ECONOMIC VALUE OF ECOSYSTEM SERVICES FROM EASTERN ARC MOUNTAINS OF TANZANIA




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LIST OF ACRONYMS & ABBREVIATIONS

DOE	Division of Environment
CVM	Contingent Valuation Method
EAMCEF	Eastern Arc Mountains Conservation Endowment Fund
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EAM	Eastern Arc Mountains
EMA	Environmental Management Act
ES	Ecosystem Services
GEF	Global Environment Fund
LKHP	Lower Kihansi Hydropower Plant
MAFC	Ministry of Agriculture, Food and Cooperatives
MEA	Millennium Ecosystem Assessment
MoW	Ministry of Water
MLHRD	Ministry of Lands, Housing and Residency Development
MNRT	Ministry of Natural Resources and Tourism
NBS	National Bureau of Statistics
NCMC	National Carbon Monitoring Centre
NF	Natural Forest
NEMC	National Environment Management Council
NEP	National Environmental Policy
NGO	Non-Governmental Organization
KCCMP	Kihansi Catchment Conservation and Management Project
KST	Kihansi Spray Tod
KWH	Kilowatt per Hour
PES	Payment for Ecosystem Services
PF	Planted Forest
PV	Present Value
PBWO	Pangani Basin Water Office
WRBWO	Wami/Ruvu Basin Water Office

RBWO	Rufiji Basin Water Office
SPSS	Statistical Package for Social Sciences
STATA	Statistical Analysis Software Package
TFS	Tanzania Forest Services
TANESCO	Tanzania Electricity Supply Company
TAZARA	Tanzania and Zambia Railways Corporation
TEV	Total Economic Value
TEEB	The Economics of Ecosystems and Biodiversity
TZS	Tanzania Shillings
TWPF	Tanzania Wildlife Protection Fund
UK	United Kingdom
UNEP-WCMC	United Nations Environmental Program-World Conservation Monitoring Centre
URT	United Republic of Tanzania
USA	United States of America
USD	United States Dollar
WA	World Atlas
WCST	Wildlife Conservation Society of Tanzania
WTP	Willingness to Pay
WSDP	Water Sector Development Programme

EXECUTIVE SUMMARY

Introduction

This study was carried out to value the Eastern Arc Mountain (EAM) natural assets and ecosystem services supplied by the mountains for the purpose of sensitizing the society and development partners on the ecological and economic importance of the mountains. This is derived from the fact that the EAMs encompasses a series of mountain blocks which are the sources of a number of big rivers draining from the mountain blocks to the Indian Ocean supplying water for domestic and industrial use to many cities and urban centers in eastern regions of Tanzania. The mountains are important habitat to the endemic species of plants and animals. Understanding of the ecological and hydrological importance of the mountains is not enough to justify its conservation but understanding of the economic values of these ecological and hydrological importance helps to justify its conservation. In 2015 the Eastern Arc Mountains Conservation Endowment Fund (EAMCEF) issued a consultancy work on economic valuation of EAM ecosystem services and existing assets to a team led by UNEP-WCMC, with inputs from Cambridge, York, Southampton, Exeter Universities in the UK, and Sokoine University of Agriculture in Tanzania. The work involved field data collection, analysis and drafting a comprehensive report on the value of ecosystem services supplied by the mountains. The study based its valuation on GIS and hydrological modeling of the EAM natural assets. The report was prepared and submitted to EAMCEF and EAMCEF provided comments and the consultants worked on the comments accordingly. However, the approach used tends to undervalue the asset because is using the actual market price indices of the ES supplied by the mountains. Following this EAMCEF issued the same assignment to another team of consultants to conduct a detailed economic value of the mountains this time using market price indices for the ES supplied that would help the organization to justify its investment in conserving the mountains against alternative land uses. This report is a step towards achieving that and was commissioned to two consultants by Eastern Arc Mountains Conservation Endowment Fund (EAMCEF) for three major objectives:

- To Identify the Ecosystem Services (ES) in the all EAM blocks,
- To estimate the economic value of the identified ecosystem services in the EAM blocks,
- To update the report on EAMs valuation carried out in 2015.

Study methods

The assignment was carried out between 22nd January and 9th February 2018, by conducting field survey in 28 villages randomly selected from eleven EAMs blocks. To establish the types of ecosystem services the catchment supply and usage at household level, individual household survey which involved interviews of randomly selected household members, village key informants, various officials from Rufiji, Pangani and Wami/Ruvu Water Basin Offices, officials from water supply companies (i.e. Tanga UWASA, MOROWASA and DAWASCO), officials from Sugar and rice estates (Mtibwa Sugar, Kilomero Sugar and Kilombero Paddy Production Limited), officials from forests and nature reserves (i.e. Udzungwa Mountains National park, Amani Nature Reserve, Magamba Nature Reserve, Chome Nature Reserve, Nilo Nature Reserve, Uluguru Nature Reserve and Mkingu Nature Reserve), officials from forest plantations (i.e. Ukaguru, Mtibwa, Longuza and SAO Hill planted forests), agricultural and forest officers from Muheza, Mkinga, Korogwe, Lushoto, Same, Mwanga, Morogoro Rural, Mvomero, Kilombero, Kilolo, Mufindi and Mahenge Districts. We also interviewed officials from TANESCO and visited all the hydropower plants in EAMs (i.e. Nymba ya Mungu, Hale, New Pangani fall, Kidatu, Kihansi, Mbingu Sisters, and Iyovi hydropower plants). We also visited and interviewed TANESCO head office staff in Dar-es-Salaam. The information gathered from these groups included the type of ecosystem used, quantity used and the market prices for those with market prices.

To establish the economic value, we categorized ecosystem services supplied by EAMs into eight categories: (i) Agricultural ES, (ii) Extracted forest products, (iii) standing timber (iv) water resources (v) Biodiversity, (vi) Carbon sequestration, (vii) Bequest value or value of existence and (viii) Tourism. To account for the time preference in our calculation, we have used a discount rate/rate of return to capital of 9 percent as recommended by central bank of Tanzania (BoT) that led to a discount factor of about 0.1214947754. The exchange rate used throughout is USD 1=Tsh. 2,276.87/=.

Results and discussion

Type of ecosystem services supplied by EAMs and their economic values

The EAM blocks supply a number of ecosystem services with multiple uses. The ecosystems services supplied give the mountains a remarkable economic value as indicated in the Table below.

Aggregated total economic value of EAM ecosystem services

Categories of the Ecosystem services	Type of the ecosystem services	Total value in USD	% of the total value
Agricultural products	Crops	3,186,381,332.37	1.34
	Vegetables	106,859,398.76	0.05
	Fruits	933,304,626.92	0.39
	Livestock	165,121,780.53	0.07
Extracted forest products	Natural forests	51,513,125.69	0.02
	Planted forests	18,833,440.16	0.01
Standing timber	Natural forests	88,769,595,456.95	37.44
	Woodland	58,877,686,970.33	24.84
	Planted forests	13,486,327,112.89	5.69
Water resources	Water (domestic, irrigation, livestock & industrial use)	321,137,563.44	0.14
	Hydropower	66,665,423,437.24	28.12
Biodiversity	Biodiversity value	3,519,100.00	0.0015
Value of existence	Bequest value	775,465.00	0.00033
Carbon sequestration	Forests	2,547,681,986.59	1.07
	Woodland	1,935,289,472.29	0.82
Tourism	Tourism	21,997.93	0.0000093
	EAM total value	**237,069,472,267.08**	**100.00**
	EAM NPV	**28,787,986,000.00**	

The total economic value of EAM block ecosystem services is 237,069,472,267.08 USD which is equivalent to 28,685,406,144.32 USD net present value. Standing timber in natural forests account for 37.44% of this value followed by water resource used to generate hydropower (28.12%). Standing timber in woodland take the third place by accounting for 24.84% of the total value followed by standing timber in planted forests which account for 5.69% of the total value. Agricultural crops take the fifth place by accounting for 1.34% followed by fruits production which accounts for 0.39% of the total value. The mountain capacity to store carbon is high accounting for 1.07% in natural forests followed by woodland which account for 0.82% of the

total value. Other ecosystem services account for less than 0.1% of the total value. Higher value in forest products implies that forest cover dominates the EAMs land area and it shows how important forest cover is to the mountain capacity to supply ecosystem services and support production of consumable goods. The capacity to supply ecosystem services and support production of consumable goods varies across the mountain blocks. The Table below clearly shows that variation among EAMs.

Aggregated total economic value of EAM by mountain blocks

Name of the mountain block	Total economic value in USD	% of the total
East Usambara	7,013,538,404.06	2.96
West Usambara	15,403,755,298.67	6.50
South Pare	7,451,233,800.00	3.14
North Pare	1,896,086,156.60	0.80
Nguru	12,036,287,769.71	5.08
Nguu	10,334,796,253.03	4.36
Uluguru	26,278,126,642.53	11.08
Ukaguru	12,088,013,686.58	5.10
Rubeho	21,893,848,602.43	9.24
Mahenge	489,172,381.98	0.21
Udzungwa	122,184,613,271.50	51.54
EAM total economic value	**237,069,472,267.08**	**100.00**
EAM NPV	**28,787,986,000.00**	

Among the EAM blocks Udzungwa accounts for a higher value followed by far by Uluguru, Rubeho, West Usambara, Ukaguru, Nguru, Nguu, South Pare and East Usambara. The mountain blocks account for 51.54%; 11.08%; 9.24%; 6.50%; 5.10%; 5.08%; 4.36%; 3.14% and 2.96% of the total value respectively. Other mountain blocks account for less than 1% of the total value. This also indicate how potential the mountain blocks are in terms of ecosystem services provision, forest stocks, agricultural production supporting services, regulating services and cultural services. Udzungwa mountain block led other mountain blocks in many respects as far as ecosystem services provisioning, supporting, regulating and cultural services are concerned. Uluguru and Rubeho mountain blocks follow in this respect. In addition to the potentiality, this also show how well preserved the block is, much of Udzungwa land cover is under reserved

areas with a national park in it. This has made the block to have a higher value in standing timber in both forests and woodland, hence higher value in carbon storage and water. This emanate from the fact that water has a strong connection with the condition of the forests.

Conclusion

- The EAM blocks have high value in all respect of ecosystem services ranging from provisioning, supporting, regulating and cultural aspects. The valuation based on the materials harvested to consume directly and to produce other consumable goods and services;
- Out of the total value, standing timber stocks in natural forests and woodlands, planted forests and water account for the largest value. The value of these natural assets varies across the mountain blocks with Udzungwa taking the lead in most of the natural assets valued by this study. This not only show how potential the mountain blocks are but also how valuable they are that necessitates for more investment in preserving them for today's' generation and future generations;
- The study also has revealed that the EAM blocks have higher values of crop, livestock and fruit products. These economic activities employ more than 99.9% of the population living in the mountain blocks. However, this depends on the presence of forests and woodlands which create the climatic conditions favorable for various crop and animal production.
- On the case of extracted timber, the study has revealed a significantly high value of timber harvested from the mountain blocks natural forests despite the fact that much of these forests are under controlled management system. This clearly indicates that there is illegal timber harvesting going on in the mountain blocks. Even though this provide employment to the people involved along the market chain but it threatens the future capacity of the mountains to continue supporting other valuable economic activities as shown by the study;
- EAMs forests also support the hydropower plants installed in the mountain blocks water resources. The hydropower generated from the EAMs blocks installed power plants contribute about *one third* of the total power generated in the country. Therefore,

protecting the EAM blocks forests and its environment is not an option task but a must task;

- Apart from direct and consumable economic values, EAM blocks also have higher economic value in terms of biodiversity, carbon sequestration and bequest value *in situ* value of existence. Again these depends on the presence of the forests and its environment; forests provide a habitat for biodiversity to thrive, forests trees and plants absorb Co_2 from the atmosphere cleaning greenhouse gases and releases O_2, and their existence is valuable.

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CHAPTER ONE

1.0 INTRODUCTION

1.1. Background of the assignment

The decline in the quality and quantity of ecosystem services society derives from mountain forests is a growing global concern (MEA, 2005). Mountain forests play four major roles: provisioning, regulating, supporting and cultural ecosystem services. Mountain forests provide freshwater for domestic and commercial uses, regulate storm flow hence reducing floods downstream, support agricultural production of various crops and fruits, supply clean air that support lives of humans and other living biodiversity, the landscape provide beauty for recreation, provide habitat for various biodiversity, and the forest have cultural touch with the communities living around (Sanga and Mungatana, 2016; Dasgupta 2008). Overtime demands for ecosystem services from mountain forests have intensified worldwide following the increase in population and the growth of economic activities requiring ecosystem services from forests as inputs in producing consumable goods such as hydropower generation, irrigated agriculture, industries, tourism, mining, livestock keeping, domestic use, fisheries, wildlife, and forestry activities (i.e. harvesting of timber, collection of wild products, and hunting) (TEEB, 2010).

In Tanzania just like the rest of the world this problem is growing at an increasing rate. The demand for the mountains forest ecosystem services is growing faster than the capacity of the mountain forests to provide; the country is getting 45% of electricity from hydropower plants installed in the Eastern Arc mountain (EAM) forests (URT, 2002). Equally important, the areas are under increasing pressure emanating from internal population growth and in-migration of people from different areas due its assured continued supply of water and fertile land for agriculture (Sanga and Mungatana, 2016). EAMs are known for a fertile agricultural land which is suitable for production of high value crops such as vegetables, fruits, spices, tea, sugar, and paddy; they are also popular for fresh water supply and fishing (Burgess *et al*., 2015). The area is also rich of natural forests and planted forest which provide timber and other forest products. All these attract people from other parts of the country to migrate to the areas in search for agricultural land, water and pasture. The overall result of such population growth and increased demand for ecosystem services from mountain forests countrywide for production of consumable

goods is the increased degradation of the forests leading to reduced capacity of the forests to provide ecosystem services and imbalance of biodiversity. EAMs present an evidence of this degradation of mountain forests in the country. Less than 10% of the mountain area is forested which is less than a third of the historical forests before humans started to clear the land for agriculture (Burgess *et al*., 2015).

The decline in the supply of ecosystem services not only threatens imbalance of biodiversity but also food security, energy production and consequently induces ecosystem services use conflicts between sectors of the economy. Such conflicts over ecosystem services in EAMs are common and growing over time. For example, in North Pare and East Usambara the conflicts between livestock keepers and farmers are reported to grow over time, in Nguru, Uluguru and Udzungwa mountains flood plains similar conflicts are also reported. Other conflicts are between mountains natural forests conservers and miners; in almost all EAMs there is illegal mining going on which not only destroys water sources hotspots and pollute water that flow downstream but also destroys river banks increasing floods downstream. Realizing the challenges facing the mountain forests in Tanzania, EAMs Conservation Endowment Fund (EAMCEF) of Tanzania in 2015 issued a consultancy work of economic valuation of EAMs ecosystem services in Tanzania to a team led by UNEP-WCMC, with inputs from Cambridge, York, Southampton, Exeter Universities in UK, and Sokoine University of Agriculture in Tanzania. The work involved field data collection, analysis and drafting a comprehensive report on the value of ecosystem services supplied by the mountains. The report was prepared and submitted to EAMCEF and EAMCEF provided comments and the consultants worked on the comments accordingly. However, EAMCEF is seeking to have a detailed economic value of the mountains that would help the organization to justify its investment in conserving the mountains against alternative land uses.

This may be achieved in many ways and one of them is the Total Economic Valuation (TEV) of the mountains ecosystem services. Total economic valuation of ecosystem services gives a room for identification of the type of ecosystem services, beneficiaries and the costs that can be incurred in case of deterioration of the forests. Such information is crucial in defending the importance of conserving the mountain forests against other land uses. Nevertheless, such

information is important in understanding the contribution of the forest to the beneficiaries' economies (micro-economy) and the national economy (macro-economy). It is also important information for planning the long-term management of the forests that will induce sustainable use of ecosystem services. Therefore, this study was designed to identify and value ecosystem services from EAMs and carry out economic analysis of the ecosystem services.

1.2. Objectives of the assignment

Specifically, this assignment was designed to achieve the following objectives:

- To identify the Ecosystem Services (ES) in the twelve EAM blocks,
- To estimate the economic value of the identified ecosystem services in the EAMs,
- To update and finalize the Synthesis valuation for the EAMs report.

1.3. Nature and scope of the assignment

Even though the benefits of ecosystem services supplied by the mountain forests go beyond the perimeters of the mountains, the study confined itself to the mountains and the population surrounding the mountains. Therefore, to achieve the objectives above, EAMCEF assigned two consultants an assignment with three terms of reference as follows:

- To identify ecosystem services and determine the economic and financial values of ecosystem services from each mountain;
- To write a comprehensive report on the total economic value of the EAMs.
- To submit the report, receive comments from the EAMCEF, revise the report and resubmit it to EAMCEF for approval.

The assignment was carried out between 22nd January 2018 and 9th February 2018, by conducting field survey in 28 villages selected from twelve Districts (i.e. Muheza, Korogwe, Lushoto, Same, Mwanga, Kilindi, Mvomero, Morogoro rural, Gairo, Kilosa, Kilombero and Ulanga) to collect data and secondary information from existing documents about the EAMs. Two villages were selected from each mountain (i.e. one upstream and one downstream) except for Uluguru and Udzungwa where four villages were selected (i.e. two upstream and two downstream).

CHAPTER TWO

2.0 STUDY APPROACH AND LIMITATIONS

2.1. Ecosystem valuation theoretical background

The major reason for the persistent poor management of mountain forests is under-valuation of ecosystem services supplied by the forests (Mooney *et al.*, 2005). Traditionally, concepts of economic value have been basing on a very narrow definition of benefits supplied by natural ecosystems like mountain forests (Barbier *et al.*, 2009). In many cases the value of ecosystem services is seen in terms of raw materials and physical products they generate for human consumption and production only, especially focusing on commercial activities and profits (Sanga and Mungatana, 2016; Daniels and Moore, 2002). These direct uses however represent only a small proportion of the total value of ecosystems which generates economic benefits far in excess of just physical or marketed products (Gómez-Baggethun and de Groot, 2007). To reverse the shortfalls of the traditional ecosystem valuation process, the total economic valuation framework is used for identifying and categorizing ecosystem benefits (Fisher *et al.*, 2009; Balmford *et al.*, 2008; Boyd and Banzhaf, 2007).

2.1.1. The total economic ecosystems services valuation framework

Instead of focusing only on commercial values, the framework encompasses the subsistence and non-market values, ecological functions and non-use benefits (Walker *et al.*, 2004). Basically the framework presents a complete picture of the economic importance of ecosystems, and clearly demonstrates the high and wide-ranging economic costs associated with their degradation, which extends beyond loss of direct use values (Brand, 2009; Deutsch *et al.*, 2003). Broadly defined, the total economic value of mountains forests ecosystems includes the direct use value, indirect use value, optional values and non-use value as shown in Figure 1.

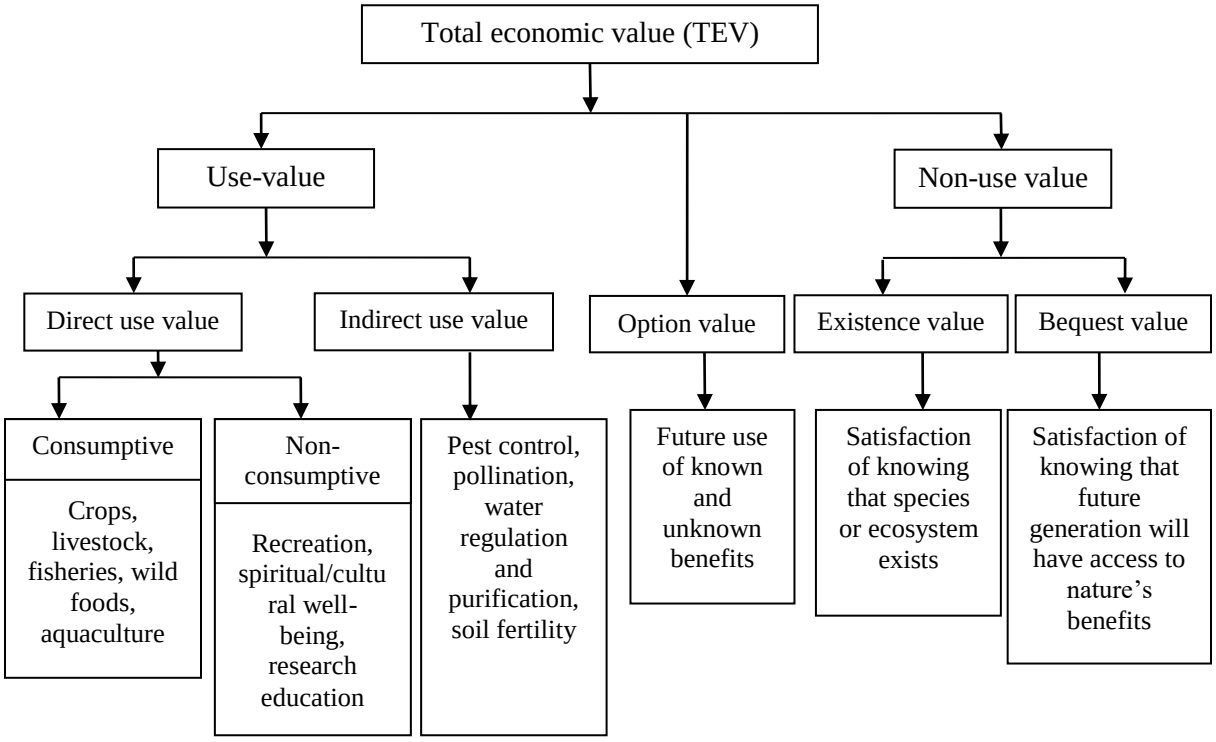

Figure 1: The total economic valuation framework

2.1.2. Study approaches

Since most of ecosystem services do not have market values, their values are then derived from individual behavior observed during market transactions that involve directly ecosystem services (Balmford *et al.*, 2008; de Groot, 2006). In the absence of such information, price information can be derived from parallel market transactions that are associated indirectly with the goods and services to be valued (Kontoleon and Pascual, 2007; Bateman *et al.*, 2002). If both direct and indirect price information on ecosystem services is absent, hypothetical markets are created in order to elicit values (Spash, 2008; Philip and MacMillan, 2005; Wilson and Howarth, 2002). Following these limitations, valuation techniques that are commonly used to value ecosystem services are categorized into three groups i.e. (a) direct market valuation approaches, (b) revealed preference approaches and (c) stated preferences approaches (García-Llorente *et al.*, 2008; Christie *et al.*, 2007; Spash, 2007; Martín-López *et al.*, 2007).

For this assignment, we employed the following approaches:

(i) **For mountains forests ecosystem services direct use value:** Market based approach was used whereby market prices of agricultural, forest and water products were used. The method is common in obtaining the value of provisioning services, since the commodities produced by provisioning services are often sold at market price, e.g., agricultural products like crops, and forest products like timber and building poles. We assumed that market for products produced from the mountain forests is functioning well; therefore, markets preferences and marginal cost of production are reflected in a market price, which implies that market information are accurate on the value of commodities. The market prices of the commodities produced were used as indicators of the value of the ecosystem service used as inputs to produce them.

(ii) **For catchment ecosystem services indirect use, non-use and option values:** Stated preference approach, specifically contingent valuation method (CVM) was employed. The method simulates a market and demand for ecosystem services by means of surveys on hypothetical (policy-induced) changes in the provision of ecosystem services. To derive the ecosystem services value, a structured questionnaire was designed with a special question on how much beneficiaries of ecosystems services are willing to pay to enhance the provision of the service, or alternatively, how much they are willing to accept as compensation for its loss or degradation.

(iii) **For carbon sequestration value of the mountains vegetation cover:** The study employed secondary information on types of catchment canopy covers and the carbon storage capacity (i.e. of standing biomass, liter and ground) to establish the value.

2.1.3. Limitation of market based approach in valuing ecosystem services

The approach can provide biased economic values of an asset if the market is imperfect competitive i.e. the market operates in a situation where information about the product and prices are asymmetry or some players in the market do not have access to market information. This situation makes the prices existing not to be equilibrium market prices as they are not determined by demand and supply market forces. The possibilities of markets to be imperfect competitive

have rendered the application of market based approaches in valuing ecosystem services to criticism (Polasky and Segerson, 2009). The argument is that since perfect competitive markets rarely exists; the validity of values derived from this approach is also questionable (Drechsler and Wätzold, 2007; Shogren and Tschirhart, 2005; Shogren *et al*., 2003).

2.1.4. Assumptions

To resolve the problem of imperfect market, we assumed that markets for products with market values are functioning well. Therefore, markets preferences and marginal cost of production are reflected in a market price, which implies that market information collected is accurate on the value of commodities. The market prices of the commodities produced were used as indicators of the value of the ecosystem service used as inputs to produce them.

2.2. Methods

To address the specific objectives and the terms of reference; desk review, field survey which involved interview of key informants, focus group discussion, and questionnaire administration were undertaken.

2.2.1. Desk review

A desk review involved review of Eastern Arc Mountains Conservation Endowment Fund (EAMCEF) and Tanzania Wildlife Protection Fund (TWPF) reports on ecosystem services and biodiversity inventory for all EAMs; review of NEMC economic valuation report of Kihansi river catchment; review of protected areas conservation reports; review of tourism in EAM nature reserves reports; review of Nyumba ya Mungu, Hale, New Pangani , Kidatu and Kihansi Hydropower plants water use and power generation reports; review of Rufiji, Wami/Ruvu and Pangani River Basin Water Office reports on water sources hotspots management and use; and review of District's reports on EAM natural resources, economic activities, water use and sources hotspots management.

The review of the reports from the stakeholders aforementioned involved identification of ecosystem services supplied by EAM and the usage, charges if any to the users and the amount

collected/abstracted per year, the current management and role of each stakeholder in managing the catchment, type of economic activities being carried out in the catchment (in both upstream and downstream) and the type of ecosystem services supporting the economic activities. In addition to reports from the mentioned stakeholders, other documents reviewed include the Constitution of Tanzania (1977-1995), the National Water Policy of 2002 and its regulatory document, the National Environment Management Council water catchment regulatory document and reports, Village Land Act (1999), Rural Development Strategy (2001), the Forest Act (2002), draft of National Forest Policy (2015), the National Environment Policy (NEP) (1997), the Environmental Management Act (2004) (or Cap 191), the Land Use Planning Act (2007), the National Water Policy (2002), the Water Resource Management Act (2009), the Energy and Water Utilities Regulatory Authority Cap 414, the Electricity Act, 2008 (Act No. 10/2008), the Energy Policy (2015), the Wildlife Conservation Act (2009), the URT (1995): National Conservation Strategy for Sustainable Development and the EAM Conservation Strategy (2008).

2.2.2. Field survey

To establish actual catchment ecosystem services, supply, usage and value at household level the study conducted household survey which involved interviews of some household members, village key informants, meetings with various officials from the stakeholders mentioned in 2.2.1 and focus group discussion with village executive committees, environmental committees and water user associations (WUA).

The survey covered twelve Districts found within the EAMs. These included Muheza, Korogwe, Lushoto, Mkinga, Same, Mwanga, Kilindi, Mvomero, Morogoro Rural, Gairo, Kilosa, Kilombero and Ulanga. Information for Kilolo and Mufindi were adopted from NEMC economic valuation report of Kihansi river catchment. Two villages were visited from each District except for Kilombero, Morogoro Rural, where four villages were visited and Lushoto and Korogwe where one village was visited for each District. The villages visited are presented in Appendix 1. The villages visited were selected to cover the whole landscape of the EAM in terms of biodiversity, standing timber diversity, water sources and rivers, ecotourism diversity, ecosystem

services diversity, economic opportunities and activities diversity. The field survey was conducted as elaborated below:

(i) **Key informant interviews:** This involved officials responsible for managing and monitoring EAM Water Basin Offices, Districts agriculture and natural resource departments, Hydroelectric Power Plant officials; EAM nature reserves management officials, EAM ecosystem service large and medium beneficiaries, village leaders and selected elders. To gather information from these officials we used structured questionnaire.

(ii) **Focus group discussion:** Focus group discussions with the village executive committees, environment committees and water user associations were conducted using focus group discussion guideline. See checklist for focused group discussion in Appendix 2.

(iii) **Household survey:** This involved 30 households randomly selected from each village. A structured questionnaire was used to interview individual households for the purpose of identifying the type of ecosystem services household benefits, the market price of ecosystem they use at household level, household opinion on the value of the catchment (see questionnaire in Appendix 3). Other information captured at household level by using this instrument included household characteristics, household type and quantity of ecosystem services used by household, household crop production, timber and other forest products harvesting, household water use, and household understanding of the importance of EAM to their daily livelihood.

2.3. Data analysis and reporting

2.3.1. Data analysis

Field data collected through questionnaires were coded, entered, cleaned and analyzed using Statistical Package for Social Science (SPSS), EXCEL and SIGMA PLOT programs. The results are summarized and presented in chapter five and six.

CHAPTER THREE

3.0 THE NATIONAL CONTEXT ON NATURAL RESOURCES MANAGEMENT

3.1. National issues affecting natural resources management

Worldwide it is known that the patterns of demographic, social and economic changes generate intensive and extensive demand for ecosystem services from natural systems like mountain forests for production of consumptive goods and services (Skoufias, 2012). Tanzania is one of the countries whose population and its economy grow fast; a situation which implies increased demand for resources to support the economy and the population. These exert pressure on mountain forests which supply ecosystem services that are used as inputs to produce consumable goods and services at various stage of the economy. As a result of this all of the country's mountain forests are under pressure. The major challenges facing the mountain forests in the country include: poor land use practices which encroaches the forests, water sources and river banks; expansion of crop land which in return reduces natural forests and vegetation cover; inefficient use of ecosystem services supplied by the forests (i.e. inefficient use of water and resultant wastage, excessive clearing and burning natural forests); management institutional overlaps, lack of sufficient skilled manpower; and lack of clear management financing mechanisms.

3.2. The National forest and water catchment management policy and legal frameworks

To protect and ensure sustainable use of forests and water catchments ecosystem services, Tanzania has formulated and adopted a number of important policies, acts and institutional frameworks relevant for management of forests and water catchments. The responsibility for management, development and protection of forests and water resources and their environment presently lies within the two ministries i.e. Ministry of Natural Resources and Tourism (MNRT) and Ministry of Water (MoW) (URT, 2009). However, forests and water catchments or water resources management is a crosscutting issue which surfaces in other national institutions such as Division of Environment (DoE) and the National Environment Management Council (NEMC) which are under the Vice President's Office; and Ministry of Agriculture, Food and Cooperatives (MAFC)-Land Use Department (Burgess *et al*., 2007). Given that it is a crosscutting issue,

management of forests and water resources is therefore stated in a number of legislations. It is well stated in the Constitution of Tanzania (1977-1995), the National Water Policy of 2002 and its regulatory document, Village Land Act (1999), Rural Development Strategy (2001), the Forest Act (2002), draft of National Forest Policy (2015), the National Environment Policy (NEP) (1997), the Environmental Management Act (2004) (or Cap 191), the Land Use Planning Act (2007), the National Water Policy (2002), the Water Resource Management Act (2009), the Energy and Water Utilities Regulatory Authority Cap 414, the Electricity Act, 2008 (Act No. 10/2008), the Energy Policy (2015), the Wildlife Conservation Act (2009), the URT (1995): National Conservation Strategy for Sustainable Development and the EAM Conservation Strategy (2008).

3.2.1. The Constitution of Tanzania (1977-1995)

The Constitution of the United Republic of Tanzania (1977-1995, Revised 2000) recognizes the basic rights for its people. Article 24 stipulates that every person is entitled to own property and has a right to the protection of his/her property held in accordance with the law. However, there are certain limitations related to the enforcement and preservation of basic rights, freedom and duties. Article 30(2) states that "freedom and duties do not invalidate existing legislation or prohibit the enactment of any legislation or the doing of any lawful act in accordance with such legislation for the purpose of –among others -ensuring the defense, public safety, public order, public morality, public health, rural and urban development and utilization of minerals or the increase and development of property or any other interest for the purpose of enhancing the public benefit".

3.2.2. The national environment policy (1997) and the environmental management Act (2004)

The national environment policy (NEP) (1997) aims to provide a framework for making fundamental changes that are needed in order to bring environmental considerations into the mainstream of the decision-making in Tanzania. The two overall objectives of NEP are (i) to raise public awareness and understanding of the essential linkages between environment and

development and to promote individual and community participation in environmental action; and (ii) to conserve and enhance the natural and man-made heritage, including the biological diversity of the unique ecosystems of Tanzania (URT/WB, 2001). In addition, the policy provides guidelines for the determination of priority actions to be taken to conserve the environment. It also provides sectoral and cross-sectoral policy analysis in order to achieve compatibility among sectors and other stakeholders.

To enhance protection of the environment, in 2004 the government enacted the Environmental Management Act (2004). Apart from repealing the National Environmental Management Act of 1983, the Act establishes the National Environmental Management Council (NEMC) to oversee the management of natural resources, and charges the NEMC with the responsibility for evaluating environmental policies and formulating proposals for environmental legislation and strategies including environmental valuation for designing management financing mechanisms. Furthermore, NEMC is mandated to review environmental mismanagement arrangements and involve the public in environmental management decision making (EMA, 2004). This requires an understanding of the various issues involved including the value of ecosystem services supplied by the forest catchment in question.

3.2.3. Village Land Act (1999)

The Village Land Act No.5 of 1999 is amongst the laws that directly touch the backbone of the rural economy as most of Tanzania rural dwellers depend on land to derive their everyday livelihood. Unlike the Land Act, the Village Land Act has in its provisions, which bear witness of some attempt to learn from past problems and experiences. The Act gives villages administrative powers on land for the purpose of protecting the small-holder land tenure security. Fundamentally, the Act vests all village land in the village. The precise distribution of authority between the Village Council and the Village Assembly is not clearly defined, but the underlying principle is clear that Village Land is vested in the Village Assembly and that the Village Council administers the land through the authority of the Village Assembly.

The Village Land Act through Section 18 (1) states that a “customary” right of occupancy is in every respect of equal status and effect to a granted right of occupancy. The meaning of this

statement is somewhat unclear as the holder of customary rights answers to a different set of rules with different hindrances and privileges than does a holder of a granted right of occupancy. This statement in its own right is unimportant because the status of customary rights will only be determined by the way in which the law will be administered.

However, Section 60 of the Act makes special provisions for the establishment of a Village Land Council "to mediate between and assist parties to arrive to mutually acceptable resolution on any matters concerning the village land. Sections 11 and 58 of the Act show that for some reasons, the Village Land Council jurisdiction has been limited to cases related to land sharing arrangements with other villages and land sharing. Managing EAM which will involve raising funds from various sources including catchment ecosystem services beneficiaries, understanding of the complications arising from land ownership is important. The knowledge is important not only in choosing the approach to take and designing the mechanism to raise funds for management of the catchment but also for the land holders' capacity building that may be needed to achieve the goal.

3.2.4. Wildlife Conservation Act (2009)

The objective of this Act is to protect, conserve and administer areas with great biological biodiversity; protect and conserve wildlife resources and its habitats. Section 12 (1 & 2) of the Act provide the protection of natural vegetation cover and punishment to a person who will lawfully be convicted for destroying natural vegetation. Section 18 of the Act provides protection to all wild animals and reptiles by declaring that they are all national game, and Section 19 (1) prohibits hunting these animals without permission. Section 19 (2) continues to provide the kind of punishment one can get by violating subsection 1 of the Act. Section 35 of the Act provides legal requirement of conducting EIA for significant intervention in wildlife protected areas and their associated dispersal areas. While the Act provides clear protection of vegetation and wild animals found within and outside protected areas, it is silent about financing management of natural resources that are outside the protected areas. Many forests and water catchments in EAM fall under this category and they inhabit significantly valuable vegetation and wild animals and reptiles. There is no clear financing mechanism to manage these resources

even though penalties for unlawful harvesting are provided in the Act. This not only threatens the future flow of revenue to the government but also the existence of these resources. EAM are habitat of valuable natural vegetation and wild animals and reptiles which are protected by the Act, but it lacks a clear management financing mechanism.

3.2.5. The Forest Act (2002)

Forests are catchments of water and habitats of diverse biodiversity, therefore, Laws and Acts that govern management of forest resources affect a wide range of ecosystem services and biodiversity found in forests. The 2002 Forest Act objectively aim at promoting and enhancing the contribution of forest sector to the sustainable development, conservation and management of natural resources for the benefit of present and future generations. Section 4 of the Act classify forests into four categories basing on management institutions that are responsible to ensure the aforementioned objective is achieved as follows: (a) National forest reserves which consists of forest reserves or nature forest reserves; which are designated in accordance with the provisions of the Act and forests on general land; (b) local authority forest reserves which consist of local authority forest reserves and forests on general land; (c) village forests which consist of village land forest reserves, community forest reserves created out of village forests and forests which are not reserved which are on village land and of which the management is vested in the village council; and (d) private forests which are forests on village land held by one or more individuals under a customary right of occupancy and forests on general or village land of which the rights of occupancy or a lease has been granted to a person or persons or a partnership or a corporate body or a Non-Governmental Organization or any other body or organization for the purpose of managing the forest which is required to be carried out in accordance with this Act.

Section 11(2) under this Act realizes the complication that may arise in managing forest reserves and therefore, state that there shall be a forest management plan which shall define the management objectives by which the forest manager shall use its best endeavors to achieve the sustainable management of the forest resources over the period for which the plan has been prepared. One of the objectives is to protect the forests and in so doing water sources and its environment are preserved.

Section 49(1) of the Act provides the procedures to acquire the legal permit for harvesting forest ecosystem services or conducting activities in all the four categories of forests. Sub-section 6 gives power to village council to provide harvesting permits and sub-section (7) requires village council to send a copy of a resolution to the District council having jurisdiction in the area where the village is situated.

While all these sections show well defined forest management institutions, financing management is concentrated at reserved forests. Section 78 (2) of the Act highlights the royalties required to be paid for harvesting or extraction of forest produce *in situ* ecosystem services from category A and B of forests. Sub-section 3 clearly states that no royalties shall be required for harvesting or extraction of forest produce within a village forest or a community forest reserve by the resident of the village. This not only makes it difficult to collect revenue from this level but also it creates loopholes for loss of revenue for managing forests. It also creates loopholes for harvesters to use the opportunity of acquiring residents and continue destroying the forests. Equally important, section 79(1) establishes a fund known as forest fund which is aimed at redistributing the revenue collected from royalties for management purposes. However, nothing goes to village forests where the majority of water catchments fall in. EAM forests are a typical example; large proportion of the mountains village land which implies that most of its remaining forest pockets outside the protected areas are either village/community reserve or privately owned. Harvesting of ecosystem services is not controlled to a point where it is difficult to know its value. Justifying funding its management activities is difficult.

3.2.6. The Water Resource Management Act (2009)

The Act provides institutional and legal framework for sustainable management and development of water resources. It outlines principles for water resources management; for prevention and control of water pollution; and provides an avenue for participation of stakeholders and the general public in implementation of the National Water Policy. Its main objective is to ensure that the Nation's water resources are protected, used, developed, conserved, managed and controlled in ways that among others, meets the basic human needs of

present and future generations. It also aims to prevent and control pollution of water resources, and protects biological diversity especially the aquatic ecosystems.

According to Section 10(1) of this Act, all water resources in Mainland Tanzania are public water and vested in the President as the trustee for and on behalf of citizens. To manage water resources, sub-section 2 states that the president through various designated institutions confers powers to the Minister of water. The minister appoints the director of water resources and the national water board (sections 15 (1) and 20 (1) respectively). The director of water resources and National water board will be advisors to the minister on various matters regarding water resources management. As noted in section 3.4, water does not follow administrative border; it normally forges its own borders, to manage it the minister by the power vested in him/her with section 22(1) establish the so called Basin Water Boards in respect to each water basin. Basin Water Boards are responsible for managing the basin water resources and its environment, provide permit to abstract water, collect use charges, prepare and implement basin water resources management plans, penalize illegal abstractors and polluters, establish catchment and sub-catchment management committees.

Financing of water catchment management activities is foreseen by the basin water board which is responsible for collecting revenue and budgeting (section 26 (1) of the Act). As noted in above the Basin Water Board is responsible for planning all the basin management activities. Catchments and sub-catchments committees are responsible for: (a) coordinating and harmonizing catchment integrated water resources management plan; (b) resolving water resources conflicts in the catchment; and (c) performing other delegated functions by the Basin Water Board (section 29(2) of the Act).

Managing water resources is costly. Section 96 (1 & 2) of the Act states that collection of water use charges is done by the Basin Water Boards. Section 97 explains how this revenue is used; according to this Act the revenue is used for: (a) financing water resource management and (b) funding water resource development and construction of water works. The catchment management is funded through Water Catchment Committees and Water Users Associations.

This institutional framework sounds well in ensuring sustainable management of water catchment, but the reality on the ground is different. Water catchments are plagued by problems such as water pollution, catchment destruction, intensive water abstraction, increased sedimentation in streams and rivers draining them, changes in water flows, inadequate socio environmental flows, and land degradation (Sanga and Mungatana, 2016; TEEB, 2010). This is attributed to the fact that financing catchment management activities is very low something which makes it difficult to ensure effective reinforcement of bylaws established to manage water resources environment at local or village level. EAM water catchments present a compelling case: the catchments are plagued by similar problems emanating from low funding of management activities.

3.2.7. Land Use Planning Act (2007)

The Act established the Land Use Planning Commission, which is the principal advisory organ to the Government on all matters related to land use (section 6(1)). The commission has the function of formulating policy on land use planning, coordinating the activities of all bodies concerned with land use planning matters, and evaluating existing and proposed policies and activities of the Government directed to the safeguarding of land against its wrongful, wasteful or premature use or development and, on that basis, recommend policies and programs which will achieve more effective protection and enhancement of the land quality and encourage better land use planning.

Section 14 (1) of the Act provides funding sources of the commission activities. According to the Act there shall receive part of its funds from the budget allocated by the Parliament and others from assets as may accrue to or vest in the commission in the course of the exercise of its powers or the performance of its functions. Section 15 (1-3) provides other sources of funding the commission's activities. According to the Act, where necessary the Minister in the public interest may, after consultation with the minister responsible for finance and by order published in Gazette, impose fees payable to the commission by any person benefiting from the activities of the commission or whose activities affect the activities of the commission. Section 16 (7) of the Act provides how the commission use the funds. According to the Act the commission may use

the funds to fund land use planning activities and prepare the books of accounts and records with receipts and submit to the Minister ready to report to the National Assembly. Section 45 (1 & 2) of the Act provides implementation of land use plan, enforcement and coordination.

While the Act provides a well elaborative land use planning process, enforcement and coordination which are important institutions for protecting land and its environment, it is silent about managing land which host very important resources like water sources. The Act has left this to the Ministry of Water as the custodian of water and its environment, but water exists on lands which need proper land use planning. Planning alone is not enough; it needs also a clear funding mechanism for enforcing compliance to the land use plan. EAM water catchment just like other water catchments in the country are found in the middle of management dilemma emanating from lack of clear land use plan. There is high encroachment of the water sources and river banks except in reserved areas.

3.3. Summary and relevance of the study

Water catchments management is a crosscutting issue which needs policy and strategic attention. Having a sustainable financing of its management is imperative; however, all the relevant policy Acts are silent about it; they provide well elaborated institutional layout for managing specific resources and leaving the responsibility of managing water catchments under one institution and Act i.e. the Ministry of Water and the Act of Water Resource Management of 2009. Although this Act provides institutional layout and strategies for managing water catchment, it is also silent about financing management activities at local/village level.

Nevertheless, clear water catchments management institutions are also imperative; the review indicates that there is a serious problem of institutional overlap on managing the water catchments. According to the current institutional set up this responsibility is under the Ministry of Water, but it also found to appear in other institutions with no clear demarcation of the responsibilities. For example, water sources exist on land, but the responsibility of planning land use and providing land holding titles is under the Ministry of Land, Housing and Residence Development (MLHRD); while agricultural land use planning is under the Ministry of

Agriculture, Food and Cooperatives-land use division and that of ensuring protection of water resources environment *in situ* water catchments is under the Ministry of Water (MoW). This overlap of responsibilities subject water catchments at the risk of destruction and loss of its capacity to continue providing water ecosystem service.

These confusions make this study to be more relevant for providing policy and strategic area that needs to be reviewed and include the water catchment management issue. The review finds the following key Acts relevant to be reviewed to include the aspect of financing management of water catchments: The National Environmental Management Act (2004), the National Village Land Act (1999), the National Wildlife Conservation Act (2009), the National Forest Act (2002), the National Water Resource Management Act (2009), and the National Land Use Planning Act (2007). The study is also very important in providing guideline on the picture of what is happening on ground and how revenue can be raised. This information is important to the institutions that are responsible for reviewing the Acts aforementioned to use the information to adjust the Acts and hence achieve management of water catchments that are important habitats for a diverse biodiversity and suppliers of precious ecosystem services like water.

CHAPTER FOUR

4.0 THE EASTERN ARC MOUNTAINS

4.1. Introduction

This chapter highlights the characteristics of EAM in general. The chapter highlights issues like geographical location of the mountains, topography and rainfall distribution, water sources distribution, rivers and wetlands distribution, vegetation, biodiversity, land use and population, and economic activities. Much of the descriptions are site specific. Other aspects such as climate and socio-economic issues are general and broad for the EAM.

4.2. Geographical Location

The EAM is a chain of mountains found in Kenya and Tanzania. The chain runs from northeast to southwest, with the Taita Hills being in Kenya and the other ranges being in Tanzania (Figure 2; Table 1). They are delimited on the southwest by the fault complex represented by the Makambako Gap that separates them from the Kipengere Range. To the northeast, they are delimited by more recent volcanism represented by Mount Kilimanjaro. The mountains together with a map of the area were first appeared in print in 1985 (Lovett, 1985).

The boundaries of the EAM region used in this new project are the same as those used in the Valuing the Arc Programme (Platts et al. 2011a). Beyond the mountain boundaries, Valuing the Arc conducted some of its analyses across the Tanzanian watersheds that drain the EAM (Figure 1), including those of the Sigi, Pangani, Wami, Ruvu, Rufiji and Kilombero Rivers. This wider region covers 34 million ha and contained around 13 million people in 2002, including the administrative and commercial capitals of Dodoma and Dar es Salaam, as well as Arusha, Morogoro, Moshi and Tanga. We used the mountain boundaries for some services (timber, NTFP, tourism), whereas for others the use of the larger watershed region makes more sense (water and carbon).

Figure 2: Location of Eastern Arc Mountains

4.3. Physical Characteristics

4.3.1. Geology

These mountain ranges are the oldest in East Africa, and though physically they are separated from each other, they share a similar geomorphology and ecology. They were formed at least one hundred million years ago along a fault lying to the east of the East African Rift valley, which is a more recent structure (Sanga and Mungatana, 2016). The EAM are formed from heavily metamorphosed Pre-Cambrian basement rocks, periodically uplifted by faulting and weathering over millions of years. These block-faulted mountains have been geologically isolated, probably since the Miocene (Hamilton, 1982). The mountains cover an area of 5400 km^2, with highest

peak in South Uluguru (Kimahandu) rising to 2600 m a.s.l although maximum altitudes of 2200 to 2500 m a.s.l are more typical.

Table 1: Location, area (km^2) and altitudinal range of forests in EAMs

Mountain Block	Coordinates degree and minutes	Forest area (km^2) according Newmark (2002)	Forest area according to other various published sources	Forest area according to standardized satellite images	Size of the block	Altitudinal range of forest (m.a.s.l)
Taita Hills	0325S 3820E	6	3	3	NA	1500–2140
North Pare	0335–0346S 3733–3740E	151	25	27	453.58	1300–2113
South Pare	0404–0434S 3745–3801E	333	211.1	138	1577.73	820–2463
West Usambara	0420–0507S 3806–3841E	547	220	319	2506.65	1200–2200
East Usambara	0445–0520S 3826–3848E	413	450	263	1082	130–1506
Nguu	0527–0538S 3736–3732E	Included in Nguru	140.42	188	1591	1000–1550
Nguru	0527–0613S 3726–3737E	647	328.35	297	1672.9	400–2000
Uluguru	0651–0712S 3736–3745E	528	230	278	1477.5	300–2400
Ukaguru	0619–0635S 3653–3703E	184	155.38	172	1258.8	1500–2250
Rubeho	0648–0722S 3634–3658E	499	654	464	4636.4	520–2050
Malundwe Hill	0724S 3718E	6	4.5	13	1661.5	1200–1275
Mahenge	0837–0838S 3642–3644E	291	5	19	2802.29	460–1040
Udzungwa	0722–0843S 3507–3658E	2103	1017	1353	16,131.40	300–2580
Total		**5708**	**3443**	**3534**		

4.3.2. Climate

Rainfall patterns in the EAM are associated with the passage of the Inter-Tropical Convergence Zone (ITCZ), which migrates from approximately 10°S during January to 10°N during August. The southeast trade winds are driven by annual oscillation of the ITCZ bringing monsoonal rainfall to the east of Tanzania (Burgess *et al*., 2007). Wet and dry seasons are clearly defined; northern Tanzania experiences rainy seasons from March to May and from October to

December, while southern areas have one long rainy season (November to May). The average rainfall is 1700 mm yr^{-1}; on the eastern sides of the mountains (facing the Indian Ocean), precipitation is up to 2000 mm yr^{-1}. The elevetional gradient on the eastern slopes of the EAM is steeply sloping (Usambara, Pare, and Uluguru), while the western sides are relatively gentle sloping (Udzungwa) (Lovett, 1999). The coring site is located at 7°49′S, 35°55′E, 40 km east of Iringa town, at 2100m altitude on the southwestern edge of the main southern block of the Udzungwa Mountains.

4.3.3. Hydrological characteristics and flow variation

The Eastern Arc Mountains hydrological characteristics are highly influenced by the Indian Ocean. Incoming air masses from the ocean are forced to rise, cool and is converted to precipitation on the mountains. This phenomenon, known as the orographic effect, is responsible for availability of stable rainfall which produces sufficient runoff and groundwater recharge. Lower temperatures on the slopes of these mountains result in lower evapotranspiration rates so that the overall water balance is positive. In general, the lowlands immediately adjacent to these mountains have less precipitation and high evapotranspiration rates, resulting in negative water balance. The main source of water for the lowlands which are the main population centers is therefore from the EAMs.

The Mountains are estimated to have not less than 40 rivers and numerous streams draining downstream which are distributed unevenly in all the 12 mountain blocks found in Tanzania. The streams and small rivers discharge their water to five major rivers (i.e. Pangani, Sigi, Wami, Ruvu and Rufiji) which discharge their water to the Indian Ocean.

The Rivers draining the EAM experiences a transition pattern of intra-annual flow variation between the bimodal and unimodal rainfall regimes with a defined peak during the long rains (March- May) and low flows in October. During the peak rains (between March and May) the rivers results to a higher flooding in downstream.

4.3.3.1. The hydrological importance

The EAMs are the source of water for major rivers in Tanzania which are used for power generation, irrigation and water supply for domestic and industrial use. The mountains maintain the base flow in rivers making water available during dry season. More than 6,000,000 people or roughly 10% of Tanzanian population living in Dar es Salaam, Morogoro and Tanga depend on water supply derived from rivers draining from the EAMs. In addition, EAM Rivers including Kihansi, Great Ruaha and Pangani have important hydropower plants which provide roughly 32.5% of the hydropower in the National grid. Of late, hydropower generation has been facing problems due to shortages of water during the dry season which has led to concerns about proper management of the head water catchments including upland forests to ensure stable river flow for hydropower generation.

Rivers draining from the EAMs also support various irrigation schemes producing food and cash crops as well as providing employment to rural communities. The main irrigation schemes are located in Kilombero, Wami and Great Ruaha River basins. The commonly irrigated crops are sugar, rice and horticultural products. The Great Ruaha River basin is famous for sugar plantations in Kilombero and Wami sub-basin for Mtibwa estates.

4.4. Ecological characteristics

The EAMs are known in Africa for high concentrations of endemic species of vertebrates and invertebrates. Ecological characteristics of the mountains ranges are similar and are highly influenced by climatic conditions and forest cover. About thirty million years ago, all this area was covered by extensive rainforest. Ten million years ago, when the climate was cooler and drier, the lowland forests were converted to savanna, leaving the mountain ranges as "islands" where the tropical forests continued to flourish, fed by moisture-laden winds from the Indian Ocean (Mumbi *et al*., 2008). This isolation of each mountain range has led to a great deal of endemism, and a very diverse flora and fauna. However, despite these changes the EAMs are still known as one of the world's top twenty biodiversity hotspots (Burgess *et al*., 2007).

4.4.1. Vertebrates

The Udzungwa Mountains have the largest number of single block endemic vertebrate species found in no other forest blocks. Seventee species are endemic to this mountain block, followed by the Uluguru (13 species), the Taita Hills (6 species), the West Usambara (5 species) and the East Usambara (4 species) (Burgess *et al*., 2007). All other blocks have two or less single block endemic species, and four blocks have none at all. In terms of Eastern Arc endemic vertebrate species, the Uluguru Mountains have the largest number of vertebrate species (44 species), followed by the Udzungwa (41 species), the East Usambara (35 species), the West Usambara (22 species), the Nguru (20 species) and the Rubeho (12 species). All other sites have 10 or fewer Eastern Arc endemic vertebrate species, with the North and South Pare Mountains and Mahenge Mountains being particularly impoverished (Doggart *et al*., 2006).

When endemic and near-endemic vertebrates are combined, the Udzungwa Mountains have the largest number of vertebrate species (96 species), followed by the Uluguru (81 species), East Usambara (77 species), Nguru (52 species), West Usambara (48 species), Rubeho (35 species), Ukaguru and Nguu (27 species) (Cordeiro *et al*., 2005). Malundwe Mountain is lowest on this scale with two Eastern Arc endemic or near-endemic species (but virtually no research has been done there to explore endemic and or near endemic species in the mountain block). Looking at the way the mountain blocks vary in the number of endemic and near-endemic species, the Uluguru and East Usambara Mountains are the most important sites for endemic and near-endemic species (Burgess *et al*., 2006).

Despite of ecological importance in terms of endemic and near-endemic species, the mountain blocks are not free from threats of extinction of some of these species emanating from depletion of forest cover. The most important on this aspect is the Udzungwa Mountains (40 species), followed by Uluguru (29 species), East Usambara (28 species) and West Usambara (21 species).

4.4.2. Trees

EAMs are very rich of different plants (around 270 endemic species of plants) ranging from small plants to forest trees. In these areas the number of endemic and near endemic trees varies

considerably among mountain blocks across the EAMs. The highest numbers of Eastern Arc endemic/near endemic trees are found in the East Usambara (40 species), Udzungwa (37 species), West Usambara (27 species) and Uluguru (26 species) Mountains (Burgess *et al*., 2006). The small forests include the Taita Hills and Mahenge. Other mountain blocks are all poorly known, and none are known to contain more than six endemic or near-endemic trees, with Rubeho and North Pare having no known endemics. Therefore, the most important forests are those of the East Usambara Mountains, followed by West Usambara, Udzungwa, Uluguru and Nguru Mountain bocks.

4.4.2.1. Forest categorization

The EAMs range up to 2635m a.s.l in altitude (Lukwangule Plateau and Kimhandu Peak in the Ulugurus) and contain a diverse assemblage of habitats. It is estimated that prior to major human influence on the landscape, the wetter (eastern and south-eastern) slopes supported a continuous forest cover throughout all elevations, while the drier (western and north-western) slopes supported deciduous woodland at lower elevations and evergreen forest only at higher elevations (Mumbi *et al*., 2008). Tall evergreen forest was found on the top plateaus well away from the rain-capturing scarps, as a consequence of persistent fog over the highlands during the night. In other parts of the highlands, montane grassland and heathland dominated (Burgess *et al*., 2006). A desiccation-adapted flora occurred on rocky outcrops (Lovett, 1993).

On the Uluguru Mountains, the forest formations have been divided into upper montane (1800–2635 m a.s.l), montane (1250–1800 m a.s.l) and sub-montane (800–1250 m a.s.l) forest zones (Po´ cs, 1976). Elsewhere the same zones are recognized (Lovett, 1993), but their boundaries occur at somewhat different altitudes-depending on inclination of the terrain, rainfall, distance from the coast, height of the mountains, and incidence of cloud cover e.g. the forest zone divisions at lower elevations in the cloudy and maritime East Usambara Mountains where evergreen forest is limited to top plateaus (>2000 m a.s.l). At lower elevations (below 800 m a.s.l on the Ulugurus, but below 500 m a.s.l elsewhere) the sub-montane forest grades in species composition and physiognomy into that of the transitional' rainforests. Transitional forests are often grouped within the lowland Coastal Forests found along the eastern littoral plain of Africa

from Somalia in the north to Mozambique in the south (Burgess and Clarke, 2000). In reality, no hard boundary exists between these two forest types (Lovett et al., 2001) and in some mountain blocks there is a continuum between the Eastern Arc and Coastal Forest types (e.g. East Usambara, Uluguru and Udzungwa).

4.4.2.2. Reserved areas

To date much of these forests are under some form of management: half designated for catchment protection or multi-resource use (Forest Reserves i.e. more than 150), the rest have been gazetted for nature conservation (8 Nature Reserves) and two are National Parks. The first national park is the Udzungwa Mountains National Park (1900 km^2) which contains large areas of mountain forest and grassland; the second is Mikumi National Park (1450 km^2) that includes a small area (4 km^2) of montane forest on Malundwe Hill (Burgess *et al*., 2015). Both parks have the internationally agreed protected area code IUCN II and are managed by the Tanzania National Parks Authority (TANAPA).

The majority of the rest of the Eastern Arc forest in Tanzania is found within various different categories of Forest Reserve and tree plantations. The Tanzania Forest Services (TFS) Agency manages the majority of the larger Forest Reserves for water catchment and biodiversity conservation and some tree plantations. Other are privately managed (both natural and planted forests) and are found at Mazumbai (owned by Sokoine University of Agriculture), within the tea estates of Ambangulu in the West Usambaras, and Mufindi tea estates in the Udzungwa Mountain bolock; the Mufindi, Amani/Kwamkoro in the East Usambaras and Ukaguru tree plantations. Within the human-dominated landscape outside the Reserves and private estates smaller patches of natural forest remain under traditional village authority or community based management. Almost every village has a forest patch for rituals and as a burial area for its people, but these are generally under 1 km^2 in area and the total area is probably under 100 km^2 (Ylha¨ isi, 2004).

4.4.3. Invertebrates

The invertebrate fauna of the Eastern Arc is poorly known than the vertebrate fauna. However, the available information suggests that many species of invertebrate are confined to a single EAM block. For example, Scharff (1992) shows that single site endemism for linyphiid spiders is over 80%. Moreover, for carabid beetles Uluguru Mountains have 95% endemism (Basilewsky, 1962, 1976), and for harvestmen arachnids this site has 88% endemism (Scharff *et al*., 1981). Some of the patterns known for individual invertebrate groups are outlined below.

4.4.3.1. Odonata (dragonflies and damselflies)

Three odonate species are endemic to the Eastern Arc (*Platycypha auripes*, *Amanipodagrion gilliesi* and *Micromacromia miraculosa* – the last two are East Usambara endemics). Two near-endemic species found in the Eastern Arc are *Umma declivium* (Eastern Arc and north Malawi) and *Chlorocnemis abbotti* (Eastern Arc and Kilimanjaro) (Clausnitzer, 2001). Some of these represent genera that are more widespread in the Central and West African forests. The endemic Eastern Arc Odonata species are found in forest habitats and breed in montane streams, or in small water filled holes in tree-trunks. Three coastal forest endemics that may perhaps range into the lowlands of the Eastern Arc are *Coryphagrion grandis* (*Gondwana relict* with nearest relatives in Central and South America), *Hadrothemis scabrifrons* (relict form also found in coastal Gabon and Cameroon), and *Thermochoria jeanneli* (coastal swamp forest) (Clausnitzer, 2001).

4.4.3.2. Lepidoptera (Butterflies and moths)

At least 43 species of butterflies are endemic to the Eastern Arc and contiguous forests in their foothills (Congdon *et al*., 2001). A further 35 species are only found on the higher altitude grasslands of the Eastern Arc and further south into the Southern Highlands of Tanzania and into Malawi. The most important Eastern Arc blocks in terms of endemic butterflies are the Rubeho (13 species), Udzungwa (9 species), Usambara (7 species), Uluguru (7 species), and Nguru (4 species) (Burgess *et al*., 2006). The forest butterfly fauna also has genera that are representative of groups which are more diverse in the Central and West African rainforests.

4.4.3.3. Millipedes

East Usambaras, Udzungwas and Ulugurus are the only areas where inventories have been compiled for these species, the areas support at least 26 species and 10 genera endemic to one or other of these mountains (Hoffman, 1993). New collections from the East Usambara Mountains (Frontier Tanzania, 1999-2002), Uluguru Mountains (Doggart *et al*., 2005) and Udzungwa Mountains (Frontier Tanzania, 2001) hold additional new genera and species. It is likely that the number of endemic genera and species will rise significantly with further research.

4.4.3.4. Bryophytes

The EAMs support a diverse assemblage of bryophytes, with around 700 species recorded (Burgess *et al*., 2006). At least 32 species are endemic (5%). Although this level of endemism is low compared with vascular plants, it is high compared with the bryophyte flora of many other areas. A number of monotypic endemic genera are also present, for example Cladolejeunea and Neorutenbergia. A notable feature of the bryoflora is the high number (45 species, 6%) of Lemurian (Madagascan) species within the assemblage, which reaches its peak in the Uluguru Mountains (40 species) (Burgess *et al*., 2007). The bryoflora of the Usambara and Uluguru Mountains is quite well known, but information is scanty to non-existent for the other EAM blocks (Burgess *et al*., 2004).

4.5. Economic Characteristics

4.5.1. Demography

According to the 2012 population and housing census, the total population in the EAMs is 587,758 inhabitants (NBS, 2013). The total number of households in the area is 131,364 and the average household size ranges between 4 and 5 with the growth rate of 2% per year. According to SMEC International (2005), 85% of the EAM population is engaged in crop production and 15% engaged in animal keeping. The types of crops grown are vegetables, coffee, tea, banana, cassava, sweet potatoes, Irish potatoes, mangoes, oranges, pineapple, temperate fruits, paddy, beans, maize and spices.

4.5.2. Economic activities

The main livelihood activities in EAM include irrigation and rain-fed agriculture; livestock keeping; fishing and fish-farming; trading on basic necessities; and harvesting of ecosystem services such as forest products. These activities are carried out mainly for subsistence. All villagers have access to agricultural land through customary ownership or through temporary use rights. There are no individuals or groups of people who cannot access agricultural land in the area. Customary (traditional) ownership is the dominant form of land ownership in the area. Land is more accessible in the lowland/downstream areas in comparison to the upland areas/upstream. Irrigation is dominant in the downstream than in the upstream.

Crop production is dominant accounting for 85% followed by livestock keeping (15%). Different crops are grown between the lowland and upland areas of the mountains due to the difference in altitude and climate between the two areas. Maize; cassava; sweet potatoes; and some of the fruits/vegetables are grown in both areas. Upland crops include maize, beans, green peas, wheat, finger millet, Irish potatoes, sweet potatoes, bananas, pigeon-peas, groundnuts, and sesame. Fruits grown in upland areas include pears, peaches, avocado, oranges and guava. Vegetables grown in those areas include cabbages, amaranths, Chinese cabbage, pumpkin leaves and tomatoes. Lowland crops include rice, maize, beans, bananas, sorghum, cassava; sweet potatoes, and pumpkin leaves. Other lowland and upland crops include coconuts, cashew nuts, cocoa, palm-oil, sugar cane and tea. The sugar cane plantations are found in downstream of Udzungwa and Nguru, while tea plantations are found in the upstream of East and West Usambara, and Udzungwa mountain blocks

Fruit production is common in both upstream and downstream with upstream being dominant in producing temperate fruits and downstream tropical fruits. Fruits grown in lowland areas include oranges, mangos, pawpaw, water melons, lime fruits and guava, while in the upland peaches, plums apples and some tropical fruits like mangoes and avocado are grown. Livestock keeping include cattle in lowland areas and dairy cows in upland areas. Goats, sheep, pigs, rabbits and chicken are kept in both areas.

Exploitation of natural forestry resources is primarily for fuel because much of these forests are under conservation i.e. in nature reserves and national parks. The main source of energy is firewood obtained from woodland forests and rain forest. Firewood is used for cooking. Electricity is available in some areas of EAM from power produced from the 7 hydropower plants installed in the area. Alternative power sources include generators, which produce energy to various financially able households as well as solar powers. Illegal logging is becoming widespread following the flourishing market of timber within and outside the country. Preferred species for logging include Mninga, Mhongo, Mpangapanga, Msekeseke, Pamosa, Msufi, Teak and Mtondo/Mtondoro. Illegal hunting for bush-meat is among the activities carried out in lowland areas.

Commercial and trade facilities are run by the private sector. Private businessmen operate shops of various merchandise, restaurants, hotels, guesthouses, bars and kiosks. Supplies are obtained from nearby towns through roads and railway.

CHAPTER FIVE

5.0 TYPES OF ECOSYSTEM SERVICES FOUND IN EAMS AND PROPORTION OF HOUSEHOLD BENEFITING

5.1. An overview of EAMs ecosystem services

EAMs provides a wide range of ecosystem services of local, regional and global importance (Cork & Shelton, 2000). Among the many ecosystem services, EAM are known as a host of mountains which cool warm air from the coast to rains and trap the rain water and release it slowly downstream a process which takes relatively longer than other areas which receive the same amount of rain (Zhang *et al*., 2007). This process provides other benefits along with it which include water filtration and purification; buffering of flood from storm flows; reduction of soil erosion; maintenance of soil fertility, structure and nutrient cycling (Sanga & Mungatana, 2016). Its capacity to hold water for a relatively longer period makes EAM to be suitable for production of various crops and growth of various vegetation (Tscharntke *et al*., 2005).

The EAMs' vegetation remnants have many economic importance; much of the remnant vegetation in streams and rivers draining the mountains are grazed, used for handmade crafts, the mountains forests (natural and planted) are used for production of timber, firewood, harvesting of wild foods and medicines. EAMs also have social values; native mountains vegetation provides beautiful landscapes for recreation, education and ecotourism, spiritual and historical values.

5.2. Types of ecosystem services from EAMs

EAMs provides a variety of ecosystem services ranging from those with direct consumptive use by households living in and around the mountains to others which goes beyond the boundaries of the mountain blocks. The survey results indicate that EAM blocks provide forest products and services from both natural and planted forests, wetland products, hydrological services and products, and are habitat to various biodiversity. It supports production of various crops with high economic value. Also is a home to a significantly large human population engaging in various economic activities.

5.2.1. Provisioning ecosystem services from EAM blocks forests

As noted in chapter 4, EAM blocks are covered by both natural and planted forests. The household survey results indicate that forests provide a range of forest products ranging from timber to non-timber products. The availability of these products is determined by the topography of the mountains, whereby ecosystems from forests are found in the upper zone (upstream) of the mountains with patches of forests in the lower zone (downstream). Much of the natural forests are found in reserved areas both nature reserves and national parks.

5.2.1.1. Timber provisioning ecosystem services

5.2.1.1.1.Firewood and charcoal

Firewood is the most harvested ecosystem service from both upstream and downstream of the EAM blocks. Household survey results show that 85% of energy used by households for cooking is from firewood followed by charcoal (14.6%). Only 0.4% comes from other sources (i.e. gas and electricity) (Table 2).

Table 2: Number of household using firewood and charcoal from EAMs

Energy source	Frequency	Percentage
Firewood	470	85.0
Charcoal	81	14.6
Gas (LPG) and Electricity	2	0.4
Total	**553**	**100.0**
Summary statistics		
Mean	1.154	
Median	1.000	
Std. Deviation	0.371	
Minimum	1.000	
Maximum	3.000	

The proportion of households using firewood and charcoal differs from one mountain block to another. East Usambara mountain block is leading in the number of household using firewood (100%) followed by South and North Pare mountain blocks (Figure 3). Household survey results also shows that Nguru has the lowest number of household using firewood.

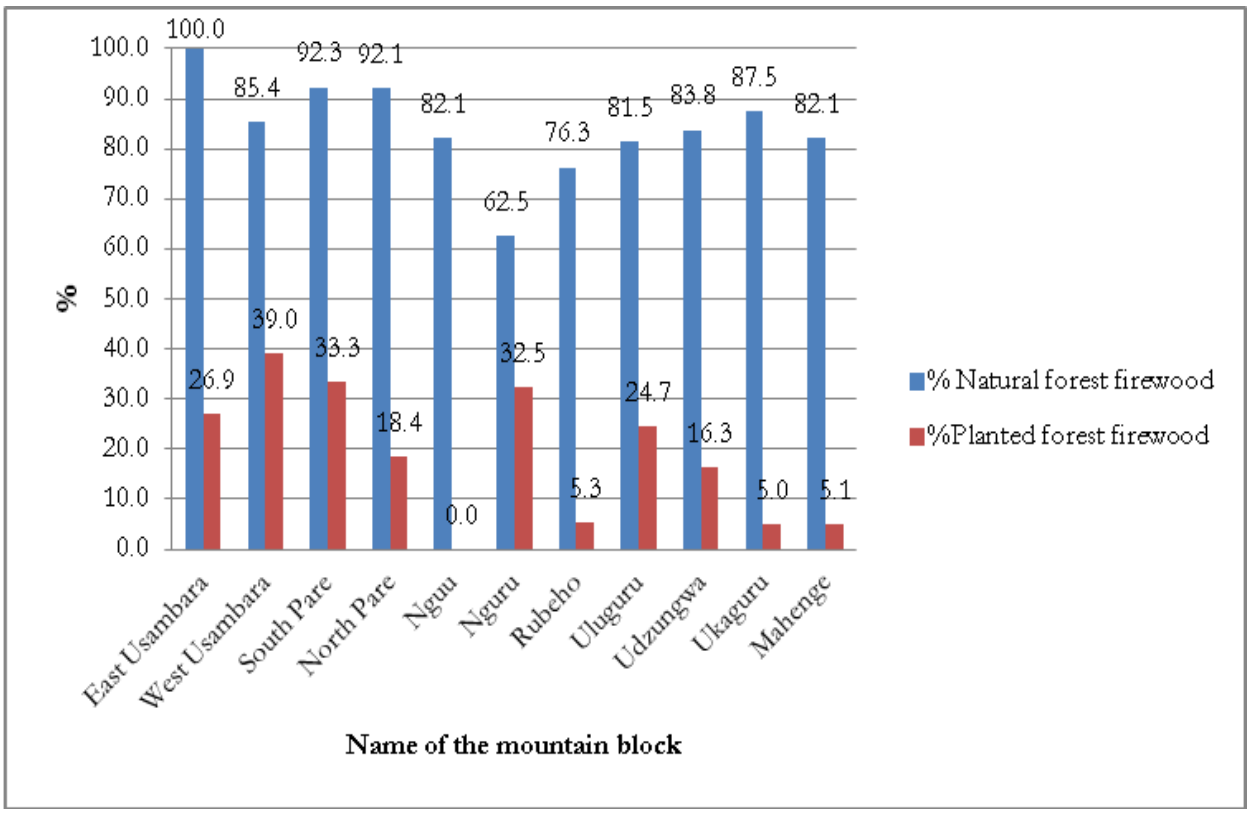

Figure 3: Proportion of household harvesting firewood from natural and planted forests found in EAMs

On the other hand, household survey results in Figures 3 and 4 shows that the proportion of household using charcoal is lower than the number of households using firewood. Nonetheless, the results also show that the proportion of household using these products from natural forests is higher than from planted forests despite the fact that many of the forests in EAM blocks are under different controlled management regimes. The results in Figure 3 shows higher proportion of households using firewood from natural forests in East Usambara Mountain block than in the rest of the mountain blocks. Nguru Mountain block has the lowest proportion of household than all mountain blocks.

In case of charcoal Nguru and Rubeho Mountain blocks have the highest proportion of households using charcoal from natural forest than the rest of the mountain blocks and is zero in East Usambara Mountain block. The observed higher proportion of households using charcoal in Nguru and Rubeho can be attributed to the project implemented by Tanzania Forest

Conservation Group which encourages the communities living in and around the Mountain blocks to make charcoal under the so called "Sustainable Forest Use" which is actually not sustainable. The project has raised the use of charcoal in the two mountain blocks a situation which threaten the state of the forests and biodiversity in the area. In East Usambara much of the forests are under nature reserves, the communities are not allowed to make charcoal, they are only allowed to collect firewood from dead trees and tree branches.

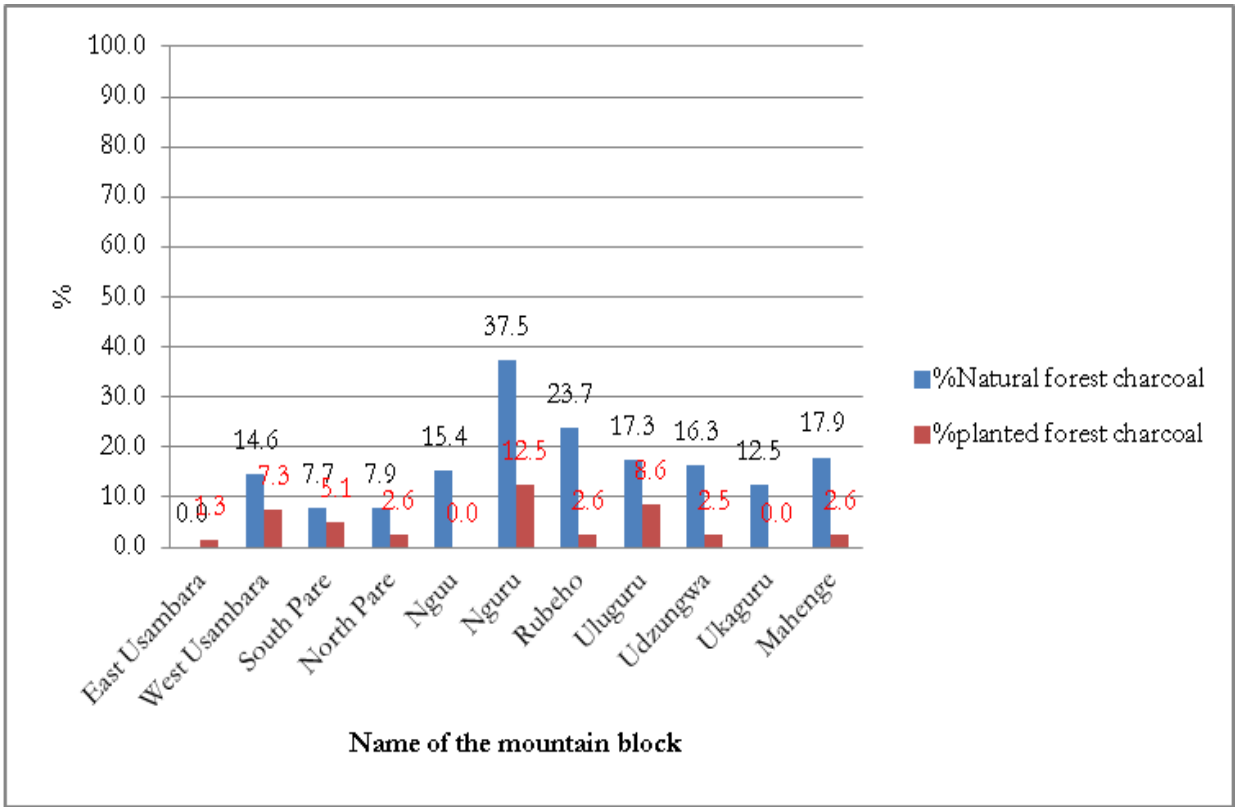

Figure 4: Proportion of households harvesting charcoal from natural and planted forests found in EAMs

5.2.1.1.2.Timber

Timber is the second ecosystem services harvested from EAMs from both natural and planted forests. Similarly, this differs across the mountain blocks; the household survey results in figure 5.3 indicate that timber in Rubeho Mountain block (45%) is leading in the proprotion of households harvesting timber from natural forests followed by Mahenge (43%), Udzungwa (38%) and Ukaguru (32%) Mountain blocks. Very little (i.e. less than 10%) and nothing (0%) is harvested from East Usmbara and West Usambara Mountain blocks respectively (Figure 5).

Timber is also harvested from planted forests both plantations and household owned woodlots. However, the amount of timber from planted forest is very little compared to timber from natural forests despite the fact that much of the forests in the EAMs are under various controlled management regimes. Household survey results indicate that Udzungwa (15%) Mountain block leads by having a relatively large number of households harvesting timber from planted forest followed by Ukaguru (13%), West Usamabra (12%) and Rubeho (10%) Mountain blocks respectively. Other mountain blocks with relatively higher proportion of households harvesting timber from planted forests are Uluguru (9%), South Pare (8%), and East Usambara (5%) respectively. Households in North Pare and Nguu mountain blocks depend primarily on the natural forests for timber (Figure 5).

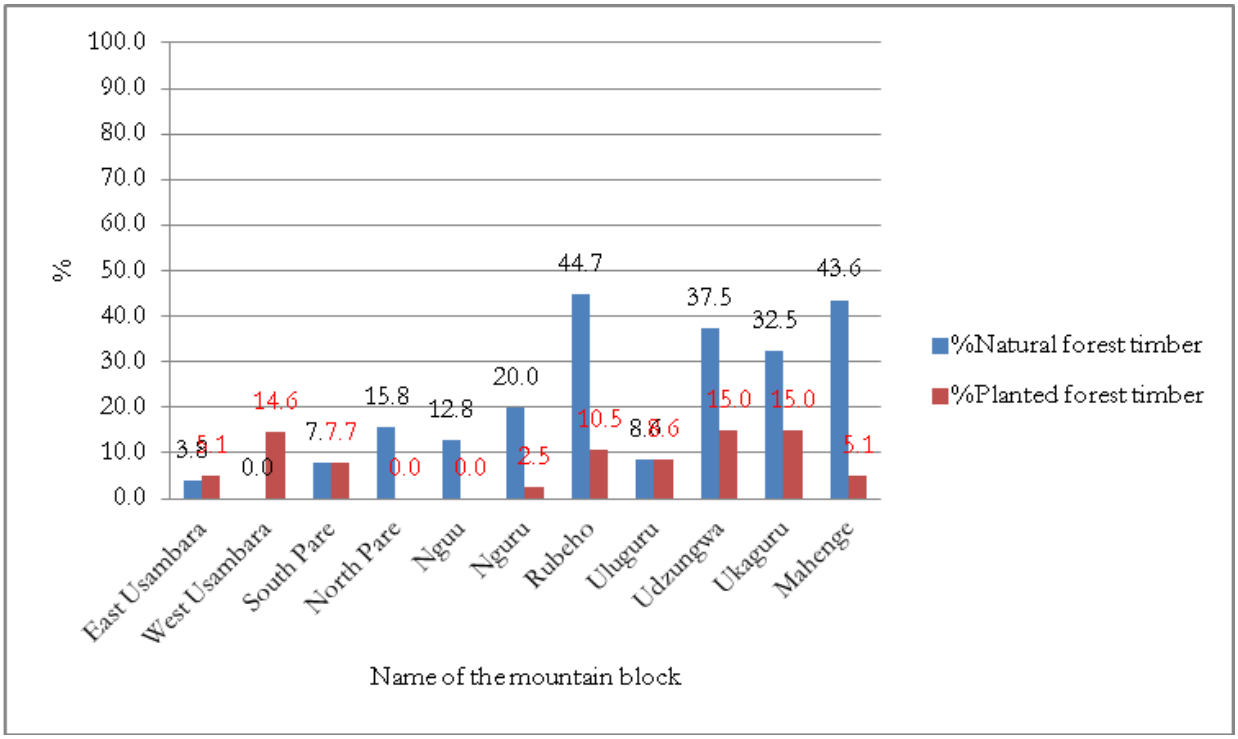

Figure 5: Proportion of households harvesting timber from natural and planted forests found in EAMs

5.2.1.1.3.Building poles

This is another ecosystem services provided by EAMs but harvested by a relatively small proportion of households. Many households harvest it from natural forests in Mahenge (33.3%), Udzungwa (32.5%), Ukaguru (27.5%) and Rubeho (26.3%) (Figure 6). Very few harvest from

planted forest except in Udzungwa mountain block where it is common to find large woodlots designated for building poles production in the upstream of the mountain block (Figure 7). In West Usambara and North Pare there are no building poles harvested from neither of the forest type (Figure 6). The high dependence on natural forest indicates how these forests are under pressure emanating from the communities living around and within the mountain blocks.

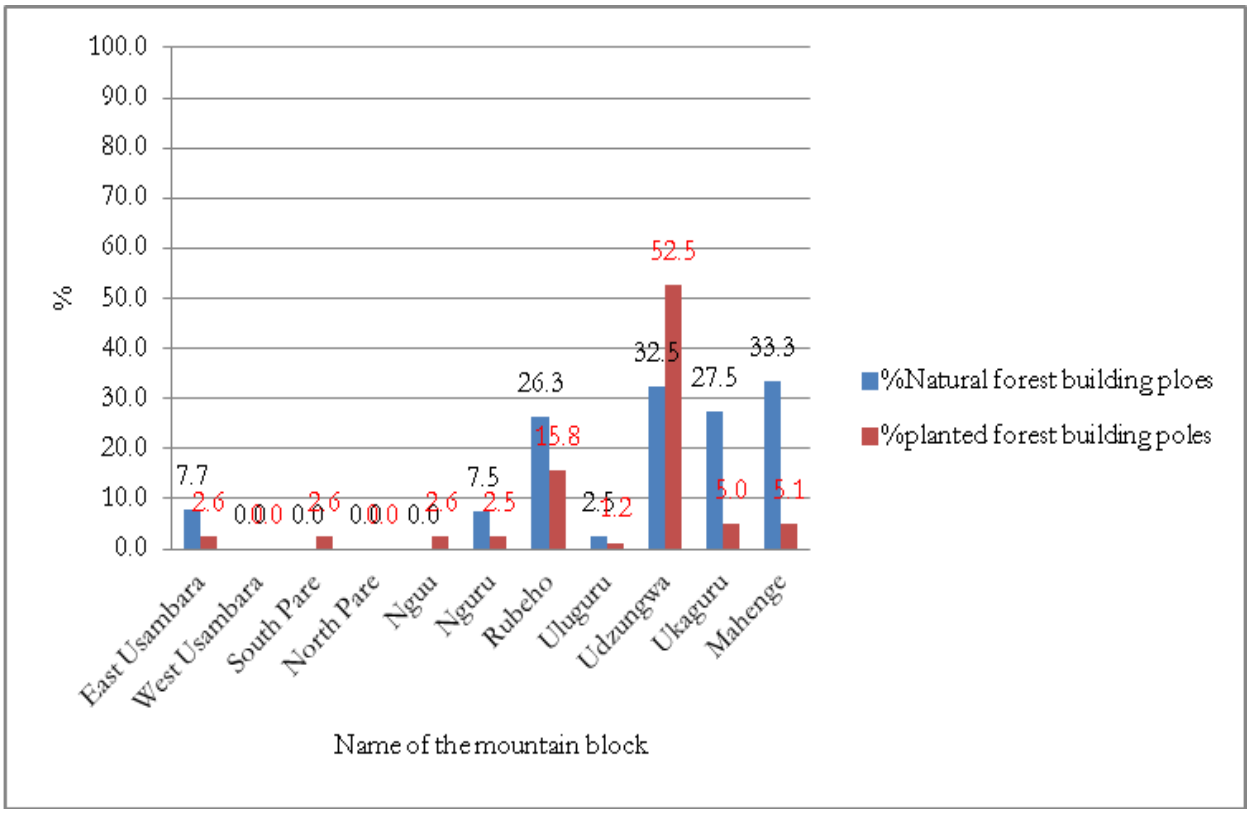

Figure 6: Proportion of households harvesting building poles from natural and planted forests found in EAMs

On the other hand, a small proportion of households harvesting building poles from planted forests indicate that the rate of planting trees in the mountain blocks is very low. Very few households have their own forests for meeting their demand for building poles and other timber products in many EAM blocks. Unlike other mountain blocks, in Udzungwa mountain block especially in the upstream the situation is different with regards to building poles; in this mountain block building poles production is at commercial level.

Figure 7: A farm of building poles in Kibengu village in Mufindi District located in the Upstream of Udzungwa Mountain block

5.2.1.1.4. Withies

Just like building poles, withies are also obtained in EAM blocks but they are harvested by a relatively very small proportion of households and much of it are harvested from natural forest. Household survey results indicate that households in Nguu, Nguru and Rubeho Mountain blocks obtain withies from natural forest only (Figure 8). Household in Mahenge, Udzungwa, Uluguru and East Usamabara Mountain blocks obtain withies from both natural and planted forests but the number of households harvesting from natural forests in all mountain blocks exceed that from planted forests. These results clearly indicate the level of dependence on natural forests for ecosystem services and the pressure the communities living around and within these mountain blocks exert on the remaining forests resources. Equally important, the small proportion of households harvesting from planted forest is an indication of low rate of planting trees in the household owned lands.

Household survey results also shows that in West Usamabara, North and South Pare Mountain blocks households are not harvesting withies from neither natural forest nor planted forest. This can be an indication of two scenarios; one could be low demand for withies in the areas and secondly could be an indication of scarcity of trees due to low rate of planting trees in the

privately owned lands and strictness of the authorities responsible for protecting the remaining natural forests in the blocks.

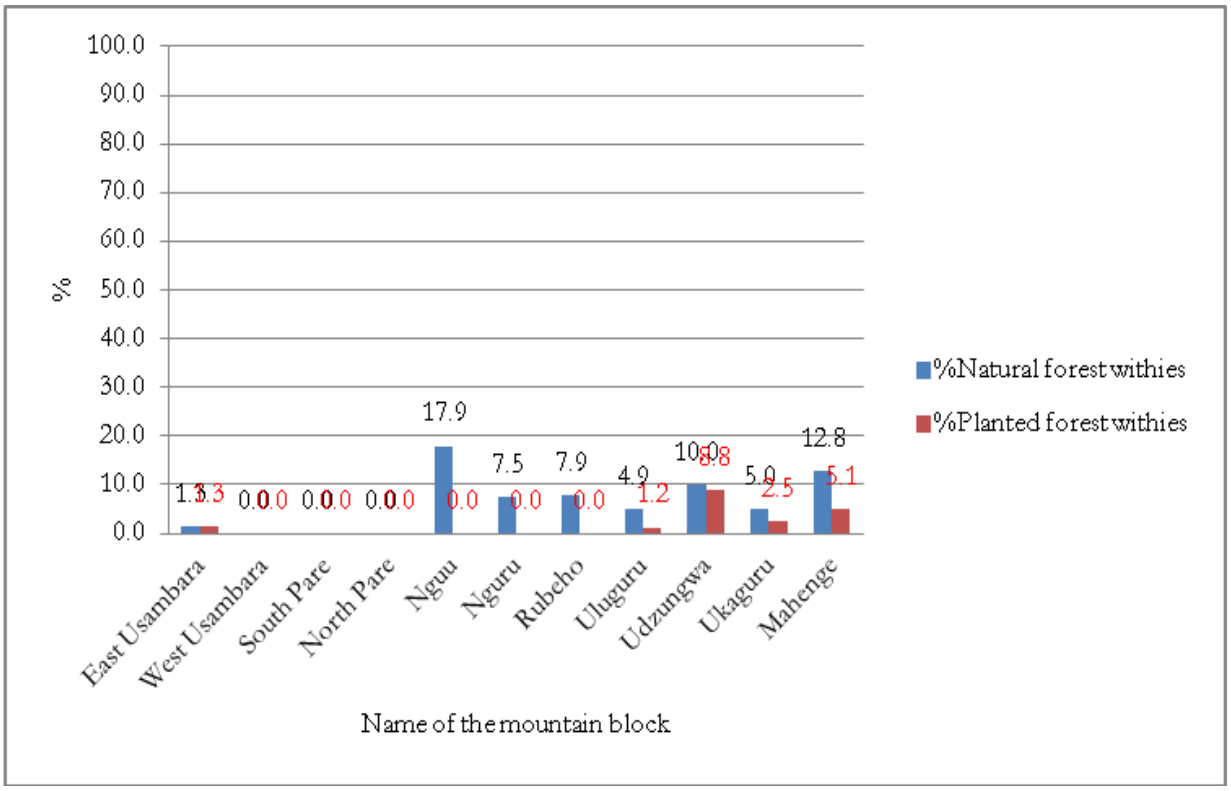

Figure 8: Proportion of households harvesting withies from natural and planted forests found in EAMs

5.2.1.1.5.Fodder

EAMs also provides fodder for animal feeding. The survey results show that households in South Pare, East Usambara, North Pare, West Usambara and Nguu harvest fodder from natural forest than the rest of EAM blocks (Figure 9). Results also shows that in the same mountains blocks households harvest fodder from planted forests (Figure 9). Other mountain blocks (i.e. Nguru and Rubeho) households do not harvest fodder from neither of the forest. In Uluguru households harvest fodder from planted forests, Udzungwa from natural forests, Ukaguru from planted forests and Mahenge from natural forests (Figure 9). These results imply that natural forests are still the major provider of ecosystem services to the communities living within or around the EAM blocks than planted forests.

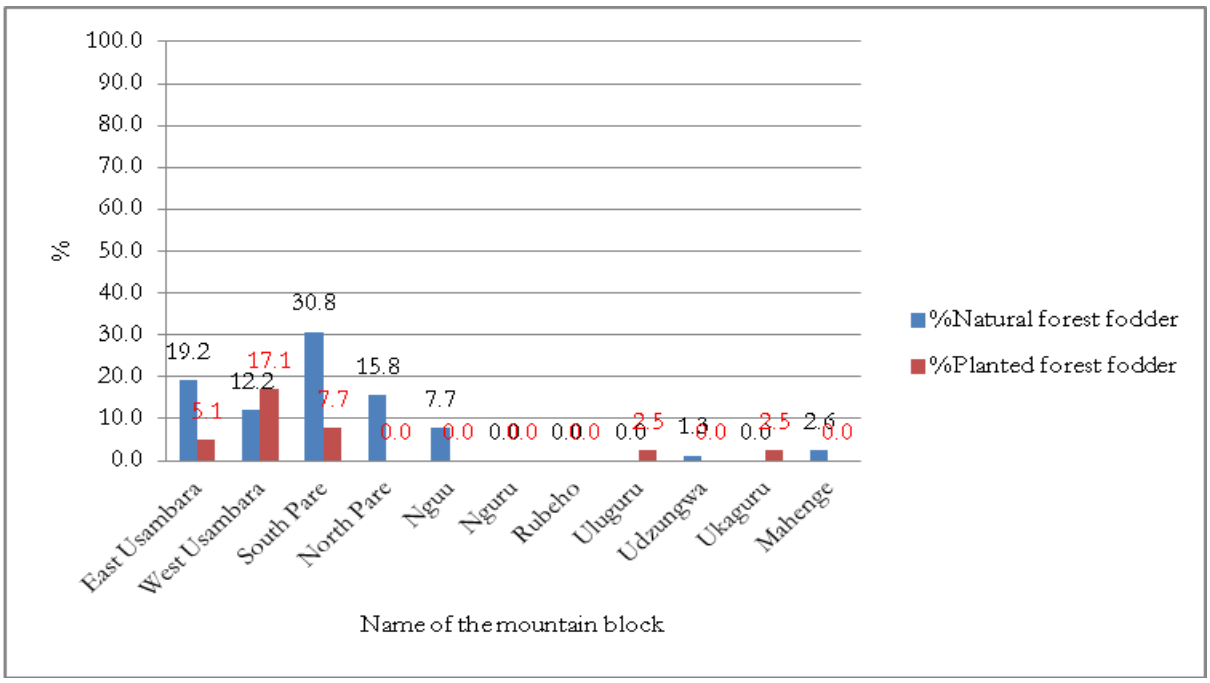

Figure 9: Proportion of households harvesting fodder from EAMs

5.2.1.2. Non timber forest provisioning ecosystem services

5.2.1.2.1. Wild mushroom

Wild mushroom is one of the non-timber ecosystem services provided by EAM blocks forests. The proportion of households harvesting wild mushrooms from natural forests is higher than from planted forests. Wild mushrooms from natural forests are harvested by a relatively large number of households in Mahenge (33.3%), Rubeho (28.9%) and Udzungwa (13.8%) Mountain blocks (Figure 10). On the other hand, wild mushroom from planted forests are harvested in a relatively large proportion of households in Rubeho (15.8%), Udzungwa (10%) and Ukaguru (7.5%) Mountain blocks. Again natural forests appear to be the major providers of wild mushrooms compared to planted forests.

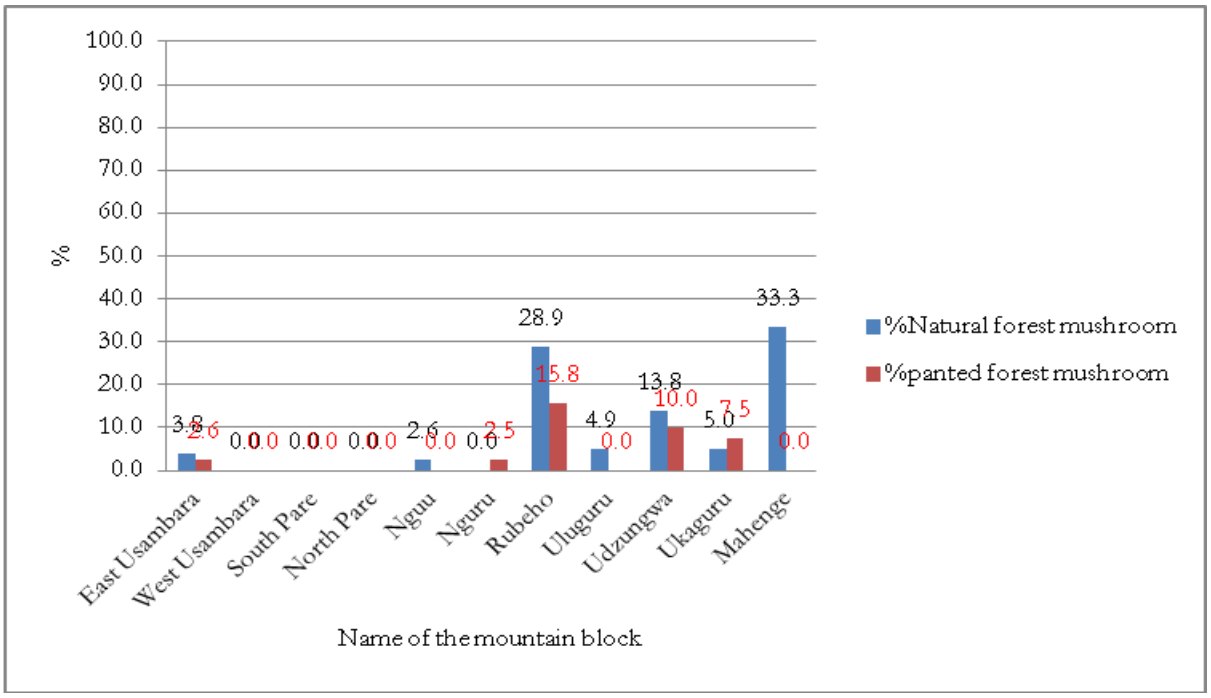

Figure 10: Proportion of households harvesting mushroom from natural and planted forests found in EAMs

5.2.1.2.2.Wild vegetables

Wild vegetables are other ecosystem services provided by EAMs. Just like other ecosystem services provided by these mountains, much of wild vegetables are harvested from natural forests than planted forests. Households living around and in Rubeho, Mahenge, Ukaguru, and Udzungwa mountain blocks harvest much of wild vegetables from natural forests (Figure 11). Very few wild vegetables are harvested from planted forests in Rubeho, Udzungwa and East Usamabara mountain blocks. Likewise, natural forests in EAM blocks still play a major role in providing ecosystem services to communities living in and beyond the mountains.

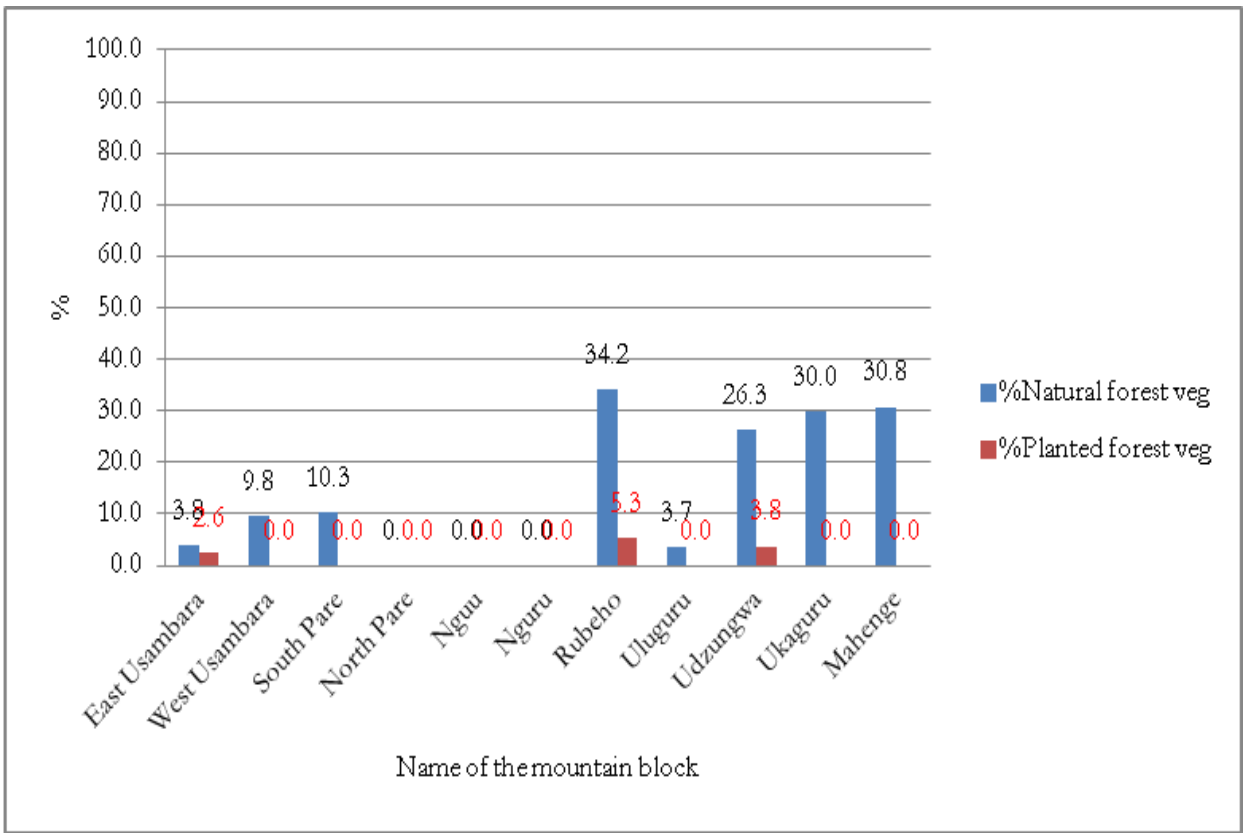

Figure 11: Proportion of households harvesting wild vegetables from natural and planted forests found in EAMs

5.2.1.2.3.Wild fruits

Wild fruits are also other ecosystem service provided by EAMs. Similarly, these ecosystems services are relatively harvested more from natural forests than planted forests. Wild fruits are harvested from natural forests by a relatively large proportion of households in Rubeho, Mahenge, Ukaguru, and Udzungwa mountain blocks (Figure 12). They are also harvested in South Pare, Uluguru and East usambara mountain blocks by relatively small proportion of households. The number of households harvesting wild fruits in West Usambara, North Pare, Nguru and Nguu mountain blocks is very small to account. Again these results show that natural forests play a great role in supplying wild fruits in EAMs.

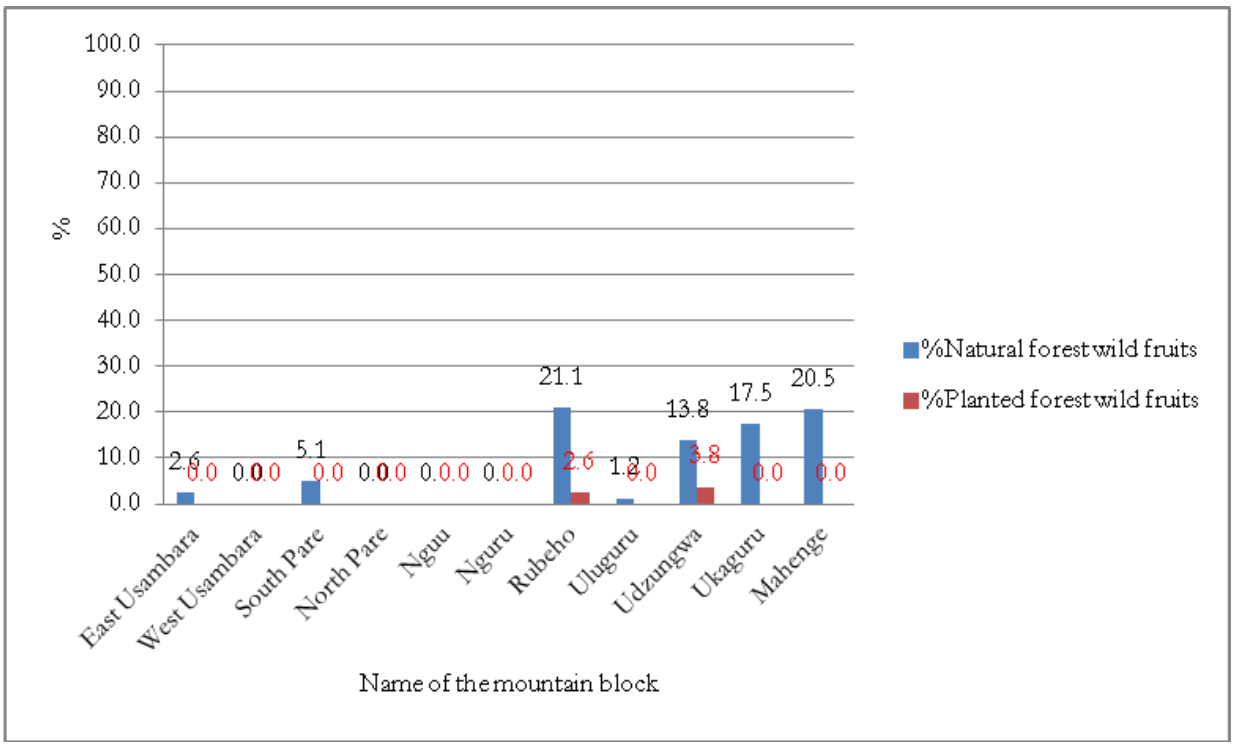

Figure 12: Proportion of households harvesting wild fruits from natural and planted forests found in EAMs

5.2.1.2.4.Reeds and sedges

EAMs also have wetlands which support growth of valuable reed and sedges. The proportion of households harvesting these ecosystem services is relatively low compared to other ecosystems services and this is due to the fact that most of the wetlands in the lowland have been converted into crop production and the few remaining in the upstream are cultivated vegetables. Because of this the proportion of households harvesting these ecosystem services are higher in upstream than in downstream. Results in Figures 13, 14 and 15 show that Udzungwa mountain blocks is leading in the proportion of households harvesting sedges and reeds from wetlands followed by Mahenge, North and South Pare. Rubeho, Nguu and Nguru have the lowest proportion to account.

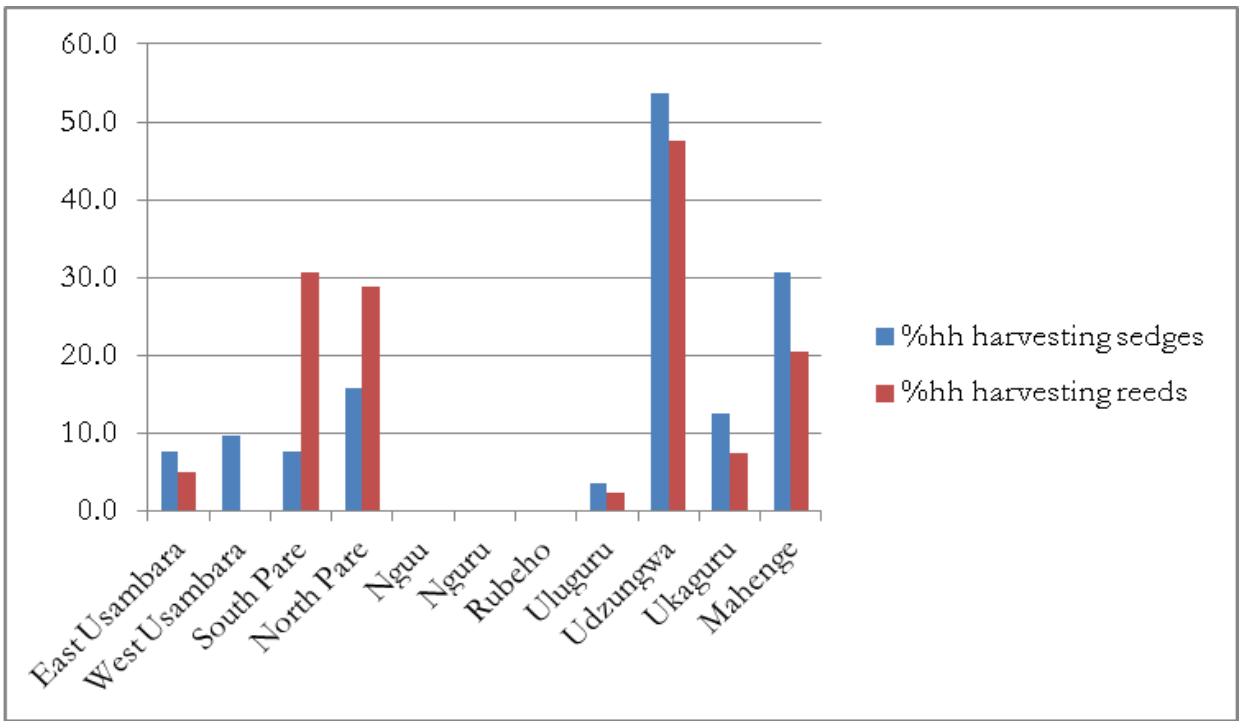

Figure 13: Proportion of households harvesting edges and reeds from EAM blocks wetlands

Figure 14: Natural reeds and sedges growing in the wetland in Boma la Ng'ombe village in Kilolo District

5.2.1.2.5. Mammals and birds

Wild mammals and birds are other ecosystem services harvested from wetlands found in the catchment. Wild mammals and birds account for 7% and 2% of total ecosystem services harvested from wetland in the upstream. Also mammals are harvested from downstream and it accounts for 1% of the total ecosystem services harvested from wetlands downstream. As noted in other wetland ecosystem services, this is due to the fact that fewer wetlands are in good condition downstream than upstream to provide ecosystem services. Frequent fire and conversion of these systems into other uses has affected the habitat of mammals and birds downstream wetlands.

5.2.1.2.6. Biodiversity

A variety of biodiversity is found in the catchment wetland and forests; in downstream forests and wetlands are the home to the popular Kihansi Spray Toads (KST). These ecosystems are not harvested by the communities living in the catchment, but they are important in ensuring ecosystem balance, research and tourism. In the catchment they are found in the wetlands found in Kihansi Gorge.

Figure 15: Spray Tod found in Kihansi Gorge in Kihansi Catchment, Tanzania

5.2.2. Regulating ecosystem services

EAM mountains vegetation cover provides regulation service. The mountain blocks are covered by three major vegetation and these include the grassland, bushland and forest. The three vegetation types play a great role in absorbing carbon dioxide from the atmosphere and convert it to carbon and other products, and store it in the plant matter and soil. It also regulates the global temperature and rain, and this service goes beyond the boundaries of the mountain blocks.

5.2.3. Supporting ecosystem services

EAMs support production of various crops and vegetables. Its ability to trap water during rainy season and release it slowly throughout the year is giving the mountain blocks the capacity to support production of various crops throughout the year. Crops and vegetables produced are similar across the mountain blocks. Crops produced include maize, paddy, beans, banana, cassava, sweet potatoes, Irish potatoes, sunflower, pigeon and cow pea, sugarcane, sesame, and yams. The vegetables produced are such as tomatoes, cabbage, pumpkin leaves, amaranths, white radish, sweet potato-leaves, sweet pepper, okra, bitter tomato, onions, cauliflower, and Chinese cabbage. The mountains support growth of fruits both tropical and temperate fruits which include mangoes, oranges, avocado, pineapples, passions, watermelon, guava and peas. The mountains also support livestock keeping as they provide water for animal drinking, pasture and good climatic condition for temperate animals to flourish. Livestock kept in the mountains include local chicken, ducks, goats, sheep, cows, cattle and pigs.

5.2.3.1.Maize, paddy, beans and banana across the mountains blocks

Maize is grown by almost all households in EAMs followed by paddy and beans. Paddy is a popular crop in Udzungwa, Nguu, Nguru, Rubeho, and Mahenge Mountain blocks flood plains (Figures 16 and 17). In South Pare the crop is grown in the wetland and river valleys and production is by Irrigation. Banana is popular in Uluguru, South Pare and East Usambara mountain blocks and is grown in the mountains popularly known as **“banana in the hills”**.

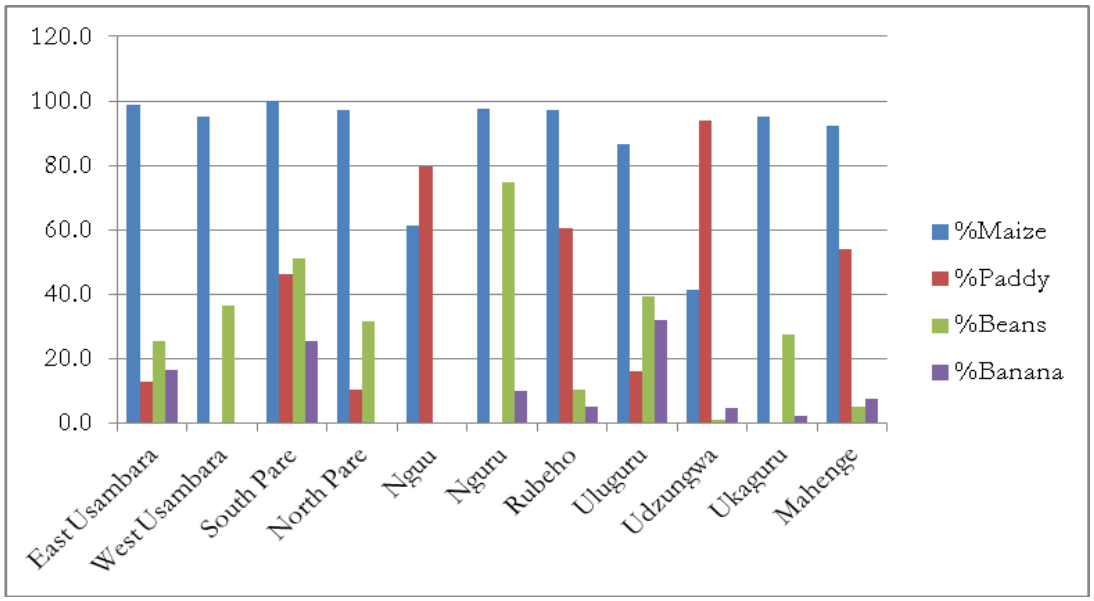

Figure 16: The proportion of households growing maize, paddy, beans and banana in EAMs

Figure 17: Maize farm plot in West Usanbara mountain block

5.2.3.2. Cassava, Sweet potatoes and Irish potatoes

Cassava, Sweet potatoes and Irish potatoes are grown by relatively small proportion of households in EAM blocks compared to Maize and Paddy (Figure 18). West Usanabara has the highest proportion of households growing Sweet potatoes followed by Uluguru, East Usambara and Nguru mountain blocks. On the case of Cassava, East Usambara has the highest proportion of households growing the crop followed by Nguru, Uluguru and South Pare mountain blocks (Figure 18). Irish potatoes are popular in West Usamabara, Nguru, Rubeho and Udzungwa even though is grown by a small proportion of households compared to Maize and Paddy.

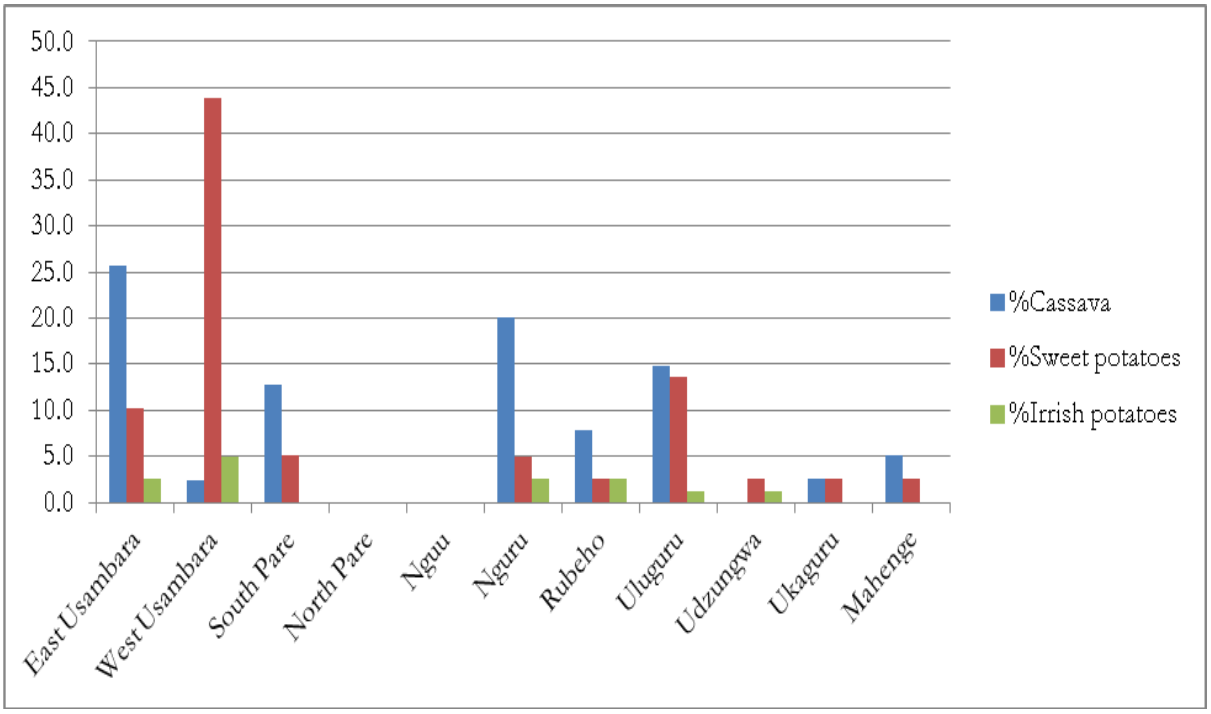

Figure 18: The proportion of households growing cassava, sweet potatoes and Irish potatoes in EAMs

5.2.3.3.Sunflower, Pigeon pea and Cow pea

The EAM blocks are also popular in producing Sunflower, Pigeon pea and Cow pea even though is grown by small proportion of households. Household survey results indicate that sunflower is grown by relatively large proportion of households in Ukaguru, North Pare, Nguu and Nguru mountain blocks (Figure 19). Pegeon pea is second in the list of this group and is grown by a relatively large proportion of households in Rubeho, Mahenge and East Usambara mountain

blocks. The crop is also grown in Nguu and Uluguru mountain blocks but by a relatively small proportion of households (Figure 19). Cow pea is the third in the list and is grown by a relatively large propotion of households in East Usambara and Rubeho mountain blocks. The crop is also grown in West Usambara, Nguru and Ulguru mountain blocks but by a relatively small proportion of households to a point that they are insignificant to be quantified.

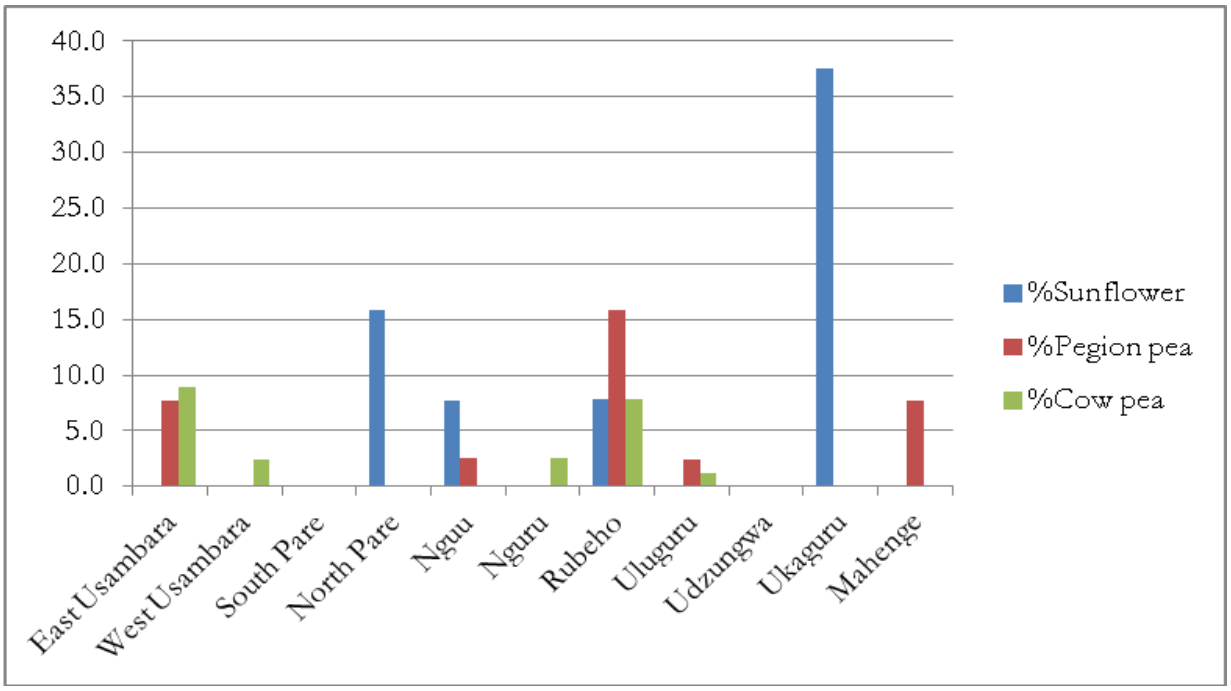

Figure 19: The proportion of households growing sunflower, pigeon pea and cow pea in EAMs

5.2.3.4.Sugarcane, sesame, and yams

Sugarcane, Sesame and Yams are the crops grown in Eastern Arc Mountaiuns blocks even though are grown by a small proportion of households. Household survey results indicate that Sugarcane is grown by a relatively large proportion of houeholds in Udzungwa especially in Kilombero flood plains and Nguru in Mtibwa flood plains (Figure 20). The crop is also grown in East usambara, West Usambara, South Pare and Mahenge mountain blocks but by a relatively small proportion of households. Household survey also indicate that Sesame is grown only in two mountain blocks-the Rubeho and Mahenge mountain blocks. Similarly household survey results indiacte that yams are grown in Uluguru, Mahenge and East Usambara mountain blocks

but by a small proportion of households (Figure 20). The crops are grown in small quantity in North Pare and Nguu mountain blocks to a point that they are insignificant to be quantified.

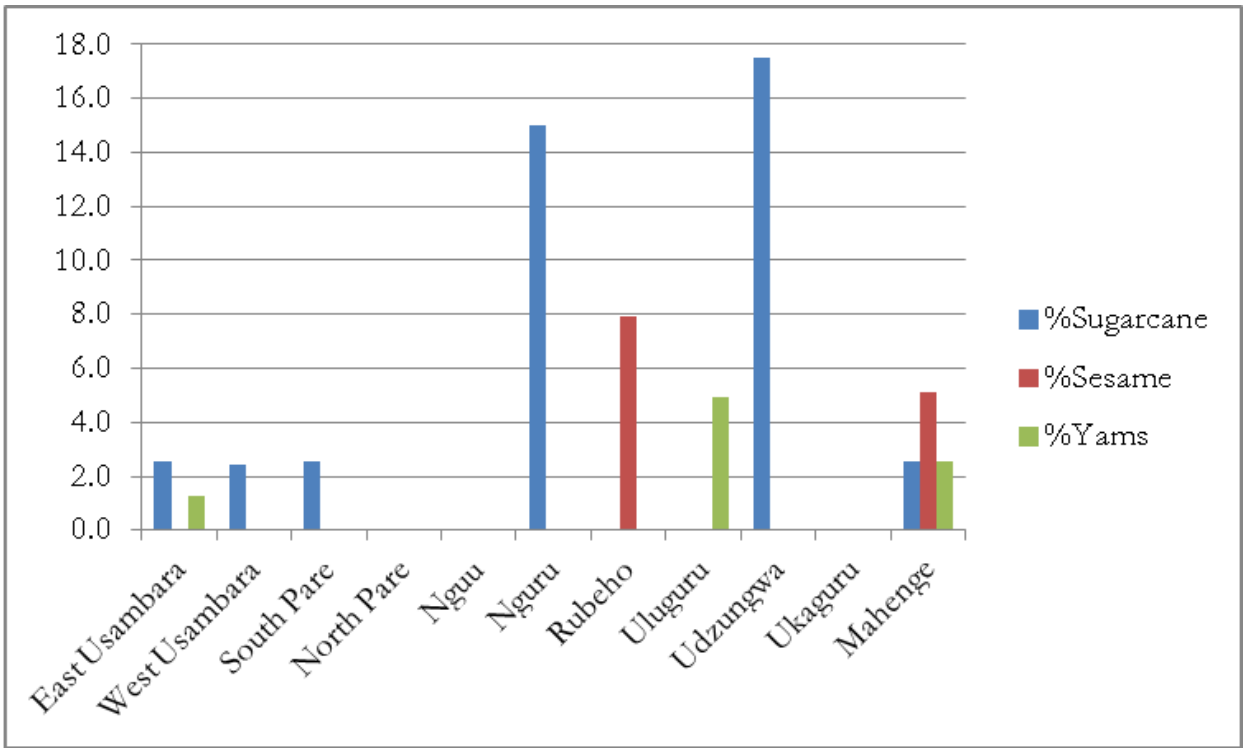

Figure 20: The proportion of households growing sugarcane, sesame and yams in EAMs

5.2.3.5. Vegetables grown in EAMs

EAMs also supports production of vegetables, the vegetables that are grown by a relatively large proportion of households includes tomatoes, cabbage and pumpkin leaves (Figures 21 and 22). Cabbage is grown by a relatively large proportion of households in West Usambara and Uluguru mountain blocks. Tomatoes are also grown by a relatively large proportion of households in West Usambara, North Pare, East Usambara, South Pare, Nguru and Mahenege mountain blocks. Equally important, pumpkin leaves are grown by a relatively large proportion of households in Udzungwa, Mahenge, and Rubeho mountain blocks. In Nguu Mountain block vegetables are grown by a small proportion of households to a point that they are insignificant to be quantified.

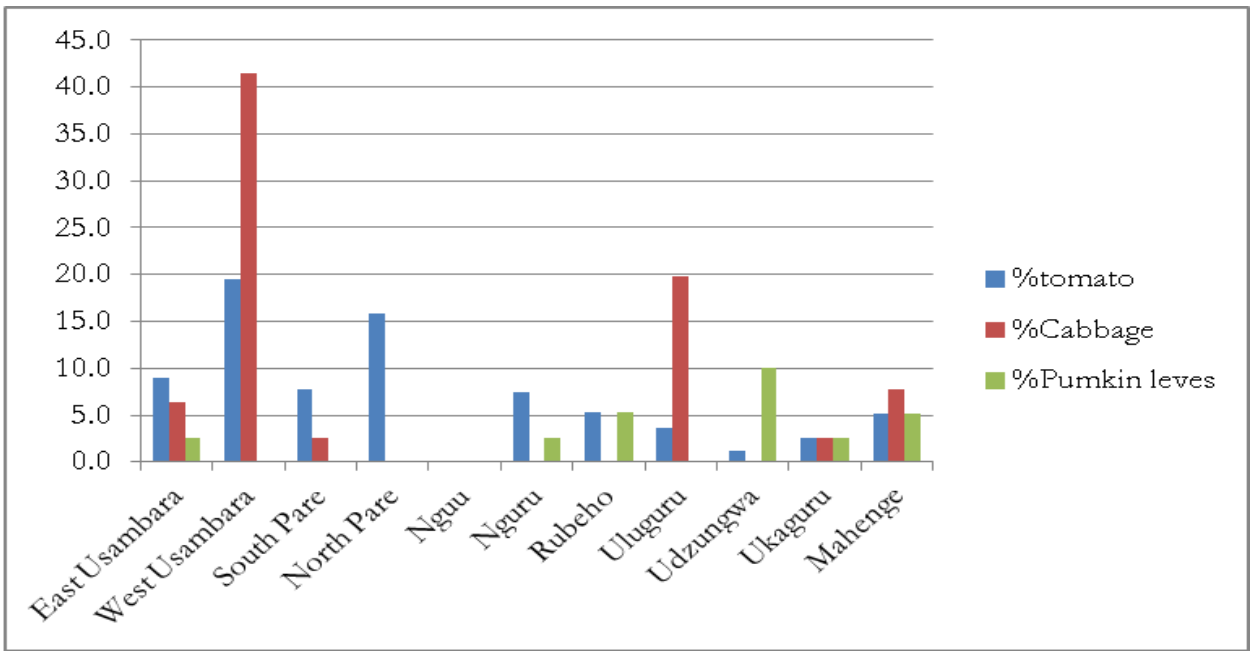

Figure 21: The proportion of households growing tomatoes, cabbage and pumpkin leaves in EAMs

Figure 22: Cabbage farm plot in West Usmabara Mountain block

5.2.3.6.Amaranths, White radish and Sweat potato leaves

Amaranths, White radish and Sweat potato leaves are among the vegetables grown in EAMs by relatively large proportion of households (Figure 23). Household survey results indicate that Amaranths are grown by large proportion of households in Mahenege, Uluguru, East Usambara, South Pare, Rubeho and Udzungwa mountain blocks. The vegetable is also grown by relatively small proportion of households compared to other vegetables in North Pare, Nguu and Nguru mountain blocks. On the other hand, White radish is grown by large proportion of households in Rubeho and Uluguru Mountain blocks. The vegetable is grown by small proportion of households in Udzungwa and East Usambara and is grown in an insignificant proportion of households in North Pare, Nguu and Nguru mountain blocks. Sweet potaoe leaves are grown by relatively large proportion of households in Rubeho, Uluguru, Udzungwa and East Usambara mountain blocks and is grown by insignificant proportion of households to account in Ukaguru, West Usambara, North Pare, Nguu, and Nguru mountain blocks.

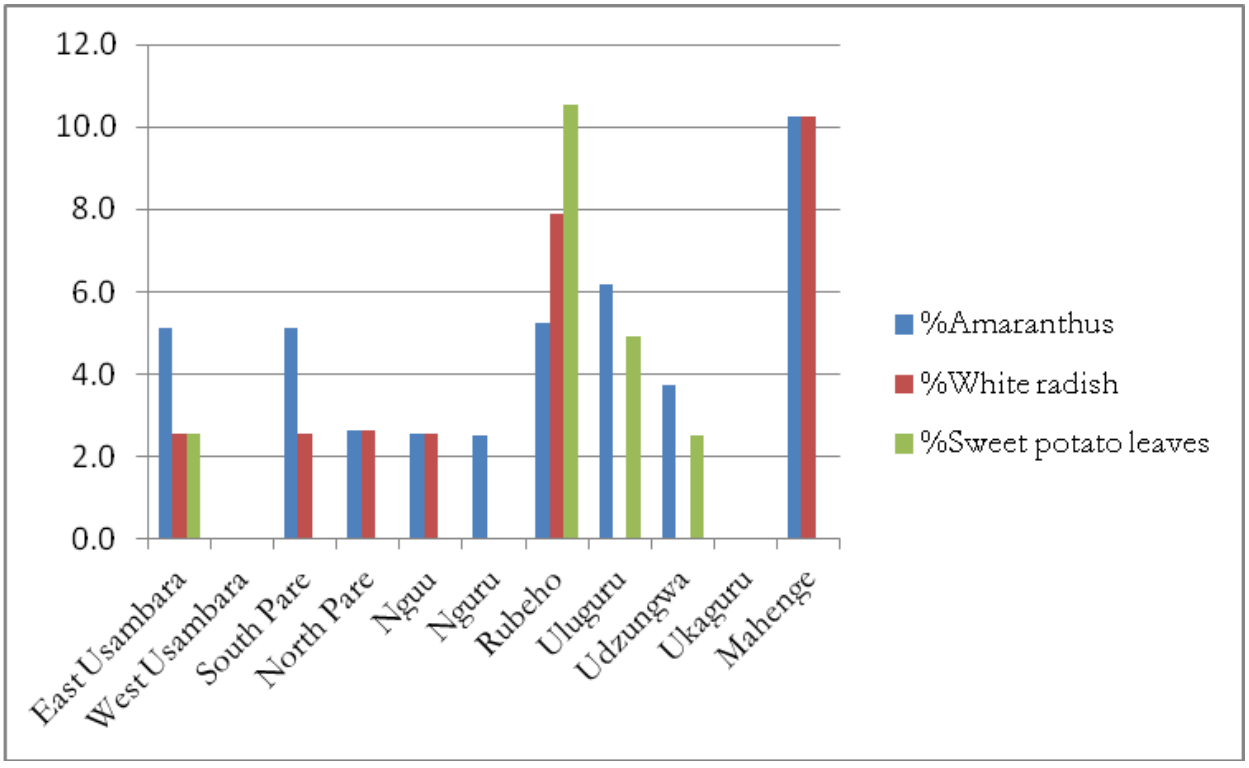

Figure 23: The proportion of households growing amaranths, white radish and sweet potato leaves in EAMs

5.2.3.7.Sweet pepper, Okra and Bitter tomato

Sweet pepper, Okra and Bitter tomato are among the vegetables grown in EAMs by relatively small proportion of households (Figure 24). Household survey results indicate that Sweet pepper are grown by large proportion of households in Rubeho, West Usambara and Nguru mountain blocks. The vegetable is also grown by relatively small proportion of household in Uluguru and East Usambara mountain blocks. On the other hand, Okra is grown by large proportion of households in Ukaguru, West Usambara and Mahenge Mountain blocks. The two vegetables are grown in an insignificant proportion of households in North Pare, Nguu and Udzungwa mountain blocks. Bitter tomatoes are grown by relatively large proportion of households in Mahenege, South Pare and West Usambara mountain blocks. The vegetable is grown by small proportion of households in East usambara and Uluguru mountain blocks and is grown by insignificant proportion of households to account in North Pare, Nguu and udzungwa mountain blocks.

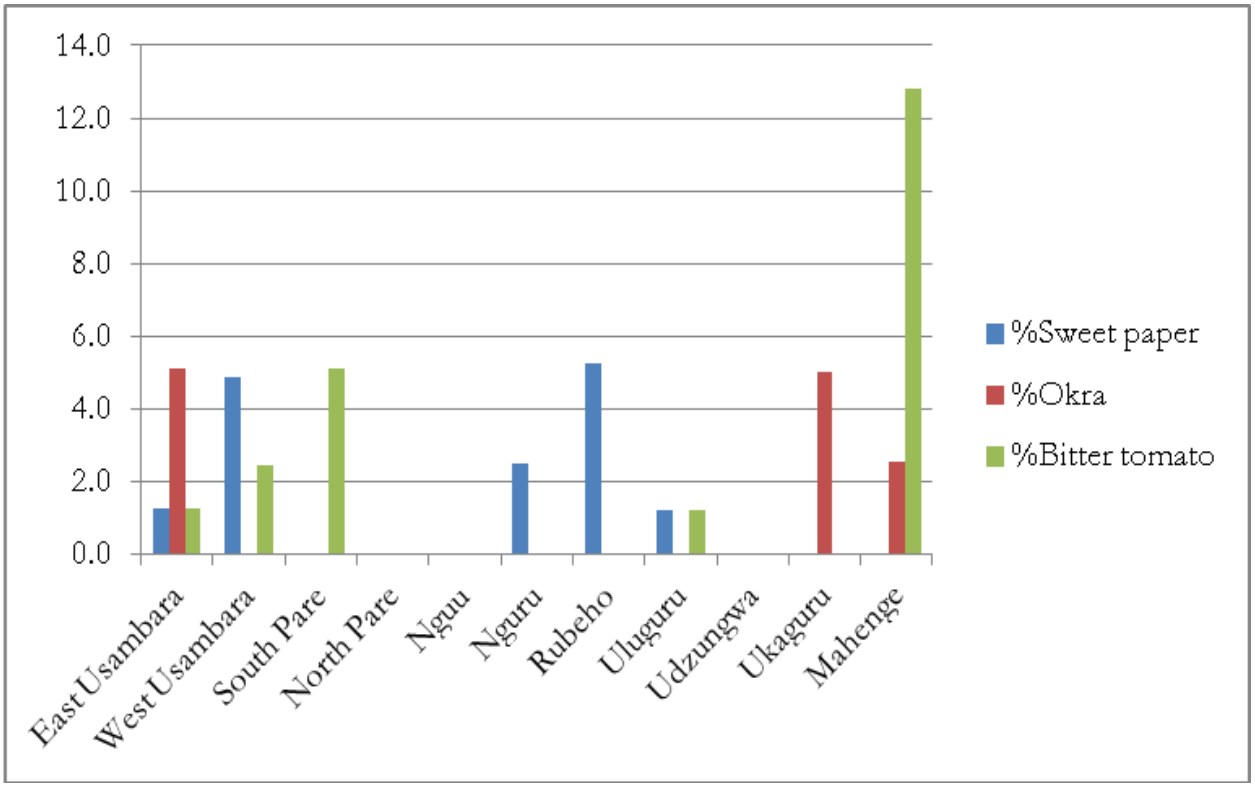

Figure 24: The proportion of households growing Sweet pepper, Okra and Bitter tomato in EAMs

5.2.3.8.Onions, Cauliflower and Chinese cabbage

Onions, Cauliflower and Chinese cabbage are among the vegetables grown in EAMs by relatively small proportion of households compared to other vegetables grown in the mountain blocks (Figure 25). Household survey results indicate that onions are grown by relatively large proportion of households in Nguru, North Pare and West Usambara mountain blocks. The vegetable is grown by an insignificant proportion of households to account in the rest of the mountain blocks. On the other hand, Cauliflower is grown by relatively large proportion of households in West Usambara and small proportion in Uluguru Mountain blocks. The vegetable is grown by an insignificant proportion of households to account in the rest of the mountain blocks. Equally important, Chinese cabbage is grown by relatively large proportion of households in Rubeho, West Usambara and a small proportion in Uluguru mountain blocks. The vegetable is grown by an insignificant proportion of households to account in the rest of the mountain blocks.

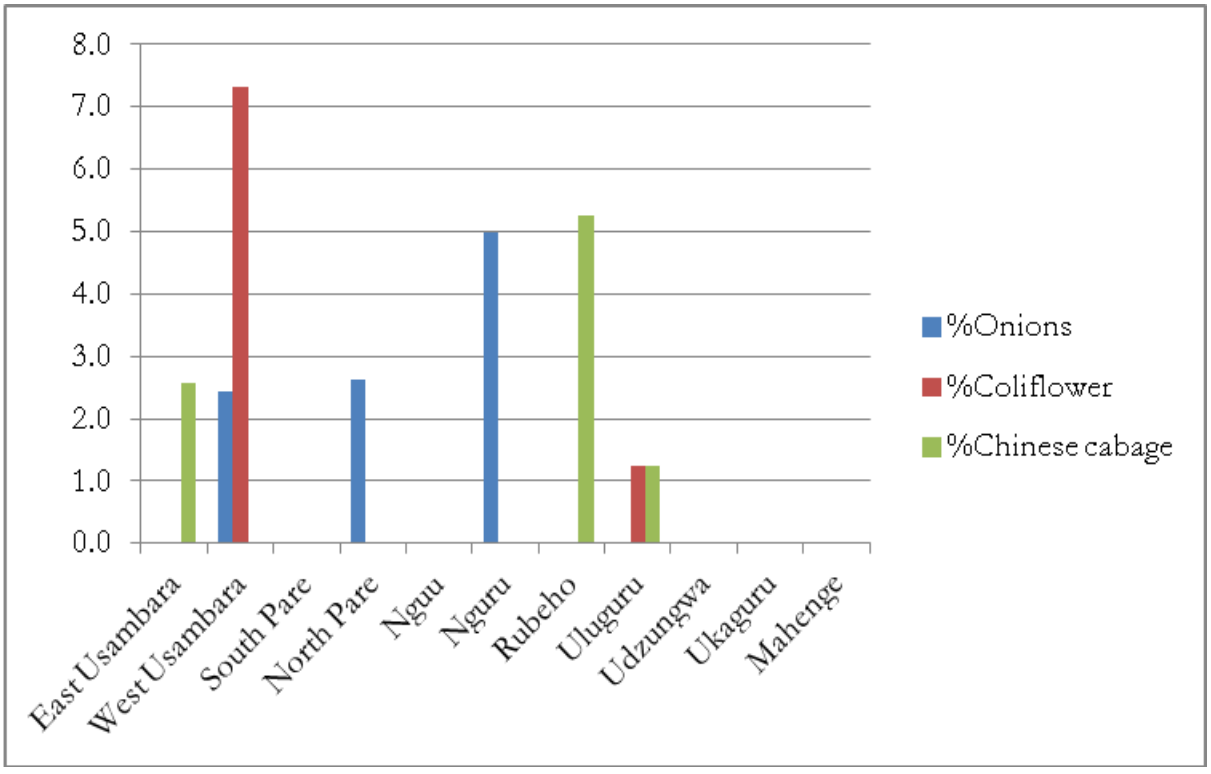

Figure 25: The proportion of households growing Onions, Cauliflower and Chinese cabbage in EAMs

5.2.3.9.Support fruits production

EAMs also supports production of both temperate and tropical fruits. The fruits grown by a significantly large proportion of households include Mangoes, Oranges, Avocado, Pineapples, Passions, Watermelon, Guava and Peas. Other fruits mainly temperate fruits are grown by small proportion of households in West Usambara (particularly in Lushoto), Uluguru (in Mgeta) and Udzungwa (in Kilolo and Mufindi Districts); these fruits include Peaches, Apples, Plums and Strawberry (Figure 26)

Figure 26: Type of Temperate fruits grown in West Usambara, Uluguru and Udzungwa mountain blocks of EAMs

5.2.3.9.1.Tropical fruits (Mangoes, Oranges, Avocado and Pineapples)

Mangoes are grown by relatively large proportion of households in Nguu, Uluguru, Nguru and South Pare mountain blocks (Figure 27). Oranges are grown by a significantly large proportion of households in Uluguru, West Usambara, Udzungwa and Mahenge mountain blocks. Nonetheless, avocadoes are grown by relatively large proportion of households in Nguru, Rubeho and South Pare mountain blocks. The fruits are also grown by a small proportion of households in Mahenge and East Usambara mountain blocks. Equally important, pineapples are grown by large proportion of households in Uluguru, Udzungwa and East Usambara mountain blocks (Figure 27).

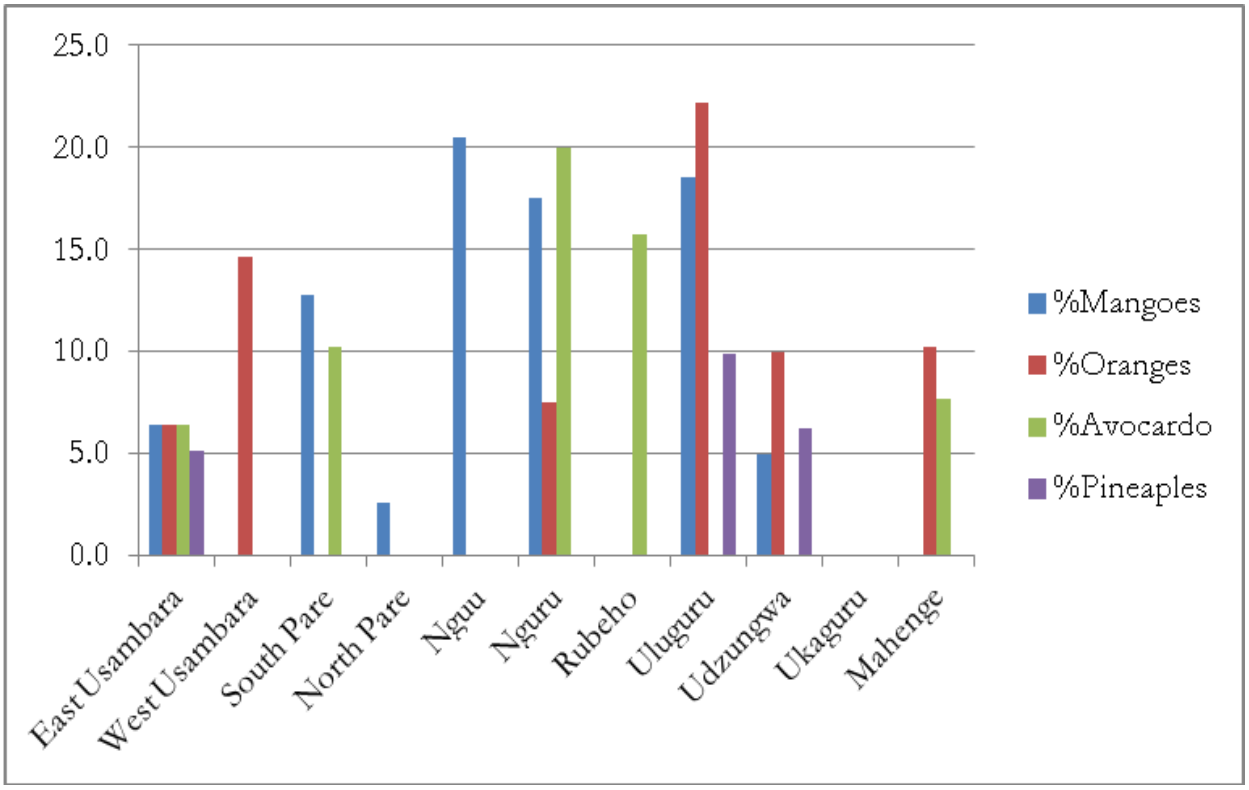

Figure 27: The proportion of households growing Mangoes, Oranges, Avocado and Pineapples in EAMs.

5.2.3.9.2.Passions, Watermelon, Guava and Peas

Other fruits grown in EAMs include Passions, Watermelon, Guava and Peas. Passions are grown by relatively large proportion of households in Uluguru, Udzungwa and East Usambara

mountain blocks (Figures 28 and 29). Watermelons are grown by a significantly large proportion of households in Udzungwa, South Pare, East Usambara and Uluguru mountain blocks. Nonetheless, Guava are grown by relatively large proportion of households in Rubeho and Nguru mountain blocks. Lastly, Peas are grown by large proportion of households in Uluguru, Udzungwa and West Usambara mountain blocks (Figure 28). These fruits are not grown in North Pare, Nguu, Ukaguru and Mahenge mountain blocks.

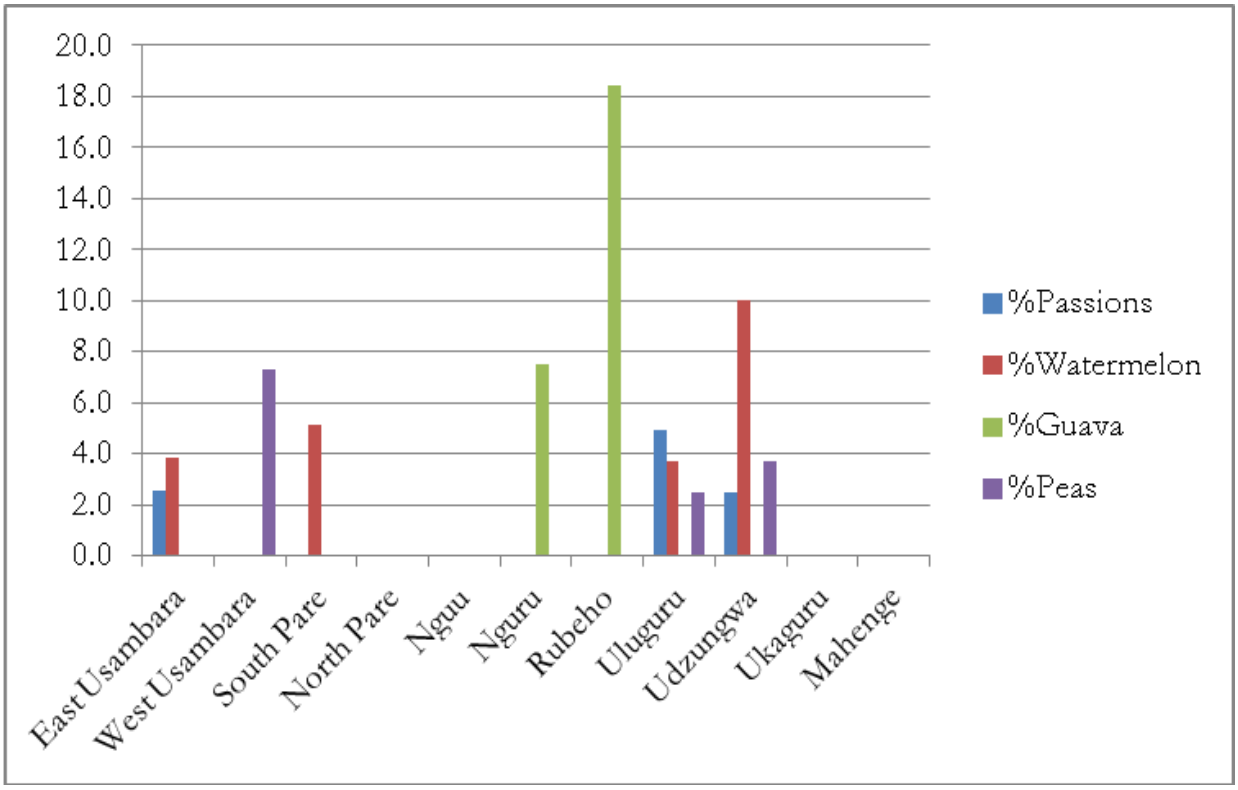

Figure 28: The proportion of households growing Passions, Watermelon, Guava and Peas in EAMs

Figure 29: Peas fruit farm in Boma la Ng'ombe village in Kilolo District

5.2.3.10. Type of livestock kept

EAMs also support livestock production, its ability to trap rain water and reliese it slowly downstream through streams and rivers make water availbale for animal drinking. Its vegetation cover provide pasture to animals and its weather condition favours flourishment of livestocks. Livestocks that are kept by large proportion of households include Local chicken, Ducks, Goats, Sheep, Cows, Cattle and pigs.

5.2.3.10.1. Local chicken, Ducks and Goats

Local chicken, ducks and goats are livestocks kept by a significantly large proportion of households in EAMs. Loca chicken are kept by a fairly large propotion of households in all the mountain blocks (Figure 30). Goats on the other hand are kept by large proportion of houesholds in North Pare, West Usambara, Nguu, Ukaguru, East Usambara, and Nguru mountain blocks and they are kept by a small proportion of households in Mahenge and Udzungwa Mountain blocks (Figure 30). Ducks are kept by a small proportion in all mountain blocks and in some they are kept by a small proportion to account. Ducks are kept bya relatively large proportion of

households in Rubeho, Uluguru, Udzungwa, Mahenge and Ukaguru Mountain blocks (Figure 30).

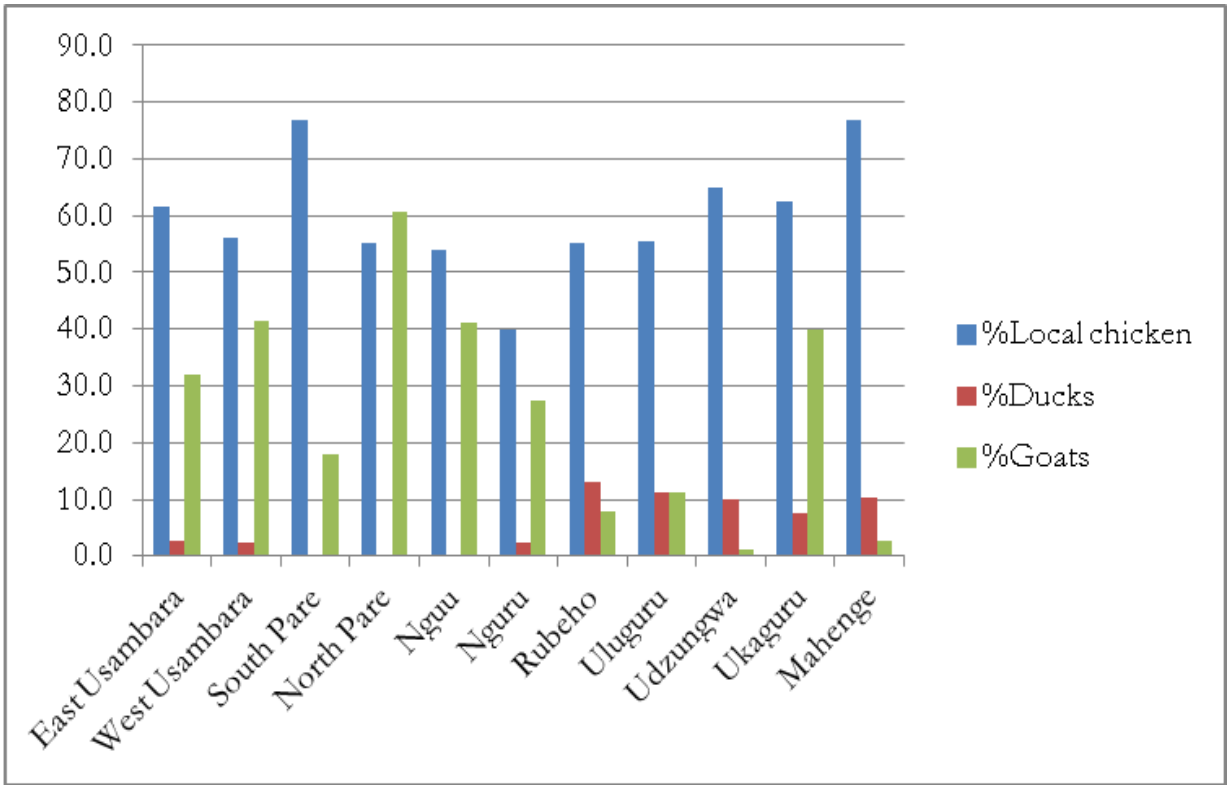

Figure 30: The proportion of households keeping Local chicken, Ducks and Goats in EAMs

5.2.3.10.2. Sheep, Cows, Cattle and Pigs

Sheep, Cows, Cattle and Pigs are livestocks kept by a significantly large proportion of households in EAMs. Sheeps are kept by a large propotion of households in Nguu, South Pare and North Pare mountain blocks (Figure 31). The animals are also kept by a relativelly small proportion of households in East Usambara, Nguru and Rubeho Mountain blocks (Figure 31). Cows (African breeds) on the other hand are kept by a large proportion of houesholds in North Pare, West Usambara, Nguu, Nguru and South Pare mountain blocks and they are kept by a small proportion of households in Mahenge, Udzungwa and Uluguru mountain blocks (Figure 31). Cattle for milk are kept by a small proportion in all mountain blocks and in some they are kept by small proportion to account. Cattle are kept by a relatively large proportion of

households in West Usambara, East Usambara, South Pare, Rubeho, Udzungwa and Mahenge mountain blocks (Figure 31). Lastly Pigs are kept by a relatively large proportion of households in Uluguru, Mahenge, Udzungwa and South Pare mountain blocks.

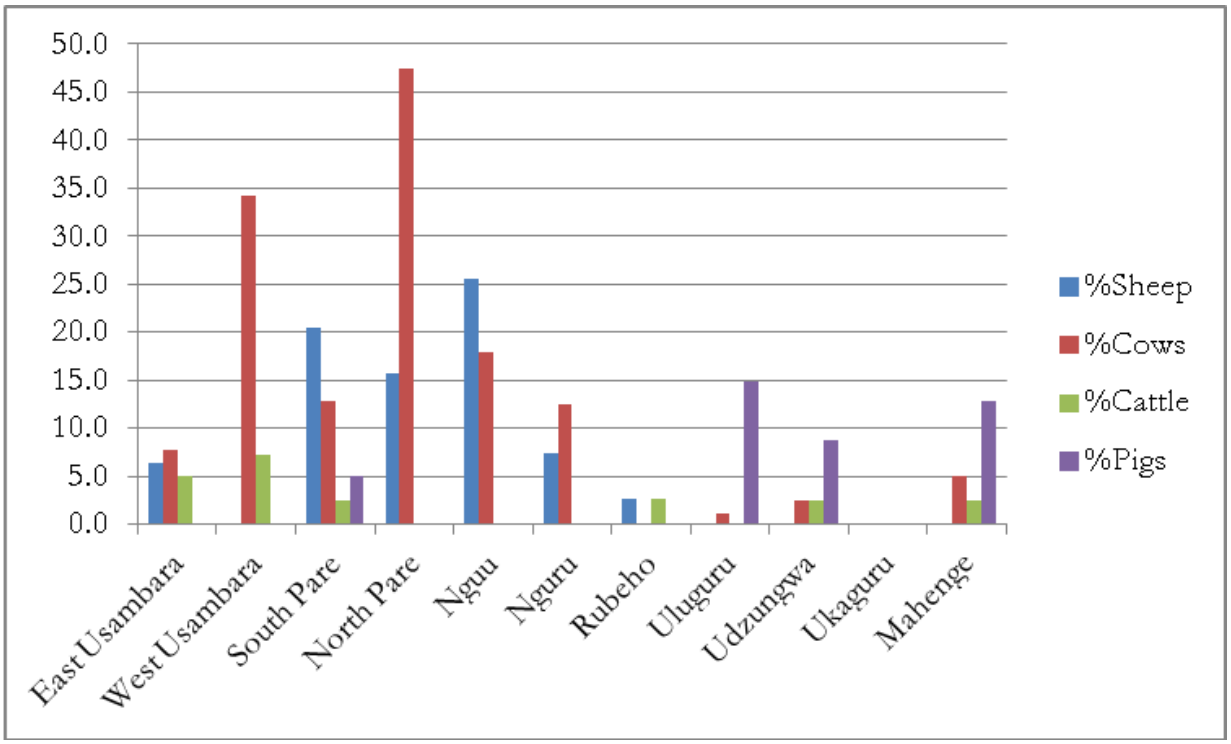

Figure 31: The proportion of households keeping Sheep, Cows, Cattle and Pigs in EAMs

CHAPTER SIX

6.0 ECONOMIC VALUE OF EAMS ECOSYSTEM SERVICES

6.1. Introduction

As noted in chapter one, defending conservation of EAM forest land needs justification of its value against alternative uses. EAM forest land is rich of so many precious natural resources ranging from natural forest, water resources, minerals and productive land. The mountains are also a home of various biodiversity. Its natural landscape is attractive to investment in Hotels and recreation sites. The productive land for temperate crops like tea, fruits and vegetables is also an attraction to investment in commercial production of these crops. Nevertheless, the abundant water resource is another attraction to investment in hydropower generation, water abstraction for domestic and industrial use in the surrounding urban centers. Investment in any of these alternative uses tends to affect the biodiversity and functioning of the mountains' natural systems. The resulting effect of such investments if happens is the decreased capacity of the mountains systems to provide ecosystem services. To reverse the situation economic valuation is imperative for the purpose of showing the opportunity costs the society is likely to incur if such decisions are made. This chapter presents detailed results on the total economic value of the Easter Arc Mountains based on field survey findings.

6.2. The economic role of EAMs

As noted in chapter five, EAMs provides a number of ecosystem services ranging from provisioning, regulating, and supporting to cultural respects. Some of these services are of direct economic value accrued to beneficiaries and others are of indirect economic value. For example, some of the remnant vegetation is used as fodder to feed cows, cattle and goats-an indirect value which in return produces milk and meat with direct value. Others are used for income generation through handmade crafts. Catchment forests are used for production of timber, harvesting of wild foods (such as fruits, vegetables, and honey), medicinal products, and forest soil. The mountains' fertile soil support production of various cereal crops, vegetables and fruits. The mountains' fresh water is used for domestic purposes, livestock, irrigation, hydroelectric production and

industrial uses. The mountains' forests, vegetation and soil are a store of carbon that play the role of cleaning our atmosphere. Furthermore, the mountains' forests are also a habitat for valuable biodiversity both vertebrates and invertebrates including the unique Kihansi Spray Toads (KST).

In accounting for the total economic values of any natural asset it is reasonable to consider; "what is the total value of the goods and services the society would be missing if the asset is transformed to other uses or disappears?", the flip side of this is that "what will cost the society to restore the natural asset to its capacity of providing the provisioning, supporting, regulating and cultural services if it is transformed to other uses or destroyed?" This involves estimating the total economic value in monetary terms which will be the opportunity cost if the natural asset if transformed or destroyed. To obtain the total economic value of EAMs we classified the ecosystem services derived from each of the mountains blocks into seven categories namely: crop and livestock production-supporting service; standing timber-regulating services; extracted forest products-provisioning service; water-provisioning service; biodiversity-supporting services; carbon sequestration-regulation services; and beautiful landscape-cultural and educational services.

To take into account the effect of period on values estimated, values are discounted basing on a discount rate (rate of return to capital) of 9% which is the rate that is used by the central banks of Tanzania (BoT) to value economic assets and capitals (BoT, 2017) and the discounting period of 25 years. Computing the discounting factor, the discount rate and discount period give the discounting factor of 0.1214947754 from the formula as indicated in chapter one.

6.2.1. Value of crops produced from EAMs

As noted in chapter five, the EAMs support production of various crops and this is one of the main economic activities of the communities living in the mountain blocks. Crop production contributes significantly to income and food supply to communities living in the mountain blocks and others outside the mountains. Crops produced include maize, paddy, beans, banana, cassava, sweet potatoes, Irish potatoes, sunflower, pigeon pea, cow pea, sesame, and yams (Table 6.1a to c).

6.2.1.1.The total economic value of maize produced from EAMs

The household survey results show that all households in EAMs exploit the mountains' maize production supporting ecosystem services. The household survey results show that the mountain blocks support the production of about 27,710,591.50 kg≈27,710.59 tons of maize per year (Table 6.1a). Basing on the market prices which ranges between 18-30 USD per 100 kg across the mountain blocks, the total economic value of maize produced in EAMs is 847,117,266.20 USD which is equivalent to 102,920,322.02 USD net present value.

Disaggregating this quantity and value to the respective mountain blocks show that the quantity of maize produced per year varies across the mountain blocks. Household survey results in Table 6.1a shows that Udzungwa mountain block is leading by far among the EAM blocks in exploiting maize production supporting ecosystem service. Households in the block produce about 26,886,835.04kg ≈26,886.84 tons of maize per year with the economic value of 825,892,100.96 USD which is equivalent to 99,932,944.21 USD net present value. Nguru mountain block is the second among the EAM blocks in exploiting maize production supporting ecosystem service. Households in the block produce about 174,513.98kg≈174.5 tons per year with the economic value of 3,679,029.18 USD which is equivalent to 445,162.53 USD net present value.

East Usambara Mountain block is the third among the EAM blocks in exploiting maize production supporting ecosystem service followed by West Usambara. Household survey results show that households in the two mountain blocks produce about 128,202.12kg≈128.20 tons and 114,014.17kg≈114.01 tons of maize per year respectively with the economic value of 3,452,009.29 and 3,128,367.18USD which are equivalent to 445,162.53 and 445,162.53 USD net present values respectively. South and North Pare mountain blocks are the fifth and sixth among the EAM blocks in exploiting the maize production ecosystem service. Households in the two blocks produce about 93,236.40kg ≈93.24 tons and 80,561.20kg ≈80.56 tons maize per year with

economic values of 2,465,583.33 USD and 2,113,634.72 USD which are equivalent to 298,335.58 and 255749.80 USD net present values respectively.

Mahenge mountain block is the seventh among EAM blocks in exploiting the maize production supporting ecosystem service. Household survey results indicate that the block produce about 69,003.28kg≈69 tons of maize per year with economic value of 1,962,975.81 USD which is equivalent to 140,850.29 USD net present value. Uluguru, Nguu and Ukaguru mountain blocks follows after Mahenge Mountain block in exploiting ecosystem service. Household survey results indicate that the blocks produce about 55,962.01kg≈55.96 tons, 51,493.25kg≈51.49 tons and 42,052.20kg≈42.05 tons of maize per year with economic values of 1,470,561.34; 1,514,316.71 and 1,164,052.00 USD which are equivalent to 177,937.92; 1832,232.32 and 140,850.29 USD net present values respectively. Rubeho mountain block produces the lowest quantity of maize among the EAM blocks. Household survey results indicate that the block produces about 14,717.85kg ≈14.72 tons of maize per year with the economic value of 274,635.68 USD which is equivalent to 33,230.92 USD net present value.

6.2.1.2.The economic value of paddy produced from EAMs

Equally important, EAM support the production of paddy. Household survey results show that the mountains support paddy production of about 1,747,693.01 kg≈1,747.69 tons per year (Table 3). Basing on the market price which ranges between 21-43 USD per 100 kg across the mountain blocks; the total economic value of paddy produced in the mountains is 67,527,728.92 USD which is equivalent to 8,204,266.26 USD net present value.

Disaggregating this quantity and value to the respective mountain blocks, paddy produced per year varies across the mountain blocks. Household survey results in Table 3 shows that Udzungwa mountain block is leading by far among the EAM blocks in producing paddy. Households in the block produce about 917,322.96kg≈917.32 tons of paddy per year with economic value of 39,644,151.62 USD which is equivalent to 4,796,942.34 USD net present value. Nguru mountain block follows after Udzungwa in supporting paddy production.

Households in the block produce about 368,373.46 kg≈368.37 tons per year with economic value of 12,619,574.05USD which is equivalent to 1,526,968.46USD net present value.

Nguu Mountain block is the third among the EAM blocks in supporting paddy production followed by South Pare. The household survey results show that households in the two mountain blocks produce about 170,665.03 kg≈170.67 tons and 130,337.08 kg≈130.34 tons of paddy per year respectively with the economic values of 5,561,250.24 and 4,325,099.92 USD which are equivalent to 672,911.28 and 523,337.09 USD net present values respectively. South Pare mountain block is the fourth among the EAM blocks in supporting paddy production. Households in this block produce about 130,337.08kg≈130.34 tons of paddy per year with economic values of 4,325,099.92 USD which is equivalent to 523,337.1USD net present value.

Mahenge and East Usambara mountain blocks are the fifth and sixth among EAM blocks in exploiting the paddy production supporting ecosystem service. Household survey results indicate that the two mountain blocks produce about 76,756.31kg≈76.76 and 59,553.85≈59.56 tons of paddy per year with the economic value of 3,322,973.60 and 1,255,488.73 USD which are equivalent to 402,079.73 and 151,914.14 USD net present values respectively. Uluguru, Rubeho and North Pare mountain blocks are the seventh, eighth and ninth in supporting the paddy production. Household survey results indicate that the three blocks produce about 16,753.09kg≈16.75tons, 5,654.95kg≈5.65tones and 2,276.30kg≈2.28 tons of paddy per year with the economic values of 492,416.38; 226,768.12 and 80,006.25 USD which are equivalent to 59,582.38; 27,438.94 and 9,680.76USD net present values respectively. West Usambara and Ukaguru mountain blocks support a relatively low production of paddy among the EAM blocks to account.

6.2.1.3.The value of beans produced from EAMs

The household survey results show that EAMs also support production of beans. The results show that the mountain blocks support the production of about 419,479.25kg≈419.48tons of beans per year (Table 3). Basing on the market prices which ranges between 43-76 USD per 100

kg across the mountain blocks, the total economic value of beans produced in EAMs is 22,027,695.20USD which is equivalent to 2,676,249.88 USD net present value.

Disaggregating this quantity and value to respective mountain blocks, the household survey results show that the quantity of beans produced per year varies across the mountain blocks. Results in Table 3 shows that Udzungwa mountain block lead by far among the EAM blocks in supporting beans production. Households in the block produce about 311,463.11kg ≈311.46 tons of beans per year with the economic value of 16,415,330.32 USD which is equivalent to 1,986,254.97 USD net present value. Nguru mountain block follows after Udzungwa among the EAM blocks in supporting beans production. Households in the block produce about 34,522.75 kg≈34.52tons of beans per year with the economic value of 1,778,925.40 USD which is equivalent to 215,249.93 USD net present value.

Uluguru Mountain block is the third among the EAM blocks in supporting beans production supporting followed by Mahenge and South Pare mountain blocks. The household survey results show that households in the three mountain blocks produce about 19,060.99; 15,155.61 and 14,048.31kg which are equivalent to 19.06; 15.16 and 14.05tons of beans per year with the economic value of 949,650.72; 665,633.44 and 783,591.10 USD which are equivalent to 114,907.74; 80,541.65 and 94,030.92 USD net present values respectively. West Usambara mountain block is the sixth among the EAM blocks in supporting beans production. Households in the block produce about 12,388.60kg ≈12.39 tons of beans per year with the economic value of 711,225.08 USD which is equivalent to 86,058.23 USD net present value.

North Pare, Ukaguru and East Usambara mountain blocks are the seventh, eighth and ninth among the EAM blocks in supporting beans production. Household survey results indicate that the mountain blocks produce about 5,688.77; 3,883.74 and 2,967.77kg which is equivalent to 5.69; 3.88 and 2.97 tons of beans per year with the economic values of 287,985.45; 241,904.59 and 170,750.83 USD which are equivalent to 34,846.24; 29,270.46 and 20,660.85 USD net present values respectively. Rubeho mountain block support lowest bean production and Nguru does not support bean production at all among the EAM blocks. Household survey results

indicate that the households in Rubeho produce about 299.6kg≈0.3tons of beans per year with the economic value of 22,698.27 USD which is equivalent to 2,746.49 USD net present value.

6.2.1.4.The economic value of banana produced from EAMs

As noted in chapter five, EAMs also support production of banana. The household survey results show that the Mountains support the production of about 1,685,335.90kg≈1,685.34tons of banana per year (Table 3). Basing on the market price which ranges between 1-4 USD per bunch of banana across the mountain blocks, the total economic value of 5,702,554.88 USD which is equivalent to 692,830.62 USD net present value is realized.

Disaggregating this quantity and value, the survey results show that the quantity of banana produced per year varies across the mountain blocks. Household survey results in Table 3 shows that Udzungwa and Uluguru mountain blocks are leading by far among the EAM blocks in supporting banana production. Households in the two blocks produce about 776,219.97kg≈776.23 tons and 675,504.30kg≈675.5tons of banana per year with the economic values of 2,727,322.94 and 2,411,907.47 USD which are equivalent to 330,006.08 and 291,840.8 USD net present values respectively. South Pare and East Usambara Mountain blocks follows after the two blocks among the EAM blocks in supporting banana production. Households in the blocks produce about 121,752 kg≈121.75 tons and 67,097.33 kg≈67.1 tons per year with the economic values of 326,187.79 and 108,809.02 USD which are equivalent to 39,468.72 and 13,165.89 USD net present values respectively.

Mahenge and Ukaguru follows after South Pare and East Usambara Mountain blocks in supporting banana production. The two mountain blocks produce about 25,209.18 kg≈25.2 tons and 11,149.50 kg≈11.15 tons of banana per year respectively with the economic values of 62,740.52 and 44,071.69 USD which are equivalent to 7,591.6 and 5,332.59 USD net present values respectively. Nguru and Rubeho Mountain blocks follows after the two mountain blocks in supporting banana production. Households in the two blocks produce about 4,658.61kg≈4.7tons and 3,745kg≈3.75 tons of banana per year with the economic values of 14,936.23 and 6,579.21 USD which are equivalent to 1,807.28 and 796.08 USD net present

values respectively. The quantity of banana produced in West Usambara, North Pare and Nguu is too small to account, implying that the blocks are not supporting the production of the crop.

Table 3: Economic value of crops produced from EAMs

Name of the mountain block	Maize			Paddy			Beans			Banana		
	Quantity produced (100kg bag)	Price (USD/100kg bag)	Value (USD)	Quantity produced (100kg bag)	Price (USD/100kg bag)	Value (USD)	Quantity produced (100kg bag)	Price (USD/100kg bag)	Value (USD)	Quantity produced (bunch)	Price (USD/bunch)	Value (USD)
East Usambara	128,202.12	26.93	3,452,009.29	59,553.85	21.08	1,255,488.73	2,967.77	57.54	170,750.83	67,097.33	1.62	108,809.02
West Usambara	114,014.17	27.44	3,128,367.18	-	-	-	12,388.60	57.41	711,225.08	-	-	-
South Pare	93,236.40	26.44	2,465,583.33	130,337.08	33.18	4,325,099.92	14,048.31	55.78	783,591.10	121,752.00	2.68	326,187.79
North Pare	80,561.20	26.24	2,113,634.72	2,276.30	35.15	80,006.25	5,688.77	50.62	287,985.45	-	-	-
Nguru	174,513.98	21.08	3,679,029.18	368,373.46	34.26	12,619,574.05	34,522.75	51.53	1,778,925.40	4,658.61	3.21	14,936.23
Nguu	51,493.25	29.41	1,514,316.71	170,665.03	32.59	5,561,250.24	-	-	-	-	-	-
Uluguru	55,962.01	26.28	1,470,561.34	16,753.09	29.39	492,416.38	19,060.99	49.82	949,650.72	675,504.30	3.57	2,411,907.47
Ukaguru	42,052.20	27.68	1,164,052.00	-	-	-	3,883.74	62.29	241,904.59	11,149.50	3.95	44,071.69
Rubeho	14,717.85	18.66	274,635.68	5,654.95	40.10	226,768.12	299.60	75.76	22,698.27	3,745.00	1.76	6,579.21
Mahenge	69,003.28	28.45	1,962,975.81	76,756.31	43.29	3,322,973.60	15,155.61	43.92	665,633.44	25,209.18	2.49	62,740.52
Udzungwa	26,886,835.04	30.72	825,892,100.96	917,322.96	43.22	39,644,151.62	311,463.11	52.70	16,415,330.32	776,219.97	3.51	2,727,322.94
Total quantity and value	**27,710,591.50**		**847,117,266.20**	**1,747,693.01**		**67,527,728.92**	**419,479.25**		**22,027,695.20**	**1,685,335.90**		**5,702,554.88**
NPV			**102,920,322.02**			**8,204,266.26**			**2,676,249.88**			**692,830.62**

6.2.1.5.The economic value of cassava produced from EAMs

Cassava is another crop supported by EAMs. The household survey results show that the EAMs supports production of about 361,610.99 kg≈361.61 tons of cassava per year (Table 4). Basing on the market price which ranges between 5 and 21 USD per basket of cassava across the mountain blocks the total economic value of cassava produced in EAMs is 2,661,160.44 USD which is equivalent to 322,000.41 USD net present value.

Disaggregating this quantity and value, it shows that the quantity of cassava produced per year varies across the mountain blocks. Household survey results in Table 4 shows that Udzungwa mountain block is leading by far among the EAM blocks in supporting cassava production followed by East Usambara, Uluguru and Mahenge mountain blocks. Households in these blocks produce about 282,431.96; 28,585.85; 23,534.74 and 12,592.05kg which are equivalent to 282.43; 28.59; 23.53 and 12.59 tons of cassava per year respectively. The economic values of these quantities of cassava produced are 1,773,828.55; 381,040.83; 323,013.83 and 64,521.57 USD which are equivalent to 214,633.25; 46,105.94; 39,084.67 and 7,807.11 USD net present values respectively.

Nguru and South Pare mountain blocks are the fifth and sixth among the EAM blocks in supporting cassava production. Households in the two blocks produce about 9,480.68 and 3,238.92kg which are equivalent to 9.48 and 3.24 tons per year with the economic values of 43,721.05 and 48,366.01USD which are equivalent to 5,290.25 and 5,852.29USD net present values respectively. West Usambara, Rubeho and Ukaguru produces less than one (1) tone per year and the remaining mountain blocks (i.e. North Pare and Nguu) produces small quantities to account (Table 4).

6.2.1.6.The economic value of sweet potatoes produced from EAMs

EAMs also support production of sweet potatoes. The household survey results show that the EAMs support production of 584,494.54 kg≈584.49 tons of sweet potatoes per year (Table 4). Basing on the market price which ranges between 17-55 USD per basket of sweet potatoes

across the mountain blocks, the total economic value of sweet potatoes produced in EAMs is 13,680,558.51 USD which is equivalent to 1,655,347.58 USD net present value.

Disaggregating this quantity and value, the survey results show that the quantity of sweet potatoes produced per year varies across the mountain blocks. Household survey results in Table 4 shows that Udzungwa mountain block is leading by far among the EAM blocks in supporting sweet potatoes production followed by West Usambara mountain block. Households in these blocks produce about 447,526.10 and 113,636.56kg which are equivalent to 447.53 and 113.64 tons of sweet potatoes per year respectively. The economic values of these quantities of sweet potatoes produced are 10,319,043.28 and 2,961,274.01 USD which are equivalent to 214,633.25; 1,248,604.24 and 358,314.15 USD net present values respectively.

Uluguru mountain block follows after Udzungwa and West Usambara in supporting sweet potatoes production. Households in the mountain block produce about 17,691.26kg≈17.69tons per year with the economic value of 282,545.12 USD which is equivalent to 34,187.96 USD net present value. West Usambara and Mahenge are the third in supporting sweet potatoes production among the EAMs. Household survey results show that the two mountain blocks produce about 3,573.23 and 1,128.77kgs which is equivalent to 3.57 and 1.13tons of sweet potatoes per year with the economic values of 60,812.74 and 24,787.74 USD which are equivalent to 7,358.34 and 2,999.32 USD net present values respectively. The remaining mountain blocks produces less than one (1) ton per year and others (i.e. North Pare and Nguu) produces small quantities to account (Table 4).

6.2.1.7.The economic value of Irish potatoes produced from EAMs

EAMs also support production of Irish potatoes. The household survey results show that the EAMs support production of about 300,114.84 kg≈300.11 tons of Irish potatoes per year (Table 4). Basing on the market price which ranges between 13-35 USD per 100kg bag of Irish potatoes across the mountain blocks, the total economic value of Irish potatoes produced in EAMs is 4,036,922.34 USD which is equivalent to 488,467.6 USD net present value.

Disaggregating this quantity and value, the survey results show that the quantity of Irish potatoes produced per year varies across the mountain blocks. Household survey results in Table 4 shows that Udzungwa mountain block is leading by far among the EAM blocks in supporting Irish potatoes production followed by West Usambara mountain block. Households in the two blocks produce about 291,141.95 and 6,017.41kg which are equivalent to 291.14 and 6.02 tons of Irish potatoes per year respectively. The economic values of these quantities of Irish potatoes produced are 3,836,081.40 and 132,142.25 USD which are equivalent to 464,165.85 and 15,989.21 USD net present values respectively.

Uluguru and East Usambara mountain block are the third and fourth among the EAM blocks in supporting Irish potatoes production. Households in the two mountain blocks produce about 1,608.30 and 1,091.82 kg which are equivalent to 1.61 and 1.09 tons per year with the economic values of 35,318.14 and 26,373.98 USD which are equivalent to 4,273.49 and 3,191.25 USD net present values respectively. The rest of the mountain blocks produce less than one (1) ton per year and others especially North Pare, South Pare, Nguu, Ukaguru and Mahenge produces small quantities to account (Table 4).

6.2.1.8.The economic value of Sunflower produced from EAMs

EAMs also support production of sunflower even though in a very few mountain blocks. Household survey results shows that the EAMs support sunflower production of about 6,269.03kg≈6.27 tons of sunflower per year (Table 4). Basing on the market price which ranges between 25-30 USD per 100kg bag of sunflower across the mountain blocks, the total economic value of sunflower produced in EAMs is 189,445.92 USD which is equivalent to 22,922.96 USD net present value.

Disaggregating this quantity and value, the survey results show that the quantity of Sunflower produced per year varies across the mountain blocks. Household survey results in Table 4 shows that Nguu mountain block is leading among the EAM blocks in supporting Sunflower, followed by North Pare and Rubeho mountain blocks. Households in these blocks produce about 4,112.41,

1,707.22 and 449.40kg which are equivalent to 4.11; 1.71 and 0.45 tons of Sunflowers per year respectively. The economic values of these quantities of sunflower produced are 126,431.78; 50,513.65 and 12,500.49 USD which are equivalent to 15,298.25; 6,112.15 and 1,512.56 USD net present values respectively. The remaining mountain blocks produce small quantities to account (Table 4).

Table 4: Economic value of crops produced from EAMs

Name of the mountain block	Cassava			Sweet potatoes			Irish potatoes			Sunflower		
	Quantity produced (bamboo basket)	Price (USD/bamboo basket)	Value (USD)	Quantity produced (100kg bag)	Unit price (USD/100kg bag)	Value (USD)	Quantity produced (100kg bag)	Unit price (USD/100kg bag)	Value (USD)	Quantity produced (100kg bag)	Unit price (USD/100kg bag)	Value (USD)
East Usambara	28,585.85	13.33	381,040.83	3,573.23	17.02	60,812.74	1,091.82	24.16	26,373.98	-	-	-
West Usambara	925.76	15.37	14,230.70	113,636.56	26.06	2,961,274.01	6,017.41	21.96	132,142.25	-	-	-
South Pare	3,238.92	14.93	48,366.01	624.37	32.94	20,566.70	-	-	-	-	-	-
North Pare	-	-	-	-	-	-	-	-	-	1,707.22	29.59	50,513.65
Nguru	9,480.68	4.61	43,721.05	183.89	27.12	4,987.27	30.65	35.41	1,085.29	-	-	-
Nguu	-	-	-	-	-	-	-	-	-	4,112.41	30.74	126,431.78
Uluguru	23,534.74	13.72	323,013.83	17,691.26	15.97	282,545.12	1,608.30	21.96	35,318.14	-	-	-
Ukaguru	371.65	2196	8,161.42	92.91	52.70	4,896.85	-	-	-	-	-	-
Rubeho	449.40	9.52	4,276.48	37.45	43.92	1,644.80	224.70	26.35	5,921.29	449.40	27.82	12,500.49
Mahenge	12,592.05	5.12	64,521.57	1,128.77	21.96	24,787.74	-	-	-	-	-	-
Udzungwa	282,431.96	6.28	1,773,828.55	447,526.10	23.06	10,319,043.28	291,141.95	13.18	3,836,081.40	-	-	-
Total quantity/value	**361,610.99**		**2,661,160.44**	**584,494.54**		**13,680,558.51**	**300,114.84**		**4,036,922.34**	**6,269.03**		**189,445.92**
NPV			**323,317.09**			**1,662,116.38**			**490,464.97**			**23,016.69**

6.2.1.9.The value of pigeon pea produced from EAMs

EAMs support production of pigeon pea; the household survey results show that the mountains support production of about 12,273.22kg≈12.27 tons of pigeon pea per year (Table 5). Basing on the market price which ranges between 27-57 USD per 100kg bag of pigeon pea across the mountain blocks, the total economic value of pigeon pea produced in EAMs is 444,479.03USD which is equivalent to 53,781.96 USD net present value.

Disaggregating this quantity and value, the survey results show that the quantity of pigeon pea produced per year varies across the mountain blocks. Household survey result in Table 5 shows that Udzungwa mountain block is leading by far among the EAM blocks in supporting pigeon pea production, followed by Mahenge and Rubeho mountain blocks. Households in the blocks produce about 10,008.77; 993.32 and 861.35kg which are equivalent to 10.01; 0.99 and 0.86 tons of pigeon pea per year respectively. The economic values of these values of pigeon pea produced are 350,568.87; 27,702.78 and 46,342.29 USD which are equivalent to 42,418.83; 3,352.04 and 5,607.42 USD net present values respectively. The rest mountain blocks produce less than one (1) ton per year and others especially East and West Usambara, North and South Pare, Nguu, and Ukaguru produces small quantities to account (Table 5).

6.2.1.10. The value of cowpea produced from EAMs

EAMs support production of cowpea. Household survey results show that the mountains support production of about 190,130.29 kg≈190.13 tons of cowpea per year (Table 5). Basing on the market price which ranges between 35-80 USD per bag of 100kg of cowpea across the mountain blocks, the total undiscounted economic value of cowpea produced in EAMs is 8,447,629.54 USD which is equivalent to 1,022,163.17 USD discounted value.

Disaggregating this quantity and value, the survey results show that the quantity of cowpea produced per year varies across the mountain blocks. Household survey results in Table 5 shows that Udzungwa mountain block is leading by far among the EAM blocks in supporting cowpea production, followed by West Usambara mountain block. Households in the two blocks produce

about 190,130.29 and 925.76kg which are equivalent to 190.13 and 0.93 tons of cowpea per year respectively. The economic values of these values of cowpea produced are 8,364,428.76 and 73,186.48 USD which are equivalent to 1,012,095.88 and 8,855.56USD net present values respectively. The rest mountain blocks produce less than one (1) ton per year and others especially East Usambara, North and South Pare, Nguu, Ukaguru and Mahenge produces small quantities to account (Table 5).

6.2.1.11. The economic value of sugarcane produced from EAMs

EAMs support production of sugarcane. Household survey results show that the EAMs support production of about 1,046,582,618.61 tons of sugarcane per year (Table 5). Basing on the market price which ranges between 18-80 USD per ton of sugarcane across the mountain blocks; the total undiscounted economic value of sugarcane produced in EAMs is 39,352,714,851.10 USD which is equivalent to 4,781,149,252.21USD net present value.

Disaggregating this quantity and value into respective mountain blocks, the survey results show that the quantity of sugarcane produced per year varies across the mountain blocks. Household survey results in Table 5 shows that Udzungwa mountain block is leading by far among the EAM blocks in supporting sugarcane production followed by Nguru mountain block. Households in the two blocks produce about 858,542,337.74 and 188,034,246 tons of sugarcane per year respectively. The economic values of these quantities of sugarcane produced are 31,391,185,977.75 and 7,961,369,975.64 USD which are equivalent to 3,798,333,503.3 and 963,325,767.05 USD net present values respectively.

Ukaguru and West Usambara mountain blocks are the third and fourth among the EAM blocks in supporting sugarcane production. Households in the two mountain blocks produce about 4,292.56 and 1,157.20 tons per year with the economic values of 77,296.84 and 50,823.94 USD which are equivalent to 9,352.92 and 6,149.75 USD net present values respectively. The rest mountain blocks produce less than one thousands (1000) tones per year and others especially North Pare, Nguu, Uluguru and Rubeho produces small quantities to account (Table 5).

6.2.1.12. The economic value of sesame and yams produced from EAMs

EAMs support production of sesame and yams even though the quantity produced is very small and very few mountain blocks support the crops. Household survey results shows that the EAMs support production of about 1,455,166.92 and 8,398.01kgs which are equivalent to 1,455.17 and 8.4 tons of sesame and yams per year (Table 5). Basing on the market price which ranges between 37-80 USD/100kg and 13-22 USD/basket of sesame and yams across the mountain blocks, the total economic value of sesame and yams produced in EAMs are 64,728,341.45 and 150,943.33 USD which are equivalent to 7,864,155.31 and 18,338.83 USD net present values respectively.

Disaggregating this quantity and value into respective mountain blocks, the survey results show that the quantity of sesame produced per year varies across the mountain blocks. Household survey results in Table 5 shows that Udzungwa mountain block produces the highest quantity (i.e. 1,415,219.55kg≈1,415.22 tones) followed by Mahenge (2,257.54 kg≈2.26 tons), Easte Usambara (1,310.18kg≈1.31tons) and Rubeho (599.2kg≈0.599tons). Basing on the aforementioned market prices, the economic values of quantities of sesame produced are 64,562,315.81; 84,278.32; 30,210.20 and 51,537.12 USD which are equivalent to 7,812,040.21; 10,197.68; 3,655.43 and 6,235.99USD net present values respectively.

On the other hand, household survey results in Table 5 shows that yams are produced in a relatively large quantity in East Usambara, followed by Uluguru and Mahenge mountain blocks. Households in the mountain blocks produce about 3,970.26; 2,546.47 and 1,881.28kgs which are equivalent to 3.97; 2.55 and 1.88 tons per year. The economic values of these quantities produced are 52,312.03; 57,318.40 and 41,312.90 USD which are equivalent to 6,329.76; 6,935.53 and 4,998.86 USD net present values respectively. The rest mountain blocks produce small quantities to account (Table 5).

Table 5: Economic value of crops produced from EAMs

Name of the mountain block	Pigeon pea			Cowpea			Sugarcane			Sesame			Yams		
	Quantity produced (100kg bag)	Price (USD/ 100kg bag)	Value (USD)	Quantity produced (100kg bag)	Price (USD/ 100kg bag)	Value (USD)	Quantity produced (tons)	Price (USD/ Ton)	Value (USD)	Quantity produced (100kg bag)	Price (USD/ 100kg bag)	Value (USD)	Quantity produced (bamboo basket)	Price (USD/ bamboo basket	Value (USD)
E. Usambara	-	-	-	-	-	-	516.13	51.45	26,554.58	1,310.18	23.06	30,210.20	3,970.26	13.18	52,312.03
W. Usambara	-	-	-	925.76	79.06	73,186.48	1,157.20	43.92	50,823.94	-	-	-	-	-	-
South Pare	-	-	-	-	-	-	35.12	46.12	1,619.63	-	-	-	-	-	-
North Pare	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nguru	-	-	-	5.11	48.86	249.59	188,034,246.00	42.34	7,961,369,975.64	-	-	-	-	-	-
Nguu	88.12	57.10	5,031.47	-	-	-	-	-	-	-	-	-	-	-	-
Uluguru	321.66	46.12	14,833.62	53.61	79.06	4,238.18	-	-	-	-	-	-	2,546.47	22.51	57,318.40
Ukaguru	-	-	-	-	-	-	4,292.56	18.01	77,296.84	-	-	-	-		-
Rubeho	861.35	53.80	46,342.29	157.29	35.14	5,526.53	-	-	-	599.20	86.01	51,537.12	-	-	-
Mahenge	993.32	27.89	27,702.78	-	-	-	33.86	76.86	2,602.71	2,257.54	37.33	84,278.32	1,881.28	21.96	41,312.90
Udzungwa	10,008.77	35.03	350,568.87	190,130.29	43.99	8,364,428.76	858,542,337.74	36.56	31,391,185,977.75	1,415,219.55	45.62	64,562,315.81	-	-	-
Total quantity/ value	**12,273.22**		**444,479.03**	**191,272.05**		**8,447,629.54**	**1,046,582,618.61**		**39,352,714,851.10**	**1,455,166.92**		**64,728,341.45**	**8,398.01**		**150,943.33**
NPV			**54,001.88**			**1,026,342.85**			**4,781,149,252.21**			**7,864,155.31**			**18,338.83**

6.2.1.13. Summary of economic value of crops produced in the EAMs

As noted in above, EAM blocks support production of various crops and crop production is the main economic activity of the communities living in and around the mountains. Their capacity to support production of various crops gives the mountains a remarkable economic value as indicated in Table 6. The figures from the various sub-values of crops produced are aggregated in terms of actual and discounted values in USD.

Table 6: Summary of economic value of crops produced in EAMs

Name of the mountain block	Total economic value of Crops produced		
	Undiscounted value (USD)	Present value (USD)	%of the total value
East Usambara	5,564,362.23	676,040.94	0.17
West Usambara	7,071,249.65	859,119.89	0.22
South Pare	7,971,014.48	968,436.61	0.25
North Pare	2,532,140.07	307,641.79	0.08
Nguru	27,146,096.31	3,298,108.87	0.85
Nguu	7,207,030.19	875,616.51	0.23
Uluguru	6,041,803.21	734,047.52	0.19
Ukaguru	1,540,383.39	187,148.53	0.05
Rubeho	658,430.29	79,995.84	0.02
Mahenge	6,259,529.40	760,500.12	0.20
Udzungwa	3,114,389,293.17	378,382,027.68	97.74
EAM total economic value	**3,186,381,332.37**	**387,128,684.32**	**100.00**

Udzungwa mountain block account for 97.74% of the total economic value of crops produced in EAMs followed by Nguru Mountain block (0.85%). The observed variation in the value of crops produced across the mountain blocks can be attributed to EAMs' variation in microclimate caused by the forest and woodland condition of the block, and water availability which is also dependent of the forest and woodland condition of the block. It can also be attributed to land and population size of the block. EAMs are characterized by overpopulation but they differ in the size of population. Because of the high population density, land available for agriculture is very small in some mountain blocks. For example, Udzungwa is the largest among the mountain blocks with wider flood plains compared to other mountain blocks. Its flood plains are fertile and

with abundant water sources making agriculture production to be higher than other mountain blocks. The flood plains are fertilized by litter from upstream of the mountain block which increases the potential of the block to agriculture production than other mountain blocks.

The East and West Usambara, Nguu, Nguru, Ukaguru, Rubeho, and Uluguru mountain blocks are characterized by high population such that land is a limiting factor despite the fertile soil and enough water for agriculture. The North and South Pare flood plains are semi-arid areas characterized with short and low rainfall which limit agriculture production. Therefore, crop production is limited by size of land available, water, climatic condition of the flood plains, population size and the forest conditions of the mountain blocks. High population density not only limit production of crops because of shortage of land but also lead to destruction of forests and woodlands which are crucial in creating favorable climatic condition, water, soil formation and fertility. For example, the Uluguru, East and West Usambara, North and South Pare, Mahenge, Nguu, Nguru and some parts of Udzungwa are highly affected by high population size and poor land use

6.2.2. Value of fruits produced from the EAMs

EAMs also support production of both tropical and temperate fruits which is also one of the economic activities of the communities living in the mountains blocks. Fruit production contributes significantly to income and food supply to communities living in the mountain blocks and others outside the mountains. The fruits produced include mangoes, oranges, avocado, pineapples, passions, watermelon, guava, peas, pitches, lemon and plums (Table 7 to Table 19).

6.2.2.1.The value of mangoes produced from EAMs

Mangoes are one of the fruits which are supported by EAMs. Household survey results show that the mountains support the production of mangoes of about 7,548,234.60 baskets[1] of mangoes per

[1] Basket we are referring here is the container made up of bamboo or timber for packaging fruits and vegetables.

year (Table 7). Basing on the market price which ranges between 9-13 USD per container across the mountain blocks, the total economic value of mangoes produced in EAMs is 54,956,118.60 USD which is equivalent to 6,649,690.35 USD net present value.

Disaggregating this quantity and value into respective mountain blocks, the household survey results show that the quantity of mango fruits produced per year varies across the mountain blocks. Results in Table 7 show that West Usambara mountain block is leading by far among the EAM blocks in supporting production of mangoes followed by Uluguru and Udzungwa mountain blocks. Households in the blocks produce about 5,047,605.77; 1,807,666.20 and 589,190.29 baskets of mangoes per year with the economic values of 34,654,984.48; 11,453,834.25 and 8,086,626.18 USD which are equivalent to 4,193,253.12; 1,385,913.94 and 978,481.77USD net present values respectively. Nguu and Nguru mountain blocks are the fourth and fifth among the EAM blocks in supporting mango production. Households in the blocks produce about 46,998.97 and 28,809.83 baskets per year with the economic values of 386,003.95 and 225,951.05 USD which are equivalent to 46,706.48 and 27,340.08 USD net present values respectively.

East Usambara, North and South Pare are sixth, seventh and eighth mountain blocks in supporting mango production. Household survey results show that households in the mountain blocks produce about 14,491.44; 11,121.58 and 2,350.53 baskets of mangoes per year with the economic values of 70,010.93; 68,384.26 and 10,323.50 USD which are equivalent to 8,471.32; 8,274.49 and 1,249.14 USD net present values respectively. The rest of the mountain blocks produce small quantities of mangoes to account.

6.2.2.2.The economic value of oranges produced from EAMs

EAMs also support the production of oranges. Household survey results show that the mountains support the production of about 115,905,034.61 baskets of oranges per year (Table 7). Basing on the market price which ranges between 5-13 USD per basket across the mountain blocks; the

total undiscounted economic value of oranges produced in EAMs is 870,619,162.29 USD which is equivalent to 105,344,918.64 USD net present value.

Disaggregating this quantity and value to respective mountain blocks, the household survey results show that the quantity of oranges produced per year varies across the mountain blocks. Household survey results in Table 7 shows that Uluguru mountain block is leading among the EAM blocks in producing oranges followed by West Usambara, Nguru and Mahenge mountain blocks. Households in the blocks produce about 98,910,222.22; 6,619,156.10; 6,415,805.00 and 3,010,051.28 baskets of oranges per year with the economic values of 738,524,040.85; 39,098,470.07; 64,810,750.55 and 18,963,323.08 USD which are equivalent to 89,361,408.94; 4,730,914.88; 7,842,100.82 and 2,294,562.09 USD net present values respectively.

East Usambara and Udzungwa mountain blocks are fifth and sixth among the EAM blocks in supporting orange production. Households in the blocks produce about 496,282.05 and 453,517.96 baskets of oranges per year with the economic values of 3,147,440.49 and 6,075,137.26 USD which are equivalent to 380,840.3 and 735,091.61USD net present values respectively. The rest of the mountain blocks produce small quantities of oranges to account.

6.2.2.3.The economic value of avocado produced from EAMs

Avocado is another fruit produced in EAMs. The household survey results show that the Mountains support the production of avocado of about 5,413,709.27 baskets of avocado per year (Table 7). Basing on the market price which ranges between 11-17 USD per basket of avocado across the mountain blocks; the total economic value of avocado produced in EAMs is 80,155,565.82 USD which is equivalent to 9,698,823.46 USD net present value.

Disaggregating this quantity and value to respective mountain blocks, the survey results shows that the quantity of avocado produced per year varies across the mountain blocks. Household survey results in Table 7 shows that East Usambara mountain block is leading among the EAM blocks in supporting avocado production followed by Mahenge and Udzungwa. Households in

the blocks produce about 2,640,220.51; 2,257,538.46 and 331,419.76 baskets of avocado per year with undiscounted economic values of 39,708,916.51; 32,869,760 and 5,183,405.1 USD which are equivalent to 4,804,778.9; 3,977,240.96 and 627,192.02 USD net present values respectively.

Uluguru, Nguru, Rubeho and South Pare mountain blocks are the fourth, fifth, sixth and seventh among the EAM blocks in supporting avocado production. Households in the blocks produce about 56,016.96; 52,307.20; 51,231.60 and 24,974.77 baskets of avocado per year with the respective economic values of 615,066.22; 606,240.45; 862,740.14 and 309,437.39 USD which are equivalent to 74,423.01; 73,355.09; 104,391.56 and 37,441.92 USD net present values. The rest of the mountain blocks produce small quantities of avocado to account.

6.2.2.4.The economic value of pineapples produced from EAMs

Pineapples are other fruits produced in EAMs. The household survey results show that the Mountains support the production of the fruits of about 3,416,684.62 pieces of pineapples per year (Table 7). Basing on the market price which ranges between 0.2-1 USD per piece of pineapple across the mountain blocks; the total economic value of pineapples produced in EAMs is 744,783.99 USD which is equivalent to 90,118.86 USD net present value.

The fruit is popular in three mountain blocks; the Uluguru; Udzungwa and East Usambara mountain blocks. Household survey results in Table 7 shows that the mountain blocks produce about 3,152,260.74; 185,018.75 and 79,405.13 pieces of pineapples per year with the respective economic values of 646,086.52; 81,260.13 and 17,437.34 USD which are equivalent to 78,176.47; 9,832.48 and 2,109.92 USD net present values. The rest of the mountain blocks produce small quantities of pineapples to account.

Table 7: Economic value of mangoes, oranges, avocado and pineapples fruits produced from EAMs

Name of the mountain block	Mangoes			Orange			Avocado			Pineapples		
	Quantity produced (100kg bag)	Unit price (USD/ 100kg bag)	Value (USD)	Quantity produced (100kg bag)	Unit price (USD/100kg bag)	Value (USD)	Quantity produced (bamboo basket)	Unit price (USD/bamboo basket)	Value (USD)	Quantity produced (piece)	Unit price (USD/piece)	Value (USD)
East Usambara	14,491.44	4.83	70,010.93	496,282.05	6.34	3,147,440.49	2,640,220.51	0.04	100,883.75	79,405.13	0.22	17,437.34
West Usambara	5,047,605.77	6.87	34,654,984.48	6,619,156.10	5.91	39,098,470.07	-	-	-	-	-	-
South Pare	11,121.58	6.15	68,384.26	-	-	-	24,974.77	4.39	109,689.04	-	-	-
North Pare	2,350.53	4.39	10,323.50	-	-	-	-	-	-	-	-	-
Nguru	28,809.83	7.84	225,951.05	6,415,805.00	10.10	64,810,750.55	52,307.20	6.59	344,599.38	-	-	-
Nguu	46,998.97	8.21	386,003.95	-	-	-	-	-	-	-	-	-
Uluguru	1,807,666.20	6.34	11,453,834.25	98,910,222.22	7.47	738,524,040.85	56,016.96	10.98	615,065.42	3,152,260.74	0.20	646,086.52
Ukaguru	-	-	-	-	-	-	-	-	-	-	-	-
Rubeho	-	-	-	-	-	-	51,231.60	16.84	862,534.09	-	-	-
Mahenge	-	-	-	3,010,051.28	0.03	79,320.77	2,257,538.46	0.04	99,150.96	-	-	-
Udzungwa	589,190.29	13.72	8,086,626.18	453,517.96	13.40	6,075,137.26	331,419.76	15.64	5,181,913.58	185,018.75	0.44	81,260.13
Total value	**7,548,234.60**		**54,956,118.60**	**115,905,034.61**		**851,735,159.99**	**5,413,709.27**		**7,313,836.23**	**3,416,684.62**		**744,783.99**
NPV			**6,676,881.29**			**103,481,371.96**			**888,592.89**			**90,487.36**

6.2.2.5.The economic value of passion and watermelon produced from EAMs

Passions and Watermelons are other fruits produced in EAMs. The household survey results show that the EAMs support the production of about 9,235.88 baskets of passions and 5,194,551.29 pieces of watermelons per year (Table 19). Basing on the market price which ranges between 14-21 USD per basket of passions and 0.3-2 USD per piece of watermelon across the mountain blocks, the total economic values of passions and watermelons produced in EAMs are 178,024.43 and 5,363,550.29 USD which are equivalent to 21,540.96 and 648,989.59 USD net present values respectively.

Passions fruits are popular in three mountain blocks; Udzungwa, East Usambara and Uluguru Mountain blocks. Household survey results in Table 19 shows that the mountain blocks produce about 5,920.60; 2,779.18 and 536.10 containers of passions per year with undiscounted economic values of 120,484.21; 49,691.73 and 7,848.49 USD which is equivalent to 14,578.59; 6,012.7 and 949.67 USD discounted economic values respectively.

On the other hand, watermelon is popular in Udzungwa, Uluguru, South Pare and East Usambara mountain blocks. Household survey results in Table 19 shows that the mountain blocks produce about 4,860,812.60; 148,767.41; 93,655.38 and 91,315.90 pieces of watermelon per year with economic values of 5,016,935.36; 254,167; 61,700.09 and 30,747.85 USD which are equivalent to 607,049.18; 30,754.12; 7,465.71 and 3,720.49 USD net present values respectively. The rest of the mountain blocks produce small quantities of the fruits to account.

6.2.2.6.The economic value of Guava and Peas produced from EAMs

Guava and Peas are also types of fruits produced in EAMs. The household survey results show that the EAMs support the production of about 892,860 and 2,929,736.41 baskets of guava and peas per year respectively (Table 19). Basing on the market price which ranges between 7-9 USD per basket of guava and 0.4-0.6 USD per piece of peas across the mountain blocks, the total economic values of guava and peas produced in EAMs are 7,566,545.30 and 1,484,076.73 USD which are equivalent to 915,551.98 and 179,573.28 USD net present values respectively.

Guava fruits are popular in two mountain blocks; Nguru and Rubeho Mountain blocks. Household survey results in Table 19 shows that the mountain blocks produce about 735,570 and 157,290 baskets of guava per year with the economic values of 6,461,238.45 and 1,105,306.85 USD which are equivalent to 781,809.8 and 133,742.13 USD net present values respectively.

On the other hand, peas fruits are popular in West Usambara, Udzungwa, and Uluguru mountain blocks. Household survey results in Table 19 shows that the mountain blocks produce about 1,416,406.83; 841,721.28 and 671,608.30 baskets of peas per year with economic values of 739,079.98; 410,054.79 and 334,941.95 USD which are equivalent to 89,428.68; 49,616.63 and 40,527.98 USD net present values respectively. The rest of the mountain blocks produce small quantities of the fruits to account.

Table 8: Economic value of passions, watermelon, guava and peas fruits produced from EAMs

Name of the mountain block	Passions			Watermelon			Guava			Peas		
	Quantity produced (100kg bag)	Unit price (USD/ 100kg bag)	Value (USD)	Quantity produced (piece)	Unit price (USD/ piece)	Value (USD)	Unit price (USD/ 100kg bag)	Quantity produced (100kg bag)	Value (USD)	Quantity produced (20kg tin)	Unit price (USD/ 20kg tin)	Value (USD)
East Usambara	2,779.18	17.88	49,691.73	91,315.90	0.34	30,747.85	-	-	-	-	-	-
West Usambara	-	-	-	-	-	-	-	-	-	1,416,406.83	0.52	739,079.98
South Pare	-	-	-	93,655.38	0.66	61,700.09	-	-	-	-	-	-
North Pare	-	-	-	-	-	-	-	-	-	-	-	-
Nguru	-	-	-	-	-	-	735,570.00	8.78	6,461,238.45	-	-	-
Nguu	-	-	-	-	-	-	-	-	-	-	-	-
Uluguru	536.10	14.64	7,848.49	148,767.41	1.71	254,167.00	-	-	-	671,608.30	0.50	334,941.95
Ukaguru	-	-	-	-	-	-	-	-	-	-	-	-
Rubeho	-	-	-	-	-	-	157,290.00	7.03	1,105,306.85	-	-	-
Mahenge	-	-	-	-	-	-	-	-	-	-	-	-
Udzungwa	5,920.60	20.35	120,484.21	4,860,812.60	1.03	5,016,935.36	-	-	-	841,721.28	0.49	410,054.79
Total value	**9,235.88**		**178,024.43**	**5,194,551.29**		**5,363,550.29**	**892,860.00**		**7,566,545.30**	**2,929,736.41**		**1,484,076.73**
NPV			**22,463.90**			**651,643.34**			**919,295.72**			**461,006.15**

6.2.2.7.Summary of economic value of fruits produced from EAMs

EAM blocks also support production of various fruits. Fruits production is one of the economic activities of the communities living in the mountains. Again their capacity to support production of various fruits gives the mountains a remarkable economic value as indicated in Table 9. The figures from the various sub-values of fruits produced are aggregated in terms of actual and discounted values in USD.

Table 9: Summary of economic value of fruits produced in EAMs

Name of the mountain block	Economic value (USD)	Net present value (USD)	% of the total value
East Usambara	3,393,984.18	412,351.35	0.36
West Usambara	76,333,863.41	9,274,165.59	8.18
South Pare	239,773.39	29,131.21	0.03
North Pare	10,323.50	1,254.25	0.00 1
Nguru	71,842,539.43	8,728,493.19	7.70
Nguu	386,003.95	46,897.46	0.04
Uluguru	751,499,268.76	91,303,234.87	80.52
Ukaguru	-	-	-
Rubeho	1,967,840.94	239,082.39	0.21
Mahenge	178,471.73	21,683.38	0.02
Udzungwa	27,452,557.62	3,335,342.32	2.94
Total economic value	**933,304,626.92**	**113,391,636.03**	**100.00**

Household survey results show that Uluguru mountain block is leading in producing relatively large quantities of fruits accounting for 80.52% of the total economic value of fruits produced in the EAMs followed by far by West Usambara (8.18%) and Nguru (7.7%) mountain blocks (Table 9). Udzungwa mountain block is the fourth accounting for 2.94% of the total value. Ukaguru mountain block do not support production of any fruit. Other mountain blocks account for less than 1% of the total value.

Similarly, the observed variation in the value of fruits produced across the mountain blocks can be attributed to EAMs' variation in microclimate caused by the forest and woodland condition of the block, and water availability which is also dependent of the forest and woodland condition of

the block. It can also be attributed to land and population size of the block. As noted earlier EAMs are characterized by overpopulation but they differ in the size of population. Because of the high population density, land available for agriculture is very limited and it varies across the mountain blocks.

6.2.3. Economic value of vegetables produced in EAMs

EAMs support production of both tropical and temperate vegetables. Vegetable production is also one of the economic activities of the communities living in the mountains blocks. Vegetable production contributes significantly to income of the communities living in the mountain blocks and others outside the mountains. As noted earlier the vegetables produced include tomatoes, cabbage, pumpkin leaves, amaranths, white radish; sweet potato leaves, green pepper, okra, bitter tomato, onions, cauliflower, Chinese cabbage, and eggplant (Table 10 and Table 11).

6.2.3.1.The economic value of tomatoes produced from EAMs

Tomato is one of the vegetable produced in EAMs. Household survey results shows that the EAMs support tomatoes production of about 2,652,728.35 baskets of tomatoes per year (Table 10). Basing on the market price which ranges between 8-32 USD per basket across the mountain blocks, the total undiscounted economic value of tomatoes produced in EAMs is 51,251,262.12 USD which is equivalent to 6,201,402.72 USD discounted value.

Disaggregating this quantity and value to the respective mountain blocks it shows that the quantity of tomato produced per year varies across the mountain blocks. Household survey results in Table 10 shows that Nguru mountain block is leading among the EAM blocks in supporting tomato production. Households in the block produce about 1,502,953.40 baskets of tomatoes per year with economic value 29,704,332.31 USD which is equivalent to 3,594,224.21 USD net present value. Udzungwa and West Usambara mountain blocks follow after Nguru Mountain block in supporting tomato production. Households in the blocks produce about 417,049.75 and 280,504.10 baskets of tomatoes per year with the economic values of

13,737,600.86 and 2,140,552.03 USD which are equivalent to 1,662,249.7 and 259,006.8 USD net present values respectively.

Uluguru and North Pare are the fourth and fifth mountain blocks among the EAM blocks in supporting tomato production. Survey results show that households in the mountain blocks produce about 230,522.47 and 133,509.89 baskets of tomatoes per year with the economic values of 3,040,734.94 and 1,807,988.64USD which are equivalent to 367,928.93 and 218,766.64 USD net present values respectively. East Usambara and Rubeho mountain blocks are the sixth and seventh among the EAM blocks in supporting tomato production. Households in the two blocks produce about 48,635.64 and 21,721 baskets of tomato per year with the economic values of 418,060.31 and 190,797.02 USD which are equivalent to 50,585.3 and 23,086.44 USD net present values respectively.

South Pare and Mahenge mountain blocks are the eighth and ninth among EAM blocks in supporting tomato production. Household survey results indicate that about 10,536.23 and 6,020.10 baskets of tomatoes per year with the economic value of 109,517.65 and 83,286.81 USD which are equivalent to 13,251.64 and 10,077.7 USD net present values respectively. Nguru and Ukaguru mountain blocks produce less than one thousands baskets per year making them less supportive and less potential for tomato production. The blocks produce about 718.29 and 557.48 baskets of tomato per year with economic values of 13,249.87 and 5,141.70 USD which are equivalent to 1,603.23 and 622.15 USD net present values respectively.

6.2.3.2.The economic value of cabbage produced from EAMs

EAMs also support production of cabbage. Household survey results show that the mountains support production of cabbage of about 12,241,476.57 pieces per year (Table 10). Basing on the market price which ranges between 0.2-2 USD per piece across the mountain blocks, the total economic value of cabbage produced in EAMs is 8,358,082.94 USD which is equivalent to 1,011,328.04 USD Net present value.

Disaggregating this quantity and value to the respective mountain blocks it shows that the quantity of tomatoes produced per year varies across the mountain blocks. Household survey results in Table 10 shows that Uluguru mountain block is leading among the EAM blocks in supporting cabbage production followed by West Usambara mountain block. Households in the blocks produce about 4,927,283.75 and 4,128,872.20 pieces of cabbages per year with economic values of 2,765,939.45 and 3,029,441.87 USD which are equivalent to 334,678.67 and 366,562.47USD net present values respectively. Mahenge and Udzungwa are the third and fourth mountain blocks in supporting cabbage production. Households in the blocks produce about 1,806,030.77 and 983,647.03 pieces of cabbage per year with the economic values of 396,603.84 and 2,043,773.73 USD which is equivalent to 47,989.06 and 247,296.62USD net present values respectively.

Ukaguru and South Pare are the fifth and sixth mountain blocks among the EAMs in supporting cabbage production. Survey results show that households in the mountain blocks produce about 222,990 and 117,069.23 pieces of cabbages per year with the economic values of 63,659.1 and 25,708.37 USD which are equivalent to 7,702.75 and 3,110.71 USD net present values respectively. East Usambara mountain block is the seventh among the EAMs in supporting cabbage production. Households in block produce about 55,583.59 pieces of cabbage per year with the economic value of 32,956.58 USD which is equivalent to 3,987.75 USD net present value. The rest of the mountain blocks produce small amounts of the vegetable to account.

6.2.3.3.The economic value of pumpkin leaves produced from EAMs

Pumpkin leaves vegetable is also produced in EAMs. Household survey results shows that the mountains support production of pumpkin leaves of about 1,051,947.94 bundles per year (Table 10). Basing on the market price which ranges between 0.09-0.22 USD per bundle across the mountain blocks, the total economic value of pumpkin leaves produced in EAMs is 98,680.43 USD which is equivalent to 11,940.28 USD net present value.

Disaggregating this quantity and value to the respective mountain blocks it shows that the quantity of pumpkin leaves produced per year varies across the mountain blocks. Household survey result in Table 10 shows that Udzungwa mountain block is leading among the EAM blocks in supporting pumpkin leaves production followed by Mahenge and Nguru mountain blocks. Households in the blocks produce about 537,116.83; 188,128.21 and 166,994.82 bundles of pumpkin leaves per year with economic value of 47,180.28; 16,525.16 and 14,668.81 USD which are equivalent to 5,708.81; 1,999.54 and 1,774.93 USD net present values respectively. Rubeho, East Usamabaa and Ukaguru are the fourth, fifth and sixth mountain blocks in supporting pumpkin leaves production. Households in the blocks produce about 74,900; 47,643.08 and 37,165 bundles of pumpkin leaves per year with the economic values of 6,579.21; 10,462.41 and 3,264.57 USD which are equivalent to 796.08; 1,265.95 and 395USD net present values respectively. The rest of the mountain blocks produce small amounts of the vegetable to account.

6.2.3.4.The economic value of amaranths produced from EAMs

EAMs also support production of amaranths. Household survey results show that the mountains support production of amaranths of about 3,125,356.11 bundles per year (Table 10). Basing on the market price which ranges between 0.1-0.13 USD per bundle across the mountain blocks, the total economic value of amaranths produced in EAMs is 282,352.48 USD which is equivalent to 34,164.65 USD net present value.

Disaggregating this quantity and value to the respective mountain blocks, the survey results show that the quantity of amaranths produced per year varies across the mountain blocks. Household survey results in Table 10 shows that Udzungwa mountain block is leading among the EAM blocks in supporting amaraths production followed by Mahenge, East usambara, Nguru and Uluguru Mountain blocks. Households in the blocks produce about 2,136,785.32; 218,228.72; 201,159.66; 166,994.82 and 143,406.42 bundles of amaranths per year with economic value of 187,694.98; 19,169.19; 20,614.81; 11,001.60 and 17,635.52 USD which are equivalent to 22,711.09; 2,383.98; 2,494.39; 1,331.19 and 2,133.9 USD net present values respectively.

South Pare, Rubeho, Nguu and North Pare are the sixth, seventh, eighth, and ninth Mountain blocks in supporting amaranths production. Households in the blocks produce about 97,557.69; 86,135.00; 44,061.54 and 31,026.95 bundles of amaranths per year with the economic values of 10,711.82; 7,566.09; 3,870.36 and 4,088.11 USD which is equivalent to 1,296.13; 915.5; 468.31 and 494.66 USD net presnt values respectively. West Usambara and Ukaguru mountain blocks produce small amounts of the vegetable to account.

Table 10: Economic value of tomato, cabbage, pumpkin leaves and amaranths produced from the EAMs

Name of the mountain block	Tomato			Cabbage			Pumpkin leaves			Amaranths		
	Quantity produced (100kg bag)	Unit price (USD/ 100kg bag)	Value (USD)	Quantity produced (piece)	Unit price (USD/piece)	Value (USD)	Quantity produced (piece)	Unit price (USD/piece)	Value (USD)	Quantity produced (bundle)	Unit price (USD/bundle)	Value (USD)
East Usambara	48,635.64	8.60	418,060.31	55,583.59	0.59	32,956.58	47,643.08	0.22	10,462.41	201,159.66	0.10	20,614.81
West Usambara	280,504.10	7.63	2,140,552.03	4,128,872.20	0.73	3,029,441.87	-	-	-	-	-	-
South Pare	10,536.23	10.39	109,517.65	117,069.23	0.22	25,708.37	-	-	-	97,557.69	0.11	10,711.82
North Pare	133,509.89	13.54	1,807,988.64	-	-	-	-	-	-	31,026.95	0.13	4,088.11
Nguru	1,502,953.40	19.76	29,704,332.31	-	-	-	166,994.82	0.09	14,668.81	166,994.82	0.07	11,001.60
Nguu	718.29	18.45	13,249.87	-	-	-	-	-	-	44,061.54	0.09	3,870.36
Uluguru	230,522.47	13.19	3,040,734.94	4,927,283.75	0.56	2,765,939.45	-	-	-	143,406.42	0.12	17,635.52
Ukaguru	557.48	9.22	5,141.70	222,990.00	0.29	63,659.10	37,165.00	0.09	3,264.57	-	-	-
Rubeho	21,721.00	8.78	190,797.02	-	-	-	74,900.00	0.09	6,579.21	86,135.00	0.09	7,566.09
Mahenge	6,020.10	13.83	83,286.81	1,806,030.77	0.22	396,603.84	188,128.21	0.09	16,525.16	218,228.72	0.09	19,169.19
Udzungwa	417,049.75	32.94	13,737,600.86	983,647.03	2.08	2,043,773.73	537,116.83	0.09	47,180.28	2,136,785.32	0.09	187,694.98
Total value	**2,652,728.35**		**51,251,262.12**	**12,241,476.57**		**8,358,082.94**	**1,051,947.94**		**98,680.43**	**3,125,356.11**		**282,352.48**
NPV			**6,226,760.58**			**1,015,463.41**			**11,989.16**			**34,304.35**

6.2.3.5.The economic value of white radish and Sweet potato leaves produced from EAMs

EAMs support production of white radish and sweet potato leaves even though the quantities produced of these vegetables are very small and very few mountain blocks support the vegetables especially the sweet potato leaves. Household survey results shows that the EAMs support production of about 955,126.29 and 462,722.76 bundles of the vegetables. Basing on the market price which ranges between 0.09-013 USD per bundle of the vegetables across the mountain blocks, the total economic value of white radish and sweet potato leaves produced in EAMs are 84,930.53 and 51,937.89 USD which are equivalent to 10,276.59 and 6,284.48 USD net present values respectively.

Disaggregating this quantity and value into respective mountain blocks, the survey results show that the quantity of white radish produced per year varies across the mountain blocks. Household survey results in Table 11 shows that Mahenge mountain block produces the highest quantity (338,630.77 bundles/year) followed by Rubeho (329,560 bundles/year) with economic values of 29,745.29 and 28,948.51USD which are equivalent to 3,599.18 and 3,502.77USD net present values respectively.

South Pare and East Usambara follows after the two mountain blocks in supporting the production of white radish; the two blocks produce about 124,873.85 and 109,182.05 bundles with economic values of 10,968.90 and 9,590.54 USD which are equivalent to 1,327.24 and 1,160.46USD net present values respectively. Nguru and North Pare mountain blocks are also supporting the production of white radish. Household survey results show that the blocks produce about 29,374.36 and 23,505.26 bundles of the vegetable with economic value of 2,580.24 and 3,097.05 USD which is equivalent to 312.21 and 374.74 USD net present values respectively. West Usambara, Nguru, Uluguru, Ukaguru and Udzungwa produce small quantities to account.

On the other hand, household survey results in Table 11 shows that sweet potato leaves are produced in a relatively large quantity in Rubeho followed by Uluguru and Udzungwa mountain

blocks. Households in the mountain blocks produce about 149,800; 112,580.74 and 111,011.25 bundles of sweet potato leave per year with the economic value of 17,544.55; 14,833.62 and 9,751.22USD which is equivalent to 2,122.89; 6,935.53 and 1,179.9 USD net present values respectively. East Usambara follows after these mountain blocks, the block produces about 89,330.77 bundles of sweet potato leaves per year with economic value of 9,808.51 which is equivalent to 1,186.83 USD net present value. The rest mountain blocks produce small quantities to account (Table 11).

6.2.3.6.The economic value of green pepper and okra produced in EAMs

EAMs also support production of green pepper and okra even though the quantities produced are very small compared to vegetables produced in the mountains. Household survey results shows that the EAMs support production of about 196,121.36 and 21,338.32 baskets of the vegetables. Basing on the market price which ranges between 4-20 USD and 4-13 USD per basket of the vegetables across the mountain blocks, the total economic value of green pepper and okra produced in EAMs are 1,774,469.31 and 133,096.50 USD which are equivalent to 214,710.79 and 16,104.68 USD net present values respectively.

Disaggregating this quantity and value into respective mountain blocks it shows that the quantity of green pepper produced per year varies across the mountain blocks. Household survey results in Table 11 shows that Nguru mountain block produces the highest quantity of green pepper (166,994.82 baskets/year) followed by Rubeho (24,342.50 baskets per year) with economic values of 1,613,568.67 and 106,912.12 USD which are equivalent to 195,241.81 and 12,936.37 USD net present values respectively.

Uluguru and West Usambara follows after the two mountain blocks in supporting the production of green pepper. The two blocks produce about 1,903.15 and 1,629.33 baskets with economic values of 37,613.82 and 8,229.41 USD which are equivalent to 4,551.27 and 995.71 USD net present values respectively. East Usambara and Nguu mountain blocks also support the production of green pepper. Household survey results show that the blocks produce about 694.79

and 556.76 baskets of green pepper with economic value of 3,417.72 and 4,727.57 USD which is equivalent to 413.54 and 572.04 USD net present values respectively. South Pare, North Pare, Ukaguru, Mahenge and Udzungwa produce small quantities to account.

On the other hand, household survey results in Table 11 shows that okra is produced in a relatively large quantity in East Usambara followed by Uluguru and Mahenge mountain blocks. Households in the mountain blocks produce about 15,136.60; 4,320.43 and 1,881.28 baskets of green pepper/year with the economic value of 71,465.86; 53,368.06 and 8,262.58 USD which is equivalent to 8,647.37; 6,457.54 and 999.77 USD net present values respectively. The rest mountain blocks produce small quantities to account (Table 11).

Table 11: Economic value of white radish, sweet potato leaves, green pepper and okra produced from the EAMs

Name of the mountain block	White radish			Sweet potato leaves			Green pepper			Okra		
	Quantity produced (bundle)	Unit price (USD/ bundle)	Value (USD)	Quantity produced (bundle)	Unit price (USD/ bundle)	Value (USD)	Quantity produced (10kg tin)	Unit price (USD/10kg tin)	Value (USD)	Quantity produced (10kg tin)	Unit price (USD/10kg tin)	Value (USD)
East Usambara	109,182.05	0.09	9,590.54	89,330.77	0.11	9,808.51	694.79	4.92	3,417.72	15,136.60	4.72	71,465.86
West Usambara	-	-	-	-	-	-	1,629.33	5.05	8,229.41	-	-	-
South Pare	124,873.85	0.09	10,968.90	-	-	-	-	-	-	-	-	-
North Pare	23,505.26	0.13	3,097.05	-	-	-	-	-	-	-	-	-
Nguru	-	-	-	-	-	-	166,994.82	9.66	1,613,568.67	-	-	-
Nguu	29,374.36	0.09	2,580.24	-	-	-	556.76	8.49	4,727.57	-	-	-
Uluguru	-	-	-	112,580.74	0.13	14,833.62	1,903.15	19.76	37,613.82	-	-	-
Ukaguru	-	-	-	-	-	-	-	-	-	4,320.43	12.35	53,368.06
Rubeho	329,560.00	0.09	28,948.51	149,800.00	0.12	17,544.55	24,342.50	4.39	106,912.12	-	-	-
Mahenge	338,630.77	0.09	29,745.29	-	-	-	-	-	-	1,881.28	4.39	8,262.58
Udzungwa	-	-	-	111,011.25	0.09	9,751.22	-	-	-	-	-	-
Total value	**955,126.29**		**84,930.53**	**462,722.76**		**51,937.89**	**196,121.36**		**1,774,469.31**	**21,338.32**		**133,096.50**
NPV			**10,318.62**			**6,310.18**			**215,588.75**			**16,170.53**

6.2.3.7.The economic value of bitter tomatoes and onions produced from EAMs

EAMs also support production of bitter tomatoes and onions even though the quantities produced of these vegetables are very small compared to other vegetables produced in the mountains. Household survey results shows that the EAMs support production of about 98,583.92 and 773,104.64 baskets of the vegetables. Basing on the market price which ranges between 2-10 USD and 30-80 UD per basket of the vegetables across the mountain blocks, the total economic value of bitter tomatoes and onions produced in EAMs are 368,471.57 and 43,643,671.66 USD which are equivalent to 44,585.06 and 5,280,884.27 USD net present values respectively.

Disaggregating this quantity and value to the respective mountain blocks it shows that the quantity of bitter tomatoes produced per year varies across the mountain blocks. Household survey results in Table 12 shows that South Pare mountain block produces the highest quantity bitter tomatoes (31,608.69 baskets per year) followed by Mahenge (31,229.28 baskets per year) and East Usambara (29,776.92 baskets per year) with economic values of 156,178.35; 117,956.59 and 65,390.04 USD which are equivalent to 18,897.58; 14,272.75 and 7,912.19 USD net present values respectively.

West Usambara and Uluguru follows after the two mountain blocks in supporting the production of bitter tomatoes. The two blocks produce about 4,628.78 and 1,340.25 baskets with economic values of 14,230.70 and 14,715.89 USD which are equivalent to 1,721.91 and 1,780.62 USD net present values respectively. North Pare, Nguru, Nguu, Ukaguru, Rubeho and Udzungwa produce small quantities to account.

On the other hand, household survey results in Table 12 shows that onions are produced in a relatively large quantity in Nguru followed by far by South Pare, North Pare and West Usambara mountain blocks. Households in the mountain blocks produce about 667,979.29; 72,290.25; 28,206.32 and 4,628.78 bags of onions per year with the economic values of 36,672,015.20; 5,446,318.09; 1,362,701.75 and 162,636.62 USD which are equivalent to 4,437,313.84;

659,004.49; 164,886.91 and 19,679.03 USD net present values respectively. The rest mountain blocks produce small quantities to account (Table 12).

6.2.3.8.The economic value of cauliflower, Chinese cabbage and eggplant produced in EAM

EAMs also support production of Cauliflowers, Chinese cabbages, and eggplants even though are produced in small quantities compared to other vegetables produced in the mountains. Household survey results shows that the mountains support production of about 907,998.78 and 98,236.62 baskets of Cauliflower and eggplant and 670,488.54 bundles of Chinese cabbage. Basing on the market price which ranges between 0.22-0.25 USD for cauliflower per bundle, 0.09-0.13 USD for Chinese Cabbage per bundle and 5.27 USD for eggplant per basket across the mountain blocks, the total economic values of the vegetables produced in the mountains are 222,843.05; 71,854.64 and 517,745.63 USD which are equivalent to 26,964; 8,694.41 and 62,647.22USD net present values respectively.

Disaggregating these quantities and values to the respective mountain blocks it shows that the quantity of Cauliflower produced per year varies across the mountain blocks. Household survey results in Table 12 shows that the vegetable is produced in relatively large quantities in West Usambara and Uluguru, other mountain blocks produce in small quantities to account. The two mountain blocks produce about 800,779.02 and 107,219.75 bundles per year with the economic values of 199,297.62 and 23,545.43 USD which are equivalent to 24,115 and 2,848.9 USD net present value respectively. Chinese Cabbage on the other hand is produced in relatively large quantities in Rubeho, East Usambara and Uluguru mountain blocks. Household survey results in Table 12 shows that the mountain blocks produce about 322,070; 214,393.85 and 134,024.69 bundles per year with economic values of 35,363.24; 18,832.33 and 17,659.07 USD which are equivalent to 4,278.95; 2,278.91 and 2,136.75 USD net present values respectively.

Nonetheless the mountains also support the production of eggplant. The household survey results show that the vegetable is produced in a relatively large quantity in Udzungwa mountain block, other mountain blocks produce small quantities to account. Households in Udzungwa produce

about 98,236.62 baskets of the vegetable with economic values of 517,745.63 USD which is equivalent to 69,181.22 USD net present value.

Table 12: Economic value of Bitter tomatoes, Onions, Cauliflower, Chinese cabbage and Eggplant produced from the EAMs

Name of the mountain block	Biter tomatoes			Onions			Cauliflower			Chinese cabbage			Eggplant		
	Quantity produced (10kg tin)	Unit price (USD/ 10kg tin)	Value (USD)	Quantity produced (100kg bag)	Unit price (USD/ 100kg bag)	Value (USD)	Quantity produced (piece)	Unit price (USD/ piece)	Value (USD)	Quantity produced (bundle)	Unit price (USD/ bundle)	Value (USD)	Quantity produced (10kg tin)	Unit price (USD/ 10kg tin)	Value (USD)
East Usambara	29,776.92	2.20	65,390.04	-	-	-	-	-	-	214,393.85	0.09	18,832.33	-	-	-
West Usambara	4,628.78	3.07	14,230.70	4,628.78	35.14	162,636.62	800,779.02	0.25	199,297.62	-	-	-	-	-	-
South Pare	31,608.69	4.94	156,178.35	72,290.25	75.34	5,446,318.09	-	-	-	-	-	-	-	-	-
North Pare	-	-	-	28,206.32	48.31	1,362,701.75	-	-	-	-	-	-	-	-	-
Nguru	-	-	-	667,979.29	54.90	36,672,015.20	-	-	-	-	-	-	-	-	-
Nguu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uluguru	1,340.25	10.98	14,715.89	-	-	-	107,219.75	0.22	23,545.43	134,024.69	0.13	17,659.07	-	-	-
Ukaguru	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubeho	-	-	-	-	-	-	-	-	-	322,070.00	0.11	35,363.24	-	-	-
Mahenge	31,229.28	3.78	117,956.59	-	-	-	-	-	-	-	-	-	-	-	-
Udzungwa	-	-	-	-	-	-	-	-	-	-	-	-	98,236.62	5.27	517,745.63
Total value	**98,583.92**		**368,471.57**	**773,104.64**		**43,643,671.66**	**907,998.78**		**222,843.05**	**670,488.54**		**71,854.64**	**98,236.62**		**517,745.63**
NPV			**44,767.37**			**5,302,478.09**			**27,074.27**			**8,729.96**			**62,903.39**

6.2.3.9.The total economic value of fruits and vegetable produced in EAMs

As noted in above, EAM blocks support production of various vegetables. Vegetable production is also one of the economic activities of the communities living in the mountains. Vegetable production is possible also because of the mountains capacity to support production and this gives the mountains a remarkable economic value as indicated in Table 29. The figures from the various sub-values of vegetables produced are aggregated in terms of undiscounted and net present values.

Table 13: Summary of economic value of vegetables produced in EAMs

Name of the mountain block	Economic values (USD)	Net present values (USD)	% of the total value
East Usambara	660,599.10	80,259.34	0.62
West Usambara	5,554,388.26	674,829.15	5.20
South Pare	5,759,403.18	699,737.40	5.39
North Pare	3,177,875.54	386,095.28	2.97
Nguru	68,015,586.59	8,263,538.42	63.65
Nguu	24,428.04	2,967.88	0.02
Uluguru	5,932,677.74	720,789.35	5.55
Ukaguru	125,433.43	15,239.51	0.12
Rubeho	393,710.74	47,833.80	0.37
Mahenge	671,549.45	81,589.75	0.63
Udzungwa	16,543,746.69	2,009,978.79	15.48
EAM total economic value	**106,859,398.76**	**12,982,858.65**	**100.00**

Values in Table 29 indicate that Nguru mountain block is leading in producing relatively large quantities of vegetables which account for 63.65% of the total economic value of vegetables produced in the Mountains followed by far by Udzungwa (15.48), Uluguru (5.55%), South Pare (5.39%) and West Usambara (5.2%) mountain blocks. North Pare mountain block is the sixth in the list accounting for 2.97% of the total economic value. The rest of the mountain block account for less than 1% of the total economic value of vegetable produced in the EAM.

The observed variation in the value of vegetables produced across the mountain blocks is due to the fact that EAMs' vary in microclimate caused by the forest and woodland condition of the blocks, and water availability which is also dependent of the forest and woodland condition of

the block. The variation is also due to land and population size of the blocks; EAMs are characterized by overpopulation but they differ in the size of population. Because of the high population density, land available for agriculture is very small and it varies across the mountain blocks.

6.2.4. Value of Livestock kept in EAMs

EAMs also support production of livestock and this is also one of the economic activities of the communities living in the mountains blocks. Livestock production contributes significantly to income and protein supply to communities living in the mountain blocks and others outside the mountains. The type of animals kept include Local chicken, Ducks, Goats, Sheep, Cows (African breeds), Cattle and Pigs (Table 14 and Table 15).

6.2.4.1.The economic value of local chicken and ducks kept in EAMs

EAMs support production of local chicken and ducks even though the production is not commercial. Household survey results shows that the EAMs support production of about 1,491,397.43 and 76,508.33 local chickens and ducks respectively. Basing on the market price which ranges between 3-5 USD and 5-9 USD per local chicken and ducks respectively across the mountain blocks, the total economic values of these birds produced in EAMs are 6,531,046.56 and 473,127.63SD which are equivalent to 790,256.63 and 57,248.44 USD net present values respectively.

Disaggregating the number of these domestic birds and their values to the respective mountain blocks, the survey results show that the quantity of local chickens produced per year varies across the mountain blocks. Household survey results in Table 14 shows that Udzungwa mountain block produces the highest number of local chicken per year followed by Mahenge, Rubeho, Uluguru, South Pare, West Usambara, East Usambara and North Pare mountain blocks. Household in these blocks produce about 388,539.38; 166,305.33; 144,557; 143,942.52; 132,678.46; 122,662.68; 117,916.62 and 109,064.42 local chickens per year with economic values of 1,778,659.21; 757,193.85; 631,870.21; 654,672.75; 571,068.58; 504,770.15;

442,374.40 and 497,258.32 USD which are equivalent to 215,217.76; 91,620.46; 76,456.3; 69,099.29; 61,077.19; 53,527.3 and 60,168.26U SD net present values respectively.
Nguu, Nguru and Ukaguru follows after the above eight mountain blocks in supporting the production of local chicken; the blocks produce about 70,204.72; 61,706.15 and 33,820.15 local chickens per year with economic values of 312,993.17; 262,543.90 and 117,642.02 USD which are equivalent to 37,872.17; 32,130.81 and 14,234.68 USD net present values respectively.

On the other hand, household survey results in Table 14 shows that ducks are produced in a relatively large quantity in Udzungwa followed by far by Uluguru, Rubeho, Mahenge and West Usambara mountain blocks. Households in the mountain blocks produce about 33,303.38; 17,423.21; 8,988; 6,772.62 and 4,628.78 ducks per year with the economic values of 190,148.70; 119,035.21; 55,265.34; 36,437.98 and 36,593.24 USD which are equivalent to 23,007.99; 14,403.26; 6,687.11; 4,408.9 and 4,427.78USD net present values respectively. Ukaguru, Easte Usambara and Nguru produce about 2,601.55; 2,382.15 and 408.65 ducks per year with economic values of 12,568.59; 20,924.81 and 2,153.75 USD which are equivalent to 1,520.8; 2,531.9 and 260.6 USD net present values respectively. North Pare, South Pare and Nguu mountain blocks produces small quantities of ducks to account (Table 14).

6.2.4.2.The economic value of local Goats and Sheep kept in EAMs

EAMs also support the production of goats and sheep. The production is largely carried out in the lowlands of the mountains which are flood plains. In upstream the animals are also kept but in small numbers and grazing is zero grazing because of limited land for grazing. Household survey results shows that the mountains support production of about 429,145.14 and 108,387.11 goats and sheep respectively. Basing on the market prices which ranges between 17-27 USD and 17-25 UD per local goat and sheep respectively across the mountain blocks, the total economic values of these animals kept in EAMs are 8,808,447.10 and 2,277,146.55 USD which are equivalent to 1,065,822.1 and 275,534.73 USD net present values respectively.

Disaggregating the number of animals and their economic values to the respective mountain blocks, the survey results show that the number of goats kept per year varies across the mountain blocks. Household survey result in Table 14 shows that North Pare produces the highest number of goats per year followed by Nguu, Nguru, East Usambara and West Usambara Mountain blocks. Household in these blocks keep about 172,528.63; 89,885.54; 51,081.25; 32,357.59 and 30,164.22 goats per year with economic values of 3,343,960.58; 1,936,873.53; 1,121,742.79; 699,202.6 and 563,044.59 USD which are equivalent to 404,619.23; 234,361.7; 135,730.87; 84,603.44 and 68,128.39 USD net present values respectively.

Ukaguru, Udzungwa, Uluguru, South Pare and Rubeho follows after the above mountain blocks in supporting the production of goats; the blocks keep about 18,582.5; 8,880.9; 8,845.63; 8,194.85 and 6,366.5 goats per year with economic values of 359,612.72; 205,945.67; 233,099.73; 174,816.91 and 130,487.61 USD which are equivalent to 43,513.14; 24,919.43; 28,205.07; 21,152.85 and 15,789 USD net present values respectively. Mahenge mountain block keep a relatively lower number of goats compared to other mountain blocks; households in the block keep about 2,257.54 goats per year with the economic value of 39,660.38 USD which is equivalent to 4,798.91 USD net present value.

On the other hand, household survey results in Table 14 shows that sheep are kept in a relatively large number in Nguu followed by far by North Pare, South Pare and East Usambara mountain blocks. Households in the mountain blocks keep about 54,048.82; 17,393.89; 15,219 and 8,105.94 sheep per year with the economic values of 1,246,256.08; 299,209.39; 271,544.65 and 167,622.52 USD which are equivalent to 150,796.99; 36,204.34; 32,856.9 and 20,282.32 USD net present values respectively. Nguru, Rubeho, Uluguru and West Usambara keep about 4,495.15; 3,282.38; 3,048.36 and 2,793.56 sheep per year with economic values of 85,551.58; 83,274.78; 66,942 and 56,745.54 USD which are equivalent to 10,351.74; 10,076.25; 8,099.98 and 6,866.21 USD net present values respectively. Ukaguru, Mahenge and Udzungwa mountain blocks keep small number of sheep to account (Table 14).

Table 14: Economic value of Local chickens, Ducks, Goats and Sheep kept in EAMs

Name of the mountain block	Local chicken			Ducks			Goats			Sheep		
	Quantity owned (piece)	Unit price (USD/ piece)	Value (USD)	Quantity owned (piece)	Unit price (USD/ piece)	Value (USD)	Quantity owned (piece)	Unit price (USD/piece)	Value (USD)	Quantity owned (piece)	Unit price (USD/piece)	Value (USD)
East Usambara	117,916.62	3.75	442,374.40	2,382.15	8.78	20,924.81	32,357.59	21.61	699,202.60	8,105.94	20.68	167,622.52
West Usambara	122,662.68	4.12	504,770.15	4,628.78	7.91	36,593.24	30,164.22	18.67	563,044.59	2,793.56	20.31	56,745.54
South Pare	132,678.46	4.30	571,068.58	-	-	-	8,194.85	21.33	174,816.91	15,219.00	17.84	271,544.65
North Pare	109,064.42	4.56	497,258.32	-	-	-	172,528.63	19.38	3,343,960.58	17,393.89	17.20	299,209.39
Nguru	61,706.15	4.25	262,543.90	408.65	5.27	2,153.75	51,081.25	21.96	1,121,742.79	4,495.15	19.03	85,551.58
Nguu	70,204.72	4.46	312,993.17	-	-	-	89,885.54	21.55	1,936,873.53	54,048.82	23.06	1,246,256.08
Uluguru	143,942.52	4.55	654,672.75	17,423.21	6.83	119,035.21	8,845.63	26.35	233,099.73	3,048.36	21.96	66,942.00
Ukaguru	33,820.15	3.48	117,642.02	2,601.55	4.83	12,568.59	18,582.50	19.35	359,612.72	-	-	-
Rubeho	144,557.00	4.37	631,870.21	8,988.00	6.15	55,265.34	6,366.50	20.50	130,487.61	3,282.38	25.37	83,274.78
Mahenge	166,305.33	4.55	757,193.85	6,772.62	5.38	36,437.98	2,257.54	17.57	39,660.38	-	-	-
Udzungwa	388,539.38	4.58	1,778,659.21	33,303.38	5.71	190,148.70	8,880.90	23.19	205,945.67	-	-	-
Total value	**1,491,397.43**		**6,531,046.56**	**76,508.33**		**473,127.63**	**429,145.14**		**8,808,447.10**	**108,387.11**		**2,277,146.55**
NPV			**793,488.03**			**57,482.53**			**1,070,180.30**			**276,661.41**

6.2.4.3.The economic value of local Cows and Cattle kept in EAMs

EAMs also support the production of cows and cattle. Like goats and sheep, the production of cows and cattle is largely carried out in the lowlands of the mountains (the flood plains). In Upstream the animals are also kept but in small numbers and grazing is zero grazing because of limited land for grazing. Household survey results in Table 15 shows that the mountains support production of about 404,554.46 and 109,717.42 cows and cattle respectively. Basing on the market prices which ranges between 240-700 USD and 110-800D per cow and cattle respectively across the mountain blocks, the total economic values of these animals kept in EAMs are 126,711,970.08 and 16,871,716.26 USD which are equivalent to 15,332,148.38 and 2,041,477.67 USD net present values respectively.

Disaggregating the number of animals and their economic values to the respective mountain blocks, the survey results show that the number of cows kept per year varies across the mountain blocks. Household survey result in Table 15 shows that North Pare keep the highest number of cows per year followed by Udzungwa, Nguu, West Usambara, Mahenge and Nguru Mountain blocks. Household in these blocks keep about 217,405.60; 65,126.60; 50,230.15; 23,761.07; 16,837.47 and 12,940.58 cows per year with economic values of 64,855,953.62; 21,538,484.76; 15,757,896.29; 6,493,417.61; 5,546,256.82 and 3,883,722.81 USD which are equivalent to 7,847,570.39; 2,606,156.66; 1,906,705.45; 785,703.53; 671,097.08 and 469,930.46 USD net present values respectively (Table 15).

South Pare, East Usambara and Uluguru follows after the above mountain blocks in supporting the production of cows. The blocks keep about 9,755.77; 7,827.08 and 670.12 cows per year with economic values of 6,569,916.66; 1,895,617.16 and 170,704.35 USD which are equivalent to 794,959.92; 299,369.68 and 20,655.23 USD net present values respectively. Ukaguru and Rubeho mountain blocks keep a smaller number of cows to account.

On the other hand, household survey results in Table 15 shows that Cattle are kept in a relatively large number in North Pare followed by far by Udzungwa, East Usambara, West Usambara,

South Pare, Nguu and Rubeho mountain blocks. Households in the mountain blocks keep about 92,619.06; 4,440.45; 3,392.76; 2,430.11; 2,199.48; 2,048.25 and 1,498 cattle per year with the economic values of 10,887,410.84; 1,560,194.48; 613,699.12; 1,726,701.77; 683,687.64 and 461,641.05 USD which are equivalent to 1,317,376.71; 188,783.53; 74,257.59; 208,930.91; 82,726.2 and 55,858.57 USD net present values respectively. Mahenge and Ukaguru keep about 940.64 and 148.66 cattle per year with economic values of 330,503.2 and 45,703.97 USD which are equivalent to 39,990.89 and 5,530.17 USD net present values respectively. Nguu and Uluguru mountain blocks keep small number of cattle to account (Table 15).

6.2.4.4.The economic value of pigs kept in EAMs

EAMs also support the production of pigs; pigs are produced in a relatively smaller number mainly in the upstream of the mountains and grazing is zero grazing because of limited land for grazing. Household survey results in Table 15 shows that the mountains support production of about 47,178.02 pigs. Basing on the market prices which ranges between 29-103 USD per pig across the mountain blocks, the total economic value of these animals kept in EAMs is 2,141,826.92 USD which is equivalent to 259,161.06 USD net present value.

Disaggregating the number of pigs and their economic values to the respective mountain blocks, the survey results show that the number of pigs kept per year varies across the mountain blocks. Household survey result in Table 15 shows that Udzungwa keep the highest number of pigs per year followed by Uluguru, Mahenge and South Pare Mountain blocks. Households in these blocks keep about 25,902.63; 9,917.83; 9,406.41 and 1,951.15 pigs per year with economic values of 780,097.24; 1,016,377.60; 276,796.43 and 68,555.65 USD which are equivalent to 94,391.77; 122,981.69; 33,492.37 and 8,295.23 USD net present values respectively (Table 15). East Usambara, West Usambara, North Pare, Nguru, Nguu, Ukaguru and Rubeho mountain blocks keep a smaller number of pigs to account.

Table 15: Economic value of Cows, Cattle and Pigs kept in EAMs

Name of the mountain block	Cows			Cattle			Pigs		
	Quantity owned (piece)	Unit price (USD/piece)	Value (USD)	Quantity owned (piece)	Unit price (USD/piece)	Value (USD)	Quantity owned (piece)	Unit price (USD/piece)	Value (USD)
East Usambara	7,827.08	242.19	1,895,617.16	3,392.76	165.70	562,174.19	-	-	-
West Usambara	23,761.07	273.28	6,493,417.61	2,430.11	252.54	613,699.12	-	-	-
South Pare	9,755.77	673.44	6,569,916.66	2,199.48	785.05	1,726,701.77	1,951.15	35.14	68,555.65
North Pare	217,405.60	298.32	64,855,953.62	92,619.06	117.55	10,887,410.84	-	-	-
Nguru	12,940.58	300.12	3,883,722.81	2,048.25	333.79	683,687.64	-	-	-
Nguu	50,230.15	313.71	15,757,896.29	-	-	-	-	-	-
Uluguru	670.12	254.74	170,704.35	-	-	-	9,917.83	102.48	1,016,377.60
Ukaguru	-	-	-	148.66	307.44	45,703.97	-	-	-
Rubeho	-	-	-	1,498.00	308.17	461,641.05	-	-	-
Mahenge	16,837.47	329.40	5,546,256.82	940.64	351.36	330,503.20	9,406.41	29.43	276,796.43
Udzungwa	65,126.60	330.72	21,538,484.76	4,440.45	351.36	1,560,194.48	25,902.63	30.12	780,097.24
Total value	**404,554.46**		**126,711,970.08**	**109,717.42**		**16,871,716.26**	**47,178.02**		**2,141,826.92**
NPV			**15,394,842.35**			**2,208,558.23**			**260,220.78**

6.2.4.5.Summary of the total economic value of livestock kept in EAMs

As noted in above, EAM blocks support production of various livestock. Livestock production is also one of the economic activities of the communities living in the mountains. Livestock production is also possible because of the mountains capacity to support production by providing water and pasture, and this gives the mountains a remarkable economic value as indicated in Table 16. The figures from the various sub-values of livestock kept in the mountain blocks are aggregated in terms of undiscounted and net present values and presented in the Table 16.

Table 16: Summary of economic values of livestock produced in EAMs

Name of the mountain block	Economic value (USD)	Net present value (USD)	% of the total value
East Usambara	3,787,915.67	460,211.96	2.29
West Usambara	8,268,270.24	1,004,551.64	5.01
South Pare	10,689,103.66	1,298,670.25	6.47
North Pare	79,883,792.76	9,705,463.46	48.38
Nguru	6,039,402.46	733,755.85	3.66
Nguu	19,254,019.06	2,339,262.72	11.66
Uluguru	2,260,831.65	274,679.23	1.37
Ukaguru	535,527.30	65,063.77	0.32
Rubeho	1,362,539.01	165,541.37	0.83
Mahenge	6,986,848.66	848,865.61	4.23
Udzungwa	26,053,530.06	3,165,367.78	15.78
Total economic value	**165,121,780.53**	**20,061,433.64**	**100.00**

Values in Table 16 indicate that North Pare mountain block is leading in the number of livestock kept accounting for about 48.38% of the total economic value of livestock kept in the Mountains followed by Udzungwa (15.78%), Nguu (11.66%), South Pare (6.47%) and West Usambara (5.01%) mountain blocks. The rest of the mountain blocks produce smaller number of animals, hence accounting for less than 5% of the total economic value of livestock produced in the EAM.

The observed variation in the value of livestock kept across the mountain blocks is due to the fact that EAMs' vary in the capacity to provide supporting ecosystem services, hence their

capacity to support animal production. This is due to the fact that the mountains vary in microclimate caused by the forest and woodland condition of the blocks, and water availability which is also dependent on the forest and woodland condition of the block. Much of the mountains flood plains are dry which is good for animal production but lack of water limit the utilization of this land for animal production. The variation is also due to land and population size of the blocks; EAMs are characterized by overpopulation but they differ in the size of population. Because of the high population density, land available for animal production is very small and it varies across the mountain blocks.

6.3. Economic value of EAMs forests

As noted in Chapter four (4) and five (5), EAM blocks are covered by both natural and planted forests. EAM forests are clearly demarcated into forests and woodland both of which are comprised of various tree species. The trees are either hardwood or softwood. EAMs forests stock have been documented in terms of tree species, area coverage, biodiversity inhabited, volume of standing timber, and carbon storage capacity but not their economic values. Standing timber in its natural condition has remarkable economic value which adds to other values of the mountain blocks. In this section the values of standing timber, extracted products and other non-timber forest products are presented.

6.3.1. Economic value of standing timber

Standing timber is either in natural forests, woodland or planted forests; in either source, they do have the economic value as they stand. Following are the economic values of standing timber in their respective source and mountain block.

6.3.1.1. The economic value of standing timber in natural forests lands

EAMs are a home of valuable natural forests comprised of different standing timber stocks. Currently the mountains natural forests inhabit a stock about 320,355,443.20 m^3 of natural standing timber. Basing on the market prices which ranges between 130-200 USD per m^3 volume of natural forests standing timber, the total economic value of natural forests standing

timber in EAM is 58,557,534,608.03 USD which is equivalent to 7,085,461,687.57 USD net present value.

Disaggregating the volume of standing timber and its economic value to the respective mountain blocks, Udzungwa mountain block lead by far in the volume of natural forests' standing timber followed by Rubeho; West Usambara, Nguru, Uluguru, East Usambara, Nguu, Ukaguru and South Pare Mountain blocks. Result in Table 17 shows that these blocks inhabit about 132,916,035.2; 40,034,550.4; 28,121,641.6; 25,620,025.6; 24,385,420.8; 19,314,214.4; 18,359,411.2; 14,301,497.6 and 13,425,734.4m^3 of natural forests' standing timber respectively with economic values of 25,014,393,040.97; 7,305,799,492.81; 4,955,876,899.17; 4,796,855,733.21; 4,115,724,152.14; 3,779,791,758.08; 3,435,026,668.72; 2,754,060,107.92 and 1,829,903,731.35 USD which are equivalent to 3,026,741,557.96; 884,001,738.63; 599,661,104.8; 580,419,543.72; 497,639,622.41; 457,354,802.73; 415,638,226.92; 333,241,273.06 and 221,418,351.49 USD net present values respectively (Table 17).

South Pare and Mahenge follows after the above mountain blocks; the blocks inhabit about 2,277,932.8 and 1,598,979.2m^3 of natural forests' standing timber respectively with economic values of 327,819,615.29 and 242,283,408.36 which are equivalent to 39,666,173.45 and 29,316,292.41 USD net present values respectively (Table 17).

6.3.1.2.The economic value of standing timber in woodlands

As noted in above, EAMs also are a home of valuable woodlands comprised of different natural standing timber stocks. Currently the mountains woodlands inhabit natural standing timber stocks of about 226,270,432.50m^3. Basing on the market prices which ranges between 130-240 USD per m^3 of natural standing timber in woodlands, the total economic value of natural woodlands standing timber in EAM is 40,943,209,857.09 USD which is equivalent to 4,954,128,392.7 USD net present value.

Disaggregating the volume of standing timber and its economic value to the respective mountain blocks, Uluguru Mountain block lead by far in the volume of natural woodlands' standing timber followed by Rubeho; Ukaguru; West Usambara, Nguru, Nguu and South Pare Mountain blocks. Result in Table 17 shows that these blocks inhabit about 77,788,004.7; 47,827,403.4; 26,671,008; 20,279,240.1; 20,150,119.5; and 10,601,010m^3 of natural woodlands' standing timber respectively with economic values of 13,128,908,962.3; 8,727,896,679.52; 5,136,074,642.34; 4,466,097,047.22; 3,772,721,298.47; 2,808,057,094.17 and 1,444,898,817.24 USD which are equivalent to1, 588,597,984.44; 1,056;075,498.22; 621,465,031.72; 540,397,742.71; 456,499,277.12; 339,774,908.39 and 174,832,756.89 USD net present values respectively (Table 17).

North Pare and Udzungwa follows after the above mountain blocks; the blocks inhabit about 3,553,947.6 and 1,850,927.4m^3 of natural woodlands standing timber respectively with economic values of 511,452,196.92 and 348,338,899.85 USD which are equivalent to 61,885,715.83 and 42,149,006.88 USD net present values respectively.

6.3.1.3.The economic value of standing timber in planted forests (plantations and privately owned woodlots)

Planted forests are also found in EAMs even though are not in all mountain blocks. In the mountains the common timber planted are Teak and Pines; Teak are found in East Usambara and Nguru while Pines are found in West Usambara, Ukaguru and Udzungwa Mountain blocks. Currently the mountains planted forests inhabit stocks of timber of about 22,550,128.02m^3. Basing on the market prices which ranges between 192-195 USD per m^3 for teak and 32-36 USD per m^3 for Pines, the total economic value of planted forests standing timber in the EAM is 3,884,768,183.01 USD which is equivalent to 470,056,950.14 USD net present value (Table 17).

Disaggregating the volume and its economic value of planted forests standing timber to the respective mountain blocks, Udzungwa mountain block lead by far in the volume of planted forests' standing timber. The mountain block has pines plantations and household woodlots, the

block plantations have a stock of planted forest standing timber of about 18,961,327.1m^3 and household woodlots has a stock of about 51,161,108.04m^3 which is equivalent to 70,122,435.04m^3 in total. The economic values of these stocks of standing timber in Udzungwa mountain block are 3,428,838,712.23 and 9,251,630,270.8 USD which are equivalent to 414,889,484.18 and 1,119,447,262.77 USD net present values respectively (Table 17).

West Usambara, Nguru and East Usambara follows after Udzungwa mountain block. Result in Table 17 shows that these blocks inhabit about 1,504,839.87; 1,318,346.6 and 765,614.45m^3 of planted forests' standing timber respectively with economic values of 53,512,105.75; 253,122,547.74 and 149,294,817.29 USD which are equivalent to 6,474,964.8; 30,627,828.28 and 18,064,672.89 USD net present values respectively (Table 17). The rest of the mountains inhabit small planted forests to account, many of the planted trees in mountain blocks are home gardens trees.

Table 17: Economic value of standing timber in natural, woodlands and planted forests found in Easter Arc Mountains

Name of the mountain block	Natural forest						Planted forest		
	Forest			Woodland			Forest Plantations		
	Quantity (m^3)	Price (USD/m^3)	Value (USD)	Quantity (m^3)	Price (USD/m^3)	Value (USD)	Quantity (m^3)	Price (USD/m^3)	Value (USD)
East Usambara	19,314,214.40	195.70	3,779,791,758.08	2,540,365.80	235.70	598,764,219.06	765,614.45	195.00	149,294,817.29
West Usambara	28,121,641.60	176.23	4,955,876,899.17	20,279,240.10	220.23	4,466,097,047.22	1,504,839.87	35.56	53,512,105.75
South Pare	13,425,734.40	136.30	1,829,903,731.35	10,601,010.00	136.30	1,444,898,817.24	-	-	-
North Pare	2,277,932.80	143.91	327,819,615.29	3,553,947.60	143.91	511,452,196.92	-	-	-
Nguru	25,620,025.60	187.23	4,796,855,733.21	20,150,119.50	187.23	3,772,721,298.47	1,318,346.60	192.00	253,122,547.74
Nguu	18,359,411.20	187.10	3,435,026,668.72	15,008,406.00	187.10	2,808,057,094.17	-	-	-
Uluguru	24,385,420.80	168.78	4,115,724,152.14	77,788,004.70	168.78	13,128,908,962.30	-	-	-
Ukaguru	14,301,497.60	192.57	2,754,060,107.92	26,671,008.00	192.57	5,136,074,642.34	-	-	-
Rubeho	40,034,550.40	182.49	7,305,799,492.81	47,827,403.40	182.49	8,727,896,679.52	-	-	-
Mahenge	1,598,979.20	151.52	242,283,408.36	-	-	-	-	-	-
Udzungwa	132,916,035.20	188.20	25,014,393,040.97	1,850,927.40	188.20	348,338,899.85	18,961,327.10	32.46	3,428,838,712.23
Udzungwa (Hh farms)	-	-	-	-	-	-	51,161,108.04	32.46	9,251,630,270.80
Total	**320,355,443.20**		**58,557,534,608.03**	**226,270,432.50**		**40,943,209,857.09**	**22,550,128.02**		**3,884,768,183.01**
NPV			**7,114,434,515.18**			**4,974,386,085.74**			**471,979,037.88**

6.3.1.4.Summary of the total economic value of standing timber in EAMs

As noted in above, EAM blocks inhabit valuable natural and planted standing timber in natural forests, woodlands and planted forests which give the mountains a remarkable economic value. The figures from the various sub-values of standing timber found in the mountain blocks are aggregated and presented in the Table 18.

Table 18: Summary of economic value of standing timber in EAMs

Name of the mountain block	Standing timber					
	Natural forests		Woodland		Planted forests	
	Total value (USD)	% of the total value	Total value (USD)	% of the total value	Total value (USD)	% of the total value
East Usambara	5,803,812,950.45	6.54	763,365,655.14	1.30	228,500,778.03	1.69
West Usambara	8,450,395,357.84	9.52	6,093,797,753.31	10.35	351,868,610.00	2.61
South Pare	4,034,357,782.63	4.54	3,185,543,965.27	5.41	-	-
North Pare	684,506,012.57	0.77	1,067,941,293.34	1.81	-	-
Nguru	6,167,805,794.21	6.95	4,850,971,882.17	8.24	225,488,741.82	1.67
Nguu	5,516,899,951.43	6.21	4,509,941,709.48	7.66	-	-
Uluguru	5,870,585,067.03	6.61	18,726,808,224.12	31.81	-	-
Ukaguru	4,094,238,500.76	4.61	7,635,386,926.73	12.97	-	-
Rubeho	9,637,981,467.34	10.86	11,514,045,318.22	19.56	-	-
Mahenge	457,756,410.25	0.52	-	-	-	-
Udzungwa	38,051,256,162.44	42.87	529,884,242.56	0.90	12,680,468,983.03	94.02
EAM total economic value	**88,769,595,456.95**	**100.00**	**58,877,686,970.33**	**100.00**	**13,486,327,112.89**	**100.00**

The values in Table 18 indicate that Udzungwa mountain block is leading in the value standing timber stock accounting for about 42.87% of the total economic value of standing timber found in natural forests followed by Rubeho (10.86%), West Usambara (9.52%), Nguru (6.95%), Uluguru (6.61%), East Usambara (6.54%), Nguu (6.12%), Ukaguru (4.61%) and South Pare (4.54%) mountain blocks. The rest of the mountain blocks inhabit smaller of standing timber in natural forests accounting for less than 1% of the total economic value of standing timber found in EAM.

For the case of standing timber in woodlands Uluguru mountains block is leading by accounting for 31.81% of the total value, followed by Rubeho (19.56%), Ukaguru (12.97%), West

Usambara (110.35%), Nguru (8.24%), Nguu (7.66%), South Pare (5.41%), North Pare (1.81%) and East Usambara (1.30%) of the total economic value. Other mountain blocks account for less than 1% of the total value. Planted forests are found in few mountain blocks, among the blocks with planted forests Udzungwa is leading accounting for 94.02% followed by West Usambara (2.62%), East Usambara (1.69%) and Nguru (1.67%).

The observed variation in the value of standing timber inhabited across the mountain blocks is due to the fact that EAMs' vary in the land use status, the size of reserved or protected area and population size. The mountains are highly populated and the communities living in the mountains depend on the mountains supply of ecosystem services for their livelihood. This implies that the mountains are under pressure from high demand of ecosystem services to produce consumable goods to support their livelihood. Following high demand of ES, conversion of forest into agricultural land and other uses is high in EAM which in turn degrade forests and woodlands, hence the value of standing timber. Equally important, forests are one of the major providers of timber, water, non-timber products and regulation services (i.e. regulate the climatic condition and run-off). Increased demand of ES for production of consumable goods increases demand for timber and non-timber forest products. This also increases pressure on forests which affect the density of standing timber, hence the value.

6.3.2. Economic value of extracted timber

Apart from supporting ES, EAM blocks also provide direct benefits to the communities living in the mountains; the mountain forests standing timber stocks are extracted to produce timber for various uses. Although it is not allowed in natural forests but harvesting timber from EAM forests is one of the economic activities of the communities living in the mountains. The activity contributes significantly to income and food to both communities living in the catchment and others outside the mountain blocks. The following sub sections present the economic values of timber extracted from EAM standing timber.

6.3.2.1.The economic value of extracted timber from EAM natural forests

As noted in section 6.3.1.1, EAMs are a home of valuable natural forests comprised of different standing timber stocks. Household survey results in Table 18 shows that households in the mountains harvest about 56,519.93m^3 of natural forest standing timber per year. Basing on the market prices of extracted natural forest timber which ranges between 150-240 USD per m^3, the total economic value of natural forests extracted timber from EAM is 10,108,508.94 USD which is equivalent to 1,223,129.58 USD net present value.

Disaggregating the volume and its economic value of natural forest extracted timber to the respective mountain blocks, Udzungwa mountain block lead by far in the volume of natural forests' extracted timber followed by North Pare, Nguru, South Pare, Nguu and Mahenge mountain blocks. Household survey result in Table 18 shows that households harvest about 18,947.4; 5,171.16; 5,148.99; 5,073; 4,699.9 and 4,210.31m^3 of natural forests' timber with economic values of 3,565,843.01; 744,186.57; 964,049.08; 691,440.88; 879,345.9 and 637,962.06 USD which are equivalent to 431,467; 90,046.57; 116,649.94; 83,664.35; 10,568.85 and 77,193.41 USD net present values respectively (Table 18).

East Usambara, Ukaguru, Rubeho and Uluguru follows after the above mountain blocks; households in the blocks harvest about 3,970.26; 3,287.7; 3,084.12 and 2,927.1m^3 of natural forests' timber with economic values of 935,793.63; 633, 117.15; 562,812.49 and 494,030.15 USD which are equivalent to 113,231.03; 76,607.18; 68,100.31 and 59,778.13 USD net present values respectively (Table 18). Nonetheless, household survey results show that in West Usambara households are not harvesting timber from natural forests.

6.3.2.2.The economic value of extracted timber from EAM woodlands

As noted in above, EAMs also inhabit valuable woodlands comprised of different natural standing timber stocks. Household survey results show that households harvest timber from natural trees found in woodlands of about 43,059.44m^3 per year. Basing on the market prices which ranges between 109-170 USD per m^3 of natural timber from woodlands, the total

economic value of natural timber from woodlands in EAM is 6,090,537.44 USD which is equivalent to 736,955.03 USD net present value.

Disaggregating the volume and its economic value of natural trees extracted timber from woodlands to the respective mountain blocks, West Usambara mountain block lead in the volume of natural trees extracted timber followed by Uluguru, Udzungwa, Nguu and East Usambara mountain blocks. Household survey result in Table 18 shows that households harvest about 8,331.80; 8,041.48; 7,418.75; 5,385.30 and 3,970.26m^3 of natural tree timber from woodlands with economic values of 1,178,643.84; 1,102,935.08; 1,037,160.85; 766,331.38 and 562,572.29 USD which are equivalent to 142,615.9; 133,455.14; 125,496.46; 92,726.09 and 68,071.25 USD net present values respectively (Table 18).

Ukaguru, Mahenge, Rubeho, South Pare and Nguru follows after the above mountain blocks; households in the blocks harvest about 2,787.38; 2,633.79; 2,007.32; 1,257.41 and 1,225.95m^3 of natural tree timber from woodlands with economic values of 423,373.84; 386,936.62; 287,406.10; 137,879.38 and 207,298.07 USD which are equivalent to 51,228.23; 46,819.33; 34,776.14; 16,683.40 and 25,083.07 USD net present values respectively (Table 18). Nonetheless, household survey results show that in North Pare households are not harvesting natural tree timbers from woodlands.

6.3.2.3.The economic value of extracted timber from natural forests, plantations and woodlot

Planted forests are also found in EAMs even though not in all mountain blocks. The forests are either plantations or owned by individual households. The common tree species planted are teak and pines. Household survey results show that households harvest timber from planted forests of about 1,553,730m^3 per year. Basing on the market prices which ranges between 32-36 USD per m^3 for pines and 192-195 USD per m^3 for teak, the total economic value of timber from planted forests in EAM is 54,174,703 USD which is equivalent to 6,555,139.06 USD net present value.

Disaggregating the volume and its economic value of extracted timber from planted forests to the respective mountain blocks, Udzungwa mountain block lead by far in the quantity of natural timber extracted from planted forests followed by West Usambara, East Usambara and Nguru mountain blocks. Household survey result in Table 19 shows that households harvest about 650,000 and 856,000m^3 of timber per year from plantations and woodlots owned by households with economic values of 21,099,000 and 27,785,760 USD which are equivalent to 2,552,979 and 3,362,076.96 USD net present values respectively (Table 19).

West Usambara, East Usambara and Nguru follows after Udzungwa mountain block; households in the blocks harvest about 25,000; 12,261 and 10,469m^3 of timber from planted forests with economic values of 889,000; 2,390,895 and 2,010,048 USD which are equivalent to 107,569; 289,298.3 and 243,215.81 USD net present values respectively (Table 19). In other mountain blocks households harvest timber from planted forests in small quantities to account.

Table 19: Economic value of extracted timber from natural forests, plantations and woodlot

Name of the mountain block	Extracted timber (household extraction from natural and woodlots)						Extracted timber (from forest plantation)		
	Natural			woodland			Plantations and woodlots		
	Quantity (m^3)	Price (USD/m^3)	Value (USD)	Quantity (m^3)	Price (USD/m^3)	Value (USD)	Quantity (m^3)	Price (USD/m^3)	Value (USD)
East Usambara	3,970.26	235.70	935,793.63	3,970.26	141.70	562,572.29	12,261.00	195.00	2,390,895.00
West Usambara	-	-	-	8,331.80	141.46	1,178,643.84	25,000.00	35.56	889,000.00
South Pare	5,073.00	136.30	691,440.88	1,257.41	109.65	137,879.38	-	-	-
North Pare	5,171.16	143.91	744,186.57	-	-	-	-	-	-
Nguru	5,148.99	187.23	964,049.08	1,225.95	169.09	207,298.07	10,469.00	192.00	2,010,048.00
Nguu	4,699.90	187.10	879,345.90	5,385.30	142.30	766,331.38	-	-	-
Uluguru	2,927.10	168.78	494,030.15	8,041.48	137.16	1,102,935.08	-	-	-
Ukaguru	3,287.70	192.57	633,117.15	2,787.38	151.89	423,373.84	-	-	-
Rubeho	3,084.12	182.49	562,812.49	2,007.32	143.18	287,406.10	-	-	-
Mahenge	4,210.31	151.52	637,962.06	2,633.79	146.91	386,936.62	-	-	-
Udzungwa	18,947.40	188.20	3,565,843.01	7,418.75	139.80	1,037,160.85	650,000.00	32.46	21,099,000.00
Udzungwa (HH planted woodlots)	-	-	-	-	-	-	856,000.00	32.46	27,785,760.00
Total value	**56,519.93**		**10,108,580.94**	**43,059.44**		**6,090,537.44**	**1,553,730.00**		**54,174,703.00**
NPV			**1,228,139.77**			**739,968.48**			**6,581,943.37**

6.3.3. Economic value of other forest products from natural forests and woodlands

Apart from timber products natural forests provide other timber related products with remarkable economic value that accrue to households living in and around the EAM mountain blocks. These include firewood, charcoal, building poles, withies, medicine, fodder, ropes, resins, bamboo and thatch grass.

6.3.3.1.The economic value of firewood and charcoal

Firewood and charcoal are the major ecosystem service harvested by a relatively large proportion of households living in the EAM blocks. Household survey results indicate households in the mountains harvest a total of 18,781,488.80 head loads of firewood and 419,179.55 bags of charcoal per year. Basing on the prices ranging between 0.7-2 USD per head load of firewood and 7-12 USD per bag of charcoal the economic values of firewood and charcoal harvested per year are 16,525,782.53 and 3,935,213.25 USD which are equivalent to 1,999,619.69 and 476,160.80 USD net present values respectively**.**

Disaggregating the quantity and its economic value of firewood harvested from EAM mountain blocks to the respective mountain blocks, West Usambara Mountain block lead in the quantity of firewood harvested followed by North Pare, South Pare, East Usambara, Uluguru, Udzungwa, Nguu and Mahenge mountain blocks. Household survey result in Table 20 shows that households harvest about 2,836,374.26; 2,562,327.80; 2,455,796.06; 2,351,185.85; 2,097,535.50; 2,042,749.09; 1,126,836.02 and 1,059,538.05 head loads of firewood per year from natural forests with economic values of 1,868,600.93; 2,494,069.67; 1,967,687.43; 1,509,242.31; 2,208,372.30; 2,242,935.58; 1,567,201.49 and 740,883.80 USD which are equivalent to 226,100.71; 301,782.43; 238,090.18; 183,618.32; 267,213.05; 271,637.21; 189,631.38 and 89,646.96 USD net present values respectively (Table 20).

Other mountain block harvest less than 1 million head loads of firewood per year and these includes Rubeho, followed by Ukaguru and Nguru. Household survey results indicate that the mountain blocks harvest about 968,620.84; 755,818.74 and 524,706.60 head loads per year with

economic values of 826,905.69; 550,346.71 and 549,536.61 USD which are equivalent to 100,055.59; 66,591.95 and 66,493.93 net present values respectively.

On the other end of the spectrum, household survey results in Table 20 shows that Nguu leads in the quantity of charcoal harvested per year followed by Nguru, Rubeho, West Usambara, Uluguru, Mahenge, North Pare and Ukaguru. Household survey result shows that households in these mountain blocks harvest about 149,557.45; 76,008.90; 54,294.36; 32,401.46; 30,200.23; 27,577.38; 19,391.84 and 113,062.40 bags of charcoal per year from natural forests with economic values of 1,341,861.88; 854,606.47; 548,977.57; 317,819.06; 312,649.64; 89,782.17 and 99,216.36 USD which are equivalent to 162,365.29; 103,407.38; 66,426.29; 38,456.11; 10,863.64 and 12,005.18 USD net present values respectively (Table 20).

Just like firewood, in charcoal other mountain blocks harvest less than ten thousand bags of charcoal per year from natural forests. These include Udzungwa and South Pare which harvest about 8,880.90 and 7,804.62 per year with economic values of 95,561.91 and 65,984.82 USD which are equivalent to 11,562.99 and 7,984.16 USD net present values respectively. The survey results also revealed that in East Usambara charcoal is not harvested from natural forest (Table 20).

6.3.3.2.The economic value of building poles and withies

Building poles and withies are other ecosystem services harvested from natural forests by a relatively large proportion of households living in the EAM blocks. Household survey results indicate households in the mountains harvest a total of 553,627.19 pieces of building poles and 419,433.6 head loads of withies per year respectively. Basing on the prices ranging between 0.3-4 USD per piece of building poles and 0.2-1 USD per head load of withies the economic values of building poles and withies harvested per year are 590,952.71 and 99,338.17 USD which are equivalent to 71,505.28 and 12,019.92 USD net present values respectively**.**

Disaggregating the quantity and its economic value of building poles harvested from EAM mountain blocks natural forests to the respective mountain blocks Udzungwa Mountain block lead in the quantity harvested followed by East Usambara, Mahenge and Rubeho mountain blocks. Household survey result in Table 20 shows that households harvest about 142,886.28; 127,048.21; 114,381.95 and 69,657 pieces of building poles per year from natural forests with economic values of 180,422.27; 79,049.29; 44,826.40 and 41,912.84 USD which are equivalent to 21,831.09; 9,564.96; 5,423.99 and 5,071.45 USD net present values respectively (Table 20).

Other mountain blocks harvest less than forty thousand pieces of building poles per year and these mountain blocks includes Ukaguru followed by South Pare, Uluguru, and Nguru. Household survey results indicate that the mountain blocks harvest about 34,749.28; 25,670.65; 22,516.15 and 16,717.68 pieces per year with economic values of 69,372.10; 41,574.84; 87,023.90 and 46,771.06 USD which are equivalent to 8,394.01; 5,030.56; 10,529.89 and 5,659.3 net present values respectively. The survey results also revealed that in West Usambara, North Pare and Nguu building pole are harvested from natural forests in small quantities to account (Table 20).

On the other end of the spectrum, household survey results in Table 20 shows that Nguu leads in the quantity of withies harvested per year followed by South Pare, Uluguru, Udzungwa and Mahenge. Household survey result shows that households in these mountain blocks harvest about 132,282.53; 84,374.14; 80,414.81; 51,805.25 and 35,744.36 head loads of withies per year from natural forests with economic values of 57,130.10; 6,484.99; 14,568.73; 10,238.78 and 2,982.79 USD which are equivalent to 6,912.74; 784.68; 1,762.82; 1,238.89 and 360.92 USD net present values respectively (Table 20).

Just like building poles, in withies other mountain block harvest less than twenty-five thousand head loads of withies per year from natural forests. These include Rubeho, Ukaguru, East Usambara and West Usambara where households harvest about 20,597.50; 10,096.49; 2,410.51 and 1,708.02 head loads per year with economic values of 3,618.56; 1,921.56; 892.33 and

1,500.32 USD which are equivalent to 437.85; 232.51; 107.97 and 181.54 USD net present values respectively. The survey results also revealed that in North Pare and Nguru withies are harvested from natural forest in small quantities to account (Table 20).

Table 20: Economic value of other forest products from natural forests and woodlands

	Firewood			Charcoal			Building poles			Withes		
Name of the mountain block	**Quantity harvested (headloads/year)**	**Price (USD/headload)**	**Value (USD)**	**Quantity harvested (100kg bag/year)**	**Price (USD/100kg bag)**	**Value (USD)**	**Quantity harvested (pieces/year)**	**Price (USD/piece)**	**Value (USD)**	**Quantity harvested (bundle/year)**	**Price/head load (USD/bundle)**	**Value (USD)**
East Usambara	2,351,185.85	0.64	1,509,242.31	-	-	-	127,048.21	0.62	79,049.29	2,410.51	0.37	892.33
West Usambara	2,836,374.26	0.66	1,868,600.93	32,401.46	9.81	317,819.06	-	-	-	1,708.02	0.88	1,500.32
South Pare	2,455,796.06	0.80	1,967,687.43	7,804.62	8.45	65,984.82	25,670.65	1.62	41,574.84	84,374.14	0.08	6,484.99
North Pare	2,562,327.80	0.97	2,494,069.67	19,391.84	4.63	89,782.17	-	-	-	-	-	-
Nguru	524,706.60	1.05	549,536.61	76,008.90	11.24	854,606.47	16,717.68	2.80	46,771.06	-	-	-
Nguu	1,126,836.02	1.39	1,567,201.49	149,557.45	8.97	1,341,861.88	-	-	-	132,282.53	0.43	57,130.10
Uluguru	2,097,535.50	1.05	2,208,372.30	30,200.23	10.35	312,649.64	22,516.15	3.86	87,023.90	80,414.81	0.18	14,568.73
Ukaguru	755,818.74	0.73	550,346.71	13,062.40	7.60	99,216.36	34,749.28	2.00	69,372.10	10,096.49	0.19	1,921.56
Rubeho	968,620.84	0.85	826,905.69	54,294.36	10.11	548,977.57	69,657.00	0.60	41,912.84	20,597.50	0.18	3,618.56
Mahenge	1,059,538.05	0.70	740,883.80	27,577.38	7.57	208,753.37	114,381.95	0.39	44,826.40	35,744.36	0.08	2,982.79
Udzungwa	2,042,749.09	1.10	2,242,935.58	8,880.90	10.76	95,561.91	142,886.28	1.26	180,422.27	51,805.25	0.20	10,238.78
Total value	**18,781,488.80**		**16,525,782.53**	**419,179.55**		**3,935,213.25**	**553,627.19**		**590,952.71**	**419,433.61**		**99,338.17**
NPV			**2,007,796.24**			**478,107.85**			**71,797.67**			**12,069.07**

6.3.3.3.The economic value of medicines and fodder

Medicine and fodder are also one of the ecosystem services harvested from natural forests by households living in the EAM blocks. Household survey results indicate households in the mountains harvest a total of 10,101.55kg of medicine and 65,316.49 head loads of fodder per year respectively. Basing on the prices ranging between 0.2-2 USD per kilogram of medicine and 0.4-1 USD per head load of fodder the economic values of these products harvested per year are 4,956.94 and 42,642.64 USD which are equivalent to 599.79 and 5,159.76 USD net present values respectively**.**

Disaggregating the quantity and economic value of medicine harvested from EAM mountain blocks natural forests to the respective mountain blocks, East Usambara Mountain block leads in the quantity harvested followed by Uluguru and Udzungwa mountain blocks. Household survey result in Table 21 shows that households harvest about 5,955.38; 3,484.64 and 661.52kg of medicine per year from natural forests with economic values of 1,307.80; 2,486.99 and 1,162.16 USD which are equivalent to 158.24; 300.93 and 140.62 USD net present values respectively (Table 21). Other mountain blocks harvest medicine in small quantities to account (Table 21).

On the other hand, household survey results in Table 21 shows that Udzungwa leads in the quantity of fodder harvested per year followed by East Usambara, Mahenge, West Usambara, Nguu, South Pare and North Pare. Household survey results shows that households in these mountain blocks harvest about 11,576.59; 11,434.34; 10,535.18; 8,281.81; 8,056.97; 7,726.57 and 7,705.03 head loads of fodder per year from natural forests with economic values of 5,084.43; 8,872.12; 9,254.09; 5,092.32; 6,318.96; 4,241.88 and 3,778.85 USD which are equivalent to 615.22; 1,073.53; 1,119.74; 616.17; 764.59; 513.27 and 457.24 USD net present values respectively (Table 20). Other mountain blocks harvest fodder in small quantities to account (Table 21).

6.3.3.4.The economic value of ropes and resins

Ropes and Resins are other ecosystem services harvested from natural forests households living in the EAM blocks. Household survey results indicate households in the mountains harvest a total of 32,165.98 and 75,765.26 head loads of ropes and resins per year respectively. Basing on the prices ranging between 0.07-1 USD and 0.13-0.5 USD per head load of ropes and resins the economic values of ropes and resins harvested per year are 19,955.17 and 18,248.78 which are equivalent to 2,414.58 and 2,208.1 USD net present values respectively**.**

Disaggregating the quantity and economic value of ropes harvested from EAM mountain blocks natural forests to the respective mountain blocks, Udzungwa Mountain block leads in the quantity harvested followed by Uluguru, Ukaguru, Mahenge and Rubeho mountain blocks. Household survey results in Table 21 shows that households harvest about 11,576.59; 9,381.73; 3,902.33; 3,762.56 and 3,542.77 head loads of ropes per year from natural forests with economic values of 7,626.65; 6,867.42; 3,384.95; 247.88 and 1,828.28 USD which are equivalent to 922.82; 830.96; 409.58; 29.99 and 221.22 USD net present values respectively (Table 20). Other mountain blocks harvest ropes in small quantities to account (Table 21).

On the other end of the spectrum, household survey results in Table 21 shows that Rubeho leads in the quantity of Resins harvested per year followed by East Usambara; North Pare and Nguu. Household survey result shows that households in these mountain blocks harvest about 44,940; 11,513.74; 11,282.53 and 8,028.99 head loads of resins per year from natural forests with economic values of 5,921.29; 4,551.15; 4,955.28 and 2,821.06 USD which are equivalent to 716.29; 550.69; 599.59 and 341.35 USD net present values respectively (Table 21). Other mountain blocks harvest Resins in small quantities to account (Table 21).

Table 21: Economic value of other forest products from natural forests and woodlands

	Medicine			Fodder			Ropes			Resins		
Name of the mountain block	**Quantity harvested (bunch/year)**	**Price (USD/bunch)**	**Value (USD)**	**Quantity harvested (headload/year)**	**Price (USD/head load)**	**Value (USD)**	**Quantity harvested (bunch/year)**	**Price (USD/bunch)**	**Value (USD)**	**Quantity harvested (headload/year)**	**Price (USD/head load)**	**Value (USD)**
East Usambara	5,955.38	0.22	1,307.80	11,434.34	0.78	8,872.12	-	-	-	11,513.74	0.40	4,551.15
West Usambara	-	-	-	8,281.81	0.61	5,092.32	-	-	-	-	-	-
South Pare	-	-	-	7,726.57	0.55	4,241.88	-	-	-	-	-	-
North Pare	-	-	-	7,705.03	0.49	3,778.85	-	-	-	11,282.53	0.44	4,955.28
Nguru	-	-	-	-	-	-	-	-	-	-	-	-
Nguu	-	-	-	8,056.97	0.78	6,318.96	-	-	-	8,028.99	0.35	2,821.06
Uluguru	3,484.64	0.71	2,486.99	-	-	-	9,381.73	0.73	6,867.42	-	-	-
Ukaguru	-	-	-	-	-	-	3,902.33	0.87	3,384.95	-	-	-
Rubeho	-	-	-	-	-	-	3,542.77	0.52	1,828.28	44,940.00	0.13	5,921.29
Mahenge	-	-	-	10,535.18	0.88	9,254.09	3,762.56	0.07	247.88	-	-	-
Udzungwa	661.52	1.76	1,162.16	11,576.59	0.44	5,084.43	11,576.59	0.66	7,626.65	-	-	-
Total value	**10,101.55**		**4,956.94**	**65,316.49**		**42,642.64**	**32,165.98**		**19,955.17**	**75,765.26**		**18,248.78**
NPV			**602.24**			**5,180.86**			**2,424.45**			**2,217.13**

6.3.3.5.The economic value of bamboo and thatch grass

Bamboo and thatch grasses are also one of the ecosystem services harvested from natural forests by households living in the EAM blocks. Household survey results indicate households in the mountains harvest a total of 37,422.07 pieces of bamboo and 55,533.13 head load of thatch grasses per year respectively (Table 22). Basing on the prices ranging between 0.04-2 USD per piece of bamboo and 0.2-0.25 USD per head load of thatch grasses the economic values of these products harvested per year are 7,644.83 and 11,608.06 USD which are equivalent to 925.02 and 1,404.58 USD net present values respectively**.**

Disaggregating the quantity and economic value of bamboo harvested from EAM mountain blocks natural forests to the respective mountain blocks, Mahenge Mountain block lead in the quantity harvested followed by East Usambara, Rubeho and Uluguru mountain blocks. Household survey result in Table 22 shows that households harvest about 11,576.59; 11,910.77; 3,745 and 1,072.2 pieces of bamboo per year from natural forests with economic values of 4,550.48; 1,046.24; 1,883.63 and 164.48 USD which are equivalent to 550.61; 126.59; 227.92 and 19.9 USD net present values respectively (Table 22). Other mountain blocks harvest bamboo in small quantities to account (Table 22).

On the other hand, household survey results in Table 22 shows that Mahenge leads in the quantity of thatch grasses harvested per year followed by Nguu, Rubeho and Ukaguru. Household survey result shows that households in these mountain blocks harvest about 20,468.35; 19,387.08; 8,988 and 6,689.7 head loads of thatch grasses per year from natural forests with economic values of 4,095.30; 4,044.53; 1,881.65 and 1,586.58 USD which are equivalent to 495.53; 489.39; 227.68 and 191.98 USD net present values respectively (Table 22). Other mountain blocks harvest thatch grasses in small quantities to account (Table 22).

Table 22: Economic value of other forest products from natural forests and woodlands

Name of the mountain block	Bamboo			Thatch grass		
	Quantity harvested (piece/ Year)	Price (USD/ Piece)	Value (USD)	Quantity harvested (headload/ Year)	Price (USD/ head load)	Value (USD)
East Usambara	11,910.77	0.09	1,046.24	-	-	-
West Usambara	-	-	-	-	-	-
South Pare	-	-	-	-	-	-
North Pare	-	-	-	-	-	-
Nguru	-	-	-	-	-	-
Nguu	-	-	-	19,387.08	0.21	4,044.53
Uluguru	1,072.20	1.76	1,883.63	-	-	-
Ukaguru	-	-	-	6,689.70	0.24	1,586.58
Rubeho	3,745.00	0.04	164.48	8,988.00	0.21	1,881.65
Mahenge	20,694.10	0.22	4,550.48	20,468.35	0.20	4,095.30
Udzungwa	-	-	-	-	-	-
Total value	**37,422.07**		**7,644.83**	**55,533.13**		**11,608.06**
NPV			**928.81**			**1,410.32**

6.3.4. Economic value of non-timber products from natural forests and woodlands

Apart from timber related products, natural forests and woodlands also provide valuable non timber products accrued to the communities living in and around the EAM. These products include Wild mushrooms, Wild fruits, Wild vegetables, Honey and Reeds. The following sections provide the quantities harvested and their economic value for each mountain block.

6.3.4.1.The economic value of wild mushrooms and fruits

Wild Mushrooms and Fruits are among the non-timber products harvested from the EAM. Household survey results shows that households harvest about 107,887.82kg of wild mushroom and 163,772.53 baskets of wild fruits per year. Basing on the market prices which ranges between 0.19-1 USD for wild mushroom and 0.1-0.3 USD of wild fruits, the economic values of these products harvested from EAM per year are 26,461.11 and 22,358.15 USD which is equivalent to 3,201.79 and 2,705.34 USD net present values respectively.

Disaggregating the quantity and economic value of Wild mushroom harvested from EAM mountain blocks to the respective mountain blocks Udzungwa Mountain blocks, lead in the quantity of the product harvested followed by Mahenge and Rubeho mountain blocks. Household survey result in Table 23 shows that households in these mountain blocks harvest about 59,206; 22,951.64 and 13,388.38kg of wild mushrooms per year from natural forests with economic values of 11,538.94; 6,591 and 2,499.07 USD which are equivalent to 1,396.21; 797.51 and 302.39 USD net present values respectively (Table 23).

Other mountain blocks harvest less than 4000kg of wild mushroom per year and these includes Nguu (3,524.92kg) followed by Nguru (2,451.90kg); Uluguru (2,323.09kg); East Usambara (2,183.64kg) and Ukaguru (1,858.25kg) mountain blocks. The economic values of the quantities harvested from these mountain blocks are 774.07; 2,074.61; 538.44; 2,045.98 and 399 USD which are equivalent to 93.66; 251.03; 65.15; 247.56 and 48.28 USD net present values respectively. Other mountain blocks harvest wild mushrooms in small quantities to account (Table 23).

On the other end of the spectrum, household survey results in Table 23 shows that Mahenge leads in the quantity of wild fruits harvested per year followed by Udzungwa, West Usambara, Uluguru, Rubeho and Ukaguru. Household survey result shows that households in these mountain blocks harvest about 90,301.54; 31,083.15; 12,311.98; 10,721.98; 8,988 and 5,017.28 baskets of wild fruits per year from natural forests with economic values of 18,923.59; 6,825.85; 2,433.34; 1,412.73; 986.88 and 629.6 USD which are equivalent to 2,289.75; 825.93; 294.43; 170.94; 119.41 and 76.18 USD net present values respectively (Table 23).

Also household survey results show that South Pare and East Usambara mountain blocks harvest about 3,902.31 and 1,446.31 baskets of wild fruits per year with economic values of 828.38 and 317.79 USD which are equivalent to 100.23 and 38.45 net present values respectively. Other mountain blocks harvest wild fruits in small quantities to account (Table 23).

6.3.4.2.The economic value of wild vegetables, honey and reeds

Wild vegetables, Honey and Reeds are among the non-timber products harvested from EAM. Household survey results shows that households harvest about 277,470.93 bundles of wild vegetables; 4,032.94 liters of honey and 12,005.90 bundles of wild reeds. Basing on the market prices which ranges between 0.09-0.25 USD per bundle for wild vegetable; 4-5 USD per liter for honey and 0.9-2 USD per bundle of reeds, the economic values of these products harvested from EAM per year are 33,038.40; 17,882.09; and 13,477.86 USD which are equivalent to 3,997.65; 2,163.73 and 1,630.82 USD net present values respectively.

Disaggregating the quantity and economic value of Wild vegetables harvested from EAM mountain blocks to the respective mountain blocks, Udzungwa Mountain block lead in the quantity of the product harvested followed by Rubeho, Uluguru, Mahenge, Ukaguru, West Usambara, South Pare and East Usambara mountain blocks. Household survey result in Table 23 shows that households in these mountain blocks harvest about 66,606.75; 51,306.50; 45,568.40; 21,741.53; 19,903.76; 18,731.08 and 10,719.69 bundles of wild vegetables per year from natural forests with economic values of 5,850.73; 5,720.11; 6,004.08; 2,228.07; 3,059.60; 4,524.67 and 1,412.42 USD which are equivalent to 707.94; 692.133; 726.49; 269.59; 370.21; 547.49 and 170.90 USD net present values respectively (Table 23). Other mountain blocks harvest wild vegetables in small quantities to account (Table 23).

Honey is also harvested from EAM, household survey results in Table 23 shows that Rubeho leads in the quantity of honey harvested per year followed by South Pare, East Usambara, Uluguru and West Usambara. Household survey result shows that households in these mountain blocks harvest about 898.80; 858.51; 828.19; 804.15 and 643.29 liters of honey per year from natural forests with economic values of 18,923.59; 6,825.85; 3,947.52; 3,770.56; 3,564.67; 3,531.81 and 3,067.52 USD which are equivalent to 2,289.75; 825.93; 477.65; 456.24; 431.33; 427.35 and 371.17 USD net present values respectively (Table 23). Other mountain blocks harvest honey in small quantities to account (Table 23).

Also household survey result shows that North Pare leads among EAM blocks in the quantity of Reeds harvested per year followed by Rubeho, East Usambara and Nguu mountain blocks. Households in these mountain blocks harvest about 4,061.71; 3,745; 2,568.91 and 1,630.28 bundles of reeds per year with economic values of 3,822.64; 5,382.99; 2,482.18 and 1,790.04 USD which are equivalent to 462.54; 651.34; 300.34 and 216.59 USD net present values respectively. Other mountain blocks harvest reeds in small quantities to account (Table 23).

Table 23: Economic value of non-timber products from natural forests and woodlands

Name of the mountain block	Mushrooms			Wild fruits			Wild vegetable			Horney			Reeds		
	Quantity harvested (kg/ year)	Price (USD/ kg)	Value (USD)	Quantity harvested (bundle/ year)	Price (USD/ bundle)	Value (USD)	Quantity harvested (bundle/year)	Price (USD/ bundle)	Value (USD)	Quantity harvested (liters/ year)	Price (USD/ Liter)	Value (USD)	Quantity harvested (headload/ year)	Price (USD/ headload)	Value (USD)
East Usambara	2,183.64	0.94	2,045.98	1,446.31	0.22	317.79	10,719.69	0.13	1,412.42	828.19	4.30	3,564.67	2,568.91	0.97	2,482.18
West Usambara	-	-	-	12,311.98	0.20	2,433.34	19,903.76	0.15	3,059.60	643.29	4.77	3,067.52	-	-	-
South Pare	-	-	-	3,902.31	0.21	828.38	18,731.08	0.24	4,524.67	858.51	4.39	3,770.56	-	-	-
North Pare	-	-	-	-	-	-	-	-	-	-	-	-	4,061.71	0.94	3,822.64
Nguru	2,451.90	0.22	538.44	-	-	-	-	-	-	-	-	-	-	-	-
Nguu	3,524.92	0.22	774.07	-	-	-	-	-	-	-	-	-	1,630.28	1.10	1,790.04
Uluguru	2,323.09	0.89	2,074.61	10,721.98	0.13	1,412.73	45,568.40	0.13	6,004.08	804.15	4.39	3,531.81	-	-	-
Ukaguru	1,858.25	0.21	399.00	5,017.28	0.13	629.60	21,741.53	0.10	2,228.07	-	-	-	-	-	-
Rubeho	13,388.38	0.19	2,499.07	8,988.00	0.11	986.88	51,306.50	0.11	5,720.11	898.80	4.39	3,947.52	3,745.00	1.44	5,382.99
Mahenge	22,951.64	0.29	6,591.00	90,301.54	0.10	8,923.59	42,893.23	0.10	4,238.70	-	-	-	-	-	-
Udzungwa	59,206.00	0.19	11,538.94	31,083.15	0.22	6,825.85	66,606.75	0.09	5,850.73	-	-	-	-	-	-
Total value	**107,887.82**		**26,461.11**	**163,772.53**		**22,358.15**	**277,470.93**		**33,038.40**	**4,032.94**		**17,882.09**	**12,005.90**		**13,477.86**
NPV			**3,214.89**			**2,716.40**			**4,013.99**			**2,172.58**			**1,637.49**

6.4. Economic value of forests products from planted forests

As noted in chapter five above, EAM are also covered by planted forests which are either plantations or households privately owned woodlots. From these forests, households harvest a number of economically valuable ecosystem services. Timber products from these forests have already been accounted earlier therefore, this present the economic value of other timber related forest products and non-timber forest products.

6.4.1. Economic value of timber related products from EAM planted forests

6.4.1.1.The economic value of firewood and charcoal

Firewood and charcoal are the major ecosystem services harvested from planted forests by a relatively large proportion of households living in the EAM blocks. Household survey results indicate households in the mountains harvest a total of 5,544,700.28 head loads of firewood and 316,764.64 bags of charcoal from planted forests per year. Basing on the prices ranging between 0.4-2 USD per head load of firewood and 10-16 USD per bag of charcoal the economic values of firewood and charcoal harvested from planted forests per year are 6,566,021.26 and 3,946,435.95 USD which are equivalent to 794,488.57 and 477,518.75 USD net present values respectively**.**

Disaggregating the quantity and economic value of firewood harvested from EAM mountain blocks' planted forests to the respective mountain blocks, Udzungwa Mountain block lead in the quantity of firewood harvested followed by West Usambara, Uluguru, East Usambara, Nguru, North Pare and South Pare mountain blocks. Household survey result in Table 24 shows that households harvest about 2,042,749.09; 1,058,139.22; 678,701.04; 601,493.85; 524,706.60; 389,247.16 and 131,357.68 head loads of firewood per year from planted forests with economic values of 2,242,935.58; 1,626,569.49; 812,281.92; 654,149.48; 549,536.61; 390,759.15 and 190,828.11 USD which are equivalent to 271,395.21; 196,572.91; 98,286.11; 79,152.09; 66,493.93; 47,281.86 and 23,090.20 USD net present values respectively (Table 24).

Other mountain block harvest less than 100,000 head loads of firewood per year from EAM planted forests and these includes Rubeho, followed by Ukaguru and Mahenge. Household

survey results indicate that the mountain blocks harvest about 45,689; 36,496.03 and 36,120.62 head loads per year with economic values of 35,116.52; 47,980.25 and 36,120.62 USD which are equivalent to 4,249.1; 5,805.61 and 4,370.59 net present values respectively. Results also reveal that households in Nguu mountain block depend on natural forest only for firewood (Table 24).

On the other end of the spectrum, household survey results in Table 24 shows that West Usambara leads in the quantity of charcoal harvested from planted forests per year followed by Nguru, South Pare, Uluguru, East Usambara, North Pare and Udzungwa mountain blocks. Household survey result shows that households in these mountain blocks harvest about 91,649.85; 76,008.90; 53,851.85; 51,465.48; 16,873.59; 11,282.53; and 8,880.90 bags of charcoal per year from planted forests with economic values of 1,341,752.11; 854,606.47; 662,247.60; 526,341.20; 222,326.13; 173,434.77 and 95,561.91 USD which are equivalent to 162,352; 103,407.38; 80,131.96; 63,687.29; 26,901.46; 20,985.61 and 11,562.99 USD net present values respectively (Table 24).

Just like firewood, charcoal in other mountain blocks is harvested at less than five thousand bags of charcoal per year from planted forests. These include Rubeho and Mahenge which harvest about 4,494 and 2,257.54 bags per year with economic values of 49,344.06 and 20,821.70 USD which are equivalent to 5,970.63 and 2,519.43 USD net present values respectively. The survey results also revealed that households in Nguu and Ukaguru depend primarily on natural forests for charcoal (Table 24).

6.4.1.2.The economic value of building poles and withies

Building poles and withies are other ecosystem services harvested from EAM planted forests by a relatively large proportion of households living in the mountain blocks. Household survey results indicate households in the mountains harvest a total of 8,375,107.21 pieces of building poles and 322,252.74 head loads of withies per year respectively. Basing on the prices ranging between 0.4-4 USD per piece of building pole and 0.1-4 USD per head load of withies the economic values of building poles and withies harvested per year are 10,902,005.58 and

572,036.90 USD which are equivalent to 1,319,142.68 and 69,216.46 USD net present values respectively.

Disaggregating the quantity and economic value of building poles harvested from EAM mountain blocks planted forests to the respective mountain blocks, Udzungwa Mountain block lead in the quantity harvested followed by South Pare, Mahenge, Rubeho and East Usambara mountain blocks. Household survey result in Table 24 shows that households harvest about 8,142,886.28; 144,045.46; 45,150.77; 20,223 and 11,910.77 pieces of building poles per year from planted forests with economic values of 10,260,036.71; 362,994.56; 19,830.19; 12,878.80 and 28,771.62 USD which are equivalent to 1,241,464.44; 43,922.27; 2,399.53; 1,558.33 and 3,481.37 USD net present values respectively (Table 24).

Other mountain blocks harvest less than ten thousand pieces of building poles per year and these mountain blocks includes Uluguru followed by Ukaguru, and Nguu. Household survey results indicate that the mountain blocks harvest about 5,360.99; 3,716.50 and 587.49 pieces per year with economic values of 7,063.63; 2,040.36 and 1,548.14 USD which are equivalent to 854.69; 246.88 and 187.32 net present values respectively. The survey results also revealed that in West Usambara and North Pare, building poles are harvested from planted forests in small quantities to account (Table 24).

On the other end of the spectrum, household survey results in Table 24 shows that West Usambara leads in the quantity of withies harvested from planted forests per year followed by Mahenge, Udzungwa and Rubeho mountain blocks. Household survey results shows that households in these mountain blocks harvest about 151,824; 94,064.10; 51,805.25 and 14,980 head loads of withies per year from planted forests with economic values of 533,448.11; 16,525.16; 10,238.78 and 1,480.32 USD which are equivalent to 64,547.22; 1,999.54; 1,238.89 and 179.12 USD net present values respectively (Table 24).

Other mountain blocks harvest withies from planted forests less than twenty ten thousand head loads per year, these include Uluguru and East Usambara mountain blocks. Household survey results show that households in these mountain blocks harvest about 5,360.99 and 4,218.40 head loads of withies per year with economic values of 9,418.17 and 926.36 USD which are equivalent to 1,139.59 and 112.09 USD net present values respectively. The survey results also revealed that in North Pare, South Pare, Nguu, Nguru and Ukaguru withies from planted forests are harvested in small quantities to account (Table 24).

Table 24: Economic value of other forest products from planted forests

Name of the mountain block	Firewood			Charcoal			Building poles			Withes		
	Quantity harvested (headloads /year)	Price (USD/ head load)	Value (USD)	Quantity harvested (100kg bag/ Year)	Price (USD/ 100kg bag)	Value (USD)	Quantity harvested (pieces/year)	Price (USD/piece)	Value (USD)	Quantity harvested (headloads/ year)	Price (USD/head load)	Value (USD)
East Usambara	601,493.85	1.09	654,149.48	16,873.59	13.18	222,326.13	11,910.77	2.42	28,771.62	4,218.40	0.22	926.36
West Usambara	1,058,139.22	1.54	1,626,569.49	91,649.85	14.64	1,341,752.11	-	-	-	151,824.00	3.51	533,448.11
South Pare	131,357.68	1.45	190,828.11	53,851.85	12.30	662,247.60	144,045.46	2.52	362,994.56	-	-	-
North Pare	389,247.16	1.00	390,759.15	11,282.53	15.37	173,434.77	-	-	-	-	-	-
Nguru	524,706.60	1.05	549,536.61	76,008.90	11.24	854,606.47	1,225.95	3.95	4,845.93	-	-	-
Nguu	-	-	-	-	-	-	587.49	2.64	1,548.14	-	-	-
Uluguru	678,701.04	1.20	812,281.92	51,465.48	10.23	526,341.20	5,360.99	1.32	7,063.63	5,360.99	1.76	9,418.17
Ukaguru	36,496.03	1.31	47,980.25	-	-	-	3,716.50	0.55	2,040.36	-	-	-
Rubeho	45,689.00	0.77	35,116.52	4,494.00	10.98	49,344.06	20,223.00	0.64	12,878.80	14,980.00	0.10	1,480.32
Mahenge	36,120.62	0.44	15,864.15	2,257.54	9.22	20,821.70	45,150.77	0.44	19,830.19	94,064.10	0.18	16,525.16
Udzungwa	2,042,749.09	1.10	2,242,935.58	8,880.90	10.76	95,561.91	8,142,886.28	1.26	10,260,036.71	51,805.25	0.20	10,238.78
Total value	**5,544,700.28**		**6,566,021.26**	**316,764.64**		**3,946,435.95**	**8,375,107.21**		**10,902,005.58**	**322,252.74**		**572,036.90**
NPV			**797,737.28**			**479,471.35**			**2,520,172.72**			**69,499.49**

6.4.1.3.The economic value of medicines, fodder and ropes

Medicine, fodder and ropes are also among the ecosystem services harvested from planted forests by households living in the EAM blocks. Household survey results indicate households in the mountains harvest a total of 15,843.92kg of medicine, 786,136.96 head loads of fodder and 11,576.59 bundles of ropes per year respectively. Basing on the prices ranging between 1-2 USD per kilogram of medicine, 0.4-2 USD per head load of fodder and 0.4-1 USD per bundle of ropes the economic values of these products harvested per year are 28,310.85; 1,072,430.30 and 7,626.65 USD which are equivalent to 3,425.61; 129,764.07 and 922.82 USD net present values respectively**.**

Disaggregating the quantity and economic value of medicine harvested from EAM mountain blocks planted forests to the respective mountain blocks, West Usambara Mountain block lead in the quantity harvested followed by Udzungwa mountain block. Household survey result in Table 25 shows that households harvest about 15,182.40 and 661.52 kg of medicine per year from planted forests with economic values of 27,148.70 and 1,162.16 USD which are equivalent to 3,284.99 and 140.62 USD net present values respectively (Table 25). Other mountain blocks harvest medicine in small quantities to account (Table 25).

On the other hand, household survey results in Table 25 shows that, West Usambara leads in the quantity of fodder harvested from planted forests per year followed by Uluguru, South Pare, Udzungwa, Ukaguru and East Usambara mountain blocks. Household survey result shows that households in these mountain blocks harvest about 499,908.29; 234,489.60; 21,072.46; 11,576.59; 11,149.50 and 7,940.51head loads of fodder from planted forests per year with economic values of 831,189.29; 205,975.40; 15,425.02; 5,084.43; 15,425.02 and 7,410.87 USD which are equivalent to 100,573.90; 24,923.02; 1,866.43; 615.22; 1,866.43 and 896.72 USD net present values respectively (Table 24). Other mountain blocks harvest fodder in small quantities to account (Table 25).

Lastly ropes are not harvested in large quantities from planted forests in EAM compared to natural forests. Household survey results show that households in Udzungwa Mountain block harvest significantly large quantities of ropes from planted forests than the rest of the mountain blocks. In this mountain block households harvest about 11,576.59 bundles of ropes with economic value of 7,626.65 USD which is equivalent to 922.82 USD net present value (Table 25).

Table 25: Economic value of other timber related forest products from planted forests

Name of the mountain block	Medicine			Fodder			Ropes		
	Quantity harvested (bunch/ year)	Price (USD/ Bunch)	Value (USD)	Quantity harvested (headload/ year)	Price (USD/ head load)	Value (USD)	Quantity harvested (bunch/ year)	Price (USD/ Bunch)	Value (USD)
East Usambara	-	-	-	7,940.51	0.93	7,410.87	-	-	-
West Usambara	15,182.40	1.79	27,148.70	499,908.29	1.66	831,189.29	-	-	-
South Pare	-	-	-	21,072.46	0.73	15,425.02	-	-	-
North Pare		-	-	-		-	-	-	-
Nguru	-		-	-	-		-	-	-
Nguu	-	-	-	-	-	-	-	-	-
Uluguru		-	-	234,489.60	0.88	205,975.40	-	-	-
Ukaguru	-	-		11,149.50	0.66	7,345.28	-	-	-
Rubeho	-	-	-	-	-	-	-	-	-
Mahenge		-	-		-	-	-	-	-
Udzungwa	661.52	1.76	1,162.16	11,576.59	0.44	5,084.43	11,576.59	0.66	7,626.65
Total value	**15,843.92**		**28,310.85**	**786,136.96**	**5.30**	**1,072,430.30**	**11,576.59**		**7,626.65**
NPV			**3,439.62**			**130,294.68**			**926.60**

6.4.2. Economic value of non-timber products harvested from planted forests

Planted forests in EAMs also provide products which are not timber related products. These products are of remarkable economic value which in total they add to the economic value of EAM. These products include wild mushrooms, fruits and vegetables. This section provides the economic value of non-timber products harvested by households from planted forests.

6.4.2.1.The economic values of wild mushrooms, wild fruits and wild vegetables

Wild Mushrooms, Fruits and Vegetables are among the non-timber products harvested from EAM. Household survey results shows that households harvest about 201,893.92 kg of wild mushroom, 37,516.34 baskets of wild fruits and 140,121.29 bundles of wild vegetables per year. Basing on the market prices which ranges between 0.16-0.22 USD per kg of wild mushroom, 0.22-2 USD per basket of wild fruits and 0.09-0.15 USD per bundle of wild vegetable, the economic values of these products harvested from EAM per year are 41,370.67; 16,997.48 and 15,917.77 USD which are equivalent to 5,0005.85; 2,056.7 and 1,926.05 net present values respectively.

Disaggregating the quantity and economic value of Wild mushroom harvested from EAM mountain blocks to the respective mountain blocks, Rubeho Mountain block lead in the quantity of the product harvested followed by Udzungwa, Ukaguru, East Usambara and Rubeho mountain blocks. Household survey result in Table 26 shows that households in these mountain blocks harvest about 111,601; 59,206; 16,724.25; 11,910.77 and 2,451.90 kg of wild mushrooms from planted forests per year with economic values of 24,507.55; 11,538.94; 2,693.27; 2,092.48 and 538.44 USD which are equivalent to 2,965.41; 1,396.21; 325.89; 253.19 and 65.15 USD net present values respectively. Other mountain blocks harvest small quantities of wild mushrooms from planted forests to account (Table 26).

On the other hand, household survey results in Table 26 shows that Udzungwa leads in the quantity of wild fruits harvested from planted forests per year followed by Uluguru mountain blocks. Household survey result shows that households in these mountain blocks harvest about 31,083.15 and 6,433.19 baskets of wild fruits from planted forests per year with economic values of 6,825.85 and 10,171.62 USD which are equivalent to 825.93 and 1,230.77 USD net present values respectively. Other mountain blocks harvest small quantities of wild fruits from planted forests to account (Table 26).

Also household survey results show that Udzungwa mountain block leads in the quantity of wild vegetables harvested from planted forests per year followed by East Usambara and Rubeho mountain blocks. Household survey result shows that households in these mountain blocks harvest about 66,606.75; 54,789.54 and 18725 bundles of wild vegetables from planted forests per year with economic values of 5,850.73; 8,422.24 and 1644.8 USD which are equivalent to 707.94; 1,019.09 and 199.02 USD net present values respectively. Other mountain blocks harvest small quantities of wild vegetables from planted forests to account (Table 26).

Table 26: Economic value of non-timber products harvested from planted forest

Name of the mountain block	Mushrooms			Wild fruits			Wild vegetable		
	Quantity harvested (bundle)	Price (USD/bundle)	Value (USD)	Quantity harvested (bundle)	Price (USD/bundle)	Value (USD)	Quantity harvested (bundle)	Price (USD/bundle)	Value (USD)
East Usambara	11,910.77	0.18	2,092.48	-	-	-	54,789.54	0.15	8,422.24
West Usambara	-	-	-	-	-	-	-	-	-
South Pare	-	-	-	-	-	-	-	-	-
North Pare	-	-	-	-	-	-	-	-	-
Nguru	2,451.90	0.22	538.44	-	-	-	-	-	-
Nguu	-	-	-	-	-	-	-	-	-
Uluguru	-	-	-	6,433.19	1.58	10,171.62	-		-
Ukaguru	16,724.25	0.16	2,693.27	-	-	-	-		-
Rubeho	111,601.00	0.22	24,507.55		-	-	18725	0.09	1644.80
Mahenge	-	-	-	-	-	-	-	-	-
Udzungwa	59,206.00	0.19	11,538.94	31,083.15	0.22	6,825.85	66,606.75	0.09	5,850.73
Total value	**201,893.92**		**41,370.67**	**37,516.34**		**16,997.48**	**140,121.29**		**15,917.77**
NPV			**5,026.32**			**2,065.10**			**1,933.93**

6.4.3. Economic value of EAM carbon sequestration capacity

Despite the fact that agriculture is widespread in the EAM with communities utilizing natural resources outside protected areas for most of their livelihood needs, the mountain blocks still have pockets of forests and woodlands with high carbon storage capacity. Because of intensive conversion of forests to farmland, woodland is the largest natural vegetation cover followed by forests. Based on allometric tree biomass and volume models in Tanzania and National Forest Resources Monitoring and Assessment (NAFORMA) reports on total carbon stock above and below ground for forest and woodlands, the quantity and its economic value of carbon dioxide absorbed and stored by the forests and woodlands in EAM were estimated. Estimation results in

Table 27 show that EAM blocks forests and woodlands stores about 509,536,397.32 and 387,057,894.46 tons of CO_2 with economic values of 2,547,681,986.59 and 1,935,289,472.29 USD which are equivalent to 308,269,520.38 and 234,170,026.15 USD net present values respectively.

Results in Table 27 indicate that Udzungwa mountain block leads in quantity of carbon dioxide stored in the EAM forests followed by Rubeho, West Usambara, Nguru, Uluguru, East Usambara, Nguu, Ukaguru and South Pare mountain blocks. Results in Table 27 show that these mountain blocks store CO_2 of about 211,407,544.84; 63,676,335.18; 44,728,442.27; 40,749,535.62; 38,785,854.04; 30,719,925.11; 29,201,277.64; 22,747,025.90 and 21,354,094.28 tons respectively. Basing on a prevailing market price of USD Table 5 per ton of CO_2 (Stern, 2007), the economic values of CO_2 stored in EAM blocks are estimated to be 1,057,037,724.18; 318,381,675.92; 223,642,211.36; 203,747,678.10; 193,929,270.21; 153,599,625.53; 146,006,388.19 and 106,770,471.41 USD which are equivalent to 127,901,564.63; 38,524,182.79; 27,060,707.57; 24,653,469.05; 23,465,441.65; 18,585,554.69; 17,666,772.97 and 12,919,227.04 USD net present value respectively. North Pare and Mahenge store the lowest amount among the EAM, the two blocks store about 3,623,130.80 and 2,543,231.65 tons of CO_2 with economic value of 18,115,653.99 and 12,716,158.23 USD which are equivalent to 2,191,994.13 and 1,538,655.15 USD net present values respectively.

On the other hand, results in Table 27 indicate that Uluguru mountain block leads in quantity of carbon dioxide stored in the EAM woodlands followed by Rubeho, Ukaguru, West Usambara, Nguru, Nguu and South Pare mountain blocks.

Table 27: Economic value of carbon stocks in EAMs

Name of the mountain block	Forests			Woodland		
	Total tCO_2	**Price (USD/ tCO_2)**	**Total value (USD)**	**Total** tCO_2	**Price (USD/ tCO_2)**	**Total value (USD)**
East Usambara	30,719,925.11	5.00	153,599,625.53	468,545.00	5.00	2,342,725.00
West Usambara	44,728,442.27	5.00	223,642,211.36	35,041,057.97	5.00	175,205,289.87
South Pare	21,354,094.28	5.00	106,770,471.41	18,317,777.40	5.00	91,588,887.00
North Pare	3,623,130.80	5.00	18,115,653.99	6,140,964.02	5.00	30,704,820.12
Nguru	40,749,535.62	5.00	203,747,678.10	34,817,946.93	5.00	174,089,734.65
Nguu	29,201,277.64	5.00	146,006,388.19	25,933,438.44	5.00	129,667,192.20
Uluguru	38,785,854.04	5.00	193,929,270.21	134,412,037.58	5.00	672,060,187.89
Ukaguru	22,747,025.90	5.00	113,735,129.50	46,085,569.92	5.00	230,427,849.60
Rubeho	63,676,335.18	5.00	318,381,675.92	82,642,288.72	5.00	413,211,443.58
Mahenge	2,543,231.65	5.00	12,716,158.23	-	-	-
Udzungwa	211,407,544.84	5.00	1,057,037,724.18	3,198,268.48	5.00	15,991,342.38
EAM total economic value	**509,536,397.32**		**2,547,681,986.59**	**387,057,894.46**		**1,935,289,472.29**
NPV			**309,530,050.75**			**235,127,559.77**

Note: tCO_2 was calculated as 3.67 x tC

Results in Table 27 show that these mountain blocks store CO_2 of about 134,412,037.58; 82,642,288.72; 46,085,569.92; 35,041,057.97; 34,817,946.93; 25,933,438.44 and 18,317,777.40 tons with economic value of 672,060,187.89; 413,211,443.58; 230,427,849.60; 175,205,289.87; 174,089,734.65; 129,667,192.20; and 91,588,887 USD which are equivalent to 81,319,282.73; 49,998,584.67; 27,881,769.8; 21,199,840.07; 21,064,857.89; 15,689,730.25 and 11,082,255 USD net present value respectively. North Pare, Udzungwa and East Usambara store the lowest amount among the EAM, the blocks store about 6,140,964.02; 3,198,268.48 and 468,545 tons of CO_2 with economic value of 30,704,820.12; 15,991,342.38 and 2,342,725 USD which are equivalent to 3,715,283.23; 1,934,952.43 and 283,469.73 USD net present values respectively.

The observed variation in the value of Co_2 stored in forests and woodlands across EAM blocks is due to the fact that land use, size of reserved or protected forests and population size vary across the mountain blocks. Udzungwa is the largest in terms of land cover and protected forest cover among the EAM blocks which makes it to lead other mountain blocks in terms of Co_2 storage. The mountains are highly populated and the communities living in the mountains depend on the

mountains supply of ecosystem services for their livelihood. This implies that the mountains are under pressure from high demand of ecosystem services to produce consumable goods to support the communities' livelihood. Following high demand of ES conversion of forest into agricultural land and other uses is high in EAM which in turn degrade forests and woodlands, hence the value of CO_2 stored. Equally important, forests are one of the major providers of timber, water, non-timber products and regulation services (i.e. regulate the climatic condition and run-off). Increased demand of ES for production of consumable goods increases demand for timber and non-timber forest products. This also increases pressure on forests which affect the density of standing timber, hence the value.

6.4.4. Economic value of EAMs biodiversity

Biodiversity is defined as "the variability between living organisms from all sources including, terrestrial, marine and other ecosystems and the ecological complexes of which they are part". This includes diversity within species, between species and of ecosystems. There is, however, a question of the extent to which biodiversity values are captured within other categories of goods, for example tourism and hunting, etc., or whether it should be included as a separate category. In this study we have treated it as a separate category because of the potential EAM blocks have in this respect. EAM blocks are one of the most important world biodiversity hotspot with a remarkable economic value. The mountain blocks provide a habitat for various biodiversity.

Biodiversity values can be derived based on assumptions and estimates from the literature. In the literature, total biodiversity values for tropical forests range from USD 11 to 20 USD/hectare/year (Pearce & Moran, 1994). We have chosen the highest optional value because of the high diversity in the EAM blocks in terms of plants, birds, and reptiles. Therefore, the economic value of EAM blocks were estimated at global level and brought down to Tanzania level by taking the share of Tanzania to the global value of 5% to get the national value which is the block biodiversity value. Basing on this we estimated the biodiversity value for each EAM block as presented in Table Table 28. The results show that biodiversity found in EAM blocks have a total economic value of about 3,519,100 USD which is equivalent to 425,811.1 USD net present value.

Disaggregating the economic value of biodiversity inhabited in EAM mountain blocks to the respective mountain blocks, Udzungwa Mountain block lead in the value followed by Rubeho, Mahenge and West Usambara mountain blocks. Estimation results in Table Table 28 shows that these mountain blocks inhabit biodiversity with economic values of about 1,613,100; 463,600; 280,200 and 250,700 USD which are equivalent to 195,185.1; 56,095.6; 33,904.2 and 30,334.7 USD net present values respectively.

Nguru, Nguu, South Pare, Uluguru and East Usambara follows after the above mountain blocks in the value of biodiversity inhabited in the blocks. Results in Table Table 28 show that the mountain blocks inhabit biodiversity with economic value of about 167,300; 159,100; 157,800; 147,800; 125,900 and 108,200 USD which is equivalent to 20,243.3; 19,251.1; 19,093.8; 17,883.8; 15,233.9 and 13,092.2 USD net present value respectively.

Table 28: Economic value of EAMs biodiversity

Name of the mountain block	Block size (ha)	Biodiversity value (USD)*	Total Global value (USD)	Share for Tanzania (%)	Block value (USD)
East Usambara	108,200.00	20.00	2,164,000.00	0.05	108,200.00
West Usambara	250,700.00	20.00	5,014,000.00	0.05	250,700.00
South Pare	157,800.00	20.00	3,156,000.00	0.05	157,800.00
North Pare	45,400.00	20.00	908,000.00	0.05	45,400.00
Nguru	167,300.00	20.00	3,346,000.00	0.05	167,300.00
Nguu	159,100.00	20.00	3,182,000.00	0.05	159,100.00
Uluguru	147,800.00	20.00	2,956,000.00	0.05	147,800.00
Ukaguru	125,900.00	20.00	2,518,000.00	0.05	125,900.00
Rubeho	463,600.00	20.00	9,272,000.00	0.05	463,600.00
Mahenge	280,200.00	20.00	5,604,000.00	0.05	280,200.00
Udzungwa	1,613,100.00	20.00	32,262,000.00	0.05	1,613,100.00
EAM total economic value	**3,519,100.00**		**70,382,000.00**		**3,519,100.00**
NPV			**8,551,045.28**		**427,552.26**

***Pearce &Moran, 1994**

North Pare has the lowest economic value of biodiversity among the EAM blocks, the block inhabits biodiversity with economic value of about 45,400 USD which is equivalent to 5,493.4 USD net present value.

These results show variation in economic values of biodiversity across the mountain blocks, this can be attributed to the fact that size of block and reserved or protected forests, land use and population sizes differ across the mountain blocks. Udzungwa is the largest in terms of land cover and protected forest cover among the EAM blocks which makes it lead other mountain blocks in terms biodiversity inhabited and hence the economic value. Also the mountain block differs in terms of pressure results from human population; as noted earlier, the communities living in the block depends on mountains capacity to provide ES agriculture being their main economic activity. The kind of economic activity plus the population results to pressure on the mountain blocks emanating from demand for ES to produce consumable goods and services and this differ across the mountain blocks. The mountain blocks with larger values are relatively well preserved compared with blocks with lower values.

6.4.5. Non-use values

Non-use values capture the intrinsic significance of natural resources in terms of cultural values, aesthetic values, heritage values and bequest values. This value is particularly important due to the fact that EAM blocks have high cultural and heritage values. For non-use values, we have had to rely on figures established in other works. The range of values arrived at for non-use purposes shows wide divergence in the literature, from 3 USD/hectare/year to 893 USD/hectare/year. It is suggested to use estimate provided by Pearce and Moran (1994), which is a conservative estimate of a global scale, based on conservation finance for tropical forests. The value provided in their study is 5 USD per hectare per year. Basing on this value the economic value of EAM blocks were estimated at global level and brought down to Tanzania level by taking the share of Tanzania to the global value of 5% to get the national value which is the block non-use value. Basing on this we estimated the non-use value for each EAM blocks as presented in Table 29. The results show EAM wealth about 775,465USD non-use value which equivalent to 93,831.27USD net present value.

Disaggregating this value of to the respective EAM Mountain blocks, Udzungwa Mountain block lead in the value followed by Mahenge and West Usambara mountain blocks. Result in Table 29 shows that these mountain blocks wealth about 403,275; 70,050 and 62,675 USD non-

use value which are equivalent to 48,796 and 7,583.68 USD net present values respectively. Nguru, Nguu, South Pare, Uluguru, Ukaguru and East Usambara follow after the three mountain blocks in non-use wealth/value. Results in Table 29 shows that these mountain blocks wealth about 41,825; 39,775; 39,450; 36,950; 31,475 and 27,050 USD non-use value which are equivalent to 5,060.83; 4,773.45; 4,773.45; 4,470.95; 3,808.48 and 3,273.05 USD net present value respectively. Rubeho and North Pare have the lowest non-use values among the EAM blocks; the blocks have about 11,590 and 11,350 USD non-use values which are equivalent to 1,402.39 and 1,373.35 USD net present values respectively.

Table 29: Bequest value of EAMs

Name of the mountain block	block size (ha)	Biodiversity value (USD)*	Total global value (USD)	Share for Tanzania (%)	Block value (USD)
East Usambara	108,200.00	5.00	541,000.00	0.05	27,050.00
West Usambara	250,700.00	5.00	1,253,500.00	0.05	62,675.00
South Pare	157,800.00	5.00	789,000.00	0.05	39,450.00
North Pare	45,400.00	5.00	227,000.00	0.05	11,350.00
Nguru	167,300.00	5.00	836,500.00	0.05	41,825.00
Nguu	159,100.00	5.00	795,500.00	0.05	39,775.00
Uluguru	147,800.00	5.00	739,000.00	0.05	36,950.00
Ukaguru	125,900.00	5.00	629,500.00	0.05	31,475.00
Rubeho	46,360.00	5.00	231,800.00	0.05	11,590.00
Mahenge	280,200.00	5.00	1,401,000.00	0.05	70,050.00
Udzungwa	1,613,100.00	5.00	8,065,500.00	0.05	403,275.00
EAM total economic value	**3,101,860.00**		**15,509,300.00**		**775,465.00**
NPV			**1,884,298.92**		**94,214.95**

***Pearce &Moran, 1994**

These results show how the mountain blocks constituting EAM varies in non-use value which is a value pulled from cultural, aesthetic and heritage values. Udzungwa is still the mountain block with higher values in all the three categories followed by far with other mountain blocks. Rubeho and North Pare have the lowest values of cultural, aesthetic and heritage among the EAM blocks. Again this is due to the size of the block, history of the communities living in the mountain block, population size which determines how preserved the block is to maintain the historical

sites and world heritage i.e. unique species of both plant and animal, historical sites like slave trade routes and local religious beliefs.

6.4.6. Economic value of EAMs water resources

Water is one of the important ecosystem services supplied by EAM blocks. It supports survival of biodiversity, plant and mammals in all mountain blocks. Economically water is important for domestic, livestock, industrial and hydropower generation. Results in Table 30 shows that a total amount of 221,243,185,977.83 m^3 of water is abstracted per year from EAM blocks for various uses. Hydropower generation though is non-consumptive account for a large use of this amount; results in Table 30 show that hydropower generation uses 99.65% of the total amount abstracted from EAM blocks. Irrigation in plantations found in EAM follows by using about 0.22% of the total amount of water abstracted. Irrigation at household level and small scale each uses 0.01% of the total amount of water abstracted. Domestic use at rural and urban areas each uses 0.04% of the total water abstracted per year from the mountain blocks.

Table 30: Quantity of water abstracted from EAM for various uses

Type of water use	**Quantity used (m^3)**	**% used**
Domestic use (Rural)	87,470,552.40	0.04
Domestic use (Urban)	93,833,137.30	0.04
Livestock use	14,265,453.30	0.01
Irrigation household	31,975,975.06	0.01
Irrigation small scale	822,448.21	0.00
Irrigation plantation	490,877,639.75	0.22
Industrial use	64,928,553.74	0.03
Hydropower generation	220,459,012,218.07	99.65
Total quantity (m^3)	**221,243,185,977.83**	**100.00**

6.4.6.1.Water abstracted from EAM for domestic use in rural areas

Disaggregating the quantity of water abstracted into respective use and mountain blocks and valuing it shows that Udzungwa mountain block lead by far in water abstracted and used for domestic purposes in rural areas followed by Uluguru, West Usambara, East Usambara, Mahenge, Rubeho and Nguru. Household survey results indicate that households in these mountain blocks abstract about 28,044,106.02; 9,253,929.42; 8,729,996.79; 7,060,799.29;

6,507,648.69; 6,431,565.83 and 6,045,086.10m^3 of water per year for domestic use respectively. The economic values of this water abstracted are 7,564,793.31; 1,994,226.59; 1,128,142.44; 912,438.75; 1,623,131.51; 1,394,047.38 and 1,083,239.33 USD which is equivalent to 915,339.99; 241,301.42; 136,505.24; 110,405.09; 196,398.91; 168,679.73 and 131,071.96 USD net present values respectively (Table 31).

Nguu, North Pare, Ukaguru and South Pare follows after the above mountain blocks in the amount of water abstracted and used for domestic purposes. Results in Table 31 show that households in these mountain blocks abstract about 4,375,980.97; 4,159,415.14; 3,458,174.66 and 3,403,849.50 m^3 per year for domestic use with economic values of 397,029.93; 417,204.53; 653,485.63 and 310,363.38 USD which are equivalent to 48,040.62; 50,482.75; 79071.76 and 37,553.97 USD net present values respectively.

6.4.6.2.Water abstracted from EAM for domestic use in Urban areas

Among the EAM blocks Uluguru lead by far in the amount of water abstracted for urban use followed by East Usambara, Rubeho and Nguru Mountain blocks. The survey results indicate that from these mountain blocks urban water supply companies abstract about 77,160,100.41; 9,636,026.07; 3,480,500.41 and 2,670,500.41 m^3 of water per year for domestic use in urban centers respectively. The economic values of this water abstracted are 34,458,285.13; 4,969,883.28; 978,325.62 and 740,088.70 USD which are equivalent to 4,169.452.50; 601,355.88; 118,377.40 and 89,550.73 USD net present values respectively.

West Usambara and Ukaguru follow after the above mountain blocks in the amount of water abstracted and used for urban domestic purposes. Results in Table 31 show that water companies in these mountain blocks abstract about 740,000.00 and 146,010.00 m^3 per year for urban domestic use with economic values of 134,065.63 and 49,249.93 USD which are equivalent to 16,221.94 and 5,959.24 USD net present values respectively. In other mountain blocks water is abstracted for urban domestic use but the records on the quantity and the price per unit are not available. Therefore, they were not valued and included in this report.

6.4.6.3.Water abstracted from EAM for Livestock use

As noted in chapter five above, livestock keeping is one of the major economic activities in EAM, therefore, a significant amount of water is abstracted for livestock use each year. Among the EAM blocks North Pare lead by far in the amount of water abstracted for livestock use followed by Udzungwa and Mahenge Mountain blocks. The survey results indicate that households abstract about 7,711,035.16; 2,083,451.65 and 1,394,030.00 m^3 of water per year for livestock use respectively. The economic values of this water abstracted are 791,636.97; 566,568.93 and 349,394.76 USD which is equivalent to 95,788.07; 68,554.84 and 42,276.77 USD net present values respectively.

Nguru, Nguu, Rubeho, South Pare and Ukaguru follow after the above mountain blocks in the amount of water abstracted for livestock use purposes. Results in Table 31 show that households in these mountain blocks abstract about 821,072.15; 724,077.95; 578,855.54; 512,239.50 and 398,332.56 m^3 per year for livestock use with economic values of 148,573.14; 66,076.37; 124,150.46; 50,956.90 and 74,352.66 USD which are equivalent to 99,349.73; 87,613.43; 70,041.52; 61,980.98 and 48,198.24 USD net present value respectively.

West and East Usambara mountain blocks abstract relatively low amount of water for livestock use. The survey results in Table 31 show that households in these mountain blocks abstract about 35,812.76 and 6,546.03 m^3 of water for livestock use per year respectively. The economic values of these quantities abstracted are 4,112.54 and 845.92 USD which is equivalent to 497.62 and 102.36 USD net present values respectively. Uluguru mountain block is not popular in livestock production, therefore, the amount of water abstracted for livestock use is very small to account.

Table 31: Economic value of EAM blocks water resources

Name of the mountain block	Domestic use (Rural)			Domestic use (Urban)			Livestock use		
	Quantity used (m^3)	Price (USD/m^3)	Value (USD)	Quantity used (m^3)	Price (USD/m^3)	Value (USD)	Quantity used (m^3)	Price (USD/m^3)	Value (USD)
East Usambara	7,060,799.29	0.13	912,438.75	9,636,026.07	0.52	4,969,883.28	6,546.03	0.13	845.92
West Usambara	8,729,996.79	0.13	1,128,142.44	740,000.00	0.18	134,065.63	35,812.76	0.11	4,112.54
South Pare	3,403,849.50	0.09	310,363.38	-	-	-	512,239.50	0.10	50,956.90
North Pare	4,159,415.14	0.10	417,204.53	-	-	-	7,711,035.16	0.10	791,636.97
Nguru	6,045,086.10	0.18	1,083,239.33	2,670,500.41	0.28	740,088.70	821,072.15	0.18	148,573.14
Nguu	4,375,980.97	0.09	397,029.93	-	-	-	724,077.95	0.09	66,076.37
Uluguru	9,253,929.42	0.22	1,994,226.59	77,160,100.41	0.37	34,458,285.13	-	-	-
Ukaguru	3,458,174.66	0.19	653,485.63	146,010.00	0.34	49,249.93	398,332.56	0.19	74,352.66
Rubeho	6,431,565.83	0.22	1,394,047.38	3,480,500.41	0.28	978,325.62	578,855.54	0.21	124,150.46
Mahenge	6,507,648.69	0.25	1,623,131.51	-	-	-	1,394,030.00	0.25	349,394.76
Udzungwa	28,044,106.02	0.27	7,564,793.31	-	-	-	2,083,451.65	0.27	566,568.93
Total value	**87,470,552.40**		**17,478,102.77**	**93,833,137.30**		**41,329,898.28**	**14,265,453.30**		**2,176,668.66**
NPV			**2,123,498.17**			**5,021,366.71**			**264,453.87**

6.4.6.4.Water abstracted from EAM for irrigation at household level

As noted in chapter five, irrigation agriculture is one of the economic activities in EAM; therefore, a significant amount of water is abstracted for irrigation at household level each year. Among the EAM blocks South Pare lead by far in the amount of water abstracted for irrigation at household level followed by North Pare, Udzungwa, Nguru, Uluguru, West Usambara and Nguu Mountain blocks. The survey results indicate that households abstract about 10,499,283.72; 6,083,416.22; 5,250,597.92; 3,540,795.08; 2,787,097.07; 1,448,808.29 and 1,251,053.95m^3 of water per year for irrigation at household level respectively. The economic values of this water abstracted are 970,950.99; 705,363.89; 1,134,581.32; 684,250.67; 602,252.99; 318,157.89 and 118,381.63 USD which is equivalent to 117,485.07; 85,349.03; 137,284.34; 82,794.33; 72,872.61; 38,497.10 and 14,324.18 USD net present values respectively (Table 32).

Mahenge, Rubeho and East Usambara follow after the above mountain blocks in the amount of water abstracted for irrigation purposes at household level. Results in Table 32 show that households in these mountain blocks abstract about 581,553.79; 291,927.81 and 241,441.22 m^3 per year for irrigation at household level with economic values of 147,350.70; 63,081.55 and 10,898.34 USD which are equivalent to 17,829.43; 7,632.87 and 1,318.67 USD net present values respectively. Ukaguru mountain block is not popular in irrigation farming, therefore, the amount of water abstracted for irrigation at household level is very small to account.

6.4.6.5.Water abstracted from EAM for irrigation by small scale farms

Apart from irrigation at household level, irrigation is also carried out at small scale level; therefore, a significant amount of water is abstracted for irrigation at this level each year. Among the EAM blocks, Uluguru mountain block lead in the amount of water abstracted for irrigation at small scale level followed by Udzungwa Mountain block. The survey results indicate that households in the two mountain blocks abstract about 622,828.53 and 199,619.68 m^3 of water per year for irrigation at small scale level respectively. The economic values of the water abstracted are 134,584.60 and 43,135.04 USD which is equivalent to 16,284.74 and 5,219.34 USD net present values respectively (Table 32). This farming is not common in other mountain

blocks, therefore, the amount of water abstracted for irrigation at small scale level is very small to account.

6.4.6.6.Water abstracted from EAM for irrigation by plantations

Water abstracted from EAM mountain blocks is also used to irrigate plantations found in downstream of the mountain blocks. These plantations are found in three mountain blocks i.e. East Usambara, Nguru and Udzungwa. Among these mountain blocks, Udzungwa mountain block lead in the amount of water abstracted for irrigating plantations followed by Nguru and East Usambara Mountain blocks. The survey results indicate that plantations in the three mountain blocks abstract about 800,678,564; 427,902,523.20 and 54,296,552.55 m^3 of water per year for irrigation respectively. The economic values of the water abstracted are 16,831,213,944; 213,944,683.89 and 6,295,611.90 USD which is equivalent to 2,036,576,887.22; 25,887,306.75 and 761,769.04 USD net present values respectively (Table 32).

6.4.6.7. Water abstracted from EAM for industrial use

Water abstracted from EAM is also used for industrial purposes. Among the EAM blocks Nguru mountain block lead in the amount of water abstracted and used in industries found in the nearby urban centers followed by Uluguru, West Usambara, South Pare, Udzungwa and East Usambara Mountain blocks. The survey results indicate that about 31,236,408; 11,965,868.74; 8,989,865; 5,349,100; 3,687,452; 2,969,860 and 730,000m^3 of water per year is used in industries respectively with economic values of 18,109,096.51; 5,820,119.61; 1,974,171.78; 2,969,542.57; 1,689,166.46; 344,351.25 and 84,642.51 USD which are equivalent to 2,191,200.68; 704,234.47; 238,874.79; 359,314.65; 204,389.14; 41,666.5 and 10,241.74 USD net present values respectively (Table 32).

Table 32: Economic value of EAM blocks water resources

Name of the mountain block	Irrigation at HH level			Irrigation small scale			Irrigation plantations			Industrial use		
	Quantity used (m^3)	Price (USD/m^3)	Value (USD)	Quantity used (m^3)	Price (USD/m^3)	Value (USD)	Quantity used (m^3)	Price (USD/m^3)	Value (USD)	Quantity used (m^3)	Price (USD/m^3)	Value (USD)
East Usambara	241,441.22	2.20	10,898.34	-	-	-	54,296,552.55	0.12	6,295,611.90	2,969,860.00	0.12	344,351.25
West Usambara	1,448,808.29	0.22	318,157.89	-	-	-	-	-	-	8,989,865.00	0.22	1,974,171.78
South Pare	10,499,283.72	0.09	970,950.99	-	-	-	-	-	-	5,349,100.00	0.56	2,969,542.57
North Pare	6,083,416.22	0.12	705,363.89	-	-	-	-	-	-	730,000.00	0.12	84,642.51
Nguru	3,540,795.08	0.19	684,250.67	-	-	-	427,902,523.20	0.50	213,944,683.89	31,236,408.00	0.58	18,109,096.51
Nguu	1,251,053.95	0.09	118,381.63	-	-	-	-	-	-	-	-	-
Uluguru	2,787,097.07	0.22	602,252.99	622,828.53	0.22	134,584.60	-	-	-	11,965,868.74	0.49	5,820,119.61
Ukaguru	-	-	-	-	-	-	-	-	-	-	-	-
Rubeho	291,927.81	0.22	63,081.55	-	-	-	-	-	-	-	-	-
Mahenge	581,553.79	0.25	147,350.70	-	-	-	-	-	-	-	-	-
Udzungwa	5,250,597.92	0.22	1,134,581.32	199,619.68	0.22	43,135.04	800,678,564.00	0.46	16,831,213,944.00	3,687,452.00	0.46	1,689,166.46
EAM total economic value	**31,975,975.06**		**4,755,269.96**	**822,448.21**		**177,719.64**	**1,282,877,639.75**		**37,051,454,239.79**	**64,928,553.74**		**30,991,090.69**
NPV			**577,740.46**			**21,592.01**			**27,242,629.33**			**3,765,255.60**

6.4.7. Economic value of Hydroelectric power generated from water from EAM

As noted in section 6.4.6 that much of the water abstracted from EAM blocks is used for hydropower generation which is non-consumptive. To value the water used to produce electricity; we based our calculations on gate price per KWH generated which is the price the power plant could charge the power transmission if it were a different distributor instead of water user fee charged by Water Board per megawatt installed capacity. The reason behind our decision is that using the installed capacity charges as raised by water boards tend to undervalue water resources as it does not take into account the amount of water used, the quantity of power generated and the actual market price of the power generated. We also did not use the consumer price since consumers are charged differently depending on the power demand which results to so many prices that are difficult to harmonize to a single price.

6.4.7.1. Basing on water boards water user fee

The installed capacity of power plants in EAM blocks are 200MW for Kidatu, 180 MW for Lower Kihansi, 0.82 MW for Mbingu sisters' hydropower plant, 0.99MW for Iyovi hydropower plant, 80MW for Nyumba ya Mungu, 80MW for New Pangani falls and 25 MW for Hale power plants making a total of 566.81 MW installed capacity (Table 33). Therefore, basing on Water Basin Board charges which is 216.59 per MW installed capacity, the total value of water used to generate electricity in all the power plants installed in EAM blocks is 123,320.37 USD per year (Table 33). Disaggregating this value to respective power plants the economic values of water used for hydropower generation for each power plant are 17,567.2; 5,489.75; 17,567.2; 43,318.00; 38,986.2; 177.60 and 214.42 USD per year respectively (Table 33). However, this under values the resource because it is not based on the actual market price of water and the total power generated per year. The price also does not take into account the amount of water used to generate the power.

6.4.7.2.Basing on market price (gate price)

The installed power plants in EAM blocks abstracted about 220,459,012,218.07 m^3 of water to generate about 1,515,123,259,937.25 KWH per year with the economic value of about 66,665,423,437.24 USD which is equivalent to 8,066,516,235.91 USD net present value basing

on the gate price of 0.04 USD per KWH and the total power generated per year (Table 32). Disaggregating this value to respective power plants the economic values of water used for hydropower generation for each power plant are 3,083,520.00; 952,036.80; 30,835,200.00; 36,347,175,333.33; 30,282,679,700.71; 316,060.80 and 381,585.60 USD per year which are equivalent to 373,105.92; 115,196.45; 3,731,059.20; 4,398,008,215.33; 3,664,204,243.79; 38,243.36 and 46,171.86 USD net present values respectively (Table 33).

Table 33: Economic value of hydroelectric power generated from EAM water resources

Name of the Power plant	Location	Power plant installed capacity (MWH)	Quantity of water used (m^3)	Amount produced (KWH)	Water basin water user fee charged/ installed capacity (USD)	Unit gate price (USD)	Value at water basin price (USD)	value at market gate price (USD)	NPV at Market gate Price (USD)
Nyumba ya Mungu	North Pare	80	42,998,000.00	70,080,000.00	219.59	0.04	17,567.2	3,083,520.00	373,105.92
Hale	East Usambara	25	27,306,137,287.50	21,637,200.00	219.59	0.04	5,489.75	952,036.80	115,196.45
New Pangani	East Usambara	80	31,355,883,492.57	700,800,000.00	219.59	0.04	17,567.2	30,835,200.00	3,731,059.20
Kidatu	Udizungwa	200	113,690,694,718.00	826,072,166,666.67	219.59	0.04	43,318	36,347,175,333.33	4,398,008,215.33
Kihansi	Udizungwa	180	48,041,811,200.00	688,242,720,470.59	219.59	0.04	38,986.2	30,282,679,700.71	3,664,204,243.79
Mbingu sisters	Udizungwa	0.82	10,134,560.00	7,183,200.00	219.59	0.04	177.60	316,060.80	38,243.36
Iyovi	Rubeho	0.99	11,352,960.00	8,672,400.00	219.59	0.04	214.42	381,585.60	46,171.86
Total		**566.81**	**220,459,012,218.07**	**1,515,123,259,937.25**			**123,320.37**	**66,665,423,437.24**	**8,066,516,235.91**

6.5. The EAMs total economics value

As noted in chapter five and earlier sections EAM blocks supply a number of ecosystem services with multiple uses; it supports production of a range of crops, fruits and vegetables. It inhabits both natural and planted forests as well as woodland from which a range of forest products are harvested. The mountain blocks' wetlands also supply numerous products, and it also has many water sources which form numerous streams that drain the mountains and eventually join to form big rivers such as the Pangani, Ruvu, Mgeta, Kilobero, Wami, Zigi and Kihansi Rivers. The forests, wetlands, streams and rivers provide a habitat for diverse and unique biodiversity. The ecosystems services supplied gives the mountain blocks a remarkable economic value as indicate in Table 34. The figures from the various sub-values are aggregated in terms of undiscounted value in USD.

6.5.1. Aggregated total economic value of ES from EAM and standing timber

Table 34 shows that among the ES provided by EAM, standing timber in natural forests account for higher value accounting for 37.44% of the total EAM blocks economic value followed by water resource used to generate hydropower (28.12%), standing timber in woodlands (24.84%) and standing timber in planted forests accounting for 5.69%. While this is the situation with forests and water, agricultural products follow with crop leading the group accounting for 1.34% followed by far by fruits which account for 0.39% of the total value. Having a higher value in forest products implies that forests cover dominates the EAM land area and this is supported by the capacity to absorb and store carbon dioxide both above and underground. Table 34 indicate that economic value of carbon stored in EAM blocks account for 1.07% followed by woodland which account for 0.82% of the total value. Other ecosystem services have less than 0.1% of the total value. These results suggest that much of the EAM blocks economic value comes from the forest stocks and its functions such as hydrological cycle which facilitate water availability and flow throughout the year and carbon absorption and storage. Other ES add to the total value in relatively small values but significant.

Table 34: Aggregated total economic value of ES from EAM and standing timber

Categories	Name of the ecosystem services	Total value (USD)	% of the total value
Agricultural products	Crops	3,186,381,332.37	1.34
	Vegetables	106,859,398.76	0.05
	Fruits	933,304,626.92	0.39
	Livestock	165,121,780.53	0.07
Extracted forest products	Natural forests	51,513,125.69	0.02
	Planted forests	18,833,440.16	0.01
Standing timber	Natural forests	88,769,595,456.95	37.44
	Woodland	58,877,686,970.33	24.84
	Planted forests	13,486,327,112.89	5.69
Water resources	Water (domestic, irrigation, livestock & industrial use)	321,137,563.44	0.14
	Hydropower	66,665,423,437.24	28.12
Biodiversity	Biodiversity value	3,519,100.00	0.0015
Value of existence	Bequest value	775,465.00	0.00033
Carbon sequestration	Forests	2,547,681,986.59	1.07
	Woodland	1,935,289,472.29	0.82
Tourism	Tourism	21,997.93	0.0000093
	EAM total value	**237,069,472,267.08**	**100.00**

6.6. Aggregated total economic value of EAM ecosystem services

The EAM blocks supply a number of ecosystem services with multiple uses. The ecosystems services supplied give the mountains a remarkable economic value as indicated in the Table 35. The total economic value of EAM block ecosystem services is 237,069,472,267.08 USD which is equivalent to 28,787,986,000 USD net present value. Standing timber in natural forests account for 37.44% of the total economic value followed by water resources used to generate hydropower (28.12%). Standing timber in woodland take the third place by accounting for 24.84% of the total value followed by standing timber in planted forests which account for 5.69% of the total value. Agricultural crops take the fifth place by accounting for 1.34% followed by fruits production which accounts for 0.39% of the total value. The mountain capacity to store carbon is high accounting for 1.07% in natural forests followed by woodland which account for 0.82% of the total value. Other ecosystem services account for less than 0.1% of the total value. The capacity to supply ecosystem services and support production of

consumable goods varies across the mountain blocks. Among the EAM blocks Udzungwa accounts for a higher value followed by far by Uluguru, Rubeho, West Usambara, Ukaguru, Nguru, Nguu, South Pare and East Usambara.

Table 35: Aggregated total economic value of EAMs

Mountain block name	Crops ($x10^3$ USD)	Vegetables ($x10^3$ USD)	Fruits ($x10^3$ USD)	Livestock ($x10^3$ USD)	Extracted forests products		Standing timber			Water ($x10^3$ USD)	Hydropower ($x10^3$ USD)	Biodiversity value ($x10^3$ USD)	Bequest value ($x10^3$ USD)	Carbon sequestration		Tourism ($x10^3$ USD)	Total value ($x10^3$ USD)
					Natural forests ($x10^3$ USD)	Planted forests ($x10^3$ USD)	Natural forests ($x10^3$ USD)	Woodland ($x10^3$ USD)	Planted forests ($x10^3$ USD)					Forests ($x10^3$ USD)	Woodland ($x10^3$ USD)		
East Usambara	5,564	661	3,394	3,788	2,550	1,487	5,803,813	763,366	228,501	12,534	31,729	108	27	153,600	2,343	17	7,013,538
West Usambara	7,071	5,554	76,334	8,268	2,202	5,539	8,450,395	6,093,798	351,869	3,559	-	251	63	223,642	175,205	5	15,403,755
South Pare	7,971	5,759	240	10,689	2,787	1,028	4,034,358	3,185,544	-	4,302	-	158	39	106,770	91,589	-	7,451,234
North Pare	2,532	3,178	10	79,884	3,511	564	684,506	1,067,941	-	1,999	3,078	45	11	18,116	30,704	-	1,896,086
Nguru	27,146	68,016	71,843	6,039	4,408	1,813	6,167,806	4,850,972	225,489	234,710	-	167	42	203,748	174,090	-	12,036,288
Nguu	7,207	24	386	19,254	3,861	768	5,516,900	4,509,942	-	581	-	159	40	146,006	129,667	-	10,334,796
Uluguru	6,042	5,933	751,499	2,261	3,141	2,674	5,870,585	18,726,808	-	43,009	-	148	37	193,929	672,060	-	26,278,127
Ukaguru	1,540	125	-	536	10,606	484	4,094,239	7,635,387	-	777	-	126	31	113,735	230,428	-	12,088,014
Rubeho	658	394	1,968	1,363	2,017	412	9,637,981	11,514,045	-	2,560	381	464	12	318,382	413,211	-	21,893,849
Mahenge	6,260	672	178	6,987	1,673	460	457,756	-	-	2,120	-	280	70	12,716	-	-	489,172
Udzungwa	3,114,389	16,544	27,453	26,054	14,757	3,604	38,051,256	529,884	12,680,469	14,987	66,508,939	1,613	403	1,057,038	15,991	168	122,184,613
EAM total value	3,186,381	106,859	933,305	165,122	51,513	18,833	88,769,595	58,877,687	13,486,327	321,138	66,544,127	3,519	775	2,547,682	1,935,289	190	237,069,472
NPV	**387,129**	**12,983**	**113,392**	**20,061**	**6,259**	**2,288**	**10,785,042**	**7,153,331**	**1,638,518**	**39,017**	**8,084,764**	**428**	**94**	**309,530**	**235,128**	**23**	**28,787,986**

CHAPTER SEVEN

7.0 CONCLUSION AND WAY FORWARD

- The study indicates that dependence on EAM blocks ecosystem services is high. Communities living in and around the mountain blocks depend primarily on the mountain blocks ES to derive their livelihoods. Agriculture mainly valley bottom, steep slope and flood plain cultivation are the main land use practices in EAM blocks. Woodlot is another land use practice in the EAM blocks even though it is not popular in many of the blocks except in Udzungwa upstream areas. Livestock are popular in some and not in other mountain blocks. This is due to the topography and lack of grazing land especially in Uluguru and Udzungwa mountain blocks. Fruit production is also popular in some and not in other mountain blocks but the fact, that promotion of households practicing this farming is very low and climate change has added another challenge to this farming system. Fruits which were introduced by colonialists are now being invaded by invasive pests and as a result few of them are still being produced.
- The EAM blocks have high value in all respects of ecosystem services ranging from provisioning, supporting, regulating and cultural respects. The valuation was based on the materials harvested to consume directly and to produce other consumable goods and services. The mountain blocks supply ecosystem services which support a range of economic activities ranging from production to tourisms.
- The largest and most mountain natural assets are standing timber stocks in natural forests and woodlands, planted forests and water. The value of these natural assets varies across the mountain blocks with Udzungwa taking the lead in most of the natural assets valued by this study. This not only shows how potential mountain blocks are but also how valuable they are that necessitates for more investment in preserving them for today's' generation and future generations.
- The study also has revealed that the EAM blocks have higher values of crop, livestock and fruit products. These economic activities employ more than 99.9% of the population living in the mountain blocks. However, this depends on the presence of forests and

woodlands which create the climatic conditions favorable for various crop and animal production.

- On the case of extracted timber, the study has revealed a significantly high value of timber harvested from the mountain blocks natural forests despite the fact that much of these forests are under controlled management system. This clearly indicates that there is illegal timber harvesting going on in the mountain blocks. Even though this provide employment to the people involved along the market chain but it threatens the future capacity of the mountains to continue supporting other valuable economic activities as shown by the study.
- The catchment forests also support the hydropower plants installed in the mountain blocks water resources. The hydropower generated from the EAM blocks installed power plants contribute about *one third* of the total power generated in the country. Therefore, protecting the EAM blocks forests and its environment is not an option task but a must tasks.
- Apart from direct and consumable economic values, EAM blocks also have higher economic value in terms of biodiversity, carbon sequestration and bequest value *in situ* value of existence. Again these depends on the presence of forests and its environment; forests provide a habitat for biodiversity to thrive, forests trees and plants absorb CO_2 from the atmosphere cleaning greenhouse gases and releases O_2, and their existence is valuable.

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APPENDICES

Appendix 1: **A list of mountain blocks and villages visited during data collection exercise held**

SN	Mountain block	District	Forest/nature reserves and national park	Location and village	
				Upstream	**Downstream**
1	East Usambara	Muheza	Amani Nature Reserve	Sakale	Shembekeza
		Korogwe	Nilo Nature Reserve	Bombomajimoto	Foroforo
2	West Usambara	Lushoto and Korogwe	Magamba Nature Reserve	Kinko	Magila
3	South Pare	Same	Chome Nature Reserve	Mwambeni	Maore
4	North Pare	Mwanga	Mramba Forest Reserve	Kwanyange	Kileo
5	Nguru	Kilindi	North Nguru Forest Reserve	Gombero	Nkoa
6	Nguu	Mvomero	Mkingu Nature Reserve	Bungoma/Mkindo	Kambala
7	Uluguru	Morogoro Rural	Uluguru Nature Reserve	Kiswira	Lanzi
		Mvomero	Uluguru Nature Reserve	Nyandira	Langali
8	Ukaguru	Gairo	North Mamiwa Kisara Forest Reserve	Rubeho	Masenge
9	Rubeho	Kilosa	Ukwiva Forest Reserve	Nyameni	Ulaya Kibaoni
10	Mahenge	Ulanga	Mahenge Scarp/Ndororo Forest Reserve	Makanga	Idunda
11	Udzungwa	Kilombero	Kilombero Nature Reserve	Njage	Mkangawalo
			Udzungwa National Park	Msufini	Magombera

Appendix 2: Checklist for village government and environmental committee members

SECTION A: IDENTIFICATION VARIABLES

ITEM	NAME/ NUMBER
1. Date	
2. Name of respondent	
3. Position and address	
4. Village name	
5. Ward	
6. Division	
7. District	
8. Region	
9. Interviewer	

1. Provide the following information based on the 2012 national census

Categories	**Female**	**Male**	**Total**
Total population			
Total households			

2.Provide the following information about the current catchment natural resources (forest, land and water)

Categories	**Acres/hectares**
Total area under crop production	
Total area under tree fruits production	
Total area under forest (natural)	
Total area under forest (planted)	
Number of water sources/catchments	
Total area under water sources	
Categories	**Acres/hectares**
Farm land area	
Total area under forest	
Number of water sources/catchments	

3. Provide information about agriculture production in your village in the past 12 months as indicated in the table below?

3A: C**rops**

SN	Type of crop	acreage	Yields (Bags, Tin, Kg, Tonne)	Price/unit (bag, tin, kg, or tonne)	Total value (Tsh)
1	Maize				
2	Beans				
3	Wheat				
4	Rice				
5	Sunflower				
6	Pigeon peas				
7	Onion				
8	Banana				

3B: Fruits and vegetables

SN	Type of fruit/vegetable	acreage	Yields (Bags, Tin, Kg, Tonne)	Price/unit (bag, tin, kg, or tonne)	Total value (Tsh)
1					
2					
3					
4					
5					
6					
7					

3C Livestock keeping

SN	Type of animal produced	acreage	Yields (kg or litres)	Price/unit (kg/litre)	Total value (Tsh)
1	Beef cattle				
2	Dairy cattle				
3	Pigs				
4	Poultry farming				
5	Dairy goats				
6	Fish farming				
7	Beef cattle				
8	Dairy cattle				

3D: Fish farming

SN	Type of enterprise	Number of fish ponds	Size	Amount harvested (number of fish)	Price/piece

SECTION B: BENEFITS FROM CATCHMENT ECONSYSTEM SERVICES

4. Your area is rich of planted and natural forests resources; what ecosystem services your household is getting from these forests?

4A: Natural forest-publicly owned

Type of ecosystem services	Number of households using the ecosystem services	Total quantity used per month (units)	Total quantity used per year (units)	Market price per unit	Availability
1.Timber					
2.Building poles					
3.Charcoal					
4.Firewood					
5.Wild mushroom					
6.Medicine					
6.Fodder					
7.Wild fruits					
8.Wild vegetables					
9.Forest soil					
10. Ropes					
11. Withies					
12.Others specify …….					
…….					
……					

Codes for availability: 1=abundant; 2=available; 3=scarce

4B: Natural forest-privately owned

Type of ecosystem services	Number of households using the ecosystem services	Total quantity used per month (units)	Total quantity used per year (units)	Market price per unit	Availability
1.Timber					
2.Building poles					
3.Charcoal					
4.Firewood					
5.Wild mushroom					
6.Medicine					
6.Fodder					
7.Wild fruits					
8.Wild vegetables					
9.Forest soil					
10. Ropes					
11. Withies					
12.Others specify …….					
…….					
……					

Codes for availability: 1=abundant; 2=available; 3=scarce

4C: Privately owned forests

Type of ecosystem services	Number of households using the ecosystem services	Total quantity used per month (units)	Total quantity used per year (units)	Market price per unit	Availability
1.Timber					
2.Building poles					
3.Charcoal					
4.Firewood					
5.Wild mushroom					
6.Medicine					
6.Fodder					
7.Wild fruits					
8.Wild vegetables					
9.Forest soil					
10. Ropes					
11. Withies					
12.Others specify …….					
…….					
……					

Codes for availability: 1=abundant; 2=available; 3=scarce

4D: Water resources

S/n	Type of ecosystem services	Number of households using the ecosystem services	Total quantity used per month (units)	Total quantity used per year (units)	Market price per unit	Availability
1	Water for domestic use					
2	Water for livestock					
3	Water for fish ponds					
4	Water for irrigation					
5	Fishes in the nearby rivers					

Codes for availability: 1=abundant; 2=available; 3=scarce

5. How do you rank the demand for/dependence on forest products from the in your village?

   5a: Natural forest privately owned ……..

   5b: Public natural forests ……

   5c: Planted forests ……

   Codes for ranks: 1=Increasing; 2=Decreasing; 3=The same

6. How do you describe the current condition of the forest resources in your village given the kind of dependence/demand? .....
7. How do you describe the demand for/dependence on water resources in your village?

   1. Increasing □ 2. Decreasing □ 3. The same □
8. How do you describe the current condition of water resources in your village given the kind of dependence/demand? .....

SECTION C: ARRANGEMENT FOR SUSTAINABLE UTILIZATION OF ECOSYSTEM SERNICES

9. Provide information on any management plan that exists currently for the following catchment resources:

9A: Natural forest: …….……

……..…..

……..…..

9B: Water sources,…….……

……..…..

……..…..

9C: Land,…… ……..……

……

……

9D: Fisheries,…….……

……

……..……..

9E: Wetlands,……..……
……
……..……..
9F: Biodiversity such as birds, frogs, snakes, and large animals; ……,
……
……
……...…….

10. Was the process of making the arrangements you mentioned in 9 above participatory?
    1. Yes □ 2. No
11. How many households were involved in establishment of the arrangements? …….
12. How was the process conducted? ……., ……., ……., ……..., ……
13. Are there any ecosystem services use charges/user fees collected at village level, district level or regional level? 1. Yes □ 2. No □

14. If yes would specify the amount collected for harvesting the following ecosystem services in your area in the year 2016/2017 (*mention against the ecosystem services in the table below*)

S/n	**Type of ecosystem services**	**Charges/user fee (Tsh)/unit**
1	Water for domestic use	
2	Water for livestock	
3	Water for fish ponds	
4	Water for irrigation	
5	Fishes in the nearby rivers	
6	Timber	
7	Building poles	
8	Trees for charcoal making	
9	Firewood	
10	Wild mushroom	
11	Medicine	
12	Fodder	
13	Wild fruits	
14	Wild vegetables	
15	Forest soil	
16	Ropes	
17	Withies	
18	Others specify ……	

15. If you want to get use permit for any of the ecosystem services mentioned above, what are the procedures you need to go about

    ..……, ….……..,
    ……..., ……,
    ……, ……..,
    ……

16. In case violation of the rules guiding the use of ecosystem services as per permit or village regulations, are there any penalties for that? 1. Yes □ 2. No □

17. If yes would you specify how much you are supposed to pay? *(specify in the table below and the amount paid in Tsh)*

S/n	Type of penalty	Amount charged in Tsh
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

18. Are you satisfied with the existing arrangement for utilization of ecosystem services in your area? 1. Highly satisfied □ 2. Fairly satisfied □ 3. Not satisfied □
19. What could be the best way to utilize products from the forests and water sources that in totality are called ecosystem services sustainably?

    ……., ……..,
    ……..., ……..,
    ……..., ……..,
    ……..

20. Which type of ecosystem services should be given priority for harvesting without affecting sustainability of the ecosystem functioning? *(rank them in the order of importance and the rate at which they are harvested in your village)*

    a. …….
    b. …….
    c. ……..
    d. …….

21. Give reasons for your ranking in 20 above:

……, ……..,

……..., ……..,

…….., ……

Appendix 3: Household survey questionnaire

SECTION A: Study area information

Name of the site: ……. Location: …… (1. Upstream; 2. Downstream). Village name: …….. Ward: …… Division: …….. District: ……..

Interviewer: …….. Date of interview: ……..

SECTION B: Household Information

1. Personal information about the respondent

Respondent characteristic	Gender	Age (years)	Marital status	Education level	Main occupation

Codes for: Gender: 1. Male, 2. Female

Marital status: 1. Married, 2. Divorced, 3. Widowed, 4. Separated, 5. Single

Main occupation: 1. Farming, 2. Timber production, 3. Formal employee, 4. Casual labour in timber production, 5. Small business, 5. Others (specify)

Education level: 1. Informal, 2. Primary, 3. Adult, 4. Secondary, 5. College, 6. Others (specify)

2. Duration of the respondent has stayed in the village?..... years.

3. How do you become a resident in this village?

1. Born in the area □ 2. Employee □ 3. Immigrant □

4. others specify) …..……..…..

4. What makes you continue staying in this village?

…….,

…….,

…….,

SECTION C: HOUSEHOLD CATCHMENT ECOSYSTEM SERVICES BENEFITS & INCOME ACRUED

C1: HOUSEHOLD AGRICULTURAL ECOSYSTEM SERVICE BENEFITS

The catchment support agriculture in many ways, tell us more about your household agricultural activities:

5. What is the total size of land owned by your household?..... acres.

6. How many acres of this land is closer to the water sources?..... acres.

7. How many acres of this land is closer to a forest reserve? …….. acres.

8. How many acres of this land is irrigated using water from nearest water source/river? ……..acres.

9. What was the production and income from your household various agricultural activities in the past 12 months?

9A: C**rops**

SN	Type of crop	acreage	Yields (Bags, Tin, Kg, Ton)	Price/unit (bag, tin, kg, or ton)	Total value (Tsh)
1	Maize				
2	s				
3	Wheat				
4	Rice				
5	Sunflower				
6	Pigeon peas				
7	Onion				
8	Banana				

9B: Fruits and vegetables

SN	Type of fruit/vegetable	acreage	Yields (Bags, Tin, Kg, Ton)	Price/unit (bag, tin, kg, or ton)	Total value (Tsh)
1					
2					
3					
4					
5					
6					
7					

9C Livestock keeping

SN	Type of animal produced	acreage	Yields (kg or litres)	Price/unit (kg/litre)	Total value (Tsh)
1	Beef cattle				
2	Dairy cattle				
3	Pigs				
4	Poultry farming				
5	Dairy goats				
6	Fish farming				
7	Beef cattle				
8	Dairy cattle				

9D: Fish farming

SN	Type of enterprise	Number of fish ponds	Size	Amount harvested (number of fish)	Price/piece
1	Fish farming				

D: FOREST ECOSYSTEM SERVICES

10. Does your household own a forest? 1. Yes □, 2. No □
11. If the answer is yes in 10 above, what is the size of the forest owned by your household? …….. Acres.
12. Your area is rich of planted and natural forest resources; what ecosystem services your household is getting from these forests?

13A: Natural forest

Type of ecosystem services	**Total quantity used per month (units)**	**Total quantity used per year (units)**	**Market price per unit**
1.Timber			
2.Building poles			
3.Charcoal			
4.Firewood			
5.Wild mushroom			
6.Medicine			
6.Fodder			
7.Wild fruits			
8.Wild vegetables			
9.Forest soil			
10. Withies			
11. Ropes			
12.Weed for making mats			
13.Others specify			

13B: Privately owned forests

Type of ecosystem services	**Total quantity used per month (units)**	**Total quantity used per year (units)**	**Market price per unit**
1.Timber			
2.Building poles			
3.Charcoal			
4.Firewood			
5.Wild mushroom			
6.Medicine			
6.Fodder			
7.Wild fruits			
8.Wild vegetables			
9.Forest soil			
10. Ropes			
11. Withies			
12.Others			

specify			

14. Is the demand for ecosystem services pointed in above degreasing, increasing or the same?
    1. Increasing □ 2. Decreasing □ 3. The same □
15. Give reasons for any of the answers mentioned above
    ……,
    ……,
    ……,

E: WATER ECOSYSTEM SERVICES

16. Your area is also rich of water sources; how much water your household is using per day?

SN	Type of water ecosystem services used	Total quantity used per day (units)	Source of water
1	Water for domestic use		
2	Water for livestock		
3	Water for fish ponds		
4	Water for irrigation		

17. How do you find the current flow/availability of forests and water ecosystem services in your village as compared to 20 years ago? (*Indicate the situation against an ecosystem services in the table below*)

SN	Type of ecosystem services	Status of current availability
1	Water for domestic use	
2	Water for livestock	
3	Water for fish ponds	
4	Water for irrigation	
5	Fishes in the nearby rivers	
6	Timber	
7	Building poles	
8	Trees for charcoal making	
9	Firewood	
10	Wild mushroom	
11	Medicine	
12	Fodder	
13	Wild fruits	
14	Wild vegetables	
15	Forest soil	
16	Ropes	
17	Withies	
18	Others specify	

1. Decreasing □ 2. Increasing □ 3. Are the same □ 5. Degraded □ 4. Highly degraded □

18. Give reasons for any of the answers mentioned above:
    ……,
    ……,