KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI, GHANA

IMPACTS OF LAND COVER CHANGES ON THE PROVISIONING ECOSYSTEM SERVICES AT GOASO-GHANA

By

Veronica Mtoka

(B.A Geography & Environmental Studies)

.

A Thesis submitted to the Department of Wildlife and Range Management, College of Renewable Natural Resources in partial fulfilment of the requirements for the degree of

MSC GEO INFORMATION SCIENCE

MARCH 2015

DECLARATION

I hereby declare that this submission is my own work towards the Msc Geo information Science and that, to the best to my knowledge, it contains no material previously

Published by another person nor material which has been accepted for the award of any other Degree of the University, except where due acknowledgement has been made in the text.

Veronica Mtoka …… March, 2015

PG20434801

Certified by:

Rev.John Ayer …… March, 2015

(Supervisor)

Certified by:

Dr. Emmanuel Danquah …… March, 2015

(Head of Department)

ABSTRACT

Natural ecosystems provide services that contribute to human well-being such as food, medicines, fuel wood, fresh water, and climate regulation. In spite of this, most natural ecosystems have been converted or modified into agricultural areas and other human land use to maximize single-purpose use. Various researches reported that, the human use of ecosystem services, particularly of provisioning services, has accelerated in the last 50 years and that nearly 60% of the ecosystems globally are being degraded and used unsustainably. Also, it's projected the demand for ecosystem services is expected to grow in the future. As the human use of most ecosystem services continues to increase, there is a critical need for research involving the quantification of trade-offs among various ecosystem services. Provisioning services include harvestable goods such as bush meat, fruits & food, water, fuel wood & medicinal products from the natural environment. Provisioning ecosystem services in particular is mostly acknowledged within developing countries like those in Africa, where many rural people are poor and are reliant on these services for their livelihoods. Though these services are crucial for human wellbeing, their spatial locations in terms of occurrences are rarely considered in plan, policy development and in decision making. The objective of this research is to assess the effects of land cover conversion in the supply of ecosystem services to the local beneficiaries due to declining of provisioning ecosystem services which impacts the local people's livelihood. Ecosystem services studies currently lack information regarding stakeholder's socio values. This information is vastly relevant to human well-being, which is the motivation of ecosystem services assessments. Presented research takes a non-economic quantitative ecosystem services approach from an

analysis of stakeholder's perceptions on ecosystem services, livelihood and the impact of land cover changes. The results are presented from an analysis of stakeholder's perceptions of ecosystem services, well-being and drivers of change from the Goaso off-forest reserve, Ghana. The methodologies used includes GIS analysis for land cover mapping & change detection, semi structured interviews for collecting the values given to the services and the general information concerning their environment. While participatory mapping and valuation was for mapping ecosystem supply areas and the values given to them, participatory mapping activities and convened group discussions on ecosystem services was done for four villages. Participation of local people and other stakeholders in mapping and valuation of the ecosystem services is very essential in the identification of what are the ecosystem and their services and their relation to land cover/use from their perspective. The services valuation results showed that, water, fuel wood and bush meat were highly valued services.[Though the pattern of the values is the same in the sense that the higher value were given for specific services and lower for specific one across all communities] . The valuation of Land covers as a place for services supply pointed out to annual cropland and fallow land high values as a place for collecting multiple services. The change detection focused on two types of changes; (1) changes in the land covers of ecosystem services supply areas whereby the results showed the changes that occurred in all the land covers, but with the decrease in annual cropland from 39% to 7%, fallow land from 8% to 2%and Forest & off reserve trees from 26% to 10%. (2) Changes in the supply of ecosystem services. All of these changes are within the period of 12 years .The outcomes showed scarcity and reduction in the availability of some services like bush meat, medicinal products, water and fuelwood, as a result of land cover changes.

TABLE OF CONTENTS

Abstract ii
Table of Contents iv
List of Tables vi
List of Figures vii
Acknowledgements viii
1. Introduction 1
    1.1. Background Information 1
    1.2. Research Problem 6
    1.3. Research Objectives 8
    1.4. Research Questions 8
    1.5. Research approach. 9
2. Definition and Concepts 11
    2.1. Ecosystem and Ecosystem services. 11
    2.2. Change Detection 14
    2.3. Participatory mapping 16
    2.4. Ecosystem services valuation. 18
    2.5. Ecosystem services and livelihoods. 23
3. Materials and Methods. 25
    3.1. Study area. 25
    3.2. Biophysical and Social Profile of the study area. 26
    3.3. Data. 27
    3.4. Methods. 28
    3.4.1. Image Pre-processing. 30
    3.4.2. Sample Design 31
    3.5. Field Work. 32
    3.6. Land cover mapping and change methods. 36
4. Results. 39
    4.1. Land cover maps. 39
    4.2. Ecosystem services Mapping (PGIS). 45
    4.3. Identification of the Ecosystem services. 45
    4.4. Ecosystem Services in relation to the distance through Transect walk. 53
    4.5. Ecosystem Services Valuation. 56
    4.6. Change Detection Map. 65

5. Discussion 70
5.1. Land cover classification and accuracy 70
5.2. Assessment of the ecosystem services available and their importance. 71
5.3. Land cover types and their Ecosystem services. 72
5.4. Ecosystem Services valuation and mapping approach. 77
5.5. Comparison of Ecosystem services valuation per studied villages 81
6. Conclusion and Reccomendation. 86
6.1. Conclusion 86
6.2. Recommendation for application. 88
References 90
Appendix. 96
Appendix.1. 96
Appendix 3. 100
Appendix 4. 102
Appendix.5. 103

LIST OF TABLES

Table 1.Composition and number of participants. 34

Table 2.The Land cover classes and their description as used for this research. 39

Table 3.Accuracy Assessment report. 43

Table 4.The list of identified provisioning ecosystem services from the study area. 45

Table 5.Land covers matrix and its services. 46

Table 6.Respondents population characteristics. 57

Table 7.Ecosystem services values per each village(from cocoa beans exercise) 58

Table 8.The sum of areas (ha) and their changes per land covers for 2000 and 2012.

..... 67

Table 9.The assessment of land cover change to local community's livelihood..... 69

LIST OF FIGURES

Figure 1.Research Approach. 10

Figure 2.Ecosystem Services classification by Millennium Ecosystem Assessment. 13

Figure 3.The location of study area (points) at Asunafo North (District administrative). 26

Figure 4. The methodological flowchart. 29

Figure 5.Flow chart diagram for group discussion & PGIS adopted from Ramirez-Gomez et al., 2015 35

Figure 6.The Land cover map for the study area, February, 2000. 41

Figure 7.The Land cover classes for the study area, January, 2012. 42

Figure 8.The graphs for the Land cover classes area. 44

Figure 9.Akrodie community resource use map. 49

Figure 10.Borodedwo community resource use map. 50

Figure 11.Chiefcamp community resource use map. 51

Figure 12.Kumonso community resource use map. 52

Figure 13.Transect walk map in relation to ecosystem services, distance. 53

Figure 14.Land cover value map. 62

Figure 15. Land cover value map assessment. 64

Figure 16.Land cover change map. 66

Figure 17.Graphical representation of land cover types in 2000 and 2012. 68

ACKNOWLEDGEMENTS

Thank you Almighty God, all praises belong to you for your protection and guidance throughout my studies. Many thanks also go to my employer for nominating for this programme and to the Netherlands government for awarding me with the fellowship for my studies throughout.

Foremost, I would like to express my sincere gratitude to my supervisors, Ir. L.M. Louise Van Leuwen and Dr. L. Willemen for their support in terms of, competent guidance, comments, tolerance, readiness and sharing of knowledge and experiences throughout the research period and thesis writing. Many thanks for you encouragements when goings were tough.

My profound gratitude and appreciation also to my supervisors, Mr. J. Ayer and Dr. A. Arko-Adjei from KNUST, Ghana, for their constructive inputs. Am also thankful to the course coordinators for the GIS-NRM both in KNUST, Ghana and ITC, Enschede. My deeply love and thanks goes to my mommy (Mama Nyangi) and the rest of my family members for their moral support and always being there for me.

Lastly to the whole GIS-NRM class in ITC, my friends Irene Compaore, Beatrice Asensoh-Barneh and Alex Essilfie Gaize for your friendship and support throughout my studies and stay in Ghana.

1. INTRODUCTION

1.1. Background Information

Beyond the studies that focus on economic value as a proxy for human wellbeing, little is known about the link between ecosystem services and non- economic human wellbeing such as people's reliance and dependence on cultural and provisioning services. Dependence of rural poor in developing world on local ecosystems for livelihood has the potential to accelerate loss of ecosystem services. A key strength of the Millennium Assessment Report (2003) is its conceptual framework, which links ecosystems and the services to human wellbeing.

Although the deliberate identification and collection of goods and services that people obtain from nature (like wild animal meat, fruits, water, wood.) is not new phenomenon, however, it had received more attention recently under the banner of "nature's services'' or ''ecosystem services''(Lamarque et al., 2011). This new way of framing the relationships between biodiversity, ecosystems and human well -being first started with the field of nature conservation during the 1990s and later spreading to other scientific disciplines and more of recently into policy and decision making and business fields.

There are threats posed on the ecosystem services such as the increase in demand due to different factors such as population growth, harvest and resource consumption, land use changes (*Millennium Ecosystem Assessment.*, 2003;TEEB, 2010).Moreover, Millennium Ecosystem Assessment (2003) recognizes that human pressures to increase the provision of services have led into the change of other

equally important services. All these information describes the contribution of ecosystem services and dependence of human livelihood on the ecosystem and their services. The Millennium Ecosystem Assessment (2003) found that globally 15 out of the 24 ecosystem services investigated are in a state of decline and is likely to impact future human welfare.

Ecosystem services are increasingly threatened by a range of drivers of change including population and economic growth, land use and climate change. As the result of population growth demand for ecosystem services increases, therefore, human actions like overutilization, degradation on the ecosystems are reducing the capability of ecosystems to meet those demands. Globally, land cover changes from natural ecosystem to croplands, grasslands and urban areas have increased over time. This resulted in the modification of the natural ecosystems, leading to altered and diminished provision of ecosystems goods and services to the societies. The major land cover changes identified globally are Tropical deforestation, rangeland modification, agricultural expansion and urbanisation (Lambin et al., 2001;van Oudenhoven et al., 2012;De Fries & Bounoua, 2004;The Encyclopedia of Earth, 2010). Similarly, the high spatial variability in land covers is due to biophysical and socio economic drivers resulting in the variability in the causes and processes on land cover changes (Serneels, and Lambin, 2001).

The state of Land cover changes in Ghana has been studied by a number of authors such as (Benefoh., 2008; Asubonteng., 2007), of which Asubonteng, & Daniel apply remote sensing and Geographic Information Systems (GIS) techniques for assessing the causes and impacts of land cover changes induced by human activities. Those

literatures showed the conversion or modification of forest to agricultural land as the main land cover change in the country, followed by the change of natural vegetation to build up areas/settlement. Ghana landscape have been categorised into the mentioned land covers; forest, grassland/Savannah, settlement, agricultural land and water bodies. Forest as a land cover plays an essential role for the country's income through timber export. While at the local level forest supply provisioning ecosystem services like fuel wood, medicinal products, bush meat and fruits, other types of services supplied by the forest cover are regulation of micro climate condition which supports the production of country's cash crop (cocoa), catchment of water which flow in a river benefiting the rural people directly?

Since the late of 1960's, there has been an increased interest in the analysis and valuation of multiple benefits obtained from the ecosystem due to more awareness from different stakeholders about the importance of including benefits of ecosystem services in the decision making processes (Fisher et al., 2009).

The Millennium Assessment Report of 2003 highlighted that spatially defined ecosystem is the basic unit for analysing the services and value provided by their ecosystem for earning information to be useful in understanding the current spatial distribution, state and conditions of ecosystem in relation to the services they provide to the users. It's possible and in some circumstances preferable to integrate ecosystem services into decision making without using economic valuation methodologies.

The linkage between the ecosystem functions, services and benefits to human well-being entails the information of where the benefits of ecosystem services are evident, this is reached by doing valuation and mapping of the linkages between areas where ecosystem services are generated and where they are consumed and this is important when dealing with the aspect of management and policy development (de Araujo Barbosa et al., 2015).

Ecosystem services valuation has been given more attention among researchers and is of different types. The type of valuation technique chosen will depend on the type of ecosystem service to be valued, location relative to human communities and other ecosystems as well as the quantity and quality of data available. Some valuation methods may be more suited to capturing the values of particular ecosystem services than others (Bryan et al., 2010).

There are methods and tools which have been developed for mapping and predicting landscape changes, as the predictions can be used to assess potential changes and trade-off in ecosystem services provision and values into the feature (Nelson & Daily, 2010). Some decisions made currently underestimate the value of ecosystem services as its challenging due to different disciplines, philosophical views and school of thought which assign and assess the value of ecosystem and their services differently. Valuation methods fall broadly into two main types: monetary and non-monetary valuation approaches(Kumar & Kumar, 20081; Turner et al., 2003; Christie et al., 2012; Iniesta-Arandia et al., 2014). Economic valuation elicit public preferences for changes in the state of the environment in monetary terms. The main

types of economic valuation methods available for estimating public preferences for changes in ecosystem services are revealed and stated preferences.

Ecosystem services and values mapping is a way of defining the ecosystem and their services in terms of space and time. There are various methods for mapping ecosystem services which have been discussed by different researchers (Raymond et al, 2008; Chen et al., 2000; TEEB, 2010). The mapping methods presented in this research was built on the concept of ecosystem services mapping and participatory valuation methodologies to link local stakeholder's perception of place. Participatory Geographic Information Systems (PGIS) techniques were used to map the spatial distribution of ecosystem services, while questionnaires and semi structured interview were used to collect data on the ecosystem values, last but not least Geographic Information Systems (GIS) was used for various spatial analysis needed.

Although human well-being is at the core of Millennium ecosystem Assessment report among others, it have been seldom explicitly included as part of the ecosystem services assessment in terms of evaluating the importance of ecosystem services and how their changes might affect people's needs and willingness to maintain their quality of life (Smith et al., 2013). Likewise, research studies often overlook how changes in the provision of these services affect the wellbeing of different stakeholder groups particularly those whose livelihood is more directly dependent on the ecosystem services (Reed et al., 2009). For that reason, identification of the drivers of changes that shape the ecosystem and their service provision, and its definitive effect on the stakeholders livelihood and well-being, occurred as an

important issue among researchers(Chan et al., 2012; Smith et al., 2013; Summers et al., 2012).

In this research, the focus and attention have been given to the inferences on ecosystem services and people's livelihood in relation to the alteration of the land covers. Remotely sensed earth observation data on land cover are used as proxy for the ecosystem mapping, spatially explicit assessments and valuation of ecosystem services(de Araujo Barbosa et al., 2015).

1.2. Research Problem

Whilst biophysical model, and increasingly economic values are often used to delineate high significance hotspots in planning for conservation and environmental management, community values are rarely considered(Brown, 2013;Raymond et al., 2008).The participation of stakeholders in mapping and valuation of services play an essential role in providing their information to be incorporated into decision making which affect them. This research will focus on the impacts of the land cover changes on the provisioning ecosystem services which affects the user's livelihood and the service value .This will be assessed by understanding how ecosystem services supply and values change as land use also changes.

The identification of the ecosystem services and their importance by the local people will contribute in understanding the relationship between the state of the ecosystems, availability of the provisioning services and land cover from people's knowledge and experience on the benefit they obtain from the ecosystem. For the reason that the importance of land cover as the ecosystem proxy is based on its relative importance on the availability of the ecosystem services.

Services provided by the terrestrial ecosystem have a large contribution in supporting the livelihood of the local people close to its surrounding such as supply of fuel wood as a source of energy for cooking, collection of herbs from natural tree species for curing disease. Based on (Hapsari, 2010), fuel wood is ranked as the most important service in Ghana of which there is high demand for daily needs for cooking, as traditionally households have used biomass fuel for cooking.

Most researches have been done on the ecosystem services assessment in various parts but no research have been done on the assessing and linking the provisioning ecosystem service and local people's livelihoods at the Goaso off-forest reserve area. This study area has undergone some changes including the intensification of agriculture as well as human induced degradation activities. For that reason this research have empirically advance on the measurement of different socio-cultural values and how they relate to well-being and the effect of drivers of the changes. This research will also back up in providing information and knowledge on how the ecosystem services can be valued from local people's perspective, and how the valuation differs across space and what are their criteria for valuation. The values attached to the services by stakeholders differ due to the fact that, ecosystem services are supplied at various spatial and temporal scales.

1.3. Research Objectives

1.3.1. General Objectives.

The general objective for this research is on the assessment of the effects of land cover changes on provisioning ecosystem services contribution to the local community's livelihoods in the study area for environmental management decision making processes.

1.3.2. Specific Objectives.

1. To detect and quantify land cover changes.

2. To Map & quantify the provisioning ecosystem services provided by the ecosystem based on local peoples perspective.

3. To value the provisioning ecosystem services per stakeholders groups.

4. To identify land cover changes impacts on the ecosystem services to the user's livelihood

1.4. Research Questions.

1. How much and where are the changes at the Goaso off forest reserve (2000-2012)?

2. Where and which are the provisioning ecosystem services which are of most important to the users?

3. How much value do different stakeholder groups assign to the key ecosystem services?

4. What are the impacts of land cover changes on livelihood?

1.5. Research approach

The research was undertaken through three main phases. The first phase is the pre-field work involving literature review of key fundamental areas relating to the research topic. In the literature review different literatures (journals, books, papers) relating to this study was scrutinized so as to get the theoretical background of the study. The literature review was done to identify the existing knowledge gaps in terms of what is known and what is not known concerning the subject and also to conceptualize, define and formulate the research problem, the objectives and questions respectively. The fundamental areas which were reviewed are ecosystem services in general but with particular specification to the provisioning services and social valuation method. Participatory mapping, land cover classification and change detection techniques were also reviewed. The second phase was field work involving interviews, participatory mapping, and ground truth & training points. The final phase the post field work involving data analysis and discussion, interpretation and thesis writing. The detail research approach is shown in Figure 1.

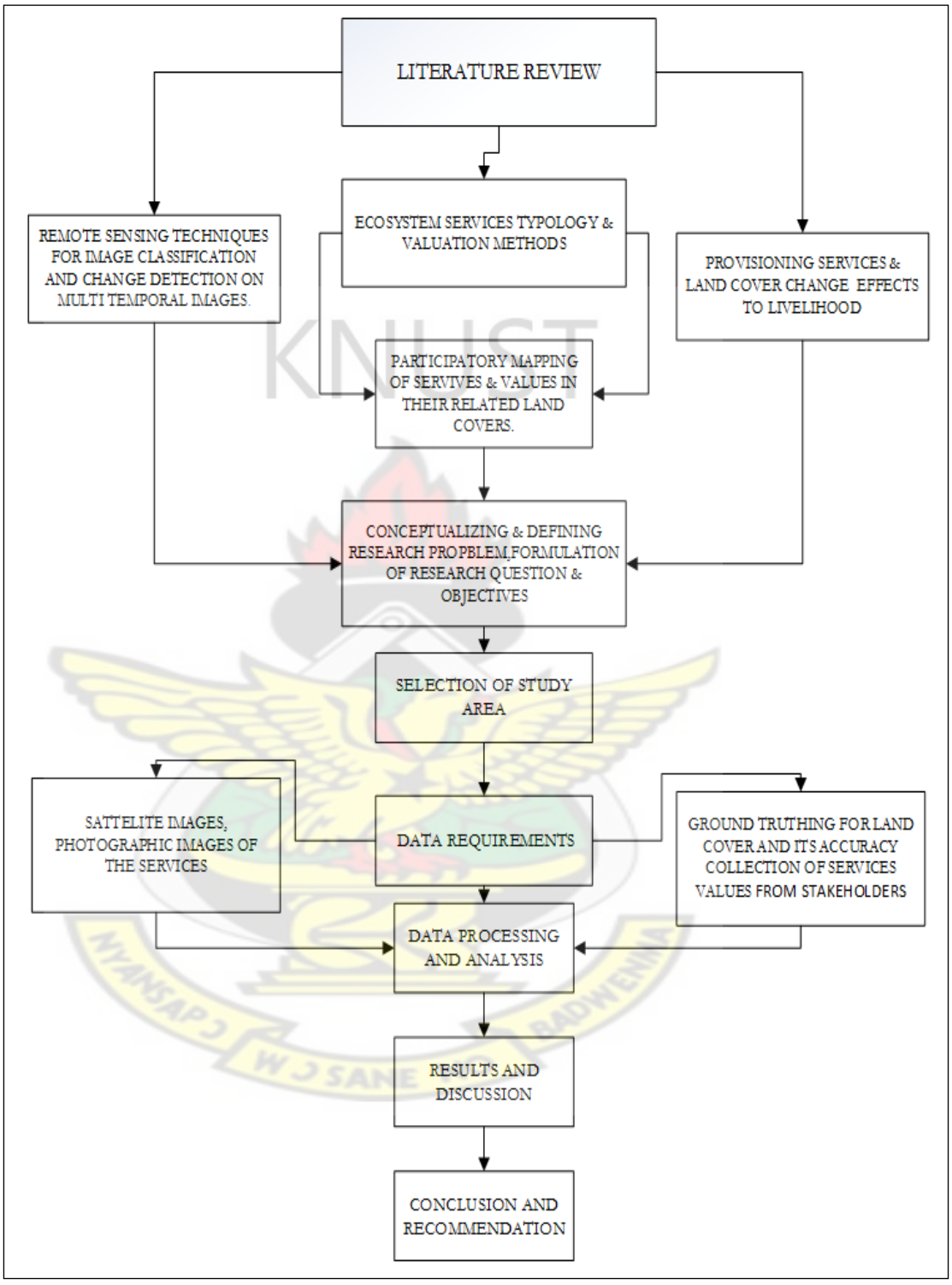


Figure 1.Research Approach.

2. DEFINITION AND CONCEPTS

2.1. Ecosystem and Ecosystem services

The term ecosystem is defined by the United Nations Convention on Biological Diversity as a dynamic complexes of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit. (www.cbd.int). Generally ecosystems can be grouped into two major groups of terrestrial and marine ecosystems. Human beings are part of the ecosystem and they benefit from the ecosystems since their life depends on the ecosystem services.

These systems interact and interconnect through processes to establish an ecological balance which interrelate at different levels to deliver valued ecosystem services to human(Daily, 1997; Costanza et al., 1998). In returns, the ecosystem services provide outputs or outcomes that directly and indirectly affect human wellbeing, because they are the benefits people obtain from ecosystems. Therefore ecosystem services are components of nature, directly or indirectly enjoyed, consumed or used to yield and satisfy human well-being(Boyd & Banzhaf, 2007).

Ecosystem processes sometimes are also called functions which express the complex physical and biological cycles, processes and interactions that underlie what we observe as the natural world which results into the ecosystem services. The specific results of those processes are either directly to sustain or enhance human life (de Groot et al., 2002). Ecosystem services as the functions in which the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly.

There are numerous, versatile and competing definition of what is meant by ecosystem services defined by different people from different disciplines and approaches(Fisher et al., 2009;Boyd & Banzhaf, 2007).Nevertheless there are common definitions of ecosystem services that are frequently used and cited;

- Daily (1997) defined ecosystem services as the conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfil human life.

- Costanza et al (1998) defines ecosystem services as the benefits human populations derive, directly or indirectly, from ecosystem functions.

- The Millennium Ecosystem Assessment., (2003) explained the ecosystem services as the benefits people obtain from ecosystems, These includes; provisioning services, regulating services, supporting services and Cultural services as outlined in (figure.2). This definition and its typology have been adopted for this research project

The definitions above suggests that, although there is broad agreement on the general idea of ecosystem services, there are important differences that can be highlighted. In Daily (1997a) and Daily (1997b) ecosystem services are the "conditions and processes," as well as the "actual life-support functions." In Costanza et al. (1998) ecosystem services represent the goods and services derived from the functions and utilized by humanity. In the Millennium Ecosystem Assessment, services are

benefits. For the purpose of this research the Millennium Assessment definition and framework have been adopted and applied.

Therefore, ecosystem services typology adopted from the Millennium Ecosystem Assessment categorized the services into; provisioning, regulating, supporting and cultural services. Among the mentioned four typology of services, this research focused on the six provisioning services which are; fuel wood, bush meat, fresh water, fruits, medicinal products and fish.

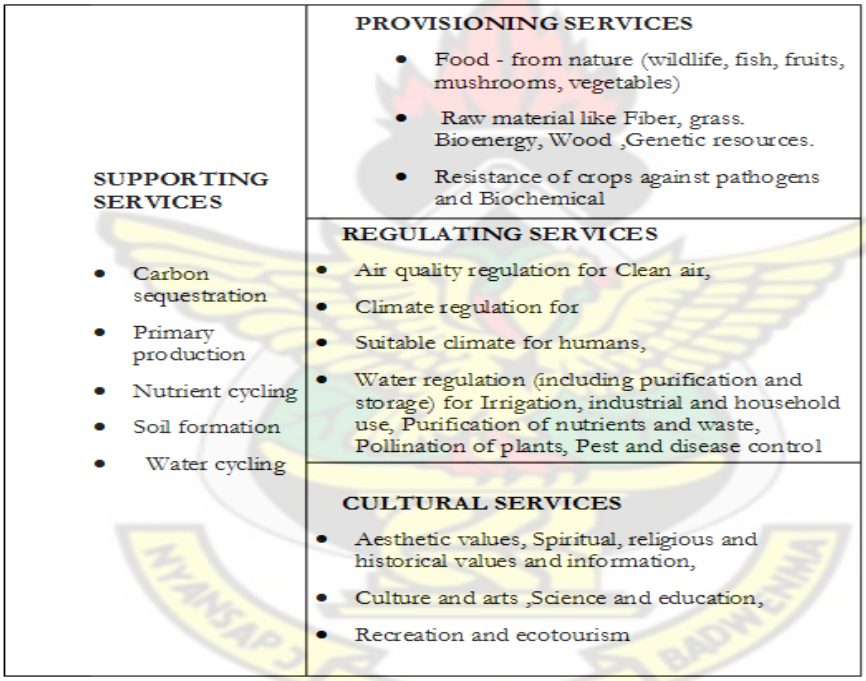


Figure 2.Ecosystem Services classification by Millennium Ecosystem Assessment.

Once the functions of an ecosystem are known, the nature and magnitude of value to human society can be analysed and assessed through the goods and services provided by the functional aspects of the ecosystem. To avoid confusion between the two terms, the difference between them have been spotted being that, a human

beneficiary is linked to a service but not to a function as focused on this work(Chee, 2004).

These functions, in turn, provide benefits to individuals and society known as ecosystem goods and services. Both ecosystem function and services are based upon natural environment which includes abiotic elements of soil, water and air (Hein et al., 2006). Natural ecosystems provide a variety of direct and indirect services and tangible benefits to humans and other living organisms (van Oudenhoven et al., 2012;Daily, 1997).

2.2. Change Detection

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times measuring how the attributes of a particular area have changed within that period(Singh, 1989).The change detection process involves the application of multi-temporal datasets to quantitatively analyse the temporal effects of the processes observed. The whole change detection process rely on the remote sensing data as the primary source of the data; one of the reasons being that, the data are in the digital format which is suitable for computer processing like Landsat images or Aster images. The goal of change detection is to discern those areas in digital images that depict change features between two or more imaging data(Hayes & Sader, 2013).

Different literature sources pointed out different change detection techniques which includes image differencing, post classification comparison, principal component analysis as the common methods used, but recently techniques like spectral mixture analysis, artificial neural networks and integration of GIS and remote sensing data

have become more important for change detection application and analysis, though each of these techniques have different algorithm(Singh, 1989;Lu et al., 2004).Among the various techniques mentioned before, Post classification change detection comparison technique has been chosen as being applicable for this research, because it involves independently produced spectral classified images of 2000 and 2012 years. And this technique have been referred to as the most commonly used quantitative method of change detection, also it operates on more than one independently classified images as inputs of which the results will be of a change map and change matrix(Chen, 2002).

For better implementation of decisions concerning spatial phenomena, better use and management of resources change detection on the land covers is needed. Time and accurate change detection of the earth's surface feature is essential and useful for understanding and explaining relationships between human and natural phenomena and their processes. Change detection is useful in monitoring changes of the earth's surface. Applicability of change detection into various fields such as land cover and land use changes, urban change, forest and wild fires, monitoring studies like flood control and coastal erosion made change detection to become an important application.(Tan et al., 2011;Lu et al., 2004).

For this project change detection have been preceded by the process of digital image classification specifically of the land cover mapping. In the land cover mapping process each pixel from the image is assigned to a land cover class based on its spectral characteristics. In this research the mapping of the land cover was performed

for the two years of 2000 and 2012 in order to perform change between the two years.

2.3. Participatory mapping

The concept of Participatory Geographic Information Systems (PGIS) or Participatory mapping emerged from participatory approaches to planning, spatial information and communication management often in developing world contexts. These approaches were also referred to as, participatory spatial engagement techniques which were linked to Geographic Information Systems (GIS) and were used as one of the methods for acquiring information on ecosystem services by making use of (PGIS).And since the 1990s, the range of PGIS applications has been extensive from community and neighbourhood planning to environmental and natural resource management. And lately the participatory approach have been used as one of the methods for acquiring information on ecosystem services by making use of Participatory GIS(PGIS).

Therefore, Participatory Geographic Information Systems is an enhanced version of Geographic Information Systems created when group participation technique is integrated with the basic Geographic Information Systems(GIS) capabilities with the overall aim of supporting peoples participation(Nyerges & Jankowski., 2002). Different researchers defined Participatory mapping in several ways and different context as follows;

- Participatory Geographic Information Systems (PGIS) is referred to as an attempt to utilize Geographic Information Systems (GIS) technology in the context of the needs and capabilities of communities that will be involved with (Abbot et al., 1998).

- (Jordan, 1999)referred to Participatory Geographic Information Systems (PGIS) as the use of Geographic Information Systems (GIS) in the participatory context.
- (Chen et al., 2009) indicated Participatory Geographic Information Systems (PGIS) as an approach designed to reflect the local community's spatial knowledge which often involves integration of local and modern knowledge for application that can potentially empower local communities.

Likewise, Participatory Geographic Information Systems (PGIS) is a result of merger between participatory Learning and Action (PLA) methods which includes Participatory Rural Appraisal(PRA),Rural Rapid Appraisal(RRA) with Geographic Information Technologies & Systems (GIT&S).From this point of view, it is built on combinations of geo-spatial information management tools ranging from aerial photographs, satellite imagery, Global Position Systems(GPS) and Geographic Information Systems(GIS) to compose local communities spatial knowledge in the form of virtual or physical phenomenon.

Participation GIS (PGIS) is a type of Geographic Information Systems (GIS) that seeks to enhance people's participation and empower non-governmental organizations, grass roots groups, and local communities. Generally PGIS describes the practice of having non-experts identify spatial information to supplement the expert information (Carver & Carver, 2001;Rambaldi et al., 2006; Vajjhala, 2005)

This research have adopted this definition of Participatory Geographic Information Systems as an enhanced version of Geographic Information Systems(GIS) created when group participation technique is integrated with the basic Geographic Information Systems(GIS) capabilities with the overall aim of supporting peoples participation. For the reason that it have been used as tool for the specific objective No.2 which need the participation of the local people (Mapping & quantifying the provisioning ecosystem services provided by the ecosystem based on local people perspective).

Also the applicability of participatory mapping is essential for this research work, due to the fact that, as one of the keys to environmental management is to understand the impact and interaction of people, with natural resources as a means to improve human welfare and the consequent environmental sustainability for future generations. Linked to this study's specific objective No.4 in terms of ecosystem services management, one of the on-going challenges is to assess what impact interventions in land covers, will have on people's livelihoods. And so, participatory mapping of ecosystem services emphasized the spatial relationships between landscape characteristics such as cover, and their contribution to human wellbeing(van Oudenhoven et al., 2012).

2.4. Ecosystem services valuation

The word value means the general importance or desirability of something, but there are more precise definitions of value which have evolved in different disciplines to meet different needs, but that greater precision sometimes limits interdisciplinary inquiry. For example (Brown, 2013) pointed out that in economic valuation

approaches values are measured by price and it is reasonable to that field, but to the non-economic approaches value is not measured by prices and there is an argument that "prices are not to be confused with values , and prices are not the only values that are important" (Cowling et al., 2008). If the identification and protection of ecosystem services is an important goal for humanity, it would appear essential also to understand the non-economic approach, of which the value has a different meaning and do not centred on the price.

For the purpose of this research there are two concepts which are being involved in the process of ecosystem services valuation which were adopted from the (Millennium Ecosystem Report, 2005) which are;

- The assessment of the total contribution the ecosystem and their services make to human well-being.
- The understanding of the incentives that individual decision makers face in managing ecosystem in different ways and to evaluate the consequences of alternative courses of action.

The broad variety of values derived from ecosystems fall within a continuum ranging from easily priced tangible benefits (such as food and pharmaceuticals); through the values associated with less easily priced services, aesthetic experiences and bequest values; all the way to moral and spiritual values(Costanza et al., 1998).The value of ecosystem services depends upon the views and needs of stakeholders (Schagner et al., 2013).

Evaluation of ecosystem services aims at analysing and quantifying the importance of ecosystems to human well-being to make better decisions regarding the

sustainable use and management of ecosystem services. The 2003 Millennium Ecosystem Assessment report found out that globally 15 out of the 24 ecosystem services investigated are in a state of decline and is likely to impact future human welfare(Fisher et al., 2009).

The social valuation of the ecosystem services through participatory mapping offers an alternative valuation approach to economic valuation which bases on money/price valuation. In addition to that, there are methods and tools which have been developed for mapping and predicting landscape changes, the results from these predictions can be integrated with the social values to evaluate likely changes and trade-off in ecosystem services supply and their values into the feature need(Hein et al., 2006).

2.4.1. Social ecosystem services valuation

A common theme that emerged out of recommendations from a broad range of researches perspectives is the need for ecosystem service valuation to more effectively incorporate the values perceived by those who benefit from those services. The term valuation can be used in many ways. In this study the concept of ecosystem services valuation refers to those values that people attach to the ecosystem services, The valuation process incorporate person's perception of the thing under valuation, the held values and associated preferences in the whole context of the valuation (Bryan et al., 2010).

The Millennium Assessment Report (2003) referred to social valuation as a process which values the ecosystem services in connection to the perceived qualities carried by a natural environment that provides benefit to support human well-being. It is

important for decision makers to assess the full range of ecosystem values including the socio-cultural apart from others (ecological and economic values).

This is a non-economic valuation approach which acknowledge the role of human perception in the assessment of conditions related to the ecosystem's ability to provide desired services and this ability can be assessed by a variety of quantitative and qualitative methods. In the evolution of this valuation approach different terminology was applied to the values obtained from this approach. The values were alternatively called forest values, then ecosystem values, environmental values, landscape values, Though the original approach wasn't explicitly linked with the concept of ecosystem services frameworks until more recent publications on community values(Raymond et al., 2008) and recently social values for ecosystem services(Bryan et al., 2010) linked the term direct.

2.4.2. Economic Valuation

1. Economic valuation attempts to elicit public preferences for changes in the state of the environment in monetary terms. The main types of economic valuation methods available for estimating public preferences for changes in ecosystem services are ;

   1.1. Revealed Preference (RP) which rely on data regarding individuals' preferences for a marketable good which includes environmental attributes. These techniques rely on actual markets such as market prices, averting behaviour, hedonic pricing, and travel cost method.

1.2. Stated Preference (SP) uses structured questionnaires to elicit individuals' preferences for a given change in a natural resource or environmental attribute. In principle, the methods can be applied in a wide range of contexts and are the only methods that can estimate non-use values which can be a significant component of an overall TEV for some natural resources. The main options in this approach are: contingent valuation and choice modelling methods. The underlying case for the valuation of ecosystem services is that it will contribute towards better decision-making, by ensuring that policy appraisals fully take into account the costs and benefits to the natural environment and by highlighting much more clearly the implications for human wellbeing, while providing policy development with new insights.

2. Non-economic valuation which are also referred to as deliberative or participatory approaches tend to explore how opinions are formed or preferences expressed in other units than money, these deliberative or participatory methods obviously have a part to play in understanding people's preferences and the process of decision-making and may therefore influence policy. Deliberative or participatory methods apply more of a qualitative approach rather than focusing solely on assigning economic values. These can elicit values often by asking people to explain or discuss why they behave in a particular way or hold a particular view. The focus can be on what people think society should do, rather than on their personal behaviour choices by using methods like qualitative semi-structured interviews, stakeholders group discussion(Department for Environment,Food and Rural affairs., 2007).

2.5. Ecosystem services and livelihoods

Livelihoods are the means people use to support themselves and are an outcome of how and why people organize to transform the environment to better meet their needs through technology, labour, power, knowledge, and social relations(Manyatsi & Mwendera, 2007).To be specific, peoples livelihood can be defined as ‘‘the capabilities, assets (including both material and social resources) and activities required for a means of living’’(Chambers & Conway., 1992)

Research on ecosystem service and goods has become important area of investigation for the past decade and the number of papers addressing ecosystem services is rising exponentially (Fisher et al., 2009).This explains the ecosystem services influence on human well-being and it’s high value to society, as human beings had always depended on the biosphere and it’s ecosystem due to its services which are resulting from different ecological processes which take place (Fisher et al., 2013).

Thus, human beings are an integral part of the ecosystem and they benefit more from the ecosystem services (appendix.1) .The concept of ecosystems services has become an important model for linking the functioning of ecosystems to human welfare. Understanding of this link is critical for a wide range of decision-making contexts. Yet human being buffered against environmental immediacies by cultural and technology development and advancement, still are ultimately fully dependent on flow of ecosystem service.

Greater management emphasis should be placed on the linkages between social and ecosystem change including the indirect drivers of ecosystem change such as demographic and cultural factors(Brown et al., 2006).

3. MATERIALS AND METHODS

3.1. Study area

The research was carried out in Goaso Forest Zone in Asunafo North district in Brong Ahafo region, Ghana. Goaso Forest Zone lies between latitudes 6° 27’ North and 7° 00’ North and longitudes 20° 23’ West and 2° 52 West. The total land area of the district is 2187.5km² with forest reserves covering 779.4km². The major land cover types identified in off-reserve areas are cropland, trees, fallow and grassland. The land use is mainly forest and agriculture. The forests are mainly reserves and off-reserves are agricultural lands. .

Goaso was selected as a study area due to its relevance on provision of empirical evidence to the reliance of local communities to the ecosystem services. Goaso has a rural side communities that directly benefit from the ecosystem provisioning services such as fuel wood, fresh water and medicinal products, the subject being studied. Figure 3 shows the location of the study area in Ghana.

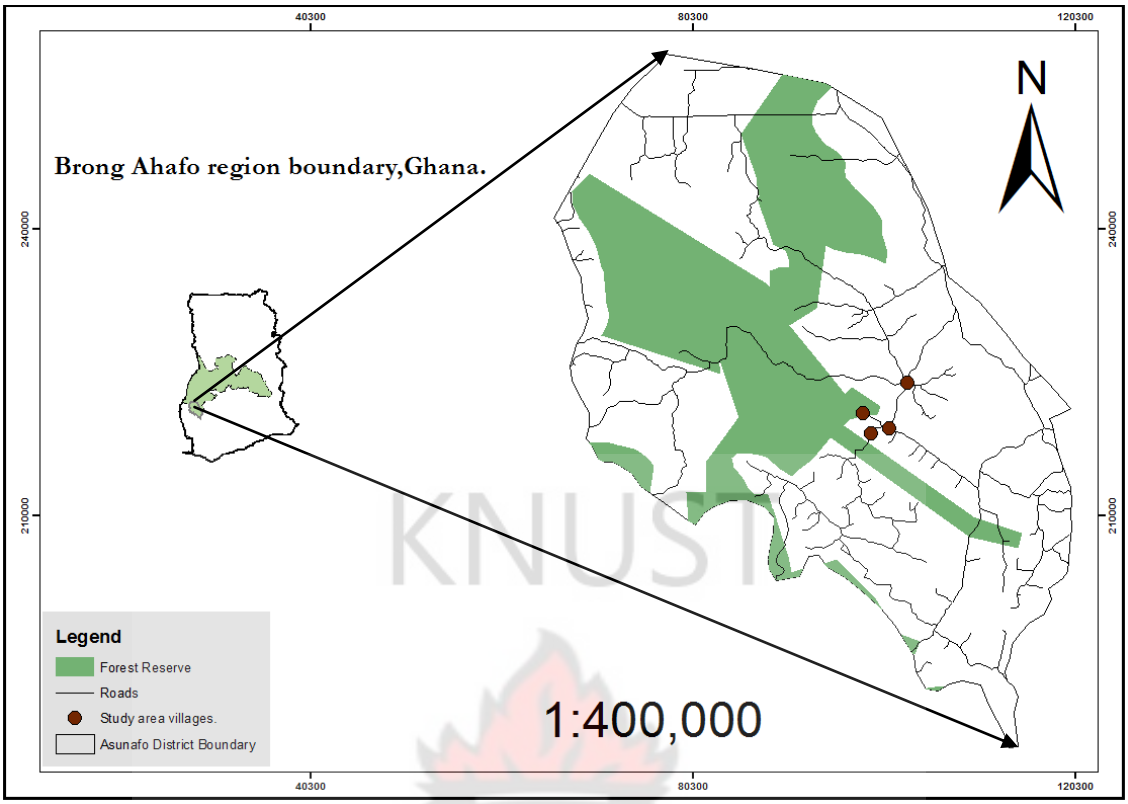


Figure 3.The location of study area (points) at Asunafo North (District administrative).

3.2. Biophysical and Social Profile of the study area

Asunafo North District is one of the twenty two district in the Brong Ahafo region of Ghana, with Goaso as the district capital. Goaso is located 85 km away from the Regional Capital Sunyani. The District covers a total land area of 1,093.7 km2 which constitutes of about 2.7% of the Regional land area. The District has a population of about 130,502 people (Ghana Statistical Service, 2010) of which 51% are female and 49% male with a growth rate of 2.6% per annum and a population density of 79.5 person per square kilometre. Agriculture is the major economic activities dominated by cash crop farming (cocoa) and mixed cropping (cocoyam, plantain, cassava, maize and vegetables.

The land tenure system is vested in the stool in which the Chief holds the land in trust for the inhabitants and communities making up the stool. The topography and drainage of the district is generally undulating with 132 as the minimum and 425meters as maximum elevation points, there are two main rivers among the several streams. The district experiences a wet-semi equatorial climate characterized by uniformly high temperatures with the mean monthly temperature of 25.2^0C while March being the hottest month (30^0C).The mean annual rainfall is between 125cm and 175cm. The major rains occurs between April and July and minor from September to October. The relative humidity being highest during the rainy season ranges from between 75% - 80%. The vegetation of the district is dominated by the semi-deciduous forest (tall trees with evergreen undergrowth) which occupies about 578.63sq.km. The forest reserves are Abonyere, Bonsambepo, Ayum and Bonkoni Forest reserves. The District experiences minimal and occasional incidences of bush fires. Lately, illegal gold mining famously known as "''galamsay'' is gaining ground. Indiscriminate disposal of plastic waste also poses environmental problems.

3.3. Data

Two multi temporal satellite images were used for the study; The Landsat Thematic Mapper(TM) of February 2000 and Landsat Enhanced Thematic Mapper of January 2012 with path and row of 155/45. These images which were cloud free were selected from the ITC database based on the suitability in terms of seasonal likelihood. Also a WorldView high resolution (0.5 meters) satellite image of 2013 printed on A1 paper at a scale of 1:25,000 was used for the ground truthing, image classification and accuracy assessment and participatory mapping. A total of 250 ground truth points were collected with Global Position Systems (GPS), of which 97

were used for image classification and 153 for accuracy assessment. Stratified sampling was used of which the land covers were divided into strata.

Shape files of Administrative Regions and Administrative Districts of Ghana were obtained from ITC database for the study. These shape files were used to prepare maps of the study area.

3.4. Methods

In order to achieve the objectives, combination of research methods were adopted. Due to participatory nature of the research, it was necessary to undertake field work study. The dynamics of the ecosystem services available and used from the local communities using participatory GIS were identified .The data collection methods used in this study are based on the tools for collecting for case study research, these includes interview, group discussion, direct observation and participation observation. The varieties of these tools are useful for collection of data from variety of informants who give multiple sources of evidence. The specific methods used are presented in the flowchart in Figure 2 and explained in the ensuing paragraphs.

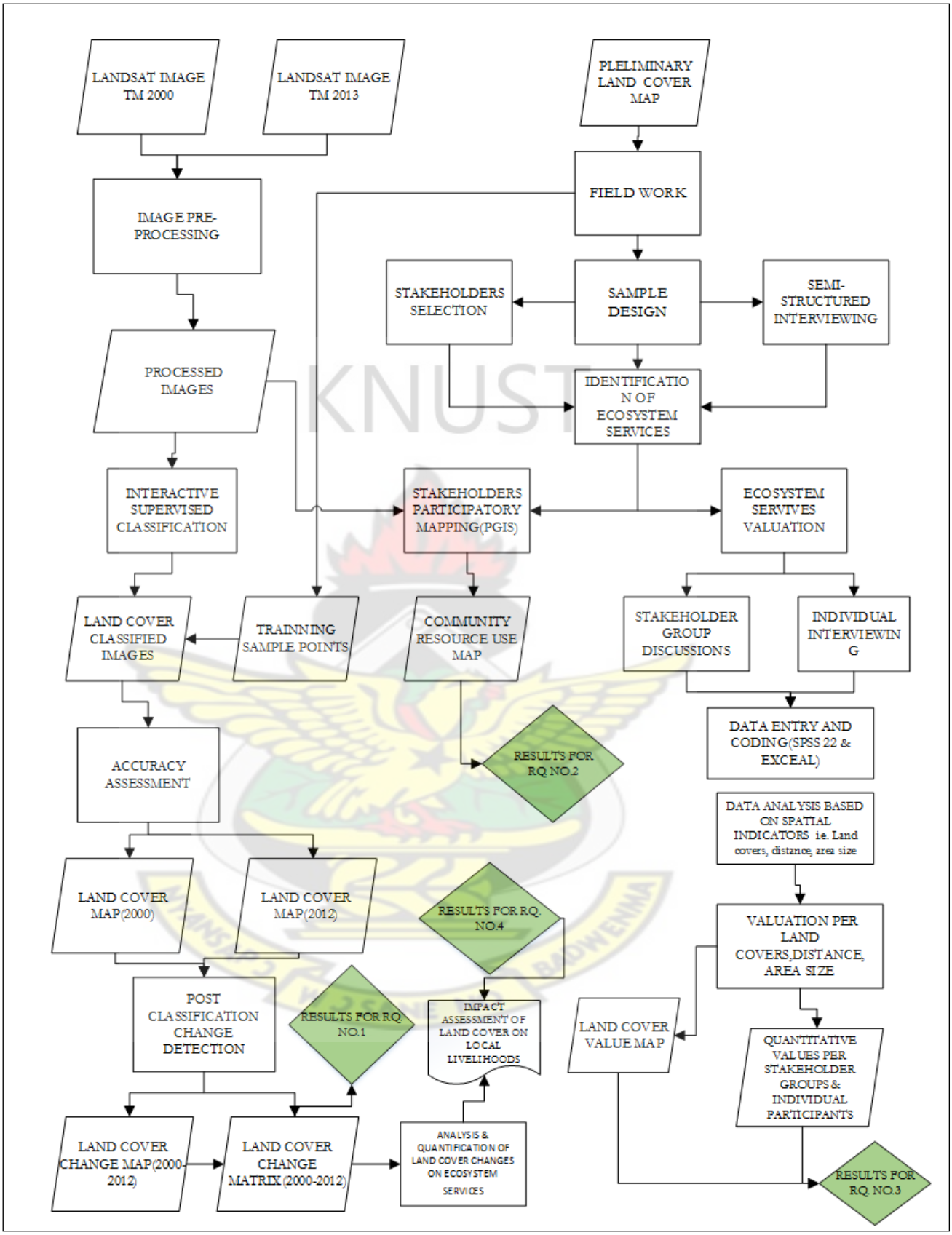


Figure 4. The methodological flowchart.

3.4.1. Image Pre-processing

The two Landsat images were geometrically corrected to the local coordinate system of Traverse Mercator projection of the WGS _1984_UTM Zone 30N by using ArcGIS 10.1 software. The geometric correction is used to register each pixel on the image to the real world coordinate by converting the geographic coordinate into the projected systems.

Before image classification three major steps are involved on image pre-processing including geometrical rectification and image registration, radiometric and atmospheric correction, selection of suitable techniques to implement change detection analyses and accuracy assessment .These corrections are done due to the nature of remote sensed image which contain some distortions.

For the participatory mapping exercise, a digital WorldView satellite image (2013) was adapted for participatory mapping exercise. The image was recorded in(FEB) was geo-referenced using the WGS84 reference system and printed on A1 size at a scale of 1:25000 for the two villages (Figure 4).This scale was chosen to enable the participants to identify and interpret different features and objects from the image.

3.4.2. Sample Design

This was a framework which served as the basis for the selection of the research samples. The probability sampling techniques namely simple random sample and purposive sample were used. The simple random sample was used for semi structured interviews in order to get information from different community members so as to reduce spatial bias. While the purposive sample was used for selecting participants for the group discussion and participatory mapping based on the two main criteria of; 1)Participants have to be active involved in the environmental dependence activities like farming, hunting, fishing and 2)Being the residence in the village who have stayed for the past 20 years going on.

3.4.3. Stakeholders Selection and Identification

Stakeholder identification process defines aspect of a social and natural phenomenon affected by a decision or action by identifying individuals, groups and organization who are affected by or can affect those parts of phenomenon and priorities these individuals/groups for participation. There are different approaches for identifying the stakeholders such as normative, instrumental (Reed et al., 2009).For this research context due to the long process of identifying stakeholders and time limitation, stakeholders have been identified from the literature (Dumenu., 2010) such as are farmers, hunters, District Forest Officers, land owners and traditional authority groups in which selection will be done by using purposive sampling and checking in the field. From the identified stakeholders two groups of men and women were formed and selected through the help of the traditional authority as the primary stakeholders for each village.

Stakeholder groups are those community individual groups that share common interest and who may be affected by land use decisions or any outcome. Stakeholders can be grouped into various ways according to different spatial and temporal scales, economic and social factors, based on their interests and influence such as, primary or secondary, active or passive. For the purpose of this research in relation to ecosystem services mapping, stakeholders refer to persons, organizations or groups with interest in the way a particular ecosystem services is used, enjoyed and managed (TEEB, 2010). For this research analysis, the local stakeholders were local farmers and hunters inhabitants. They were selected because they are the most directly affected by any changes in the ecosystem and their services. They have direct influence on the movement of ecosystem services and are beneficiaries and stewards of the services.(Reed et al., 2009).

Ecosystem services selection was done through literature review in which a preliminary list of services have been identified and selected which are fuel wood, bush meat, fruits, fresh water & medicinal products and fish was the added services identified and mentioned by the local people.

3.5. Field Work

Before starting the field work in the villages or approaching any community, there was a need of asking for the permission from the Chief to work in their villages, in which the objective of the study was explained, its relevance to the communities and researcher's expectations concerning the role to be played by the communities.

3.5.1. Questionnaires and Semi structured Interviewing

A total of 80 questionnaires were administered in Akrodie, Borodedwo, Chief camp and Kumonso for individual respondents only and not for the stakeholders groups.. Out of this, 75 were reliable and selected for further analysis. The variables used in these questionnaires were interrelated with the respondent's (a) relationship with the study area and the general environment, (b) perceptions and understanding of the ecosystem and their services importance and (c) socio-economic data. These methods were used so as to provide an adequate assessment of local circumstances, changes and perceived causes by the local people.

The group discussion were done to obtain explore more on their perspective as women group and men group, on the way they relate and benefit from the ecosystem and their services.

5.3.2. Participatory valuation and group discussion

With the help of an interpreter, a brief introduction and description on the topic was made to the participants of group discussion. The participants for the group discussion was made using snowball sampling techniques through the community leaders who used their social networks and knowledge to identify and select people who could participate in the exercise. The additional minor criteria for selection included availability and willingness to participate. In each of the four communities two focal groups (woman & men) were selected for group discussion and participatory mapping exercise. One group consist of (10-14) people.

For the participatory mapping and evaluations stakeholders used hand drawn polygons map to show or represent the location/areas where they are collecting their ecosystem services. Polygons were used rather than the points because, they can be easily converted into the vector image, and no particular skills are needed for drawing the polygons. Participatory mapping has been increasingly used to engage the general public and stakeholders to identify a range of ecosystem services that originate in place-based, local knowledge instead of proxy data from literature or process modelling. One of the way to obtain spatial information about ecosystem services is by involving stakeholder groups and having them identify crucial ecosystem services values and local ecological knowledge using participatory mapping methods (Darvill & Lindo, 2014). The composition of the groups for the participatory mapping is shown in Table 1 and Figure. 5 shows the steps used for participatory mapping.

Table 1.Composition and number of participants.

Community name	**Group Discussion & PGIS**	
	Female	Male
Akrodie	12	14
Borodedwo	13	11
Chief Camp	10	12
Kumonso	13	11

Below are the steps which were followed during the group discussion meeting with the women and men groups from the villages. The first step was the identification of the services obtained from their area and selecting the most important services, then analysis of the land cover changes based on cause and effect relationships and

assigning values to the services. The last step was the mapping of the services from their frequently areas of collection.

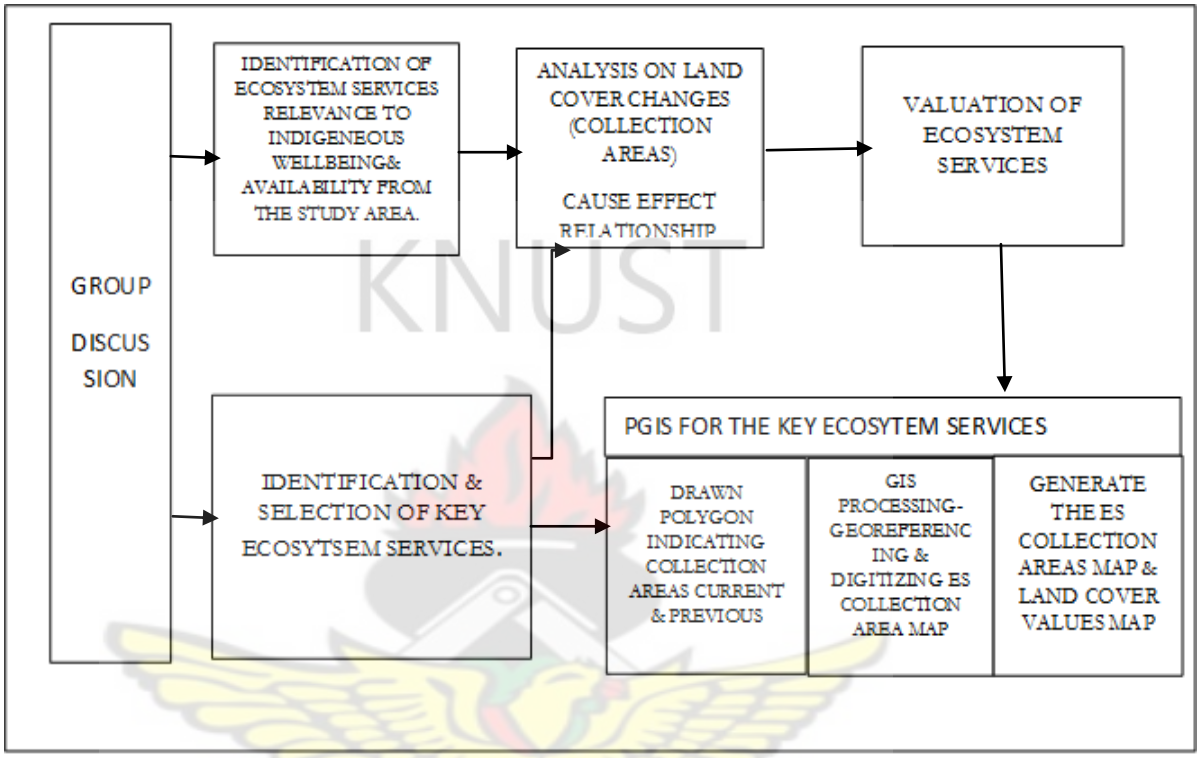


Figure 5.Flow chart diagram for group discussion & PGIS adopted from Ramirez-Gomez et al., 2015

3.5.3 Mapping of Ecosystem services values

This methods was used to map the ecosystem services values obtained from the respondents (section 3.4.2.2).The methods based on the use of land cover data as a proxy for services collection areas and values allocated to the services. The map will show the variations of ecosystem services supply/location across space according to the values given to the land cover, weather high or low.

3.6. Land cover mapping and change methods

3.6.1. Image Classification

Satellite images contributes to the provision of several types of information needed for the assessment of ecosystem conditions including land cover mapping (Millennium Ecosystem Assessment., 2003). The land cover mapping objective is to mimic the earth surface in a possible way by delineating the different features as they exist in their natural environment. Image classification converts the image data into thematic data. To have good classification process the following steps are necessary; image pre-processing, selection of training sample and selection of suitable classification approach.(Bektas et al., 2002;Campbell, 2002).

To map land cover classes an Interactive supervised classification technique in (ArcGIS 10.2)was used, this technique accelerates the maximum likelihood classification process in which is based on statistics (mean; variance/covariance).A (Bayesian) Probability Function is calculated from the inputs for classes established from training sites. Each pixel is then judged as to the class to which it most probably belongs. The statistical probability is computed for each class to determine the membership of the cell to the class, as each cell is classified to the class to which it has the highest probability of being a member (Singh, 1989). In supervised classification the main procedure is to determine the type and number of desired classes by choosing representative pixels from each class as training data, then choose the classifier algorithm and use the training data to classify the image(ITC, 2012).

The Landsat images were subset for the exactly study areas and WGS 1984 spatial reference system was applied. The Interactive Supervised Classification by using the ArcGIS software was performed on the Landsat TM (February2000) and Landsat (Jan 2012) and categorized the study area into five major classes for the purpose of the study namely; Annual cropland, Perennial cropland, Fallow land, Forest and Trees land and Settlement/bare land. The land cover maps generated will be used for understanding the ecosystem services valuation. These land cover classes were chosen in relation to the ecosystem services which can be identified and collected from them(Hein et al., 2006).

3.6.2. Change Detection.

Change detection is the process of identifying differences is the process of an object or phenomena by observing it at difference times, the process involved the use of multi-temporal and mulita-spectral data set to discriminate the changed areas.(Lu et al., 2004).

Change detection for this work has been done on the Landsat imagery (2000) and collection of the GPS points from the field. The following aspects are observed when doing change detection; detecting if a change has occurred, identifying the nature of the change, measuring the area extent of the change and assessing the spatial pattern of the changes(Lu et al., 2004). Change detection provides a land cover change map with following information: area of change (km2) and its rate, spatial distribution of changed types and accuracy assessment of change detection.

3.6.3. Data analysis (interview & stakeholder's group)

Statistical data analysis was performed on some variables for analysis which were collected during semi structured interview and group discussions meetings. The Non-parametric techniques of T-test and Chi Square were applied, the techniques are often more suitable for smaller samples or when the data collected is measured only at the ordinal (ranked) level.

The techniques explores relationships by doing comparison between the stakeholders groups in respect of the type of questions to be addressed and the nature of the data collected from the field. The data needed and collected were ordinal data.

4. RESULTS

4.1. Land cover maps

The Landsat image classification and mapping gave out five land cover classes which were required for this study. The Land cover maps are used as the basis for change detection and ecosystem services assessment. The main reason for choosing these land cover classes were due to their nature which support the ecosystem and the ecosystem services which are being studied. The following table shows the land cover classes and their description.

Table 2.The Land cover classes and their description as used for this research.

NO	LAND COVER TYPE	DESCRIPTION	REASONS.
1.	Annual Cropland	These are the areas cultivated and planted with annual (food) crops such as plantain, cocoyam, maize, beans and some trees.	This land cover supports and has multiple ecosystem services such as medicinal products, fruits, and fuelwood and bush meat.
2.	Perennial cropland	Areas which are cultivated(monoculture) and planted cash crop which takes long period of time to be harvested(3-20yrs),dominated by cocoa and little of palm trees.	Perennial cropland is the largest land cover found in the study area, it's having some of the ecosystem services such as fuelwood and fruits as the majority, while bush meat and fruits as minor services.
3.	Fallow land	These are the areas which are left undeveloped/unplowed for some time, they are covered with trees, shrubs and grasses.	Due to the scarcity of this type of land cover, not many ecosystem services are found rather than fuelwood, medicinal products and a little of bush meat.

4.	Forest and trees land	These are the areas covered by forest reserve which are protected by the government and off-reserve trees.	Due to the nature of this land cover, only bush meat and medicinal products are the only ecosystem services collected by the local.
5.	Settlement & Bare land	This class includes areas which are built up for residential utilities, infrastructure and bare land.	This class shows the population distribution across the study area, and the distance in relation to the ecosystem services availability.

These are the Land cover maps of the study area which are described in (Table.2) are presented in the maps below and their images (appendix 6);

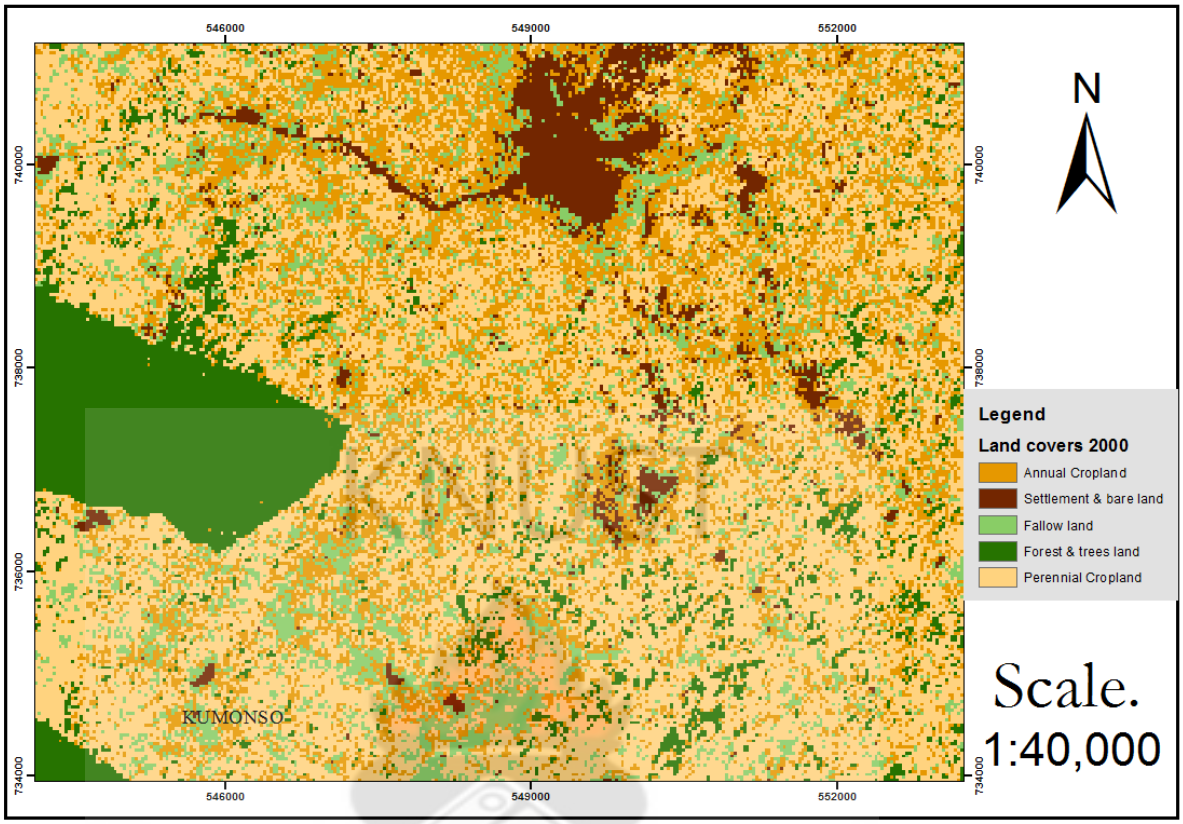


Figure 6.The Land cover map for the study area, February, 2000.

According to the Land cover thematic map (Figure.6), the forest reserve cover is located in the western portion of the study area as a large homogenous patch. The forest reserves which are close to the study villages are Bommsembepo forest reserve (135.90) km2) closer to Akrodie and Borodedwo villages. Aboniyere forest reserve (40.15km2) is closer to Chief Camp and Kumonso villages. All of these forest reserves are under the Government Forestry department which implement the collaborative management with the surrounding communities, though human activities are limited in this land cover types compare to other covers still illegal logging is taking place. Whilst fallow (trees, grass, bush) are found as patches across the area. Perennial cropland dominates the area to the large extent compare to the annual cropland. But the settlement is associates with the built up areas and the other bare/open land.

The Land cover map for 2012(figure 7) also shows the forest reserve in the western portion of the study area, dominated by the perennial cropland across the whole area, while the fallow land being more in the north east area of the study area. Settlement/bare land spread more in the area compare to the 2000 year. The 2000 and 2012 Land cover maps are explicitly covering the physical study area spatial location in relation to the four sampled villages and not the whole administrative boundary of the district (Figure.3).The forest reserve(large green patch) was not accurately classified due to some spectral implications as the accuracy assessment report indicated.

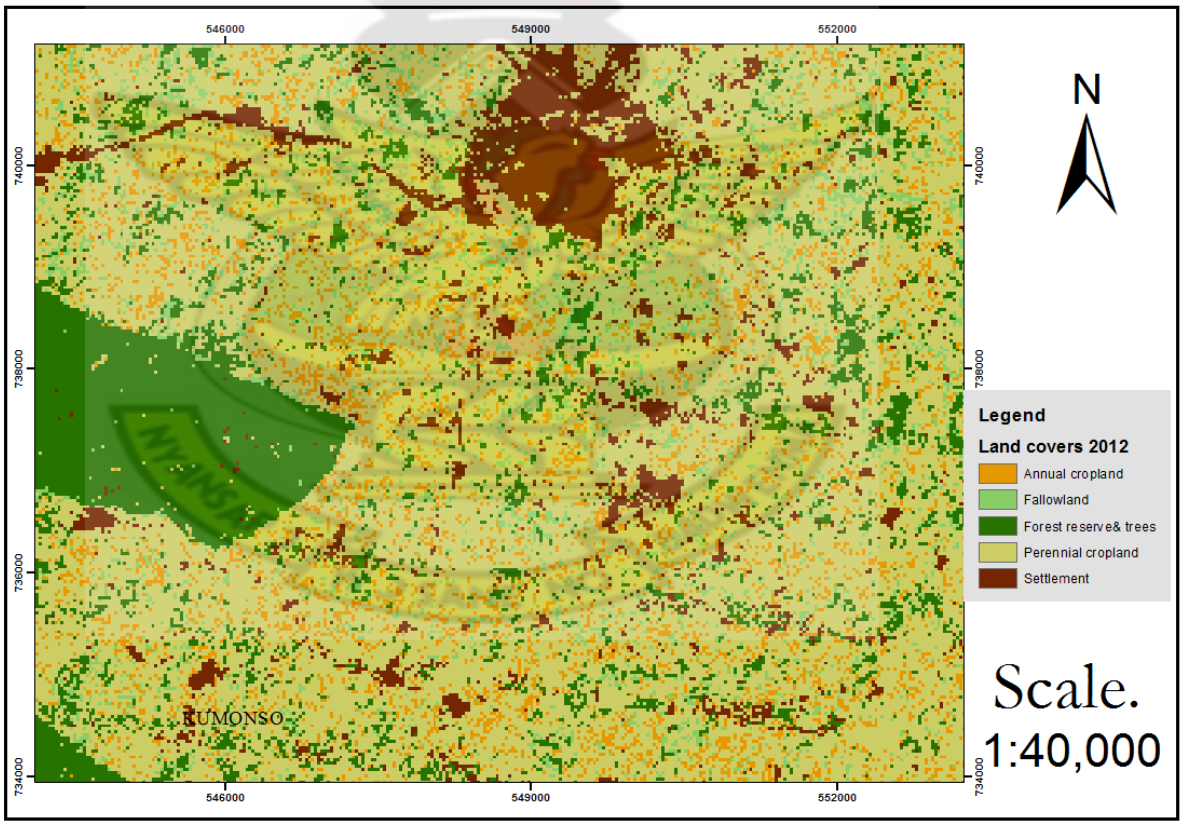


Figure 7.The Land cover classes for the study area, January, 2012.

This was done by using the ArcGIS software and the Microsoft excel. The image classification process results into a raster file of the land cover classes, to check the actual quality of the classification results accuracy assessment was done for the 2012 in the matrix table below;

Table 3.Accuracy Assessment report.

Class Names.	Annual	Fallow	Forest	Perennial	Settlement	Total of classified values.	User accuracy	Error Commission
Annual	31	2	0	4	2	39	79%	21%
Fallow	5	15	0	5	1	26	58%	42%
Forest	0	1	18	0	2	21	86%	14%
Perennial	2	6	2	28	0	38	74%	26%
Settlement	2	5	1	3	18	29	62%	38%
Total of real values	40	29	21	40	23	153		
Error of Omission	23%	48%	14%	30%	22%	The overall Classification Accuracy=72%.		
Producer accuracy	77%	52%	86%	70%	78%	The Kappa Statistics = 64%.		

The accuracy assessment was carried out using the 153 ground points collected from different land covers from the study area. The location of the sample sites were chosen by using selective sampling in order to have adequate representation of the land covers types from the area. This report gives calculation of different accuracy measures, the most common cited measure of mapping accuracy is the overall accuracy which is calculated by dividing the number of correctly classified pixels divided by total number of the pixels checked, for this research the overall accuracy is 72%.

Other accuracy measures are calculated per class as follow; The producer accuracy classes of forest(86%) ,settlement(78%)and annual(77%) and perennial(70%)

croplands has the highest producer accuracy which implies that, there were classified correctly in the sense that, the chance that a sampled point on the map is indeed matching with the real ground sample classes. While the user accuracy gave the possibility that a certain reference class has indeed actually been labelled as that class in the real ground, from matrix table in the assessment report the classes of forest (86%) and annual (79%) are having the highest user accuracy.

4.1.1. Land cover classes for the 2000 and 2012

Below is the graphical presentation of the dominant land cover classes for the two years from (Figure5 & 6).With the Perennial cropland occupying the largest size area for the both years while fallow land with the least size area.

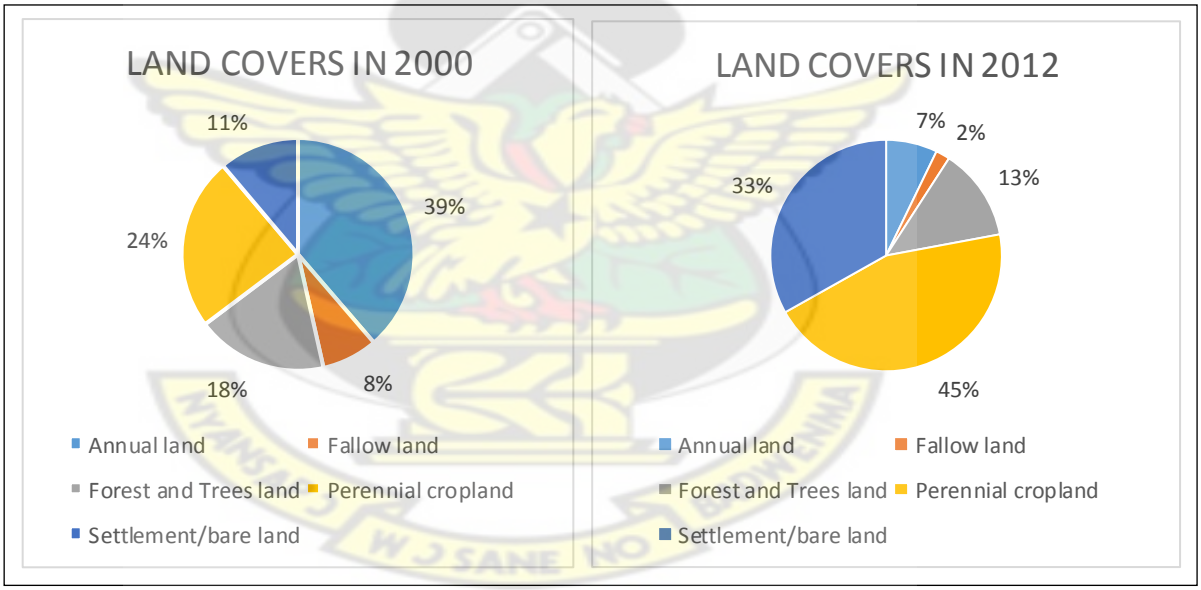


Figure 8.The graphs for the Land cover classes' area.

4.2. Ecosystem services Mapping (PGIS)

Before the mapping exercise of the ecosystem services, there was a need for the identification of the services to be mapped.

4.3. Identification of the Ecosystem services

These are the provisioning ecosystem services identified by the local people and especially that are of necessary to maintain long term human well-being and livelihood because they are being used by them as the basic for supporting their daily living.

Table 4.The list of identified provisioning ecosystem services from the study area.

ECOSYSTEM SERVICES	SPECIFIC EXAMPLES	USAGE
Bush meat-	Akrantie (grass cutter),Kusie(rat),wansane(wild pig/bushbuck).	Daily home consumption and occasionally for selling.
Fuel wood	Cocoa trees.	Basic fuel for cooking at home daily
Fish	Koboe	Home consumption and selling
Fruits	Pawpaw, oranges, anka	Home consumption
Medicinal products –	bofre,(pawpaw leaves),nyamedua, acacia leaves, mahogany	Source of medicines for curing different diseases.
Water	Fresh water from streams and wells.	Basic home usage.

.

4.3.1. Ecosystem services per land covers

Land cover matrix per ecosystem services. This study addressed the provisioning ecosystem services namely six form the five land cover classes, below is the land cover and ecosystem services matrix which shows the ecosystem services obtained from their specified land cover classes from the all study area. This information was from the respondents interviewing.

Table 5.Land covers matrix and its services.

LAND COVERS	**NO.OF ECOSYSTEM SERVICES FOUND**	**FREQUENCY**
Annul Cropland	Bush meat	*
	Fruits	***
	Fuel wood	**
	Medicinal products	**
Fallow land	Fuel wood	*
	Medicinal products	***
	Bush meat	*
	Fruits	**
Forest	Bush meat	***
	Medicinal products	**
Perennials	Bush meat	*
	Fruits	*
	Fuelwood	**
Settlement	Water(well)	***
Water	Natural water	***
	Fish	***

(*Less frequent ** frequently ***more frequently).

4.3.2. Resource use participatory mapping

These are the maps which shows the areas/places where people are collecting their required services. The maps were produced through the participatory mapping exercise for the four villages of Akrodie, Chief Camp, Borodedwo & Kumonso) from the study area.

In the mapping of ecosystem services collection places, participants identify spatially explicit direct and indirect benefits from ecosystems that contribute to human well-being and also included an assessment of their relative importance of the services provided. Participatory Geographic Information Systems (PGIS) studies have shown that participatory mapping of ecosystems services are especially appropriate to identify provisioning and cultural benefits that are grounded in personal experience (Brown & Fagerholm, 2014).

From the results the main ecosystem types found are; Agro-ecosystem and the Forest ecosystem. Also the mapping was specifically on the displaying the villages resource use map for the identification of specific places on a map that the stakeholders would like to see maintained for the conservation or trade off.

The maps (Figure.9) were derived from participatory mapping exercised per each village. They provides information about the spatial extension and distribution of the main land covers types (ecosystem) and their services collected. The (figure9.a) shows the distribution pattern of the areas were the services are collected. Among the four villages studied, this is the village which is having more population and large settlement pattern compare to the others. The mapping of the collection areas was specific on the South Eastern part of the area as showed in the map. These are the

areas where people are going frequently due to the presence of their farms (cropland) and likely land covers which supports the availability of the services.

The distribution of the services supply areas in the map below is evenly distributed (Figure.9). As services are collected all over the surrounding settlement area. Due to the large coverage area of the Akrodie village communities, one direction was selected based on its willingness and readiness of the local to participate on the participatory mapping exercise. Therefore the South Eastern part of the village was selected .The distribution pattern of the services supply areas presented as polygons on the map, can be recognized in some specific land like fallow land, perennial cropland and trees land compare to the annual cropland which is far from the settlement. Therefore from the display of the community resource use map, the forest land cover does not contribute to the supply of the services like the other land covers.

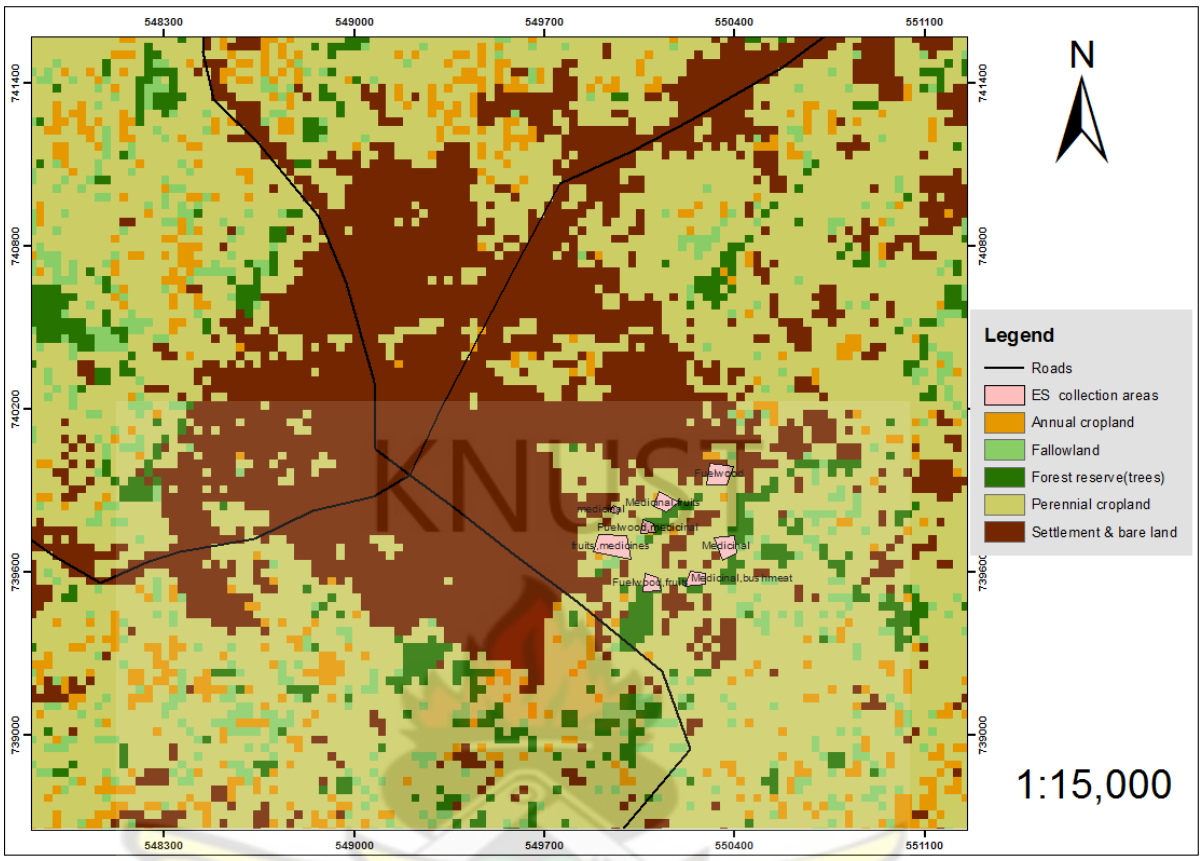


Figure 9.Akrodie community resource use map.

Figure.10 below represents the visualization of the distribution of the services collection areas across the Borodedwo village community. Though this is a Forest fringe community with the expectation that people would benefit highly in terms of services like fuel wood, bush meat from the forest compare to other communities. But during the participatory mapping none of participants drew a polygon to indicate some areas from the forest land cover were services are supplied. The services supply areas are located almost all around the settlement with the exception of the North Western part of the map. From the map, most of the polygons are associated with perennial cropland, off reserve trees and a little in the fallow land.

.

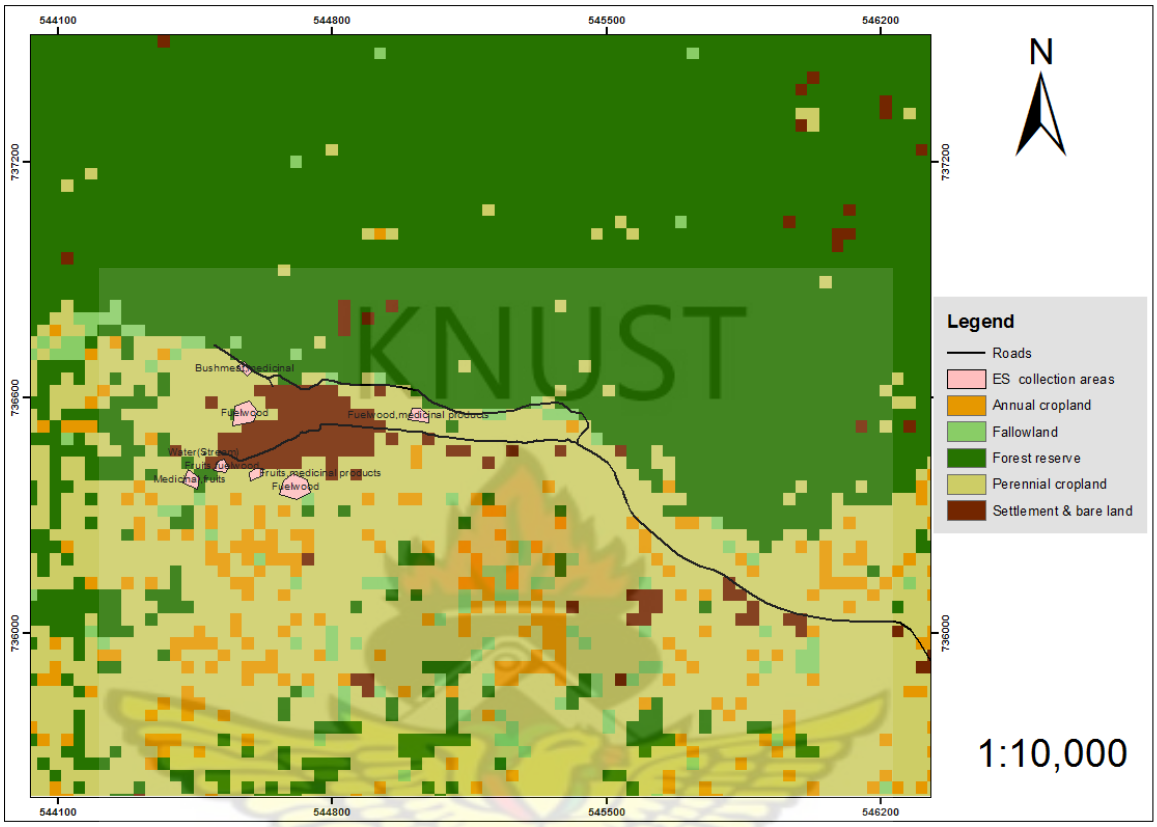


Figure 10.Borodedwo community resource use map.

The resource use map for the Chiefcamp village (Figure 11) also display the visualization of the services supply areas. The distribution pattern of the areas are almost all over the settlement surroundings, but more are observed in the Eastern part of the map. And most of these supply areas are located within or close by annual croplands rather than perennial cropland or fallow land.

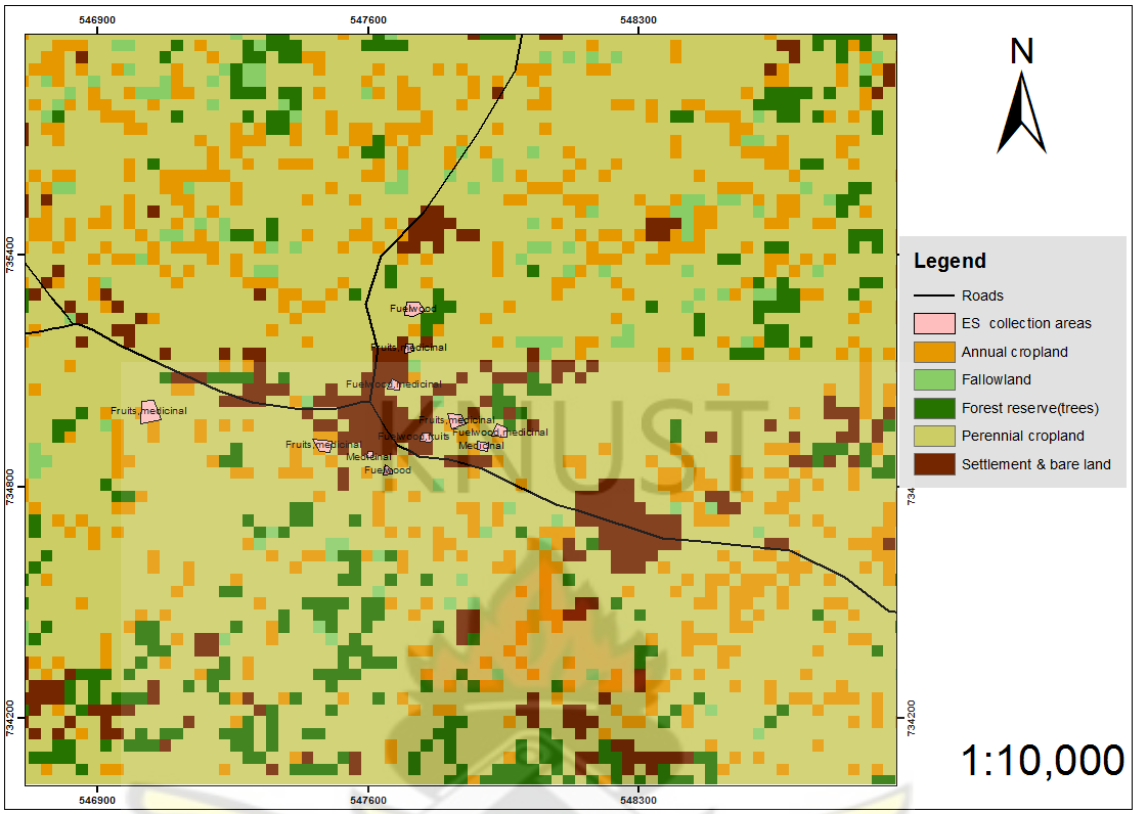


Figure 11.Chiefcamp community resource use map.

With the Kumonso community(FIGURE 12), services are collected randomly as the polygons indicated in Figure12. From this map the polygons which represent the services collection areas are associated with all land covers with the exception of settlement

& bare land. Generally the resource use maps shows the spatial distribution of the areas where the services are collected in relation to the specific land cover. Apart from the land covers as an indicator for identification of these areas, accessibility and land ownership were other indicators mentioned by the stakeholders.

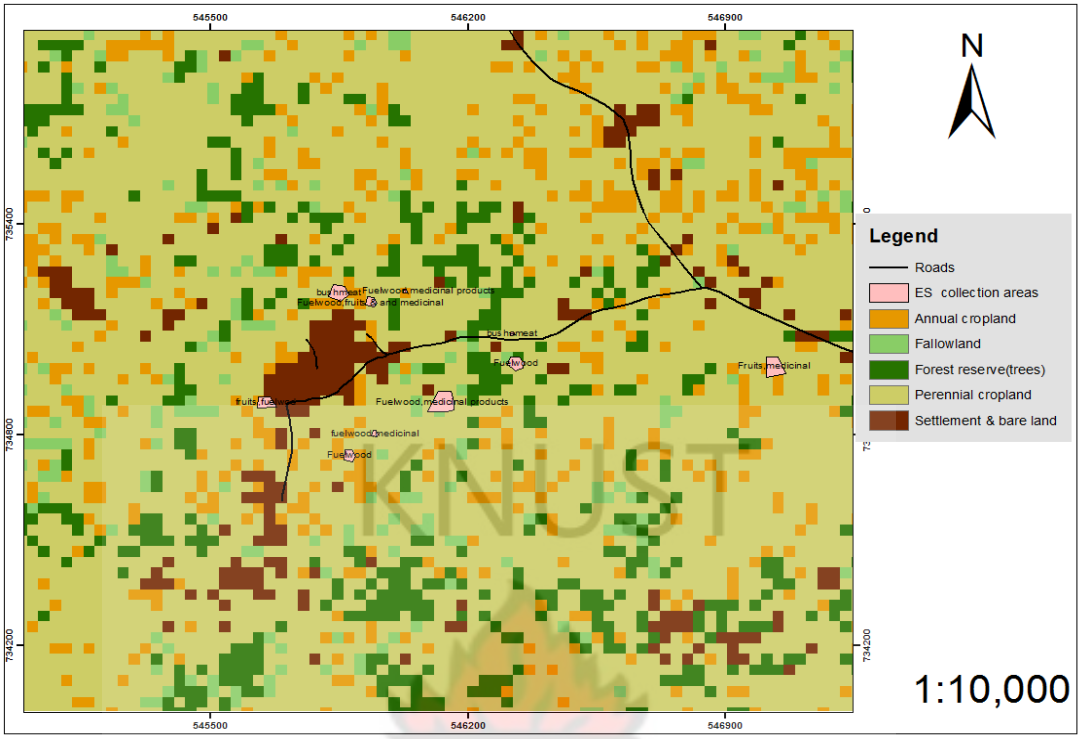


Figure 12.Kumonso community resource use map.

In this research the ecosystem services maps are referred to as the community resource use map.They are important tools for decision makers and institutions such as government ministries to enables the spatially identification of which land covers should be maintained due to their high supply of ecosystem services.

These maps are also important to assess spatial trade-offs among ecosystem services, synergies among multiple ecosystem services, as well as to prioritize areas that will allow alignment of multiple conservation.

4.4. Ecosystem Services in relation to the distance through Transect walk

The valuation of the ecosystem services based on the distance of which people have to cover to collect the services was assessed in two ways; the spatial analysis and the

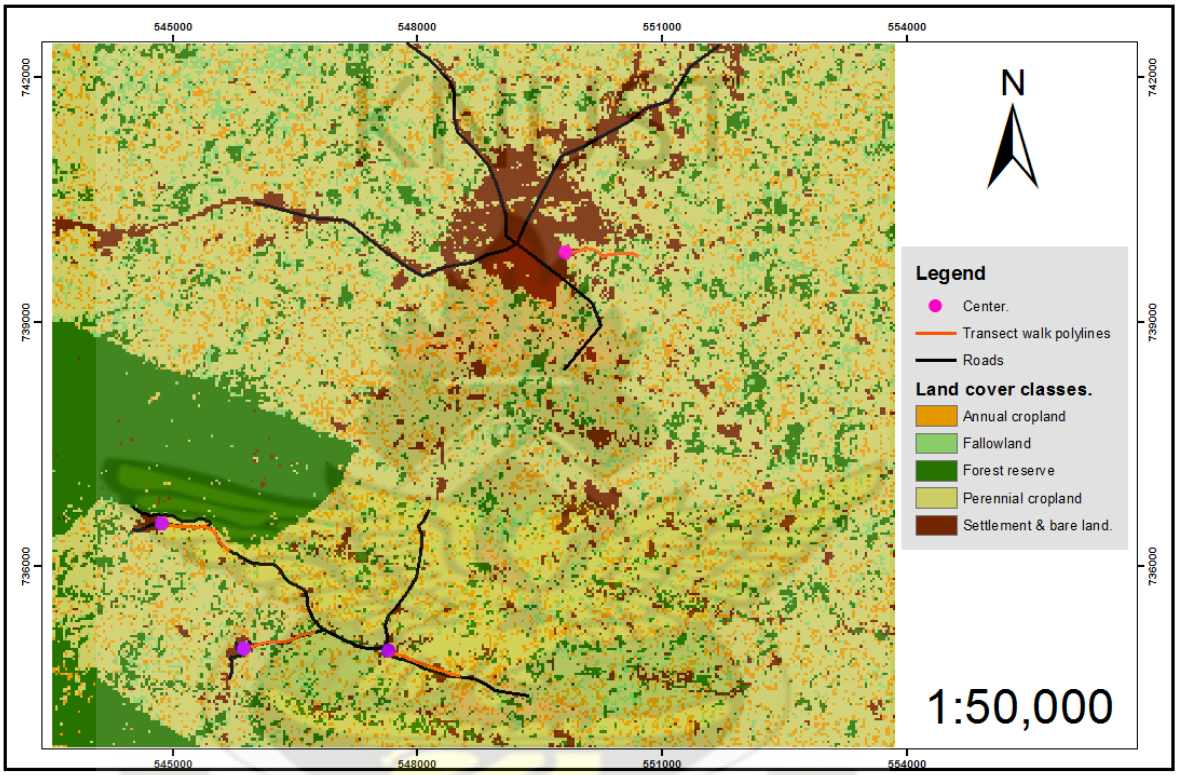


Figure 13.Transect walk map in relation to ecosystem services, distance.

Transect walk. The transect walk covers the distance of 1 km (orange polyline) in which is divided into sections of hundred meters with the recording of GPS points per each point (Figure 10).The transect walk was done to check whether there is a difference in observation different number of ecosystem services found per distance interval class(figure.13).

From the transect walk observation, the distance has influence on the availability of these services. The further people are moved from their settlement the more different

number of service are collected. From the field observation, the land covers which are close to the settlement do not have services or they are very few because are collected intensively. Also distance was associated with the value given to the land covers, in the sense that the further people walks to reach the collection place to collect the services, then the lower the value the land cover will have. From the interview and discussion there was no quantitative value given by local people on the importance of their walking distance in the influencing their valuation.

The second part of statistical analysis was on comparison categories. The Chi- square test results to check whether there is relationship between the distances covered for the collection of the ecosystem services, the distance used here was obtained through the interviewing people. The analysis was done separately per each village.

From the Chi-square test was performed at 95% confidence interval ($\alpha = 0.05$) and the results indicated (appendix 3).The results showed there was no association between the number of the ecosystem services and the distance class intervals, because the p-value for the three villages (0.146), (0.326),(0.064) are greater than the significance level of 0.05 .But an association exists on distance class intervals to the number of ecosystem services for the Akrodie village ,whereby the p-value (0.014) is less than 0.05. Generally from the Chi-square test analysis distance does not influence the number of ecosystem services found per land cover class. For the three villages(Chief camp, Kumonso & Borodedwo),which means the further people walk or the less they walk the ecosystem services collected will be the same, as most of the settlement are closer to their farms where they frequently collect the services. With the exception of Akrodie village in which the distance affect the availability and collection of the ecosystem services, as people have to walk further from their settlement to collect the services, because the village is having higher population

compare to the other three, so the demand of land is higher for other economic activities, so people have to walk further from their settlement to collect the needed services. The chi-square test was performed, rather than the t-test, because the chi-square test is more suitable to determine the association between two variables when the entire population is unavailable.

4.4.1. The average number of the ecosystem services per land covers

The ecosystem services per land cover per specific villages for comparison of which land cover has most ecosystem services and which have least services per villages. The average number of ecosystem services was calculated by taking the total number of ecosystem services found per that land cover(from interview) divide by the six number of the ecosystem services.

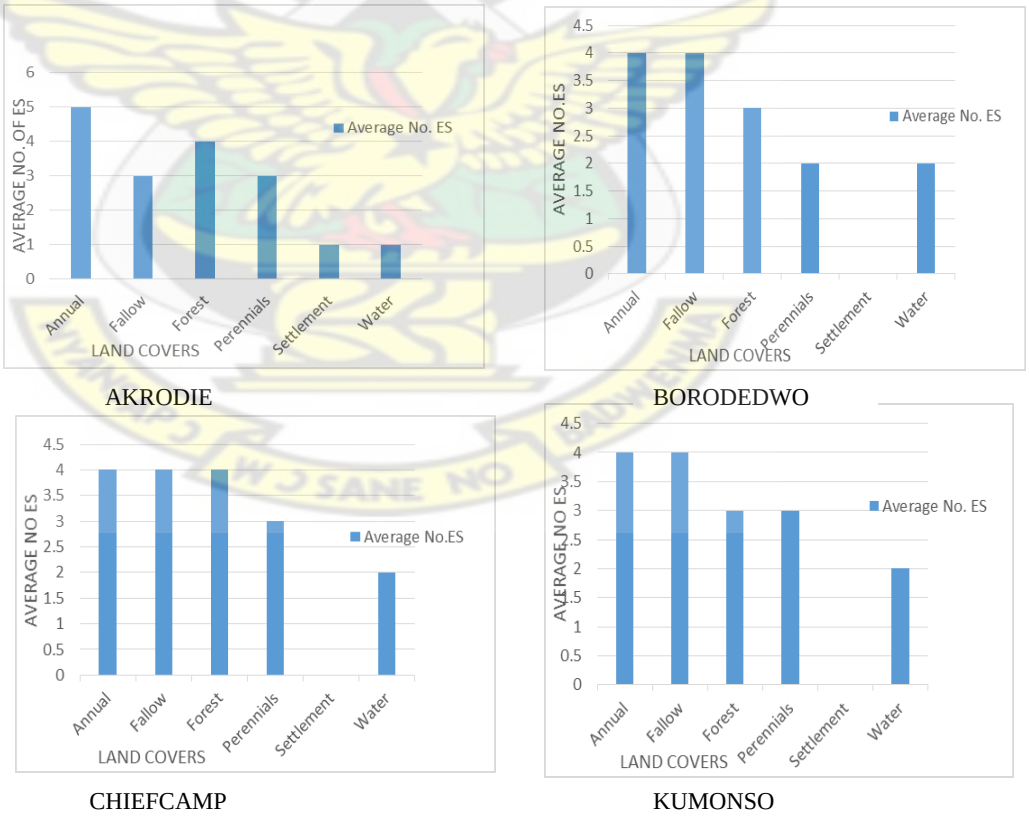


Figure.11 .Number of Ecosystem Services per land Covers for each Villages

The above (figure.11) graphical presentation illustrates the number of services which can be obtained and collected from the land covers. The graphs are also shows the comparison of number of services per land covers among the four studied villages The Chief camp graph indicates the annual, fallow an forest as the covers with the many services,while Borodedwo and Kumonso graphs shows the annual and fallow lands with more services,with the Akrodie village annual and forest are covers with more services.. The average number of the services were calculated by taking the total number of the ecosystem services found per that land cover (from interview) divide by the six number of the ecosystem services.

From the comparison above, the annual cropland and fallow land are the land covers with high average number of ecosystem services for the all communities, as 1-5 services are found within those covers. Followed by the forest with average number of 1-3 services, according to the respondents, there are rules which are imposed by the Forestry department forbid them to collect fuel wood from the forest reserve or cutting trees which are outside the reserve. Perennial cropland is having average number of 2-3 ecosystem services. While settlement and water are the land covers with least average number of ecosystem services. There are some services which are seasonal base like fruits, fish and bush meat, for example, bush animals are permitted legally to be hunted during rainy season only in the forest. This also highlights the importance of access to, and control of ecosystem and their services.

4.5. Ecosystem Services Valuation

Questionnaires were addressed to 75 respondents during the semi-structured interview, and the random sampling was used to select the respondents, of which the

relative frequency for the female was 56% and 44% for the male. The table below showed the total number of people who were interviewed and their characteristics from the four communities.

Table 6.Respondents population characteristics

VILLAGES	GENDER		AGE			EDUCATION		TOTAL NO.OF RESPONDENT
	M	F	BELOW 20	21 - 50	50+	ILLITERATE	LITERATE	
Akrodie	**8**	**22**	1	**22**	**7**	10	20	30
Borodedwo	8	7	-	11	4	5	5	15
Chiefcamp	9	6	1	5	9	7	8	15
Kumonso	8	7	1	11	3	7	8	15

Ecosystem Services valuation per Individual respondents

These are the values given by the interviewee from the four communities, the value were given based on their preference and availability through the cocoa beans exercise(The cocoa beans exercise was done by asking the respondent to assign the amount of the beans among the six services on the scale of 0-60 beans. The service with 10 beans was considered with the highest value while 0 very least value).

The table below(table 7) presents the value allocated by the respondents individually from each village, but were analysed separately between men and women. The values were tested if they are significant statistically based on the gender using the SPSSS 22.0 software. One sample T-test was performed to test the significance of

the ecosystem services values among respondents from all villages at 95% confidence interval ($\alpha = 0.05$) (Appendix.4).

Table 7.Ecosystem services values per each village(from cocoa beans exercise)

Ecosystem Services	**Ecosystem services values per each village (%)**							
	Akrodie		Borodedwo		Chiefcamp		Kumonso	
	F	M	F	M	F	M	F	M
Bush meat	12	50	19	19	15	26	15	24
Fish	6	4	0	8	12	3	2	5
Fruits	6	4	3	19	7	18	11	17
Fuelwood	25	16	22	16	22	18	21	17
medicinal	21	7	22	13	22	15	19	10
Water	29	18	28	24	22	20	32	27
Total	76	44	36	37	41	34	47	41

The highest valued service was the bush meat and water with the value of 50%, followed by water with 32% and fuel wood 25% while fish was the least valuable service. The overall high average value was 12.7 from the female from Akrodie village while 6 was the least value allocated values by females from Borodedwo village.

This values were also tested statistically, and the results showed there were not significant enough at 95% to support the average values given to the ecosystem services by men and women individuals was 12.7 as the highest to females and 6.0 as the lowest by females. Whereby for the males the highest average values was 7.3 and the least was 5.7.

Ecosystem services valuation per stakeholder groups

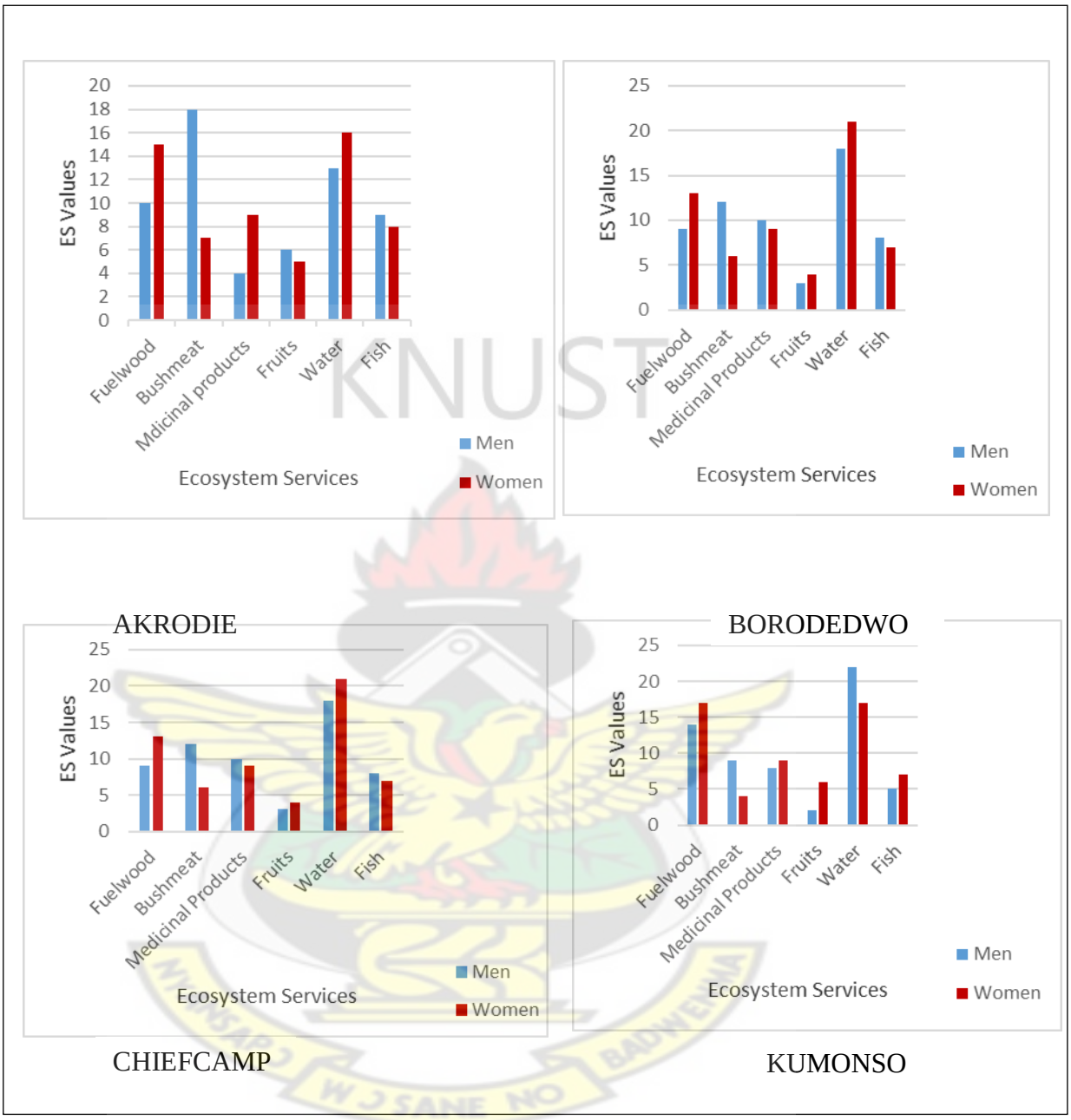


Fig.12. Ecosystem values among the stakeholders groups.

From the above graphs, generally water received the highest values within the whole study area, followed by the fuelwood, while services like fruits, fish, bush meat and medicinal the values differs according to their gender and preferences.

These values were related with the land cover area of which they were collected. From the change detection (Table.6).The perennial, cropland and forest & trees were having the largest coverage area of 5,718 and 1,650 hectares of land, but from the results most of the services were collected from annual cropland and fallow land. Therefore the size of the land do not influence the number of the services to be collected. Instead its ability of the land cover to produce the services. The values also were allocated based on the number and availability of the services per land covers trough interviewing.

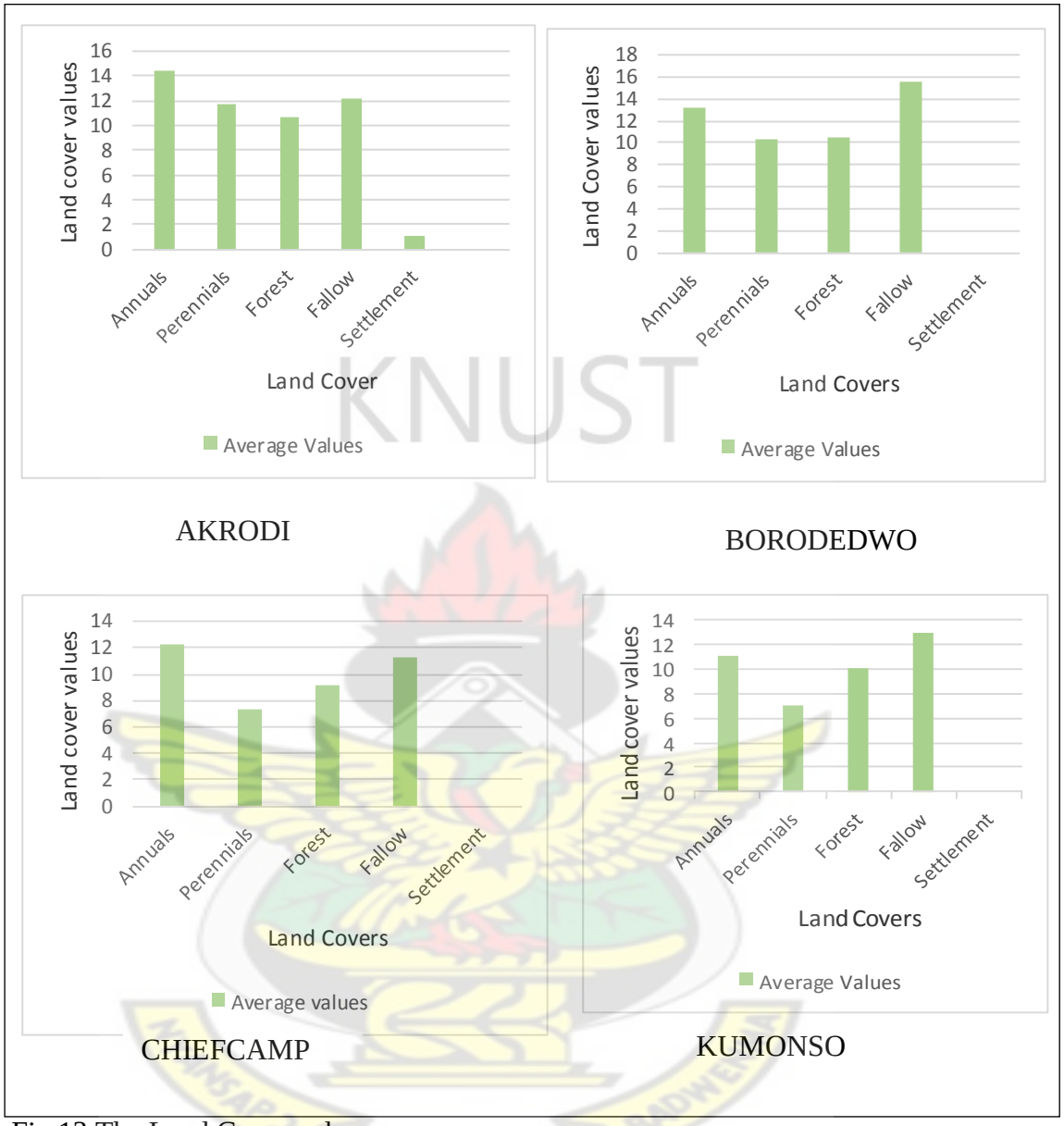


Fig.13.The Land Cover values.

Valuation of the land cover was done based on the importance of land cover as a place for supplying services. The average values were collected by summing the total value given to the services from each respondent and divided it by the number of respondents. The values were given by the respondents in consideration of the number of services collected from the land cover and the importance of the service to their livelihood. The average values are presented in the graph above (Fig 13).

4.5.1. Mapping Ecosystem Services values

This research applied the use of land cover data to map the ecosystem services values. Mapping of land cover value in a social valuation across a given geographic area shows how the values vary across the space as well as giving geographic information compare to the traditional site specific ecosystem valuation which was specific for designing land use. The land cover valuation mapping was done to visualize the ecosystem services values given by the local communities per specific land covers where they are collected(Figure 14). These values were allocated due to the people's preferences and the availability of the services to the people in terms of physical access.

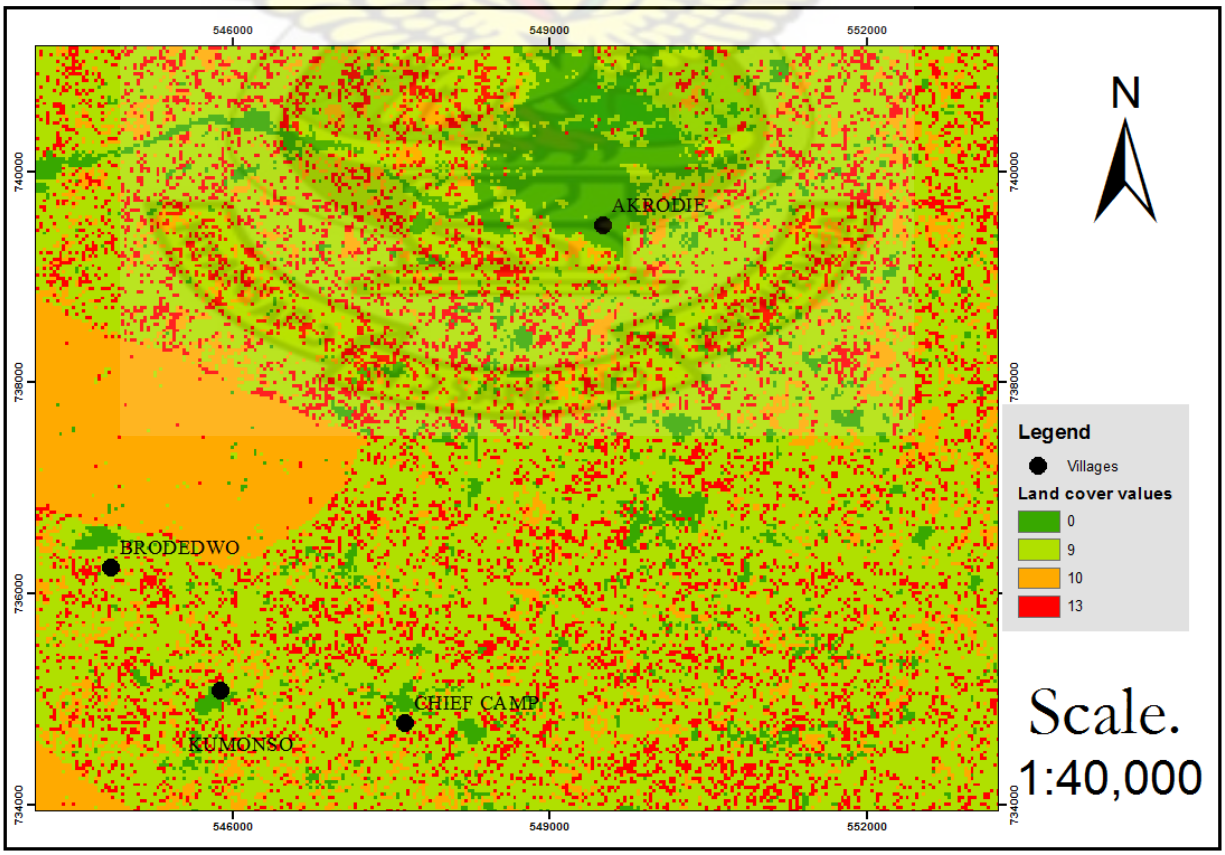


Figure 14.Land cover value map.

The values used to map the land covers were calculated from the values assigned by stakeholders to the ecosystem services from their specific land covers collected. Therefore the land cover which supply more number of services will have more values compare to the one with few numbers of services. Mapping of the land cover values gave valuable information on visualization of the specific land cover values on a large spatial scale at once. Most Land cover demonstrated high diversity of social values, with the highest frequency of social values of ecosystem services were associated with agricultural land (annual cropland), followed by fallow while forest and perennial had average values compare to the settlement and bare land which was least valuable.

4.5.2. Assessment of the Valuation

From the comparison of the above villages and with regard to ecosystem services, more than 70% participants assigned high value to the most of the provisioning services under this study different land cover got the highest value. The highest land cover values was given to the perennial cropland by the Chief camp village, followed by the annual cropland by the Akrodie village, followed by water and fallow land covers.

From the (Table 7 and Figure 12) results of the individuals and stakeholders valuation per villages, bush meat, water and fuel wood were the highly valuable services. Both women and men considered water and fuel wood to be the valuable services. But bush meat was highly valuable by the men alike the medicinal products which more valuable to women. Fruits and fish services were not considered valuable by both genders. Among the four village communities highest values were

from the Akrodie village with the average value of 12.7 and the lowest values were from Chiefcamp with the average value of 5.7.

The overall values from each land cover were mapped (Figure 15) and the annual cropland was the most valuable land cover, followed by fallow land, forest and perennial cropland, while settlement was the least valuable in terms of services supply. High values were assigned to those land covers, because they supply more than two ecosystem service and these land covers are under individual ownership. While the forest land cover which is the forest reserve is under the government ownership and protected by the laws. Therefore the land cover values were based on the benefit local people obtained from those land cover

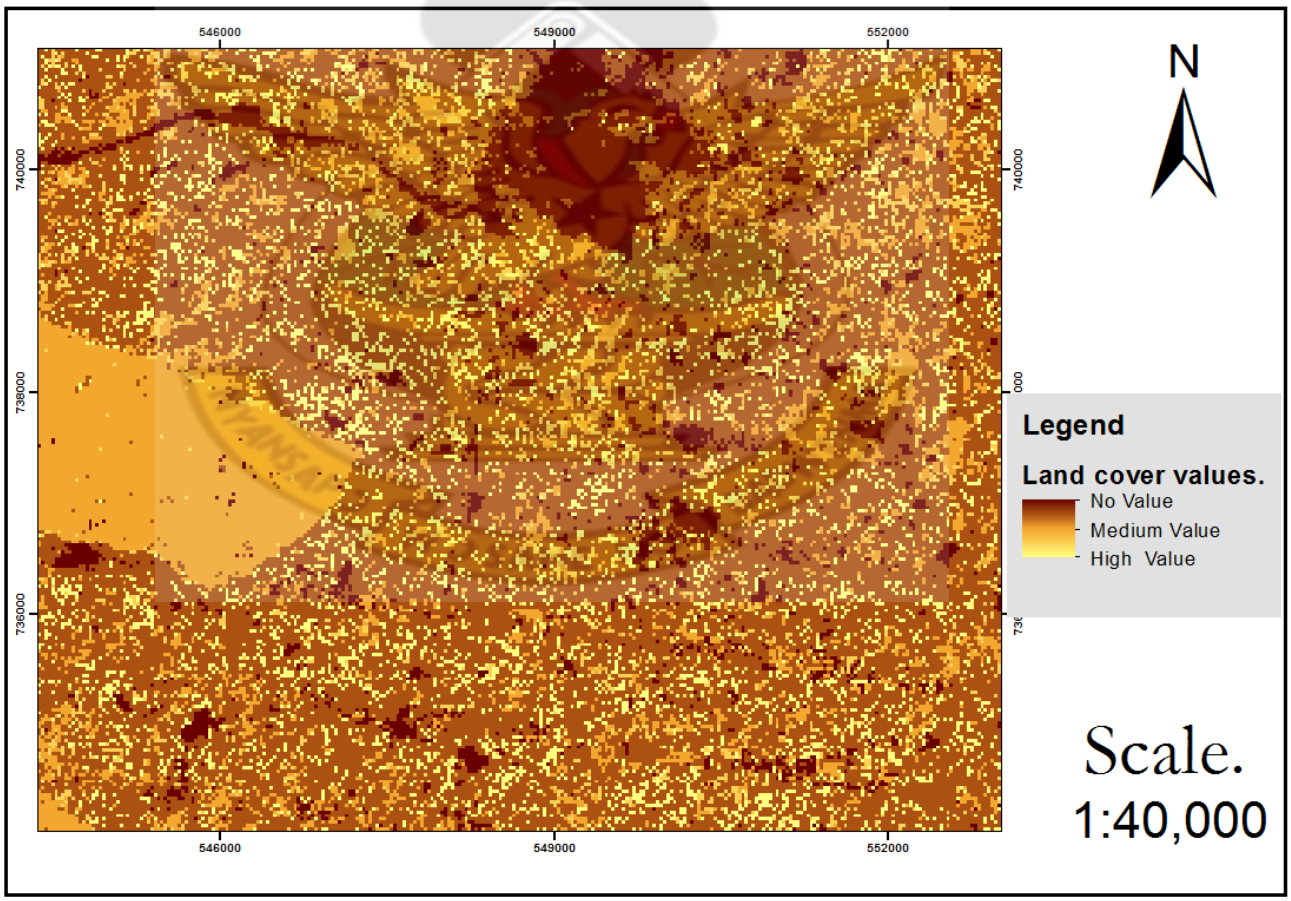


Figure 15. Land cover value map assessment.

From the Land cover value map (figure 15), the assessment of the values was assessed in terms of areas with no value, medium value and high values. The areas without value incudes settlement and bare land which does not supply any ecosystem services. While the areas with high values are in blue colour distributed unevenly across the map and covered small portion.

4.6. Change Detection Map

Change detection map are the map which shows the changes taken place in a given area within a given time interval (2000 to 2012). From the land cover changes results, the analysis was focused to the observed two main types of changes namely; 1. The Land cover change map which shows the changes in the type of cover/vegetation of particular place and 2.Changes in terms of the supply of the services from the area.

4.6.1. Land cover change map.

This was done after the classification process using the ArcGIS software(post classification change detection), whereby the raster calculator(spatial analyst tools) and field calculator was used to calculate the changes in the land cover classes for the 2000 and 2014 years by using this formula((2000 image*10)+2012 image).

The land cover changes map (figure 15) demonstrate the five (5) dominant changes which were visualized on the map from the study area. Though there were other types of changes, only five land cover were chosen because they impacts the ecosystem services directly. The dominant land cover changes are the Annual cropland changed to other land covers, fallow land changed to other land covers,

trees to other land covers, the unchanged land covers and other land covers changes. These five land cover changes were selected because of their essentiality in terms of supply of the ecosystem services to the people.

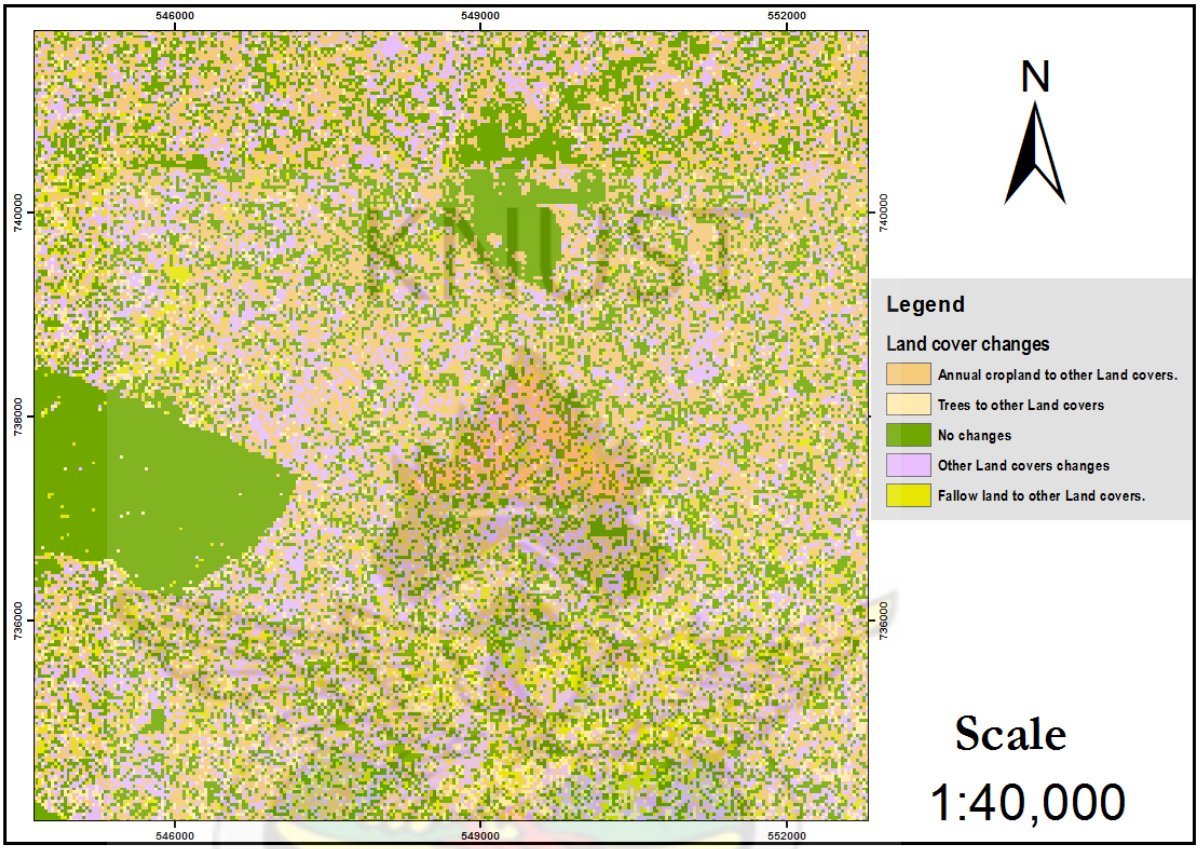


Figure 16.Land cover change map.

To calculate the changes in terms of areas, the Microsoft excel software was used, the pixel area* pixel size (for the Landsat is 30cm).The changed land cover in terms of area (m2) was calculated in the (last column) (Table.8).

Table 8.The sum of areas (ha) and their changes per land covers for 2000 and 2012.

Land Cover Classes.	**Year 2000**		**Year 2012**		**Changed areas(ha)**		**Effects on Ecosystem Services**
	Area(ha)	**%**	**Areas(ha)**	**%**	**Areas(ha)**	**%**	
Annual Crop land	2,293	39%	916	7%	-1,377	14%	Scarcity of medicinal plants, fruits.
Fallow Cropland	251	8%	47	2%	-204	2%	Reduction of bush meat.
Forest and Trees	1650	26%	1243	10%	-407	4%	Decrease in water, bush meat & medicinal products.
Perennial cropland	1,428	24%	5,718	45%	+4289	43%	Increase in fuelwood
Settlement/bare land	662	11%	4,232	33%	+3571	35%	Reduction in natural land covers which support the services.
	6284		12563		9848		

From the comparison of 2000 and 2012 Land cover maps in (figure 8 and figure 7) showed different levels of changes in the cover types, generally all the land covers experience some sort of changes within a range of 12 years (from 2000-2012), as the extend of changes are indicated in the (table.6) revealed that annual land, perennial and forest/trees land covers were major land covers occupied 39%, 24% and 18% of the areas correspondingly.

But in 2012 there were changes which occurred whereby perennial land (45%), settlement/bare land (33%) were the largest land covers of the area. As the Annual cropland decreases in size from (39% to 7%) and fallow land (8%-2%), forest /trees land from 18%-13% and fallow from (8% to 2%).Fallow land and annual cropland declines sharply in term of the size area, but the forest/trees also experiences slightly

difference especially with the trees off reserve which are more cleared for farming activities. The size area for the land covers for the two years are presented in (figure.17).

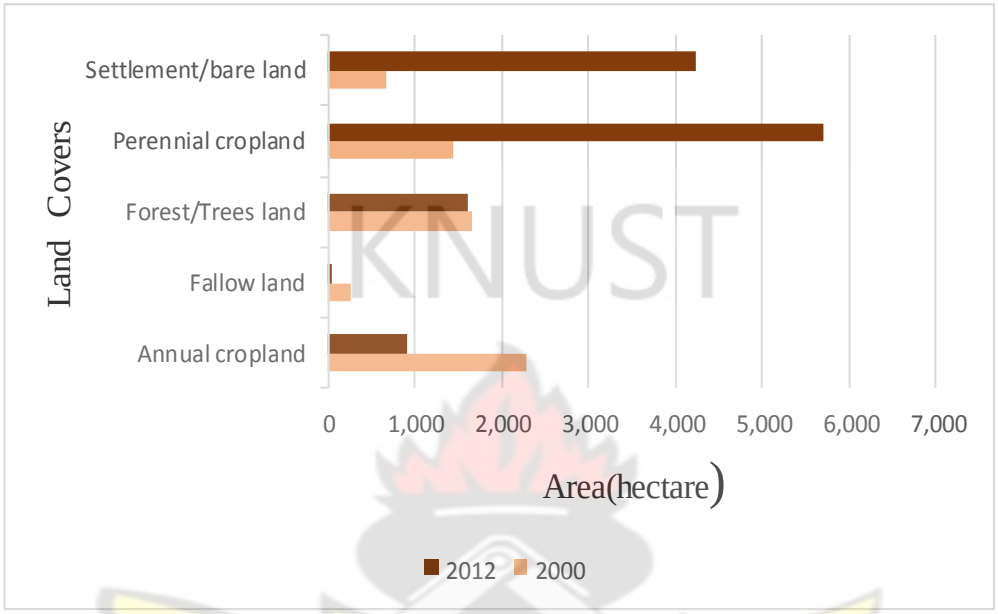


Figure 17.Graphical representation of land cover areas in 2000 and 2012.

4.6.2. Changes in the supply of the services

Changes in the supply of the services is a result of changes happened to the land cover which have changed the location of the area which supplied the services before. These types of changes affect the Ecosystem services supply which is more likely impacting the local people and their livelihoods through decrease and scarcity in the availability of services.

Therefore, the assessment on the changes in the supply of services on the local people livelihood and their well-being was based on the stakeholder group discussions meetings and the semi structured interview, where participants confirmed the occurrence of changes in the supply of the services and their bring about effects.

The quantitative information wasn't available to some quantifiable services like bush meat, fish and firewood while other services like medicinal products, water and fruits were difficult to be quantifiable.

Table 9.The assessment of land cover changes effects to local community's livelihood.

CAUSE OF LAND COVER CHANGE	**TYPE OF THE LAND COVER CHANGE**	**EFFECTS OF THE CHANGES ON THE PEOPLES LIVELIHOOD**
Increase production of cocoa.	Annual to Perennial land	Reduction in availability of some services like different varieties of medicinal products, fruits, bush meat(little animals)
Increase in land demand	Fallow to Perennials, Annuals, Settlement	Meat shortage, scarcity of different varieties of herbs
Poor monitoring and management of trees outside the forest reserve.	Trees to annuals, perennials	Destruction of water catchment areas (dry of water streams), reduction in fuelwood and bush meat.
Settlement expansion	Fallow to settlement	Reduction in natural ecosystem covers which support the production of the services.

5. DISCUSSION

5.1. Land cover classification and accuracy

The classified images of 2000 and 2012 were used as a fundamental tool in the analysis of the land cover changes from the study area. The overall accuracy of Landsat image of 2012 was 72% with the Kappa statistics 64%. This accuracy level is noted by (Campbell, 2002).The results suggested good conformity between the digital classification and the real ground land cover classes though with some few misclassification of pixels which have occurred nearly in all classes. Some of the misclassification have been due to the nature of image used, the image used was a mosaic image which is an image resulted from the combination of individual scenes from other images into a single composite image. This is because of the nature of the study area being covered by clouds often, getting a cloud free image is not a straightforward task. Another reasons which led to the misclassification of an image was in the difficulty of differentiating the spectral reflectance values from the forest/trees with the cocoa farms using the low resolution images like Landsat, the use of high resolution images would be appropriate.

The classification accuracy results of the 2000 image could not be statistically assessed because of the unavailability of useful reference data such as the validated map or aerial photos of the study area, because the available maps are specifically on forest reserve only and not off reserve. Therefore its classification depended on local people information which was established on the historical information concerning land cover changes collected from local people during field work and the unchanged areas observed from the classified 2012 image.

5.2. Assessment of the ecosystem services available and their importanc

A number of people in Africa depends on ecosystem services for the supply of fuelwood for cooking, heating water and wild animals meat for protein as well as water for drinking. For that reason, human's dependence on provisioning services is mostly acknowledged in developing countries like those in Africa where many people are poor and reliant on natural resources. However, some of service resources are also collected for sale to supplement household income, like in West and Central Africa, income from bush meat trade can be as high as $1000 per year (Egoh et al., 2012).Most of the provisioning services are the direst services which constitute and support local people livelihood. Among the six services water and fuelwood sough to be the most services collected by different gender and age, as they are considered as the basic human need.

All the respondents from different villages recognized bush meat, fuel wood, water, medicinal products, fruits and fish as the provisioning services of which they are collected direct from the environment. Provisioning services are recognized by people because they are directly services that support their livelihood. Among the six services water, fuel wood, medicinal products and bush meat were identified as the vital and most sough services. Manso-Howard's (2011) also indicated that fuel wood was the largest source of energy for cooking and heating water in Ghana, with the commercial fuel wood energy demand increased proportionally and provide an income to some people(Kwakwa et al., 2013).

The bulk of energy supply in Ghana is met from fuelwoods and charcoal, as fuelwood accounts for about seventy (70%) of the total primary energy supply in the country (Ghana Statistical Services., 2003)designated that, fuel wood remain the

main source of cooking in the Brong-Ahafo region with an average of 75.6% of households using it. It is further argued that, large household will prefer to use fuelwood because it requires large amount of fuels in aggregate to meet the family needs and fuelwood is affordable compare to other source of energy.

The reliance of local people on services is due to the importance of these different ecosystem services to the developing countries like the ones in Africa.(Cowlishaw et al, 2004) indicated that, Bush meat, is one of the most valuable tropical forest products after timber in the humid and forested areas, found in the west and central parts of Africa. For example, the hunting and trading of bush meat in West Africa has developed in to a large industry. It is an important food source, consumed in both rural and urban areas, and can make a substantial input to the cash income of rural households. Estimates of the national value of the trade range from US$42-205 million across countries in West and Central Africa(Glyn et al., 2008)

, water and fuel wood had constantly been ranked as the first services, with bush meat in the second place, then medicinal products, fruits and fish. Fuel wood and water had been ranked as the first services due to the fact that are being collects by all respondents disregard of the gender or age.

5.3. Land cover types and their Ecosystem services

With the exception of the settlement & bare land covers, the six ecosystem services(bush meat, fuel wood, water, medicinal products, fruits and fish) were identified and associated by all respondents with their five land cover classes namely; annual cropland, fallow land, forest land, perennial cropland and settlement /bare land. The (Millennium Ecosystem Assessment., 2005) resulted in the similar categorization of

the services typology. Most of these services were collected from the cultivated areas, fallow lands and forested areas because these land covers supplies multiple services. The annual cropland have been regarded as the land cover with multiple services since majority of the local people are farmers whose farms are located within the proximity of less than 2km from their settlements. All the land covers are shaped by people, directly or indirectly which affect its capacity and ability to generate essential ecosystem services. From the land cover changes result (figure 14) showed the decrease of services like bush meat, medicinal product and fuel wood as a result of land cover changes from 2000 to 2012.This is accordance with the(TEEB, 2010) findings, which indicated that, the changes of the ecosystems as a result of anthropogenic activities is and interdependent social-ecological systems.

Agriculture is the dominant land use in the study area. It is based mainly on the shifting cultivation technique
or an extensive system of farming. The annual cropland was the land covers which was highly associated with multiple services from the local people (who are mainly farmers) compare to the other classes. The annual cropland practises the intercropping/mixed farming which is a type of farming allowing multiple cropping system that two or more crops planted in a field during a growing season. This type of farming also increases diversity in an agricultural ecosystem and maintain natural ecosystems to attain an ecological balance to support production of different ecosystem services. Previous study done by (Mousavi & Eskandari, 2011) resulted in the same opinion by indicating that, intercropping prevents the destruction of natural ecosystems. Forests were highly referred to as sources of natural medicines, which are essential components of health treatment for the locals, which is commonly used in conjunction with mystical and ritual practices. Besides that, forest covers were

referred to be the main source of rainfall which flows downs to the running streams were people fetch water for their daily uses, bush meat for the big animals like antelopes which are hardly found nowadays, but grass cutter and rat are easily found outside forest land. Similarly, Fallow land was associated with a potential number of services compare to perennial and settlement.

As expected, in some cases for the forest fringe communities (communities closer to the forest) could collect fuel wood from the forest, from this study these communities are Borodedwo and Kumonso communities because fuel wood is the main source of energy from local to the national level. There were some predictions and estimations made, such as 14 million cubic meters(m^3)of wood are consumed for energy production, and it have also been estimated that the volume of fuel wood consumption in Ghana could rise to 20 million cubic meters(m^3) by the year 2010 (Agyarko, 2001). But unexpected response from the interviewed respondents from these forest fringe communities said, they are not allowed by the Forestry department to collect fuel wood from the forest reserve. Also there are rules and regulation pertain to the hunting season for the bush meat being in wet season and not drought season, because during the wet season there is plenty of food (grass) to feed on and more reproduction, while in the drought season there are no enough grass to feed even the rate of reproduction is low.

The same rules and regulations favour the natural trees species which are off reserve, not to be cut down without the permission from the Forestry department, but local people are allowed only to take some leaves, barks, seeds and roots for medicinal purposes. Some respondents claimed that, there sacred groves areas which are off-reserve were there prohibit cutting down trees for any use. Thus the reliance of fuel

woods availability which is used as the basic source of energy for cooking is mainly from the perennial croplands (cocoa) and Fallow (tree/bush) lands.

Furthermore, the use of Land cover as a proxy for the ecosystems and a means to generate approximation for the value of ecosystem services based on the land covers. The land cover map was used because of its certainly availability through the remote sensing data. Referring to this research, the Landsat image for 2000 and 2012 were already available from the ITC database. Study done by (Mendoza-González et al., 2012) in Gulf of Mexico, Mexico, give similar point of view in using the land cover map as reference to the ecosystem of which ecosystem services are supplied from. Furthermore the milestone study done by (Constanza, et al., 2007) infer to the use of land cover as a proxy indicator for the presence of various ecosystem service is a common technique used in ecosystem valuation, studies done by(Brown, 2013;Schagner et al., 2013) shared the same opinion on the use of land cover approach to derive estimates of the ecosystem and their services and the land cover changes.

Additionally, the use of land cover map was used to calculate and shows the types of changes occurred within the study area, in turns the land cover changes have influence on the values given to the services and the land cover itself. For example, according to the respondents the value of Bush meat (big animal like antelope) have been have increased more recently because of its scarcity and difficulties associated with the hunting. In previous time they could hunt the antelopes in the fallow areas, but currently (from 2010) the hunters goes to the deep forest to get some which is also in small number. (Troy & Wilson, 2006) on their research done in United States of America.

5.3.1. Land Cover Change and Ecosystem services

Study done by (Lambin., 2001) on the causes of land cover/land use changes highlighted concerns about the role land-use/cover changes in the research agenda on global environmental change several decades ago. This was due to the realization that land cover processes influence climate, terrestrial ecosystems and the ability of biological systems to support human needs in terms of the ecosystem goods and services. From the image classification results, four dominant land covers namely Annual cropland, Fallow land, Forest land, Perennial cropland and Settlement and bare land were presented for both 2000 and 2012((figure 6&7). In the 2000 year annual constitutes the highest area covered 39% with fallow the smallest area of 8%.But in 2012 the perennial cropland was the largest land cover with 45% while fallow land continued to decrease to 2%.The changes in these land covers implies the alterations in the supply of the ecosystem services from these land covers.

From the study area, over the past 12 years of the study period, the land cover have experienced some changes. Four dominant changes had been selected from the area which are; 1.Annual cropland changes to other land covers, 2.fallow land changes to other land covers, 3.forest to other land covers and 4.The unchanged land covers. The causes for the three land covers are mainly caused by settlement expansion, agricultural (changing opportunities created by markets), i.e. farmers are farming more of cocoa than food crops due to promising price given to cocoa beans compare to food crops. Because cocoa production in Ghana is based on smallholder farmers and about 700,000 households are growing cocoa mostly on plots of 2-3 hectares with small plantations. In most cocoa producing households, cocoa accounts for over 67% of household income(*Ghana Cocoa Board.*, 2012).

Among the land cover changes, three were selected and identified as the dominant land cover changes which impact the supply and availability of ecosystem services as the results showed (figure 14) are; the annual cropland changed into the other land covers (39% - 7%), fallow land changes to other land covers (8%-2%) and forest changes to other land covers (26% - 10%). The annual cropland have been cultivated for production of annual crops like plantain, cocoyam, cassava, beans & vegetables mainly to satisfy the local markets. The main reason behind these land cover changes is due to the area of land under agriculture increases every year due to the extensive system of farming being practiced in the country, which also involves cutting of vegetation. There have been intensification of cocoa production as a results of government supports through the Ghana cocoa board on opportunities created by the market on the high price of cocoa compare to food crops as mentioned by the local people. Also pervasive subsidies on fertilizer, new type of hybrid seeds (bear fruit earlier in three instead of five years of the older varieties) contributed to more expansion of the cocoa farms. This is accordance with the United Nations, (Food and Agricultural Organisation., 2013) report which indicated that, Ghana is the only cocoa producing country which has a controlled marketing system done by the Ghana Cocoa Board.

5.4. Ecosystem Services valuation and mapping approach

There was a fundamental aspect of which was taken into account before ecosystem services valuation was conducted. The identification and selection of stakeholders as key informants was particularly important because they are likely to influence the outcome. This was the similar opinion shared by(Seppelt et al., 2011) which was

presented as comprehensive but critical involvement of stakeholders within ecosystem services assessment studies one of the aspects that characterize the holistic ideal of ecosystem services research. Stakeholder knowledge is crucial, for the reason that, disciplinary expert knowledge valuations and existing proxy data such as land covers on ecosystem services can reveal little of the landscape/ecosystem benefits to the local. But when the local people are being involved as the primary stakeholder real information will be obtained. Other studies by(Fagerholm et al., 2012; Raymond et al., 2008) made the similar potential use of local stakeholder as the key informants in the spatial assessment of services values.

The importance of stakeholders have been further associated with the natural resources management. In Ghana most of the rural communities live closer by forest areas, these communities are direct and major consumers of services from the forest. On the other hand they are also the major and direct cause of forest deforestation and other forms of ecological and environmental damages. However their involvement and participation on forest management helps to reduce the deforestation rate and cutting of trees which are outside reserve (Agyarko, 2001) reported similar on the decline on the rate of deforestation in Ghana since the concept of community participation in forest management was introduced and practised.

The valuation of the ecosystem services followed the people's centred participatory approach which used participatory method in the valuation. This approach is a bottom up approach in the sense that the local people at the grass root level were involved in assigning values to the services based on their preference and needs. This approach applies considerate factors underlying the ecosystem services values such as human needs, livelihood concerns, preference, and accessibility. With regard to

these factors the results showed that, water was highly valued as one of the basic for human needs by all participants from all communities. But fuel wood, bush meat and medicinal products were valued as the livelihood pattern concern and accessibility reasons.

The people centred participatory approach was successful and useful for this research work, the participants responds in the valuation and mapping exercises was active in the sense that, people agreed and willingly participated in the discussions sessions. Because their participation gave them the sense of ownership towards the environment where services are collected, also considered their views, opinions towards services valuation are very important as primary stakeholders. For the reason that, economic and biophysical assessments have being used to portray the values of ecosystem services to the decision makers while excludes the stakeholders participation who are direct and main users of these services. The similar point of view was shared by(Darvill & Lindo, 2014) in their study done at British Columbia, Canada indicated that, neither tangible or intangible social values from stakeholders are rarely considered in decision making.

The Millennium Assessment report (2005) pin pointed out that, the identification and protection of ecosystem services is an important goal for humanity, so to make the implication of this point to the community, both economic and non-economic valuations approaches in essential end environment conservation and management as well as in development decisions. Therefore the participation of local people was essential for this research in assigning the values to the ecosystem services. This values assigned by people to the services in some literatures have been referred to as the social or community values. This approach is also useful in other applications

such as environment management. Because the services valuation was based on the biophysical assessment of the ecosystem services supply, For example the land the forest land covers were people could collect the native tree species for medicinal purpose which are not found in other land covers, would be given high priority in conservation measures. (Daily, 1997) in his milestone work on Nature's services and societal dependence on natural ecosystem, make reference of conservation measures to be prioritized to the ecosystem based on their biophysical assessment on the ability of the ecosystem to supply its services to the users. And this have been used in most of the studies as a basis for increasing investment in environmental management as a way to reduce the reliance on the economic or biophysical values.

The ecosystem services valuation results indicated that, local people recognize the importance of forest land, but not so important that they would be willing to alter current land use patterns and allow afforestation programmes in their lands or farms. This was observed in some cases during field work, whereby some interviewed respondents do recognize some benefits from the forest, but not all of the ecosystem services provided by forests and fallow land, though not necessarily the same services or benefits which are highly valued by the government. Farmers also failed to recognize the extent to which ecological impacts resulted from human activities affect water availability and climate regulation. Based on this information about some respondent's perceptions, some management actions and insights could be proposed that might help to convince farmers to promote agroforestry and reforestation inside their lands (fallow & annual).Because these are the basic land covers for varieties of services collected by local. There have been some concerns from the non-economic paradigm point of view scholars, which have been voiced out on the use of the social valuation of ecosystem services to have a role in the decision-

making process, in the argument that, “prices are not to be confused with values, and prices are not the only values that are important” (Kumar & Kumar, 2008;Cowling et al., 2008).

There are different approaches for mapping ecosystem services values and their spatial distribution. The use

Participatory Geographic Information Systems Mapping (PGIS) as the main methods for this research work was useful. The technique was used to map the services supply areas and their spatial distribution for each village which was studied (figure 9,10,11 & 12).Mapping of the key areas for ecosystem service supply is essential for the development of strategies and land use plan that will ensure their future supply. The mapping of ecosystem services was done to highlight the spatial relationships between land cover, and their contribution to human wellbeing. This corresponds with the fact that, the emergence of advanced Geographic Information Systems (GIS) technology had been useful in mapping the spatial relationship of phenomena’s to visualize the importance of spatial relationships in services mapping. This is accordance with the land cover value map (figure 14) which shows the spatial distribution of the land cover values in relationship to the services collected.

5.5. Comparison of Ecosystem services valuation per studied villages

The ecosystem services valuation results showed difference among the values which were allocated to the services per each villages. The first village of Akrodie had the average values of 12.7 as the highest and 7.3 as the lowest from individual respondents. While the second village of Borodedwo had 6.2 and 6 average values, With Chiefcamp with6.8 and 5.7 and Kumonso has7.8 and 6.8 average values given to the ecosystem services. There are variations among the values for these four

villages. The Akrodie village have got the highest values among all villages. The reason behind this village having higher values compare to the three is that, the land covers where services are collected are located far from the settlement areas compare to the other villages. Another reason which led to the services values variation, which has also being observed by(Benefoh., 2008)is due to the fact that human activities had degraded natural conditions favourable for occurrence of certain services. The likely activity which had occurred is settlement expansion due to population growth, deforestation. The same point was noted by(Schagner et al., 2013) argued that, the estimation of the services values is not a straightforward task partly due to spatial heterogeneity in biophysical and social economic conditions

Social values were assigned heterogeneously by people over the study area depending upon their views and needs. An increasing amount of empirical evidence shows that participatory mapping had been used to map different landscape-attached values, perceptions and services (Bryan et al, 2010) The method have proven to be useful in making stakeholders more aware of the use of natural resources, whilst promoting collaboration and empowerment. This shows the strength of empirical mapping methods like the participatory mapping, that they are based on the true local knowledge of the distribution of landscape services, which differs from mapping based on assumptions derived from literature or process modelling values and preferences(Brown, 2013).

The three villages of Chiefcamp, Kumonso and Borodedwo had no substantial variations to the valued given to the services. The values ranges from 5.7 - 7.8 which is likely compare to the previous village. This is because the tree villages surrounding environment had not been degraded, so there are natural conditions favourable to the production of services. Also the farms are not located very far from

their settlement. This research had observed two main reason which influence the mapped social values to display variations in services values and its supply across the study area .These reasons are; 1.The presence natural biophysical environment which favour production of services. 2. The location of the services supply area in relation to the people's settlement, i.e. the far the location is the low value will be given while the closer it is the higher value will be given.(Schagner et al, 2013) argued that spatial perspective in variation of ecosystem services has not been researched extensively, therefore there is insufficient information on why services valued differs across a given area and what are their spatial determinants.

In the last decades, there have been an emergence of the participatory mapping methods as a backup and alternative to non-economic valuation methods for analysing ecosystem services and their values from their physical landscape location. Some literatures(Dyer et al.,2014) have pinpointed that, there is lack of information regarding stakeholder's social values. The participatory mapping methods were applied to incorporate local people spatial knowledge and information on the valuation of the ecosystem services. This information applicable to human well-being and livelihood as a motivation for ecosystem services assessments.

For this research as mentioned earlier, stakeholders were groups or individuals who can affect or are affected by the ecosystem's services and their relevance land covers. There were two groups of the stakeholders (men and women groups) selected from each village whom were considered as the primary stakeholders, from the results(figure.13) water, fuel wood and bush meet were given high values by both groups due to their life style which depend on these services directly, apart from water as a basic need for any living organism, fuelwood is a major basic and reliable

useful source of power for cooking while bush meat is considered to be source of income by selling by some community members, this align with the study from done by(Vermeulen & Koziell, 2002), it was pointed out that the value of ecosystem services depends upon the needs, views and perception of stakeholders.

It had been argued that, socio-economic and cultural factors such as people's domestic and productive roles are likely to shape how individuals value ecosystem services. Therefore the variation of social-cultural values among stakeholders is due to a complex set of factors of which shape the stakeholders perceptions towards the ecosystem service, among those factors include the type of knowledge they hold, place attachment(Lamarque et al., 2011; Lewan & Soerqvist, 2002) and the way they interact with their natural surroundings (Russell et al., 2013).

Furthermore, the analysis from the valuation results from the men and women groups indicated that fuelwood, medicinal products were highly valued by women within from all villages. But bush meat was highly valued among men all men groups. Though water was highly valued by both groups, but high values were given by female. Although the value were given separately for each service, but the pattern of the valuation is the same in the sense that the higher value were given for specific services and lower for specific one also. Generally, the spatial location of communities does not have impact on the services values among stakeholder groups and individual respondents.

However, ecosystem services encompass the many ways society benefits from nature and hence, there are many reasons for which it may be valued by people. Because there is a mutual and active relationship between ecosystem services and

stakeholders, as the services supplied by an ecosystem determine the relevant stakeholders like in reference to this research farmers, hunters were the key stakeholders and in turn stakeholders determine relevant ecosystem services they collect from the ecosystem.

6. CONCLUSION AND RECCOMENDATION.

6.1. Conclusion

From the research objective, methodologies, results and discussion from the previous chapters, the conclusion and recommendation have been summarised below

Question.1. How much and where are the changes at the Goaso off forest reserve (2000-2012)?

- There are five main land cover from the Goaso off forest reserve area from 2000-2012 which are; Annual cropland, Fallow land, Forest and trees land, Perennial cropland and Settlement & bare land. With the annual constituents the large coverage area of (39%), followed by Forest (26%), perennial cropland with (24%), Settlement& bare land (11%) and fallow land (8%).

- Annual cropland, Fallow land and Forest experienced negative changes by decreased in size, however Perennial cropland, and Settlement & bare land experienced positive changes by increased in size within 12 years.

- 1,374 hectares of land equals to 14% of Annual cropland changed by being converted to other land covers, also Fallow land's 204 hectares which equals to 2% also changed. While 407 hectares of Forest were lost. But 4,289 hectares (43%) area were increased to perennial cropland, 3,571 (35%) area was increased to Settlement& bare land.

Question.2. Where and which are the provisioning ecosystem services which are of most important to the users?

- There were six main provisioning ecosystem services which were identified and recognized by the participants from the study namely; Bush meat, Fish, Fuel wood, Fruits, Medicinal products and Fresh water.

- Among the above six services four of them (i.e. Fuel wood, freshwater, medicinal products and bush meat were the most important services identified by the people compare to fruits and fish.

Question.3. How value were assigned to the ecosystem services differ among the stakeholder groups?

- The valuation of the ecosystem services was done by the individual respondents and women and men groups as the primary stakeholders.

- Water, Fuel wood and Bush meat were the services which were highly valuable from all respondents compare to medicinal products, fruits and fish.

- The valuation of services per land cover gave high value to the Annual cropland, Fallow land and Forest land covers.

Question.4. What are the impacts of land cover changes on livelihood?

- The general impacts which were associated with the people's livelihood is the reduction and scarcity in availability of the ecosystem services such as bush meat, fuel wood, fish and water.

- Due to the scarcity of bush meat, it had become more expensive to be affordable to everyone.

- The effect to the People's livelihood depends more with the availability of the services and not the change of the land covers. Because land cover can change but still can support the production and supply of the service.

6.2. Recommendation for application

This paper analyses the spatial scales of ecosystem services, and it examines how stakeholders at different spatial scales attach different values to ecosystem services because of different preferences and needs. Therefore the ecosystem services research needs to be more relevant to user need, user inspired and friendly.

Analysis on stakeholders scales and interests vary accordingly. In some situations whereby, local residents prefer management that allows the collection of services while international stakeholders are mostly worried about the global loss of forest and the associated loss of biodiversity.

There is high increase of demand on the ecosystem services due to different factors such as land cover changes, climate change, population growth, economic growth and changes in consumption pattern. And ecosystems and their surrounding landscapes differs in their capacity to provide ecosystem goods and services.

Therefore, the structures and functions of ecosystems are needed to sustain the provision of ecosystem services which are being altered by various human activities.

Trade-offs between ecosystem services can have an effect on different spatial levels from local to global and in different time ranges from the present to a distant future. It is also emphasized that Ecosystem services trade-offs can affect different stakeholder group's interest. Therefore management should considers the stakeholders participation.

The methods implemented did not aim to achieve a precise valuation, quantification or spatial representation of the subject. Rather, the study aimed to provide an adequate assessment of local circumstances, changes and perceived causes that are based on the people's centred participatory approach

REFERENCES

Abbot, Jo, Chambers, R., Dunn, Christine, Harris, T., & De, Emmanuel, Porter, Gina, Townsend, Janet, Weiner, D. (1998). Participatory GIS : opportunity or oxymoron ? *PLA Notes*, *33*, 27–34.

Agyarko, T. (2001). *Forestry Outlook Sudy for Africa(FOSA) Country Report - Ghana*. (pp. 8–9). Retrieved from http://www.fao.org/docrep/003/ab567e/AB567E03.htm#TopOfPage

Asubonteng, Kwabena, O. (2007). *Identification of land use/cover transfer hotspots in the Ejisu-Juabeng District, Ghana* . Wiley, Hoboken.

Bektas, F., Goksel, C. (2002). *Remote Sensing and GIS Integration for Land cover Analysis,A case study: Gokceada Island. Taylor & Francis* (p. 621). London.

Boyd, J., & Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, *63*(2-3), 616–626.

Brown, G. (2013). The relationship between social values for ecosystem services and global land cover : An empirical analysis. *Ecosystem Services*, *5*, 58–68.

Brown, Thomas C, Collins, F., & Bergstrom, John C, Loomis, J. B. (2006). *Discussion Paper Ecosystem Goods and Services : Definition , Valuation and Provision* (pp. 3–5).

Bryan, Brett A., Raymond, Christopher, M., Crossman, Neville D., Macdonald, D. H. (2010). Targeting the management of ecosystem services based on social values: Where, what, and how? *Landscape and Urban Planning*, *97*(2), 111–122.

Campbell, J. B. (2002). *Introduction to Remote Sensing*. *Taylor and Francis* (Vol. 107, p. 621). London.: Elsevier B.V.

Carver, S., & Carver, U. J. (2001). The Future of Participatory Approaches Using Geographic Information : developing a research agenda for the 21 st Century. *URISA*, (15), 61–71.

Chambers, R., & Conway., G. . R. (1992). Sustainable Rural Livelihoods:Practical Concepts for the 21st century. *Instute of Development Studies*, *296*.

Chan, Kai M A, Guerry, Anne D.Balvanera, Patricia, Klain, Sarah, Satterfield, T., Basurto, Xavier, Bostrom, A., Chuenpagdee, Ratana, Gould, Rachelle, Halpern, B. S., & Hannahs, N. (2012). Where are Cultural and Social in Ecosystem Services? A Framework for Constructive Engagement. *BioScience*, *62*(8), 744–756.

Chee, Y. E. (2004). An ecological perspective on the valuation of ecosystem services. *Biological Conservation*, *120*(4), 549–565.

Chen, N., Li, H., & Wang, L. (2009). A GIS-based approach for mapping direct use value of ecosystem services at a county scale: Management implications. *Ecological Economics*, *68*(11), 2768–2776.

Chen, X. (2002). Using Remote sensing and GIS to analyse land cover change and its impacts on regional sustainable development. *International Journal of Remote Sensing.*, *23*, 107–124.

Christie, Mike, Fazey, Ioan, Cooper, Rob, Hyde, T., & Kenter, J. O. (2012). An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. *Ecological Economics*, *83*, 67–78.

Costanza, Robert, De Groot, Rudolf, Farber, Stephen, Grasso, Monica, Hannon, Bruce, Limburg, Karin, Naeem, Shahid, d' Arge, Ralph, Monica, Hannon, Bruce, O'Neill, Robert.V, Paruelo, Jose, Raskin, Robert, G., & Sutton, P. (1998). The value of the world ' s ecosystem services and natural capital., *387*, 8009.

Cowling, Richard.M, Egoh, Benis, Knight, A. T., & O'Farrell, Patrick.J, Reyers, Belinda, Rouget, Mathieu, Roux, Dirk.J, Welz, Adam, Wilhelm-rechman, A. (2008). An operational model for mainstreaming services for implementation., *105*(28), 9483–9488.

Cowlishaw, G., Mendelson, S., & Rowcliffe, J. . M. (2004). The Bushmeat Commodity Chain : patterns of trade and sustainability in a mature urban market in West Africa. *Wildlife Policy Briefing*, (7).

Daily, G. C. (1997). Nature's services-societal dependence on natural ecosystems. *Island Press . Washington, DC*.

Daniel,Tutu,Benefoh. (2008). *Assessing the effects of land-use / cover change on ecosystem services in Ejisu-Juaben District , Ghana : The case study of carbon sequestration Ejisu-Juaben District , Ghana : The case study of carbon sequestration*. Enschede,Netherlands.

Darvill, R., & Lindo, Z. (2014). Quantifying and mapping ecosystem service use across stakeholder groups : Implications for conservation with priorities for cultural values. *Ecosystem Services*, 1–9.

De Araujo Barbosa, C. C., Atkinson, P. M., & Dearing, J. (2015). Remote sensing of Ecosystem Services: A systematic review. *Ecological Indicators*, *52*, 430–443.

De Groot, R., Wilson, M. A., & Boumans, Roelof, M. J. (2002). A typology for the classification , description and valuation of ecosystem functions , goods and services. *Ecological Economics*, *41*, 393–408.

DeFries, R., & Bounoua, L. (2004). Consequences of land use change for ecosystem services: A future unlike the past. *GeoJournal*, *61*(4), 345–351.

Department for Environment, F. and R. A. (2007). *An introductory guide to valuing ecosystem services* (pp. 9–11,30–34). London. Retrieved from www.defra.gov.uk

Dumenu, William, K. (2010). *Management of timber resources in areas outside forest reserves in Ghana:the role of stakeholders*. Albert -Ludwigs -Universität.

Dyer, J, Stringer, L C, Dougill, A J, Leventon, J, Nshimbi, M., Chama, F, Kafwifwi, A, Muledi, J I, Kaumbu, J K, Falcao, M., Muhorro, S, Munyemba, F., & Kalaba, G M, Syampungani, S. (2014). Assessing participatory practices in community-based natural resource management : Experiences in community engagement from southern Africa. *Journal of Environmental Management*, *137*, 137–145.

Egoh, Benis, Dunbar, MB, Maes, Joachim, Willemen, L, Drakou, E. (2012). *Indicators for mapping ecosystem services: a review*.

Fagerholm, N., Käyhkö, N., Ndumbaro, F., & Khamis, M. (2012). Community stakeholder's knowledge in landscape assessments - Mapping indicators for landscape services. *Ecological Indicators*, *18*, 421–433.

Fisher, B., Turner, R. K., & Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological Economics*, *68*(3), 643–653.

Ghana Cocoa Board,Annual Report. (2012).

Glyn, Davies & David, B. (2008). *Bushmeat and Livelihoods: Wildlife Management and Poverty Reduction* (p. 288). John Wiley & Sons.

Hapsari, A. (2010). *Assessing and mapping ecosystem services in offinso district, Ghana - hapsari.pdf*. International Instute for Geo-Information Science & Earth Observation.

Hayes, D. ., & Sader, S. . (2013). Comparison of change detection techniques for monitoring Tropical forest clearing and vegetation regrowth in a time series. *Photogrammetiric Engineering and Remote Sensing.*, *67*(9), 1067 – 1075.

Hein, Lars, van Koppen, Kris, de Groot, Rudolf S, van Ierland, E. C. (2006). Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological Economics*, *57*(2), 209–228.

Http://www.cbd.int. (1992). Convention on Bilogical Diversity(CBD).

Iniesta-Arandia, Irene, García-Llorente, Marina, Aguilera, Pedro.Montes, Carlos, Martín-López, B. (2014). Socio-cultural valuation of ecosystem services : Uncovering the links between values , drivers of change , and human well-being. *Ecological Economics*, *108*, 36–48.

ITC. (2012). *The core of GISscience a system based approach.* (pp. 215–216). Enschede: The international instute for geo-information science & earth observation.

Janet A. Fisher a, N., & D, Patricia Pinho, M. D. A. R. a. (2013). Understanding the relationships between ecosystem services and poverty alleviation: A conceptual framework. *Ecosystem Services*, *7*, 34–45.

Jordan, G. H. (1999). The use of PGIS in technology poor countries: Case studies from Zambia & Nepal. In *GISOC'99,Conference on Geographic Information and Society* (Vol. 4, p. Minneapolis.).

K. C. Tan, H. S. Lim, M. Z. MatJafri, K. A. (2011). *Land cover mapping & change detection analysis over Nanggroe Aceh province.* (N.-A. Marner, Ed.) (pp. 470–472). Indonesia: Intech.

Kumar, M., & Kumar, P. (2008). Valuation of the ecosystem services: A psycho-cultural perspective. *Ecological Economics*, *64*(4), 808–819.

Kwakwa, P. A., Wiafe, E. D., & Alhassan, H. (2013). Households Energy Choice in Ghana. *Journal of Empirical Economics*, *1*(3), 96–103.

Lamarque.P, Quetier.F, L. . (2011). The diversity of the Ecosystem Services concept and its implications for their Assessment and Management. *Comptes Rendus Biologies*, *334*(5-6), 441–449.

Lambin, Eric F.Turner, B. L., Geist, Helmut J.Agbola, Samuel B.Angelsen, Arild Bruce, John W.Coomes, Oliver T.Dirzo, Rodolfo Fischer, Günther Folke, Carl George, P.S.Homewood, K., Imbernon, Jacques Leemans, Rik Li, Xiubin Moran, E. F., & Mortimore, Michael, Ramakrishnan, P.S. Richards, John F. Skånes, Helle, Steffen, Will, Stone, Glenn D.Svedin, Uno Veldkamp, Tom A.Vogel, Coleen Xu, J. (2001). The causes of land-use and land-cover change: moving beyond the myths. *Global Environmental Change*, *11*(4), 261–269.

Lu, D., Mausel, P., Brondízio, E., & Moran, E. (2004). Change detection techniques. *International Journal of Remote Sensing*, *25*(12), 2365–2401.

Manso-Howard, B. (2011). *The potential contribution of Non-timber Forest Products (NTFP) especially wood fuel, to the revenue generation base in the Forestry sector.* Kwame Nkrumah University of Science and Technology.

Manyatsi, A. M., & Mwendera, E. J. (2007). The contribution of informal water development in improving livelihood in Swaziland : A case study of Mdonjane community. *Physics and Chemistry of the Earth*, *32*, 1148–1156.

Mendoza-González, G., Martínez, M.L., Lithgow, D., Pérez-Maqueo, O., Simonin, P. (2012). Land use change and its effects on the value of ecosystem services along the coast of the Gulf of Mexico. *Ecological Economics*, *82*, 23–32.

Millennium Ecosystem Assessment. (2005). *Island press*.

Millennium Ecosystem Assessment,Ecosystem and Human Well Being:A Framework for Assessment. (2003) (p. 245). Washington.

Mousavi, S. R., & Eskandari, H. (2011). A General Overview on Intercropping and Its Advantages in Sustainable Agriculture. *Journal of Applied Environmental and Biological Sciences*, *1*(11), 482–486.

Nelson, E. J., & Daily, G. C. (2010). Modelling ecosystem services in terrestrial systems. *F1000 Biology Reports*, *2*, 53.

Nyerges, T. ., & P.Jankowski. (2002). Data Gathering strategies for social-behavioral research about participatory geographic information system use. *International Journal of Geographic Information Science*, *16*, 1–22.

Organisation., F. and A. (2013). *Monitoring African fooa and agricultural policies:Analysis of Incentives and Disincentives for Cocoa in Ghana.* (pp. 3–6).

Rambaldi, G., Mccall, M., & Weiner, D. (2006). Participatory Spatial Information Management and Communication in Developing Countries. *Electronic Journal of Information Systems in Developing Countries (EJISDC)*, *26*, 1–9.

Raymond, Christopher, M., & Bryan, Brett, A, McDonald, Darla, Hatton.Cast, Andrea, Strathearn, Sarah, Grandgirard, Agnes, Kalivas, T. (2008). Mapping community values for natural capital and ecosystem services. *Ecological Economics*, *68*(5), 1301–1315.

Reed, Mark S, Graves, A., & Dandy, Norman, Posthumus, Helena, Hubacek, Klaus, Morris, Joe, Prell, Christina, Quinn, Claire H, Stringer, L. C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of Environmental Management*, *90*(5), 1933–49.

Seppelt, Ralf, Dormann, Carsten.F, Eppink, Florian.V, Lautenbach, Sven, Schmidt, S. (2011). A quantitative review of Ecosystem service studies : approaches , shortcomings and the Road ahead. *Journal of Applied Ecloogy*, *48*, 630–636.

Serneels, S, & Lambin, E. F. (2001). Proximate causes of land use change in Narok District,Kenya:A spatial statistical model. *Agriculture,Ecosystems and Environment*, *85*, 65 – 81.

Singh, A. (1989). Digital change detection techniques using remotely-sensed data. *International Journal of Remote Sensing*, *10*, 37–41.

Smith, Lisa M.Case, J. L., & Smith, Heather M.Harwell, Linda C.Summers, J. K. (2013). Relating ecoystem services to domains of human well-being: Foundation for a U.S. index. *Ecological Indicators*, *28*, 79–90.

Statistical, G. S. (2003). http://www.statsghana.gov.gh/. *Census and surveys.*

Summers, J K, Smith, L M Case, J L, Linthurst, R. (2012). A review of the elements of human well-being with an emphasis on the contribution of ecosystem services. *Ambio*, *41*(4), 327–40.

TEEB. (2010). *The Economics of Ecosystems & Biodiversity. cologicalandEconomicFoundations*. Earthscan London , WashingtonD.C..

The Encyclopedia of Earth. (2010). *Land-use and land-cover change,climate change*. Retrieved June 02, 2014, from http://www.eoearth.org

Troy, A., & Wilson, M. . (2006). Mapping ecosystem services: Practical challenges and opportunities in linking GIS and value transfer. *Ecological Economics, 60*(2), 435–449.

Turner, R.Kerry, Paavola, Jouni, Cooper, Philip, Farber, Stephen, Jessamy, V., & Georgiou, S. (2003). Valuing nature: lessons learned and future research directions. *Ecological Economics*, *46*(3), 493–510.

Vajjhala, S. P. (2005). Integrating GIS and Participatory Mapping in Community Development Planning. *ESRI International User Conference, Sustainable Development and Humanitarian Affairs Track,, San Diego,*.

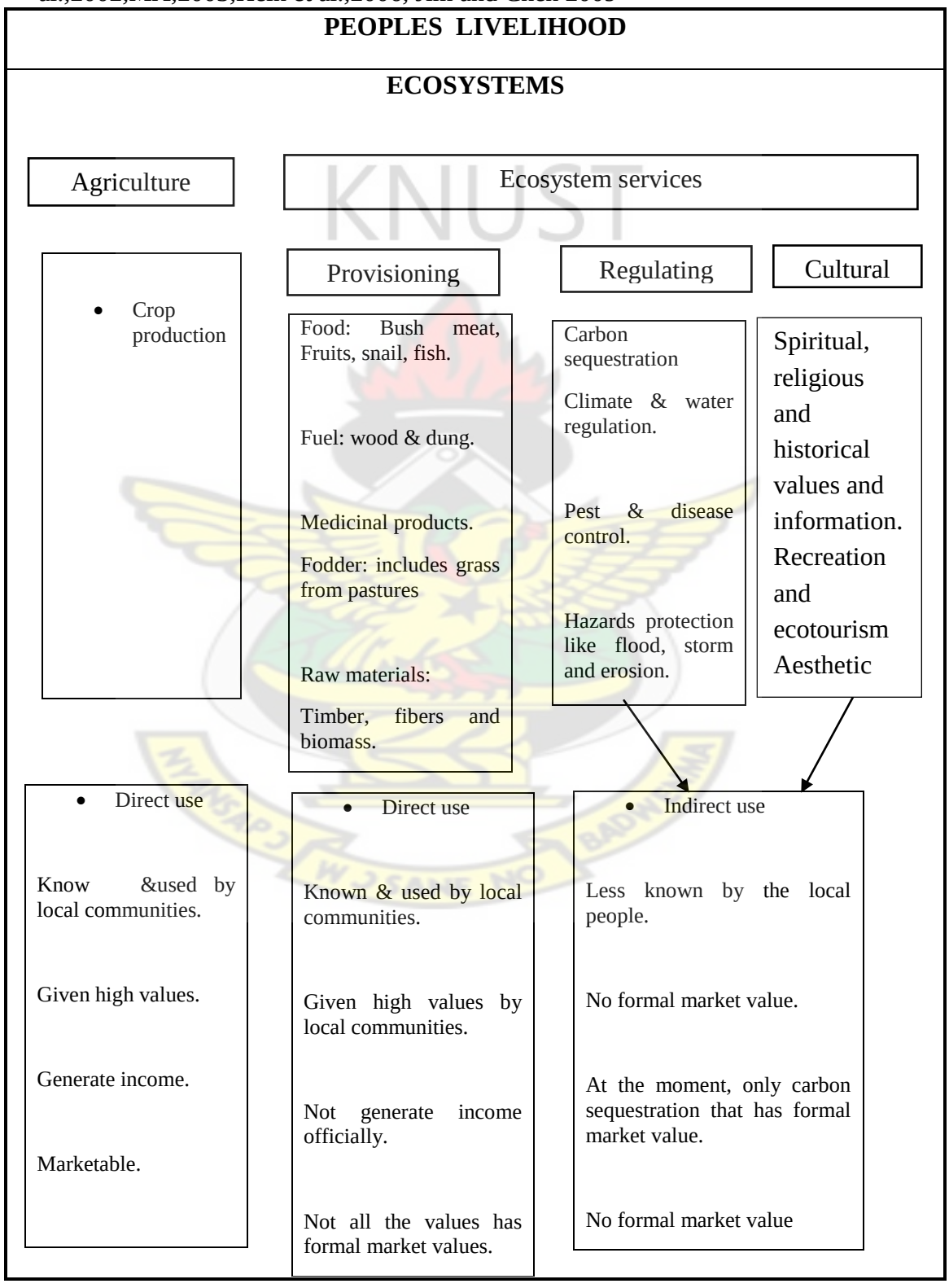
Van Oudenhoven, A. P. E., Petz, Katalin, Alkemade, R., & Hein, Lars, de Groot, R. S. (2012). Framework for systematic indicator selection to assess effects of land management on ecosystem services. *Ecological Indicators*, *21*, 110–122.

Vermeulen, S., & Koziell, I. (2002). Integrating global and local values:a Review of biodiversity assessment. *International Institute for Environment and Development, London,UK*.

Appendix.

Appendix.1.

Livelihood of local people to the ecosystem services- Adopted from de Groot et al.,2002,MA,2003,Hein et al.,2006, Jim and Chen 2009



Appendix.2.

Questionnaires.

ITC,Enschede,Netherlands

Kwame Nkurumah University 0f Science & Technology,Kumasi

College of Agric & Natural resources

Msc. GISNATUREM.

This questionnaire forms part of the data collection activities towards my MSc. Research on the topic **"Impacts of Land cover changes on the provisioning ecosystem services**". This questionnaire aims to elicit reliable information from stakeholders like you on the valuation and mapping of provisioning services provided by the ecosystem in this study area. This form of questionnaire is for **the specific stakeholder groups.** Thanks in advance, by Veronica Mtoka.

Questionnaire No. ---------- Stakeholder Group----------

1. Respondent Information

Date Village name

Name Gender F ( ) M ( )

Age Occupation

Education level: Illiterate ( ) Literate ( ) Primary ( ) Secondary ( ) Tertiary ( )

Family size No. of dependents

2. Provisioning ecosystem services valuation. (Items your collecting bush meat, fresh water, medicinal products, fuel wood))

(a)What type of services/items do you usually collect from this area? ----------

---

(b)Which do you think is the key important services to you and why? (Pairwise comparison) ----------

(c)How long do you walk to collect these items/services?

Miles/Km Hours/minutes

(d)Are there rules in the place you collect? ----------

(e)Why are you collecting these service? Home ( ) business ( ) ----------

---

(If home how many people do make use of it?

If business how many people do you earn from selling

Main source of income( ) minor source of income( )others specify( )

(f) Where do you collect these items?(Showing the pictures of items with local names written on them)

Services	Values	Rank	Uses	Collection place(Land class	Indicator	Remark
Bush meat Water				Annuals Perennials		
Firewood Medicinal products				Bush land Fallow land		
Fruits Fish				Forest Water body marshy land		

3. Current state of land cover

(g)What land cover normally changes to other land cover?

(e)Do you know key causes for the change of the mentioned land cover? ----------

---

(f)What is the effect of the land cover change to the items you collect from that land?

(g)Where were you collecting the services in previous years and where are you collecting now? ----------

Appendix 3.

Chi square analysis on the two variables of ecosystem services and the distance

AKRODIE VILLAGE

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**68.480[a]**	**45**	**.014**
Likelihood Ratio	**40.150**	**45**	**.677**
N of Valid Cases	**31**		

a. 60 cells (100.0%) have expected count less than 5. The minimum expected count is .03.

There is an association between distance covered and the ecosystem services since the p-value (0.014) is less than 0.05.

BORODEDWO

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**14.625[a]**	**10**	**.146**
Likelihood Ratio	**15.736**	**10**	**.107**
N of Valid Cases	**13**		

a. 18 cells (100.0%) have expected count less than 5. The minimum expected count is .15.

There is no association between distance covered and the ecosystem services since the p-value (0.146) is greater than 0.05.

CHIEFCAMP

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**17.500[a]**	**10**	**.064**
Likelihood Ratio	**10.455**	**10**	**.401**
N of Valid Cases	**15**		

a. 17 cells (94.4%) have expected count less than 5. The minimum expected count is .07.

There is no association between distance covered and the ecosystem services since the p-value (0.064) is greater than 0.05

KUMONSO

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**6.944[a]**	**6**	**.326**
Likelihood Ratio	**8.733**	**6**	**.189**
N of Valid Cases	**15**		

a. 12 cells (100.0%) have expected count less than 5. The minimum expected count is .20.

There is no association between distance covered and the ecosystem services since the p-value (0.326) is greater than 0.05

Appendix 4.

One sample statistics to test the significance of the ecosystem services values among respondents from all villages.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
FEMALE	24	7.38	6.099	1.245

One-Sample Test

	Test Value = 7.4					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
FEMALE	-.020	23	.984	-.025	-2.60	2.55

There is no significant relationship among the values and the ecosystem services because the tested value of 7.4 is greater than the p-value of .984

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
MALE	24	6.67	3.116	.636

One-Sample Test

	Test Value = 6.7					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
MALE	-.052	23	.959	-.033	-1.35	1.28

There is no significant relationship among the values and the ecosystem services because the tested value of 6.7 is greater than the p-value of .959.

Appendix.5.

Picture of the Land covers from the study area.

SETTLEMENT

FOREST

ANNUAL (COCO YAM)

PERENNIAL (COCOA) LAND

FALLOW LAND