vacik, 2008). In formulating the construct therefore, holding all other factors constant, the following assumptions were made that;

- Development, in whichever form it takes (be it economic or social), has the tendency to erode environmental resources upon which they are based. It is therefore not feasible to separate socio-economic growth and development from environmental health and vitality issues.
- Sustainable forest management, synonymous with sustainable development, is an equilibrium situation established with improved societal well-being, improved economic growth and development, and improved environmental health and vitality indices.
- Sustainability assessment of natural resources is a key determinant of sustainable development and a tool for measuring successes towards achieving sustainable development goals.
- A progressively positive (improved) and sustained sustainable forest management indicators over a period of time will lead to sustainable development 'all other things being equal'.
- The further away an equilibrium position is away from the origin the higher the level of well-being.

Based on the above mentioned assumptions (Panayotou 1997, Kuznets 1955, WCED 1987, Macgregor 2000, Stern 2003), if sustainable forest management is effectively implemented within the high forest zone in Ghana, all other things being equal, it will accelerate the pace of sustainable development initiatives as outlined in her vision 2015[7] document (NDPC, 2001). This is because the country's developmental drive and growth is pivoted around its natural resource base. In terms of comparative cost advantage, Ghana will perform creditable well (sustainable development) when it concentrates on processing raw materials for domestic agro-based industries and for exports (O'Sullivan and Sheffrin, 2003). The theoretical construct for this study is that sustainable forest management (*SFM*), hereby synonymous with sustainable development (*Sd*), is a function (*f*) of or depends on improved economic growth and development (Eco_{gd}), improved societal well-being (Sty_{wb}) and improved environmental health & vitality (Env_{vt}). In other words *SFM* (*Sd*) is an equilibrium position established with increasing $+Eco_{gd}$, $+Sty_{wb}$ and $+Env_{vt}$ indices. The economic construct, with variables defined, is depicted below as;

$$SFM \equiv Sd = f(+Eco_{gd}, + Sty_{wb}, + Env_{vt}) \qquad \textit{equation 3}$$

Where;

SFM = *Sustainable forest management,* ***Sd*** = *Sustainable development,* ***f*** = *Function*

$\boldsymbol{Sty}_{wb}$ = *Societal well-being,* $\boldsymbol{Eco}_{gd}$ = *Economic growth and development*

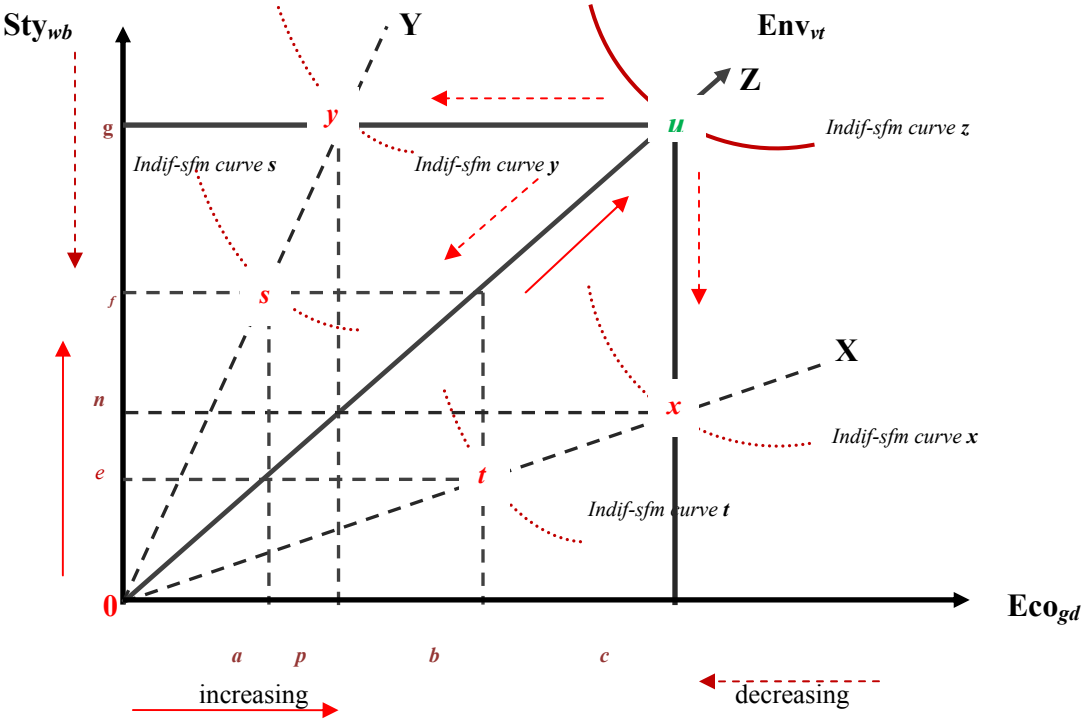
$\boldsymbol{Env}_{vt}$ = *Environmental health and vitality,* ***Plus*** *(+) = Improvement or increased*

The positive sign (+) before the variables only imply an *improved state* or increasing welfare. A negative sign (-) will therefore connote a decrease from a previously higher state of well-being. As in all macroeconomic models this function (*equation 3*), from the standpoint of Antle & Capalbo **(**2001) and Buongiorno & Gilles **(**2003), can be illustrated diagrammatically to simplify this complex socio-economic phenomenon (welfare maximization). Here the variables (Sty_{wb}, Eco_{gd} and Env_{vt},) are independent of each other, with Env_{vt} being a derived function. If the first assumption is true (that is development, in whichever form it takes has the tendency to erode

[7] Vision 2015 connotes the national version of agenda 21 implementation in Ghana

environmental resources upon which they are based) then it is therefore not feasible to separate socio-economic growth and development from environmental health and vitality issues (Macgregor, 2000). For such equilibrium to be established (Hicks, 1937; Hicks, 1980; 1981), societal well-being is represented by the abscissa and labeled $Sty_{wb.}$ The ordinate represents economic growth and development (labeled as Eco_{gd}**),** given a normal cartesian coordinate system (*x* and *y* axis), as illustrated by figure 3.1. Since none of the forms of development (economic, social) can be achieved without sound environmental settings, holding all assumptions made above constant, then the environmental health and vitality function (***Env***$_{vt}$**),** according to Pearce & Atkinson, 1993; Pearce et al, 1989 and Dasgupta, 1995; will lie in the first positive quadrant of the sustainability space (Sty_{wb} and Eco_{gd} axes) represented by a 45^0 line (**0Z**) that bisects the Sty_{wb} and Eco_{gd} into 2-equal halves (figure.3.1).

Figure 3.1 Equilibrium positions within a given sustainability space



According to Beattie and LaFrance (2006), it also become possible for equilibrium (sustainable development) to be established at point **U** along vector **0-Z** with the intersections of improved societal wellbeing, environmental health & vitality and economic growth & development

variables ***(+Sty$_{wb}$, +Env$_{vt}$*** and ***+Eco$_{gd}$)*** on the sustainable forest management *policy* indifference curve[8] **Z** (*indif-sfm curve z*) in figure 3.1.

A SFM policy indifference curve *(Indif-sfm curve)* depicts combination of policy baskets that give policy makers the same level of well-being satisfaction (utility). Here *Indif-sfm curves* are assumed to exhibit same characteristics or properties of the normal indifference curves propounded by Edgeworth and Pareto (Peter Victor, 2008; Illge L & Schwarze R, 2006). That is, among others, indifference curves are; *i.* defined only in the positive (+, +) quadrant of commodity-bundle quantities, *ii.* negatively sloped, *iii.* they do not intersect, *iv.* they are transitive in nature, and *v.* they are convex to the origin (Beattie & LaFrance, 2006).

However, this stable situation as depicted by figure 3.1, represents an ideal situation. Dasgupta (1995), Hicks (1937), and Pearce & Atkinson (1993) argue, it will be difficult to achieve such equilibrium in a real world sustainable development dynamics (eg. with improved societal well-being, economic growth & development and environmental health & vitality). Albeit, based on the light greens environmentalism's assertion[9] which is in consonance with the World Conservation Union (2004) and the World Bank's stands (1994) on the same reasoning, whenever the equilibrium situation is shattered or disturbed, it is still possible to improve on economic growth & development, societal well-being and environmental health & vitality through selection of strategic resource management policies such as those depicted by vectors **0-Y** at point ***y*** and **0-X** at point ***x*** in the sustainability arena (figure 3.1).

It is assumed that extensive substitution between environmental resources and reproductive forms of capital, according to Macgregor (2000), would be sufficient to offset continued reductions in non-renewable (finite) stocks of environmental asserts produced by on-going developmental projects (social or economic). Thus from this point of argument there are no longer zero-sum trade-offs between environmental health & vitality, societal well-being and economic growth & development (Pinfield, 1997). For example, in case of a disjoint policy (misapplication of policy baskets) or irrational implementation of management policies (development at the expense of one or two sectors) SFM can still be achieved (equilibrium) at points ***y*** and ***x*** along trade-off curves *Indif-sfm curve* ***x*** and *Indif-sfm curve* ***y*** on pathways **0-Y**

[8] SFM policy indifference curve is a curve that depicts equal level of satisfaction for a policy makers faced with various combinations of policy baskets

[9] Sustainability of environmental resources, on which ever pedestal, must begin with individuals lifestyle change towards use of natural resources

and **0-X** by resource substitution or compensation as illustrated by figure 3.1. Other equilibria situations are possible within the sustainability arena. Inferring from figure 3.1 above possibilities of the following scenarios persist with trade-offs among bundles of policy basket interventions (table 3.1) to establish equilibria positions explained under figure 3.1;

i. Sustainable forest management (SFM) can be achieved with improvements in economic well-being, improvements in environmental health and vitality at the expense of a decreasing societal welfare through capital compensation (*Indif-sfm curve* ***x***) as illustrated by equation *3.1*;

equation (3.1), $\rightarrow \quad SFM \equiv Sd = f(+Eco_{gd}, +Env_{vt}, -Sty_{wb})$ established on *Indif sfm curve* ***x***

ii. Sustainable forest management (SFM) can be achieved with an increasing societal well-being, a decreasing economic growth & development and a decreasing environmental health & vitality through a shift in policy pathway (eg from ***0-U*** to ***0-y***) by capital compensation (*Indif-sfm curve y*) as shown by;

equation (3.2,), $\rightarrow SFM \equiv Sd = f(+Sty_{wb}, -Eco_{gd}, -Env_{vt})$ established on *Indif- sfm curve* ***y***

iii. Sustainable forest management (SFM) can be achieved with improvements in environmental health & vitality, improvement in societal welfare, and a decreasing economic growth and development through capital substitution (*Indif-sfm curve* ***y***) as demonstrated by;

equation (3.3), $\rightarrow \quad SFM \equiv Sd = f(+Env_{vt}, +Sty_{wb}, -Eco_{gd})$ established on *Indif-sfm curve* ***s***

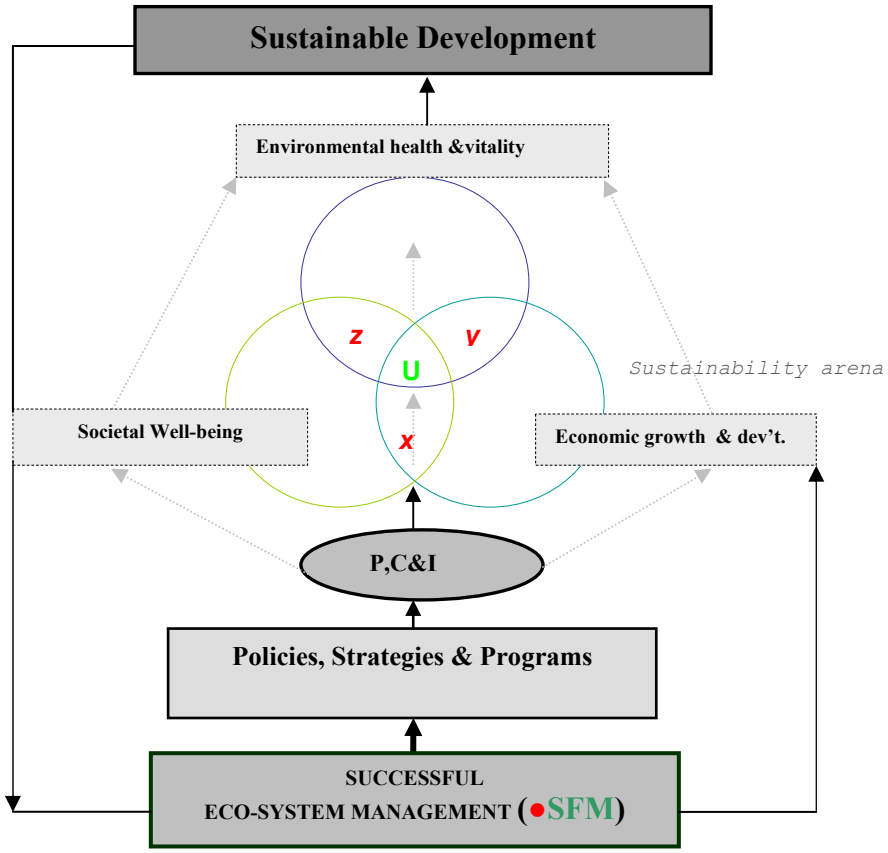
iv. Sustainable forest management (SFM) can be achieved with economic gains, decreasing environmental vitality and decreasing societal welfare with a shift in policy pathway from ***0-z*** to ***0-t*** through extensive substitution as illustrated by;

equation (3.4), $\rightarrow SFM \equiv Sd = f(+Eco_{gd}, -Env_{vt}, -Sty_{wb})$ established on *Indif-sfm curve* ***t***

3.3 CONCEPTUAL MODEL-AN EXPOSITION

Conceptually the model sees sustainable forest management as not an end in itself. It is an input and the most important contribution the forest sector can make to the sustainable development objectives of any nation (Bussolo et al., 2007). In otherwise, the official blue print of sustainable forest management in Ghana has the underpinnings of sustainable development (Vision 2015). The conceptual framework (figure 3.2), which is hierarchical in nature and depicted below, has three imperatives: a successful sustainable forest management as a means to achieving a sustainable development objective (environmental aspect) in Ghana; enabling and reinforcing policies, programs and strategies and appropriate tools for assessment.

Figure 3.2 Conceptual model for measuring progress towards SFM



If the new paradigm in forest management (SFM) is embraced, its successes in meeting stated objectives need to be intertwined with baskets of policies, strategies and programmes that are mindful of economic growth and development, the welfare (well-being) of society and ecological sustainability that allows for possible compensations (trade-offs).

This kind of game where policy baskets are tailored and trimmed occurs in the sustainability arena (figure 3.2). In between the hierarchical strata (management objectives, strategies and desired results) are the policy optional fields (shaded rings, path ways), and tools.

3.3.1 The Millennium Development Goals (Vision 2015)

The Ghana millennium development goals, packaged in a document captioned 'Vision 2015', is the revised version of what started as Ghana's vision of Agenda 21 national level implementation initiatives (vision 2020) for the period 1996-2020. This medium term sustainable development drive was intended to improve the people's quality of life, within the carrying capacity of the earth's life support system" (UNU & WB, 1995).

Vision 2020's essential policy guidelines as explained recognises the fundamental inter-connectedness among environmental degradation, distribution of human population, economic activity, and the pattern and scale of human development (NDPC, 2001) within the carrying capacity of the earth's life support system" so that a middle income statuses in Ghana could be achieved by the end of the era.

However, by the year 2000, vision 2020 had lost bearing on its thematic focus and the capacity to execute such a compact agenda. At the turn of the new millennium, vision 2015 (Millennium development goals) was embraced as a wake-up call to eradicating extreme poverty and its excruciating repercussions in developing countries by world leaders. The seventh (7th) millennium hurdle which needed to be cleared in order to achieve this success was to ensure environmental sustainability (efficient eco-system management) and this form the basis of the conceptual model of this thesis.

If in measuring progress towards sustainable forest management, combined indicators scores a weighted index within a range of good performance points on a scale, then a key objective of 'Vision 2015' (environmental sustainability) would be achieved. It is envisaged that by arriving at the end of this era under examination, the middle income earning bracket group target would have been realized by judiciously utilizing natural resources to achieve rapid economic growth, improvement societal well-being, while at the same time maintaining integrity and health of environmental resources.

3.3.2 Supportive Policies

Indispensable forest management policies needed to achieve stated objectives, as mentioned above, reflects the sustainable development aspirations of Ghana as stipulated by the 1992 constitution and its responsibilities towards fringe forest communities and the rest of the world.

Overall aim of the supportive policy is directed towards "the conservation and sustainable development of the nation's forest and wildlife resources for the maintenance of environmental quality and perpetual flow of benefits to all segments of society" (Forestry Commission, 1998). These include a democratic political system, a holistic, integrated and balanced framework for forest management, promotion of social justice and equitable distribution of proceeds through a participatory approach to resource management.

3.3.3 Strategic Programs

A set of strategies set into motion, in accordance with the shift in forest management paradigm, include timber utilization contracts, advocacy for and to enhance compliance with a sustainable annual allowable cut, call for invisible-hand pricing of forest products, equitable sharing of forest proceeds (also called stumpage), and advocacy for value-added processing of forest products, participatory resource management, institution and physical capacity building.

3.3.4 Policy Baskets

From the conceptual model (figure 3.2), such forest management processes, through sieving and shifting of strategic programs, substitution and compensations from one sector to the other will result in seven (7) bundles of possible policy outcomes, ostensibly for the promotion of;

i. Improved economic gains **(Eco_{gd})**
ii. Improved social welfare **(Sty_{wb})**
iii. Socio *eco*-economy **(z)**
iv. Improved ecosystem health & vitality **(Env_{vt})**
v. Pure ecosystem conservation **(y)**
vi. Pure community development **(x)** and
vii. Sustainable forest management ≡ Sustainable development **(U)**

The outcome of decisions (bundles of policy baskets) enumerated above are all likely to result in trade-offs (overlapping zones ***x, y*** and ***z***) as gleaned from figure 3.2 and depicted by table 3.1.

Table 3.1 Informed decisions on possible policy outcomes for resource management

Policy baskets	Policy direction	Possible policy outcome
1	Economic inclined (***Eco***$_{gd}$)	Improved economic gains only
2	Ecosystem inclined (***Env***$_{vt}$)	Improved ecosystem health & vitality only
3	Society inclined (***Sty***$_{wb}$)	Improved social welfare only
4	Economic + society + environment (***u***)	Sustainable development = *SFM*
5	Economic + ecosystem (***y***)	Pure ecosystem conservation
6	Ecosystem + Society (***x***)	A Socio *Eco*- economy
7	Economic + Society (***z***)	A Pure community development

Source: Field data analysis, 2008

Trade-offs, although in the strict Kurtz's sense are un-necessary economic evils are seen here as inevitable necessary evils in the sense that a trade-off which signifies a disjoint or unsustainable development will elicit SFM policies which will guide or direct them through sustainability pathways through mitigative measures. The exception is that of the last overlapping basket zone (***u***), whose assessment pathway draws on all three clusters (economic, society and environment) of criteria and indicator sets to ascertain the desired sustainability pathway. The policy baskets, policy directions and their probable implications are summarized by table 3.1.

3.3.5 Application fields of the model

This model will aid development of indicators at the international level useful for evaluating progress towards sustainable development by tracking environmental progress, and integrating them into sectoral and economic policies. In this way, the dynamics between environmental and economic policies would be more effectively identified and evaluated. For example this could improve on the European Commission's Environmental Pressure Indicators Programme (the p-s-r approach to modelling) and the United Nations Commission on Sustainable Development Agenda 21 initiative.

Subsequently the model will be laudable in policy formulation at the inter-departmental government levels to translate the concept of sustainable development in quantifiable terms and

track progress over time at the national level. It will also apply in tackling the effects of environmental degradation and climate change mitigation (Kyoto protocol) programs.

More so since developing the model is based on self-regulation and negotiated agreements amongst target stake-holders, leaving it to local initiatives to produce proposals which contribute to the targets, a sort of, it would incorporate the polluter-pays principle, and place heavy reliance on economic instruments rather than command-and-control regulations (Adriaanse, 1993).

The model could also be applied at the regional level as an educational tool in baseline environmental status assessments and a measure of performance in delivering sustainability on regional bases (Mendoza1 & Vanclay, 2008).

In the United Kingdom (UK), for example, Local Governments has attempted to combine the introduction of environmental management systems with the application of indicators as performance measures. Jackson and Roberts (2000) ascertain that such work will progressed more rapidly in an urban context than in rural areas, with urban authorities applying indicators in the preparation of plans and strategies.

3.3.6 Advantages associated with the use of the model

1. Measuring progress towards sustainable forest management by the criteria and indicator prognosis, from the perspective of this simplified macroeconomic model, makes it possible for stakeholders who use and manage the resources themselves to select applicable indicators that would translate the concept of sustainable development (Ghana's Vision 2015) into quantifiable aims and objectives through;

a. Optimal use of non-renewable resources,
b. Sustainable use of renewable resources,
c. Minimise risk of damage to the environment, carrying capacity, human health and the environment.

2. The model makes it easy to combine indices which tend to reflect environmental and social concerns not addressed in the standard procedure for assessing national accounting and the well-being of nations.

3. Furthermore, it allows stakeholders to define their own localised sustainability threshold limits of significance and work towards the realisation of such goals.

4. Measures of successes towards sustainable development are issues of adoptive management. Therefore with each indicator assessment stakeholders are able to learn, take feedbacks and easily adopt.

4.0 CASE STUDY: GHANA'S HIGH FOREST ZONE

4.1 STUDY AREA BACKGROUND INFORMATION

4.1.1 Location and Situation

Ghana is situated in the central southern part of West Africa along the gulf of Guinea (appendix 12a) within the confines of latitudes 4^0.30'N and 11^0N and longitudes 3^0.15'W and $1^0$10'E (CIA Fact book, 2007). The country is strategically positioned. Geographically, it lies very close to the equator and bisected by the Greenwich meridian (Long.0^0) through a port city called Tema. Its situation along these great circles explains the unique environmental characteristics of this region. The total area is 239,460 sq km, comprising 230,940 sq km area of land and 8,520 sq km water bodies (World Bank, 1994).

4.1.2 Socio-Economic Indicators

An economic and financial statement from the ministry of finance described Ghana`s economy, over the last two decades, as a developing country with a strong emerging economy growing at a real rate (GDP) of 6.2% and a per capita income of $2000 (MOF, 2008). Inflation rate, according to the ministry of finance (MOF, 2008), is stabilized around 10.5% with 28.5% of the total population living below the poverty index (Year 2007 parity). The economy is dominated by activities (farming, forestry, mining, fishing) that have to do with direct extraction from nature, making agriculture a way of life among the rural communities (60% of total population).

Timber exploitation assumed a commercial entity with the inception of the colonial era. However, harvesting reached its phenomenal apex (Senamede et al., 1995) during the economic recovery programme as it was perceived by the government to be a panacea for resuscitating a virtually battered economy. Although, to some extent, it succeeded in giving a face lift to the national coffers, it also left behind catastrophe ecological damage. The 2000 population census from the Ghana statistical services data base established a domestic populace of 18,912,079 million with an inter-censal growth rate of 2.7% (Ghana Statistical Services, 2004). Based on the annual rate of increase (2.7%) the population is currently estimated to be within the domain of 23 million (as at June, 2008). An overview of population densities in the ten administrative regions as outlined below (table 4.1), although unevenly distributed, is highly skewed towards

the high forest zone. Densities, as at year 2000 ranged from 21 to 897 with a national average of almost 77 persons per square kilometer (Statistical Service, 2004).

Table 4.1 Recent population dynamics in Ghana

Administrative Regions	Year 2000 Population Census	
	Populace	Density(Per Km^2)
Greater-Accra	2,909,643	897
Central	1,580,047	161
Ashanti	3,187,601	131
Eastern	2,108,852	109
Upper-East	917,251	104
Volta	1,612,299	78
Western	1,842,878	77
Northern	1,854,994	21
Brong-Ahafo	1,824,822	46
Upper-West	573,860	31
Total	**18,412,247**	**Ave. 77**

Source: Based on year Ghana Statistical Services population census figures, 2004

Today the average national population density is over 90 persons per square kilometer (Ghana Statistical Service, 2004).

4.1.3 Justification for choice of Study Area

• Favorable conditions exist in Ghana for achieving SFM as literature review reveal a tall history of forest management documents (table 4.4), a well composed institutional and legal framework, good governance and an impressive political will, committed to the recourse of natural resource management.

• The high forest zone (HFZ), with a total area of 8.2 million hectares (FAO, 2007), is identified within the biodiversity hot spot regions in the tropics whose fast deteriorating status, over the few decades has been of global concern to environmental scientists and natural resource managers.

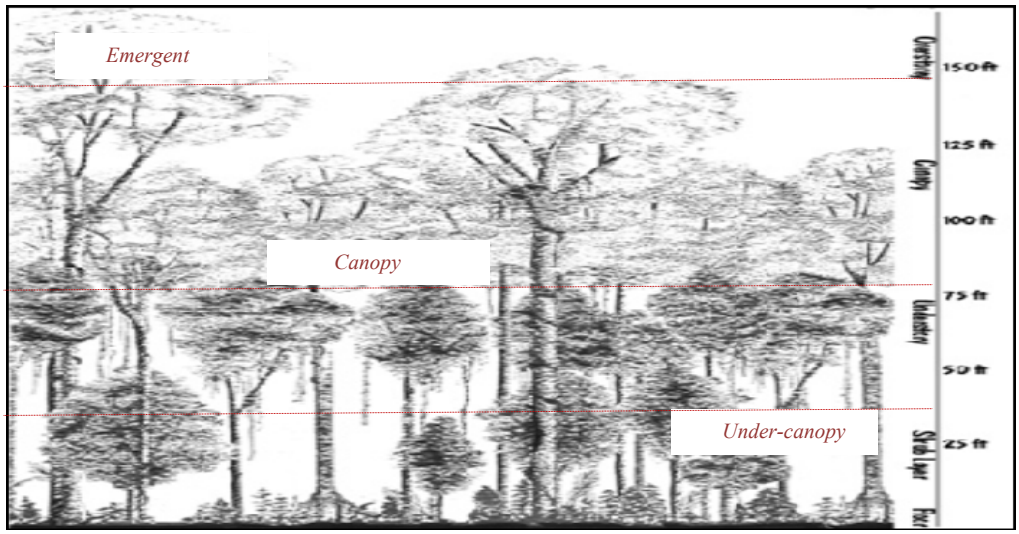
• The rich endemism of the high forest zone registers over 2,000 plant species of which 680 are tree species (Global Forest Resource Assessment, 2005). Apart from satisfying daily subsistence, traditional, medicinal and customary needs of the local communities, the high forest zone is also of environmental and economic importance.

• The forestry sector is an important economic variable in Ghana's quest for sustainable development (Vision 2015) equation in terms of employment, contribution to gross domestic product, foreign exchange earnings and most importantly cottage industrialization.

4.2 OVERVIEW OF FOREST RESOURCES IN GHANA

The high forest zone is tropical in nature. It consists of mainly woody vegetation (Jacobs, 1988) in three (3) layers (emergent's, canopy, under canopy) with very dense leverage and thin undergrowth (figure 4.1). Tropical forests are found on narrow belts on either sides of the equator (lat.0^0 -10^0 N and lat. 0^0-10^0S) making up about 7% of the earth's surface occupying a total band of 3.4 million square miles (Jacobs, 1988).

Figure 4.1 Strata of tropical rainforests

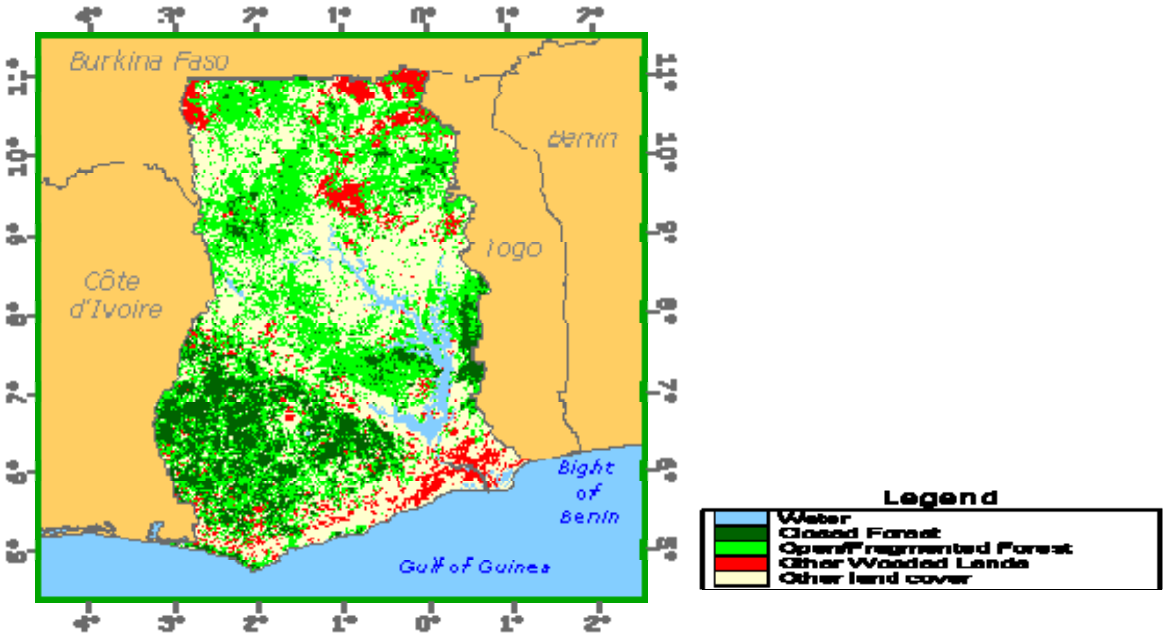


Source: Jacobs, 1988

Peculiarities of this vegetation type are that of high biodiversity, high precipitation (1000mm-2000mm) and very warm temperatures (average of 26^{0c}) throughout the year. These climatic conditions in the order of FAO's classification, however renders forest soils (mainly latosils) as

the poorest in the world (FAO, 1995a; Steen et al., 1992). This is due to their shallowness in depth and high acidic content. Ghana's share of the forest resources`s bio-geographic affinity is associated with the Guinea-Congolian and confined to the south western part of the country (figure 4.2). To the northern section is the Tropical Sudan type with the Dahomey-Gap running through the north, south-east and systematical delineates the tropical evergreen[10] forest from that of the tropical savannah. Forested lands are estimated at a little over 8 million hectares of the total land area of Ghana (FAO, 2006).

Figure 4.2 Intact forest resource out-look



Source: FAO, 2006

Prevailing ecological dynamics of the forest resources, according to FAO (2005a), puts the forest zone into 6 major researchable categories; three (3) classes of evergreen and three (3) types of deciduous, each with its own distinct association of environmental conditions and plant community as outlined in table 4.2 and depicted by figure 4.2. Most of the economic timber species, according to the Forestry Commission (2006), are found within the high forest zone with the commonest tree species being mahogany *(Khaya ivorensis),* Wawa *(Triplochiton scleroxylon),* Mansonia *(Mansonia altissima),* Makore *(Tieghemella heckelii)*, Danta *(Nesogordonia papaverifera),* Guarea *(Guarea cedrata)*, and Niangon *(Tarrietia utilis).*

[10] Forest cover in three canopy layer with thick undergrowth.

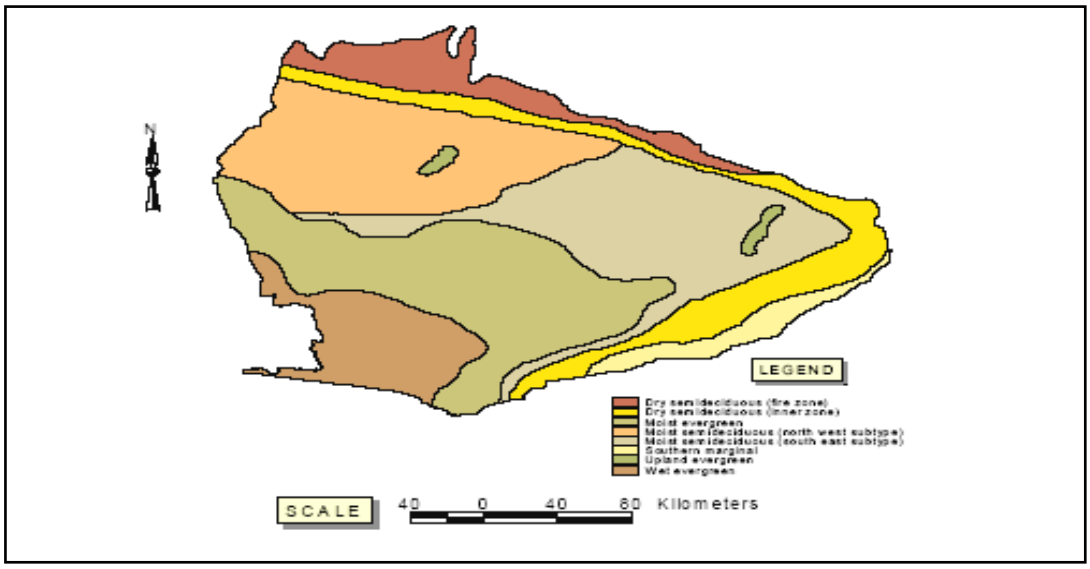
Table 4.2 Major forest types of the high forest zone in Ghana.

Vegetation Type	Total Extent(ha)	On-reserve(ha)	Off-reserve(ha)
Wet Evergreen(WE)	759,639	152, 250	607,389
Moist Evergreen (ME)	1,835,382	469, 200	1,366,182
Moist Semi-deciduous South East (MSSE)	1,726,122	204,190	1,521,932
Moist Semi-deciduous North West (MSNW)	1,560,352	457, 040	1,103,312
Dry Semi-deciduous (DS)	1,694,859	250,440	1,444,419
Upland Evergreen (UE)	948,709	66,090	902,839
Total	**8,525,063**	**1,578,990**	**6,946,073**

Source: Ministry of Environment and Science, 2005

Intact forest[11], according to Sayer et. al. (1992), constituted about 34.4% of the total land area as observed a century ago. By the turn of the early 1980s a greater proportion of the intact forest had been degraded as can be gleaned from table 4.2. What is considered to be the high forest zone[12] today is estimated at around figure of only 1.6 million hectares (Asibey et al., 1982).

Figure 4.3: Major vegetative regions of the HFZ.



Source: Ministry of Environment and Science, 2005

[11] Constitute forest on-reserves and off-reserves
[12] Forest found only within on-reserves

Results from field data analysis, collaborated with facts findings of the Food and Agricultural Organization (2006) even points to a much lesser forest cover since only 19% (1.5million ha) of the original intact forest cover is currently available (Nketia et al., 2004). Savannah woodlands cover the remaining two thirds of the total land area in the domain of 15.75 million hectares (figure 4.2).

4.3 INTRINSIC CHARACTERISTICS OF FOREST RESOURCES

Forest resources, according to a school of thought (Pacheco et al., 2005), are not public or private goods. Along the peripheries of environmental economics they however exhibit both characteristics mentioned above and therefore could be described as a communal property resource (Bromely et al., 1990). Arguably it can also be owned by the state, private individuals or a group of individuals making it apparently not feasible to exclude people from the use of such resources (Swaney 1990). 'Open-access' as they are, and in their natural environment, Aarnold (1992) argue that, these resources are sub-tractable with very poor excludability. However, once subtracted by a well defined owner or set of co-owners forest resources become private goods and therefore excludable (Feeny et al. 1990; Swaney 1990; Bromley 1991). These properties make effective management of the resources by policy makers, from the conventional management principles problematic since at one stage or the other they are confused with whether to manage it within the confines of the market mechanism or under the preview of government (Pacheco et al., 2005). By their nature therefore utilization of the resources, according to Ostrom (2003), becomes vulnerable to over-exploitation and degradation.

4.4 CUSTODIANS OF LAND RESOURCES

4.4.1 Forest Ownership

The intrinsic characteristics exhibited by forest resources and a closer look at customary prescriptions for owning a piece of land resources in Ghana reveals a complex system which makes it difficult to envisage direct management control by the government. This is because land resources form the life supporting units of chieftaincy institutions which play very import roles

in local governance (Ghartey, 1990). These institutions are symbolized by either "Stools"[13] or "Skins[14]". What pertains in Ghana today, although not devoid of occasional conflicts, is that the chieftaincies institutions administer resource ownership functions on behave of their subjects (Sayer et.al., 1992) whereas government exercises direct administrative and management functions of forested lands on behalf of, and for the benefit of her citizenry by holding the lands and trees on them in trust (Forestry Commission, 2006). This scenario sometimes presents a situation whereby one may own a piece of land but may not have control over the forest resources (eg. timber) on it because that land may form part of a concessionary leased out to timber merchants by the government. If such situation arises, as is often the case in Ghana, land tenure agreements are often violated and the property holder may harbour intents to cause damage (Nketia et.al., 2004) to environmental resources knowing very well that the benefits coming out of such resources would be enjoyed by someone else.

4.4.2 Land-Use Category

About 38 % of accessible lands in Ghana, according to Musah (1995), is committed to primary production (comprising 12% arable lands, 7% lands for permanent cropping and 19% lands for permanent pastures), 35 % still remain as forest and woodland while the remaining 27% corresponds to miscellaneous activities.

Traditional land-uses range from small and large scale farming, fuel-wood gathering, and livestock grazing to conventional usage such as forestry, urbanization, plantation and recreational reserves (Games and Parks). Within the high forest zone, 1.578,990 million hectares of land are permanently protected (Ministry of Environment and Science, 2005). Although occupancy and agricultural activities are not allowed within the reserves, certain lands within the reserve are permitted as admitted farms. Additionally, agriculture is practiced within some reserves as a component of the new *Taungya*[15] system of plantation established under departmental control and supervision. About 126,600ha in forest reserves are under the jurisdiction of the wildlife division as protected areas (Nketia et al, 2004).

[13] Chiefs in southern Ghana are enstooled into office to symbolize their authority. Land resources belong to the stools with the chiefs acting as caretakers.
[14] Chiefs in northern Ghana are enskined into office to symbolize their authority. Land resources belong to the skins with the chiefs acting as caretakers.
[15] A form of sustainable agriculture where food crops are interspersed with tree plantation.

4.5 FOREST MANAGEMENT SYSTEMS

4.5.1 Institutional Framework

The Forest Department and Wildlife Division of the Forestry Commission, Forest resources related Government Ministries such as Environment and Lands & Forestry, relevant Government Agencies and setups such as the Environmental Protection Agency, District Assemblies, Academic (Universities) and Research institutions, Forest Communities and Non-Governmental Organizations, are directly or indirectly charged with the responsibility of determining what constitute forests how these should be managed and how proceeds should be disbursed.

As a result a total of 266 forest reserves, covering an area of 2.68 million hectares (Musah, 1995) have been demarcated ostensibly to check uncontrolled conversion of forest cover to other uses. Out of the total reserves, 204 (1.6 million hectares) are located within the high forest zone. The remaining 62 reserves occupy 0.6 million hectares in the low forest zone. What remain as intact forest cover (forest reserves) are being managed for various uses (table 4.3) including both production and protective purposes (Nketia et al., 2004).

Timber production reserves, according to the Forestry Commission (2006), occupy 47% of the total forest estate, with the rest designated for protection, conservation and research as outline by table 4.3 and depicted below by figure 4.4. The production areas are forestlands where timber is presently extracted using the interim yield formula (Nketia et al, 2004).

Table 4.3 Extent of intact forest resources

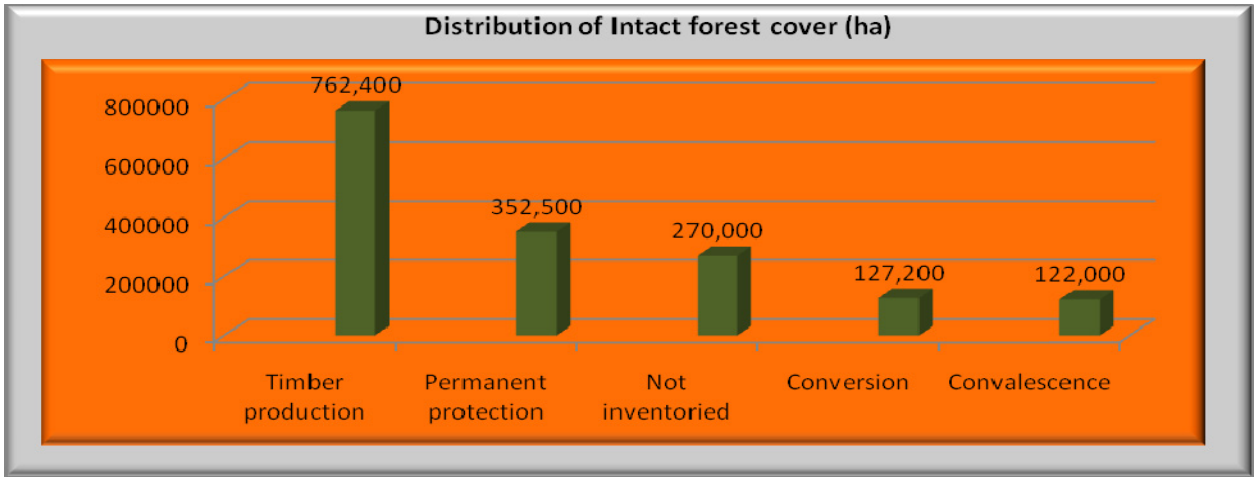
Nature of Forest	Size (ha)	Percentage (%)
Timber production	762, 400	47
Permanent protection	352, 500	22
Not inventoried	270, 000	16
Conversion	127, 200	8
Convalescence	122, 000	7
Total	**1, 634, 100**	**100**

Source: Forestry Commission, 2006

Permanent protection areas, according to the Collaborative Resource Management Unit of the Forestry Commission, consist largely of biological protection areas, shelterbelts, hill sanctuaries, swamp sanctuaries, special intact forest sanctuaries and fire protection zones. However,

according to March's inventory report in 1995, only 15% of the area protected on grounds of genetic diversity is well stocked and accessible (Musah,1995). The rest of the areas are either degraded or inaccessible.

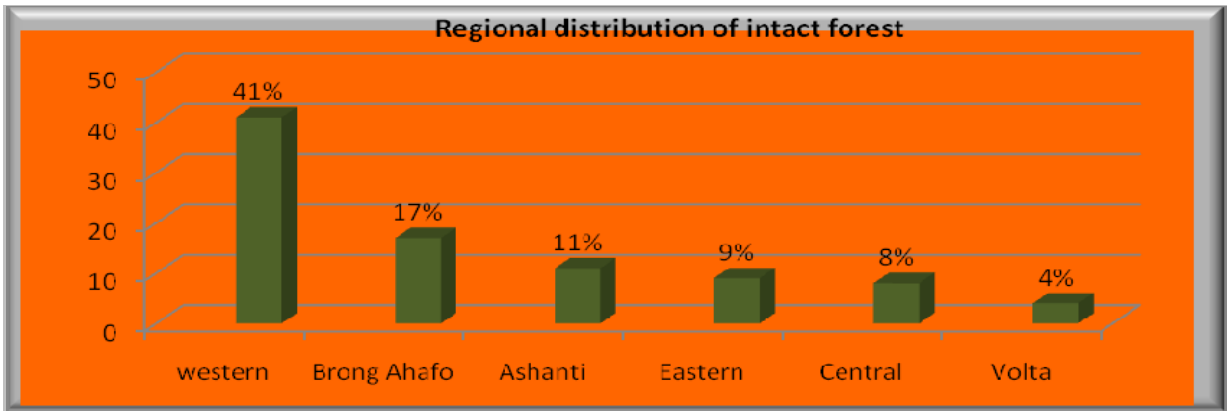
Figure 4.4 Categories of intact forest cover



Source: Sample data analysis, 2008

Convalescence are areas with reduced stocking but are assumed to be capable of rehabilitation within one felling cycle (40 years). Conversion sites are areas that have already been be re-forested or need to be re-planted. It is estimated that intact closed canopy forest (figure 4.4) outside the permanent forest reserve, available for timber production is about 374,000 ha. Plantation forests cover about 50,000 ha. The intact forest cover is found in six (6), out of the ten (10) regions with the Western and Brong-Ahafo regions alone accounting for 58% according to figure 4.5.

Figure 4.5 Regional extent of intact forest cover.



Source: Field data analysis, 2008

4.5.2 Traditional Forest Management System

Traditional forest management is seen in the form of indigenous protective area systems (Ntiamoah-Baidoo, 1995) which function on similar principles of that of the sustained yields and natural regeneration theory (CAB, 2001). With this practice pockets of productive forests of economic importance close to settlements are set aside as sacred lands. The inhabitants are then made to understand that such lands set aside are either completely inaccessible by the community or can only be accessed at certain times of the year as directed by the gods (Dwomoh, 1990). Customary laws are promulgated to strictly protect such parcels of land from further degradation. Sacred forests still exist in Ghana but are mostly identifiable with rural communities and may assume diverse names such as *Abosompow/Asoneyeso*[16], *Mpanyinpow*[17], and *Nsamanpow*[18] depending on a particular rural setup (Dwomoh, 1990; EPC, 1976; Dickson, 1969).

Sacred forests are collectively known as fetish groves and as the names depict scares people away from any form of encroachment. These practices have played significant role in natural resource regenerative management initiatives with regards to the consequences taboos in rural communities have on the people. More so numerous cultural and religious rites are maintained since strong reverence for the gods and ancestral spirits are deeply rooted in such rural community setups.

4.5.3 Planned Forest Management

Inspired by the past and engineered for the needs of today and future generations, what is now accepted as planned (conventional) forest management system in Ghana was initiated by the British[19] in 1909. Institutionalizing forest resource management was aimed at achieving *sustained increased yield* (CAB, 2001) without much recourse to environmental damage repercussions. A forest department was setup. Areas were legally constituted into permanent forest production (On-reserves) by 1927 with the passage of the Forest Ordinance (table 4.4a). In 1948 the first forest policy was adopted (Ghartey, 1990). Introducing planned management provided bases for the resources to be managed for both production and conservation objectives.

[16] Fetish shrines
[17] Ancestral forests
[18] Ghosts abode or burial grounds
[19] Britain was the formal colonial masters of the Gold Coast until 1957 when it become independent under the name Ghana.

Management was however carried out in the absence of proper forest inventories. As a result resources on both *on-reserves* and *off-reserves* were subjected to excessive exploitation for round logs by timber merchants and other land-use opportunists. During the period 1956-1970, the Modified Selection System and the Girth Limit System were applied to salvage timber harvesting. When reliable inventory data became available in the middle of 1980, the forty-year (40) felling cycle was adopted (Gyasi, 2002).

4.5.4 Sustainable Forest Management

In 1994, the government introduced a new management document receptive to a much more responsive policy aiming to achieve collaborative management effort consensuses. In order to strengthen Ghana's commitment to pursing sustainable forest management and ensure marketability of wood products, the ministry of Lands and Forestry, together with stakeholders intensified its efforts in examining sustainable forest management issues. Introduction of the forest and wildlife policy in 1994 made it possible for forest reserves to be categorized into 52 plots called Forest Management Units[20]. Reserves were further designated into zones with specific management objectives ranging from timber production, watershed management, commercial production of non-traditional forest products, to protection, restoration and conservation of forest ecosystem. Each forest management unit has a working plan period spanning from 1 to 20 years (FSDFC, 1999).

4.6 EVOLUTION OF MAJOR FOREST MANAGEMENT POLICY DOCUMENTS

At any periodic glance the state of forest resources give indication of management's actions or inactions towards proper care for the resources in order for it to deliver its maximum produce and services. A good national forest policy objective necessary to secure the integrity of ecosystem health and vitality is one which can define an integral playing field (Armstrong, 1995) for both global and national elements concerned with forest management to recognize the role other stakeholders play. The study outlines below major policies and working documents (table 4.4) which have played significant roles towards sustainable forest management in Ghana. Findings were deduced from administrative sources through the questionnaire method and desktop studies.

[20] Smallest area under observation within a managed forest

4.6.1 The Period from the 1900s-1989

Managing forest resources through formal policy promulgation and working documents can be traced back to the colonial era. The Forest Sector Legislation, which is the first of such important documents, was captured in 1906. The Act was aimed at controlling timber harvesting with '*increased sustained yield'* as management goal. Since that era evolution of major working documents and policies (table 4.4a), according to Kotey et al (1998) muddled through three (3) trying phases; a consultative era[21], an accelerated timberization phase[22], the diktat period[23] and is now undergoing reforms under a collaborative dispensation.

Table 4.4a Evolution of major forestry working documents from 1900-1989

Year	Policy/document	Main objectives
1906	Forestry sector legislation	▪ Control harvesting of commercial tree species
1907	Timber Protection Ordinance	▪ Diameter harvesting of commercial timber species
1908	Initial Forestry sector Survey	▪ Functional unit responsible for policy implementation.,▪ Forestry department created, ▪ Forest reserves proposed
1927	First forest ordinance	▪ Statute governing constitution and management of forest reserves.,▪ Consolidated power in central government to constitute and manage forest reserves.
1947	First national forest inventory	▪ Document merchantable species, ▪ Covered 1, 290 sq miles of land ▪ 26 economic trees listed.
1948	First forest policy	▪ Planned management first introduced in forest reserves , ▪ Provided bases for management of resources with production and conservation objectives
1952	Follow-up of forest inventory	▪ Same objectives as 1947
1962	First concessions Acts (Act 124)	▪ First forest ordinance modified, ▪ Timber resources, timber concessions, forest reserves vested in the state in trust for owners, ▪ Power to grant concessions vested in sector minister
1973	Follow-up forest inventory	▪ Document merchantable species
1974	Forest Protection Decree	▪ Certain activities within reserves prohibited ▪ Resource user rights entirely transferred to state
1985	Recent forest inventory	▪ Estimate commercial log volume,▪ 334 secondary timber listed, ▪ Provide data base for SFM, ▪ Asses biological productivity, ▪ Asses ecological status of forest, ▪ Provide information on Non timber products
1989	Forest Resource Management Project (FRMP)	▪ Maintain ecosystem and ecological processes essential for the vitality of the biosphere., ▪ Ensure sound management of natural resources and the environment,▪ Protect man, plants and animals with respect to biodiversity conservation, ▪ Minimize pollution and public nuisance stemmed from development activities; Educational training & research

Source: Based on field data analysis, 2008

[21] Consultative era; decisions concerning forest resources were done in consultation with the chiefs and elders.
[22] Timberization phase; harvesting the capital stock of forest resources was the dominant concern in forestry policy.
[23] Diktat period; indigenisation" policy took the timber industry away from being controlled by minority foreign timber merchant into the hands of local companies who also had considerable influence at the policy levels.

Agronomy for cocoa plantation which requires high forest cover for micro-climate brought in conservation measures by stakeholders and large areas were set aside as forest reserves by the end of 1947.

Inventories were carried out thereafter to assess the situation on the ground. However these conservationist policies began changing with the outbreak of the Second World War. When the concessions Act (Act 124) was promulgated commercial timber exploitation rapidly gained prominence (Kotey et al., 1998). The 'Concessions Acts' (Act 124) modified the first forest ordinance, vested forest reserves in the State in trust for its owners and empowered a sector minister to grant concessions. By this development cocoa farmers who were concerned about the productivity of their forest dependent cocoa farms often protested (anti-concessionaire) against foresters (pro-concessionaire).

This, most often than not, breaded acrimony between the stakeholders. Meanwhile forestry plans which majored on timber production and revenue generation for developmental needs continued.

By the middle of 1980 forest inventory (through satellite images), according to the Forestry Commission (2006) revealed what was to be expected from poor management policies and practices in that while forest reserve boundaries still remained intact, about 32 percent of the reserves had been degraded (FSDFC, 1999). It also presented a scenario where reserves remained under the ultimate authority of traditional "stools," but the owners had no incentives for protecting trees on their land from loggers.

4.6.2 The Period from 1991-1999

The 1990s gave management a clue as to how to rethink and strategize in sustaining the remaining forest because by 1993 timber harvesting off-reserves had reached alarming levels as the timber industry expanded. Opportunistic timber contractors operated illegally in response to a lucrative, but an aggressive Far East Logging Markets offers. More so forest policies from the early 1960s that allowed concessionaires full salvage in advance of the expanding cocoa plantation frontier were still in effect, even though most of the remaining timber trees were on farms or in sacred groves. It also deepened and worsened old antagonisms between cocoa

farmers and timber concessionaires. Evolving management working documents began to change with a National Environmental Action Plan and Policy in 1991. Two years later (1993) the Ghana Environmental Resource Management Programme was adopted. These programmes, as depicted by table 4.4b, are subsequently outlined as follows;

Table 4.4b Evolution of major forestry working documents from 1991-1999

Year	Policy/document	Main objectives
1991	National environmental action plan & policy	▪ Maintain ecosystem and ecological processes essential for the vitality of the biosphere, ▪ Ensure sound management of natural resources and the environment, ▪ Protect man, plants and animals with respect to biodiversity conservation, ▪ Minimize pollution and public nuisance stemmed from development activities
1993	Ghana environmental resource management programme	▪ Actual implementation programme for NEAP ▪ Established the Environmental Protection Agency(EPA)
1994	Wildlife and forest policy	▪ Conserve and protect forest and wildlife resources, ▪ Promote viable and efficient forest-based industries, ▪ Raise awareness of participatory resource management ▪ Promote scientific-based management and utilization of forest and wildlife resource ▪ Enhanced capacity building of national, regional and district agencies for SFM/wildlife management.
1996	Forest development master plan (1996-2020)	▪ Aim to achieve sustainable development of forest and wildlife resources, ▪ Modernize the timber industry, ▪ Conserve biodiversity, ▪ Conserve the environment to be driven, to a larger extent, by the private sector
1997	Timber resource management Act (Act 547)	▪ Promulgated to consolidate existing forest laws, . Proposed stakeholders management of forest resources, ▪ Introduced Timber Utilization Contract (TUC) ▪ Called for due diligence from stakeholders (EIA)
1998	Forest management certification system	▪ Rolled out a computerized system for log tracking, ▪ Provide legal basis for financing the forestry department under the timber resource management regulation Act (L.I. 1649/88)
1999	National land policy	▪ Enacted to address fundamental problems associated with land management (Wetlands, National parks & Reserves), ▪ Initiated the natural resource management programme (NRMP) to consolidate management of land, forest and wildlife resources through Collaborative management and to maximize returns of stakeholders input ▪ Promulgated the forest commission Act No. 571/99 that that established the Forestry Commission

Source: Based on field data analysis, 2008.

The 1994 wildlife and forest policy in particular confirmed worldwide assertion that there was the need to manage forests in a way which recognises the many roles our forests play in agriculture, biodiversity, as sources of timber production, employment, income generation, nature conservation, recreation, and as carbon sinks. It also saw the need to identify all parties involved such a complex web of management system. This led to the execution of a forest development master plan (1996), enactment of the Timber Resource Management Act (Act 547) in 1997, a forest certification scheme (1998) and a national land policy in 1999 (table 4.4b).

4.6.3 The New Millennium

At the end of the 1990s policies that sought to strengthened and consolidate sustainable forest management were seen taking shape. These were identified in the form of principles, Criteria and Indicator Standards and Thresholds, and Certification Scheme working documents. In recent times the need to restore a balance between national and industrial interests and the rights of forest communities to the resource base has become imperative. As already hinted the 1994 Forest and Wildlife Policy were passed to support local forest management initiatives outside reserves. Subsequent documents enumerated with the dawn of the new millennium (in year 2000) and thereafter (table 4.4c) sought to encourage local community initiatives that protect natural resources for traditional, domestic and economic purposes, and to guarantee the right to utilize such resources for sustainable development through national forestry development programmes, forest protection Acts and community forestry management projects (table 4.4c).

Table 4.4c: Evolution of major forestry working documents from 2000-present

Year	Policy/document	Major objectives
2000	Pilot Testing of Principles, C&I	▪ Adopted forest standards for SFM and Forest Certification by standards boards ▪ Develop Ghana Forest Management Certification Standards and checklists
2001	National Forestry Development Programme	▪ Ambitious tree planting exercise to be championed by the forest communities private entities/individuals, NGOs through agro-forestry and the taungya system in degraded areas
2002	Forest Protection ACT 2002	▪ Amended the forest protection Act to make punishment by forest offenders more deterrent ▪ Made provisions for joint liability in prosecuting offences
2003	Community Forestry Management Project	▪ Emphasized on community forest management of wildlife resources

Source: Based on field data analysis, 2008.

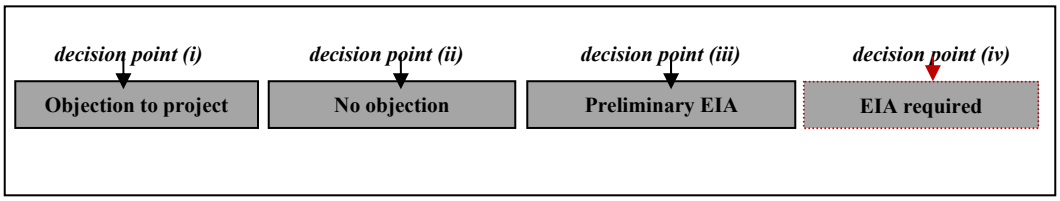
4.7 MEASURES FOR THE IMPLEMENTATION OF SFM IN GHANA

4.7.1 The Role of Environmental Impact Assessment

Environmental impact assessment is a systematic process by which the likely significant effects of a project or development on the environment are identified, assessed and taken into account by a competent authority in the decision-making process (Miner, 1994). In Ghana it is applied to development projects as an environmental permitting pre-requisite and a major environmental

management tool (EPA, 2005a) of which forestry developments are no exceptions. Implementation of the environmental impact assessment has impacted positively on initiatives being undertaken to ensure that forest resources are managed on sustainable basis through the establishment of threshold limits. The legal basis for thresholds is enshrined in the Environmental Protection Agency Act of Ghana, ´EPA Act 490` (EPA, 2005a) which allows certain projects with unlikely significant environmental effects to proceed without screening under `cut-off points` (Sheate, 1994) if they are found below minimum requirement limits, meet certain criteria or located within certain areas (appendix 13). With specific reference to sustainable forest management in Ghana, as stipulated by the Environmental Protection Agency law (EPA Act 490), projects that require an assessment go through the final decision making process (figure 4.6) from which decision point *iv* is reached.

Figure 4.6 EIA decision point



Source: Based on EPA, 2005

Such projects are enlisted under schedule II of the EPA Act 490 (EPA, 2005a). They include; *i.* Logging or conversion of forest land to other land use within the catchment`s area of reservoirs used for water supply, irrigation or hydro-power generation or in areas adjacent to forest or wildlife reserves, *ii.* Conversion of hill forest land to other land uses, *iii.* Conversion of wetlands for industrial, housing or agricultural use, *iv.* Land development for agricultural purposes not less

Table 4.5a Threshold limits for selected forestry projects Ghana.

Project type	**Area threshold**	
	Sensitive areas	***Non sensitive areas***
Agriculture	0 hectares → opinion always needed	> 40 hectares
Logging	Hill sanctuary slope ≥ 30% Close to water course > 25m Other sensitive areas, 0 hectares → opinion always needed	Intensity in all contract areas >2 trees/hectare
Forest roads	0 hectares in all sensitive areas → opinion always needed	> 5 hectares

Source: Field data analysis, 2008

than 40 hectares and *v.* Agricultural programmes necessitating resettlement of 20 families or more. The research identified practical implementation of the EIA process in forestry projects in Ghana where threshold limits are being tested on both sensitive[24] and non sensitive areas as gleaned from table 4.5a.

From the assessment (table 4.5a) EIA decision point *iv* (figure 4.6) is always needed for agricultural and forest road developments in all sensitive areas. Under logging EIA opinions are also sought for in hill sanctuaries and areas close to water courses with gradients greater or equal to 30% and gradients greater than 25% respectively. However, on non-sensitive areas, cut-off points are established at 40 hectares and all developments greater than the threshold limit requires an EIA. Under logging all contract areas where more than 2 trees per a hectare of land are to be harvested also need an impact assessment. Likewise forest road developments of an area with size greater than 5 hectares need to go through the EIA opinion process as shown by table 4.5a above.

4.7.2 Setting Standards for monitoring and conservation

Another area which has played a vital role towards the success of sustainable forest management implementation in Ghana`s high forest zone is setting of standards for vascular plant species. Standards, in relation to forestry, are sets of principles, criteria and indicators that serve as reference for sustainable forest management assessment (Sayer, 1996). Standards for sustainable forest management in Ghana cover a broad spectrum of stakeholder's views and concerns. They include socio-economic well-being indicators, environmental status and, rights and responsibilities of stakeholders. Issues bordering on biodiversity conservation, workers rights and responsibilities, compliance with laws and regulations, land tenure, and resource rights as well as other relevant areas have been captured and generally categorized under 7 principles (table 2.3). These form the basis of criteria and indicator development within the hierarchical framework and serve as a yard stick for monitoring land degradation and conservation measures.

[24] Sensitive areas are areas that have been identified and listed under schedule 5 of the Ghana EPA's EIA regulation as highly susceptible to damage by human activities.

Tracking biodiversity conservation in Ghana, for instance, take the form of classifying plant species into a star rating system (Musah, 1995) to show priority species, their distribution and protection (Hawrthrone, 1995; Abu Juam, 1995).

Species assigned with a black star, for example, connotes scarcity of the resource at the international scene and also in Ghana. Implicit for sustainability demands that such species (eg black star rated) need to be given the highest conservation priority. The star categories, their implication for species conservation as well as management can be gleaned from table 4.5b below.

Table 4.5b Standards for monitoring timber species.

Star label	Species implication for conservation	Implicit for SFM
Black	Rare globally and almost unknown in Ghana	Given highest conservation prority
Gold	Fairly rare globally and fairly rare in Ghana	Require high protection
Blue	Known globally but rare in Ghana (and vice versa)	Require protection
Scarlet	Known globally and common in Ghana Under high pressure from over exploitation	Strict control on AAC if to remain commercially viable Level of cut > 200% of ACC
Red	Common globally and common in Ghana Tend to be over exploited	Restriction needed Level of cut (100-200)% of ACC
Pink	Utilizable but not popular to the international trade Utilizable in Ghana	Harvest levels set below ACC
Green	No particular conservation concern	Judicious resource utilization

Source: Analysis based on Musah (1995) and the Forestry Commission (2006) data sources.

These standards are intended to ensure genetic diversity of tree species, their productivity and safe-guard their environmental protective functions. It also makes species-specific policy promulgation possible. The conservation strategy gives rise to a genetic heat index (GHI) in Ghana which exhibits genetic value of forests in terms of composition of tree species by a special computer programming (Forestry Commission, 2006). Derivation of the index, according to Hawthorne (1995b), draws on distribution of tree species in Ghana with the following conservation multiplier expressed below as;

$$GHI = \left[\frac{(bk.27) + (gd.9) + (bu.3) + (rd.1).100}{(bk + gd + bu + rd + gn)} \right]$$

Values range from 0-533, where; *bk* = tree species labelled as black star, *gn* = tree species labelled as green star, *gd* = tree species labelled as gold star, *bu* = tree species labelled as blue star, *rd* = tree species labelled as red star (Hawthorne, 1995b).

The index expresses scarcity or availability of a specific vascular plant species. A compilation of selected vascular plant species based on Okyeman Foundation (2003) carried out during this study revealed the following pattern of some species of conservation concerns in the Atewa forest reserves in the Eastern Region of Ghana as gleaned from table 4.6. For instance under this assessment species with no conservation concerns (eg *Uapaca spp. – Assam*) in the Atewa forest reserves are categorized under the green star (table 4.6) and assigned with a programming value, zero (*gn* = 0). Species with the highest conservation priority (eg. *Neolemonniera clitandrifolia*) are labelled under black stars with the multiplier 27 (bk = 27). Those that are of some conservation interest but not as that of the black stars are labelled as gold stars (eg. *Okoubaka aubrevillei)* which assumes the conservation value 9 (gd = 9). In other words higher genetic heat index connotes that endangered species are on the rise and vice versa.

Table 4.6 Selected vascular plants of conservation concern in the Atewa forest reserve

Scientific Name	Family	Habit	Guild	Star	Multiplier
Neolemonniera clitandrifolia	Sapotaceae	Tree	shade	black	*bk* = 27
Khayaivorensis, (Mahogany)	-	Tree	economic value	red	*rd* = 1
Okoubaka aubrevillei	Santalaceae	Tree	NPLD	gold	*gd* = 9
Tieghemella heckelii (Makore)	-	tree	economic value	red	*rd* = 1
Pavetta akeassii	Rubiaceae	Climber	shade	black	*bk* = 27
Guarea cedrata (Guarea)	-	tree	economic value	black	*bk* = 27
Tarrietia utilis (Niangon)	Rubiaceae	Shrub	shade	black	*bk* = 27
Uapaca spp. (Assam)	-	Tree	economic value	green	*gn* = 0
Orthopichonia barteri	Apocynaceae	Liane	NPLD	gold	*gd* = 9
Nesogordonia papaverifera (Danta)	-	Tree	economic value	green	*gn* = 0
Mansonia altissima (Mansonia)	-	Tree	economic value	red	*rd* = 1
Buforrestia obovata	Commelinaceae	Herb	shade	gold	*gd* = 9
Triplochiton scleroxylon (Wawa)	-	Tree	economic value	blue	*bu* = 3
Pandanus abbiwii	Pandanaceae	Tree	swamp	gold	*gd* = 9

Source: Based on Okyeman Environment Foundation data, 2003

Therefore a genetic heat index assigned with the multiplier 3 (*bu* = 3), as in the case of Wawa tree (*Triplochiton scleroxylon)* species, are labelled as blue stars indicating that their conservation concerns are not in critical stages as compared to a gold or black labelled stars.

Following after green labelled stars are the blue labelled star plant species (*rd* = 1) with minimal conservation concerns in the forest where; *NPLDs* = 'Non pioneer light demanders', being intermediates between the previous and next forest categories, *Shade-bearers* = are often to be found healthy in the shady under-storey of tropical forests, and rarely benefit from disturbances, *Swamp* = species are largely restricted to rivers and swamps and *Economic value* = trees of economic value.

From the exposition above table 4.6 became a standardized checklist for management and stakeholders of this forest reserve to monitor and report progress on utilization of vascular plant species, carry out appropriate conservation measures and make informed decisions based on data provided by the table to the public. It also minimizes the impact human activities may have on the resources and thus may serve as benchmarks of environmental performance and good practices.

5.0 RESEARCH METHODOLOGY

5.1 INTRODUCTION

Although the concept of sustainability is yet to assume an accepted harmonized definition at the global level (Dixon & Fallon, 1989; Cook & Laughlin, 1999; Paehlke, 2000), sustainability measures has been opted for by policy makers as an appropriate tool to the rescue of the increasingly declining forest cover in recent times. Its applicability is deeply rooted in the 1980's Brundtland Commission's blueprint `` *our common future*`` (WCED, 1987; UNCED, 1992) and engineered by the Club of Rome's *Limits to Growth*[25] round table conference in the 1970's (Meadows et al, 1972, 1992, 2004).

Forest resource-use and measures of successes towards sustainability assessments prove to be a very challenging task. There is therefore wisdom in the choice of criteria and indicators as a practical tool for this kind of operations because it allows for only those who are involved with the use and management of the resources to undertake the task. The main issue with the use of criteria and indicators, however, is selection of universally agreed on criteria and applicable indicators for measurement.

Many set of criteria and indicators for sustainable forest management have already been developed globally and Ghana has participated in a number of such initiatives. The Ghana criteria and indicator initiative, over the years, have been supplemented by performance standards and thresholds, and good forest management prescriptions (Tang, 2001) specific to tropical forests. Selected criteria and indicators for this research were those that have been field tested, accepted by management stakeholders, and also sufficient enough to communicate meaningful information about performance progress trends in ecosystem vitality, economic gains and social well-being from which deterministic policy or management responses are inferred.

5.2 IDENTIFICATION OF CRITERIA SET

A set of criteria were identified (figure 5.1). The criteria defined characteristics of the main aspects of sustainable forest management to be measured. It provided the basic framework for

[25] *Limits of growth*, the Club of Rome in 1972 drew the attention of the world to the consequences of a rapid population growth rate and finite resources supplies.

policy formulation and direction. The baseline framework on choice of criteria set is built on three thematic categories; Environmental health and vitality, Economic growth and development and Societal Well-being in addition to an Enabling condition (figure 5.1) that must prevail for such an exercise to be carried out.

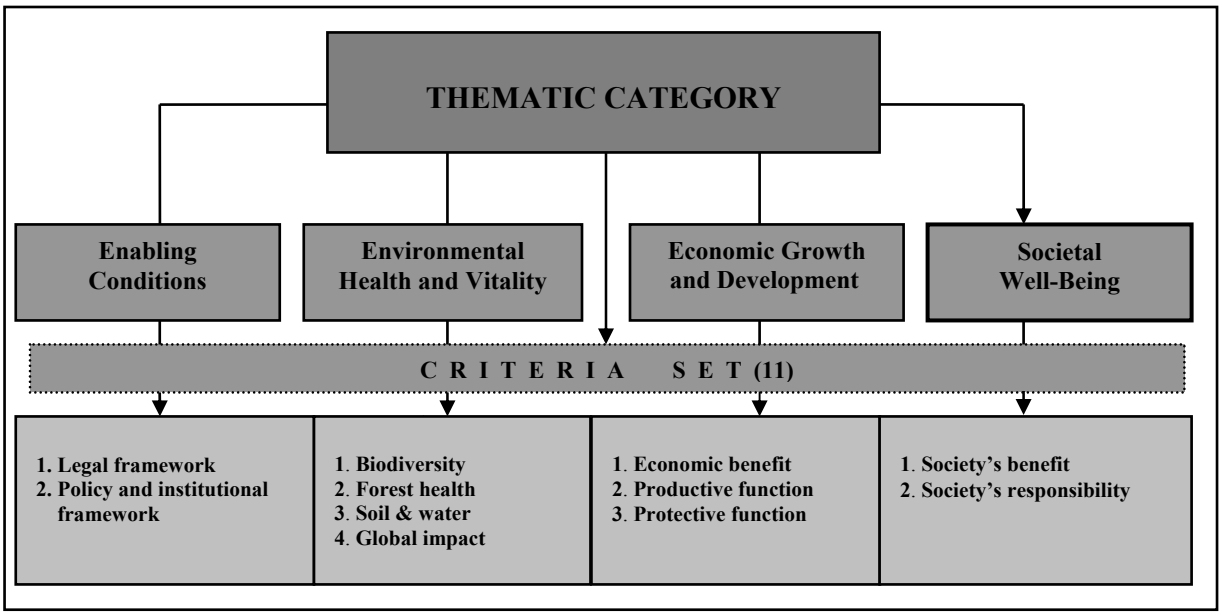
Selection of relevant criteria set for the study was influenced by a review of the outcome of major global forest resource management initiatives and processes on sustainable forest management (FAO, 2005b) that have been pursued around the globe and outlined under appendices 10.1a and 10.1b. Most of these initiatives, in one way or the other, have been sponsored by international organizations and institutions such as the UNCED (Sponsored the Rio declaration in 1992), UNEP (Sponsored the Dry zone Africa in 1995 and Near East in 1996), ITTO (Sponsored the ITTO initiatives in 1991 and 1998), FAO (Sponsored the ITTO initiatives in 2000), ATO (Sponsored the ATO process in 1996 and 2001) and the Britton Woods financial institutions (WB, 1994). Other official documents from the Commission for Sustainable Development, the Intergovernmental Panel on Forest in year 2000 and the Intergovernmental Forum on Forests (2000) were also taken into consideration. The objective was to establish a basis that allows for, as much as possible, an extensive scope of comparison of outcome of this research (Ghanaian experience) with other countries' measures of sustainable forest management successes initiatives.

All the advances and processes mentioned (see appendix 10.1a, 10.1b) sought to harmonize a common ground for a criteria set appropriate for assessing forests of all types (Anon, 1992) and in all their submissions the following, according to CICI (2003), emerged as broad areas common for the measurement of forests of all types at both international and national levels; *i.* Extent of forest resources*, ii.* Biological diversity*, iii.* Forest health and vitality*, iv.* Productive functions of forest resources*, v.* Protective functions of forest resources*, vi.* Socio-economic functions*, vii.* Legal policy and institutional frameworks.

This study did not go outside the methodology explained above because the steps has been acknowledged in all the criteria and indicator initiatives and processes mentioned (appendix 10.1a, 10.1b). Also it is the aim of this research to compare results with others assessments elsewhere therefore the broad thematic areas were deemed appropriate for this study. In

consonance with chapter 11 of Agenda 21[26] (UNCED, 1992) these are re-structured under three thematic categories (Environmental health & vitality, Economic growth & development and Societal Well-being), in addition to prevailing enabling conditions from which 11 criteria sets were identified for the study as can be gleaned from figure 5.1.

Figure 5.1Thematic groupings showing selected criteria for SFM



Source: Based on UNCED, 1992; UNEP, 1996; FAO, 2001 data sources

From the diagram (figure 5.1) the study identified major focal elements under the broad groupings as; enabling conditions (2 criteria sets), environmental health and vitality (4 criteria sets), societal well-being (2 criteria sets) and under economic growth and development (3 criteria sets).

5.3 IDENTIFICATION AND SELECTION OF MEASUREABLE INDICATORS

An indicator is the measureable aspect of a criterion by which numeric values can be assigned. Selection of the core set of indicators also commenced with copious review of literature (CICI, 2003; MCPFE, 2003; Kotka *IV*, 2003; Braatz, S. 2002; FAO, 2002a; ITTO, 2002; Puustjärvi E. & Simula M., 2002a; and Puustjärvi E. & Simula M., 2002b). In addition to the major international initiatives and processes that have worked towards development of criteria and indicator sets for sustainable forest management (appendix 10.1a, 10.1b), indicators specific for

[26] Chapter 11 of Agenda 21, '*Combating desertification'* called for "the formulation of scientifically sound criteria and guidelines for the management, conservation and sustainable development of all types of forests."

the management of forest resources in the high forest zone of Ghana were of prominence. They include indicators considered under the ATO/ITTO principles (Prado D, 2002), Criteria and Indicators for Sustainable Management of African Natural Forest (Indufor, 2002), the 1998 Forestry Commission's manual of procedures for forest management planning for the high forest zone, the 1994 Forest and Wildlife Policy, the Forest Development Master Plan for 1996-2020, the Natural Resource Management Projects, and the National Committee White Paper on Forest Certification (Forestry Commission, 2006).

5.3.1 Examination of documents from administrative sources

Preliminary investigations from desk top studies undertaken during this research at Government Ministries and Agencies, Research Institutions, and Non-Governmental Organizations by way of document examinations identified 52 indicators bordering on forest resource security (table 5.1a), enabling conditions which must existing before considering any initiative that has to do with management of natural resources on sustainable basis (table 5.1b), the economy (table 5.1c), ecosystem health & vitality–*physical environment* (5.1d), and socio-cultural themes (5.1e). They are summarily tabulated below (tables 5.1a, 5.1b, 5.1c, 5.1d & 5.1e).

Table 5.1a Forest resource security measurable indicators

Criteria 5.1a	***Element***	***Value***	**Indicators**	***Goal***
Forest Resource Security	Resource base description	Conservation and preservation of natural forest ecosystem	Extent of area (ha) total land area under ***i.*** natural forest ***ii.*** plantation ***iii.*** permanent forest estate ***iv.*** comprehensive integrated land plans	SFM

Source: Based on field data analysis, 2008

Forest resource security gives a vivid description of the resource base with the main environmental values being conservation and preservation of natural forest ecosystems. Four indicators were considered for this assessment. They are identified under an umbrella that borders on extent of forest areas which still remains as natural forests, plantation, permanent forest estates and areas been used for comprehensive integrated land plans (table 5.1a).

Enabling conditions are the necessary and sufficient conditions which must prevail before considering any SFM initiative. For each of the elements their relevant values were assessed upon which 12 measureable indicators were identified (table 5.1b). Indicators were collectively accepted (together with stakeholders) and attributed with quantitative values (eg. actual performance limits, minimum and maximum threshold limits) and assessed.

Table 5.1b Identified enabling conditions measurable indicators.

Criteria 5.1b	*Element*	*Value*	Indicators	*Goal*
Enabling conditions for SFM	Policy and legal framework	Forest production, forest conservation and protection	**Degree (%) of** ***i.*** Land tenure and property rights relating to forests, ***ii.*** Control over forest management, harvesting and encroachment, ***iii.*** Health and safety of forest workers, ***iv.*** Local community participation.	SFM
	Economic framework	Existence of econo -mic instruments to promote SFM. Financial investment.	**Degree (%) of** ***i.*** Investment by the government ***ii.*** Domestic and private sources ***iii.*** International sources	SFM
	Institutional framework	Organized institutions, account - ability and Public participation.	**Extent of** ***i.*** No. and adequacy of institutions to support SFM ***ii.*** Adequacy of professionals and technicians to perform and support management, implementation, research and extension ***iii.*** Existence and application of appropriate technology to practice SFM and for periodical monitoring and evaluation ***iv.*** Degree of public participation in forest management ***v.*** Access to information on forest policies, legislation and SFM practices.	SFM

Source: Based on field data analysis, 2008

Economic growth and development as a criterion here imply that judicious use of the resources must translate into structural and qualitative improvement in the totality of economic growth and development indicators of the country. The major elements considered for assessment are flow of economic benefits or proceeds from forest resources and how these are going to be equitably distributed among stakeholders. How continuous flow of timber resources are going to be

sustained, employment level and recreational activities were identified as important values that need to be seriously promoted. Its corresponding measurable indicators were subsequently identified tabulated under table 5.1b for assessment.

Table 5.1c Economic growth and development measurable indicators

Criteria 5.1c	*Element*	*Value*	Indicators	*Goal*
Economic Growth & Develop-ment	Economic benefits	Sustained timber production	***i.*** Timber harvesting timber levels, ***ii.*** Total area available for commercial timber production, ***iii.*** Mean annual increment, ***iv.*** Volume of merchantable timber remaining on site after harvesting.	Economic develop-ent
	Distribution of benefits	Forest industry & employment	***v.*** No. of people employed in each forest based activity, ***vi.*** Related employment per unit volume of wood harvested, ***vii.*** Value of paper and value added manufacturing of timber per volume harvested, ***viii.*** No. of timber and non-timber base industries, ***ix.*** Contribution of timber to GDP.	Economic well-being
	Distribution of benefits	Recreation	***x.*** Proportion of areas conserve for recreational activities	Economic well-being
	Distribution of benefits	Forest products for domestic use	***xi.*** Volume of wood allocated for domestic use	Economic well being

Source: Based on field data analysis, 2008

Forest eco-system health and vitality as a criterion is the ability of the forest eco-system to support healthy organisms of its kind, its capability for renewal while maintaining the ability to support mankind and the environment with its benefits and services. The major elements considered for assessment include; ecosystem diversity, productivity and climate change. Probing further values that needed to be conserved were identified as representative landscape, ecosystem health, natural reproductive capacity, wildlife habitat forest land conservation and adaptation to climate change (table 5.1c). Measurable parameters under this criterion for the analysis are also tabulated;

Table 5.1d Environmental health and vitality measurable indicators

Criteria 5.1d	Element	Value	Indicators	Goal
Bio-diversity	Forest ecosystem diversity	Representative Landscapes	***i.*** Proportion of eco-region in protected area status (ha), ***ii.*** Proportion (ha) and extent of area by forest type and age class in protected area	Environmental vitality
	Ecosystem diversity	Special places	***iii.*** Area (ha) of biologically unique protected or treated with special mgt. provisions	Environmental vitality
	Species diversity	Wildlife habitat	***iv.*** Area of habitat and population levels for known forest dependent species classified as endangered, threatened and vulnerable on risk lists	Environmental vitality
Healthy Forest	Incidence of disturbance and Stress	Ecosystem health	***v.*** Area of forest disturbed by fire, logging, insects & diseases	Environmental vitality
	Eco-system productivity	Natural productive capacity	***vi.*** Mean Annual Increment (MAI) for tree species by eco-region ***vii.*** Area planted & tinned	Environmental vitality
Soil and Water	Eco-system productivity	Surface water	***vii.*** Water quality standards, ***viii.*** Flow rates of major rivers in the HFZ	Environmental vitality
	Eco-system productivity	Forest soils	***ix.*** Proportion of total productive forest area without measurable soil erosion & soil compaction due to forest operations	Environmental vitality
Global Impact	Climate Change	Adopting to climate change	***x.*** Net mass of carbon per unit area accumulated in the HFZ, ***xi.*** No. of communication tools developed to explain climate change, ***xii.*** Climate change strategies developed	Environmental vitality.
	Climate Change	Forest land conservation	***xiii.*** Area (ha) of permanent forest depletion	Enviromental vitality

Source: Based on field data analysis, 2008

Societal Well-being here imply that the social fabric, including all dynamics involved with the usage of forest resources must conform to social norms in utilizing resources to improve societal living standards and ensure that at the same time resources are not stretched beyond a community`s tolerance for change. In the context of sustainable development all segment of the fringe society must benefit from managing forest resource-use in perpetuity. However for local people to see the need to cooperate in efforts to protect and manage the forest, they must be synthesized on the real value and impact the resources make to them. Therefore the main elements taken into consideration with regards to dealing with measurable indicators included forest fringe community's involvement with

resource management, their well-being, and compliance to environmental laws, informed decision and decision making (table 5.1e).

Table 5.1e Societal Well-being measurable indicators

Criteria 5.1e	Element	Value	Indicators	Goal
Societal Well-being	Community involvement	Community perspectives and participat-ion.	***i.*** No. of households in communities that have forest based employment.	Societal well-being
	Forest com-munity well -being	Forest contribution to community sustainability.	***ii.*** No. of people that depend on the forest as their source of fuel-wood, ***iii.*** No. of house-hold that use non-timber forest values.	Societal well-being
	Fair decision making	Fair and effect-tive decision making	***iv.*** No. of community participation processes used in preparing ecosystem based forest management plans, ***v.*** Extent (proportion) of community involvement in community planning processes.	Societal well-being
	Informed decision	Informed decis-ion making	***vi.*** Proportion of citizens who under -stand SFM, ***vii.*** Scope, frequency and statistical reliability of forest inventories, ***viii.*** Availability and accessibility of forest inventory information by the public, ***ix.*** Research initiatives taken that will improve decision making.	Societal well-being
	Compliance to promulga-ted laws	Informed de-cision making	***x.*** Degree of compliance with eco- system based forest management laws, regulations and environmental protection plans, ***xi.*** Proportion of forested area that meets SFM standards as determined by an environmental auditor.	Societal well-being

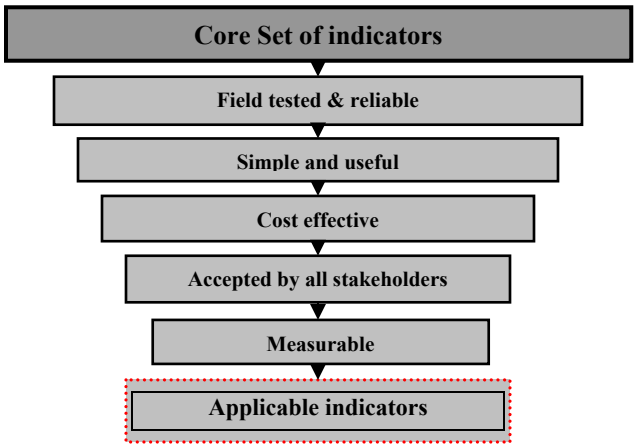
Source: Based on field data analysis, 2008

5.3.2 Selection of applicable indicators

From the examination and identifiable stage (chapter 5.3.1), the indicators were taken through the next stage which involves sizing up measurable parameters for only feasible and applicable indicators. In other words the (52) indicators identified above were further sieved down for only feasible and applicable ones by the sieve and score card method involving the use of experts knowledge. Applicability here refers to the feasibility of using certain parameters to rate respective indicator sets enumerated above (tables 5.1a, 5.1b, 5.1c, 5.1d, 5.1e) within the context

of Ghana's tropical forest[27]. Data collated during the examination of documents provided the basic set of indicators for performance assessment with the following sequential parameters (figure 5.2) outlined below;

Figure 5.2: Indicator filter parameters



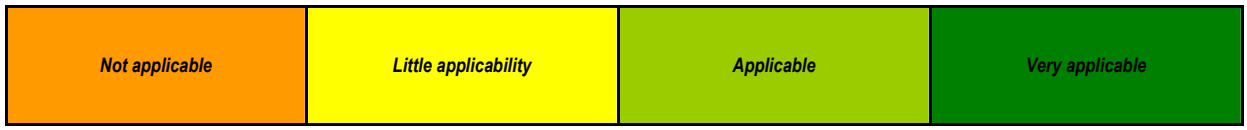
Source: based on Cagliostro, 2005; Tang, 2001; Poore, 1989

For an indicator to be accepted as applicable, it must first pass the phase of ratings called *Sieving* which involves fulfilling the sequential parameters outlined above (figure 5.2). From the core set of indicators an applicable indicator must have been field tested and therefore reliable (Poore, 1989), simple and not cumbersome in nature, cost effective and acceptable by all stake holders Analysis to evaluate applicability was not soft on the relative importance of indicators either. It also took into consideration availability of mechanisms and instruments to measure them. The methodology for this analysis was evaluated using an *applicable indicator ratings litmus scale* designed specifically for this research. This is a scale graduated from 0 to 100 with the ratings and colours shown by figure 5.3. Scoring was done with the assistance of expert's knowledge using score cards. Each listed indicator identified (table 5.1a, 5.1b, 5.1c, 5.1d), was further probed by experts and assessed on its own merit by assigning them with marks by the experts after further considerations. For instance when an indicator is picked up, experts or specialist with deep knowledge on such indictor are asked to rate it for its possible consideration for the assessment with the score cards. Indicators which scored between 0-23 and 25-49 were rated as

[27] International expert meeting on monitoring, assessment and reporting on the progress toward sustainable forest management. Tarapota process 5-8 November 2001, Yokohama, Japan.

not applicable and having little applicability respectively and as such were not adopted (figure 5.3) for the study.

Figure 5.3: Indicator applicability ratings litmus scale



Source: Based on IEM, 2001

Indicators whose score ranged between 50 – 74 and 75 – 100 were accepted and adopted as *applicable* and *very applicable* accordingly for the research (figure 5.3) Through this process of *Sieving* and *Scoring* indicators 29 final indicator sets were adopted from the five major areas (tables 5.1a, 5.1b, 5.1c,5.1d,5.1e) and re-organized under three areas for assessment. These have been summarily tabulated below under three major thematic groupings; Environmental health and vitality (table 5.2a) made up of 10 indicators under, Societal Well-being (table 5.2b), 10 indicators and Economic growth and development (table 5.2c), 9 indicators:

Table 5.2a Environmental health and vitality measurable indicators

Criterion 1	Nr.	Indicators
Environ-mental health & vitality	1	Extent of area by forest type as a proportion of the high forest zone
	2	Extent of Eco-regions as a proportion of the high forest zone
	3	Extent of area of habitat and population levels for known forest dependent species at risk
	4	Extent of mean annual increment (MAI) including planted area in the high forest zone
	5	Area of forest disturbed by logging, fire, insects and diseases
	6	Extent of area harvested using good tree technology
	7	Habitats and population levels for known forest species at risk
	8	Extent of appropriate technology for timber harvesting
	9	Extent of area under natural forest
	10	Net mass carbon per unit area accumulated in the high forest zone

Source: Based on field data analysis, 2008

Table 5.2b Societal Well-being measureable indicators

Criterion 2	Nr.	Indicators
Societal Well-being	1	Number of households that depends on forest as sources of fuel-wood
	2	Number of households with forest based employment
	3	Access to environmental education
	4	Degree of forest communities' participation in sustainable forest management
	5	Equitable sharing of proceeds (stumpage)
	6	Extent of area under plantation
	7	Employment in each forest base activities
	8	Adequacy of professionals to manage resources
	9	Extent of area considered for special management provisions in the high forest zone
	10	Control over management of forest resources

Source: Based on field data analysis, 2008

Table 5.2c Economic growth and development measurable indicators

Criterion 3	Nr.	Indicators
Economic growth & development	1	Contribution of timber to gross domestic product.
	2	Forest area available for commercial timber production.
	3	Extent of eco-regions conserved for re-creational activities.
	4	Contribution to employment (households) levels.
	5	Number of timber trade related industries
	6	Extent of land tenure and property rights
	7	Number and adequacy of institutions to support sustainable forest management
	8	Extent of financial commitment to sustainable forest management
	9	Extent of domestic wood demand by volume

Source: Field data analysis, 2008

5.3.3 Validating the model using a Pairwise Comparison Scenario

The Pairwise Comparison (PC) method involves one-on-one comparisons between each of the indicators (Brinker et al, 2006). The Expert Team is asked to make comparative judgments on the relative importance of each pair of indicators in terms of the criterion they measure.

These judgments, according to Hüllermeier & Fürnkranz (2004) and Mendoza & Prabhu (1998), could also be used to assign relative weights to the indicators. This method is based at the Indicator level because it is at this level that the Principles and Criteria are the most measurable and observable.

Objective: To test for judgment of inconsistency or consistency (Landres, 1992) in the selecting and ranking indicators by the Stake-holder team and minimise the element of subjectivity

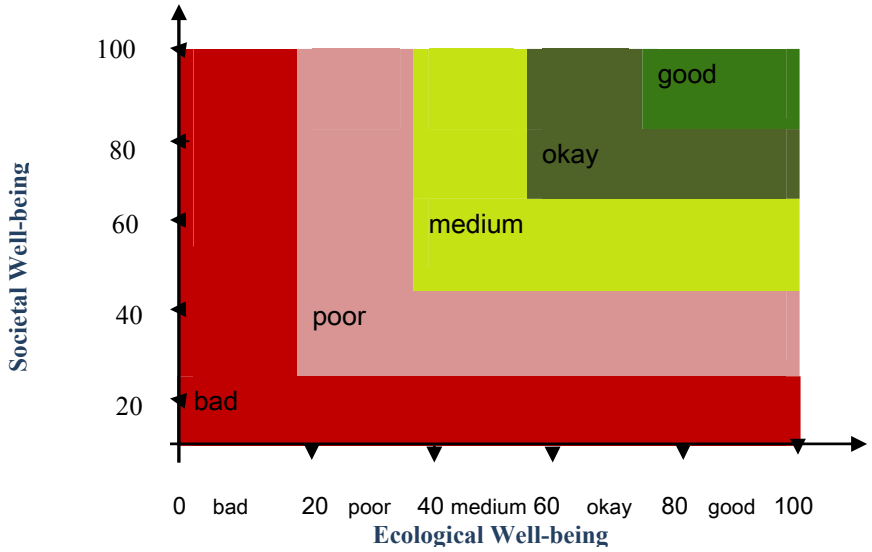
Scenario: Consider a stake-holder team expert who is to perform a Pairwise Comparison (PC) of indicators on three of the indicators from the criterion (C) under table 5.2a; C.1.1, C.1.2 and C.1.3. In his wisdom the expert reason that indicator C.1.1 is more important than indicator C.1.2 by rating it with a value of 5; indicator C.1.2 is also more important than indicator C.1.3 by a value of 5 and concluded that indicator C.1.3 and indicator C.1.1 have equal importance.

Analysis: In this scenario the expert's decision to give indicator C.1.1 and C.1.2 for example equal importance is inconsistent. Given his previous comparisons above (eg C.1.1 > C.1.2, C.1.2 > C.1.3) a logically consistent judgment would be to decide that indicator C.1.1 is more important than indicator C.1.3 by a value of 10. Any number of reasons could account for this inconsistency, which according to Mendoza & Prabhu (1998), may be attributed to the team expert's interpretation of the indicators, tiredness and the repetitive nature of the methodology involved. Guided by this sense of judgment, it is assumed that all indicators captured on the scale and finally accepted as *applicable* and *very applicable* for the research was logically representative.

5.4 Finding a Common Scale

From the expositions above three basic sets of indicators emerged, all measuring different entities (*the Environment, Economy and Society*). To make them useful in achieving the goal and stated objectives of this research the indicators were combined and brought to a common denominator using a computation based on the Conservation International Union's (IUCN) *sustainability principles* for converting indicators to a common scale called Barometer of Sustainability (Prescott-Allen, 1998; Moiseev et.al 2002) as depicted by figure 5.4.

Figure 5.4 Barometer of Sustainability



Source: Based on Prescott-Allen, 1998

The Barometer of Sustainability was developed by Prescott-Allen (1996) for the Conservation International Union (IUCN) as a systematic way of organizing and combining indicators to assess the conditions of *society-ecosystem* interactions and its effect and the general Well-being of Nations (Prescott-Allen, 1998). Conclusions drawn are then presented visually to depict the extent of human and ecosystem well-being and setting a desired mark on a performance scale (figure 5.4) for measuring and communicating a society's progress and environmental well-being towards sustainability.

The Barometer of Sustainability, according to Prescott-Allen (1998), works in the following way; first, the scale derives its support base from a core set of indicators which need to be

identified by major stakeholders undertaking the research. Indicators deemed undesirable, unacceptable, un- measurable and of unknown significance (Prescott-Allen, 1999) with respect to human or ecosystem well-being are excluded from such assessment. Applicable indicators are then combined and converted to a common base (indices) by a non complex basic statistical method. Second, Prescott-Allan (1996) delineates indicators into human and ecosystem well-being to ensure that an improvement in human well-being does not mark a decline in ecosystem well-being or vice versa. Indicators that scored between 0-19 marks on his scale were rated as bad, between 20 and 39 marks are rated as poor, between 40-59 marks are rated as medium, between 60-79 marks as okay and between 80-100 marks as good. A lower score on one axis (e.g. eco-system well-being) overrides a higher score on the other axis (e.g. human well-being). Data on the condition of human Well-being and the ecosystem well-being are then mapped on to the *x* and *y* axis of the scale respectively as points. Intersection of these coordinate depicts the overall well-being and progress of the *Human-ecosystem* interactions toward sustainability (figure 5.4). Reading of overall Well-being and sustainability is based on whichever the sub-system (the society or the ecosystem) is in best or worse condition. This is to prevent an improvement in ecosystem well-being from been understood as compensating for a drop in human well-being, or vice versa. Thus the Barometer does not allow a trade-off between human well-being and ecosystem well-being, reflecting a view, according to Prescott-Allan (1999) that people and the ecosystem are equally important and that sustainability is a combination of human well-being and ecosystem well-being.

5.5 The Measure of Forest Resource-Use Sustainability Scale

The Measure of Forest Resource-Use Sustainability Scale is a modified version of the Barometer of Sustainability. It is specifically calibrated for this study to measure extent of forest resource-use sustainability in the high forest zone of Ghana. It maintains the same technique used in converting indicators on to the performance scale on the Barometer of Sustainability (figure 5.4). However, instead of dealing with only two set of sub-entities (e.g. Human well-being, Ecosystem vitality) as on the Barometer of Sustainability, the Measure of Forest Resource-Use Sustainability Scale have three dynamic entities as fringe forest community, forest ecosystem, and the national economy. The set of indictor scores calculated as points and plotted on the *x* –

axis of the performance scale (figure 5.5) to register actual performance strength of each indicator set. The scale also allows for trade-offs between the trio sectors where compensations are made from one sector to another. This feature is not possible on the barometer of sustainability. A sustainability equilibrium situation is established only when all three sets of indicators, with aggregate points register a position within the segments are rising with positive values and are at a par (same level) or have the potential to rise to the same level. Graduations on the scale and implications for sustainability are displayed on the *y*- axis as captured by figure 5.5 below.

Figure 5.5 The Measure of forest resource-use sustainability scale

Segment (Top band of scale)	**Sector performance**			**Scale**
Desired sustainability				100
Potentially sustainable				80
Transition zone				60
Potentially unsustainable				40
Unsustainable				20
Base of scale	Environmental$_{vt}$	Society$_{wb}$	Economic$_{gd}$	0

Source: Based on Prescott-Allen, 1999

The measure of resource-use sustainability scale is a 0-100 end point scale graduated into five sections of 20 points or marks each (figure 5.5). Indicators that score marks within segment with marks between 0-19 are interpreted to mean indicators that are unsustainable for assessment. This region corresponds to the *bad* state regime on the *Well-being of Nations* (Prescott-Allen, 1999) segment of the Barometer of Sustainability scale. Between 20-39 indicator scores on the measure of resource-use sustainability scale correspond to the potentially unsustainable segment (rated as *poor* on the Barometer of Sustainability), between 40-59 marks indicators reflects transitional performance as opposed to *medium* ratings on the Barometer of Sustainability, between 60-79 marks reflects indicators that have the potential to be sustainable (corresponds to *okay* segment on the Barometer of Sustainability) and between 80-100 marks defines the region with indicators likely to achieve desired sustainability (corresponds to *good* segment on the Barometer of Sustainability).

5.6 ADVANTAGES AND PITFALLS OF METHODOLOGY

5.6.1 Intended Audience

Selection and aggregation of Criteria and Indicators using this approach is a transparent and robust system of comparing scenarios, testing and communicating measures of successes towards sustainable development among those who really matter in the assessment. The approach tends to be scientific, reduce value judgment and ensure equity of knowledge between academicians, scientists and government officials, fringe forest communities and other stakeholders with vested interest in the subject matter. The model will therefore be useful to;

1. Research scientists and academicians researching into measures of successes towards sustainability issues

2. Natural resource management teams tasked with improving on sustainable use of natural resources at the international, national regional and FMU levels.

3. Inter-departmental Government Officials responsible for formulating sustainable policies pertaining to use of forest and other related resources.

4. Forest Certifiers assessing timber companies' harvesting practices for certification purposes

5.6.2 Usefulness and Critique

Although computer-based modeling and multi-criteria analysis continue to be significant in sustainability assessments it must be stressed that all science is not necessarily always as value-free as it may be argued (Prescott-Allen, 1997). Addressing uncertainty and risks in forestry make almost every undertaking as much value-based as it may be scientific. This model calls for a scale (Measure of Forest Resource-Use Sustainability Scale) that allows for one or more of the segments on the scale to be defined without which results could appear unclear if only end points on the scale are defined. It elicit a series of judgments which starts with identifying the criteria

set to be assessed, their elements, values and the goals to be achieved for the society, economy and ecosystem.

It allows for threshold levels of achievement and actual performance marks perceived desirable or acceptable to be determined. Indicator results from the field are then converted to a common denominator which is then fed into the scale for processing. The results are presented graphical (figure 6.8) to communicate to policy makers' extent of sustainability and in which direction it is moving. It has advantage over computer modeling in that it is transparent and incorporates only stakeholders who know their resource better than outsiders. They are considered the most qualified people to examine their forest, decide the management objective, and design indicators that are capable of tracking the progress towards meeting these objectives.

The card and scoring system has been critiqued as being value-based and subjective. Prescott-Allen (1997), however argues, this approach is in fact, no more subjective or objective than attaching monetary value such as in Gross Domestic Product (GDP) assessment for National Accounting where one cannot tell what values are buried in those ranks of dollars and zeros.

The Measure of Forest Resource-Use Sustainability Scale and Multi-Criteria Analysis approach also ensure equity of knowledge between scientists, fringe forest communities and vested stakeholders in particular as known management strategies that we know today (adaptive management) are basically rediscovery of indigenous knowledge (Berkes *et al*. 2000). Computer software simulation does not.

Furthermore, in as much as the method has been simplified to allow input from fringe forest communities and stakeholders without much in-depth mathematical and statistical knowledge, both MoFRUSS and MCA does not make room for uncertainty and risk analysis in forest resource management.

6.0 DATA ANALYSIS AND PRESENTATION OF RESULTS

6.1 INTRODUCTION

Applicable and measurable data (both quantitative and qualitative) on indicators emanated from administrative sources, actual involvement in fieldwork, expert's knowledge and forest community participatory activities. Administrative institutional setups include the ministry of lands and forestry, ministry of environment, the forestry commission of Ghana, environmental protection agency and Non-governmental Organizations. Data analysis entails converting all indicator results from the field to a common denominator by simple statistical methods. The position each indicator will occupy on the scale are then determined.

6.2. Calibrating the scale (MoFRUS)

The scale is set for each indicator by defining the positions both best and worse values will occupy on the graduation. Informed decisions deduced from the scale are greatly influenced by the end points on the scale (Prescott-Allen, 1999). To make this point clear I will illustrate with the position a 20 mark performance score will occupy on three graduated scales with end points; 0-100, 0-50 and 0-25. The 20th mark will lie very close to the bottom of the 0-100 scale, near the middle of a 0-50 scale and very close to the top of a 0-25 scale. A fairly objective way of setting the end points of the scale therefore, according to Prescott-Allen (1999), is to choose best and worse values that encompass the range of performance that have been experienced in recent past with expert's knowledge and background information on the indicators.

A graduated scale of 0-100 is employed for this research. The acceptable mark on the measure of forest resource-use sustainability is synonymous with Prescott-Allen (1999)'s desired mark on his 'performance criteria' operations scale. The desired mark according Prescott-Allan (1999) translate goals and objectives into measurable performance indices providing the basis for putting processed indicator results on the scale (figure 5.5) by defining both the top and base bands.

6.3. Setting the desired mark

Setting the desired mark involves calibrating the scale in such a way that either the desired (*acceptable*) or undesirable (*unacceptable*) mark or sometimes both variables are defined using formulas' 6.1 and 6.2, expressed below as;

formula 6.1

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where the variables are defined as,

$\mathbf{Ap_l}$ = Actual performance level. This is the exact performance level of the indicator observed or recorded over the cumulative period under investigations. It paints a vivid picture of what pertains on the ground.

$\boldsymbol{MinT_{lmt}}$ = Minimum threshold limit. This is the level below which exploitation of the resource (s) will adversely impact the environment. It is either a management or political target which is determined collectively by all management stakeholders of that particular resource(s).

$\boldsymbol{Max.T_l}$ = Maximum threshold level. This is a desired target necessary to put the system into environmental sustainability equilibrium within the sustainability space. The maximum threshold level is also a management or political goal. It is determined jointly by management stakeholders of the resource.

$\boldsymbol{(AP_l\text{-}MinT_{lmt})}$ = Likely attainable targets given management budget constraints.

$\boldsymbol{(MaxT_l\text{-}MinT_{lmt})}$ = Unattainable goals given management budget constraints.

formula (*6.2*);

$$1 - \left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

a. When the maximum value of the indicator describes best situation or performance of an event and the minimum value presents a worse scenario, then formula 6.1 is applied, which is the actual performance level indicator (Ap_l) minus the minimum threshold limit indicator ($MinT_{lmt}$) divided by the maximum threshold limit ($Max.T_l$) minus the minimum threshold limit indicator ($MinT_{lmt}$) multiplied by 100 and expressed below as:

b. When the minimum value describes best situation and the maximum value a worse scenario, it is the actual performance level indicator (Ap_l) minus the minimum threshold limit indicator ($MinT_{lmt}$) divided by the maximum threshold limit ($Max.T_l$) minus the minimum threshold limit indicator ($MinT_{lmt}$) multiplied by 100. The result is then subtracted from the value`1´ representing the totality of the indicator in question. It is expressed below as;

Where variables are defined as,

Ap_l = Actual performance level. This is the average performance level or score of the indicator over the cumulative period under investigation. It tells how the situation actually looks like.

$MinT_{lmt}$ = Minimum threshold limit. This is the level below which usage of the resources will adversely impact the environment. It is either a management or political target and is determined or set by the appropriate outfit.

$Max.T_l$ = Maximum threshold level. This is a desired target necessary to put the system into an equilibrium (sustainability) within the sustainability space. The maximum threshold level is also a management or political goal. It is determined or set collectively by the appropriate outfit.

Base = Base of the band. This is the lowest segment of the scale (figure 5.5) used as reference point.

In all cases the desired sustainability segment is determined within the scoring range of the 80th - 100th marks. If this is not the case from the outcome of periodic assessment, then management brainstorm for optional policies which will guide them towards achieving the goal from the optional policy baskets as already explained under see figure 2.1 and depicted below by table 2.1.

6.4 ANALYSIS OF THEME 1: ENVIRONMENTAL HEALTH AND VITALITY

Environmental health and vitality, as a criterion, is the ability of the forest eco-system to support healthy organisms, maintain its capability for renewal while maintaining the ability to support mankind and the environment with its benefits and services. To assess this criterion, measurable indicators were selected based on the methodology already discussed under chapter 5.3 and enlisted by table 5.2a. These measureable parameters were quantitatively characterized and analyzed. The indicators are;

1. Extent of area by forest type as a proportion of the high forest zone
2. Extent of Eco-regions as proportion of the high forest zone
3. Extent of area of habitat and population levels for known forest dependent species at risk
4. Extent of mean annual increment (MAI) including planted area in the high forest zone
5. Area of forest disturbed by logging, fire, insects and diseases.
6. Extent of area harvested using good tree technology
7. Extent of primary forest estate as a percentage of the high forest zone
8. Extent of appropriate technology for timber harvesting
9. Extent of area under natural forest
10. Net mass of carbon per unit area accumulated in the high forest zone

6.4.1: Extent of area by forest type as a proportion of total forest area

Extent of area by forest type as a proportion of total forest area is the extent of variability in the total area of forested lands in Ghana. The study identified 6 major forest types within the high forest zone. They were all found to be in *on-reserves* or protected areas. Data for the analysis emanated from the Global Forest Resource Assessment (2005), and the Forestry Commission of Ghana (2006) and have been summarily tabulated below (table 6.4.1).

From the table (6.4.1) maximum extent of area capable of exhibiting such endemism, according to the Forestry Commission of Ghana (2006), was determined at 8,525,063 million hectares (total forested lands in Ghana). However the extent of forest types left actually within protected area are in the realm of 1,578,990 million hectares (Forestry Commission of Ghana, 2006) with the potential to regenerate the whole of forested lands. Since it is the goal of forestry

management outfits to green the total area the minimum threshold limit was established at zero (0) hectares (Forestry Commission of Ghana, 2006).

Table 6.4.1 Extent of area by forest type.

Vegetation Type	Total Extent(ha)	On-reserve(ha)	Off-reserve(ha)
Wet Evergreen(WE)	759,639	152, 250	607,389
Moist Evergreen (ME)	1,835,382	469, 200	1,366,182
Moist Semi-deciduous South East (MSSE)	1,726,122	204,190	1,521,932
Moist Semi-deciduous North West (MSNW)	1,560,352	457, 040	1,103,312
Dry Semi-deciduous (DS)	1,694,859	250,440	1,444,419
Upland Evergreen (UE)	948,709	66,090	902,839
Total	**8,525,063**	**1,578,990**	**6,946,073**

Source: Global Forest Resource Assessment, 2005

Here conversion of the scale is performed using *equation 6.1* since a maximum value signifies good performance and a minimum value a worse one. The conversion of scale is performed as follows;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 1{,}578{,}990$; $MinT_{lmt} = 0$; $MaxT_l = 8{,}525{,}000$

$$\left(\frac{1578{,}990 - 0}{8{,}525{,}000 - 0} \right) \times 100 =$$

$$0.19 \times 100 = 19$$

Extent of forest types, as a proportion of the total high forest zone, performed poorly by scoring only 19 points. Subsequently, its position on the scale is registered within the unsustainable segment as depicted by table 6.4.1b.

Table 6.4.1b Position of indicator 6.4.1on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of forest type area
Good	Desired sustainability	81-100	6,404,000-8,004,000
OK	Potentially sustainable	61-80	4,803,000-6,403,000
Medium	Transitional performance	41- 60	3,202,000-4,802,000
Poor	Potentially unsustainable	21-40	1,601,000-3,201,000
Bad	Unsustainable	0-20	0-1,600,000 *(AP_l=19)*
Base	Base of MoFRUSS	Base of Scale	

AP_l=actual performance level

6.4.2: Extent of Eco-regions as proportion of the high forest zone

Extent of ecological regions in protected areas in the high forest zone, as an indicator under this theme refers to areas that have broad similarities with respect to soil, relief, dominant vegetation and animal species in Ghana (Forestry Commission of Ghana - Wildlife Division, 1998). Regions that have been identified, according to the Forestry Commission of Ghana (2006) include 5 coastal wetland protected areas, 6 national parks, 6 resource reserves, 1 strict nature reserve and 2 wildlife sanctuaries (table 6.6.3). The total actual area legally gazetted as eco-regions in protected areas is 12,685 km^2 or 1,268,500 hectares (Forestry Commission of Ghana - Wildlife Division, 1998). However the total area considered as the high forest zone (*Forest on-reserves*), according to FAO (2005a), currently stands at 1,578,990ha (table 6.4.1). Since it is management´s goal to see that the entire forest *on-reserves* become ecological diverse the maximum threshold level needed to achieve desired targets was therefore determined by the Ghana Forestry Commission at 1,578,990ha (Forestry Commission, 2006).

The minimum threshold level below which dying consequences on the environment will be impacted was also established by the same outfit (Forestry Commission, 2006) at zero (0) km^2 since the aim of management is to achieve above stated objectives. Conversion of the indicator is thus performed with *formula 6.1* as follows;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 1{,}268{,}500$; $MinT_{lmt} = 0$; $MaxT_l = 1{,}578{,}990$

$$\left(\frac{1{,}268{,}500 - 0}{1{,}578{,}990 - 0} \right) \times 100 =$$

$$0.80 \times 100 = 80$$

The indicator performed creditably well by scoring 80 points and thus registering an impressive presence on scale within the potentially sustainable region (table 6.4.7).

Table 6.4.2 Position of indicator 6.4.2 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of Eco-regions
Good	Desired sustainability	81-100	1,220,004-1,500,004 and above
OK	Potentially sustainable	61-80	940,003-1,220,003*(Apl= 1,268,500)*
Medium	Transitional performance	41- 60	560,002-940,002
Poor	Potentially unsustainable	21-40	280,001-560,001
Bad	Unsustainable	1-20	0-280,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.4.3: Extent of habitat and population levels for known forest dependent species at risk

The variety and variability among living organisms and the ecological complexes in which the high forest zone occur is what is referred to as biodiversity (Convention on Biological Diversity, 2000). This indicator analyzes extent of habitats and population levels that depends on the high forest community for survival. Deforestation has been identified as a major cause of biological diversity loss to known forest dependent species in the high forest zone (FAO, 2005a). Habitat sustainability is thus crucial for curbing this risk. According to FAO (2005b) traditional conservation efforts have been focused on protecting areas of high biodiversity. Its relevance to the high forest zone is expressed in measures of species richness and data for the analysis is based on FAO (2005a) data sources summarized by table 6.4.3a.

From table 6.4.3a the study found out that of the total 4,703 population levels for known forest dependent species within the zone, the maximum level of probable known species threatened is established at 140 (3%). The data also depicts actual higher species at risk to be 117 (table 6.4.3a).

Table 6.4.3a Extent of forest dependent species at risk

Mammals		**Birds**		**Higher Plants**	
Total known species	Threatened	Total known species	Threatened	Total known species	Threatened
249	15	729	8	3,725	117
Total population *(4,703)*	Threatened *(140)*		Percentage threatened *(3%)*		

Source: Analysis based on FAO (2005a) global forest resources assessment data.

Since maximum threshold here signifies bad conservation measures and a minimum value a good situation, conversion of the scale is calibrated using *formula 6.2* as;

$$1 - \left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 140$; $MinT_{lmt} = 0$; $MaxT_l = 4{,}703$

$$1 - \left(\frac{140 - 0}{4{,}703 - 0} \right) \times 100 =$$

$$0.97 \times 100 = 97$$

Table 6.4.3b Position of indicator 6.4.3 on MoFRUSS

BoS Band	**MoFRUSS segment**	**Point on Scale**	**Extent of species at risk**
Good	Desired sustainability	81-100	86-107 and above *(AP_l score = 97)*
OK	Potentially sustainable	61-80	64-85
Medium	Transitional performance	41- 60	43-63
Poor	Potentially unsustainable	21-40	22-42
Bad	Unsustainable	1-20	0-21
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

The indicator scored 97 points and performed extremely well on the scale. Its actual position on the scale was found within the desired segment. However it pre-empts the need for immediate conservation and protection measures for the known population species at risk in the habitat area.

6.4.4: Mean Annual Increment (MAI) including planted area

This indicator analyzes average annual additions to the total volume of woods available for domestic consumption. Data for the assessment is based on Agyarko´s report (2003) of the Ministry of Lands and Forestry prepared for the Food and Agriculture Organization. According to the report the forest of Ghana contains, on the whole, a standing volume of 188 million m^3 of wood with a natural growth rate of 4.6 million m^3 at an incremental rate of 4 m^3/ha/yr (Agyarko, 2003). The study, from the outfit of the Forestry Commission (2006), also determined annual yields from plantation at 50,000 m^3. It went on further to establish a total annual incremental rate (actual performance level) at 4,650,000m^3. The minimum threshold limit below which regeneration of resources will be adversely hampered was established at 2,513,754m^3 (FAO, 2006) and established the maximum threshold limit needed to establish equilibrium in the ecosystem at 6,000,000m^3. Here a maximum value is deemed desirable and minimum value a worse one. Therefore the conversion of scale employed *formula 6.1* depicted below as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 4{,}650{,}000$; $MinT_{lmt} = 2{,}513754$; $MaxT_l = 6{,}000{,}000$

$$\left(\frac{4{,}650{,}000 - 2{,}513754}{6{,}000{,}000 - 2{,}513{,}754} \right) \times 100 =$$

$$0.61 \times 100 = 61$$

Indicator 6.4.4 recorded 61 points and registers a strong presence on the scale within the potentially sustainable zone (table 6.4.4).

Table 6.4.4 Position of indicator 6.4.4 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of MAI in HFZ
Good	Desired sustainability	81-100	5,808,004-7,260,004
OK	Potentially sustainable	61-80	4,356,003-5,808,003*(Ap_l =4,650,000)*
Medium	Transitional performance	41- 60	2,904,002-4,356,002
Poor	Potentially unsustainable	21-40	1,452,001-2,904,001
Bad	Unsustainable	1-20	0-1,452,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.4.5 Extent of Forest area disturbed (Logging, fire, insects, diseases).

Literature review (Gyasi et al., 2003; World Bank, 2006a; Nketia, 2004; Kotey et al., 1998) could not attribute causes of forest disappearance in Ghana to a single factor. The research however rated logging and forest conversion to other uses as very high, and to a lesser extent bush fires, diseases and insects. More so whereas literature review (FAO, 2005b; Forestry Commission, 2006; ITTO, 1999) identifies forested area to have diminished from an initial size of 8.525,063 million hectares in 1990 to 1.6million hectares in 2005 (Larsen, 2006), the study found a much lower figure of 1,578,990 million hectares over the same period (FAO, 2005b).

For the past two decades the International Tropical Timber Organization (ITTO) ´s report on tropical timber update in 1999 established that an average of 75,000 hectares of forests is actually destroyed annually with a propensity to hit a maximum deforestation level of 100,000 hectares per annum. The report (ITTO, 1999) identified a minimum rate of 22,058 hectares per annum as the rate forest cover is been destroyed below which it will be unsustainable. Since maximum value here signifies a worse situation and minimum value a good one, *formula 6.2* shown below, is used for the scale conversion as;

$$1 - \left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 75{,}000$; $MinT_{lmt} = 22{,}000$; $MaxT_l = 100{,}000$

$$1 - \left(\frac{75{,}000 - 22{,}058}{100{,}000 - 22{,}058} \right) \times 100 =$$

$$0.32 \times 100 = 32$$

The indicator performed poorly by scoring 32 points and occupied a place within the potentially unsustainable region (table 6.4.5).

Table 6.4.5 Position of indicator 6.4.5 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of area disturbed
Good	Desired sustainability	81-100	164,000-204,000 and above
OK	Potentially sustainable	61-80	123,000-163,000
Medium	Transitional performance	41- 60	82,000-122,000
Poor	Potentially unsustainable	21-40	41,000-81,000 *(Ap_l score 75,000)*
Bad	Unsustainable	1-20	0-40,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.4.6 Extent of high forest area harvested using good tree technology

This indicator assesses extent of area within the high forest zone harvested using good tree technology management in order to minimize deforestation. As a result of sustainable forest management initiatives (setting standards and threshold), harvesting timber by the clear-cut felling system in Ghana has become a thing of the past (Nunoo, 2008). When this does happen it is considered illegitimate and the due process of the law is applied to offenders.

Data for this analysis was based on the Ministry of Food and Agriculture (2003) and the Food and Agricultural Organization`s forest resources assessment report (2005b). The assessment found out that the maximum extent of area that could be harvested using good harvesting technology is not confined to only protected forest areas (*On-reserves*). The maximum threshold limit of 1,136,400ha identified, according to FAO (2005a) also include pockets of Off-reserves (table 6.6). However, actual extent of area where usage of good technology is been emphasized and applied is limited to only areas designated as production zones (762,400ha) and the minimum area being extent of forest cover off-reserves (374, 400ha) as gleaned from table 6.4.6a.

Table 6.4.6a Extent of forest area harvested using good tree technology

Production	Protection	Plantation	Off-Reserve
762,400 ha	352,000 ha	160,000 ha	374,000 ha

Source: FAO, 2005a

Since here maximum value signifies a desired position and minimum a worse scenario, *formula 6.1* is applied for the conversion of scale as shown below;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 762{,}400$; $MinT_{lmt} = 374{,}400$; $MaxT_l = 1{,}136{,}400$

$$\left(\frac{762{,}400 - 374{,}400}{1{,}136{,}400 - 374{,}400} \right) \times 100 =$$

$$0.51 \times 100 = 51$$

The indicator scored 51 points and registers its presence within the transitional zone on the measure of forest resource-use sustainability scale (table 6.5.6).

Table 6.4.6b Position of indicator 6.4.6 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Area with good harvesting tec.
Good	Desired sustainability	81-100	1,120,004-1,400,004 and above
OK	Potentially sustainable	61-80	840,003-1,120,003
Medium	Transitional performance	41- 60	560,002-840,002*(Ap_l =762,400)*
Poor	Potentially unsustainable	21-40	280,001-560,001
Bad	Unsustainable	1-20	0-280,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

APl=actual performance level

6.4.7 Extent of primary forest estate as a percentage of the high forest zone

Indicator 6.4.7 assesses the extent to which the most undisturbed and bio-diverse form of forest within the high forest zone persist. This area is what is referred to as primary forest. Data for this analyzing this indicator emanated from the Forestry Commission of Ghana (2006), the Forest Resource Assessment (2005a) of UNO and the Food and Agricultural Organization (2005a) of the United Nations. The high forest area according to the Forest Resource Assessment (2005) is estimated at 1.634,000 million ha (100%) with the following management plan categorization depicted by table 6.4.7a. Primary forest (permanent protection) currently occupies an area of 35,500ha (22%) of the high forest zone (Forestry Commission, 2006).

Table 6.4.7a Management planned categorization of the high forest zone

Nature of Forest	Size (ha)	Percentage (%)
Timber production	762, 400	47
Permanent protection	352, 500	22
Not inventoried	270, 000	16
Conversion	127, 200	8
Convalescence	122, 000	7
Total	**1, 634, 100**	**100**

Source: Forestry Commission (2006), Forest Resource Assessment (2005), FAO (2005b)

The presumption here is that the total area declared as the high forest zone should be conserved intact if not enhanced, hence, setting the maximum threshold limit needed to keep the whole area intact at 1,634,100ha (Forestry Commission, 2006). The minimum threshold limit was then determined at zero (0) hectares (FAO, 2005b), meaning none of the high forest area should be degraded. With maximum value representing best performance and minimum value otherwise, *formula 6.1* is applied. The conversion takes the form expressed below as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 352{,}500$; $MinT_{lmt} = 0$; $MaxT_l = 1{,}634{,}100$

$$\left(\frac{352,500 - 0}{1,634,100 - 0} \right) \times 100 =$$

$$0.22 \times 100 = 22$$

The indicator scored 22 points from the conversion and registered its actual presence on the scale within the unsustainable region (table 6.4.7b).

Table 6.4.7b Position of indicator 6.4.7 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of primary forest (ha)
Good	Desired sustainability	81-100	854-1,054and above
OK	Potentially sustainable	61-80	653 -853
Medium	Transitional performance	41- 60	452-652
Poor	Potentially unsustainable	21-40	251-451*(Ap_l = 353,000)*
Bad	Unsustainable	0-20	0-250
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.4.8 Existence and application of appropriate technology

For sustainable forest management to be successful appropriate technology must exist for its implementation, monitoring and evaluation. According to Cagliostro (2005), baseline mechanisms necessary to put such initiative on course entail putting up structures for; *i.* the development of criteria and indicators, *ii.* setting of standards and thresholds for harvesting, *iii.* certification of forest products, *iv.* collaboration with international bodies for data dissemination, *v.* good governance and storage for use as well as *vii.* compliance with a universally harmonized methodology for monitoring and reporting.

Assessment of this indicator is based on Tachie-Obeng and Agyeman-Bonsu (2005) whose survey confirmed Cagliostro´s (2005) seven (7) mechanisms as the maximum threshold of mechanisms needed in the high forest of Ghana. From the Conservation Union`s assessment (2005b) on biodiversity hotspots by regions the minimum threshold limit was established at zero (0). The actual numbers of applicable technologies or mechanisms being utilized in Ghana were

identified to be only 3 (Tachie-Obeng and Agyeman-Bonsu, 2005). With maximum value describing best performance and minimum value signifying a worse one, the conversion is determined with *formula 6.1* as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 3$; $MinT_{lmt} = 0$; $MaxT_l = 7$

$$\left(\frac{3 - 0}{7 - 0} \right) \times 100 =$$

$$0.43 \times 100 = 43$$

The indicator scored 43 points and registers a place within the transitional zone segment of the scale depicted by table 6.4.8.

Table 6.4.8 Position of indicator 6.4.8 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Adequacy of SFM professional
Good	Desired sustainability	81-100	5.0 and above
OK	Potentially sustainable	61-80	4.0-4.9
Medium	Transitional performance	41- 60	3.0-3.9*(Ap_l =43)*
Poor	Potentially unsustainable	21-40	2.0-2.9
Bad	Unsustainable	1-20	0-1.9
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Ap_l =actual performance level

6.4.9 Extent of area under natural forest as a percentage of total land area

Natural forest is the total land area in Ghana naturally covered by forest excluding plantation. Data for this assessment is based on the Food and Agriculture Organization (FAO, 2005b) and the Global Forest Resource Assessment (FRA, 2005) `s reports. The total land area of Ghana, according to FAO (2006) and Global Resource Assessment report (2005), is estimated at

23,850,000ha in size. Out of this 8,525,063ha, is naturally forested (FRA, 2005). Inferences from the reports estimated what is left as intact forest after degradation is established at 1,634,000ha representing almost 7% of total land area (Forestry Commission, 2006). The upper ceiling of the extent to which natural forest could be conserved, according to FAO (2005b) was estimated at 8.525,063ha and a minimum threshold level below which forest resource use would be unsustainable was determined at 1,300,000 ha (FAO, 2005b; FRA, 2005). Since maximum value describes best situation and minimum a worse one, conversion of the indicator is determined with *formula 6.1 as*;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; AP_l = 1,634,000; $MinT_{lmt}$ = 1,300,000; $MaxT_l$ = 8,525,063

$$\left(\frac{1,634,000 - 1,300,000}{8,525,063 - 1,300,000} \right) \times 100 =$$

$$0.046 \times 100 = 5$$

Indicator 6.4.9 performed badly by scoring 5 points registering its actual position on the scale within the unsustainable segment (table 6.4.9).

Table 6.4.9 Position of indicator 6.4.9 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of natural forest(000ha)
Good	Desired sustainability	81-100	6,600,004-8,250,004 and above
OK	Potentially sustainable	61-80	4,950,003-6,600,003
Medium	Transitional performance	41- 60	3,300,002-4,950,002
Poor	Potentially unsustainable	21-40	1,650,001-3,300,001
Bad	Unsustainable	1-20	0-1,650,000*(Apl =5)*
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Ap_l =Actual performance level

6.4.10 Net mass of carbon per unit area accumulated in the high forest zone

According to the Intergovernmental Panel on Climate Change (2002) annual anthropogenic carbon dioxide sources accounts for about 7.9 gigatons (Gt Ca-1) of the heat waves out of which 20 percent is attributed to tropical deforestation (Herold, 2001). Indicator 6.4.10 assesses net mass carbon accumulation per unit area within the high forest zone since about two-thirds of terrestrial carbon (UNFCCC, 2000) is sequestered through standing forests. Carbons in forest ecosystem are stored in living biomass, understory vegetation, dead mass litter, woody debris and soil matter. Above-ground biomass is the largest pool and the most impacted by deforestation and land degradation.

Data for the analysis are based on Houghton (2003), the Food and Agricultural Organization forest resource assessments (2005), World Bank (2006) and IPCC (2006) sources. According to FAO (2005) an average net mass of 66 metric tonnes of carbon in above-ground biomass is stored in a hectare of tropical rainforest that would be otherwise released by deforestation and subsequent land conversion for agriculture or pasture. Net carbon released from deforestation of primary and secondary tropical forest, allowing for the carbon fixed by subsequent land use, is of the order 100-200 metric tons per hectare (FAO, 2005).

Table 6.4.10 Net mass carbon per unit area in the high forest zone of Ghana

Carbon stock in forest Total size =1.6 million ha, Deforestation rate = 1.7%	**Primary and secondary forest** (Ave. million metric tons carbon)		
Stock Categories	**Period**		
	1990	*2000*	*2005*
Carbon in above-ground biomass (C_{agb})	484	399	363
Carbon in below-ground biomass (C_{bgb})	180	147	133
Carbon in dead wood (C_{dw})	93	76	70
Carbon in litter (C_l)	na	na	na
Carbon in soil (C_s)	na	na	na
Total	757	623	566
Calculations Max. threshold level over the period =$\sum$mean[C_{agb}+C_{bgb}+C_{dw} +C_1+C_S] = 649 million *mtc* Min. threshold limit over the period =$\sum$ mean[C_{bgb}+C_{dw}] = 233 million *mtc* Actual performance level over the period = Mean [C_{agb}] = 415 millions mtc			

Source: Analysis based on IPCC Guidelines for national greenhouse gas inventories (2006), Global forest resource assessment of FAO (2005a),World Bank (2006) and Houghton (2003) data. *na = not available.*

From table 6.4.10 net mass of carbon in Ghana's high forest zone was determined by taking averages from the period 1990-2005. The actual performance level, which is carbon stored in the high forest zone of this calibre, is established at 415 metric tonnes per hectare (table 6.4.10).

A maximum threshold level of 649 metric tons per hectare has been calculated by FAO (2005b) as the desired amount of carbon dioxide that ought to be stored in tropical high forest that exhibits such characteristics. The minimum threshold limit below which sustaining ecosystem functions will be jeopardized was determined at 233 metric tons (table 6.4.10). Accepting maximum value as best situation and minimum value as a worse performance, *formula 6.1* was applied and expressed below as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 415$; $MinT_{lmt} = 233$; $MaxT_l = 649$

$$\left(\frac{415 - 233}{649 - 233} \right) \times 100 =$$

$$0.44 \times 100 = 44$$

The indicator scored 44 points. On the scale it registered its presence within the transitional performance zone as depicted by table 6.4.10b.

Table 6.4.10b Position of indicator 6.4.10 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Net mass of Co_2 (mt/ha)
Good	Desired sustainability	81-100	800-999 and above
OK	Potentially sustainable	61-80	600-799
Medium	Transitional performance	41- 60	400-599 *(Ap_l score = 415)*
Poor	Potentially unsustainable	21-40	200-399
Bad	Unsustainable	1-20	0-199
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level.

6.5. ANALYSIS OF THEME 2: SOCIEAL WELL-BEING

Societal well-being here imply that the social fabric, including all dynamics involved with the usage and management of forest resources, must conform to social norms of fringe forest communities in using the resources to improve societal standards of living. At the same time they must ensure that the resources are not over stretched beyond the community's tolerance for change (Gyasi et al, 2003). In the context of sustainable development all segment of the forest society must benefit from the use and management of the resource in perpetuity (GoG, 2003). If any of the parties, especially the forest communities, are excluded their actions, willfully or otherwise, may adversely thwart efforts towards achieving sustainable forest management goals (Gyasi, 2002) as has been witnessed in Ghana over the years. However for local people to see the need to cooperate in these efforts, they must be synthesized on the real value and impact the resources make to them **(**Goldman and Schurman, 2000).

The 1994 Forest and Wildlife Policy (Forestry Commission, 2006) make adequate provisions to attract fringe forest communities to participate in forest management. Under this broad thematic grouping this research, through the steps already outlined under chapter 5.3, adopted 10 applicable and measurable indicators to assess the criterion. They are listed below as;

1. Number of households that depends on forest as sources of fuel-wood
2. Number of households with forest based employment
3. Access to environmental education
4. Degree of forest communities' participation in sustainable forest management
5. Equitable sharing of proceeds (stumpage)
6. Extent of area under plantation
7. Employment in each forest base activities
8. Adequacy of professionals to manage resources
9. Extent of area considered for special management provisions in the high forest zone
10. Control over management of forest resources

6.5.1 Number of households that depends on forest as sources of fuel-wood

The last Ghana population census conducted in year 2000 established a total population of 18,912,079 (Statistical Service, 2004). Literature review (Statistical Service, 2004; Ministry of Food and Agriculture, 1999; World Bank, 1998) estimated that 56.2% of the population according to the 2000 census is rural out of which 84% (8,935,759.6) use fuel-wood in its untransformed state as alternative sources of fuel. A further 13% (1,072,145.1) of the urban Ghanaian population according to FAO (2006), the EPA (2005a) and the Ghana Statistical Service (2004) depend on fuel-wood (charcoal) as their choice of energy for cooking (equivalent to $1m^3$ or 640kg fuel wood/yr). From table 6.5.1a, 30% (5,673,623.7) of the total population is estimated to be the maximum threshold limit at which it would be sustainable to use forest resources as sources of fuel-wood to argument for the shortage (FAO, 2006) in conventional sources of energy use.

Table 6.5.1a Population statistics of Ghana

Population Characteristics	Population statistics			
	Period			
	1960	1970	1984	2000
Total population(P_t)	6,726,815	8,559,313	12,296,081	18,912,079
Urban population (P_u)	1,547,167	3,311,504	3,934,796	8,247,270
Urban percentage (%)	23.00	29.00	32.00	43.80
Rural population (P_r)	5,179,648	5,247,809	8,361,285	10,637,809
Rural percentage (%)	77.00	71.00	68.00	56.20
population density (P_d)	28.00	36.00	52.00	79.30
population growth rate (P_{gr})	1,3	2.40	2.60	2.70

Source: Ghana statistical service (2000a, 2000b)

The actual performance level (size of population using fuel-wood) according to FAO (2006) was however established at 60% (10,007,894.6) which is over and above sustainable levels with a minimum threshold limit of 10% (1,891,207.9) or size of the total population below which it will be undesirable for the communities. Since maximum value indicates worse performance and minimum a good position, the scale was carefully controlled by taken into account both the top band (100) and the band intervals (20) of the scale. The conversion is performed as follows;

$$Topband - \left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 20 =$$

Where; $AP_l = 60$; $MinT_{lmt} = 10$; $MaxT_l = 30$

$$100 - \left(\frac{60 - 10}{30 - 10} \right) \times 20 =$$

$$100 - (2.5 \times 20) = 50 \text{ deficit}$$

The indicator scored a deficit of 50 points and registers its performance on the scale within the transistional zone (table 6.6.1)

Table 6.5.1b Position of indicator 6.5.1 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Percentage of fuel-wood use
Good	Desired sustainability	81-100	81-100
OK	Potentially sustainable	61-80	61-80
Medium	Transitional performance	41- 60	41- 60 *(Ap_l=50)*
Poor	Potentially unsustainable	21-40	21-40
Bad	Unsustainable	1-20	0-20
Base	Base of MoFRUSS	Base of Scale	Base of Scale

APl=actual performance level

6.5.2 Number of adult households in communities with forest based employment

Forest based employment refers to all economic activities, subsistence or commercial, that deals with direct extractions from the forest. Making inferences from table 6.5.1a it is estimated that about 2,740,000 households or 56% of the rural population in Ghana own or operate a farm or keep livestock, or operates both (Ghana statistical service , 2000a; Ghana statistical service, 2000). Although farming and keeping of livestock is predominantly a rural activity the population census also noted that a significant number of urban households, around a third (32%) in urban areas also have some involvement in agricultural activities (Ghana statistical service, 2000b). Efforts made towards achieving the millennium development goals (MDGs) in Ghana according to Armstrong (2008) and FAO (2005) demands a maximum threshold level of 35% of the total population to be engaged in forest based employment activities with a minimum threshold limit of 15% (Armstrong 2008, FAO 2005). The actual performance level which is the

number of households with forest based employment was observed to be 53% ((Armstrong, 2008; FAO, 2005) which is far above sustainable levels. Here also since maximum value indicates worse performance and minimum a good position, the scale was carefully controlled for the scale conversion by taken into consideration the topband (100) and the scale interval (20) as follows;

$$Topband - \left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 20 =$$

Where; $AP_l = 53$; $MinT_{lmt} = 15$; $MaxT_l = 35$

$$100 - \left(\frac{53 - 15}{35 - 15} \right) \times 20 =$$

$$100 - 38 = 62_{\text{deficit}}$$

The indicator scored a deficit of 62 points registering a position within the transitional zone (table 6.5.2).

Table 6.5.2 Position of indicator 6.5.2 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Forest-based employment
Good	Desired sustainability	81-100	89-109 and above
OK	Potentially sustainable	61-80	68-88
Medium	Transitional performance	41- 60	47- 67*(Ap_l= 62)*
Poor	Potentially unsustainable	21-40	26-46
Bad	Unsustainable	1-20	0-25
Base	Base of MoFRUSS	Base of Scale	Base of Scale

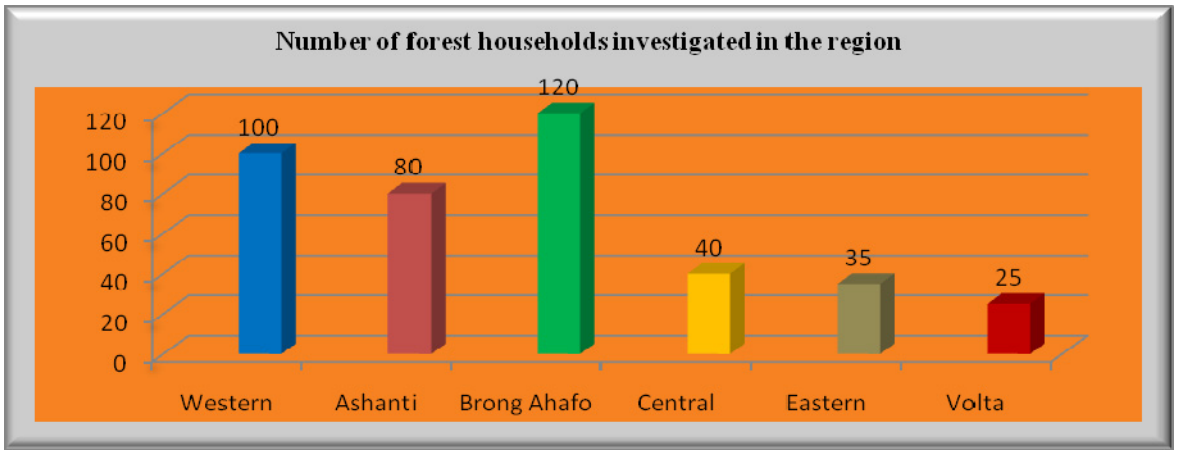
AP_l=actual performance level

6.5.3 Access to environmental education

Open records or freedom of information legislation are laws which set rules on access to information or records held by government bodies, organizations or departmental heads (Hansen, 1997). In Ghana, access to open records is guaranteed under the Right to Information (RTI) Act 2005 and enshrined in the 1992 constitution which gives *'each person the right of access to information or part of information in the custody or under the control of a government agency unless the information or part of the information falls within any of the exemptions specified in section 3 to 17 of RTI Act 2005'* (Ministry of Information, 2008).

Literature reviewed (Ministry of Food and Agriculture, 1999; Ghana Statistical Service, 2004; Amanor, 2002; Gyasi, 2002; Ghartey, 1990) shows that relevant information exist in many government ministries, departments and agencies (including the Environmental Protection Agency). These are however scattered and unsystematically coordinated. Nevertheless, environmental information need not only be available, up-to-date, reliable and accurate (Poore, 1989). They must also be relatively easy to access since such information is crucial to the management of the environment (Forestry Commission, 2006).

Figure 6.5.3 Forest fringe communities with access to environmental information



Source: Field data analysis, 2008

Based on stratified random selection, this study took into consideration population dynamics of the 6 forest regions, their level of literacy, extent of forest degradation and administered 400 questionnaires to households eliciting for information on access to environmental education in the following order; Western =100, Ashanti=80, Brong Ahafo=120, Central=40, Eastern=35, Volta=25 (figure 6.5.3).

Respondents were asked, among other relevant questions, how they are informed on environmental issues, the media through which this is done and how they perceived it to be done. Returned responses are depicted by table 6.5.3a where ***´Yes`*** corresponds to communities perceived to have access to environmental information, ***´No`*** corresponds to communities perceived not to have access to environmental information, and ***`No idea`*** corresponds to communities who are perceived to be adamant. Questionnaires which were not received back are captured as ***´not returned`***. Table 6.5.3a reveals that access to environmental information by forest communities is limited as the ***´yes´*** respondents registers only 13.5% with the print media and frequency modulation (FM) radio stations as the most common sources. The communities however intimated that the Forest Division of the Forestry Commission´s inspectors and guards, districts assembles and community opinion leaders would be the appropriate and an effective medium for making such information accessible since these would be communicated in a language understood by the rural folks.

Table 6.5.3a Access to environmental information by forest communities in Ghana

Extent of Community Participation in SFM		**Returned responses**			
Forest Communities	***No. of households investigated***	***'Yes'***	***'No'***	***No idea***	***Not received***
Western	100	10	25	10	55
Ashanti	80	12	28	11	29
Brong-Ahafo	120	8	30	15	67
Central	40	9	21	8	2
Eastern	35	8	23	2	2
Volta	25	6	11	3	5
Total	**400**	**53** ***(13.25%)***	**138** ***(34.5%)***	**49** ***(12.25)***	**160** ***(40%)***
The 6 forest regions represents a total rural population of 3,701,241(Ghana population Council, 2006) =maximum threshold level Actual performance, returned *'yes'* responses (53) rep. 490,414 (13.2%) of the forest rural population The minimum threshold is 0, that is all must be sensitized (Forestry Commission, 2006)					

Source: Sampled field data analysis, 2008

Indicator 6.5.3 analysis is based on table 6.5.3a. From the data actual performance level was determined to be 53 (13.3%) of the number of households investigated. The maximum threshold limit was established by the Forestry Commission (2006) at 87 which is 21.8% of households that need to be sensitized on environmental issues in the high forest zone.

The minimum limit, according to the Forestry Commission (2006), is zero percent (0%) since all forest communities need to have access to environmental information. Here maximum value is a

desired performance and minimum value a worse one and so *formula 6.1* is used for the scale conversion as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 53$; $MinT_{lmt} = 0$; $MaxT_l = 87$

$$\left(\frac{53 - 0}{87 - 0} \right) \times 100 =$$

$$0.61 \times 100 = 61$$

The indicator scored 61 points and its position on the scale was determined within the transitional performance zone depicted by table 6.5.3b.

Table 6.5.3b Position of indicator 6.5.3 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Access to information
Good	Desired sustainability	81-100	87-107
OK	Potentially sustainable	61-80	66-86
Medium	Transitional performance	41- 60	45- 65*(Ap_l =61)*
Poor	Potentially unsustainable	21-40	24-44
Bad	Unsustainable	1-20	0-23
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.5.4: Degree of public participation in forest management

Participatory conservation is a way of approaching conservation issues through building relationships between local peoples and conservation initiatives (Wells et al, 1992). Public participation is therefore crucial for the implementation of sustainable forest management, be it community-based conservation, joint forest management, co-management or protected area outreach (Hickey, 2004). Involvement of the various stakeholders in forest management, according to the Forestry Commission (2006) will lead to effective collaboration, so as to protect

the resource while allowing economic activities to develop. In-house review exercise in the Forestry Sector in the 1980s resulted in policy and legislative reforms in Ghana.

The exercise gave birth to the 1994 Forest and Wildlife Policy which called for wider stakeholder participation in forest management (Forestry Commission, 2006). As emphasized by one authority; *"forestry in the 21st century would no longer be an exclusive or solitary profession, no longer the sole purview of the forester. As never before, the achievement of success will depend on the ability to forge a successful partnership with local people that live in and around the forest" (Avoka, 1998).*

Analysis of indicator 6.5.4 is based on field data (table 6.5.4a). The questionnaires elicited from forest communities information related to environmental education, policy and legislation reforms, sector institutional reforms, forest reserve management, bush fire management, plantation development, logging and wood industry development. ``***Yes***`` returned responses refers to households who have participated in all of the above mentioned forestry activities. ``***No***`` returned responses refers to households who have not participated in all of the above mentioned.

Table 6.5.4a Extent of community participation in forest management

Extent of Community Participation in SFM		**Returned responses**			
Forest Communities	***No. of households investigated***	***'Yes'***	***'No'***	***No idea***	***Not received***
Western	100	10	25	10	55
Ashanti	80	12	28	11	29
Brong-Ahafo	120	8	30	15	67
Central	40	9	21	8	2
Eastern	35	8	23	2	2
Volta	25	6	11	3	5
Total	**400**	**53** ***(13.25%)***	**138** ***(34.5%)***	**49** ***(12.25)***	**160** ***(40%)***
The 6 forest regions represents a total rural population of 3,701,241(Ghana population Council, 2006) = maximum threshold level Actual performance level = returned *'yes'* responses (53 or 13.3%). This represents 490,414 (13.2%) of the forest rural population The minimum threshold is 0, that is all must be sensitized (Forestry Commission, 2006)					

Source: Sampled field data analysis, 2008

From table 6.5.4a returned responses revealed that not more than 490,414 (13.2% of ***'yes'*** respondents) people, out of the near 4 million (3,701,241) forest communities, have participated in forestry activities. Based on the sample size stakeholders established the maximum threshold

level at 3,701,241 and a minimum threshold limit of zero (0%) percent (Forestry Commission, 2006). With best as maximum and worse as minimum, *formula 6.1* was applied for the scale conversion as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 490{,}414$; $MinT_{lmt} = 0$; $MaxT_l = 3{,}701{,}241$

$$\left(\frac{490{,}414 - 0}{3{,}701{,}241 - 0} \right) \times 100 =$$

$$0.13 \times 100 = 13$$

The indicator scored 13 points and registered its position on the scale within the un-sustainable zone as depicted below.

Table 6.5.4b Position of indicator 6.5.4 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Public participation
Good	Desired sustainability	81-100	2,000,004 and above
OK	Potentially sustainable	61-80	1,500,003-2,000,003
Medium	Transitional performance	41- 60	1,000,002- 1,500,002
Poor	Potentially unsustainable	21-40	500,001-1,000,001
Bad	Unsustainable	1-20	0-500,000 *(Ap_l =13)*
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.5.5 Equitable sharing of forest proceeds

The vision of managing forest resources on sustainable basis would be difficult to achieve without bringing all stakeholders on board (Tropenbos International, 2005). It is in the light of this that the new management paradigm advocates strongly for collaborative forest management (Forestry Commission, 2006). However collaboration is only possible when all partners are convinced of at-least, some 'returns of their input' (Oliver, 2003). Equitable sharing of fees

charged by government, on behave of land owners (stools/skins), to companies for harvesting trees from public land, called stumpage (benefit) has been considered as one kind of incentive scheme that has the potential to promote or engender such collaboration (Forestry Commission, 2006). The 1992 constitution, under ACT 267 section 6, prescribes modalities for disbursement of forest proceeds. Literature review (Forestry Commission, 2006; Ministry of Lands & Forestry, 2005; Ministry of Information, 2008) established that the office of Administrator of Stool Lands (OASL) and Forestry Commission retain some percentage of the stumpage meant for forest communities as fees as managers of the resources on behalf of stools and landowners according to the following rates outlined by table 6.5.5a.

Table 6.5.5a Modalities for disbursement of forest proceeds by stakeholders in Ghana

Modalities for disbursement of forest proceeds (stumpage)	**Extent of proceeds (Percentage %)**	
Managers	***On- reserves***	***Off-reserves***
Forestry Commission (*FC*)	**60.0**	**40.00**
OASL	**4.0**	**6.00**
Other Stakeholders		
District Assembly (*DA*)	19.8	29.7
Traditional Council (*TC*)	7.2	10.8
Stool Landholders (*SLH*)	9.0	13.5
Total	**100**	**100**
Calculation of thresholds		
Actual performance level=∑(TC+SLH) on-reserves and off-reserves=7.2+9.0+10.8+13.5=**40.5**%		
Maximum threshold limit=∑(TC+SLH+DA) on-reserves and off-reserves=19.8+7.2+9.0+29.7+10.8+13.5=**90**%		
Minimum threshold limit=∑(SLH) on-reserves and off-reserves=9.0+13.5=**22.5**%		

Source: Based on Forestry Commission data sources, 2006

The 1992 constitution stipulates under Article 267 (6) that the Forestry Commission retains 60% of proceeds (stumpage) accruing from forest on-reserves and 40% from proceeds from off-reserves (Forestry Commission, 2006). Office of the Administrator of Stool Lands, which together with the Forestry Commission form core managers of the resources, shall be paid 10% of the proceeds (in parts of 4% on-reserves and 6% off-reserves) to cover administrative expenses (table 6.5.5a). The remaining revenue, according to the Forestry Commission (2008), were disbursed in the following proportions depicted by table 6.5.5a; 22.5% (9.0% on-reserves+13.5% off-reserves) to Stool Landholders (SLH) through the traditional authority for

the maintenance of the stool in keeping with its status; 18.0% (7.2% on-reserves+10.8%off-reserves) to the traditional authority (TA); and 49.5% (19.8% on-reserves+29.7% off-reserves) to the District Assembly (DC), within the area of authority of which the stool lands are situated.

This trend in resource disbursement over the years has been viewed as expropriation of community resources by resource managers (Tropenbos International, 2005) under the camouflage of constitutional provisions. The assertion is collaborated by data (table 6.5.5a) gathered for analyzing indicator 6.5.5. The study revealed that actual stumpage that accrues to forest communities (actual performance level) to forest communities in the high forest zone from both on-reserves and off-reserves is 40.5% =(∑TC + SLH) of the total proceeds. The maximum percentage of the proceeds needed to sustain forest communities on sustainable levels, according to the Forestry Commission (2006), was calculated to be 90% =∑(TC+SLH+DA) and the minimum, at 22.5% =(∑SLH) of total proceeds that accrued over the period under investigation. Here maximum connote best performance and minimum a worse one. Therefore *formula 6.1* is applied for the conversion where it scored 31 points locating its position on the scale within a potentially unsustainable region (table 6.5.5b) as,

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 40.5$; $MinT_{lmt} = 22.5$; $MaxT_l = 90$

$$\left(\frac{40.5 - 22.5}{90 - 22.5} \right) \times 100$$

$$0.27 \times 100 = 27$$

Table 6.5.5b Position of indicator 6.5.5 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Sharing of proceeds
Good	Desired sustainability	81-100	81-100

OK	Potentially sustainable	61-80	61-80
Medium	Transitional performance	41- 60	41- 60
Poor	Potentially unsustainable	21-40	21-40*(Ap_I= 27)*
Bad	Unsustainable	1-20	0-20
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_I=actual performance level

6.5.6 Extent of area under plantation in the high forest zone

This is the extent of area being rehabilitated through the planting of trees interspersed with farming activities. This indicator is considered on the merit that fuel-wood from plantation will argument for woods that would otherwise be harvested from the high forest by fringe communities (EPA, 2005b). Ecologically it will contribute to increasing the size of forest sinks and socially solve some unemployment problems (Birikorang et al., 2006).

Forestry is relatively young in Ghana (Swanzy, 1990). Field exercise shows that an estimated 200,000ha of plantation, over the last two decades, have been established with expected annual additions of 20,000ha (Forestry Commission, 2006; Ministry of Lands & Forestry, 2005; Ministry of Agriculture, 2005). Therefore in arriving at the actual performance level it was determined as the total area rehabilitated (200,000ha) plus annual additions over the two decade period (20,000ha×10yrs) = 400,000ha. According to the Ministry of Lands and Forestry (2005) and World Bank et al. (2005), this is expected to generate an annual yield of 50,000 m^3 of wood. This initiative is a young project being carried out jointly by the executive arm of government, the forestry department of the Ghana Forestry Commission, timber firms and other stakeholders including non-governmental environmental organizations. The main species used in this exercise, according to the Forestry Commission (2006), are Tectona (grandis), cedrela (Cedrela odorata) and Gmelina (Gmelina arborea). The source also established a maximum extent of 2,000,000ha of degraded area as the size expected to be rehabilitation to sustain societal well-being and a minimum threshold hold of zero (0) hectares since all degraded lands need to be rehabilitated (FAO 2005b, Forestry Commission, 2006). Since a maximum value is desirable situation and a minimum value otherwise, the conversion of scale is performed with *formula 6.1* as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; AP_l = 400,000; $MinT_{lmt}$ = 0; $MaxT_l$ = 2,000,000

$$\left(\frac{400,000 - 0}{2,000,000 - 0} \right) \times 100 =$$

$$0.2 \times 100 = 20$$

The indicator performed badly as it scored only 20 points and registers its position at the bottom of the scale within the unsustainable region (table 6.5.6).

Table 6.5.6: Position of indicator 6.5.6 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of plantation (ha)
Good	Desired sustainability	81-100	1,700,700 -2,000,800
OK	Potentially sustainable	61-80	1,100,500-1,400,600
Medium	Transitional performance	41- 60	800,300-1,100,400
Poor	Potentially unsustainable	21-40	500,100-800,200
Bad	Unsustainable	1-20	20,000-500,000*(Ap_l =400,000)*
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Apl =Actual performance level

6.5.7 Number of people employed in each forest based activity

Indicator 6.5.7 assesses the number of households who are engaged in livelihood activities which depends directly or indirectly on the high forest zone. Two areas were considered for the forest based activities. These are logging, forest plantation and their related income generating activities as well as their spill over effects.

Data from the statistical services of Ghana (2004), Forestry Commission (2006) and (FAO, 2005a) established that for every 104,000 direct employments within the forestry sector, 3,000,000 indirect employments opportunities are opened. In the plantation sector, it is in the

order of 46,058 direct annual employments to 1,000,000 people indirectly. Thus the maximum adult households that needed to be engaged in such activities to establish sustainable development equilibrium within the fringe forest communities was established at 4,150,058 thresholds (Forestry Commission, 2006). However an actual performance level of (104,000 + 3,000,000 +46,000) =3,150,000 adult households limit was determined by the same source with a minimum level below which the economy will perform badly was established at 3,000,000 adult household (Forestry Commission, 2006). Since maximum is the desired value and minimum a worse one *formula 6.1* was applied as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; $\boldsymbol{AP_l}$ = 3,150,000 $\boldsymbol{MinT_{lmt}}$ = 3,000,000 $\boldsymbol{MaxT_l}$ = 4,150,058

$$\left(\frac{3,150,000 - 3,000,000}{4,150,058 - 3,000,000} \right) \times 100 =$$

$$0.13 \times 100 = 13$$

The indicator scored only 13 points. However, on the actual performance scale, it registers an impressive presence within the potentially sustainable region as shown by table 6.5.7.

Table 6.5.7 Position of indicator 6.5.7 on the MoFRUSS

BoS Band	MoFRUSS Segment	Point on Scale	Employment in forest activities
Good	Desired sustainability	81-100	3,500,004-4,000,004 and above
OK	Potentially sustainable	61-80	3,000,003-3,500,003*(Apl score 9)*

Medium	Transitional performance	41- 60	2,500,002-3,000,002
Poor	Potentially unsustainable	21-40	2,000,001-2,500,001
Bad	Unsustainable	1-20	1,500,000-2,000,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

APl = actual performance level.

6.5.8 Adequate number of professionals and technocrats for SFM implementation

Indicator 6.5.8 assesses adequacy of professionals and technocrats available to effectively implement and sustain sustainable forest management programs in the high forest zone. This analysis is based on a questionnaire sampling methodology and the Forestry Commission (2004)'s data sources. Findings from the research are summarized by table 6.5.8a.

Questionnaires were issued out to management of the main subsidiaries of the Forestry Commission who are charged with the day to day activities of the forestry sector soliciting for thresholds of personnel needed to effectively run, implement and achieve the goals and aspirations of the Commission.

Table 6.5.8a Professionals/Technocrats at the Forestry Commission of Ghana

Divisions of the Commission	**Total number of professionals at post**	
	Retuned responses from questionnaires	*From Forestry Commission data sources*
Forestry Commission Secretary	57	57
Forestry Services Division	2,600	2000
Wildlife Division	1,050	780
Timber Industry Development Division	180	180
College of Renewable Natural Resources	46	46
Resource Management Support centre	100	100
Wood Industry Training Centre	39	39
Forest Guards	*5,548*	*5000*
Total	**10,520**	**8,202**

Sources: Field data, 2008; Forestry Commission, 2004

The sampling exercise concluded that a maximum of 10,520 professionals and technocrats would be needed to sustain the commission's activities. The results from the field are distributed in the

following categories as depicted table 6.5.8a; Forestry Commission Secretary = 57; Forestry Services Division = 2,600; Forest guards, also under the forestry services = 5,548; Wildlife Division =1,050; Timber Industry Development Division = 180; Wood Industry Training Centre =39; Resource Management Support Centre = 100; and the College of Renewable Natural Resources = 46.

These results were then compared with a review of the Commissions documents, notably the 1994 Forest and Wildlife Policy and the Forestry Master Plan for the period 1996-2020. The results showed an actual performance level of a resized figure of 8,202 (table 6.5.8a) with explanation to the reduction in numbers being lack of logistics and inadequate financial support (Forestry Commission, 2004). The commission also established that the minimum number of personnel/technocrats needed below which management will be unsustainable, with dying consequences on the resource base at 5000 (Forestry Commission, 2004). With maximum value describing a best situation and minimum value a worst one, the conversion of scale is performed with *formula 6.1* as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; Ap_l = 8,202; $MinT_{lmt}$ = 5,000; $Max.T_l$ = 10,520

$$\left(\frac{8,202 - 5,202}{10,520 - 5,202} \right) \times 100 =$$

$$0.58 \times 100 = 58$$

With an appreciable score of 58 the actual performance position on the scale is established within the transitional zone (table 6.5.8b).

Table 6.5.8b Position of indicator 6.5.8 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Adequacy of SFM professional

Good	Desired sustainability	81-100	12,504-15,504
OK	Potentially sustainable	61-80	9,503-12,503
Medium	Transitional performance	41- 60	6,502-9,502*(Ap_l=58)*
Poor	Potentially unsustainable	21-40	3,501-6,501
Bad	Unsustainable	1-20	0-3,500
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Ap_l =actual performance level

6.5.9: Extent of area considered for special management provisions in the HFZ

Areas with high floral diversity have been identified across the high forest zone (FAO, 2006) using the Genetic Heat Index (Hawthrone, 1995b). These areas, according to FAO (2006), are to be considered as biological unique and treated with special management provisions towards giving a global security to flora and fauna (FAO, 2006). Fringe forest communities matter a lot with regards to the peculiar attention such ecosystems should receive and therefore considering this indicator under this theme is in the right perspective. The genetic heat index communicate concentrations of rare plant species or otherwise with forest managers (Musah & Hawthrone, 1995). Inference from the indices have established that some of the forest reserves are biological diverse that they have become of global significance. Investigations identified a maximum threshold area in the high forest zone capable of exhibiting such management provisions at 357,800ha (World bank et al, 2006).

However, the actual area with such unique characteristics was established at 117,322ha (FAO, 2005a). The minimum threshold area within the protected area, according to the World bank (2006b), was determined at 43,400 hectares. Since maximum value signifiers good performance and minimum a bad one, *formula 6.1* is adopted for the scale conversion in the following order;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; $AP_l = 117{,}322$; $MinT_{lmt} = 43{,}400$; $MaxT_l = 357{,}800$

$$\left(\frac{117{,}322 - 43{,}400}{357{,}800 - 43{,}400} \right) \times 100 =$$

$$0.27 \times 100 = 27$$

The indicator scored 24 points and registered its presence on the scale within the potentially unsustainable zone (table 6.5.9).

Table 6.5.9 Position of indicator 6.5.9 on MoFRUSS

BoS Band	MoFRUSS Segment	Point on Scale	Extent of Special Mgt. Areas
Good	Desired sustainability	81-100	284,000-354,000
OK	Potentially sustainable	61-80	243,000-283,000
Medium	Transitional performance	41- 60	142,000-212,000
Poor	Potentially unsustainable	21-40	71,000-141,000 (*Ap_l = 117,322l)*
Bad	Unsustainable	1-20	0-70,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.5.10 Extent of management control over forest resources

The Government of Ghana, by law (Ministry of Lands & Forestry, 2005) exercises direct administrative and management functions of forested lands on behalf of, and for the benefit of her citizenry by holding the lands and trees on them in trust (Forestry Commission, 2006). Indicator 6.4.10 assesses the effect of government control over management of forest resources on sustainable management of the resources. Although sustainable forest management subscribes to a management initiative that involves all stakeholders, control over management of the resources in order to achieve stated management objectives in the case of Ghana by law is assumed be 100% state lead controlled (Ghana Lands & Forestry, 2005).

The extent to which this is done is well defined by the Ministry of lands and forestry (2005) and summarized by table 6.5.10a. Based on the data from the Ministry of lands and forestry (2005) and the World Bank (2006a) the research established an actual performance level by the state on both *On-reserves* and *Off-reserves* at 79.7% (table 6.510a), a minimum threshold of 0% and a

maximum control level by the state at 100%.

Table 6.5.10a Extent of management control over forest resources

Management(mgt.) Stakeholders	Extent of Management Control				Actual Control by state (FC+OASL+Das)
	On-reserve		Off-reserve		
	%	*Absolute value(ha)*	%	*Absolute value(ha)*	
Forestry Commission (FC)	60.0	947,394.00	40.0	2,778,429	
Office of Admin. of Stool Lands (OASL)	4.0	63,315.60	6.0	416,764.38	
District Assemblies (DAs)	19.8	312,640.02	29.7	2,062,983.68	
Traditional Councils (TC)	7.2	113,687.28	10.8	750,175.88	
Stool landholders (SH)	9.0	142,109.10	13.5	937,719.86	
Total	**100**	**1,578,990**	**100**	**6,946,073**	
Calculations Actual mgt. control by state = ∑ mean management control (FC+OASL+DAs) = 6,100,446.70 ha (79.8%) Maximum mgt. control = ∑ mean management control (FC+OASL+DAs + TC+ SH) = 8,525,065 ha (100%) Minimum management control = 0ha (0 %)					

Source: Analysis based on the Forestry Commission and Ministry of Lands & Forestry data, 2005.

With the maximum score describing a best situation and worse score as minimum, *formula 6.1* as depicted below is used for the conversion. It scored 80 points and registered its position on the scale within the potentially sustainable zone depicted by table 6.5.10b.

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; $Ap_l = 79.8$; $MinT_{lmt} = 0$; $Max.T_l = 100$

$$\left(\frac{79.8 - 0}{100 - 0} \right) \times 100 =$$

$$0.80 \times 100 = 80$$

Table 6.5.10b Position of indicator 6.5.10 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Control of forest mangement
Good	Desired sustainability	81-100	81-100

OK	Potentially sustainable	61-80	61-80*(Ap$_l$ = 80)*
Medium	Transitional performance	41- 60	41-60
Poor	Potentially unsustainable	21-40	21-40
Bad	Unsustainable	1-20	0-20
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Apl =Actual performance level

6.6 ANALYSIS OF THEME 3: ECONOMIC GROWTH & DEVELOPMENT INDICATORS.

Economic growth and development as a criterion here imply that judicious use of the resources must translate into qualitative and quantitative improvements in economic well-being of the

nation as a whole. Nine (9) measureable indicators were identified and adopted as the most applicable ones for the assessment. The indicators were selected based on stakeholder multi-criteria approach already described under chapter 5.3. Here 9 indicators instead of 10 were analyzed to test the pre-assumption that economic motives have always been very high on all previous management policy agenda on decision making previously. They are listed below as;

1. Contribution of timber to gross domestic product(GDP).
2. Forest area available for commercial timber production.
3. Extent of eco-regions conserved for re-creational activities.
4. Contribution to employment (households) levels.
5. Number of timber trade related industries
6. Extent of land tenure and property rights
7. Number and adequacy of institutions to support sustainable forest management
8. Extent of financial commitment to sustainable forest management
9. Extent of domestic wood demand by volume

6.6.1 Contribution of timber to gross domestic product (GDP)

Indicator 6.61 looks at the role lumbering play towards economic growth and development in terms of contribution to gross domestic product. Ghana's economic growth and development is strongly centred on processing raw materials for domestic agro-based industries, local consumption and for export (ISSER, 2008). Assessment of this indicator is based on information provided by the Ministry of Finance and Economic Planning, the Institute of Statistical, Social & Economic Research (ISSER) and the Ghana Statistical Service.

Over the last two decades agriculture's contribution to gross domestic product, according to the Ministry of Finance and Economic Planning (2008), has been sustained at an average level of 36.0% (table 6.6.1a) of which the forestry sector has a share potential of 5.4%. Therefore, in terms of achieving economic development targets and sustaining them the forest sector must contribute a maximum threshold level of 5.4% (ISSER, 2008) to the gross domestic product. The minimum threshold limit below which usage of the resources will impact negatively on the environment was pegged at of 0.2% of the gross domestic product (table 6.6.1a).

Table 6.6.1a Forestry share of gross domestic product and contribution to overall growth

Period	1990		2000		2006	
	percentage(%)					
Sectors	Ave. Share of GDP	Additions to growth	Ave. share of GDP	Additions to growth	Ave. share of GDP	Additions to growth
Agriculture	37.0	2.6	36.0	1.5	35.8	2.1
Forestry	***3.6***	***0.2***	***3.6***	***0.2***	***3.4***	***0.1***
Cocoa	4.3	1.3	4.6	0.6	4.7	0.4
Industry	24.7	1.2	25.1	1.9	25. 2	1.8
Mining & quarring	5.1	0.2	5.1	0.3	5.0	0.1
manufacturing	9.0	0.4	8.9	0.4	8.8	0.4
Services	29.9	1.5	30.0	2.1	30.1	2.0
Transport, storage and Communication	5.0	0.3	5.0	0.4	5.0	0.4
Wholesale, trade & retail	7.2	0.4	7.3	0.7	7.4	0.5

Calculation of thresholds
Actual performance level of the forestry sector = mean∑(GDP over the period) = (3.6+3.6+3.4)÷3=**3.5**
Minimum threshold limit= mean∑(additions to growth over the period) = (0.2+0.2+0.1)÷3=**0.2**
Maximum threshold determined = **5.4**

Sources: Data analysis based on sources from the Ministry of Finance & Economic Planning (2008), Ghana Statistical services (2004) and Institute of Statistical, Social & Economic Research –ISSER (2008)

From the data (table 6.6.1a) actual performance level is calculated to be 3.5% of the gross domestic product (table 6.6.1a). With maximum value representing best situation and minimum value a worse one, the conversion of scale is performed with *formula 6.1* as follows;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; $AP_l = 3.5$; $MinT_{lmt} = 0.2$; $MaxT_l = 5.4$

$$\left(\frac{3.5 - 0.2}{5.4 - 0.2} \right) \times 100 =$$

$$0.63 \times 100 = 63$$

The indicator makes an impressive presence on the scale by scoring 63 points which lies within the potentially sustainable segment (table 6.6.1b).

Table 6.6.1b Position of indicator 6.6.1 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Contribution to GDP (%)

Good	Desired sustainability	81-100	4.5-5.0 and above
OK	Potentially sustainable	61-80	3.6-4.0*(Ap_l =3.5)*
Medium	Transitional performance	41- 60	3.0-3.5
Poor	Potentially unsustainable	21-40	2.4-2.9
Bad	Unsustainable	0-20	1.8-2.3
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Ap_l =actual performance level

6.6.2 Forest area available for commercial timber production

Indicator 6.6.2 assesses designated areas within forested lands in Ghana where timber is harvested for economic purposes. Statistical data from the FAO (2005a), Forest Resource Assessment (FRA) of the Food and Agriculture Organisation (2005b) and the Forestry Commission (2006) puts the high forest zone, which according to the sources stands at 1,648,400ha into the following management categories; Production = 762,400; Protection = 352,000ha; Plantation = 160,000ha and Off-reserves = 374,000 (table 6.6.2a).

Table 6.6.2a Management categorization of the high forest zone

Production	Protection	Plantation	Off-Reserve	Total size
762,400 ha	352,000 ha	160,000 ha	374,000 ha	**1,648,400**

Source: FAO, 2005; FRA, 2005; Forestry Commission, 2006

The study established from the data (table 6.6.2a) that actual forest area available for commercial timber production is 1,136,400ha = (areas demarcated for production + Off-reserves). The minimum threshold limit below which extraction of the resources will have adverse consequences on the forest ecosystem was established at 500,000ha (Forestry Commission, 2006). Maximum threshold limit, which is the level needed to achieve and sustain economic growth and development targets is calculated to be 1,296,400ha = (Production + Off-reserve + Plantation). With maximum signifying best situation and minimum value a worse one, *formula*

6.1 is applied for the scale conversion as follows;

$$\left(\frac{AP_l - Min T_{lmt}}{Max T_{lmt} - Min T_{lmt}} \right) \times 100 =$$

Where; $AP_l = 1{,}136{,}400$; $MinT_{lmt} = 500{,}000$; $MaxT_l = 1{,}296{,}400$

$$\left(\frac{1{,}136{,}400 - 500{,}000}{1{,}296{,}400 - 500{,}000} \right) \times 100 =$$

$$0.799 \times 100 = 80$$

Indicator 6.6.2 performed creditably well as scored 80 points and occupied a position on the scale very close to the top within the potentially sustainable segment (table 6.6.2b).

Table 6.6.2b Position of indicator 6.6.2 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of commercial timber
Good	Desired sustainability	81-100	1,200,004-1,440,004
OK	Potentially sustainable	61-80	960,003-1,200,003*(Ap_l =1,136,400ha)*
Medium	Transitional performance	41- 60	720,002-960,002
Poor	Potentially unsustainable	21-40	480,001-720,001
Bad	Unsustainable	1-20	240-480,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Ap_l =actual performance level

6.6.3 Extent of eco-regions conserved for recreational activities

Indicator 6.6.3 assesses extent of forest areas being conserved and harnessed for tourism and recreational activities. Such designated areas which are packaged as eco-tourism products come in the form of Game and Wildlife sanctuaries, National parks, National parks, Canopy walk-ways, Aesthetic sceneries, Educational and scientific parks, Religious and cultural parks. The Ghana Wildlife Department has an estate of 15 protected areas covering 13,385 km^2 (Forestry Commission, 2006) or a little over 5.6% of the land area and roughly half of the forest on-reserves (FAO, 2005b). Ghana's wildlife protected areas have a potential for tourism (EPA, 2005b). Areas identified include six (6) national parks, six (6) reserves, two (2) wildlife sanctuaries and one (1) strict nature reserve (Protected Areas Development Programme in 2000).

Table 6.6.3a Protected areas and other designated sites for tourism/recreational activities

Protected Area	Area Statistics		
	Type of Ecosystem	*Size (km²)*	*Gazetted*
Mole National Park	Woodland savannah	4840	1971
Digya National Park	Transition zone	3478	1971
Bui National Park	Woodland savannah	1821	1971
Gbele Resource Reserve	Woodland savannah	565	1975
Ankasa &Nini Suhien National Park	*Moist forest*	*490*	1976
Kogyae Strict Nature Reserve	Moist forest	360	1971
Kyabobo National Park	Woodland savannah	360	2005/6
Kakum NP/Assin Attandanso Reserve	Moist forest	350	1991
Kalakpa Resource Reserve	Woodland savannah	325	1975
Bia National Park/Bia Resource Reserve	Moist forest	306	1974/1977
Bomfobiri Wildlife Sanctuary	Forest	53	1975
Shai Hills Resource Reserve	Coastal savannah	49	1971
Owabi Wildlife Sanctuary	Inland Ramsar wetland	13	1971
Boabeng-Fiema community forest	*na*	*4*	*Proposed*
Agumatsa Wli community forest	-	*3*	*Proposed*
Other Proposed Sites			
Ramsar coastal wetlands	-	*na*	*na*
Densu Delta	-	-	1999
Keta Lagoon Complex	-	-	1999
Muni-Pomadze	-	-	1999
Sakumo	-	-	1999
Songor	-	-	1999
Owabi (inland wetland)	-	-	*na*
In-situ conservation	-		-
Aburi Botanical Gardens and Arboretum)	-	65 ha	1890

Based on Pleydell, 2005. *Na= information not available*

The Forestry Commission (2006) intimated that the most developed protected areas among the lot (table 6.6.3a) are the Mole Game Reserve, Shai Hills and the Kakum National Park. Whereas the former receives 3,000 to 5,000 annually (Ghana Tourist Board) the later attracts about 36,000 tourists during the same period. It is anticipated that tourism could become the 3rd foreign income earner in Ghana with expected annual revenue of $1.5m (Ghana Tourist Board, 2006). Tourists visit and nights are also expected to increase steadily when such resources are properly developed (Pleydell, 2005). According to Forestry Commission (2006) and FAO (2005), total area legally gazetted as protected areas for recreational and a tourism activity (actual performance level) is 12,685 km^2 which represents about 5.3% of Ghana's land area. Together with other proposed areas (table 6.6.3a) the maximum area needed to achieve and sustain vision 2015 was established at 13,385km^3 (Forestry Commission, 2006) which is 5.8% of the total land area. The minimum threshold limit was determined at zero (0km^2) since management expect all

protected areas to be harnessed for such benefits. With maximum value indicating best performance and minimum otherwise, *formula 6.1* is used for the conversion as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; AP_l = 12,685; $MinT_{lmt}$ = 0; $MaxT_l$ = 13,385

$$\left(\frac{12,685 - 0}{13,385 - 0} \right) \times 100 =$$

$$0.95 \times 100 = 95$$

The indicator performed creditably well as it lies very close to the top of the scale within the desired sustainability zone (6.6.3b).

Table 6.6.3b Position of indicator 6.6.3 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Prospects for tourism activities
Good	Desired sustainability	81-100	10,004-12,504 and above *(Ap_l=13,385)*
OK	Potentially sustainable	61-80	7,503-10,003
Medium	Transitional performance	41- 60	5,002-7,502
Poor	Potentially unsustainable	21-40	2,501-5,001
Bad	Unsustainable	0-20	0-2,500
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Ap_l = actual performance level.

6.6.4 Contribution to employment levels (households)

Indicator 6.6.4 evaluates the role played by the forestry sector towards solving unemployment problems, taking into consideration population dynamics and poverty levels, in the country (table 6.6.4a). The total population of Ghana has been increasing at a phenomenal rate. By year 2000 the census registered a total populace of 18,912,079 million growing at 2.7% per annum as compared to the 1960 total population of 6,726,815 (Ghana Statistical Services, 2004). Given an

annual growth rate of 2.7% it is estimated at 20.3m by June, 2007 (own estimation by 2007) with an unemployment rate of 20% (represent 4,000,000 people out of the total population).

Table 6.6.4a Population dynamics of Ghana 1960-2000

Population Characteristics	Population Statistics			
	Period			
	1960	1970	1984	2000
Total population(P_t)	6,726,815	8,559,313	12,296,081	18,912,079
Urban population (P_u)	1,547,167	3,311,504	3,934,796	8,247,270
Urban percentage (%)	23.00	29.00	32.00	43.80
Rural population (P_r)	5,179,648	5,247,809	8,361,285	10,637,809
Rural percentage (%)	77.00	71.00	68.00	56.20
population density (P_d)	28.00	36.00	52.00	79.30
population growth rate (P_{gr})	1,3	2.40	2.60	2.70
Poverty level (%)	-	-	-	28
Unemployment (%)	-	-	-	20

Source: Based on Ghana Statistical Service (2004), Ghana statistical service (2000)

Poverty level, according to the Ghana statistical service (2006), was established at 28.5% (representing 5,600,000 of the total population). The study also observed from the data (Ghana statistical service, 2004) that the forestry sector, currently gives direct employment to 104,000 adult households annually (World Bank, 2006b) and established a minimum threshold level below which fringe communities will be adversely affected at 13,520 adult-heads representing 2% of unemployment rate (Ghana statistical service, 2004). The maximum threshold level at which developmental targets would be achieved and sustained was determined at 200,000 adult households (representing 5% of unemployment rate). The higher the number of adult households the sector absorbs the better development goals and vice versa. Since maximum value connotes best performance and minimum otherwise *formula 6.1* was employed for the conversion as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; $\boldsymbol{AP_l}$ = 104,000 $\boldsymbol{MinT_{lmt}}$ = 13,520 $\boldsymbol{MaxT_l}$ = 200,000

$$\left(\frac{104,000 - 13,520}{200,000 - 13,520} \right) \times 100 =$$

$$0.49 \times 100 = 49$$

Indicator 6.6.4 failed to score an average mark, missing it by one mark (49). It registered its presence on the scale within the transitional region (table 6.6.4b).

Table 6.6.4b Position of indicator 6.6.4 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of employment levels
Good	Desired sustainability	81-100	160,004-200,000
OK	Potentially sustainable	61-80	120,003-160,003
Medium	Transitional performance	41- 60	80,002-120,002 *(Ap_l=104,000)*
Poor	Potentially unsustainable	21-40	*40,001-80,001*
Bad	Unsustainable	1-20	*0-40,000*
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level

6.6.5 Number of timber trade related industries

This indicator relates to firms and industries that deal with the harvesting and processing of timber for both domestic and export markets. They play vital roles in the economic growth and development equations in terms of revenue generation, employment and infrastructural development. Data for the analysis came from the International Tropical Timber Organization (2007), the Forestry Commission (2002), Agyarko (2003) and the FAO (2005b). In his submission Agyarko (2003) estimated that over the period under consideration, annual total demand for log was pegged at 2,513,754m^3/yr that signified a log demand deficit of 1,3m^3/yr above an annual allowable cut of 1,200,000m^3/yr (Agyarko, 2003). With annual estimates of the volume of wood needed, the study identified a maximum threshold limit of 400 firms (The Forestry Commission, 2004) needed to sustain the timber industry in operations so as to meet developmental targets. The minimum threshold limit below which even local demands may not be met was determined at 350 firms (The Forestry Commission, 2004). However the actual number of firms in operation were identified with 411 industries (Bussolo, 2007) indicating an excess of 11 timber enterprises.

Here a minimum value connotes best performance and maximum value otherwise. *Formula 6.1* is adopted for the scale conversion as;

$$1 - \left(\frac{AP_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $AP_l = 411$; $MinT_{lmt} = 350$; $MaxT_l = 400$

$$1 - \left(\frac{411 - 350}{400 - 350} \right) \times 100$$

$$1 - (1.22) \times 100 = 22 \; deficit$$

Indicator 6.6.5 scored a deficit of 22 points and registered its position on the potentially unsustainable region as depicted below (table 6.6.5).

Table 6.6.5 Position of indicator 6.6.5 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Timber related industries
Good	Desired sustainability	81-100	484-604
OK	Potentially sustainable	61-80	363-483 *(Ap_l = 411)*
Medium	Transitional performance	41- 60	242-362
Poor	Potentially unsustainable	21-40	121-241
Bad	Unsustainable	1-20	0-120
Base	Base of MoFRUSS	Base of Scale	Base of Scale

AP_l=actual performance level.

6.6.6 Extent of land tenure and property rights

Forest tenure is the degree to which ownership rights, tenancy and arrangement for management of forest resources are defined (Swanzy, 1990) either through legal or customarily means. This indicator is analyzed under the assumption that forest tenure structures determine the conduct of the tenure holder which in turn influences tenure performance (Ostrom, 2003). Therefore, the

higher the degree of tenure by fringe communities, the less effective central management efforts will be towards management of resources on sustainable basis. Information on this indicator came from the Institute of Statistical, Social & Economic Research (2008), Food and Agricultural Organization (2007a) and the Forestry Commission (2006). From the data (table 6.6.6a) the study established a minimum threshold level, below which effective management goals would not be achieved, at 28% (Forestry Commission, 2006) and a maximum threshold level, at which economic growth and development goals, would be achieved at 83% (Institute of Statistical, Social & Economic Research, 2008).

Table 6.6.6a Extent of land tenure and property right in Ghana

Type of resource	**Forest Tenure**	**Total area (%)**	**Share (ha)**
Total forest (On-reserve)	State (FC)	***52***	1,120,000
	District Assemblies	***3***	64,000
	Private individuals	20	208,000
	Community/groups	14	112,000
	Indigenous people	1	96,000
	Industries	0	0
	Other ownership	0	0
Total =1. 6m ha		100%	1.6m (ha)
	Forest Tenure	**Total area (%)**	**Share (ha)**
Total forest (Off-reserve)	State (FC)	***25***	1,725,000
	District Assemblies	***3***	207,000
	Private individuals	47	3,243,000
	Community/groups	8	552,000
	Indigenous people	10	690,000
	Industries	6	414,000
	Other ownership	1	69,000
Total = 6.9m ha		100 %	6.9m (ha)

Calculations

Minimum threshold limit = ∑[(tenure by Forestry Commission (State)+District Assemblies] *off*- reserves = (25+3) = **28**

Maximum threshold level = ∑[(tenure by the State+District Assemblies)] on both *On* and *Off*-reserves = (52+3+25+3) = **83**

Actual Performance level = ∑[(tenure by the State+District Assemblies)] *On*-reserves = 52+3=**55**

Source: Analysis based on ISSER (2008), FAO (2005a), Forestry Commission, (2006) data

However, according to FAO (2006) actual performance level by the States tenancy rights was determined at 55% (table 6.6.6a). Since in this case maximum tenancy rights in the hands of the

indigenes would indicate worse management control on the part of government and minimum tenancy rights best management results, *formula 6.2* applies for the conversion as shown below;

$$1 - \left(\frac{Ap_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100$$

Where; $\mathbf{Ap_l} = 55$, $\boldsymbol{MinT_{lmt}} = 28$, $\boldsymbol{Max.T_l} = 83$

$$1 - \left(\frac{55 - 28}{83 - 28} \right) \times 100$$

$$0.51 \times 100 = 51$$

Indicator 6.6.6 scored 51 points on the scale and is captured within the transitional segment as depicted by table 6.6.6b.

Table 6.6.6b Position of indicator 6.6.6 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of land tenure right
Good	Desired sustainability	81-100	86-106
OK	Potentially sustainable	61-80	68-85
Medium	Transitional performance	41- 60	47-67*(Ap_l=51)*
Poor	Potentially unsustainable	21-40	26-46
Bad	Unsustainable	1-20	0-25
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Apl =actual performance level

6.6.7 Extent of financial commitment to sustainable forest management.

This indicator assesses availability of funds to implement and sustain the programme over the period. Implementing sustainable forest management initiatives is capital intensive and therefore to be able to sustain the program financial commitment must be sufficiently available (Tang, 2001). The study investigated main sources of funding towards this course in Ghana from 1999-2012 mainly from administrative successes (Forestry Commission 2006, Ministry of Lands and

Forestry 2005, FAO 2005b, ITTO 2005, The World-Bank 1998). Analysis of documents from these sources revealed that sustainable forest management initiatives in the high forest zone of Ghana are financially under starved (appendix 10.3). Over the period, a maximum amount of $5.0 billion US dollars from both domestic and foreign sources would be needed to execute the programme (Forestry Commission, 2006; Ministry of Lands and Forestry, 2005).

A minimum threshold level below which it will be undesirable for management is $2.2 billion (Forestry Commission, 2006; Ministry of Lands & Forestry, 2005). However the actual performance level was established at $1.9 billion US dollars (appendix 10.3). Since maximum connotes a good situation and minimum a bad one *formula 6.1* is applied for the scale conversion as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; $\mathbf{Ap_l}$ = $1.9b, $\boldsymbol{MinT_{lmt}}$ = $2.2b, $\boldsymbol{Max.T_l}$ = $5.0b

$$\left(\frac{1,939,600,000 - 2,200,000,000}{5,000,000,000 - 2,200,000,000} \right) \times 100 =$$

$$0.11 \times 100 = 11$$

Indicator 6.6.7 scored 11 points and registers its position on the scale within the unsustainable zone (table 6.6.7).

Table 6.6.7 Position of indicator 6.6.7 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Extent of financial support
Good	Desired sustainability	81-100	404-484
OK	Potentially sustainable	61-80	243-323
Medium	Transitional performance	41- 60	162-242
Poor	Potentially unsustainable	21-40	81-161*(Apl score= 98)*
Bad	Unsustainable	1-20	0-80
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Ap_l =actual performance level

6.6. 8 Number and adequacy of institutions to support sustainable forest management

Indicator 6.6.8 assesses the number and adequacy of institutional setup that are available to support the course of managing forest resources on sustainable basis in Ghana. Questionnaires were administered out to institutions, agencies and bodies to elicit for information on the availability and adequacy of institutional framework in place to support working towards sustainable forest management initiatives in the high forest zone.

Table 6.6.8a Desired institutional setups to promote sustainable forest management

#	Stakeholders	Representatives	Stake
1	Forestry Services Division	Representatives	Management, forest resources
2	Wildlife Division	Representatives	Management, wildlife services
3	Timber Industry Development Division	Representatives	Development, timber species
4	Wood Industry Training Centre	Representatives	Development, wood products
5	College of Renewable Natural Resources	Heads/students	Renewable, education, experts
6	Resources Management Support Centre	Directors	Management support, advise
7	Forestry Commission Secretariat	Directors	Plan, implement, monitor, mgt
8	Ministry of Lands and Forestry	Minister/directors	Land-use and, forest products
9	Regional Coordinating Council	Minister/director	Sustainable development
10	Law enforcement agencies (Police, Judiciary)	Police, Judges	Law and order
11	Forest Fringe Communities	Chiefs/heads	Sustained flow of benefit
12	District Assemblies	Chief executive/heads	Equitable sharing of proceeds
13	Environmental Protection Agency	Directors/heads	Environmental protection
14	Forest Research Institutions	Head/researchers	Education and research
15	Non Government Organization (NGOs)	Heads/leaders	Awareness and education
16	Ministry of Tourism	Minister/directors	Sustainable tourism
17	Ministry of Science and Environment	Minister/directors	Environment and technology
18	Tertiary Institutions (Universities)	Faculty heads/students	Education and research

Source: Based on field data returned responses, 2008.

The questionnaires, among other issues, probed for answers with regards to whether there are enough institutions in place, do they have the necessary logistics, financial support, are they enough and efficient? From the fieldwork, returned responses established that there are enough institutions to manage and support sustainable forest management (table 6.6.8b) programs. These are the Forestry Commission and its subsidiaries, Government Ministries (Lands and Forestry, Science and Environment, Tourism), the Environmental Protection Agency (EPA), Tertiary institutions (Universities), Forest Research Institutes, Regional Coordinating Councils (RCCs), District Assemblies (DAs), and Non-Governmental Organizations (NGOs). The data is collaborated by additional information (Gyasi et al., 2003; Tachie-Obeng E, & Agyeman-Bonsu

W 2005; Ghana Gazette, 2000a; Birikorang & Rhein, 2005; Kasanga & Kotey, 2001) which established that a maximum threshold limit of 18 institutions or setups are needed to optimize management targets. The data also determined a minimum threshold level of 8 institutions (Birikorang & Rhein 2005; Kasanga & Kotey, 2001) below which management of the resources will be thrown out of equilibrium. Desired results may not be achieved. However the actual number of institutional setups, according to FAO (2005) and Kasanga & Kotey (2001), that deals with the day to day management and implementation of programs were identified to be 13 (table 6.6.8a). Since a maximum number of 18 institutions would be a desired mark, *formula 6.1* is use for the scale conversion as;

$$\left(\frac{AP_l - MinT_{lmt}}{MaxT_{lmt} - MinT_{lmt}} \right) \times 100 =$$

Where; $\mathbf{Ap_l} = 13$, $\boldsymbol{MinT_{lmt}} = 8$, $\boldsymbol{Max.T_l} = 18$

$$\left(\frac{13 - 8}{18 - 8} \right) \times 100 =$$

$$0.5 \times 100 = 50$$

The indicator scores 50 points and identifies its actual position on the scale within the transitional zone (table 6.6.8b).

Table 6.6.8b Position of indicator 6.6.8 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Adequate institutions
Good	Desired sustainability	81-100	21and over
OK	Potentially sustainable	61-80	16-20
Medium	Transitional performance	41- 60	11-15 *(Ap_l= score 50)*
Poor	Potentially unsustainable	21-40	*6-10*
Bad	Unsustainable	1-20	1-5
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Apl =actual performance level

6.6.9 Extent of domestic wood demand by volume

Indicator 6.6.9 assesses extent to which total domestic demand for wood will be met and sustained towards satisfying economic growth and development targets (vision 2015) within the context of maintaining ecosystem health and vitality. The indicator is analyzed based on statistics provided by table 6.6.9a and on the premise that global demand for tropical sawn wood is going to increase by an average of 2.6% by the year 2015 (FC, 2006; ITTO, 2002). If Ghana`s high forest zone is to maintain its percentage share of 2.2 (FC, 2006; Agyarko, 2003) to annual global output (tropical woods) then, all other things being equal, a total volume of 1.563,000 cubic metric tons (FAO, 2005) would be needed annually by 2015 to satisfy domestic demand at a recovery rate of 35% (FC, 2006).

Table 6.6.9a Projected future demand for wood by the domestic economy

Wood demand in Ghana (by sector)	Projected annual demand (m^3)	Volume by 2015 (million m^3)
Housing and construction	522,000	1.116
Mining	63,000	0.063
Energy and Power	345,000	0.345
Fishing	1000	0.023
Transport and Service sectors	13,000	0.013
Art and Craft	2,000	0.002
Total demand for wood (domestic)	**946,000**	**1.563,000**
Demand for export		950,754m^3
Total Demand for log (domestic+export)		2,513,754 m^3 / yr.
Annual Allowable Cut (AAC)	1.2million m^3	1.2million m^3
Total demand deficit	-	1.3m m^3
Demand deficit (domestic)	-	363, 000m^3
Population growth rate	-	2.7%

Source: Based on FAO, 2006; FAO, 2005b; ITTO, 2002; Agyarko, 2003

From the data (table 6.6.9a) maximum threshold level for domestic wood demand necessary to meet development targets was determined at 2,513,754 m^3 (FC, 2006; Forestry Commission, 2006). This figure also happens to be total future domestic demand plus exports (table 6.6.9a). The annual sustainable cut permissible by the forest management body (Forestry Commission) was set at 1,200,000m^3. However, with an expected increase in demand, actual future demand was determined at 1,563,000m^3 (table 6.6.9a) likely to create a back log of 363,000m^3. The minimum threshold limit below which the resource base will be negatively impacted was determined at 946, 000m^3 (table 6.6.9a). Since maximum value in this case will signify bad performance and minimum value otherwise, *formula 6.2* is used for the scale conversion as;

$$1 - \left(\frac{Ap_l - MinT_{lmt}}{MaxT_l - MinT_{lmt}} \right) \times 100 =$$

Where; $\mathbf{Ap_l} = 1.563{,}000$ $\boldsymbol{MinT_{lmt}} = 946{,}000$ $\boldsymbol{Max.T_l} = 1{,}200{,}000$

$$1 - \left(\frac{1{,}563{,}000 - 946{,}000}{1{,}200{,}000 - 946{,}000} \right) \times 100 =$$

$$1 - (0.28) \times 100 = 72$$

The indicator scored 72 points and registered its presence on the scale within the potentially sustainable segment as depicted by table 6.6.9b.

Table 6.6.9b Position of indicator 6.6.9 on MoFRUSS

BoS Band	MoFRUSS segment	Point on Scale	Future domestic wood demand
Good	Desired sustainability	81-100	1,000,004-1,250,004 and over
OK	Potentially sustainable	61-80	750,003-1,00,003*(Ap_l= score 72)*
Medium	Transitional performance	41- 60	500,002-750,002*)*
Poor	Potentially unsustainable	21-40	250,001-500,001
Bad	Unsustainable	1-20	0-250,000
Base	Base of MoFRUSS	Base of Scale	Base of Scale

Apl =actual performance level

6.7 WEIGHTED INDICES

All indicator scores under the 3-tier thematic category (*environment, society, economy*) are tallied. They are combined and the sum total of the indicator scores under each specific thematic group (table 6.7.1, table 6.7.2, table 6.7.3) are imputed to arrive at weighted indicator indices (table 6.7.4) which are fed into the measure of forest resource-use scale (figure 6.8.1). Results exhibited on the scale (MoFRUSS) paints a graphic picture of what is actually happening on the ground with regards to managing the resources, extent of progress and in which direction it is moving. Stakeholders can then make decisions and take holistic policy actions towards pursuing sustainable development progress within the forestry sector. The resultant thematic categories, indicators and indicator scores are explained further into details supported by the tables below;

6.7.1 Environmental Health and Vitality Indicator Scores

Ten (10) indicators were identified and assessed under this criterion *(environmental health and vitality)*. Selection and adoption of the indicators were based on the methodology already explained under chapter 5.3. The indicator scores are summarily outlined below with a cumulative score of 454 points (table 6.7.1). The highest score point (97 points) was accumulated under indicator 6.7.1.3 -*'Habitats and population levels for known forest species at risk`*

Table 6.7.1 Environmental health and vitality indicator scores

Criterion	Nr.	Indicators	Scores
Environmental health & vitality	6.7.1.1	Extent of area by forest type	19
	6.7.1.2	Extent of eco-regions in protected area	80
	6.7.1.3	Habitats and population levels for known forest species at risk	97
	6.7.1.4	Mean annual increment of resources	61
	6.7.1.5	Extent of natural area disturbed (logging, fire, insects, diseases)	32
	6.7.1.6	Extent of area harvested using good tree technology	51
	6.7.1.7	Extent of primary forest	22
	6.7.1.8	Extent of the use of appropriate tree technology	43
	6.7.1.9	Extent of natural forest	05
	6.7.1.10	Net mass carbon per unit area accumulated in the HFZ	44
	Total		**454**

Source: Based on field data analysis, 2008

and the lowest score point (05 points) was scored by indicator 6.7.1.9 -*'extent of natural forest'*. With the exception of indictors 6.7.1.1 (19 points), 6.7.1.5 (32 points), 6.7.1.7 (22 points), 6.7.1.8 (43 points), 6.7.1.9 (05 points) and 6.7.1.10 (44 points), all other indicators under this criterion performed above the average mark (table 6.7.1).

6.7.2 Societal Well-being Indicator Scores

Under this criterion, *(Societal Well-being)*, ten (10) indicators were also selected and adopted for analysis based on the stakeholder multi-criteria methodology discussed under chapter 5.3. The indicator scores are summarized for data input as gleaned below (table 6.7.2). The criterion scored a total of 411 points with indicators 6.7.2.1 (No. of households that depend on forest as sources of fuel-wood), 6.7.2.2 (number of households with forest–based employment) and 6.7.2.3 (access to environmental information), 6.7.2.8 (adequacy of professionals to manage resources) and indicator 6.7.2.10 (extent of control over management of forest resources) scoring either the average mark (50 points) or over and above the average mark (table 6.7.2).

Table 6.7.2 Societal Well-being indicator scores

Criterion	Nr.	Indicators	Score
Societal Well-being	6.7.2.1	No. of households that depend on forest as sources of fuel-wood	50
	6.7.2.2	Number of households with forest–based employment	62
	6.7.2.3	Access to environmental information	61
	6.7.2.4	Degree of community participation in forest management	13
	6.7.2.5	Equitable sharing of forest proceeds (stumpage)	27
	6.7.2.6	Extent of area under plantation	20
	6.7.2.7	Employment in each forest based activity	13
	6.7.2.8	Adequacy of professionals to manage resources	58
	6.7.2.9	Extent of area considered for special management provisions	27
	6.7.2.10	Control over management of forest resources	80
		Total	**411**

Source: Based on field data analysis, 2008

In this case the highest score point is attributed to indicator 6.7.2.10 which scored 80 points and performed creditably well on the scale within the upper mark of the potentially sustainable

segment (table 6.5.10b).The rest of indicators scored points far below the average mark. The lowest mark(s) were registered by indicators 6.7.2.4 (13 points) and 6.7.2.7 (13 points). They performed poorly on the measure of forest resource-use sustainability scale.

6.7.3 Economic growth and development indicator scores

Under economic growth and development criterion (table 6.7.3) nine (9) instead of ten (10) indicators were selected, adopted and considered for this analysis following the same procedure already discussed above (chapter 5.3). This was to test the pre-assumption that economic indicators performed better than the other indicators because previous management policies were all directed towards economic gains. The end result proved this to be the case as only two of the measuring variables (indicator 6.7.3.5 and 6.7.3.7) scored points far below the average mark. The third indicator (indicator 6.7.3.4) which performed abysmal only missed the average mark by only one point. All other indicators performed creditably well with both score points and their positions on the scale. The criterion (*economic growth and development*) registered a total of 493 cumulative points as depicted by table 6.7.3 below.

Table 6.7.3 Economic growth and development indicator scores

Criterion	Nr.	Indicators	Score
Economic growth & development	6.7.3.1	Contribution to gross domestic product	63
	6.7.3.2	Extent of area available for timber production	80
	6.7.3.3	Extent of *Eco*- regions conserved for recreational activities	95
	6.7.3.4	Contribution to employment levels	49
	6.7.3.5	Number of timber related industries	22
	6.7.3.6	Degree of land tenure and property rights	51
	6.7.3.7	Extent of financial commitment towards SFM	11
	6.7.3.8	Number and adequacy of institutions to support SFM	50
	6.7.3.9	Extent of domestic wood demand	72
		Total	**493**

Source: Based on field data analysis, 2008

Weighted indices are then calculated for each thematic group by summing up the cumulated mean indicator scores and dividing the resultants by the total number of variables considered

under each thematic category. Following the order, as presented by table 6.7.4 below, environmental vitality indicators scored 45.4 points, societal well-being indicators scored 41.1 points and economic growth and development indicators scored 54.8 points.

Table 6.7.4 Weighted indices

Thematic Criteria					
Environmental health & *Vitality*(Env_{vt})		**Societal Well-being** (sty_{wb})		**Economic growth & development** (Eco_{gd})	
Indicators	∑ *mean Score*	*Indicators*	∑ *mean score*	*Indicators*	∑ *mean score*
6.7.1.1	19	6.7.2.1	50	6.7.3.1	63
6.7.1.2	80	6.7.2.2	62	6.7.3.2	80
6.7.1.3	97	6.7.2.3	61	6.7.3.3	95
6.7.1.4	61	6.7.2.4	13	6.7.3.4	49
6.7.1.5	32	6.7.2.5	27	6.7.3.5	22
6.7.1.6	51	6.7.2.6	20	6.7.3.6	51
6.7.1.7	44	6.7.2.7	13	6.7.3.7	11
6.7.1.8	22	6.7.2.8	58	6.7.3.8	50
6.7.1.9	43	6.7.2.9	27	6.7.3.9	72
6.7.1.10	05	6.7.2.10	80	-	-
Total	***454***	**Total**	***411***	**Total**	***493***
Weighted Score	**454÷10=45.4**	**Weighted Score**	**411÷10=41.1**	**Weighted Score**	**493÷9=54.8**

Source: Based on field data analysis, 2008

6.8 PRESENTATION OF RESULTS ON THE SCALE (MoFRUSS)

The weighted indicator scores from table 6.7.4 (45.4 points, 41.1 points, and 54.8 points) are imputed into the measure of forest resource-use sustainability scale (MoFRUSS) to paint a clear picture of the actual performance of measures of successes towards sustainable forest management situation on the ground. A higher score is indicative of desired successes towards sustainable forest management performance. A lower score depicts otherwise. All indicators are assumed to be statistically reliable with a 0.5% degree margin of error.

6.8.1 Environmental health and vitality dimension (Env_{vt})

Out of the ten (10) indicators analysised under this criterion four (4) scored points equal to, marginally greater or far over and above the 50th mark necessary to put it within, at least, an appreciable performance level (transitional zone) for a developing country. However, the relatively poor performance of the other indicators presented a weighted index of 45.4 points which registers actual performance of the criterion within the mid-section of the transitional segment of the scale (figure 6.8.1).

6.8.2 Society well-being dimension (Sty_{wb})

Comparatively, society well-being indicators showed a dip in improvement in individual score points than the former. Five (5), out of the ten (10) indicators (6.7.2.1, 6.7.2.2, 6.7.2.3, 6.7.2.8, 6.7.2.10) either made the 50th mark or passed it. The weighted indicator score of 41.1 points, however, was only strong enough to put it at the inception of the transitional zone point. This seems to confirm widely held assertions that societal well-being indicators have not performed any better than that of environmental indicators because of the much dependence on the resources base by forest communities (figure 6.8.1).

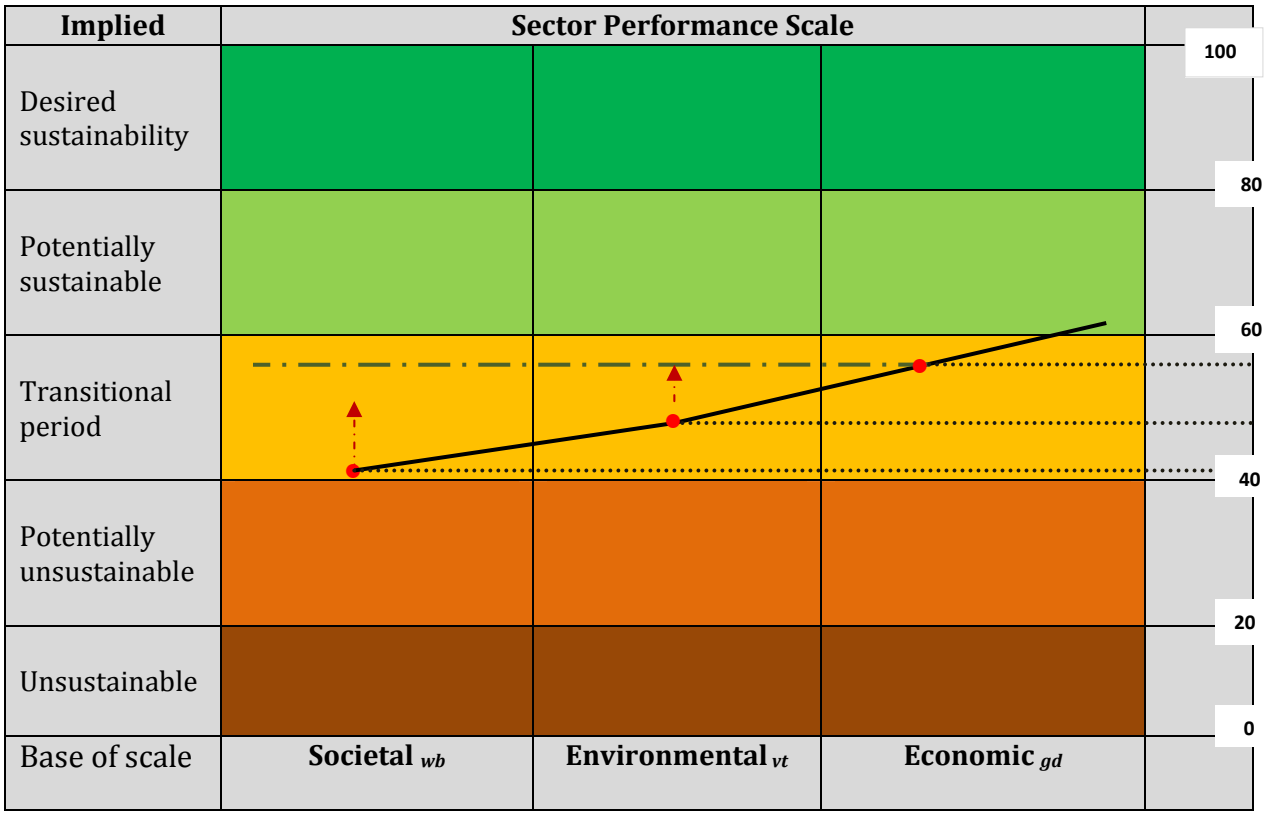
6.8.3 Economic growth and development dimension (Eco_{gd})

With the exception of indicators 6.7.3.4, 6.7.3.5 and 6.7.3.7, which scored points below the average mark (49, 22 and 11 points respectively), as presented by table 6.7.3, all other indicators under this category scored appreciable marks leading to a cumulative score of 493 points and a

mean weighted index of 54.8 (table 6.7.4). It registers an impressive position within the upper limits of the transitional zone on the measure of forest resource-Use Sustainability Scale (figure 6.8.1). One of the likely explanations to this may be linked to the fact that until the mid-nineties policies with regards to resource management were all economic centred. The quest for a progressive economic growth and development during the economic recovery program in the 1980s, although improved the national vault, caused an extensive damage to the resource base (Nunoo, 2007). It also exemplifies a clear case for *harvesting the capital of the forest stock* with serious environmental consequences.

From the foregoing analysis, and as depicted by the Measure of Forest Resource-Use Sustainability Scale by figure 6.8.1, measures of successes towards sustainable forest management in Ghana over the last two (2) decades has not achieved the desired sustainable level (desired sustainability). However with weighted cumulative index skewed towards the centre of the scale it can be concluded that extent to which progress towards SFM has been achieved so far translates to the transitional period.

Figure 6.8.1 MoFRUSS showing extent of progress towards sustainable forest management in Ghana



7.0 POLICY IMPLICATIONS

Policy deductions associated with achievements in this region (transitional performance zone) are enormous in that the transitional period (safe zone), once reached, become a launching pad for decision makers to either concretize efforts so far made (launch into the potentially sustainable zone) or negates all efforts (fall back in the potentially unsustainable zone) achieved.

From the conceptual model it is established that equilibrium will occur in the sustainability arena if all 3-tier sector (society, ecosystem, environment) indicators rises (becomes positive) or has the potential to rise to the same level as exemplified by the *equation* below;

$$SFM \equiv Sd = f\,(+Eco_{gd}, + Sty_{wb}, + Env_{vt}) \quad \rightarrow \quad \textit{Indif sfm c}\text{urve } \mathbf{Z} \textit{ at point } U \text{ (see figure 3.1)}$$

That is from the equation sustainable forest management *(SFM)* equilibrium, which is synonymous with sustainable development *(Sd)*, is established with rising (positive) economic growth and development indicators, rising (positive) societal well-being indicators and rising (positive) environmental health and vitality indicators.

This situation can be achieved through capital substitution or shifting of resources from one sector to the other in the form of compensations. With reference to the indicator results (table 6.7.4) such compensation should be made from the economic sector to that of environment and fringe forest communities in order to keep them apar. In other words, the present conditions or levels of societal well-being and environmental health and vitality must be raised to that of Economic growth and development through policy interventions that have Environmental issues and societal well-being as top priority.

Again the conceptual model (figure 3.2) postulates 7 bundles of policy baskets for decision makers. To tackle the issue of raising societal well-being and ecosystem vitality levels as presented by the *measure of forest resource-use sustainability scale*, bundles of policy basket six (6), which has ecosystem and societal well-being as its policy direction and a *socio eco-economy* as the possible policy outcome (table 3.1), should be pursued.

7.1 THE SOCIO *E*CO-ECONOMY

A forest management policy with a forest *ecosystem* + *society* (table 3.1) goal to achieve is one purported to, whilst encouraging forest communities to maximise resource–use to improve standards of living on the one hand, on the other, commits such communities to be mindful of the forest ecosystem's ability to sustain itself over the next reasonable period of time through the collaborative efforts of all stakeholders. The policy's strategies for enjoying a *socio eco*-e*conomy* are, *inter alia*:

1. Instill collective institutional management discipline and review legislative instruments to foster due diligence to ensure effective and smooth running of stakeholder administrative machinery.

2. Promote public education and participatory forest community's involvement in forestry and wildlife conservation through modernized agriculture (Sustainable agriculture).

3. Encourage community and private sector involvement (participation) in commercial plantation development, usage of lesser known timber species and non-traditional timber products.

4. Ensure competitive bidding for Timber Utilization Contracts (environmentally friendly) to transform the timber industry into a low volume but a high quality one (processing for both domestic and exports).

5. Enforce strict adherence to resource harvesting standards and enforcement of annual allowable cut (AAC).

6. Allow for the price mechanism to determine prices of forest products and ensure an effective revenue generation and equitable distribution among stakeholders.

7. Establishment of databases and information linkages to facilitate decision making and policy analysis.

8. Subscription to global initiatives towards natural resource conservation and climate change mitigations.

7.2. OPPORTUNITY FOR IMPROVEMENT

An opportunity for improvement associated with the model employed for the research, which policy makers could explore to effectively achieve stated objectives, mentioned above, is embedded in the concept of avoided deforestation. When the concept is properly implemented avoided deforestation could;

i. Minimize deforestation and sustain annual timber yields through implementation and enforcement of harvesting standards and threshold. This could safeguard biodiversity and preserve other ecosystem services.

ii. Mobilize financial support and other needed logistics to forest communities as means of diversifying their stereotype subsistence way of living. This could improve living standards by way of employment.

iii. Satisfy obligations under Article 4.1(a) of the UNFCCC treaty by helping to fight climate change at a relatively minimum cost.

Tropical forests as sinks have the potential to sequester carbon dioxide (CO_2) over longer periods. About two thirds of global terrestrial carbon is sequestered through standing forests. Through sinks (process of photosynthesis) plants transform CO_2 from the atmosphere into the biotic system. The dynamics involved make forest sinks useful media for off-setting green house gas (GHG) emissions to combat climate change.

However deforestation, which is the removal of forest (through agricultural activities, grazing, fuel-wood gathering, lumbering, wildfire, construction and illegal tree harvesting) militate against Sustainable Forest Management. Through such activities carbon is released into the atmosphere contributing to one one-fifth of annual greenhouse gases emissions.

7.2.1 Avoided Deforestation

Avoided deforestation, according Sedjo et al., (2000) is reducing damaged CO_2 that would have accumulated in tropical forests to offset GHGs emissions limit under the Kyoto protocol.

Nevertheless as much as the Kyoto protocol recognize forest as sinks to mitigate CO_2 emission levels the Kyoto agreement does not recognize conscious efforts undertaken by tropical countries to reduce national rates of deforestation as stipulated under article 4 section 8c, and article 6.1b and 6.1d of the convention.

From the analysis made so far above the study identified avoided deforestation as a key aspect of measures of successes towards Sustainable Forest Management operations which could be tapped as an opportunity for improvement. Desktop studies established a daily deforestation rates in tropical countries at 86,000ha. In the case of Ghana annual loss is pegged at 65,000 hectares. Cost of environmental degradation (Morgan, 2007) to the economy of Ghana is estimated at 10 percent (10%) of Gross Domestic Product.

7.2.2 Prospects of Avoided deforestation

This research presents a case under *'avoided deforestation'* by which progress towards SFM at the national level could become a reality. So far the research have established that over the last two decades measures (tables 4a, 4b & 4c) towards Sustainable Forest Management have succeeded in putting these structures in place;

a. A Sustainable Development Initiative to raise standards of living to that of a middle income status by the year 2015 as captured in its vision 2015 document and in accordance to Article 3, section 4 of the UNFCCC.

b. A National Policy for the judicious utilization of and sustainable management of natural resource (The 1994 Forest and Wildlife Policy).

c. Re-structured all forest resource management establishments and agencies, which hitherto were non-performing, under one umbrella, now efficient and up to the task called the Forestry Commission.

d. Established standards and thresholds for harvesting timber products from the forest

e. Established Principles, Criteria and Indicators for certification of forest products and working towards Sustainable Forest Management initiatives.

d. Encouraged competitive bidding for timber utilization contracts and the extraction of timber products.

e. Established a much more realistic and acceptable annual allowable timber cuts (AAC) which currently stands at 1.2million m^3

f. Established a mechanism for equitable disbursements of forest proceeds (stumpage) among stakeholders.

These measures have succeeded in reducing deforestation rates (table 7.1) drastically over the two–decade period (1980-2010). Forest resource-use has been a way of life among Ghanaian communities. The degree of association however varies across the ecological zones with a greater emphasis on rural areas.

Timber exploitation for commercial purposes became an integral part of the economy since the colonial era. Extraction, according to Senamede (1995), reached its phenomenal apex during the Economic Recovery Programme (ERP) in the early 1980s where logging was perceived by the government to be a panacea for resuscitating a virtually battered economy. Just over a decade of the inception of Economic Recovery Programme deforestation rates doubled from 60,000 hectares to 120,000 hectares (Larsen, 2006) with an increasing marginal deforestation rate pegged at 34 by 1990 (table 7.1). Although it raked in some immediate needed assistance in terms of giving a facelift to the national coffers (GDP) in absolute terms, it left behind devastating ecological footprints for the future generation. Cost to environmental damage is yet to be fully recovered.

Table 7.1 deforestation rates in Ghana from 1980-2010

Period	1980	1985	1990	1995	2000	2005	2010
Deforestation rates (000ha/yr)	60	86	120	135	138	115	65*
Marginal deforestation rates	0	26	34	15	3	-23	-50*

Source: Based on field data analysis, 2008; * Projected figures.

By early 1990 concerns for environmental care had become a global cry and therefore embracing Sustainable Forest Management principles in Ghana necessitated the 1994 wildlife and forest policy (Nsiah-Gyabaah, 1994). This conscious initiative to manage resources on sustainable basis paid off. Data analysis show that between the period 1990 and 2000 deforestation rates were still of concern to policy makers but was increasing at a decreasing rate. Over the same period additions to increase (marginal rates) decreased from 34 to 3 (table 7.1). By 2005 marginal rates of deforestation had recorded negative digits (-23) and it is projected that by the end of the era under study (2015) this figure will be stable around -50 or less as shown in figure 7.1.

7.2.3 How Much Land Will this Translate to?

Considering the period between 1995 and 2005, with the former as the base year, avoided deforestation will correspond to 20,000 hectares of land (figure 7.1) over the ten year period and expressed as;

$$(d_l baseyr - d_l currentyr) =$$

Given $d_l$baseyr =135,000 and $d_l currentyr = 115{,}000;$ from table 7.1

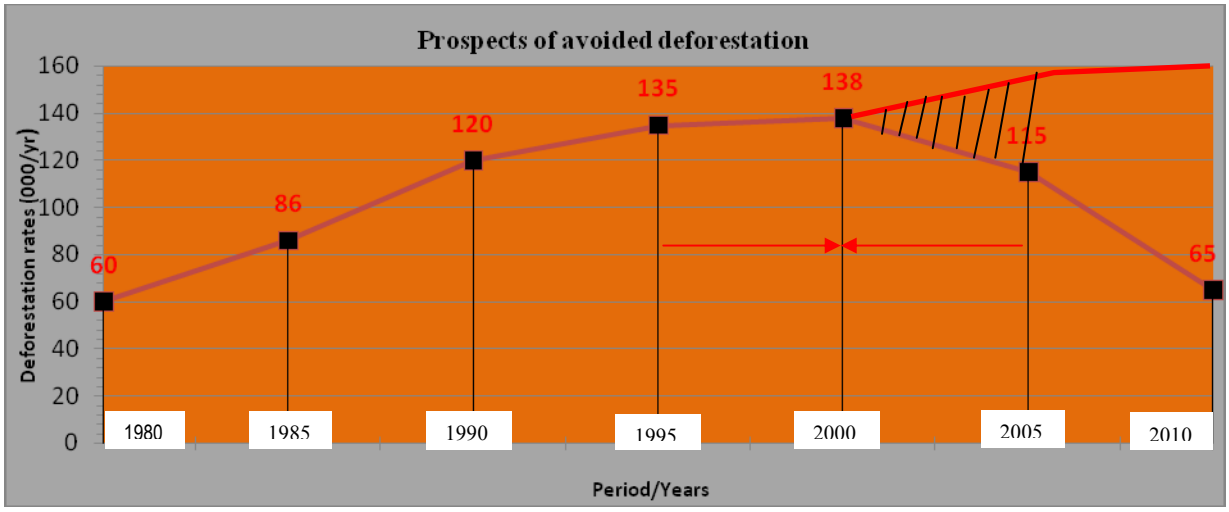
$$135{,}000 - 115{,}000 = 20{,}000$$

Where;

a. $d_l baseyr$ is deforestation level at base year

b. $d_l currentyr$ is deforestation level at current year

Figure 7.1 Prospects of avoided deforestation, 1980-2010



Source: Field data analysis, 2008

7.2.4 How Much Damaged Carbon will this Represent?

The study also established that a hectare of undisturbed tropical forest on the average harbours about 140 metric tons of carbon (140mtc) in above-ground biomass and about 64 metric tons (64mtc) of carbon in below-ground biomass. It implies therefore that over the same period under consideration avoided deforestation could mitigate;

a. $20,000 \times 140 = 2,800,000$ metric tonnes of carbon on the higher side and;

b. $20,000 \times 64 = 1,280,000$ metric tonnes of carbon on the lower side.

7.2.5 How much Money will this Quantify?

The economic argument for avoided deforestation is how much this translates into quantifiable monetary terms. From the statistical data (table 7.1), and given a world market price of 17 euros (Point carbon, 2008 market price) per metric tonnes the following scenarios will persist;

a. On a high side avoided deforestation could generate $2,800,000 \times 17 = 47,600,000 euros$ over the period under review.

b. On a low side avoided deforestation could generate $1,280,000 \times 17 = 21,760,000 euros$ over the same period.

From the foregoing examination, opportunities associated with measure of successes towards SFM as identified under the case of avoided deforestation presents some laudable prospects. Avoided deforestation could form the legal basis for tropical countries to make a case for carbon financing under the Kyoto protocol. It could also mitigate against damaged carbon from adding up to GHG emissions in the atmosphere, minimize desertification and channel inflow of hard currencies from developed countries to tropical countries. This could motivate tropical countries, especially forest communities within the region to do more in saving forest resources from destruction.

8.0 CONCLUSION AND RECOMMENDATIONS

It is evident from the research that, so far, sustainable forest management is the best contribution forestry as a discipline can inject into *sustainable development agenda's* of countries that depends so much on the natural resource base. This impetus stems from the fact that;

a. development, in which ever form it may take, has the tendency to erode environmental resources

b. degradation of environmental resource has reached critical levels that calls for global attention and remedies.

c. the need to tackle management of resources-use on sustainable basis should be approached from participatory perspective where all stakeholders, especially forest communities are identified and acknowledged with all the seriousness it deserves (adoptive management).

Attempt at measuring progress towards sustainable forest management in the high forest zone of Ghana by the criteria and indicator prognosis, the first quantitative assessment of this kind, have also established that although natural resource policies and management working documents exists, the focus has all along been on management of the resources for *increased yields* (economic gains) with little or no regards to environmental implications and societal well-being considerations. The measure of successes performance operations, which this study undertook actually confirmed that sustainable forest management initiative in the high forest zone has not achieved the desired sustainability results. However, since its inception, some credible gains have been made after subscribing to the following principles;

a. A pro-active sustainable development initiative to raise national standards of living to that of a middle income status by the year 2015 as captured in its 'Vision 2015' document and in accordance to Article 3, section 4 of the UNFCCC.

b. A National policy for the judicious utilization of and sustainable management of natural resource (The 1994 Forest and Wildlife Policy).

c. Restructuring of all forest resource management establishments and agencies, which hitherto were non-performing, under one umbrella. They are now assumed to be efficient and up to the task, operating under the Ghana Forestry Commission.

d. Established standards and thresholds limits of significance for harvesting timber products from the forest.

e. Established Principles, Criteria and Indicators for certification of forest products and working towards Sustainable Forest Management initiatives.

d. Encouraged competitive bidding for timber utilization contracts and the extraction of timber products.

e. Established a much more realistic and acceptable annual allowable timber cuts (AAC) which currently stands at 1.2million m^3

f. Established a mechanism for equitable disbursements of forest proceeds (stumpage) among stakeholders.

In response to the question 'in which direction success is being made towards sustainable management of her resources?', the study also reveal that weighted indices from the trio sector grew appreciably within the first thematic group (environmental health and vitality) with 45.4 points and dipped to the lowest (41.1 points) within the societal well-being segment and picked up again creditably well within the last thematic group (economic growth and development) scoring a total of = 54.8 points with the cumulative index registering a position skewed towards the upper limits within the transitional performance region of the *Measure of Forest Resource–Use Sustainability Scale*(see table 6.7.4, figure 6.81).

Here management`s efforts could be rewarded immensely if the right bundle of policy basket, one which has *Ecosystem and Societal Well-being* as its policy direction and a *Socio Eco-economy* as the possible policy outcome (table 3.1) is adopted and pursued towards establishing a sustainable equilibrium.

An important opportunity associated with the measure of successes operations towards sustainable forest management and this policy option is *avoided deforestation.* This scenario presents a platform where in taking proactive measures in reducing national deforestation rates it could also be used to make a case for soliciting for carbon financing incentives under the Kyoto protocol green house gases (GHGs) mitigation package against clear timber cutting. Sustainable forest management initiatives could also channel inflow of funds from the developed countries to tropical countries for keeping their forests and help minimize desertification.

Measuring progress towards sustainable forest management by the criteria and indicator prognosis is laudable in that it allows for data base to be built which could be useful in tracking and monitoring progress of forest management initiatives. It also makes it possible to see the actual extend of achievement on the ground and calls for collaborative management initiatives. Use of the *Measure of Forest Resource-Use Sustainability Scale* (MoFRUS) clearly depicted three dimensions of sustainability; ecosystem, society and the economy making it relatively easier for managers and stakeholders to locate and examine issues separately and where to focus attention most when the need arises.

However, carrying out this research was met with a number of challenges with the first being selection of indicators and adoption of applicable ones since a wide range of indicators existed for this exercise. The task was therefore to make sure the right indicator sets needed to achieve desired results were chosen with minimum subjectivity. The second limitation was availability and reliability of data on indicator sets. For a fair assessment there should be reliable and readily available data on all indicators accepted as applicable. However in the case of this research only 29 indicators out of the 52 indicators identified had data on its measurable parameters. The outcome of this research is therefore indicative of the available information. Other issues confronted had to do with the unwilling attitude of heads of state institutions in giving out information to researchers (who are often perceived as *strangers*), limited time frame and financial constraints.

Nevertheless, this exercise will serve as a baseline studies for future researches within the same discipline, especially in strengthening data base for monitoring progress towards sustainable forest management within tropical forests. It will also be useful for government officials responsible for making decisions on natural resource management, to academicians and resource persons. I will also recommend that future studies that will be built on this work will also focus

much more attention on working compensations mechanisms in quantifiable terms in order to restore equilibrium when the sustainable forest management equilibrium is shattered.

9.0 REFERENCES

Aaron Cosbey, 2004. A Capabilities Approach to Trade and Sustainable Development: Using Sen's Conception of Development to Re-examine the Debates International Institute for Sustainable Development. International Institute for Sustainable Development and the Swiss Agency for Development and Cooperation. November, 2004. Winnipeg, Manitoba- Canada.

Achard F, H D Eva, P Mayaux, H J Stibig and A Belward, 2004. Improved estimates of net carbon emissions from land cover change in the tropics for the 1990s. *Global Biogeochemical Cycles* 18, GB2008, doi:10.1029/2003GB002142.

Adjei Kwabena, 1994. Minister for Lands and Forestry. Forest and Wildlife Policy. Processes of Implementation in Global Forestry. A paper presented at the 39th Convention of the International Studies Association. Minneapolis Minnesota, USA. 17-21 March 1998.

Adriaanse A, 1993. Essential environmental information. Ministry of Housing, Physical Planning and Environment. The Hague, Netherlands.

Agyarko T, 2003. Forestry Outlook Studies for Ghana (FOSA). Ministry of Lands and Forestry. 2nd Draft, Accra.

Amanor K S, 2002. Indigenous knowledge in space and time in H Brookfield, C Padoch, H Parsons and M Stocking, (eds). Cultivating Biodiversity: Understanding, Analysing and Using Agricultural Diversity. ITDG Publishing. The United Nations University, London (2002). pp. 126–131.

Andreas Obers, 1998. Criteria and Indicators of Sustainable Forest Management and related Certification Schemes. Interorganizational Processes of Implementation in Global Forestry. Paper presented to the 39th. Annual Convention of the International Studies Association (ISA). Minneapolis, Minnesota, USA.

Anon, 1992. United Nations Conference on Environment and Development. Forest Principles. Report of the United Nations Conference on Environment and Development. Non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests. A/CONF.151/26 (Vol. III). Rio de Janeiro, 3-14 June 1992.

Antle J M and Capalbo S M, 2001. Econometric-process models for integrated assessment of agricultural production systems. *American Journal of Agricultural Economics* 83(2):389–401.

Armstrong G, 1995. Integrating policy: implementing organizational change. International Development Research Centre. Ottawa ON, Canada. 1995 pp.44.

Armstrong A T, 2008. Gold Strike in the Breadbasket: Indigenous Livelihoods, the World Bank, and Territorial Restructuring in Western Ghana. Institute for Food and development policy. First Development Report No. 18, April 2008.

Arnold J M, 1992. Community Forestry: Ten Years in Review. FAO Rome, Italy.

Asenso-Okyere K, 2001. `Transforming Agricultural production and Productivity for Sustained Rapid Growth and Development` in Ghana in the 21st Century. ISSER Millennium Seminar Series No.4 Institute of Statistical, Social & Economic Research-ISSER. Sept. 2001 Legon, Accra.

Asibey E O A and Owusu J G K, 1982. The case for high-forest national parks in Ghana. *Environmental Conservation*, 9(4), 293–304.

Avoka C, 1998. Interview with H.E. Mr. Cletus Avoka, Minister of Lands and Forestry, Ministry of Lands and Forestry (MLF), Ghana. Tropical Forest Update, International Tropical Timber Organization (ITTO) Newsletter 8(4): 16.

Beattie Bruce R and LaFrance Jeffrey T, 2006. "The Law of Demand versus Diminishing Marginal Utility". *Review of Agricultural Economics*. 28 (2), pp. 263-271.

Benneh G and Agyepong G T, 1990. Land Degradation in Ghana. Commonwealth Secretariat, University of Ghana, 1990 Accra.

Berkes F, Colding J and Folke C, 2000. Rediscovery of Traditional Ecological Knowledge as Adaptive Management. *Ecological Applications* 10 (5): 1251-1262.

Birikorang Gene, Bird Neil and Timothee Fomete, 2006. Ghana's experience in timber verification system design. Kumasi.

Birikorang Gene and Matthias Rhein, 2005. Reforming Ghana's Forest Fiscal Regime. Draft Status Report-Phase1. March 2005. Forest Sector Development Project, Forestry Commission, Accra.

Braatz S, 2002. National reporting to forest-related international instruments: mandates, mechanisms, overlaps and potential synergies. Secretariat of the United Nations Forum on Forests, New York.

Brinker Klaus, Johannes Fürnkranz, and Eyke Hüllermeier, 2006. A unified model for multilabel classification and ranking. In Proceedings of the 17th European Conference on Artificial Intelligence (ECAI-06), 2006.

Bromley D W, 1991. Environment and Economy: Property Rights and Public Policy. Blackwell Press, Oxford, UK.

Beattie Bruce R and LaFrance Jeffrey T, 2006. "The Law of Demand versus Diminishing Marginal Utility". *Review of Agricultural Economics*. 28 (2), pp. 263-271.

Bromley Daniel, David Feeny, Margaret McKean, Pauline Peters, Jere Gilles, Ronald Oakerson, C Ford Runge and James Thomson (eds.), 1992. Making the Commons Work: Theory, Practice and Policy. San Francisco, CA: ICS Press.

Brown S, 2001. Measuring carbon in forests: current status and future challenges. *Environmental Pollution*, 116: 363-372.

Bryant D, Nielsen D and Tangley L, 1997. The Last Frontier Forests: Ecosystems and Economies on the Edge. World Resources Institute, Washington DC, USA.

Buongiorno J and Gilles K, 2003. Decision Methods for Forest Resource Management. Elsevier Science (USA).

Bussolo et al., 2007. Challenges to MDG achievement in low income countries: lessons from Ghana and Hondura**s.** The World Bank Development Economics Prospects Group USA Nov. 2007.

CAB International, 2001. Criteria and Indicators for SFM. (Eds). Raison R.J., Brown A.G., Flin D.W. CAB International, Oxford, UK.

Cagliostro M, 2005. Intercriteria and indicators process collaboration workshop. A collaborative effort by the International Tropical Timber Organization (ITTO), the Ministerial Conference on the Protection of Forests in Europe (MCPFE), the Montreal Process, the Food and Agriculture Organization of the UN (FAO), the UN Economic Commission for Europe (UNECE) and the U.S. Forest Service. Bialowieza, Poland.

Castañeda F, 1998. Linkages between national and forest management unit levels criteria and indicators for sustainable forest management. CIFOR/FAO Fifth International Project Advisory Panel (IPAP) Meeting for CIFOR's Testing of Criteria and Indicators for the Sustainable Management of Forests. Rome, 25-27 March 1998.

Canadian Wood Council, 2005. Criteria and Indicators of Sustainable Forest Management, National Status 2005, Canadian Council of Forest Ministers, Natural Resources Canada.

CFMU, 1993. A strategy for the development of collaborative forest management in the High Forest Zone of Ghana. Collaborative Forest Management Unit (Planning Branch), Forestry Department, Kumasi – Ghana.

Cook P S and Laughlin J O, 1999. Towards SFM Part 1- Certification Programs. Idaho Forest Wildlife and Range Policy Analysis Group. University of Idaho.

Conservation International, 2005a Conservation International, 2005a. Biodiversity Hotspots: Hotspots by Region. http://www.biodiversityhotspots.org/xp/Hotspots/hotspots_by_region/ Assessed on 23rd June, 2008.

Collaborative Resource Management Units, 2005. Evaluation Report on Participatory Forest Management Project of the Forestry Commission, Accra.

Conservation International, 2005b. Conservation International, 2005b. Biodiversity Hotspots: Key Findings. Endemic Plant Species. http://www.biodiversityhotspots.org. Accessed on November, 2008.

Colchester M, 1990. The International Tropical Timber Organization: kill or cure for the rainforests? *The Ecologist*, 20(5), 166–173.

Colchester M, Sirait M and Wijardo B, 2003. Application of FSC Principles No. 2 and 3 in Indonesia – obstacles and possibilities. London, UK, Friends of the Earth Indonesia (WALHI), Alliance of Indigenous Peoples of the Archipelago (AMAN) and Rainforest Foundation.

Convention on Biological Diversity, 2000. Secretariat of the Convention on Biological Diversity, 2000. Sustaining Life on Earth: How the Convention on Biological Diversity Promotes Nature and Human Well-Being. Secretariat of the Convention on Biological Diversity, Montreal.

Conservation International, 2005a. Conservation International, 2005a. Biodiversity Hotspots: Hotspots by Region. http://www.biodiversityhotspots.org/xp/Hotspots/hotspots_by_region/ Assessed on August 2008.

CIA World Factbook, 2006. U.S Department of State Country Background Notes on Annual Cost of Environmental Degradation to Ghana.

CIA World Factbook, 2007. Polity IV Country Report 2007 on Ghana. The Library of Congress Country Studies. Online document, http://www.theodora.com/wfbcurrent/ghana/ghana introduction.html. Accessed on December 2008.

CICI, 2003. The International Conference on the Contribution of Criteria and Indicators for Sustainable Forest Management: the Way Forward (CICI-2003), Guatemala City in Februar, 2003.

Clark M M, Meller R D and McDonald T P, 2000. A three-stage heuristic for harvest scheduling with access roadnetwork development. *Forest Science,* 46.

Danks C M, 2000. Community participation in forest management: the role of social capital and organizational capacity in collaborative efforts in Trinity County, California. Berkeley, University of California, USA. (Ph.D. dissertation).

Dasgupta P, 1995. "Optimal development and the idea of net national product". In: Goldin I and Winters L A (eds). The economics of sustainable development Cambridge, Cambridge University Press.

Dawkins H C and Philip M S, 1998. Tropical moist forest silviculture and management: a history of success and failure. CAB International Oxford, UK.

DeFries et al., 2002. Carbon emissions from tropical deforestation and regrowth based on satellite observations for the 1980s and 90s. *Proceedings of the National Academy of Sciences* 99:14256-14261.

Dickson K B, 1969. Historical Geography of Ghana, Cambridge University Press, London. Page 344.

Dixon J A and L A Fallon, 1989. The Concept of Sustainability: Origins, Extensions and Useful -ness for Policy. *Society and Natural Resources* 2(2). p73-84, 1989.

Dwomoh D, 1990. Forest Conservation: The contribution of sacred groves. A study of Sekyere West District, Ashanti Region. Geography Department of the University of Ghana, Legon.

Elliot C, 2000. International Experts Meeting on the Role of Planted Forest in SFM. UNFF. Willington, New Zealand.

EPA, 1996. Environmental Protection Agency. Environmental Protection Agency at a Glance. Accra, Ghana.

EPA, 2005a. Ghana Environmental Impact Assessment Procedures. Environmental Protection Agency, Accra.

EPA, 2005b. Ghana. State of Environment Report 2004. Environmental Protection Agency, Accra.

EPA, 2005c. Third National Report to the Committee for the Review of the United Nations Convention to Combat Desertification. EPA, Accra.

EPC, 1976. Enviromental Protection Council. Traditional Approaches to Conservation: Sacred Groves in Ghana. Report prepared for the Environmental Protection Council, Accra.

Evans P, 1995. Embedded autonomy states, firms, and industrial transformation. Princeton, N.J., USA: Princeton University Press.

FAO, 2007. People, forests and trees in West and Central Asia, outlook for 2020. FAO Forestry Paper 152, FAO/Rome, Italy.

FAO, 2007a. State of the World's Forests, *2007*. FAO/Rome, Italy.

FAO, 2007b. People, forests and trees in West and Central Asia, outlook for 2020. FAO Forestry Paper 152, FAO/Rome, Italy.

FAO, 2006. Food and Agriculture Organization (FAO). A FAO Forestry Paper 147 Rome, Italy.

Forest Resources Assessment, 2005a. The IUCN's 2002 IUCN Red List of Threatened Animals and 1997 IUCN Red List of Threatened Plants. Kiran Dev Pandey, Piet Buys, Ken Chomitz, and David Wheeler's, "Biodiversity Conservation Indicators: New Tools for Priority Setting at the Global Environment Facility" (2006).

FAO, 2005b. Food and Agriculture Organisation of the United Nations. A National Report on the Forestry Policy of Ghana. FAO Forestry Paper No. 132 Rome.

FAO, 2002a. Expert meeting on harmonizing forest-related definitions for use by various stakeholders. Proceedings, Rome, 22-25 January 2002; Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO, 2001. Food and Agricultural Organisation of the United Nations. Use of C&Is for Monitoring Assessment and Reporting on Progress toward SFM in the United Nations Forum on Forests. Report prepared for the International Expert Meeting on Monitoring, Assessment and Reporting on Progress toward Sustainable Forest Management, November 2001.Yokohama, Japan.

FAO, 1998b. FAO YearbooK: Forest Products, FAO Forestry Series No.3, Food and Agriculture Organization of the United Nations. Rome, Italy.

FAO, 1997. State of the World's Forests. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO & UNESCO, 1987. "Soils of the World," Food and Agriculture Organization and United Nations Educational, Scientific and Cultural Organization, Elsevier Science Publishing Co. Inc., New York, NY.

FAO, 1995a. Model Code of Forest Harvesting Practice. Food and Agricultural Organization. Rome, Italy.

Feeny D, Berkes F, Acheson J M, 1990. The tragedy of the commons: 22 years later. *Human Ecology* 18:1-19.

FD, 1995a. Made in Ghana. Collaborative Forest Management. Prepared for XVIII Session of ITTC and XVI Session of Permanent Committees of the ITTO, 10 – 18 May 1995. Accra, Ghana.

FD, 1995b. Progress towards the achievement of the Year 2000 Objective. Ghana Forestry Department. August 1995, Accra.

FD, 1994. Interim measures to control illegal timber harvesting outside forest reserves. Recommendations of the Forestry Department Working Group on control of illegal felling outside forest reserves. Forestry Division (Planning Branch) of the Forestry Commission. September 1994, Kumasi – Ghana.

FD, 1993. A strategy for development of plantations in the High Forest Zone of Ghana. Forest Resource Management Support Unit (Planning Branch), Kumasi – Ghana.

FC (Forestry Commission of Ghana**)**, 2006. Ghana`s Forests: Reporting Progress. Timber Industry Development Division. Ghana Forestry Services, Accra.

Forestry Commission, 2004. The Forestry Master Plan, 199-2020. The Forestry Commission of Ghana, Accra.

Forestry Commission, 1998. Manual of Proceedings of Forest Resource Management Planning in the High Forest Zone. Section A - Strategic Planning, Accra.

FSDFC (Forest Services Division of the Ghana Forestry Commission)**,** 1999. Piloting Collaborative Forest Management Systems for Off-Reserve Areas in Southern Ghana. ITTO project PD 41/95 Rev.1 (F).

FIMP, 1994. Study of the implications of the protection proposals: Definitions of scenarios. Discussion paper No. 5. Forest Inventory Management Project, Planning Branch, Forestry Department, Kumasi – Ghana.

Gale R P and Cordray S M, 1994. Making sense of sustainability: nine answers to "What Should be Sustained?" *Rural Sociology.* 59: 311-332.

Gale R P and Cordray S M, 1991. What should forests sustain? Eight answers. *Journal of Forestry* 89(5), 31-36.

Ghana Statistical Service, 2004. The Republic of Ghana Statistical Service, 2004. Ghana Population Census 2000. Ghana Statistical Service, Accra.

Ghana Statistical Service, 2000. Population and Housing Census. Special Report on 20 Largest Localities. Medialite Co. Ltd. Accra.

Ghana Gazette, 2000. Field Testing. Newsletter about Ghana's timber industry, No. 18, May/June 2000.

Ghana Gazette, 1996. Tough proposals in forestry master plan. Newsletter about Ghana's timber industry, October 1996, p. 5.

Ghana Land and Forestry, 2005. Policy Support Facility, March 2005. Accra

Ghana Gazette, 2000a. The Co-ordinated Approach. Newsletter about Ghana's timber industry, No. 18, May/June 2000, p.1.

Ghana Gazette, 2000b. Certification Workshop. Newsletter about Ghana's timber industry, No. 19, August/September 2000, p.1.

Ghartey K K F, 1990. Results of the National Forest Inventory. Forestry Department. Planning Branch, Kumasi – Ghana.

GTMO, 2000. Effect of interventions in domestic log pricing on processing costs. Presentation by the President, Ghana Timber Millers' Organization at a Workshop on local pricing of logs at Wood Industry Training Centre (WITC). Organized by Forest Products Inspection Bureau. Kumasi – Ghana, June 2000.

Ghartey K K F, 1990. The evolution of forest management in the tropical high forest of Ghana. A Paper presented at Conférence sur la conservation et utilisation rationelle de la forêt dense d'Afrique Centrale et de l'Ouest. African Development Bank. Abidjan, Côte d'Ivoire. November 1990.

Gyasi E, 2002. Traditional forms of conserving biodiversity within agriculture: Their changing character in Ghana. In: H. Brookfield, C. Padoch, H. Parsons and M. Stocking, (Eds). Cultivating Biodiversity: Understanding, Analyzing, and Using Agricultural Diversity, ITDG, United Nations University, London (2002), pp. 245–255.

Gyasi E, W Oduro, G Kranjac-Berisavljevic, J Dittoh and W Asante, 2003. Ghana in: H. Brookfield, H. Parsons and M. Brookfield (eds). Agro-diversity: Learning from Farmers Across the World. United Nations University Press, Tokyo. pp. 79–109.

Goldman M and R Schurman, 2000. Closing the "Great divide": New social theory on society and nature. *Annual Review of Sociology* 26 (2000). pp. 563–584.

Ghana Statistical Services, 2006. Gross Domestic Product Estimates. Ghana Statistical Service, Accra.

Ghana Statistical Service, 2004. Ghana Population Census 2000. The Republic of Ghana Statistical Service, Accra.

Ghana Tourist Board, 2006. Tourism statistical factsheet on Ghana. September, 2006. Accra, Ghana

Government of Ghana (GoG), 2003. National Development Planning Commission. Ghana Poverty Reduction Strategy: An Agenda for Growth and Prosperity: 2003-2005 [GPRS I], Accra.

Gyasi E, 2002. Traditional forms of conserving biodiversity within agriculture: their changing character in Ghana. In: H. Brookfield, C. Padoch, H. Parsons and M. Stocking, Editors, Cultivating Biodiversity: Understanding, Analyzing, and Using Agricultural Diversity. ITDG, United Nations University, London.

Global Forest Resources Assessment, 2005. "Progress towards sustainable forest management". Food and Agriculture Organization. Forestry Paper 147. Rome.

Hawthorne W D and Abu-Juam M, 1995. Forest Protection in Ghana with particular reference to vegetation and species. IUCN, Gland, Switzerland.

Hawthorne W D, 1995. Forest Reserves of Ghana: Graphical Information Exhibition Manual. Froggie, Accra.

Hass J L, Brunvoll F and Hoie H, 2002. European Union Overview of Sustainable Development Indicators used by National and International Agencies. Organisation for Economic Co-operation and Development. STD/DOC(2002)2: Paris, France 2003.

Hansen K, 1997. Final Report: Draft Chapter 1, Background Paper No. 1, World Commission on Forests and Sustainable Development, p.8.

Herold A, 2001. Reporting of emissions and removals from land use change and forestry in greenhouse gas inventories of Non-Annex I National Communications. Paper for the Consultative Group of Experts on Non-Annex I National Communications, Subgroup on Inventories. Berlin, Germany, Öko-Institute.

Helsinki, 1993. Second Ministerial Conference on the Protection of Forests in Europe. June 1993, Helsinki/Finland.

Heuveldop J, 1994. Assessment of Sustainable Tropical Forest Management. Kommissionsverlag Max Wiedebusch, Hamburg.

Hicks, J R, 1937. "Mr. Keynes and the Classics - A Suggested Interpretation", *Econometrica*, v. 5 (April): 147-159.

Hicks John, 1980-1981. "IS-LM: An Explanation", *Journal of Post Keynesian Economics*, v. 3: 139-155

Hickey G M, 2004. Monitoring and information reporting for sustainable forest management in North America and Europe: Requirements, practices and perceptions. PhD Thesis. University of British Columbia, Canada.

Houghton R A, 2003. Revised estimates of the annual net flux of carbon to the atmosphere from changes in land use and land management 1850-2000. *Tellus* 55B(2):378-390.

Hüllermeier Eyke and Johannes Fürnkranz, 2004. Comparison of ranking procedures in pairwise preference learning. In *Proceedings of the 10th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems (IPMU-04)*, Perugia, Italy, 2004.

IEM, 2001. International Expert Meeting On Monitoring, Assessment And Reporting On The Progress Toward Sustainable Forest Management. Tarapota process. November 2001, Yokohama, Japan.

Illge L and Schwarze R, 2006. A Matter of Opinion: How Ecological and Neoclassical Environmental Economists Think about Sustainability and Economics. German Institute for Economic Research, Berlin.

ISSER, 2008. The State of the Ghanaian Economy Report. University of Ghana Legon, Accra.

IUCN and IDRC, 1999. International Assessment Team. Assessing well-being and sustainability. IUCN-TheWorld Conservation Union, Gland, Switzerland.

ITTO, 2005. International Tropical Timber Organisation Report on Status of Tropical Forest Management: Is forest management improving in the tropic? Tropical Forest Updates Speciale.

ITTO, 2002. ITTO guidelines for the restoration, management and rehabilitation of degraded and secondary tropical forests; ITTO in collaboration with CIFOR, FAO, IUCN and WWF; *ITTO Policy Development Series* No. 13, Yokohama, Japan.

ITTO, 1999. *Tropical forest update.* Yokohama, Japan. International Tropical Timber Organization.

ITTO, 1992. Manuel on Auditing Sustainable Forest Management Using the Philipinne Criteria and Indicators. Adoption and Implementaion of Appropriate System of Criteria and Indicators for the Philipinnes. ITTO Project PD 225/03 Rev. 1(F).

Tunstall Daniel B, 1993. Directory of Country Environmental Studies: *An Annotated Bibliography of Environmental Assessments,* WRI, USA, 1993.

IISD, 2003. A summary report of the International Conference on Criteria and Indicators for Sustainable Forest Management. Online document. The International Institute for Sustainable Development. Available at: http://www.iisd.ca/download/pdf/sd/. Accessed on 20th. Sept. 2009.

IUCN, 2002. Global Perceptions of Environment and Sustainable Development. Frits J. Hesselink, (ed). IUCN Corporate Communication Product Group Commission on Education and Communication. 2003, The Netherlands.

IUCN, 2004. Engaging People in Sustainability. Tilbury D and D. Wortmann (eds). International Union for Conservation, 2004. Cambridge, UK.

IUCN, 1999. Assessing progress Towards Sustainability. International Conservation Union Workshop Report and Trainning Notes.

IFF, 2000. Sustainable Development of All Types of Forests: Elements and Functions for a Future International Arrangement and Mechanism (E/CN.17/IFF/2000/4). Sessions Documents & Reports. The United Nations Forum on Forests Secretariat, New York.

IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4, Agriculture, Forestry and Other Land-Use. Technical Support Unit, Kanagawa, Japan.

Intergovernmental Panel on Climate Change, 2002**.** Report of the Conference of the Parties on its seventh session. Addendum. Part 2: *Action taken by the Conference of the Parties.* Marrakesh, Morocco. October - November 2001. FCCC/CP/2001/13/Add.1. Bonn, Germany.

Internation Conservation Union, 2004. Enhancing social sustainability in activities to combat desertification: *A manual for reflection* . Gland, Switzerland & Cambridge, UK.

IPF (Intergovernmental Panel on Forests), 1997. Draft final report. United Nations Commission on Sustainable Development. New York, USA.

ITTO (International Tropical Timber Organization), 1990. ITTO guidelines for the sustainable management of natural tropical forests. ITTO, Yokohama, Japan. Technical Series, No. 5.

Indufor, 2002. Criteria and Indicators for Sustainable Forest Management: An Overview of Progress and Issues. CICI in Guatamala City.

Jacobs M, 1998. The Tropical Rainforest: A First Encounter. Kruk R et al (eds). Springer-Verlag, Berlin.

Jackson Tony and Peter Roberts, 2000. A Review of Indicators of Sustainable Development: A Report for Scottish Enterprise Tayside. Final Report. Geddes Centre for Planning Research School of Town and Regional Planning. February, 2000. Dundee, UK.

Johnson S E, 2001. ITTO's C&Is. A Tool for Monitoring, Assessing and Reporting on SFM presented at the International Expert Meeting on Monitoring, Assessment and Reporting on the Progress Toward Sustainable Forest Management. ITTO Secretariat. Yokohama, 5 November 2001.

Jollands Nigel and Harmsworth Garth, 2006. Participation of indigenous groups in sustainable development monitoring: Rationale and examples from New Zealand. *Ecological Economics.* Volume 62, Issues 3-4, 15 May 2007, Pages 716-726.

Kathlyn G, 2001. Rainforest of the World in Contemporary World Issues. ABC Guio, Oxford, England.

Kasanga K and Kotey N A, 2001. "Land Management in Ghana: Building on Tradition and Modernity," *International Institute for Environment and Development*, London (United Kingdom).

Kemp R H and Whitmore T C, 1978. International cooperation for the conservation of tropical and subtropical forest genetic resources exemplified by South East Asia, in: *Eighth World Forestry Congress*, Djakarta, 16-28 October 1978. FQL/26- 11.

Kotey N A, Francois J, Owusu J, Yeboah R, Amanor KS, Antwi L, 1998. J. Mayers (eds.) Falling Into Place: Ghana Country Study. Policy that Works for Forests and People Series No: 4.

Kotka IV, 2003. Expert consultation on global forest resources assessment – linking national and international efforts. Report of the FAO, UNEP, UNECE meeting. Kotka, Finland, 1-5 July 2002.

Knetsch J L, 2005. Sustainability, Economics, and Natural Resources in Economics, Sustainability, and Natural Resources. Economics of Sustainable Forest Management. Shashi Kant and R. Albert Berry (eds). Springer, Netherlands.

Keeling W, 1991. Ghana aims for a fitter forestry sector. Financial Times, Accra. June 6,1991.

Kuznets S, 1955. Economic growth and income inequality. *American Economic Review*, 49: 1-28.

Laarman J and Rodger S, 1992. Global Forests: *Issues for Six Billion People*, McGraw-Hill Inc., New York, p.337.

Landres, P B, 1992. Ecological indicators: Panacea or liability? In: McKenzie, D.H., Hyatt, D.E. and McDonald, J.E. (eds.) *Ecological Indicators*, Volume 2, pp. 1295–1319. Elsevier Applied Science, London.

Larsen B, 2006. Ghana Cost of Environmental Damage: An Analysis of Environmental Health, World Bank. Washington, DC.

Laing E, 1991. Ghana Environmental Action Plan (Volume 1). Ghana, 1991.

Lee D R, C B Barrett, P Hazell and D Southgate, 2001. Assessing tradeoffs and synergies among agricultural intensification, economic development and environmental goals: Conclusions and implications for policy. In: Tradeoffs or Synergies? *Agricultural Intensification, Economic Development and the Environment.* D R Lee and C B Barrett (eds). Commonwealth Agricultural Bureau International. Wallingford, U.K.

Löwe H, Seufert G and Raes F, 2000. Comparison of methods used within Member States for estimating CO_2 emissions and sinks according to UNFCCC and EU Monitoring Mechanism: forest and other wooded land. *Biotechnology, Agronomy, Society and Environment*, 4: 315-319.

Macgregor C, 2000. Applying an Analytical Model for Assessing Community Sustainability: Some preliminary results from northern Australian remote towns. A paper presented to the first National Conference on the Future of Australia's Country Towns. Bendigo, Victoria. June 2000.

McCool S, Stankey G, 2001. Representing the future: a framework for evaluating the utility of indicators in the search for sustainable forest management. Pages 93–105 *in* R. J. Raison and A. Brown, (eds). *Criteria and Indicators for Sustainable Forest Management.* IUFRO (International Union of Forest Research Organizations) Series Number 7. CAB International Publishing, Oxford, UK.

McRae Michael, 1997. Is 'Good Wood' Bad for Forests? *Science* 275 (March 28, 1997): 1868-1869.

MCPFE, 2003. "The state of Europe's forests 2003 – The MCPFE report on sustainable forest management in Europe". Ministerial Conference on the Protection of Forests in Europe, Vienna, Austria.

MEA, 2005. Millennium Ecosystem Assessment: Survey of Initial Impacts of the Millennium Ecosystem Assessment. Current State and Trends Assessment of Forest Resources. Washington DC, 2006.

Meadows Donella H, Dennis L Meadows, Jorgen Randers, and William W Behrens III, 1972. The Limits to Growth. New York: Universe Books.

Meadows Donella H, J Randers and Dennis L Meadows, 1992. Beyond the Limits: Confronting Global Collapse, Envisioning a Sustainable Future. Post Mills, VT: Chelsea Green.
Meadows Donella H, J Randers and Dennis L Meadows, 2004. Limits to Growth: The 30-year Update. Post Mills, VT: Chelsea Green.

Mendoza, G A and Prabhu R, 1998b. Multiple criteria analysis for assessing criteria and indicators in sustainable forest management: A case study on participatory decision making — Part II. CIFOR Bogor, Indonesia.

Mendoza1 Guillermo and Vanclay Jerry, 2008. Trends in forestry modeling. CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 2008 3, No. 010.

Meyers Norman, 1992. The Primary Source: Tropical Forests and Our Future, W.W. Norton and Compant, London.

Miner P F and Rivasplata A, 1994. Thresholds of Significance: Criteria for Defining Environmental Significance. *CEQA Technical Advice Series* (916) 445-0613), California.

Ministry of Science and Environment, 2005. Republic of Ghana Biodiversity Status Report: *Third National Report*. Accra, Ghana.

Moiseev A, Dudley E and Cantin D, 2002. The Well-being of Forests: An e-tool for assessing environmental and social sustainability. International Union for Conservation. 2002 Gland, Switzerland.

Montreal Process, 1995. Criteria and indicators for the conservation and sustainable management of temperate and boreal forests. Seventh Meeting of the Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests: Auckland, New Zealand, 31 October 1995.

Munasinghe M, Cruz W, 1994. Economy-wide policies and the environment. Environmental Paper10. Environment Department. World Bank. Washington, D.C.

Ministry of Food and Agriculture, 1999. The Republic of Ghana, Ministry of Food and Agriculture, 1999. Agriculture in Ghana: Facts and Figures. Policy Planning, Monitoring and Evaluation Directorate, Ministry of Food and Agriculture, Accra.

Ministry of Information, 2008. Constitution of the Republic of Ghana. Arrangement of Chapters and Articles. Ministry of Information, Accra.

Ministry of Finance and Economic Planning, 2008. Ministry of Finance and Economic Planning of the Republic of Ghana budget document for the year 2008. Delivered to Parliament on behave of the President by Mr. Baah Wiredu (Sector Minister) Accra.

Ministry of Lands and Forestry, 2005. An interview with the Sector Minister (Hon. D. Fobi) at Meet the Press. Accra, Oct. 2005 at the Ministry of Information Premises.

Musah Abu-Juam, 1995. Biological inventory and monitoring. Ghana Forestry Department. Kumasi.

Morgan Mary, 2007. Annual Cost of Environmental Degradation to Ghana. The Stateman, Accra.

Nketiah K S, wieman A, Asubonteng K O, 2004. Natural Resource Management in Ghana: Challenges to Professionalism. Tropenbos International, 2004. The Netherlands.

Norton B G, 2001. "Conservation biology and environmental values: can there be a universal earth ethic?" In Potvin C et al. (eds), Protecting biological diversity: *roles and responsibilities*, Montreal: McGill-Queen's University Press.

Norton B G, 1992. A New Paradigm for Environmental Management. In: Ecosystem Health: New Goals for Environmental Management. Costanza R, Haskell B D, Norton B G, (eds). Island Press, USA.

Nsiah-Gyabaah K, 1994. Environmental degradation and desertification in Ghana. Aldershot: Avebury.

Ntiamoah-Baidoo Y, 1995. African Biodiversity Series. Indigenous vs. introduced biodiversity conservation strategies: The case of protected area systems in Ghana. *Biodiversity support program* No. 1. May 1995.

Nunoo E K, 2008. EIA Performance Standards and Thresholds for SFM in Ghana. Pages 208 - 219 in Standards and Thresholds for Impact Assessments. Schmidt M; J. Glasson, L. Emmelin, H. Helbron (eds) 2008. Springer-Velag, Berlin.

NDPC, 2001. OECD/DAC Dialogues with Developing Countries on National Strategies for Sustainable Development. Report on Status review in Ghana. National Development Planning Commission, Accra.

NCFC, 1996. National Working Group on Forest Certification on Forests in Ghana. Case Study No. 4. Ministry of Lands and Forestry, Kumasi.

Ober A, 1998. Criteria and Indicators of Sustainable Forest Management and Related Certification Schemes. Inter-Organisational Processes of Implementation in Global Forestry. A Paper presented to the 39th Annual Convention of the International Studies Association (ISA), Minneapolis, Minnesota. March 1998, USA.

Oliver C D, 2003 Sustainable Forestry-What is it? How do we Achieve It? *Journal of Forestry*, Volume *101*, Number 5, July/August 2003*,* pp. 8-14(7)**.**

Okyeman Foundation, 2003. Community-based Integrated Natural Resources Management Project in Okyeman. MEDIUM-SIZED PROJECT BRIEF (GEF)-29870. Okyeman Foundation Accra, July 2009.

Olympia, 1994. International Dialogue on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. Montreal Process, Meetings and Report. September 9, 1994. Washington, U.S.A.

Ostrom Elinor, 1990. Governing the Commons. The Evolution of Institutions for Collective Action. Cambridge: Cambridge University Press.

Ostrom E, Gibson C, Shivakumar S, Andersson K, 2002. Aid, incentives and sustainability: Institutional analysis of international development cooperation. SIDA Studies in Evaluation No. 02/01. Swedish International Development Cooperation Agency (SIDA), Stockholm, Sweden.

Ostrom E, TDietz, N Dolsak, PC Stern, S Stonich, EU Weber (eds.), 2002. The drama of the commons. National Academy Press, Washington, D.C.

Ostrom E, 2003. How types of goods and property rights jointly affect collective action. J Theor. Polit. 15(3):139-170.

O'Sullivan A and S Sheffrin, 2003. *Economics: Principles in Action*. The Wall Street Journal: Classroom Edition (2nd ed.). Upper Saddle River, New Jersey 07458. Jan, 2002.

Panayotou T, 1997. Demystifying the environmental Kuznets curve: turning a black box into a policy tool. *Environment and Development Economics*, 2: pp 465-484.

Parviainen and Frank, 2003 J. Parviainen and G. Frank, Protected forests in Europe approaches-harmonising the definitions for international comparison and forest policy making, *Journal of Environmental Management*. 67 (2003).

Paehlke R C, 2000. Environmental values and public policy. In, Environmental Policy, fourth edition, Vig and M.E. Kraft (eds.), CQ Press, Washington, D.C.

Protected Areas Development Programme, 2000. Ankasa Conservation Area Management Plan. Wildlife Division of the Forestry Commission, Accra.

Puustjärvi E and Simula M, 2002a. Forest-related definitions: issues and development needs. Discussion paper prepared for the expert meeting on harmonizing forest-related definitions for use by various stakeholders. 22-25 January, 2002. Rome.

Puustjärvi E and Simula M, (2002b). Development of common framework for forest-related definitions, Discussion paper presented at the second expert meeting on harmonizing forest-related definitions for use by various stakeholders. FAO and the Intergovernmental Panel on Climate Change (IPCC), in collaboration with the Center for International Forestry Research (CIFOR), the International Union of Forestry Research Organizations (IUFRO) and the United Nations Environment Programme (UNEP), September 2002. Rome.

Poore D (ed), 1989. No timber without trees: Sustainability in the tropical forest. Earthscan. London, UK.

Pacheco D, Andersson K, Hoskins M, 2005. Challenges and opportunities for communal forest management in South America. International Forestry Resources and Institutions (IFRI) Research Programme, Indiana University, USA.

Pearce D W and Atkinson G, 1993. "Capital theory and the measurement of sustainable development: an indicator of weak sustainability", *Ecological Economics*, 8, 103-108

Pearce D, Markandya A, Barbier E B, 1989. Blueprint for a green economy, London, Earthscan.

Peter Victor, 2008. Book Review: Frontiers in Ecological Economic Theory and Application. *Ecological Economics* **66**(2-3).

Pinfield G, 1997. "Sustainability indicators: A New Tool for Evaluation?" In: Evaluation of local environmental policy. Farthing S M (ed). Aldershot, Avebury.

Prabhu Ravi, Carol J. P. Colfer and Richard G. Dudley,1999. Guidelines for Developing, Testing and Selecting Criteria and Indicators for Sustainable Forest Management. A C&I Developer's Reference. Centre for International Forestry Research, Jakata.

Prado D, 2002. Promoting Political Commitment for the Use of Criteria and Indicators as Tools for Sustainable Forest Management. International Conference on Criteria and Indicators to Sustainable Forest Management: The Way Forward. Background Paper No. 2. May, 2002.

Prescott-Allen, 1996. Assessing the sustainability of uses of wild species. *Case studies and initial assessment procedure*. IUCN, Gland and Cambridge.

Prescot-Allen, 1998. Manual of Assessment of Biodiversity. IUCN. Gland & Cambridge, IUCN.

Prescott-Allen, 1999. System Assessment Method: Origin And Key Features. IUCN InternationalAssessment Team /PADTA.

Pleydell Geoffrey, 2005. Wildlife in Ghana. Wildlife Division of the Forestry Commission. Accra, Ghana.

Rametsteiner E and Simula M, 2001. *Forest certification, forging novel incentives for the environment and sustainable forest management*. Brussels, Belgium, European Commission.

Ravilla A V, Javier E, Vergara N and Gendrano O, 1999. Quo Vadis Philippine Forestry: Towards Environmental Disaster or On to Sustainability: A green paper on Sustainable Forestry/Watershed-Based Sustainable Development, Forestry: Los Banos, Luguna, Philippines

Rebugio L L, 2000. Role of Forestry Education in Sustainable Forest Management. Proceedings of the Workshop on Sustainable Forest Management and People to People Exchange Between Asia and Europe, University of Joensuu, Finland, 5-6 July 1999.

Rebugio L L, 1998. Paradigm Shift: The Key to Sustainable Forestry and Environmental Resources Management. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEAMEO SEARCA), College, Laguna, Philippines. ASIAN Journal of Sustainable Agriculture. Volume 1 Number 1 January-June 1998.

Rebugio L and Cruz R V, 1998. Sustainable forestry and environmental conservation. Reaction paper to the public lecture of Secretary Victor O. Ramos on Sustainable Forestry and Environmental Conservation delivered on 16 March 1998 at Balay Kalinaw, University of the Philippines, Diliman, Quezon City.

Rees W and Wackernagel M, 1994. Ecological footprints and appropriated carrying capacity: Measuring the natural capital requirements of the human economy. In Investing in natural capital: Jansson A M, M. Hammer, C. Folke, and R. Costanza (Eds). *The ecological economics approach to sustainability,* pp. 362-390. Washington: Island Press.

Sabatier Paul A, 1988. An Advocacy framework of policy change and the role of policy oriented learning therein. *Policy studies* 21: pp. 129-168.

Sabatier Paul A and **Jenkins-Smith** (eds), 1993. Policy Change and Learning: *An Advocacy Coalition Approach.* Boulder CO: Westview Press.

Sayer J, 1996**.** A Hierarchical Framework of Criteria and Indicators. Center for International Forestry Research. Boor, Indonesia 1996.

Sayer J A, 1992**.** The Conservation Atlas of Tropical Forests: Harcourt C S, Collins N M (eds). Africa. Macmillan London, UK.

Schlager E C, 1995. Policy making and collective action: Defining coalitions within the advocacy coalition framework. *Policy Sciences, 28*, 243-270.

Schmutzenhofer H, 1992. IUFRO's birthday. *IUFRO News*, 21 (1).

Schoene D and Schulte A, 1999. Forstwirtschaft nach Kyoto: Ansätze zur Quantifizierung und betrieblichen Nutzung von Kohlenstoffsenken. *Forstarchiv*, 70: 167-176.

Schaefer M B, 1957. "Some Considerations of Population Dynamics and Economics in Relation to the Management of Marine Fisheries," *Journal of the Fisheries research Board of Canada*, 14, 669-681.

Schlager Edella, 1995. Policy making and collective Action: Defining coalitions within the Moving from the on the phone from the advocacy coalition framework. *Policy Science* 28: pp. 240-270.

Sedjo R and Sohngen B, 2000. Forestry Sequestration of CO_2 and Markets for Timber. Resources for the Future. Discussion paper 00-35.

Sedjo R, Sohngen B and Mendelsohn R, 2000. Estimating Carbon Supply curves for Global Forests and Other Land Uses. Resources for the Future. Discussion paper 01-19.

Sedjo R and Sohngen B, 1999. Carbon Sequestration by Forest. Effects of Timber Markets. Report Number PH3/10, June 1999. International Energy Agency, Greenhouse Gas Research and Development Program. London, England.

Senamede Beheton and Shehu Ibrahim, 1995. Ghana Forest Loss. TED Case Studies. Volume 4, Number 193. January, 1995.

Sheil D, Nasi R and Johnson B, 2004. Ecological criteria and indicators for tropical forest landscapes: challenges in the search for progress. *Ecology and Society* 9(1): 7.

Sheate W R, 1994. Making an Impact: A Guide to EIA Law and Policy, Cameron May, London, UK. p. 23.

Shearman R, 1990. The meaning and ethics of sustainability. Journal of *Environmental. Management*, 14(1): 1-8.

Sors J C, 2001. Measuring Progress towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches. The Fondazinoe Eni Enrico Mattei Note di Lavoro Series. January 2001. Nota di Lavoro.

Steen Tucker, 1992. Changing Tropical Forest. The Forest History Society, USA.

Stern D I, 2003. International Society for Ecological Economics. Internet Encyclopaedia of Ecological Economics. The Environmental Kuznets Curve. *Department of Economics, Rensselaer Polytechnic Institute,* Troy, NY 12180, USA June 2003.

Szaro R C, and C E Peterson, 2005. Balancing ecosystem values: innovative experiments for sustainably managing forests. 22nd IUFRO World Congress: Forests in the Balance: Linking Tradition and Technology. Brisbane, Australia.

Swaney J A, 1990. Common property, reciprocity and community. *Journal of Economics*. Issues 24(2):451-462.

Tachie-Obeng E and Agyeman-Bonsu W, 2005. National survey to assess needs and requirements for implementation of Article 6 of the UNFCCC. Environmental Protection Agency of Ghana, Accra.

Tang C H, 2001. The use of criteria and indicators for monitoring, assessing and reporting on progress towards sustainable forest management in Malaysia. International expert meeting on monitoring, assessment and reporting on the progress toward sustainable forest management. Yokohama, Japan, 5-8 November 2001.

Tropenbos International, 2005. 'Equity in Forest Benefit Sharing: Stakeholders' Views'. Workshop proceedings 3. Wageningen, The Netherlands.

US DOE and USDA, 2005. Biomass as feedstock for a bioenerg y and bioproducts industry: The technical feasibility of a billion ton annual supply. U.S. Department of Energy (DOE) and U.S. Department of Agriculture (USDA). DOE/GO–102995–2135. Washington, DC.

UNFCCC, 2000. United Nations Framework Convention on Climate Change. *Review of the implementation of commitments and of other provisions of the convention. UNFCCC guidelines on reporting and review.* FCCC/CP/1999/7. Bonn, Germany.

UNFCCC, 2002. Report of the Conference of the Parties on its seventh session. Addendum. Part 2: *Action taken by the Conference of the Parties*. Marrakesh, Morocco, 29 October. 10 November 2001. FCCC/CP/2001/13/Add.1. Bonn, Germany.

UNCED, 1992. United Nations Conference on Environment and Development document: Combating Desertification. U.N Doc. A/CONF. 151/26 (Vol.1)(1992).

UNU and WB, 1995. Defining and Measuring Sustainability. Munasinghe M, W. Shearer (eds). The Biogeophysical Foundations. 1995. Washington DC.

Upton C and Bass S, 1995. The forest certification handbook. Earthscan Publications, London.

WCED, 1997. World Commission on Environment and Development. Our Common Future. Oxford University Press. Oxford, England.

WCED, 1987**.** Our common future. Oxford University Press. Oxford UK, 1987.

Wells M, Brandon K and Lee H, 1992. People and Parks: *Linking Protected Area Management with Local Communities.*The World Bank, Washington D.C.

Welford R, 1995. Environmental strategy and sustainable development: *the corporate challenge for the twenty-first century* London, Routledge.

Welford R, 1997. Hijacking environmentalism: *corporate responses to sustainable development* London, Earthscan.

Wiersum K F, 1995. 200 years of sustainability in forestry: lessons from history. *Journal of Environmental Management*, 19(3).

Williams J, Duinker, P N and Bull G, 1997. Implications of Sustainable Forest Management for Global Fibre Supply. FAO, Rome.

Williams J, and Duinker P N, 1997. Impacts of Sustainable Forest Management on Global Fibre Supply. Background Report. Prepared for the Global Fibre Supply Study. FAO Forestry Department.

Winter M, 1998. Decentralized natural resource management in the Sahel. Associates of Rural Development. Burlington, USA.

Woodwell G M, 2001. Forest in a Full World. Yale University Press.

Wolfslehner Bernhard and Harald Vacik, 2008. Evaluating sustainable forest management strategies with the Analytic Network Process in a Pressure-State-Response framework. *Journal of Environmental Management.* Volume 88, Issue 1, July 2008, Pages 1-10 Available online 6 April 2007. Accessed on December 2009.

World Bank, DFID, ISSER, 2006. Natural Resource Management and Growth Sustainability. Economic and Sector Work in Ghana: World Bank, Washington D.C.

World Bank, 2006a. Ghana: Natural Resources Management and the Sustainability of Economic Growth. *Economic and Sector Work.* Washington D.C.

World Bank, 2006b. World Development Indicators 2005. World Bank. Washington, D.C.

World Bank, ISSER, DFID, 2005. Natural Resource Management and Growth Sustainability. Africa Region. World Bank, Washington D.C.

World Bank, 1998. Republic of Ghana National Resource Management Project. Agriculture Group 3. Country Department 10, Africa Region, Accra.

World Bank, 1994. The Human Face of the Urban Environment: Serageldin I, Cohen M A, Sivaramakrishnan K C (eds). Proceedings of the Second Annual World Bank Conference on Environmentally Sustainable Development. No. 6 ESD. Sept. 1994. Washington D.C.

Write P A, A Gregory, T Hoekstra, B Tegler and M Turner, 2002. Monitoring for forest management unit scale sustainability. Final Report of the Local Unit Criteria and Indicators Development (LUCID) Test: Executive Summary. USDA Forest Service IMI (Inventory and Monitoring Institute) Report 4, Fort Collins, Colorado, USA.

10. APPENDIX

10.1a Major Global Criteria and Indicator Initiatives and Processes from 1991-1995

Global C&I Initiatives and Processes	Details	Member States
ITTO (1991 &1998)	**i.** ITTO was the first to develop the *"ITTO guidelines for the Sustainable management of Natural Tropical Forests"* in 1990 **ii.** Developed the first set of ITTO Criteria for the management of sustainable tropical forest management in 1991. **iii.** Two sets of C&I were developed in 1991: **a.** Five (5) National scale level reporting criteria & 26 indicators **b.** Six (6) FMU scale level criteria & 23 indicators **iv.** Revised set of C&I developed in 1998 comprising seven (7) criteria & 77 indicators applicable at both national & FMU scale	**i.** Process involved 53 representatives from producer and consumer countries, timber traders, inter-governmental and NGOs: **53 member countries** Australia, Austria, Belgium Luxembourg, Bolivia, Brazil, Cambodia, Cameroon, Canada, Central African Republic, China, Colombia, Cote d' Ivoire, DR Congo, Denmark, Ecuador, Egypt, EU, Fiji, India, Finland, France, Gabon, **Ghana** Germany, , Greece, Guyana, Honduras, Indonesia, Ireland, Italy, Japan, Liberia, Nepal, Malaysia, Myanmar, The Netherlands, New Zealand, Norway, Panama, Papua New Guinea, Peru, Philippines, Republic of Congo, S.Korea, Spain, Suriname, Sweden, Switzerland, Thailand, Togo, UK, USA and Venezuela. **ii.**Conference attended by 200+ policy makers and scientists from 38 countries and a number of international, inter-governmental & NGOs:
Helsinki Process ***(Pan-Euro Process)*** **June 1994**	**i.** Follow up of the Helsinki Ministerial Conference in June 1993 **ii.** Pan-European set of 6 criteria & 27 indicators were developed for SFM	**38 member countries** Albania, Austria, Belarus, UK, Malta, Belgium, Croatia, Italy, Bosnia-Herzegovina, Bulgaria, Czech Republic, Denmark, Spain Estonia, Finland, France, Germany, Greece, Ireland, Latvia, Hungary, Iceland, Lithuania, Slovak Republic, Luxembourg, Moldavia, Monaco, Netherlands, Sweden,Norway, Romania, Poland, Portugal, Russian Federation, Slovenia, Turkey, Switzerland, and Ukraine
Montreal Process (*Santiago Declaration*) Feb. 1995	**i.** Represents the Non-European Working Group on C&I for the conservation and sustainable management of temperate & boreal forests, **ii.** Seven (7) Criteria & 67 indicators at the national level for SFM were identified in a consensus called the Santiago Declaration.	Twelve countries participated in the process: **12 member countries** Argentina, Australia, Canada, Chile, China, Japan, USA, New Zealand, Republic of Korea, Mexico, Uruguay, Russian Federation,

10.1b. Major Global Criteria and Indicator Initiatives and Processes from 1995-1999

Global C&I Initiatives	Details	Member States
Tarapoto Proposal (February 1995)	**i.** Elaborated at the Regional Workshop on the definition of C&I for Sustainability of Amazonian Forests (1995), **ii.** One (1) Criterion & 7 Indicators were identified proposed for global concern, **iii.** Identified seven (7) criteria & 47 indicators at the national level, **iv.** Identified four (4) criteria & 22 indicators for use at the FMU level **v.** Conceptually, Tarapoto C&I closer to the Helsinki &Montreal processes as it also captures a wide array of forest benefits to society	**8 member countries**: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela
Dry Zone Africa Process (Nov. 1995)	**i.** Aimed at developing C&I for countries in the Sub-Saharan Dry Africa at the national scale, **ii.** Twenty seven (27) Sub-Saharan African countries endorsed 7 criteria and 47 indicators at the national scale for further development at the Sub - Regional and National level.	**28 member countries:** CILSS - (9 countries): Burkina Faso. Cape Verde, Guinea Bissau, Chad. Gambia, Niger, Mauritania, Mali and Senegal. IGADD-(7): Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan,and Uganda. SADC-(12): Angola, Botswana, Lesotho, Mauritius, Mozambique, Namibia, Malawi, Tanzania S. Africa, Swaziland, Zambia, and Zimbabwe.
Near East Initiative (Oct. 1996)	**i.** Expert meeting hosted by FAO & UNEP in Cairo, Egypt led to development of C&I for the region **ii.** 7 National level Criteria & 65 Indicators for SFM were identified and endorsed for implementation at sub-regional and national levels.	**30 member countries:** Afghanistan, Algeria, Azerbeijan, Oman, Bahrain, Cyprus, Djibouti, Iraq, Egypt, Jordan, Islamic Republic of Iran Kuwait, Kyrgyz Republic, Malta, Libya, Lebanon, Mauritania, Morocco
Central American Initiative (Jan. 1997)	**i.** Expert meeting initiated by FAO and hosted by the central American Commission for Environment and Development (CCAD) developed a set of C&I for CCAD. **ii**. Two set of C&I were identified **a.** 4 criteria & 40 indicators at the regional level **b.** 8 criteria & 42 indicators at the national level	**7 member countries:** Belize, Costa Rica, El Salvador, Panama.,Guatemala, Honduras, and Nicaragua
The Dry Forest Asian Initiative (Nov/Dec. 1999)	**i.** Outcome of one of the recommendations of the 17th Session of the Asia-Pacific Forestry Commission in February1998 **ii.** Workshop, known as the "Regional Initiative for Dev't & Implementation of C&I for Sustainable Management of Dry forests in Asia " was organized by FAO/UNEP/ITTO/ USFS/IIFM, at IIFM, Bhopal in Nov/Dec.1999 **iii.** 8 Criteria & 49 indicators at National level were identified	**9 member countries:** Bangladesh, Bhutan, China, India, Mongolia, Myanmar, Nepal, Sri Lanka, and Thailand.

10.1c Relevant International Environmental Conventions Rectified by Ghana

Convention	Date	Remarks
African Convention on the Conservation of Nature and Natural Resources	05.17. 69	Adopted at Algiers "68". signed this convention on 15.09.68
International Convention on Atlantic Tunas	04.17. 68	Concluded on 14 May 1966 at Rio de Janeiro.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	11.14.68	Adopted at Washington 3.03. 73. Signed on 16.12.74
Convention on African Migratory Locust	11. 28. 1963	Entered into force for Ghana on upon her depositing instruments of accession with the Government of Mali
United Nations Convention on the Law of the Sea	06. 07. 1983	Ghana signed the Convention on 10.12.82
Convention on Biological Diversity (Rio de Janeiro)	08. 29.1994	Ghana signed the Convention on 12.06.92
Convention Concerning the Protection of the World Cultural and Natural Heritage	07. 04.1975	Adopted 16 .11. 72 at Paris
Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR)	02. 22.1988	Adopted at Ramsar, Iran; 2 .02.71
International Plant Protection Convention	02. 22.1991	Adopted in Rome on 12.51
International Tropical Timber Agreement, 1994	03. 28. 1995	Successor to the "83" Agreement
United Nations Convention to Combat Desertification in those countries experiencing serious drought and/or desert particularly in Africa	12. 27.1996	Opened for signature on 14.10. 98

10.2 Questionnaire

10.2a Ministry of Lands and Forestry

10.2a(i) Introduction and instructions

This research '***Measuring Progress towards Sustainable Forest Management and Policy Implications***'**:** ***A Case Study of the High Forest Zone in Ghana*** is in partial fulfillment for the award of a doctorate (PhD) degree being conducted under the chair of Environmental Planning of the faculty of Environmental Sciences and Process Engineering in the Brandenburg University of Technology, Cottbus-Germany.

When completed, it will provide an in-depth knowledge and help us to know our position on progress made towards sustainable forest management as well as its effect on policy implementation in Ghana. The study is based on simple random stratified selection and therefore your participation in completing this questionnaire is of great relevance to the success of the research outcome. It would therefore be appreciated very much if the following questions are properly answered as outlined.

It is however emphasised here that respondents are been asked to participate in this interview on voluntary basis. Carefully go through the questionnaire and tick or mark the appropriate box (es) or give simple and concise answers where there is the need to do so. Your confidentiality on views expressed would be kept and treated as such. For clarity and any other information on this study please contact supervisor Professor Dr. Dr. *h.c* Michael Schmidt of the university via *umweltplanung@tu-cottbus.de*

Respondent number:……**1**…….....

Name of Establishment……***Ministry of Lands and Forestry***…….....

Department/Section:…….....

Position/Responsibility:…….....

Place & Date:…….....

10.2a(ii). Policy and planning

Has your ministry (land, forestry and mines) over the last decade (10years) undertaken or is it planning structural changes (new legislation and institutional framework) to promote the sustainable management and use of forest resources and benefit-sharing? Yes□ No □ Not applicable □

If ***'Yes'*** please briefly outline or attach documents.

……

……

……

……

How does the ministry take into consideration the needs of future generations while planning for the sustainable management and use of forest resources and benefit-sharing? Please briefly outline or attach documents.

……

……

……

……

Which policies and or programmes has the ministry implemented to promote the sustainable management and use of forest resources and the sharing of benefits arising from their utilization? Please briefly outline or attach documents.

……

……

……

……

Does the planning practices for sustainable use of forest resources by the ministry incorporate social, economic and environmental values? (i)Yes □ (ii) No □ iii. Not applicable □

If the response to the above question is ***'Yes'*** please briefly outline them

a). Social Values

i……
ii……...
iii……..
iv……..
v……...

b). Economic Values

i……
ii……...
iii……..
iv……..
v……...

c). Environmental Values

i……
ii……...
iii……..
iv……..
v……...

10.2a(iii). Indigenous and local communities

Does the programmes developed (refer to the questions above) to promote sustainable management and use of forest resources, address specific needs of indigenous and local communities, including supporting activities of indigenous and local communities involving the use of science and traditional forest-related knowledge in sustainable forest management (SFM)? i.Yes □, ii. No □ iii. Not application □

Please briefly outline your answer below if your response to the above question is ***'Yes'***

a). Local Communities (Specific social needs)

i……
ii……...
iii……..
iv……..
v……...

b). Local Communities (Specific economic needs)

i……
ii……...
iii……..
iv……..
v……...

10.2a (iv). Tools and criteria

Does the ministry assess or calculate the economic, social and environmental value of forest resources and services? i. Yes □, ii. No □, iii. Not application □

If ***'Yes'***, what are the criteria (methods), and reporting mechanisms used? Please briefly outline.

……

……

……

……

Which planning and modeling tools is your ministry promoting for sustainable management and use of forest resources? Please briefly outline

……
……
……

Which criteria and indicators is the ministry using to monitor the sustainable use of forest resources and assess progress in the implementation of sustainable management policies? If ***'Yes'***, please briefly outline or attach documents.

……

……

……

……

Does the ministry promote the use and sustainable management of non-timber forest resources (NTFR)? If ***'Yes'***, please provide information on modalities and tools of NTFR management and use. Please briefly outline or attach documents.

……

……

……

……

How does the ministry monitor unsustainable uses of forest resources and what tools/methods/criteria and reporting mechanisms are utilized? Briefly outline.

……

……

……

……

10.2a(v). Certification schemes

Is your outfit encouraging the implementation of voluntary independent forest certification schemes that take into consideration relevant forest biodiversity criteria, indigenous and local community's rights and NTFR management? Briefly outline.

……

……

……

……

10.2a(vi). Cooperation

Is the ministry in support or contribute to regional cooperation initiatives and work on sustainable use of forest products and services, including through technology transfer and capacity building programmes? If yes, please provide some examples if possible.

……

……

……

……

10.2b Ministry of Science and Environment

10.2b(i) Introduction and instructions

This research**, '*Measuring Progress towards Sustainable Forest Management and Policy Implications*': *A Case Study of the High Forest Zone in Ghana*** is in partial fulfillment for the award of a doctorate (PhD) degree being conducted under the chair of Environmental Planning of the faculty of Environmental Sciences and Process Engineering in the Brandenburg University of Technology, Cottbus-Germany.

When completed, it will provide an in-depth knowledge and help us to know our position on progress made towards sustainable forest management as well as its effect on policy implementation in Ghana. The study is based on simple random stratified selection and therefore your participation in completing this questionnaire is of great relevance to the success of the outcome of the research. It would therefore be appreciated very much if the following questions were properly answered as outlined.

It is however emphasised here that respondents are been asked to participate in this interview on voluntary basis. Carefully go through the questionnaire and tick or mark the appropriate box (es) or give simple and concise answers where there is the need to do so. Your confidentiality on views expressed would be kept and treated as such. For clarity and any other information on this study please contact supervisor, Professor Dr. Dr. *h.c* Michael Schmidt of the above mentioned university, via *umweltplanung@tu-cottbus.de.*

Respondent number:…… **2** …….....

Name of Establishment: …*Ministry of Science and Environment*……..

Department/Section:…….....

Position/Responsibility:…….

Place & Date:…….

10.2b(ii). The Ministry of Science and Environment

The forestry sector is a force to reckon in the socio economic development of Ghana. What role does the ministry play in managing these resources on sustainable basis? Please briefly outline or attach documents.

……

……

……

……

Defining what constitute forest may be approached differently by several schools of thoughts. How does your ministry see what is forest in Ghana? Please briefly outline.

……

……

……

……

What percentage of the total land surface area is forested? Please briefly outline or attach documents.

……

……....

……

……

What percentage of the forest area is in reasonable condition? Please briefly outline or attach documents.

……

……....

……

……....

How many forest reserves are currently being managed by the government and where can they be located? Please outline or attach document.

……
……....
……
……....

Do the government and other stakeholders in the forest sector establish thresholds and standards for harvesting forest resources? i.**Yes** □, ii. **No** □, iii. **Not applicable** □.

If 'Yes' what are the standards and thresholds for harvesting in

a). Forest Reserves ……
……
……
……

b). Off Reserves ……
……
……
……

Criteria and Indicators (C&I) have become a global tool by which forest resources are being managed on sustainable basis. Does the government (Your outfit) share the same view? Yes □, No □, Not applicable □

If 'Yes' what are the set of criteria and indicators that have been developed at the national for sustainable forest management

……
……....
……
……....

Have these set of C&Is been field tested? **Yes** □, **No** □, **Not applicable** □

By way of fulfilling the 1992 UNCED forest principles, if being implemented, please complete the table below.

Table 10.2 Compliance to UNCED principles

Period	Total land Area	Total Forest Stands	Percentage of land Area	% Increase over period	Gross Annual increase
1985- 1995					
1995- 2005					

12. What are the main constituents of tree species in (Briefly outline or attach documents)

a). Forest Reserves

……

……

……

……

b). Off Forest Reserves

……

……

……

……

10.2c. Resource Management Support Centre

10.2c (i) Introduction and instructions

This research '***Measuring Progress towards Sustainable Forest Management and Policy Implications*': *A Case Study of the High Forest Zone in Ghana*** is in partial fulfillment for the award of a doctorate (PhD) degree being conducted under the chair of Environmental Planning of the faculty of Environmental Sciences and Process Engineering in Brandenburg University of Technology, Cottbus-Germany.

When completed, it will provide an in-depth knowledge and help us to know our position on progress made towards sustainable forest management as well as its effect on policy implementation in Ghana. The study is based on simple random stratified selection and therefore your participation in completing this questionnaire is of great relevance to the success of the outcome of the research. It would therefore be appreciated very much if the following questions are properly answered as outlined.

It is however emphasised here that respondents are been asked to participate in this interview on voluntary basis. Carefully go through the questionnaire and tick or mark the appropriate box (es) or give simple and concise answers where there is the need to do so. Your confidentiality on views expressed would be kept and treated as such. For clarity and any other information on this study please contact supervisor Professor Dr. Dr. *h.c* Michael Schmidt of the university via *umweltplanung@tu-cottbus.de*

Respondent number:……..... **3**…….....

Name of Establishment:….....*Resource Management Support Centre*.....

Department/Section:…….....

Position/Responsibility:…….....

Place & Date:…….....

10.2c (ii) Role of the Centre

The forestry sector is a force to reckon in the socio economic development of the Ghana. What role does your agency play in managing these resources on sustainable basis? Please briefly outline or attach documents

……
……
……

How different is (are) this (these) from that of the Forestry Commission?

……
……
……

Defining a forest may be approached differently by several schools of thoughts. How does the Centre see what constitute forest in Ghana? Please briefly outline.

……
……
……
……

10.2c (iii) Policy and planning

Has the Centre (RMSC), over the last decade (10years), undertaken or is it planning structural changes (new legislation and institutional framework) to promote the sustainable management and use of forest resources and benefit-sharing? **Yes** □, **No** □, **Not applicable** □

If your response to the above question is ***'Yes'*** please briefly outline or attach documents.

……
……
……

……

……

How does the centre reconcile needs of future generations while planning for the sustainable management, use of forest resources and benefit-sharing? Please briefly outline or attach documents.

……

……

……

……

Which policies and or programes have been implemented to promote the sustainable management and use of forest resources and the sharing of benefits arising from their utilization? Please briefly outline or attach documents.

……

……....

……

……

Does the centre`s planning practices for the sustainable use of forest resources incorporate social, economic and environmental values? **Yes** □, **No** □, **Not applicable**

If the response to the above question is ***'Yes'*** please briefly outline them

b). Social Values

i……

ii……...

iii……..

iv……..

c). Economic Values

i……

ii……...

iii……..

iv……..

d). Environmental Values

i……

ii……...

iii……..

iv……..

10.2c(iv) Indigenous and local communities

Have the programmes developed (refer to the questions above) to promote sustainable management and use of forest resources, addressed the specific needs of indigenous and local communities, including supporting activities of indigenous and local communities involving the use of science and traditional forest-related knowledge in sustainable forest management (SFM)? **Yes** □, **No** □, **Not application** □

Please briefly outline your answer below if your response is ***'Yes'***

a).Local Communities (Specific social needs)

i……

ii……...

iii……..

iv……..

b). Local Communities (Specific economic needs)

i……

ii……...

iii……..

iv……..

10.2c(v) Tools and criteria

Does your outfit assess or calculate the economic, social and environmental value of forest resources and services? i. **Yes** □, ii. **No** □, iii. **Not application** □

If ***'Yes'***,what are the criteria (methods) and reporting mechanisms used? Please briefly outline.

……

……

……

Which planning and modeling tools is your outfit promoting for sustainable management and use of forest resources? Please briefly outline

……

……

……

……

Which criteria and indicators is the agency using to monitor the sustainable use of forest resources and assess progress in the implementation of sustainable management policies?

……

……

……

……

If ***'Yes***, please briefly outline or attach documents.

……

……

……

……

Does the Centre promote the use and sustainable management of non-timber forest resources (NTFR)? ……..

If ***'Yes***, please provide information on modalities and tools of NTFR management and use. Please briefly outline or attach documents.

How does the agency monitor unsustainable uses of forest resources and what tools (methods or criteria) and reporting mechanisms are utilized? ……

10.2c(vi). Certification schemes

Is your outfit encouraging the implementation of voluntary independent forest certification schemes that take into consideration relevant forest biodiversity criteria, indigenous and local community`s rights and Non Traditional Forest Resources management?

Is your outfit supporting or contributing to regional cooperation initiatives and work on sustainable use of forest products and services, including through technology transfer and capacity building programmes? If yes, please provide examples.

Does the country have the country have the needed human resource capacity to sustainably manage Ghana's forest at the national level? **Yes** □, ii. **No** □, iii. **Not application** □

If the response to the above question is **"No**", in terms of percentages, what proportion is currently been engaged? ……...

What proportion of the needed human resource need to be specialized labour? …….

Who are the other stakeholders in the quest for sustainable forest management? Please briefly outline

……

……

……

10.2c(vii). The Resource Base

What percentage of the total land area is forested? …….

What percentage of the forest area is in reasonable condition? ……..

How many forest reserves are currently being managed and where are they located?

Please briefly outline or attach documents

…….....

…….....

Do you identify deforestation as the major natural forest resource management challenge in Ghana? Yes □, No □. Not application

If the response to the above is ***"Yes"*** what programs have been initiated or in the pipeline to revamp the continuing decline in forest cover? Please briefly outline or attach documents

……...

……....

……....

What proportion (As a percentage of total degraded forests of forest lands are currently being rehabilitated? ……

Information provided will enable the researcher to assess progress made so far by government towards SFM. Please complete the table or attach supporting documents.

Table 4.3 Government efforts towards SFM

Forest Projects	Location	Duration	Objectives	Progress
1.High forest biodiversity conservation				
2.Community forest development				
3.Gov't Plantation development				
4.Participatory forest Mgt. project				
5.Wildlife mgt. project				
6.Wildlife division support project				
7.Forest sector dev'tprojects				
8.Strengthening participatory projects				
9.Bamboo and Rattan				
10. Forest resource usemgt project				
11. Others (Please specify)				

10.2c(viii) Standards and Thresholds

Does participatory co-management of the forest establish standards and thresholds for timber harvesting? **Yes** □, **No** □, **Not application** □

If the response to the above question is Yes what are the standards and thresholds for harvesting in

i. Forest Reserves ……..

……..

……..

ii. Off-Reserves ……..

……..

10.2d Environmental Protection Agency

10.2d(i) Introduction and instructions

This research, '***Measuring Progress towards Sustainable Forest Management and Policy Implications***'**:** ***A Case Study of the High Forest Zone in Ghana*** is in partial fulfillment for the award of a doctorate (PhD) degree being conducted under the chair of Environmental Planning of the faculty of Environmental Sciences and Process Engineering in Brandenburg University of Technology, Cottbus-Germany.

When completed, it will provide an in-depth knowledge and help us to know our position on progress made towards sustainable forest management as well as its effect on policy implementation in Ghana. The study is based on simple random stratified selection and therefore your participation in completing this questionnaire is of great relevance to the success of the outcome of the research. It would therefore be appreciated very much if the following questions are properly answered as outlined.

It is however emphasised here that respondents are been asked to participate in this interview on voluntary basis. Carefully go through the questionnaire and tick or mark the appropriate box (es) or give simple and concise answers where there is the need to do so. Your confidentiality on views expressed would be kept and treated as such. For clarity and any other information on this study please contact supervisor Professor Dr. Dr. *h.c* Michael Schmidt of the university via *umweltplanung@tu-cottbus.de*

Respondent number:……..... **4**…….....

Name of Establishment:….....*Environmental Protection Agency*.....

Department/Section:…….....

Position/Responsibility:…….....

Place & Date:…….....

10.2d(ii) Role of the Agency

Environmental impact assessment (EIA) may be defined in various ways. How will your agency (EPA) define or explain it? Please briefly outline.

…….
…….
…….
…….

What role does EIA play in the sustainable development of Ghana as a nation? Please briefly outline.

…….
…….
…….
…….

Does it have any implication (s) for sustainable forest management (SFM)? i. **Yes** □, ii. **No** □, iii. **Not applicable** □.

If the response to the above question is ***'Yes',*** please briefly outline.

…….
……..
……...
……...

What is the procedure for a general EIA in Ghana? Please briefly outline

……
……....

……

……

Do all projects require an environmental impact assessment in Ghana? i. **Yes** □, ii. **No** □, iii.**Not applicable** □.

If the response to the above question is **'No'** what type of forest projects will require an EIA? Please briefly outline.

……

……....

……

……

If the response to the above question is ***'Yes'*** what are the criteria and indicators for selecting a project likely to have significant impact on the environment? Please briefly outline or attach documents.

……..
……..
……..
……

What are the institutional framework, legal instruments and regulatory bodies for undertaking an EIA? Please briefly outline or attach documents.

……..
……..
……..
……

a). Legal and/or Regulatory bodies

……..
……..
……
……

b). Institutional Framework

……..
……..
…….
…….

Does the EIA procedure set standards and thresholds for timber harvesting? i. **Yes** □, ii. **No** □, iii. **Not applicable** □.

If the response to the above question is ***'Yes'*** what are the standards and thresholds for harvesting on

a). On-Forest Reserves? (Please outline or attach document)

……..
……..
……..
……...
.. ……..

b). Off - Reserves? (Please outline or attach document)

……
……..
……..
……...
.. ……

c). Hill Sanctuaries? (Please outline or attach document)

……..
……..
……..
……...
.. ……..

d). In sensitive areas? (Please outline or attach document)

……..
……..
……..

Briefly outline the standards if your response to the above question is yes?

……

……

10.2e The High Forest Zone of Ghana

10.2e(i) Introduction and instructions

This research**, '*Measuring Progress towards Sustainable Forest Management and Policy Implications*': *A Case Study of the High Forest Zone in Ghana*** is in partial fulfillment for the award of a doctorate (PhD) degree being conducted under the chair of Environmental Planning of the faculty of Environmental Sciences and Process Engineering in Brandenburg University of Technology Cottbus, Germany.

When completed, it will provide an in-depth knowledge and help us to know our position on progress made, in which direction it is moving and how it will impact on future forest policies in Ghana towards sustainable forest management. The sampling methodology for this set of questions for the study is based on proportional representation and therefore your participation in completing this questionnaire will be of great relevance to the success of the outcome of the research. It would therefore be appreciated very much if the following questions were properly answered as outlined.

It is however emphasised here that respondents are been asked to participate in this interview on voluntary basis. Carefully go through the questionnaire, tick or mark the appropriate box (es) or give simple and concise answers where there is the need to do so. Your confidentiality on views expressed would be kept and treated as such. For clarity and any other information on this study please contact Professor Dr. Dr. *h.c.* Michael Schmidt of the above mentioned university via, *umweltplanung@tu-cottbus.de.*

Forest Community:……*High Forest Zone of Ghana*……....

Region:……...

Household number:……

Respondant, position/responsibility:……..

Place & Date:……

10.2e(ii) Household head

In what capacity do you intend to answer this questionnaire? a. Chief □, b. Household head □, c. Spouse □, d. Other □

What level of formal education have you received? a. Primary/Middle □, b. Vocational/Technical □, c. Secondary/University education □, d. None □

How many people constitute this household? a. Between 2-5 people □, b. Between 2-8 □ people, c. Between 2-12 □, d. 0ver 12 people □

The active age group of this household falls within a. 14-45 years □, b. 15-55 □, c. 18-60 □

How would you describe the main occupation of this forest community? a. Farming □, b. Lumbering □, c. Mining □, d. Trading e. Mixture □

If your response to the above question (3) is (b) lumbering, in what form does it take? a. Commercial logging □ b. Logging chain-saw operations □, C.Prospecting for fuel-wood & Charcoal

What would you consider to be some main constraints to your livelihood activities?

a. Restrictions from government □, b. Reduction in size of forest cover □, c. Lack of financial support □, d. All of them □

Do you think in one way or the other your activities may contribute to the decline in size of forest cover? a. Yes □, b. No □, c. No idea □

Are you privy to reliable environmental information? a. Yes □, b. No □, c. No idea □

What are the sources of access to environmental information? a. Forestry & NGO Officials □, b. Radio & Television stations □, c. News papers □ d. Other sources □

Have you heard about the concept of sustainable forest management? a. Yes □, b. No □, c. No idea □

The forestry sector is a force to reckon in the socio economic development of the Ghana. What role does your community play in managing these resources on sustainable basis? Please briefly explain.

……

……

Do you agree that community participation in managing forest resource will safeguard the resources on sustainable basis? a. Yes ☐, b. No ☐, c. No idea ☐

What is the extent of your community involvement in such activities over the last 10 years? a. Not much ☐, b. Improving ☐, Good d. Excellent ☐

In harvesting proceeds from the forest do you have in mind leaving some for your children unborn? A. Yes ☐, b. No ☐, c. No idea ☐

How often do you get forestry authorities from the government talk to you about managing your resources on sustainable basis? a. Every year ☐, b. every 6th month ☐, c. every 3rd month ☐

What form of interactions does this take? A. lectures and seminars ☐, b. Forums and symposium ☐, c. Workshops and pilot projects ☐

How many times have you or any member of your household participated in such activities over the last 10 years? A. Between 0-4 times ☐, b. between 5-8 times ☐, c. between 9-14 times ☐ d. Over 15 times ☐

Which of the following participatory forest management activities have you actually engaged in over the last 10 years?

a. Environmental education a. Yes ☐, b. No ☐, c. No idea ☐

b. Forest policy and legislative reforms a. Yes ☐, b. No ☐, c. No idea ☐

C. Bush fire management a. Yes ☐, b. No ☐, c. No idea ☐

d. Timber harvesting a. Yes ☐, b. No ☐, c. No idea ☐

e. Plantation development a. Yes □, b. No □, c. No idea □

f. Forest reserve management a. Yes □, b. No □, c. No idea □

How many forest reserves are currently being managed by the government and where are they located? Please mention at least 3 locations.

a. …….
b. …….
c. …….

Do you have thresholds and standards for harvesting forest resources? Yes □, No □, Not applicable □.
If 'Yes' what are the standards and thresholds for harvesting in

a. Forest Reserves ……
……
……
……..
b. Off Reserves ……
……
……
……

Criteria and Indicators (C&I) have become a global tool by which forest resources are now managed on sustainable basis. Does your household share the same views? a. Yes □, b. No □, c. No idea □

If 'Yes' can you mention any three (3) set of standards that have been developed at the national for sustainable forest (SFM)? ……...

Do you have ethical responsibility towards the environment in the quest for developing tourism in your community? a.Yes □, b. No □ c. Not applicable □

If "Yes" how do you communicate it to establishments operating in this sector?

Which of the following environmental performance initiatives or standards do you subscribe to? a. Environmental Impact Assessment □, b. Ecolabeling □, c. Certification □, d. All three □, e. Others □,

If your response to the question is *"Others"* please specify

Are they backed by any legal sanctions? a. Yes □, b. No □, c. No idea □

Would you say that policies on the environment compel top-level management in forestry set ups to integrate them in their decision-making process? a. Yes □, b. No □, c. No idea □

Do you envisage an integrated environmental management system (ISO 14001 Standard) in the forestry sector? a. Yes □, b. No □, c. No idea □

Which aspects of such a system do you think will help in its acceptability by all establishments in its implementation? a. Public awareness education □, b. Education & training awareness in enterprises □, c. Financial □, d. Experts □, e. the government □, f. Individual enterprises □, g. others □.

10.3 Extent of Investment by Government towards SFM from 1993-2012

Name of project	Duration	Location	Main Objective (s)	Amount
1.North savannah biodiversity Project	2002- 2008	Tamale	**i.** Conservation & mgt. of national and, global significant plant & animal, animal species & their habitat **ii.** Enhance community awareness, adopt biodiversity mgt. plans & conservation measures	$ 7.6m
2. High forest biodiver-sity conservation project	1999-2008	Accra	**i.** Establish effective systems to protect biodiver-sity of global importance **ii.** Strengthen mgt. of GSFR with communities	$8.7m
3. Community forestry development project	2003-2008	Kumasi	**i.** Rehabilitate degraded forest reserves **ii.** Strengthen relevant institutional capacity	$10.0m
4. Plantation development project	2003-2008	Accra	**i.** Rehabilitate degraded forest reserves **ii.** Plant amenity trees in urban areas **iii.** Strengthen relevant institutional capacity	$9.2m
5. Participatory forest management in the TZ	2004-2009	Sunyani	**i.** Increase participatory forest resource management in the Brong Ahafo Region	$4.0m
6. Forest resource use management project (FORUM)	1993-2008	Ho	**i.** Reduce degradation of Forest Resources in the Volta Region **ii.** Intensify establishment of private woodlot	$18.0m
7. Wildfire mgt. project in transitional zone	2000-2012	Kumasi	**i.** Rehabilitate fire degraded forest **ii.** Recover lost economic, social and environmental benefits	$17.7m
8.Wildlife division support project	2000-2007	Accra, Mole, Damango, Kyabobo, Nkwanta, Volta Region	**i.** Strengthen wildlife depart. into effective service oriented wildlife division **ii.** Effectively conserve & manage Mole, Kyabobo parks as protected area **iii.** Conserve biodiversity	$20.1m
9. Forest sector deve-lopment project II	2000-2005	Accra	*Na*	$4.9m
10. Ghana-Canada Concert	1999-2004	Kumasi	**i.** Resource conservation **ii.** Enterpreneurship development through training	$ NA
11. Strengthening pptry approaches in FMgt	2000-2005	Accra	**i.** Reduce poverty by adopting sustainable resource management ii. Improve livelihood strategies of the rural poor	$1.5m
12. Bamboo and Ratten development project	2003-2008	Accra	**i.** Promote utilization of bamboo, ratten as alternative sources to timber **ii.** Create employment, iii. Reduce poverty	$ 1.8b
13. Community Rural Base Development project	2004 -2007	Accra	**i.** Build & strengthen capacities at local govt to mgt resources. **ii.** Transfer technical & financial resources to be managed by the rural communities **iii.** Enhance decentralisation	$38m
Total		**(1999-2012) 9.201,928,900,000/20 = 460,096,445,000**		**$9.2trillion**

Source: Ministry of Lands and Forestry, 2005. *Na* = Not available

10.4 Identified C&Is for Assessing SFM in the High Forest Zone (HFZ) of Ghana

10.4a Identified Indicators for assessing enabling conditions towards SFM in the HFZ of Ghana

Criteria 5.1a	Element	Value	Indicators	Goal
Enabling conditions for SFM	Policy and legal frame-work	Forest production, forest conservation and protection	**Degree (%) of** **i.** Land tenure and property rights relating to forests **ii.** Control of forest management, harvesting and encroachment **iii.** Health and safety of forest workers **iv.** Local community participation.	SFM
	Economic framework	Existence of economic instruments to promote SFM Financial investment.	**Degree (%) of** **v.** Investment by the government **vi.** Domestic and private sources **vii.** International sources	SFM
	Institutional frame work	Organized institution, accountability and public participation.	**Extent of** **viii.** No. and adequacy of institutions to support SFM **ix.** Adequacy of professionals and technicians to perform and support management, implementation, research and extension **x.** Existence and application of appropriate technology to practice SFM and for periodical monitoring and evaluation **xi.** Degree of public participation in forest management **xii.** Access to information on forest policies, legislation and SFM practices.	SFM

Source: Field data analysis, 2008

10.4b Identified Indicators for assessing forest resource security towards SFM in the HFZ of Ghana

Criteria 5.1b	Element	Value	Indicators	Goal
Forest resource security	Forest resou - rce base description.	Conservation and preservation of natural forest ecosystem	**i.** Extent of area (ha) and percentage of total land area under **a.** natural forest **b.** plantation forest **c.** permanent forest estate **d.** comprehensive integrated land-use plans	SFM

Source: Field data analysis, 2008

10.4c Identified Indicators for assessing economic growth towards SFM in the HFZ of Ghana

Criteria 5.1c	Element	Value	Indicators	Goal
Economic Growth & Develop-ment	Economic benefits	Sustained timber production	**i.** Timber harvesting timber levels, **ii.** Total area available for commercial timber production, **iii.** Mean annual increment, **iv.** Volume of merchantable timber remaining on site after harvesting.	Economic develop-ment
	Distribution of benefits	Forest industry & employment	**v.** No. of people employed in each forest based activity, **vi.** Related employment per unit volume of wood harvested, **vii.** Value of paper and value added manufacturing of timber per volume harvested, **viii.** No. of timber and non-timber base industries, **ix.** Contribution of timber to GDP.	Economic well-being
	Distribution of benefits	Recreation	**x.** Proportion of areas conserve for recreational activities	Economic well-being
	Distribution of benefits	Forest products for domestic use	**xi.**Volume of wood allocated for domestic use	Economic well being

Source: Field data analysis, 2008

10.4d. Identified Indicators for assessing ecosystem health & vitality in the HFZ of Ghana

Criteria 5.1d	Element	Value	Indicators	Goal
Bio-diversity	Forest ecosystem diversity	Representative Landscapes	**i.** Proportion of eco-region in protected area status (ha), **ii.** Proportion (ha) and extent of area by forest type and age class in protected area	Environmental vitality
	Ecosystem diversity	Special places	**iii.** Area (ha) of biologically unique protected or treated with special mgt. provisions	Environmental vitality
	Species diversity	Wildlife habitat	**iv.** Area of habitat and population levels for known forest dependent species classified as endangered, threatened and vulnerable on risk lists	Environmental vitality
Healthy Forest	Incidence of disturbance and Stress	Ecosystem health	**v.** Area of forest disturbed by fire, logging, insects & diseases	Environmental vitality
	Eco-system productivity	Natural productive capacity	**vi.** Mean Annual Increment (MAI) for tree species by eco-region **vii.** Area planted & tinned.	Environmental vitality
Soil and Water	Eco-system productivity	Surface water	**viii.** Water quality standards, **ix.** Flow rates of major rivers in the HFZ	Environmental vitality
Global Impact	Eco-system productivity	Forest soils	**x.** Proportion of total productive forest area without measurable soil erosion & soil compaction due to forest operations	Environmental vitality
	Climate Change	Adopting to climate change	**xi.** Net mass of carbon per unit area accumulated in the HFZ, **xii.** No. of communication tools developed to explain climate change, **xiii.** Climate change strategies developed	Environmental vitality.
	Climate Change	Forest land conservation	**xiv.** Area (ha) of permanent forest depletion	Enviromental vitality

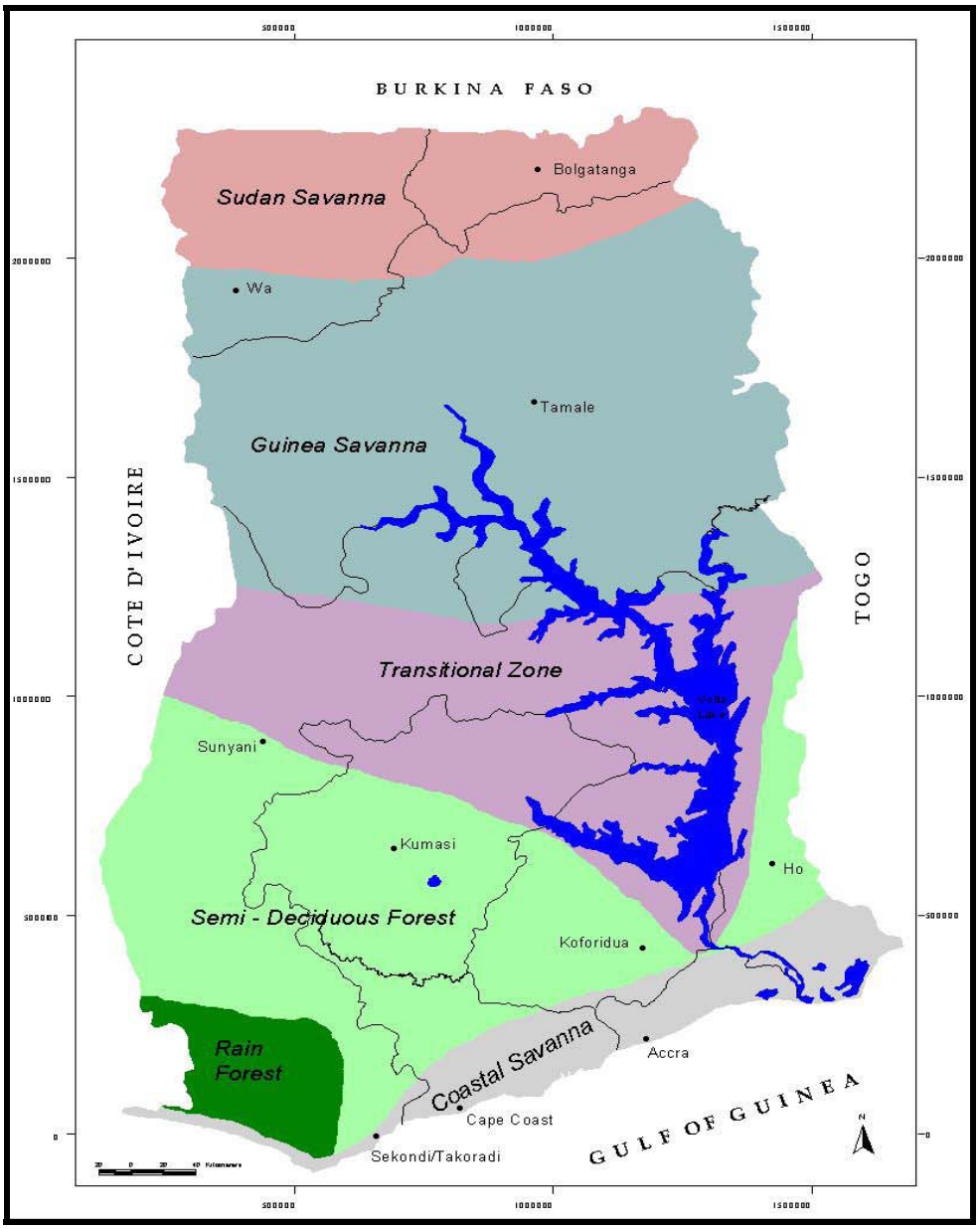
Source: Field data analysis, 2008

10.4e. Identified Indicators for assessing Societal Well-being in the HFZ of Ghana

Criteria 5.1e	Element	Value	Indicators	Goal
Societal Well-being	Community involvement	Community perspectives and participat-ion.	**i.** No. of households in communities that have forest based employment.	Societal well-being
	Forest com-munity well -being	Forest contribution to community sustainability	**ii.** No. of people that depend on the forest as their source of fuel-wood, **iii.** No. of house-hold that use non-timber forest values.	Societal well-being
	Fair decision making	Fair and effect-tive decision making	**iv.** No. of community participation processes used in preparing ecosystem based forest management plans, **v.** Extent (proportion) of community involvement in community planning processes.	Societal well-being
	Informed decision	Informed decis-ion making	**vi.** Proportion of citizens who under -stand SFM, **vii.** Scope, frequency and statistical reliability of forest inventories, **viii.** Availability and accessibility of forest inventory information by the public, **ix.** Research initiatives taken that will improve decision making.	Societal well-being
	Compliance to promulga-ted laws	Informed de-cision making	**x.** Degree of compliance with eco-system based forest management laws, regulations and environmental protection plans, **xi** Proportion of forested area that meets SFM standards as determined by an environmental auditor.	Societal well-being

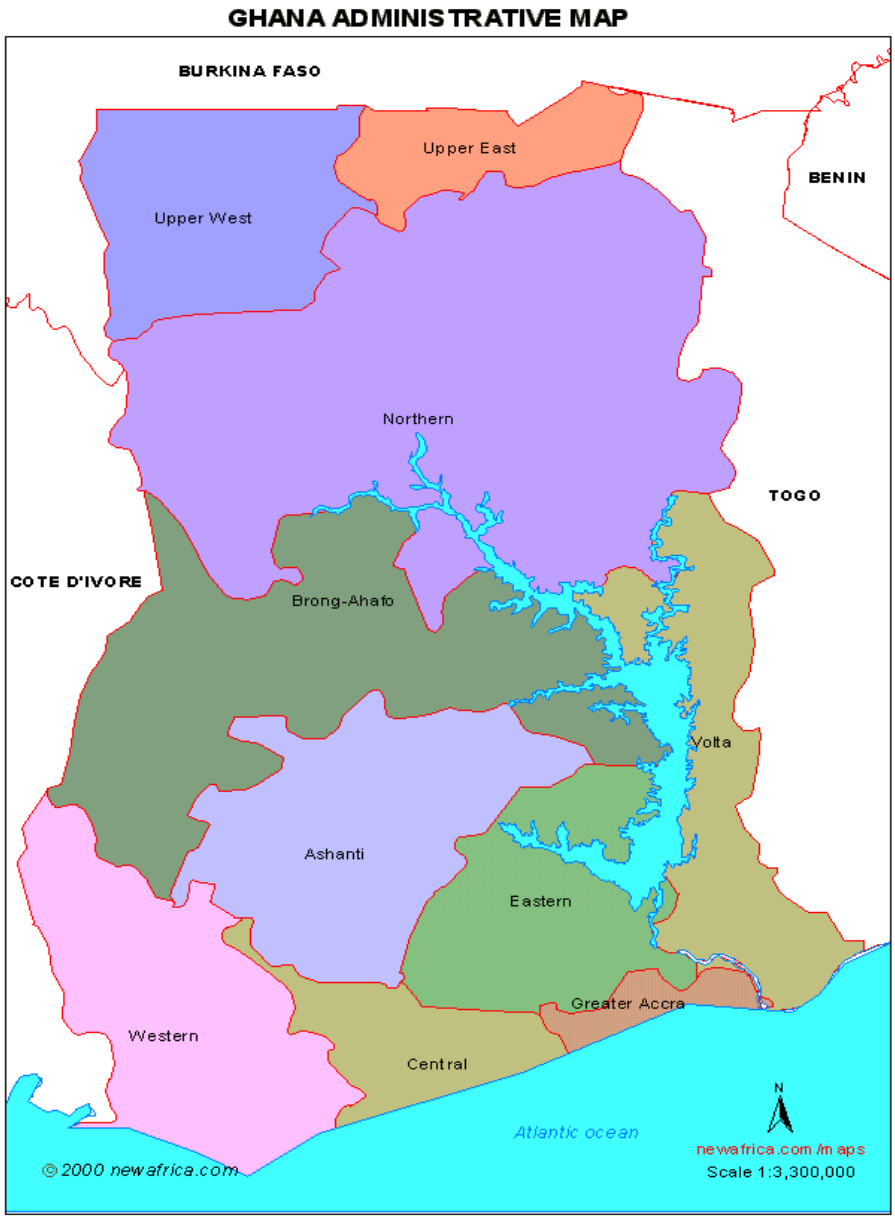
Source: Field data analysis, 2008

10.5 Major vegetative types of Ghana



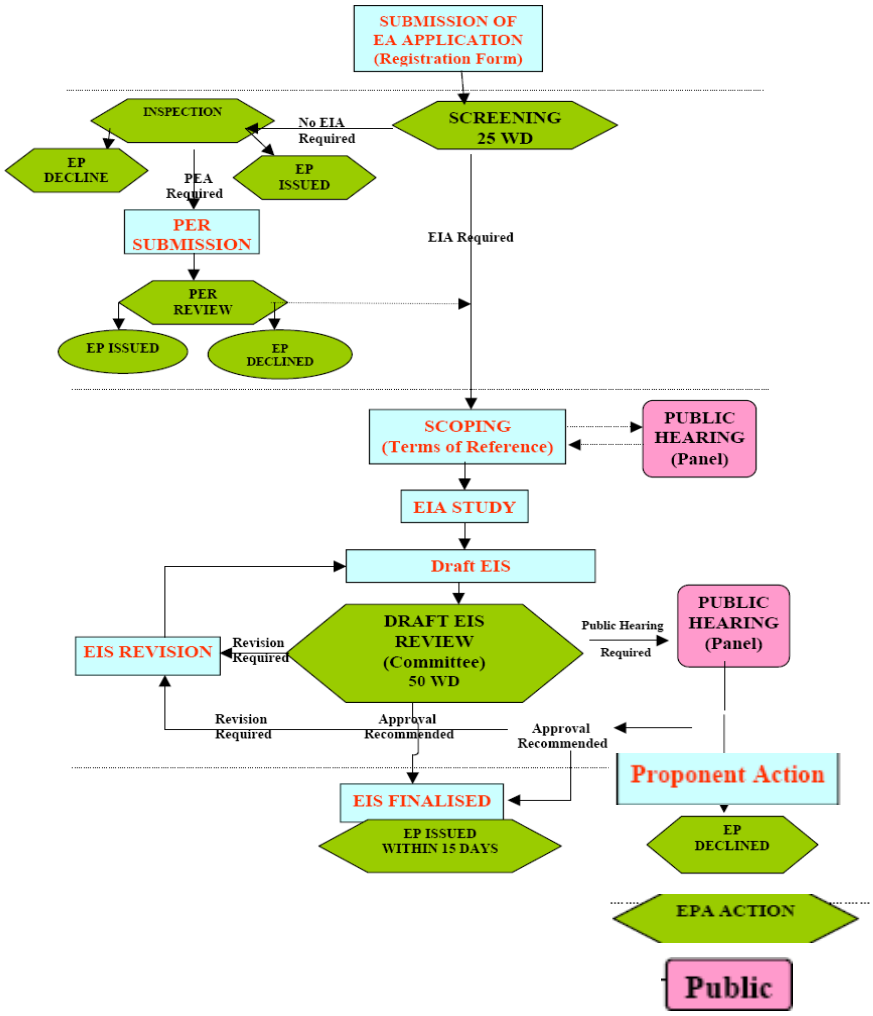
Source: Benneh & Agyepong, 1990

10.6 Administrative Regions of Ghana



Source: NewAfrica.com, 2000.

10.7 EIA Procedure in Ghana



Source: EPA (2005) of Ghana.