FOR THE PROJECT No. 69/2017/RS/EAM: VIABILITY AND ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN THE EASTERN ARC MOUNTAINS

BY

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EXECUTIVE SUMMARY

Forests and natural ecosystems supply a vast of values to the environment. These values can be grouped into social, ecological and economic importance. All these categories function dependently, meaning if one function is impaired the efficiency of the other also gets weak. The ecological functions in an ecosystem are generally the habitat and regulation services while social are attached to the perception of human being and the economic function reflects to the monetary value of a service. The misinformation about the existing relationships between ecological functions and economic functions has led to miss-pricing of goods and services accrued from the ecosystems where by the marketed (revealed preferences) values are given a higher price than the non marketed (perceived) values. As a result to this imbalances and mi-conceptions many of the benefits and economic values provided by nature remain underprivileged by market hence paid less attention in policy making and conservation. It is under this hypothesis, the study on Viability and economic valuation of Eastern Arc Mountains (EAMs) was construed.

As an initiative for conservation of EAMs this study seeks to undertake a feasibility analysis and total economic evaluation of the ecosystem services provided by the Mountains. It is well known that information about the monetary importance of ecosystem services is a powerful and essential tool to make better and more balanced decisions regarding trade-offs involved in land use options and resource use. The study was implemented in three blocks of the Eastern Arc Mountains that is Uzungwa Scarp, Uluguru and Chome Nature Reserves. Choice to these sites is based on the need to rescue the reserves and create environmental and conservation awareness to the practitioners, policy makers and the entire Tanzania community on how these important ecosystems can be sustainably managed to bring about welfare to the wider population in the country. The study used social economic survey and choice experiment to establish the viability and Total Economic Values (TEV) of the goods and services accrued from the ecosystems.

The results showed that there are enormous values which the wider population of Tanzania citizens depend upon in their welfare implying the ecosystems viability. These values include water resources, energy i.e electricity and timber and non timber forest products that enhance communities' livelihoods of communities living adjacent to these EAMs. However, the

stakeholders' showed more preferences to the marketed values of the EAMs goods and services than it is to the non marketed goods and services values. The preferences shown have a direct implication to the extent to which the stakeholders are informed about the relationship that exist between ecological and economic values as it was earlier described in the first paras of this section. Unless the awareness is raised to all stakeholders the viability of the EAMs will not be to its maximum capacity since the cost of protection will be higher than the general benefits unlike if the stakeholders will be made aware of the existing relationships. This fact is demonstrated throughout this research finding. The study therefore argues that the viability of the enormous values that are demonstrated to exist in EAC Mountains need policy orientation whereby there would be greening of our economy through application of Environmental Policy Instruments including PES and Environmental Taxation to goods and services that are exploited to enhance the sustainable management of the EAMs. The institution of PES and Environmental Taxes will increase the monetary values by adding into what is now realized/collected i.e the TEV of EAMs that are tied up in form of ES values that are not transacted in the market framework of goods and services accrued from the mountains.

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ASC	Alternative Specific Constant
CL	Conditional Logit
CNFR	Chome Nature Forest Reserve
DAWASA	Dar es Salaam Water and Sewerage Authority
EAM	Eastern Arc Mountains
EAMCEF	Eastern Arc Mountains Conservation and Endowment Fund
EWURA	Energy and Water Utilities Regulatory Authority
Ha	Hector
HEP	Hydro Electric Power
IRUWASA	Iringa Water Supply and Sewerage Authority
Km	Kilometer
Kg	Kilogram
KNFR	Kilombero Nature Forest Reserve
KPL	Kilombero Plantations Limited
MUWSA	Moshi Urban Water Supply and Sewerage Authority
MW	Mega Watts
N/A	Not Applicable
PES	Payment for Ecosystem Services
SUA	Sokoine University of Agriculture
TANESCO	Tanzania Electricity Supply Company
TFS	Tanzania Forestry Services
TZS	Tanzania Shillings
UNFR	Uluguru Nature Forest Reserve
USNFR	Uzungwa Scarp Nature Forest Reserve

1. INTRODUCTION

Forests and natural ecosystems supplies a vast of benefits to the environment, to mention a few are; purification of air and water, mitigation of droughts and floods, generation and preservation of soils and renewal of their fertility, detoxification and decomposition of wastes, pollination of crops and natural vegetation, dispersal of seeds, cycling and movement of nutrients and control of the majority of potential agricultural pests (Boyd and Banzhaf 2007). These values can be grouped into social, ecological and economic importance. All these categories functions dependently meaning if one function is impaired the efficiency of the other also gets weak. The ecological functions in an ecosystem are generally the habitat and regulation services while social are attached to the perception of human being and the economic function reflects to the monetary value of a service (Groot et al., 2002).

The World Bank (2001) states that, more than 1 billion people depend on forests for their livelihoods at varying degrees. Sixty million indigenous people are almost wholly dependent on forests, while around 350million people living within or adjacent to dense forests depend on them to a high degree for subsistence and income. In developing countries, agro-forestry farming schemes support 1.2 billion people and help sustain agricultural productivity and the generation of income. Forest industries provide employment for some 60million people worldwide. The medical needs of approximately one billion people depend on drugs derived from forest plants, many of which have been long been used in traditional medicine.

Moreover, nature contributes to the sustenance of livelihoods and national economy by providing important goods and services from the ecosystems. It offers natural capital stock obtained to several development sectors including agriculture, fisheries, forestry and tourism which depend heavily on biodiversity and ecosystem goods and services (Groot et al,. 2010). Ecosystem goods refer to the natural products harvested or used by humans such as wild fruit and nuts, forage, timber, game, natural fibers, medicines and so on. More importantly, ecosystem services support life by regulating essential processes such as purification of air and water, pollination of crops, nutrient cycling, decomposition of wastes, and generation and renewal of soils, as well as by moderating environmental conditions by stabilizing climate, reducing the risk of extreme weather events, mitigating droughts and floods, and protecting soils from erosion. The Millennium Ecosystem Assessment (MEA) classifies ecosystem services into provisioning, regulating,

supporting and cultural services all relates to the benefits that ecosystems provide to human well-being. However, many of the benefits and economic values provided by nature remain underprivileged by market hence paid less attention in policy making and conservation.

As an initiative for conservation the project seeks to undertake a feasibility analysis and total economic evaluation of the ecosystem services provided by the Eastern Arc Mountains of Tanzania. It is well known that information about the monetary importance of ecosystem services is a powerful and essential tool to make better and more balanced decisions regarding trade-offs involved in land use options and resource use. The project is to be implemented in three blocks of the Eastern Arc Mountains that is Uzungwa Scarp, Uluguru and Chome Nature Reserves. Choice to this sites is based on the need to rescue the reserves and create environmental and conservation awareness as pointed by Rovero et al,.(2010). Primarily the objective of the study will be to raise awareness of the value of the Eastern Arc mountain blocks and by doing so facilitate policy actions for conservation.

The Eastern Arc is recognized globally as a biodiversity hotspot with some of Africa‘s most unique biodiversity; however, human society has for long taken for granted the services provided by Ecosystems, as they are not formally traded and are therefore dissociated from pricing that reflects changes in supply or demand conditions. With the continued degradation of ecosystems through a variety of human-led pressures, a better understanding of the extent of human dependence on ecosystem services, and hence the vulnerability of human welfare to ecosystem changes, is essential for ensuring sustainable development. Lack of this understanding and failure of markets in reflecting the value of ecosystems mean that information that conveyed to economic decision-makers at all levels is incomplete. Typically, the full social and environmental benefit of these goods and services and the full cost of their degradation are not translated in a way that will ensure optimal decisions for both the economy and the environment. Therefore this study will give details of the total economic value carried by ecosystem services around the Eastern Arc Mountains of Tanzania.

With this study policy makers, national agencies, environmental advocates, regulatory bodies and various stakeholders shall be convinced to pay more attention to the conservation of forest and natural ecosystems for their values that are ignored. It was the objective of this research study to analyses and to document economic value of selected ecosystem services in the Eastern Arc Mountains so as to enhance their biodiversity conservation.

2. DETERMINATION OF TOTAL ECONOMIC VALUES FOR ECOSYSTEM GOODS AND SERVICES IN EASTERN ARC MOUNTAINS

2.1 Description of the study area

The study was carried out in Eastern Arc Mountain (EAM) regions and it involved three regions namely Kilimanjaro, Morogoro and Iringa. Selection of the three regions was based on the need to include all parts of EAM i.e Northern part, Central part and Southern part. Kilimajaro region represented the Northern part of EAM, Morogoro region represented the Central part of EAM regions and Iringa represented the Southern part of EAM. Specifically, in Kilimanjaro region the study was done in Same district, in Morogoro region the study was done in Mvomero and Morogoro rural districts while in Iringa region the study was conducted in Kilolo and Mufindi districts. Selection of these districts was based on their proximity to available nature reserves within EAM. Same district was included because Chome Nature Forest Reserve (CNFR) is within this district, Mvomero and Morogoro Rural districts were included because are surrounded by Uluguru Nature Forest Reserve (UNFR) while Uzungwa Scarp Nature Forest Reserve (USNFR) borders both Kilolo and Mufindi districts. The study involved 13 villages (352 households) as summarized in Table 1 below. The study also involved collection of relevant information from the following offices; Pangani water basin office in Moshi municipality, Rufiji water basin office in Iringa municipality, Wami Ruvu water basin office in Ruvu, Chome nature forest reserve in Same district, Uluguru nature reserve in Morogoro municipality, Uzungwa scarp nature reserve in Iringa municipality and Kilombero forest nature reserve in Kilolo district council.

Table 1: Location of the study area

Region	District	Villages
Kilimanjaro	Same	Mbakweni
		Msindo
		Menamu
		Ndolwa
Morogoro	Mvomero	Nyandila
		Ndungutu
	Morogoro Rural	Lanzi
		Kibungo
Iringa	Kilolo	Idegenda
		Masisiwe
		Mbawi
	Mufindi	Uhafiwa
		Ihimbo

2.2 Sampling procedure and sample determination process

The sampling covered a representative number of villages in the selected region. The selection of villages was based on the following criteria: The village must be within the mountain block area;

- The area must be significantly important for ecosystem services such as potential sites for tourism, wetlands or water resources.
- Accessibility – villages located nearby and those located away from the market centres of the natural resources.
- Presence of potential user groups/stakeholders for ecosystem services

It is considered that households in the selected villages are not homogenous; they vary in terms of how they use resources and the way they perceive values of the natural resources. Households from the villages in the selected wards will be picked randomly from each village with the help of the Village records. Therefore, the study involved 352 households from the three regions in EAM. Detailed interviews on specific ecosystem services with 5 key informants per each village were conducted. The detailed interviews on specific forest services involved only key knowledgeable people at village and district levels. In addition from each village a focus group discussion was carried out constituted 8 to 10 members (village leaders, village natural resource committee, local community and elderly persons) in consideration of gender.

2.3 Data Collection and synthesis of literature

The study involved literature review, field surveys on socio-economic information and choice experiment to determine the values of non marketed goods and services in EAM. Prior to the fieldwork the research team undertook intensive literature review on best approaches for economic valuation of ecosystem services in forests. Also, different research reports from various projects and institutions that worked in the nature reserve in more or less similar issues were reviewed to better design the study.

The study concentrated on four proposed ecosystem services categories i.e. provision,, regulating, supporting and cultural services as shown in Table 2 below.

Table 2: Categories of ecosystem services

Category	Example of Ecosystem Service
Provision	Food, water, raw materials, Medicinal
Regulating	Air quality, Waste management, Carbon sequestration
Supporting	Habitat
Cultural	Aesthetics value, recreational and tourism, spiritual , education

Both market and non marketed market survey methods were employed to capture the Total Economic Value of the EAM. For **market** surveys the questionnaire was used to capture all the goods and services that are consumed by the communities accrued from the EAM.

For **Non Market** values choice experiment was applied. Designing of choice experiment study started with identification of ecosystem service attributes to be valued. These were identified through extensive literature review and community engagement through focus group discussions. The communities were involved in identification of ecosystem service attributes so as to help the study to use most relevant attributes whose preferences will be measured in the valuation stage.

From literature review and focus group discussions, 6 ecosystem service attributes were identified. These were; water supply and protection of water sources, soil conservation for enhancing agricultural production, climate regulation and carbon sequestration, biodiversity conservation, provision of recreation and landscaping amenities and the cost attribute which was termed as payment for the provision of ecosystem services per month. After identification of these attributes, the communities were also involved in assigning levels to each attribute. Levels help to measure

each attribute, and levels of cost attributes allow respondents to do tradeoffs between different alternatives which are provided to them in a choice card. Explanations for each ecosystem service attribute are presented below;

Attribute 1: Water supply and protection of water sources;

Eastern Arc Mountain forests are endowed with various water sources. The EAM supply water to majority of people within and outside the mountain area (more than 3.5 million people). For instance; some of the sources of Ruvu River originate in the Eastern Arc Mountain, this river supply water for domestic and industrial uses to Dar es Salaam region, where largest number of Tanzanians live. Again, the Arcs supply a significant amount of water for hydro power generation thus this ecosystem service is of paramount importance and cannot be underrated. This attributes was assigned three levels which are "maintain the current water supply to communities, HEP generation plants and conservation of water sources in EAM", "reduce the amount of water supply to communities, HEP generation plants and minimize conservation of water sources in EAM, and increase water supply to communities, HEP generation plants" and "increase the water supply and conservation of water sources in EAM".

Attribute 2: Soil conservation for enhancing agricultural production

Forests in EAM help to conserve soil moisture and increase soil fertility. Natural forests protect soil for hundred thousands of farmers who are practicing agricultural activities within the EAM both crop farming and livestock grazing. Forests also regulate flood impacts which help to stabilize the soils and conserve the farms in EAM. Enhanced soil conservation in EAM increases agriculture production in the area. This attribute had two levels which are "maintain the current status of soil fertility and soil conservation in the EAM" and increase the soil fertility and soil conservation in EAM.

Attribute 3: Climate regulation and carbon sequestration

EAM ecosystem services particularly from forests help to regulate the climate and absorb carbon from the atmosphere. This ecosystem service plays a critical role in counteracting the effects of air

pollution. This was assigned three levels which were “maintain the current service”, “reduce the current service” and “increase the provision of the current service”.

Attribute 4: Biodiversity conservation

The EAM forests are biodiversity hotspot homes to hundreds of species found nowhere else on earth. These biodiversity have significance ecological and economical values to the people within and outside the EAM for instance they are source of medicine, tourist attractions, honey production etc. The ongoing loss of biodiversities in EAM necessitates the need to introduce intervention measures to protect and conserve these important species. This attributes had three levels which were “maintain the current number and diversity of species in EAM”, “reduce the number and diversity of species in the EAM by 5 times in the coming 10 years”, “increase the number and diversity of species in the EAM by 5 times in the coming 10 years”.

Attribute 5: Provision of recreation and landscaping amenities

The EAM has significant eco-tourism potential due to existence of various attractions, biodiversity and beautiful landscape in the mountains. Most people enjoy the scenic beauty of EAM like the Uluguru Mountains. Eco tourism can improve local economies through collection of entrance fees to recreation areas, can also have a multiplier effects to the local communities i.e. employment creation in established recreation centres, provide business opportunities, selling of products to tourists and visitors. This attribute was assigned three levels which were “maintain the current number of recreation centers and number of tourists/ visitors who visit the EAM”, “decrease the number of recreation centers and number of tourists/visitors who visit the EAM” and “increase the number of recreational centers and number of visitors/tourists who visit the EAM”.

Attribute 6: Payment for the provision of ecosystem services in EAM per month

The study assumed that no amount is currently paid for provision of these ecosystem services in EAM areas. The payment attribute was given four levels which are; TZS 0 as the status quo since no coin is being paid for provision of these ecosystem services in EAM, and most of these services are received at zero cost (free goods), TZS 3000, TZS 5000 and TZS 10000. Table 3 below

summarizes ecosystem services attributes and levels which were used in a Choice experiment study.

Table 3: Ecosystem Services Attributes and Levels

Attribute	Levels
Water supply and protection of water sources	1. Maintain the current water supply to communities, HEP generation plants and conservation of water sources in EAM, 2. Reduce the amount of water supply to communities, HEP generation plants and minimize conservation of water sources in EAM, 3. Increase water supply to communities, HEP generation plants and increase conservation of water sources in EAM.
Soil conservation for enhancing agricultural production	1. Maintain the current status of soil fertility and conservation in the EAM 2. Increase the soil fertility and conservation in EAM
Climate regulation and carbon sequestration	1. Maintain the current service, 2. Reduce the current service 3. Increase the provision of the current service.
Biodiversity conservation	1. Maintain the current number and diversity of species in EAM, 2. Reduce the number and diversity of species in the EAM by 5 times in the coming 10 years, 3. Increase the number and diversity of species in the EAM by 5 times in the coming 10 years.
Provision of recreation and landscaping amenities	1. Maintain the current number of recreation centers and number of tourists/ visitors who visit the EAM, 2. Decrease the number of recreation centers and number of tourists/visitors who visit the EAM 3. Increase the number of recreational centers and number of visitors/tourists who visit the EAM.
Payment for the provision of ecosystem services in EAM per month	TZS 0, TZS 3000, TZS 5000 TZS 10000.

Experimental design (orthogonal design) was employed to combine the attributes and levels in order to design the choice cards which were presented to the households during preference measurement exercise. From the full factorial design, the number of options that can be created from the study attributes and levels are 648 ($4^1x2^1x3^4$). Fractional factorial design was used to reduce the full options to 9 options. JMP software was used to construct 9 choice cards from the

ecosystem service attributes and their levels. Each choice card consisted of 2 options for ecosystem services provision and an opt out or neither option which was regarded as the status quo or current situation of ecosystem services provision in EAM. The current situation option/status quo was introduced as an alternative in the choice sets, to enable the respondent to choose no change in provision of ecosystem services by keeping the current ecosystem services situation. This enables estimation of welfare measures that are consistent with demand theory (Hanley *et al*., 2001). To reduce the burden upon the respondents, the 9 choice cards were blocked into 3 blocks each with 3 choice cards so each respondent had to complete 3 choice cards. The research team clearly explained each choice card to the interviewee. This helped the respondent to understand the options for ecosystem services provision together with their levels hence choosing his/her most preferred option from each choice card. The three choice cards that were used in this Choice Experiment are shown in Table 4,5 and 6 below;

CHOICE CARDS for Economic Valuation of Ecosystem Services in Eastern Arc Mountains

Table 4: Card 1

Given the following ecosystem services which are provided by EAM, which option would you prefer?

Card No.	Attributes	Option I(status quo)	Option II	Option III
1	Water supply and protection of water sources	Maintain the current water supply to communities, HEP generation plants and conservation of water sources in EAM	Reduce the amount of water supply to communities, HEP generation plants and minimize conservation of water sources in EAM	Maintain the current water supply to communities, HEP generation plants and conservation of water sources in EAM
	Soil conservation for enhancing agriculture productivity	Maintain the status of soil quality in EAM	Increase the soil quality and conservation in EAM	Increase the soil quality and conservation in EAM
	Climate regulation and carbon sequestration	Maintain the current service	Increase the current service	Maintain the current service
	Biodiversity conservation	Maintain the current number and diversity of species in EAM	Maintain the current service	Reduce the current service
	Provision of recreation and landscaping amenities	Maintain the current number of recreation centers and number of tourists/ visitors who visit EAM	Decrease the number of recreation centers and number of tourists/ visitors who visit EAM	Increase the number of recreation centers and number of tourists/ visitors who visit EAM
	Payment for provision of ecosystem services in Eastern Arc Mountains per month	TZS 0	TZS 3000	TZS 5000
I prefer (tick the appropriate box)				

Table 5: Card 2

Given the following ecosystem services which are provided by EAM, which option would you prefer?

Card No	Attributes	Option I(status quo)	Option II	Option III
2	Water supply and protection of water sources	Maintain the current water supply to communities, HEP generation plants and conservation of water sources in EAM	Increase the amount of water supply to communities, HEP generation plants and minimize conservation of water sources in EAM	Increase the current water supply to communities, HEP generation plants and conservation of water sources in EAM
	Soil conservation for enhancing agriculture productivity	Maintain the status of soil quality in EAM	Increase the soil quality and conservation in EAM	Maintain the status of soil quality in EAM
	Climate regulation and carbon sequestration	Maintain the current service	Increase the current service	Maintain the current service
	Biodiversity conservation	Maintain the current number and diversity of species in EAM	Reduce the current service	Increase the current service
	Provision of recreation and landscaping amenities	Maintain the current number of recreation centers and number of tourists/ visitors who visit EAM	maintain the number of recreation centers and number of tourists/ visitors who visit EAM	Increase the number of recreation centers and number of tourists/ visitors who visit EAM
	Payment for provision of ecosystem services in Eastern Arc Mountains per month	TZS 0	TZS 10000	TZS 3000
I prefer (tick the appropriate box)				

Table 6: Card 3

Given the following ecosystem services which are provided by EAM, which option would you prefer?

Card No	Attributes	Option I (status quo)	Option II	Option III
3	Water supply and protection of water sources	Maintain the current water supply to communities, HEP generation plants and conservation of water sources in EAM	Reduce the amount of water supply to communities, HEP generation plants and minimize conservation of water sources in EAM	Increase the current water supply to communities, HEP generation plants and conservation of water sources in EAM
	Soil conservation for enhancing agriculture productivity	Maintain the status of soil quality in EAM	Increase the soil quality and conservation in EAM	Increase the soil quality and conservation in EAM
	Climate regulation and carbon sequestration	Maintain the current service	Increase the current service	Reduce the current service
	Biodiversity conservation	Maintain the current number and diversity of species in EAM	Increase the current service	Reduce the current service
	Provision of recreation and landscaping amenities	Maintain the current number of recreation centers and number of tourists/ visitors who visit EAM	Increase the number of recreation centers and number of tourists/ visitors who visit EAM	Maintain the number of recreation centers and number of tourists/ visitors who visit EAM
	Payment for provision of ecosystem services in Eastern Arc Mountains per month	TZS 0	TZS 5000	TZS 10000
I prefer (tick the appropriate box)				

2.4 Methods for data analysis

Analysis of key informant and household data

Both qualitative and quantitative methods for data analyses will be used to analyze data from key informants and observations, household interviews and selected secondary sources. Qualitative data obtained through key informants and observations shall be summarized into meaningful sentences using content analysis. Quantitative data obtained through household questionnaire survey will be coded and entered into the Statistical Package for Social Sciences (SPSS) software for storage and subsequent analyses to generate descriptive statistics.

Economic analysis of forest ecosystem services

A simplified approach of measuring household use values from forest goods and ecosystem services that was used in the economic quantification is summarized in the following table. This helped in generating the TEV of the natural resources and ecosystem services in the nature reserve which is one of the main goals of this assignment.

A general valuation procedure that was used to quantify ecosystem services is as illustrated in the table below:

Table 7: Total Economic Value of EAM

Ecosystem Services	Valuation method and/or procedure
Eco-tourism	Total value of ecotourism income per year in each forest area/protected system or = No. of people visiting a particular landscape per year X average gate fee per person entering the area if any
Watershed services	Value per hectare for soil conservation and hydrological services from secondary site specific studies (If available) or willingness to pay (WTP) for such services.
Water provisioning	Relative scarcity value of water at household level or the quantity of water (in litres) is used by household per year x price per unit (20 litres' bucket) .
Any other ecosystem service that will be identified	Quantity obtained/harvested x price per unit X number of households obtaining such services from the land scape

For market values standard methods of quantification was employed whereby data on valuation were analyzed using STATA software version 11. For choice experiment data, Microsoft excel was also employed during data entry thereafter were transported to STATA software for further analysis.

Model for non market data analysis

A conditional logit model (CL) was used to analyze respondents' preferences on provision of ecosystem services in EAM. The CL model was used because it is usually modeled based on choice specific attributes (attributes of a good or service under valuation) and not on the individual characteristics (Greene, 2002). CL model holds two assumptions, which are homogeneous preferences among respondents and independence of irrelevant alternative (IIA). The IIA states that the relative probabilities of two options being chosen are unaffected by introduction or removal of other alternatives (McFadden, 1974). Use of CL model helps to capture respondents' preferences on specific choice attributes, in this case ecosystem service attributes in a Choice Experiment as individual characteristics are assumed to be homogeneous (Boxall and Adamowicz, 2002). The relevant ecosystem service attributes identified during FGDs with communities were modeled in the CL model. The following CL model was adopted in this study;

$$U_{njt} = ASC + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

Where;

U_{njt} is indirect utility function of alternative *j* for respondent *n* at choice situation *t*

X_1 water supply and protection of water sources which was modeled as "water"

X_2soil conservation for enhancing agriculture productivity, which was modeled as "soil fertility"

X_3Climate regulation and carbon sequestration which was modeled as "climate"

X_4Biodiversity conservationwhich was modeled as "biodiversity"

X_5Provision of recreation and landscaping amenities which was modeled as "recreation"

X_6Payment for provision of ecosystem services in Eastern Arc Mountains per month which was modeled as "payment"

$\beta_1 - \beta_6$ Coefficient parameters for ecosystem service attributes,

ASC Alternative specific constant

3. RESPONDENTS' SOCIO ECONOMIC CHARACTERISTICS

The study involved a multiple stakeholders whose characteristics varied in many ways. The households' socio-economic characteristics, a unit which represents almost each stakeholder in and around the study area, are described as follows in subsequent sections.

3.1 Respondents' age

Categories of respondents' age are presented in the table below;

Table 8: Respondent's age

Age category (years)	Percentage of the households
15-30	8.5
31-45	30.9
46-60	50.3
Above 60	10.2

It was found that majority of households used in this study were aged between 46-60 years and they made almost half (50.3%) of the total study respondents. This is true for mist rural areas where the households head age ranges from this age group. People aged between 15-30 years made the lowest representation in this study (8.5%), this could be argued is a result of most youths shifting from rural areas to urban areas in search of better living opportunities. The mean age of the respondents was 46.68 years, while the minimum and maximum age recorded were 18 years and 80 years respectively.

3.2 Sex of the respondents

In terms of respondents' sex, male respondents made the higher representation (55.7%) that the female respondents (44.3%) as presented in Fig. 1. This could be attributed to the fact that in most of these societies, males dominate decision making processes, hence by default a male respondent was included in the study in case when both a male and female where found at home for interview. High male representation could be advantageous in implementing decisions resulted from this study especially in valuation of non marketed ecosystem services since male are believed to influence and control the household budget.

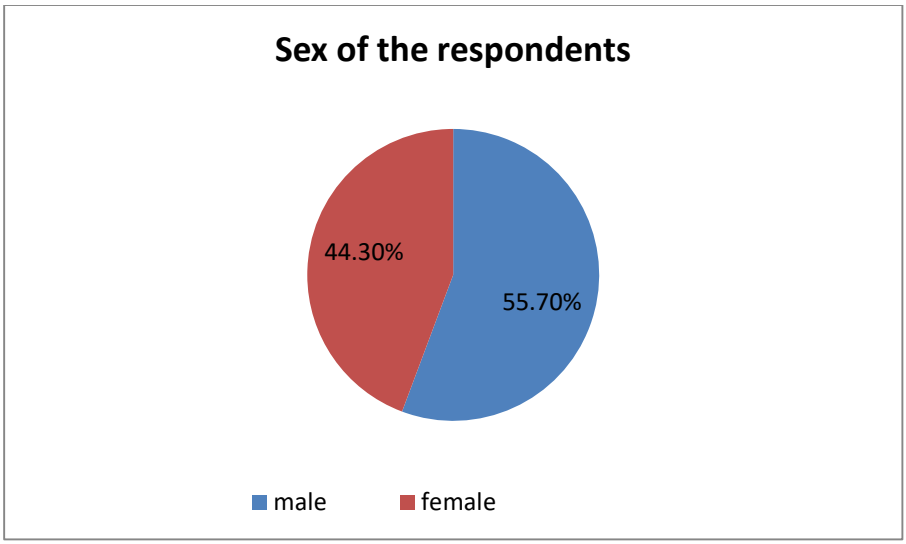


Figure 1: Sex of the respondents

3.3 Respondents' education

Table 9: Respondents' education

Education category	% of the households
Did not attend school	2.3
Primary education	90.3
Secondary education	6.8
Tertiary education	0.6

Table 9 presents that majority of respondents used in this study had attained primary education (90.3%) while very few people have attained tertiary education (2.3%). This very relevant in rural settings were majority of their population has primary education and very few have tertiary education, as it is believed the ones with tertiary education are in urban areas doing white collar jobs unlike the manual works in the village which do not require more education.

3.4 Household size

Table 10: Household size in Eastern Arc Mountains

Household size category	% of the households
Less than 4	23.9
4-7	71.6
8-10	4.0
Above 10	0.6

The study findings ascertained that the household size for majority of households used in this study is between 4-7 persons/household which made the largest representation (71.6%). Households with more than 10 persons made the lowest representation (0.6%). The mean household size in EAM was calculated as 4.6 persons per household, while the minimum and maximum household size recorded were 2 and 13 persons respectively.

3.5 Respondents' main economic activity

Table 11: Respondents' main economic activity

Main economic activity	% for households in Same district	% for households in Mvomero and Morogoro Rural districts	% for households in Kilolo and Mufindi districts	Average % for households in EAM
Crop farming	66.9	68.9	68.2	68.0
Livestock keeping	0	1.8	0	0.6
Crop farming and livestock keeping	26.4	27.4	31.5	28.43
Business	5.5	1.2	1.5	2.73
Others	0	0.8	0	0.26

The study observed that majority of the households in EAM are engaging in agriculture activities (97.03%) and very few (2.97%) are involved with business and other activities. Crop farming alone is done by most households in EAM (68%) while other activities like tailoring, masonary, carpentry is done by very few people (0.26). Table 11 is in line with most literatures which reveal that agriculture is practiced by more than 75% in rural areas and is the mostly practiced economic activity in rural settings.

4. VALUES OF MARKETED ECOSYSTEM GOODS AND SERVICES IN EASTERN ARC MOUNTAINS

4.1Forest Resources in Eastern Arc Mountains

4.1.1 Natural Forests in EAM

Table 12: Natural forests in the study area

Village	Forests available

Mbakweni	Shengena (Chome), Mashankwe, Kwasafu, Nakombo, Kwamfumamapombe
Msindo	Shengena
Menamu	Shengena, Kitondweni
Ndolwa	Shengena, Maliguene, Igondi
Idegenda	Uzungwa/Udzungwa, Ruhiti, Rukosi, Mkumbi, Mianzi
Masisiwe	Uzungwa/Udzungwa, Wengera, Ugalagala, Mnanilo, Masisiwe
Mbawi	Uzungwa, Ilulumo, Nyavetege
Uhafiwa	Uzungwa
Ihimbo	Uzungwa
Ndungutu	Nyandiduma, Kibungo, Lukwangule, Vinyemba
Lanzi	Mgeta, Uluguru, Lumba (Kisaki), Siru

Table 12 presents the natural forest available in the study area. The study revealed that villages in EAM have natural forests which a smaller in size when compared to forest nature reserves. On average, the size available natural forests apart from the nature reserves ranged from 0.5 to 25 acres. Eastern Arc Mountains contain various nature reserves, the ones which were covered by this study are Chome nature forest reserve, Uluguru nature forest reserve, Kilombero nature forest reserve and Uzungwa Scarp nature forest reserve. These nature reserves are surrounded by many villages within EAM and are of paramount importance to the livelihoods of the surrounding communities.

Uzungwa Scarp Nature Forest Reserve (USFNR) has a total size of 32763.2 hectareswith boundary length of about 126 km.USFNR was established in 1929 but it was upgraded to be a nature reserve in 2016. It is located in the Southern highlands of Tanzania within Iringa region (Kilolo and Mufindi districts) and in Morogoro region (Kilombero districts). USFNR is surrounded by 19 villages namely (Itonya, Uruti, IIrutila, Mbawi, Idegenda, Isanga and Masisiwe villages) in Kilolo district, (Uhafiwa, Kipanga, Ukami and Ihimbo villages) in Mufindi district and (Udagaji, Chita, Chinanga, Makutano, Ikule, Kidete, Itongoa and Lufulu villages) in Kilombero district.

Chome Nature Forest Reserve(CNFR) is a unique montane rain forest in the South Pare Mountains in Kilimanjaro Region. It forms part of Eastern Arc Mountain group and is located in South Pare Mountain. CNFRhas a total size of 14283 hectares (35,292 acres). The reserve is locally known as "*Shengena*" forest. The South Pare Mountains form a part of the Northern section of the Eastern Arc Mountain group with the North Pare range to the North West, the Taita Hills in Kenya

to the North East and the West and East Usambara ranges to the South East, and a chain of mountain ranges running South West. The reserve is among the eight Nature Forest Reserves found in the Eastern Arc Mountains that are earmarked for upgrading to the World Heritage status. The boundary of the reserve has a length of about 67 Km and is surrounded by 27 villages in 5 range stations. The villages include Bwambo, Malindi, Kanza, Mtii, Myombo, Luguru, Kilole, Ntenga, Mvaa, Mjema, Bombo, Mpingi, Mamba, Ndolwa, Gwang'a, Malieni, Mhero, Gonjanza, Tae, Nakigale, Kambeni, Manga, Sambweni, Menamu, Msindo and Duma.

Kilombero Nature Forest Reserve (KNFR) covers about 134511 ha and was established after combining the former three forest reserves of Matundu, Lyondo and West Kilombero Scarp in Udzungwa Mountains. The boundary of the KNFR has a length of 369 km. The reserve is located in the southern highlands of Tanzania within Iringa and Morogoro regions in Kilolo and Kilombero districts respectively. It forms the largest mountain block of the Udzungwa Mountains, which are part of the Eastern Arc Mountains chain. The KNFR consists of tall luxurious sub montane forests and deciduous to semi-deciduous highland forests of highest point being Nyumbanitu peak. The reserve is surrounded by 9 villages which are grouped into Udekwa and Ukwega sides. Udekwa side is include Udekwa, Wotarisoli, Mkalanga and Ifuwa villages while Ukwega side involves Kimala, Ipalamwa, Idunda, Lulindi and Muhanga villages.

Uluguru Nature Forest Reserve has an area of 24,115.09 Ha with a boundary length of 197 kms and surounded by 62 villages, comprising of 91,426,000 persons, surround the Nature Reserve. Most of these villages are located adjacent to its boundary. Uluguru Nature Forest Reserve (NFR) comprises the former Uluguru North, Uluguru South, Bunduki I and Bunduki II forest reserves and Bunduki 'gap' corridor, where the forest is being restored on former farmland to provide for biological connectivity between the Northern and Southern parts of the Nature Reserve. The vegetation cover comprises sub montane (below 1,500 m), montane (1,600-2,400 m) and upper montane (above 2,400 m) forests, as well as grassland with swampy areas at Lukwangule Plateau, and Kimhandu and Lupanga peaks..In general, species richness decreases with altitude but the number of endemic species is greater at higher altitudes.The Uluguru Mountains harbours the Ruvu River Basin which is the main source of Ruvu River

The average distance from the village to available natural forest was estimated to be 6.16 Km, where the nearest forest was recorded to be at a distance of 2.0 Km and the furthest forest was at a distance of 20 Km.

4.1.2 Forest Products Harvested from Natural Forests in EAM

Forest products mainly harvested are traditional medicine, honey, mushroom, natural fruits, natural vegetables, firewood, roofing materials among others. Table 7 shows that traditional medicine is the most harvested product by 42.8% of the households while mushroom is a least harvested product by 1.96% households. This could be attributed by the fact that most people in rural areas are still using traditional medicine in treating various sicknesses such as Malaria. Local herbs are mostly harvested in Uhafiwa, Ndolwa and Menamu villages, mushroom are only harvested in Msindo,Ndungutu,Kibungo and Mbakweni villages. This could be due to a reason that people in these villages know the nutritional significance of mushroom.

The study findings also show a significant number of households engaging in honey production (8.5%) through bee keeping activities in the natural forests. The study observed that the number of households engaging in honey production has been increasing since 2016, given the high market value of honey in the country, the number of population engaging in bee keeping activities is anticipated to keep on increasing.

Natural fruits and natural vegetables are mostly harvested by households in Mvomero and Morogoro Rural districts. The harvested natural vegetables are mnafu, lyulu, mchicha pori and mifigufigu , while fruits are passion fruits, matunda pori, fulu, zambarau and sada. Fuelwoods and construction materials are mainly harvested from natural forests in areas which have few planted forests/trees especially in Same district.

The results further show that large number of villagers in Ndolwa and Mbakweni harvest firewood and construction materials from natural forests, this could be due to a reason that, these villages have few planted forests in comparison to other villages like Masisiwe, Uhafiwa and Idegenda. However, the study observed roofing materials locally known as "*makopakopa*"are harvested in Idegenda village for construction purposes despite their village is having many planted forests (Plate 1).These forest products are harvested/collected from available natural forests such as

Shengena, Mashankwe, Kitondweni, Igondi, Maliguene, Uzungwa, Mianzi, Ruhiti, Rukosi, Ugalagala and Mnanilo.

The study respondents explained the reason for harvesting forest products from natural forests to be domestic use (75.8%), business purpose (17.5%) both domestic and business purposes (6.7%). Business is done mainly for honey and sometimes firewood. The rest are for domestic uses thus it can be argued that these communities do depend on natural forests for their survivals. However, it was reported that traditional healers harvest local herbs which they sell to their customers during delivering of healing services. This study did not get an opportunity to interact with any traditional man/woman.

Table 13: Households harvesting natural forest products

Forest product	Percentage of households harvesting the product
Traditional medicine	42.8%
Honey	8.5%
Natural fruits	2.6%
Natural vegetables	3.0%
Mushroom	1.96%
Firewood and construction materials	29.9%

Plate 1: A kitchen roofed with "*makopakopa*" in Idegenda village

Table 14: Quantity of forest products harvested from natural forests for the past 12 months in EAM

Forest product	Unit of measurement	Minimum amount harvested	Maximum amount harvested	Average quantity harvested per household per year
Traditional medicine	bundle	1	6	2.08
Honey	Litre	2	233	4.74
Mushroom	Kg	1.6	4.3	2.3
Natural vegetables	Bundle	4	108	5.2
Natural fruits	Bundle	2	64	2

Firewood and construction materials	Bundle	5	136	39

The study observed decrease in quantity of local herbs which are harvested from natural forests for the past three years. This could be attributed due to changing of lifestyle in which people are nowadays using modern medicine recommended by medical physicians unlike in previous time were people especially in rural areas relied mostly on local/tradition medicine. Another reason could be due to decrease in the availability of traditional medicine in natural forests unlike in previous time. Table 14portrays thaton average each household in EAM harvested 2.08 bundle of traditional medicine from natural forest for the past 12 months. This enunciates that a total of 3,764,849.96 bundles were harvested by all households using traditional medicine in EAM (42.5% households). The respondents reported that all the harvested local medicine were used for domestic purposes to cure illness such as stomach ache, headaches etc. However, it was also reported that, traditional medicine are used for business purposes by traditional healers in the area, unfortunately , the study did not come across any traditional healer who would have validated this proposition.

The study revealed an increase in number of people who are engaging in bee keeping activities in Eastern Arc Mountain areas from 2016 to 2019. This could be attributed to the fact that people are now recognizing the economic importance of honey production in raising the household income. Also, is due to the effect of EAMCEF which are providing trainings and various supports to bee keepers within the EAM areas. The study team found bee keeping facilities (mizinga) in Uhafiwa, Idegenda and Ihimbo villages and respondents explained that the facilities were donated by one of EAMCEF project in order to enable the villagers to have other sources of earning income apart from crop farming.

The honey production rate per household for the past 12 months was 41.74 litres. The minimum and maximum production was 2 and 233 litres respectively (Table 14). A total of 1,736, 330.18 litres were produced by households engaging in bee keeping activities in EAM (8.5%). It was also found that about 43% of the produced honey was used for domestic uses whilst the remaining one was used to increase farmers' income. The selling price for honey ranged from TZS 5000 to TZS10000, but the average selling price was TZS 7750. Thus each farmer doing honey production earned an average of TZS 36,735 per year, but in general honey production in EAM brought

revenue of TZS 7,670,238,570.18 per year. Market for honey is in their villages but some farmers have extended the markets of their product to town areas such as Kilolo, Iringa, Mufindi, Dumila, Morogoro urban, Same, Moshi and Dar es Salaam districts where there is high demand and selling price. The study anticipates the number of farmers engaging in bee keeping will increase in the coming years as most farmers are appreciating the financial contribution of honey production to household income, and they are also receiving supports from EAMCEF projects for instance establishing of apiculture farm groups and provision of bee keeping equipments.Bee keeping activities will offset villagers' dependence on natural resources harvesting from natural forest systems.

Households harvesting mushroom harvested about 2.3 Kg per household for the past 12 months (Table 14). A total of 194,275.9 Kg of mushroom was harvested by households in EAM (1.96% households). Mushrooms are mostly available during rainy seasons especially in November and December. All harvested mushroom was used for domestic consumption.

The study ascertained decrease in number of people who are harvesting firewood and construction materials from natural forests. This could be due to a number of reasons, such as availability of planted trees/ forests in most villages within the EAM areas which have ensured the availability of firewood and construction materials, which originally were harvested from natural forests. Another reason could be due to establishment of forest reserves in the study areas specifically CNFR, KNFR, USNFR, UNFR among others which restrict human activities like harvesting of fuel wood and construction materials in protected areas. Also, it could be due to changes in lifestyle where nowadays people are using modern energy sources which do not depend more on fuel wood for instance improved stoves, gas etc. Furthermore, they are constructing modern houses using bricks and cement thus they use less tree products unlike in previous time when they were constructing traditional houses which relied on more tree products. The average harvest of firewood and construction materials was 39 bundles per household, the minimum and maximum harvest was 5 to 136 bundles. It has to be noted that all harvested firewood and construction materials are used for domestic use, nothing is being sold.

Harvesting of natural vegetation and natural fruits in EAM was also found significant. On average households harvested 5.2 and 2 bundles of natural vegetables and natural fruits per year. These products were reported to be harvested for domestic consumption.

Plate 2: Bee keeping facilities "*mizinga*" donated by EAMCEF in Uhafiwa village

4.1.3 Charcoal Production and Lumbering Activities

The findings found that lumbering and charcoal production activities are only done by few households in EAM. Lumbering is done by 24.2% households while charcoal production is done by 9.2% households. These activities are conducted mainly in Kilolo, Mufindi and Mvomero districts due to the availability of many planted trees/forests in these districts which are harvested for lumbering or charcoal production. Pines and Eucalyptus tree species were mentioned to be the main trees used for lumbering while black wattle trees are used to make charcoal by most households. Charcoal is also produced from other natural trees and shrubs in the study area. Distance from the households to the planted tree farms was estimated to range from 0.1 -3.0 Km. Very few people are engaging in lumbering activities in Same and Morogoro Rural districts, this could be due to land scarcity issues and the small available land is devoted to subsistence cropping. The price of charcoal is varying from one location to another but on average it ranges from TZS

5000 -10000 per bag (50 kg). The price of timber varies from one location to another and depending on timber sizes. Details on timber values are presented in the section of afforestation practices in EAM.

4.1.4 Forest Ecosystem Service Values

Most respondents revealed that they appreciate other ecosystem values which are provided by forest ecosystem services apart from the forest products which are harvested from natural forest. The ecosystem services which are supplied by natural forests were mentioned as source of rainfall, climate regulation, soil conservation, air purification, protection of water sources, source of natural fruits and vegetation, improvement of soil fertility, source of tourist attractions, and provision of habitats for other biodiversities. The study respondents declared that these ecosystem services support their livelihood activities for instance in crop production and supplying of domestic water.

4.1.5 Preferences on Ecosystem Services Provided by Natural Forests in Eastern Arc Mountains

Table 15: Households' preferences on forest ecosystem services in EAM

S/No	Ecosystem service	Preferences in percentage				Ecosystem Preference ranking
		Not preferred	Less preferred	Preferred	Most preferred	
1	Biodiversity conservation	0	2.5%	16.7%	80.8%	5
2	Water conservation	0	0	0	100%	1
3	Control of soil erosion	0	0	5.8%	94.2%	2
4	Flood mitigation	0	0%	23.3%	76.7%	6
5	Nutrient cycling	0	0	15%	85%	3
6	Air purification	0	0	13.3%	86.7%	4
7	Climate regulation	0	11.7	16.7%	71.7%	7
8	Carbon sequestration	0	10%	15%	75%	8

9	Sites for cultural and spiritual activities	57.5%	14.2%	9.2%	19.2%	13
10	Recreational services	16.7%	29.2%	24.2%	30%	10
11	Wildlife for hunting	74.2%	25.8%	0	0	14
12	Availability of pasture for grazing	15%	58.3%	12.5%	14.2%	12
13	Availability of local herbs/ medicinal plants	20%	6.7%	32.5%	40.8%	9
14	Education and research activities	35.8%	33.3%	15.8%	15%	11

The study identified that people in lower EAM areas mostly prefer forest ecosystem services that have directly impact into their life and livelihood activities. Like other rural areas of the world, household in all the studied villages attached the highest preferences on forest ecosystem services that support agricultural production since almost all villagers (97.03%) in the study area are practicing crop farming and livestock keeping though there are variations in number of farmers and livestock keepers in each village. In line with agricultural productivity, respondents from all villages attached their highest preferences on 3 forest ecosystem services which are water conservation and protection of water sources, control of soil erosion and nutrient cycling. The highest preference on these ecosystem services is because these services help to increase their agricultural productivity, for instance conservation of water sources would ensure availability of water for crop farming, erosion control would help to maintain fertility of their soils thus positively impact on crop productivity. Degradation of soil and water resources would impair their livelihoods. Nutrient cycling helps to improve soil fertility in farms. Water conservation is of paramount importance as almost all households in the study area source water for domestic use from water sources which are routed from the natural forests.

Air purification, biodiversity conservation and climate regulation are also highly preferred in the study area due to the fact that, their areas are surrounded by densely natural forests which serve as habitats for wildlife species, purify natural air and stabilize the climate.

Availability of wildlife for hunting is the least preferred ecosystem service in EAM areas, and this is because currently there is no household engaging in hunting activities. Also, the forest reserve management is restricting villagers to engage in hunting activities that is why the respondents attached a lowest preference to this ecosystem service.

Sites for ritual and cultural activities are mostly not preferred in EAM areas. Respondents disclosed their less preference on rituals is due to their modern believes which discourage them from doing rituals and worshipping ghosts. Some mentioned that they are born agains, claiming that the practices of conducting cultural and rituals activities are outdated as they were being done in old times by their old parents. Others commented that they do not have these places in their villages.

The study observed that education and research activities are mostly preferred by households who are currently having children who are studying either in primary or secondary schools. High preference to this ecosystem service was also attached by academicians in the study area i.e households who are primary and secondary teachers.

4.2 Communication Towers in EAM areas

The study found that communication towers are available in Ndolwa village (Sauti ya Injili and Airtel) and Idegenda village where Vodacom and Airtel companies have mounted their communication towers. The respondents from these villages mentioned that they do not know how the payments for establishing those towers in their villages are being made. It can be argued that the logistics of mounting communication towers in these villages are not transparent to most of the villagers.

4.3 River Ecosystems in Eastern Arc Mountains

4.3.1 Rivers in EAM areas

More than 34 rivers were identified by the study. About 11 rivers were reported to originate from forest reserves within EAM areas. These include Nakombo, Shaka, Tasiwene, Indini, and Mjingo rivers which originate from Shengena/ Chome forest reserve in Same district. These rivers discharge their water in Pangani river. Other rivers include Rukosi, Nyamtitu, Ng'embe, Ngolwani,Ivala and Ruaha which originate from Uzungwa forests reserve in Mufindi and Kilolo

districts. The first 4 rivers discharge their water in Idete-Ruaha River which then feeds Kidatu dam while the last 2 rivers discharge their water to Kihansi river which then feeds Kihansi dam.

The study also observed that most of the rivers originate from villages within EAM area. These include Msindo river- in Msindo village, Mwahona and Kwasengara river in Menamu village, Maligueni and Igondi rivers in Maligueni forest, Rudege, Mkalasi and Rungu rivers in Masisiwe village, Kiseresi river in Kidigo mountain. Kidogode river in Mahala, Ngenga river in Wengela, N'gembe river in Ng'embe village, Ilambwa and Kikomele rivers in Mbawi village, Kihansi river in Ilogombe-Mapanda, Mnazungwa, Lamanga rivers in Kipanga village and Makiga river in Uhafiwa village, Mbakana, Mizona, Duzu and Nyamisembe rivers in Ndungutu village, Mgeta river in Lanzi village. It should be noted that most of rivers in Same district discharge into Pangani river basin, while those in Mufindi and Kilolo districts discharge in Kihansi and Ruaha rivers respectively.

Table 16: Rivers available in EAM areas

Village	Name of the river
Mbakweni	Nakombo, Shaka, Tasiwene, Ngiriri
Msindo	Nakombo, Shaka, Ngiriri, Tasiwene, Msindo
Menamu	Mwahona, Kwasengara, Maligueni, Igondi, Ndiva, Mjingo
Ndolwa	Indini, Maligueni, Igondi, Mjingo
Idegenda	Rukosi, Mkangasi, Nyamtitu, Rungu, Rudege, Kinyanungwi, Itambusa, Kikilo, Mkumbi, Kiseseri, Kivango
Masisiwe	Mkalasi, Rukosi, Livala, Kidogode, Ndenga, Ngolwani,Mvenge, Ng'embe, Mahame
Mbawi	N'gembe, Mkalasi, Ilambwa, Kikomele, Itwangilo, Ivala, Kihansi
Uhafiwa	Kihansi, Mnazungwa, Ruaha, Makiga, Lamanga
Ihimbo	Mnazungwa, Lamanga, Ruaha
Ndungutu	Mbakana, Mizona, Duzu and Nyamisembe rivers
Lanzi	Mgeta

Table 17: River source and discharge points in EAM

Village name	Rivers available	Type of the river	Source of the river	Discharge point	Distance from the village to the river in Km
Mbakweni	Nakombo	Seasonal	Shengena forest	Pangani river	1.5
	Shaka	Unseasonal	Shengena forest	Pangani river	1
	Tasiwene	Unseasonal	Shengena forest	Pangani river	1
	Ngiriri	Unseasonal	Shengena forest	Pangani river	0.1
Msindo	Nakombo	Unseasonal	Shengena forest		3

	Shaka	Unseasonal	Shengena forest		3
	Tasiwene	Unseasonal	Shengena forest		3
	Ngiriri	Unseasonal			1
	Msindo	Seasonal	Msindo village		0.2
Menamu	Mwahona	Unseasonal	Menamu village		2
	Kwasengara	Unseasonal	Menamu village		1
	Maligueni	Unseasonal	Maligueni forest		1
	Igondi	Unseasonal	Maligueni forest		1
	Ndiva	Unseasonal			1
	Mjingo	Unseasonal	Shengena forest		2
Ndolwa	Indini	Unseasonal	Shengena forest		1
	Maligueni	Unseasonal	Maligueni forest		1
	Igondi	Unseasonal	Maligueni forest		1
	Mjingo	Unseasonal	Shengena forest		2
Idegenda	Rukosi	Unseasonal	Uzungwa forest	Kidatu dam	2
	Mkalasi	Unseasonal	Masisiwe village	Kihansi dam	2
	Nyamtitu	Unseasonal	Uzungwa forest	Kidatu dam	2
	Rungu		Masisiwe village		2
	Rudege		Masisiwe village		5
	Kinyanungwi				2
	Itambusa				5
	Kikilo				2
	Mkumbi				2
	Kisereri		Kidigo mountain		4
	Kivango				2
Masisiwe	Mkalasi		Masisiwe village	Kihansi dam	
	Rukosi		Uzungwa forest	Kidatu dam	6
	Ivala		Uzungwa forest	Kidatu dam	4
	Kidogode		Mahala		
	Ndenga		Wengela		
	Ngwolani		Uzungwa forest		5
	Ng’embe		Uzungwa forest		5
	Mahame				
Mbawi	Ng’embe		Uzungwa forest	Kihansi dam	4
	Ivala		Uzungwa forest	Kidatu dam	4
	Mkalasi		Masisiwe village	Kihansi dam	4
	Kikomele		Mbawi village		2
	Ilambwa		Mbawi village		2
	Itwangilo		Mbawi village		1
Uhafiwa	Kihansi		Mapanda village	Kihansi dam	9
	Mnazungwa		Kipanga village		7
	Ruaha		Uzungwa forest	Kidatu	6
	Makiga		Uhafiwa village		1
	Lamanga		Kipanga village		8
Ihimbo	Mnazungwa		Kipanga village		7

	Lamanga	Kipanga village		7
	Ruaha	Uzungwa forest	Kidatu	7
	Mbakana			
Ndungutu	Mizona			
	Duzu			
	Nyamisembe			
	Mgeta			
Lanzi				

4.3.2 Water Flow in Eastern Arc Mountains

Information on water flow in EAM was sourced from the water basin offices of Pangani, Rufiji and Wami Ruvu. Literature review was also done to enrich the information provided by water basin officials. Water flow details in EAM are explained below;

4. 3.2.1 Pangani Water Basin

Information shared by the basin official revealed that Pangani Basin is a transboundary basin shared by Tanzania and Kenya. The basin covers an area of 56,300 square kilometers where 5 % of this area lies in Kenya. Pangani basin is comprised of five sub basins namely; Pangani river (43, 650 Km^2), Umba river (8, 070 km^2), Msangazi river (5, 030 Km^2), Zigi river and Coastal rivers including Mkulumuzi river (2, 080 Km^2) which all independently drain to the Indian Ocean. The Pangani river basin has two main tributaries, Kikuletwa and Ruvu rivers, which join at Nyumba ya Mungu, a large man-made water body with a surface area of 140 km^2. The source of Kikuletwa river is in Mount Kilimanjaro and Mount Meru while the source of Ruvu river is Pare and Usambara Mountains. Pangani water basin also has two lakes namely lake Jipe and lake Chala. The Basin is also endowed with high potentials for groundwater. Only 5% of all the water used in the basin is derived from groundwater sources. The Pangani basin official explained that they have installed gauges in main rivers which are used to measure the water flow and levels. Water flows and levels are measured on daily basis in the established points. On average, the highest water flow measurements at Nyumba ya Mungu Dam is 25m^3/s while the lowest water flow measurements is 10 m^3/s.

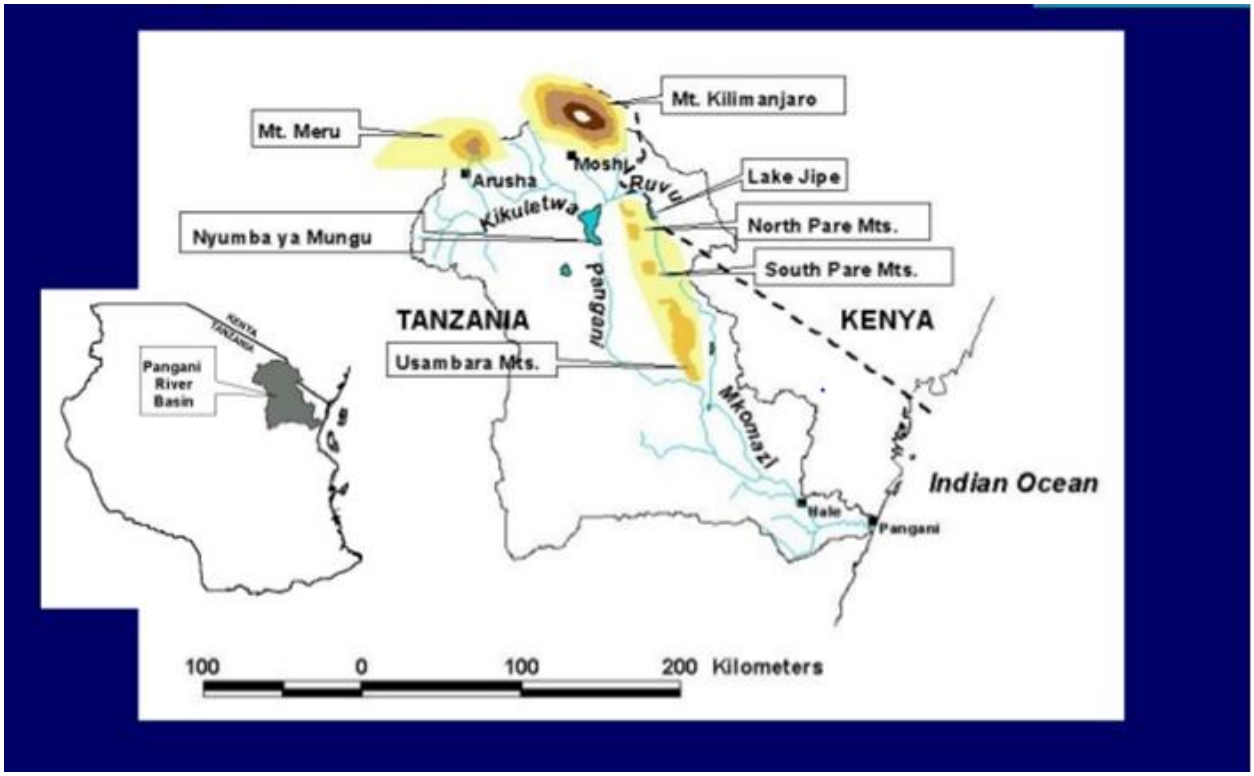


Figure 2: Water Flow Pangani Water Basin

4. 3.2.2 Rufiji Water Basin

Rufiji water basin covers an area of 183,791 square kilometres. Rufiji river lies entirely within Tanzania. It is approximately 600 kilometres (370 mi) long, with its source in Southwestern Tanzania and its mouth on the Indian Ocean at a point between Mafia Island called Mafia Channel. Rufiji water basin is made up of the four principal sub-basins, namely Great Ruaha (85,554 Km^2), Kilombero (40,330 Km^2), Luwegu (25,288 Km^2) and Lower Rufiji (32,619 Km^2). Great Ruaha river is the main tributary of Rufiji river which joins with the confluence of Kilombero and Luwegu rivers and extends into Lower Rufiji up to the Indian Ocean. The Rufiji water basin can easily be identified through its physiology. The delta and the flood plain of the Lower Rufiji form one portion of the basin gradually rising into a plateau of the coastal hinterland into the Southern highlands and the Central Plateau of Tanzania. The river's delta contains the largest mangrove forests in Eastern Africa. Rufiji sub-basins are composed of numerous river systems. Rufiji river can have maximum flows of up to 14,000 m^3/sec and minimum flows of about 50 m^3/sec in the lower catchment. Flows in the basin have a wide range of variation (between the low flow and

high flow periods). The largest part of the basin experiences longer dry seasons and shorter wet seasons.

Basin official from Rufiji water basen office explained that their office is doing measurements of water flows and levels in main rivers within the basin. They have established monitoring stations and they have installed gauges. Locations where gauges are installed flow measurements are done on daily bases, but in monitoring locations without gauges spot flow measurement is done on certain intervals i.e. during dry and wet seasons. The official cited examples of rivers in Kilombero districts were flows are measured are River Ruipa, River Mgugwe and River Mkaja in Chita. The highest water flows recorded in these rivers are $30m^3/s$ during wet seasons. The basin officer explained that on average it costs about TZS 8000000 per year to operate 1 monitoring location. This cost covers salaries of people guarding that station, fuel costs, and transport costs.

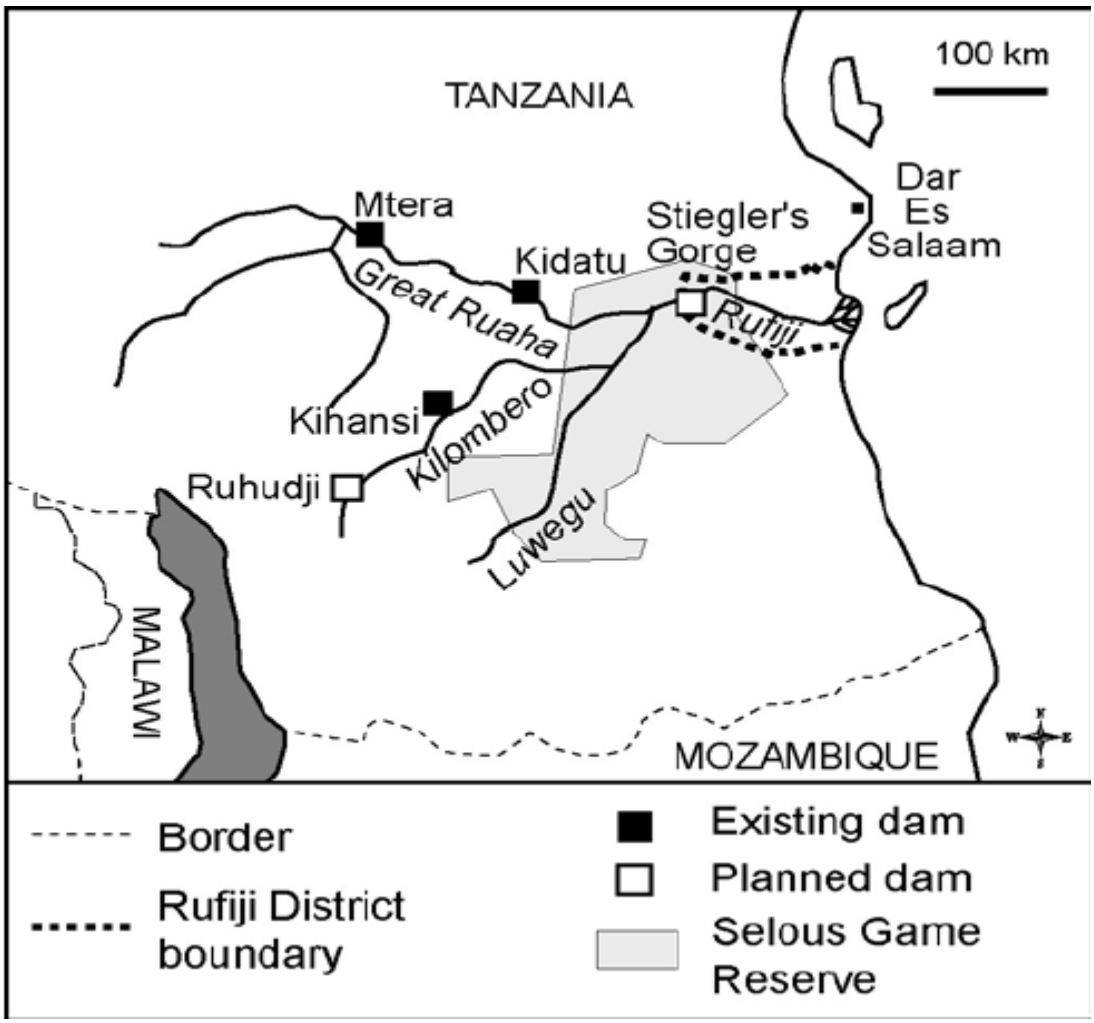


Figure 3: Water flow in Rufiji Water Basin

4.3.2.3 Wami Ruvu Water Basin

Wami/Ruvu Basin is located to the eastern part of Tanzania and includes two major rivers of Wami and Ruvu with an approximate area of 40,000 and 17,700 km2 respectively. The Ruvu sub-basin extends from Morogoro to the West of Dar es Salaam through the Coast and Dar es Salaam regions. Wami-Ruvu basin also has coastal rivers located from north to the southern part of Dar es Salaam City, which makes the total area of the whole basin to be 72,930 Km. Ruvu river originates in the Southern Uluguru Mountains and flows Eastwards to empty into the Indian Ocean near Bagamoyo. Its chief tributary is the Ngerengere River, which rises in the Northern Ulugurus and flows through Morogoro before joining the Ruvu river. Ruvu river drains a catchment of 11,789 Km^2,which includes portions of Morogoro and Pwani regions. Wami river catchment lies to the North and

West, and the Rufiji river catchment lies to the South. The most upstream of the Wami river is the Kinyasungwe river, and then its name changes to Mkondoa and Mkata river. In the downstream of the Mkondoa sub-catchment, it becomes the Wami river that flows up to the estuary. Major tributaries of the Wami river are the Diwale, Mjonga and Lukigura rivers. Mgeta river originates from Western part of the Uluguru Mountain and it joins Ruvu river after the Ruvu river gets out of mountainous area, then Ruvu river flows to the estuary, and along the way it is joined by many tributaries such as the Ngerengere, Msua and Mbiki Rivers. The Coastal Rivers catchment consists of small rivers such as the Mpiji, Msimbazi, Kizinga, Mzinga and Mbezi Rivers. Most of these rivers in the catchment are seasonal at present. Basin official from Wami –Ruvu water basin office explained that water flow measurements in their basin are done at Mgeta river, Nyandila and Mgeta Juu near Sokoine University of Agriculture campus.

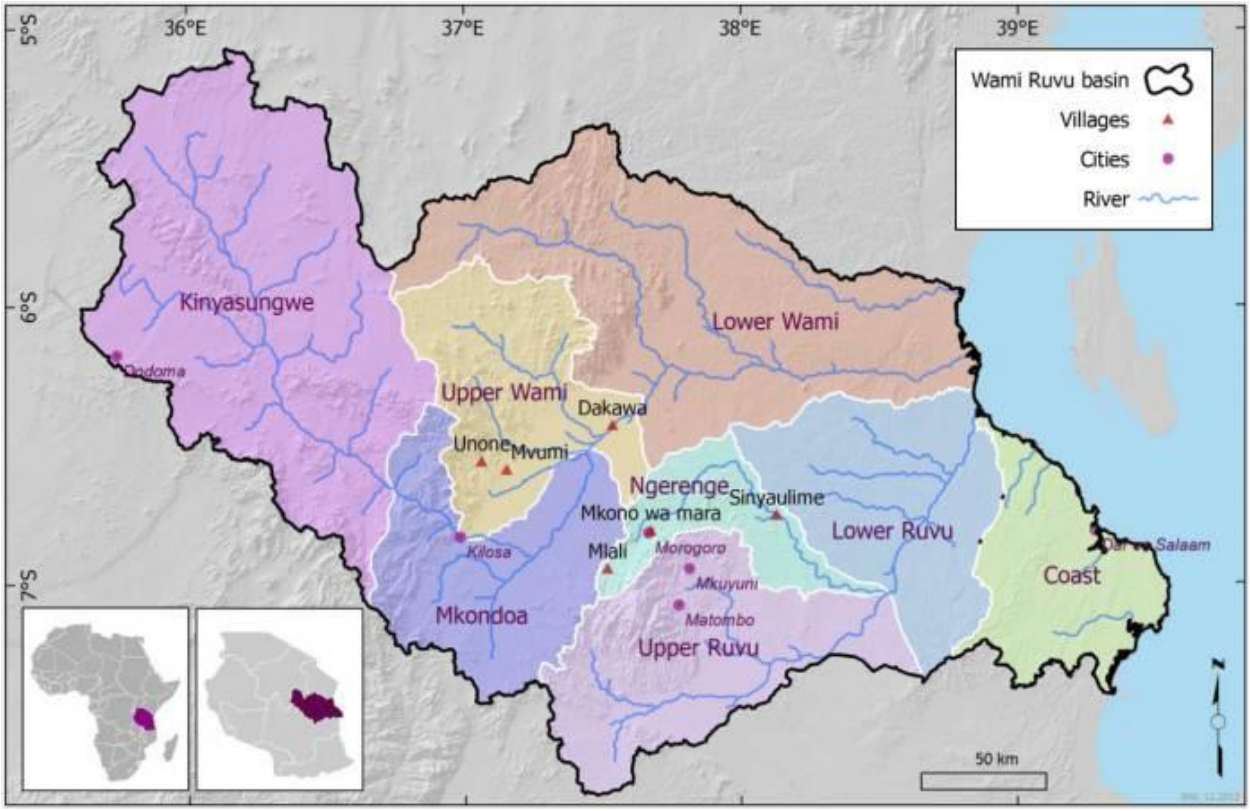


Figure 4: Water Flow in Wami Ruvu Basin

4.3.3 Harvesting of River Resources in Eastern Arc Mountains

The study identified that resources which are harvested from rivers in EAM area are water and fish. Water usage differs from one location to another but it is mainly collected for domestic uses and irrigation purposes. However, in other places, water is used for hydroelectric power production. It was observed that small scale/traditional irrigation practices are done mainly in villages within Same district and some parts of Kilolo district, while large scale irrigation practices are done in Kilombero district where large scale rice farms have been established for instance Kilombero Plantations Limited (KPL) irrigation schemes. Tradition irrigation farming is mainly done for subsistence uses while large scale irrigation farming is done for both subsistence and commercial uses.

Almost all studied villages in EAM collect domestic water from their surrounding rivers and natural streams/ springs. Some households especially in Same district are tapping water direct from water sources in forest reserve areas through connecting pipelines from forests to their villages for instance in Ndolwa and Menamu villages (See Plate 2).

The study observed that Ruvu river supply water for domestic and industrial uses to Dar es Salaam region and two districts of Coastal region which are Kibaha and Bagamoyo. This river is an important source of water for households, irrigated farms, and industries in communities along the river. It is a principal source of water for Dar es Salaam, Tanzania's largest city, which lies on the coast East of the Ruvu catchment. Water supply services are done by the Dar es Salaam Water Supply Authority (DAWASA) which has built a water treatment and distribution plants in Lower Ruvu and Upper Ruvuareas in Coastal region. Lower Ruvu plant has the design capacity of 386,000m^3/day and operating capacity of 180,000 m^3/day while the Upper Ruvu plant has a design and operating capacity of 196,000 m^3/day. It was also found that water supply services in Same district is more of individual arrangements through natural springs, dug boreholes and wells as the Moshi Urban Water Supply and SewerageAuthority (MUWSA) in Kilimanjaro region has not extended its service to the area. However, households mentioned that currently the construction of water supply project is ongoing in their area, and this project will supply water to Same District and Korogwe district. In Iringa municipal council, water supply authority (IRUWASA) has not started to use water from rivers in EAM areas, currently the authority is planning to use water from

Ruaha river. Water basin manager in Rufiji water basin office disclosed that currently IRUWASA is paying a annual fee of TZS 18,000,000 as a water use charges.

The study also revealed that water from some of rivers within EAM is used for hydroelectric power generation in the established hydroelectric power plants. This information was validated by Rufiji water basin manager who explained that rivers in Rufiji water basin area support production of hydroelectric power. For instance in Mtera Dam where about 80 Mega Watts (MW)are generated per per year , in Kidatu Dam about 200 MW are produced per year, in Kihansi dam where approximately 180 MW are produced per year and Mgeta power plant in Kilombero district where about 6MW are generated per year. About 75% of water in Kihansi Dam comes from Uzungwa Nature Forest Reserve. The manager also pointed out that the ongoing hydro power project (Rufiji Hydro Power Project/ Stiegler's Gorge Project) is being constructed in Rufiji River which also belong EAM areas. The project is anticipated to produce a significant amount of electricity of about 2100 MW per year from nine power generating turbinesthus fueling the country economic development. During the interview, the Rufiji water basin manager added that more than 65% of water which will be used in Rufiji Hydropower Project will be collected from Kilombero catchment area.

From Pangani Water Basin Office, the official mentioned that the basin is also supporting production of a significant quantity of electricity. In Nyumba ya Mungu Dam about 8 MW is produced per year, in Hale power plant which is located in Pare Mountains about 21MW is produced per year while New Pangani Falls produce about 68 MW per year.

The results showed that fishing is done in both small and large rivers like Udagaji, Kihansi, Kilombero rivers etc. Fishing in large rivers is done mainly for both commercial and subsistence uses while fishing in small rivers is mainly for subsistence purposes. Study respondents also reported that they are currently practicing fish farming in their villages in which theyhave diverted water from rivers into their established fish ponds. Fish farming is mainly done in Msindo and Mbakweni villages in Same district. Details on fish farming are discussed in agriculture section.

Plate 3: Water trapped from Shengena Forest in Ndolwa Village

4.3.3.1 Frequency of Harvesting Water Resources from Rivers

The findings show that 59.2% of the households in EAM harvest river resources mainly domestic water on daily basis. It was observed that the frequency of harvesting domestic water directly from rivers greatly varies with seasons, it is high during dry seasons and it decreases during wet seasons. Frequency for collecting water for irrigation and fishing activities varies for instance once per week (25%), twice per week (10%), once per month (4.3%), twice per month (1.5%) etc but it is also influence by seasonal variations. Harvest of water for irrigation is more regularly during dry seasons and it decreases in wet seasons. Fishing activities are more practiced in wet seasons unlike dry seasons, and this could be argued is due to decrease in water volumes in rivers as most fish in EAM prefer high river volumes.

4.3.4 Valuation of River Resources Harvested/ Used in Eastern Arc Mountains

4.3.4.1 Water for Domestic Uses

The study estimated the amount of water that is used for domestic purposes per year as 11,119,680 litres (11,119.68 m^3) per 352 households used in this study. This means each household in the EAM area uses about 87.75 litresper day and 2632.5 litres per month. The minimum and maximum amount of water used by households was recorded to be 600 litre and 6000 litres respectively. The calculated daily water usage per person was 19.1 litres as the average household size in EAM was found to be 4.6 persons. The daily water demand per person in EAM is slightly lower from the given United Nations water demand values per person. UNreported the average daily water demand per person to range from 20 to 50 litres. The reason for the difference could be attributed to the fact that this study was done in rural areas where the uses of water in domestic uses is a bit lower when compared to urban environment.

From the Tanzania Population and Housing census (2012), Eastern Arc Mountains has a population of about 4,309,581 from its surrounding 16 districts (Table 12) which is equivalent to 936,865 households. This means a total of 82,209,903.75litres (82209.9 m^3) are used per day by all households in EAM areas which give annual consumption rate of 30,006,614,868.75 litres (30006614.868 m^3). The current water charges for domestic uses charged by water basin offices as per Rufiji water basin official is TZS 1500 per 100m^3. This implies that a total amount of domestic water used by residents in Eastern Arc Mountains costs about TZS450,099,222.9 per year. Thus, the value of ecosystem services to provide domestic water supply to residents within EAM is worth TZS 450,099,222.9 in everyyear.

According to the officials, from Lower Ruvu plant, the two water treatment and distribution plants in Lower and Upper Ruvu supply water to 100,000 households in Dar es Salaam City, Kibaha and Bagamoyo districts. Based on the average household water consumption per day calculated by this study (87.75 litres/household/day), the amount of water supplied to the two regions per day is estimated to be 8,775,000 litres (8775 m^3). This implies that, the total amount of water supplied by DAWASA to the two regions in a year is about 3,202,875 m^3. This amount of water is worth TZS 53,263,811.25 as per the Water Use Fees issued by the Ministry of water, DAWASA is charged TZS 1663 per100m^3 of water it produces from Ruvu River.

This study furtherargues that the value of domestic water from water sources in EAM is about TZS 521,363,034 per year. This amount includes the costs of water used by households within all districts in EAM, and the costs of water supplied by DAWASA to other areas/ districts outside EAM.

The study observed that some villages have a system of paying for water services while others are not paying any water use charge. The payment mechanisms varies from one village to another, for instance in Ndolwa and Menamu villages households are paying TZS 1000 per month while in Idegenda and Masisiwe villages households are paying TZS 3000 per person per year. Water charges on these villages do not depend on the volume of water abstracted. The collected water use fee is used to improve water infrastructures and water conservation programmes in their village. However, the study noted that a little amount of money is collected from households' water use charges in EAM areas hence the government should device a clear mechanism which will encourage people especially in rural areas to contribute water use charges. Most people in EAM still regard water as a free good which nobody is supposed to pay for.

Table 18: Population in Eastern Arc Mountains Districts

S/No	District	Population
1	Mwanga	131442
2	Same	269807
3	Lushoto	292441
4	Korogwe	242038
5	Muheza	204461
6	Kilindi	236833
7	Mkinga	118063
8	Kilosa	438175
9	Morogoro	286248
10	Kilombero	407880
11	Ulanga	265203
12	Morogoro municipal	315866
13	Mvomero	312109
14	Mpwapwa	305056
15	Kilolo	218130
16	Mufindi	265829
TOTAL		**4309581**

Source: Tanzania Population and Housing Census 2012

4.3.4.2 Water for Irrigation Farming

The study found that 26.8% of the households in Same district are engaging in traditional irrigation farming in which they are diverting water from water resources i.e riversto irrigate their farms. Traditional irrigation can be defined as application of water to crop land using indigenous water harvesting techniques which are not based on scientific understanding but locally handed down. It is an attempt to harness the available water from rivers, springs and flood plains for irrigation, it covers relatively small and scattered areas, also they employ traditional methods and their intake structures are often temporary, having to be replaced from time to time (Lankford, 2005). Crops which are mainly being irrigated in the study area include maize, rice, beans etc. It was observed that households in Same district have constructed micro dams for collecting water which are locally known as "*Ndiva*". Micro dam technology (Ndiva) involves impounding runoff water for traditional irrigation by digging and constructing earth embankment (Soil Water Management Research Group, 2005). Water from springs or small rivers is collected first to micro dams before being directed to irrigation field. The micro dam technology works in highlands areas where the Ndiva are used to increase more pressure by impounding water from small streams so as to make the water flow easily during irrigation.

The Ndiva are of varying volumes but they greatly depend on the number of users, but on average each Ndiva can collect up to 10000 litres in 24 hours. The study found that a total of 288000 litres of water is harvested per month by farmers during dry season, and on average each household use about 8228.571 litres per month for irrigation uses. The collected water is used to irrigated farms, and when is finished, the collection exercise is done again. Traditional irrigation farming is mostly practiced in Ndolwa village (10.6%), followed by Menamu village (6.6%), Mbakweni village (5%) and Msindo village (4.16%). Same district experiences dry season in almost 5 months (January, February, June, July and August) in a year which implies that a total of 1440000 litres ($1440m^3$) are harvested per year for traditional irrigation farming. The current water charges for irrigation uses charged by water basin offices as per Rufiji water basin official is TZS 10000 per $100m^3$. This implies that the total amount of irrigation water used by farmers in Same district costs about TZS 14,400,000 per year. The average farm sizes of farms under traditional irrigation ranged from 0.25 to 1.65 acres.Yongoma River which originates from CNFR was mentioned by respondents to support traditional irrigation farming activities in Kisiwani, Gonja, Kihurio and Mkomazi where

crops such as beans and maize are grown in lowland areas and ginger are grown on upper slopes of South Pare Mountains. The excess water from irrigation farms drains into Pangani River which adds value to hydroelectric power production. Respondents from Same district, pointed out that Yongoma River which originates from CNFR supports traditional irrigation farming in Kisiwani, Gonja, Kihurio and Mkomazi were crops such as beans, maize are grown in the lowland areas and ginger are grown on upper slopes of South Pare Mountains. The excess water from irrigation farms drains into Pangani River thus adding value to hydroelectric power production.Traditional irrigation farming is not a common practice in Kilolo, Mvomero, Morogoro Rural and Mufindi districts.

Large and small scale irrigation farms were observed in areas surrounding the Kilombero valley in Kilombero district, where rice is mostly grown.Irrigation schemes such as KPL farms are established by farmers within the area. Statistics from the basin office show that KPL Irrigation Companypays TZS 6,000,000 per year asirrigation water use charges.It should be noted that, data on irrigation water values are missing in most of water basin offices as they are not captured. This could be a wakeup call to the water basin offices to start recording the amount of water used for irrigation purposes so that appropriate water use charges can be collected accordingly from farmers.

4.3.4.3 Hydro Electric Power Production in Eastern Arc Mountains

Hydroelectric power using water from the Eastern Arc Forests contributes about 100% of the total hydropower in the country and more than 50% of the electricity in Tanzania. Other sources such as natural gas and liquid fuel contribute 45% and 13% respectively of the electricity in the country. This signifies the economic importance of water sources within EAM for producing hydropower which is essential to the economic growth and development of the country. A reliable source of water is crucial to avoid serious power blackouts and shortages, with the major inevitable economic consequences.

Rivers in EAM are also used to produce a significant amount of electricity in the country. Electricity production from rivers within EAM constitutes a largest quantity of electricity production in Tanzania. The study identified the amount of electricity which is produced in each power production station within EAM. According to Rufiji water basin manager, the value of water used for hydroelectric power production in EAM, is measured on plant production capacity (units

of electricity produced per year) and not on the volume of water used in power generation. The current rate charged as per the Ministry of Water use fees is TZS 500,000 per each MW generated per year. The water value for electricity produced in EAM is presented in Table 19 below;

Table 19: Value of Water used for Hydroelectric Power Generation in EAM

Name of power production plant/area	Quantity of electricity produced per year	Amount of water use values charged for the produced electricity per year in TZS
Mtera Dam	80 MW	40,000,000
Kidatu Dam	200 MW	100,000,000
Kihansi Dam	180 MW	90,000,000
Mgeta Power Plant	6 MW	3,000,000
Nyumba ya Mungu Dam	8 MW	4,000,000
Hale Power Plant	21 MW	10,500,000
New Pangani Falls	68 MW	34,000,000
Total		**281,500,000**

Water basin offices in EAM charge water use fee of about TZS 281,500,000 per year as the cost of water used for producing 563 MW in Mtera Dam, Kidatu Dam, Kihansi Dam, Mgeta power plant, Nyumba ya Mungu Dam, Hale power plant and New Pangani falls (Table 13). It can also be argued that implementation of the Stiegler's Gorge Project in Rufiji River will contribute a water use charge of about TZS 1,050,000,000 per year from the anticipated production capacity of 2100 MW of electricity.

4.3.4.4 Value of hydro electric power produced from rivers in EAM areas

With reference to Table 19, a total of 563 MW of electricity is produced per year from rivers in EAM areas. From January 1, 2017, TANESCO proposed to EWURA the electricity tariff of TZS 286.28 per 1 Kilowatt of electricity. Using this tarrif, 563 MW (563000 Kilowatts) produced from rivers in EAM per year has a value of TZS 161,175,640.

4.3.4.5Fishing Activities in the EAM Areas

Few households (14.2%) are practicing fishing activities in the study area. Fishing is done for subsistence uses in rivers in Same, Mvomero and Kilolo districts. In EAM areas, commercial fishing is mainly practiced in Kilombero district.

4.4Ecotourism in Eastern Arc Mountain Areas

The study found that ecotourism activities in EAM are mainly done in the established nature reserves which are Chome Nature Forest Reserve, Uzungwa Scarp Nature Forest Reserve, Uluguru Nature Forest Reserve and Kilombero Nature Forest Reserve. These reserves are endowed with various tourist attractions.

Uluguru NFR has attracted a number of tourists since it is a home to a number of endemism for both plants and animals species with some of these species being threatened to extinction due to human activities In comparison with other Eastern Arc Mountains, Uluguru NFR is one among the Nature Reserve in the Eastern Arc having higher number of endemic and near-endemic plant species. The reserve is a haven for at least 135 endemic plant species including rare African violets and orchids resource, and fund better management of the region's biodiversity. Special sites and features in the Uluguru NFR include sacred forests, summits and viewpoints like Kimhandu summit, Kitumbaku ridges, Lupanga peaks and Bondwa peak. Other tourist features in Uluguru NFR include Lukwangule plateau, Kibwe and Hululu water falls; headquarter of the Waluguru's traditional leader, Chief Kingalu Mwanabanzi XIV and the famous morning side.

In Uzungwa SNFR, ecotourism attractions includes Uzungwa escarpment, Colobus monkeys(red and black white) water falls (Idasi, Funo and Ilutila) Natural dams(Mkololo),tree climbing frog (Hyperolius kihangensis), curves (Ilutila,Ngwilo). In Kilombero NFR attractions include nyumba nyitu and magombelema (njagi).

In Chome NFR, there are a number of excellent hiking trails through the reserve's forest. All times shown are for walking there and back. Shengena Peak Trail provides an excellent view of Mkomazi National Park and Taita Hills in Kenya. There is also Turaco trail for keen birders, Butterfly Trail, where high, montane forest with many species of butterflies, flowers and epiphytes are found. Chome NFR also has Thomson Waterfalls Trail, Bat Caves trail. The reserve also includes some sites of historical and cultural value, for instance the King's Stone, a huge rocky outcrop that was used for human sacrifices to the Wapare traditional gods.

Unlike other Nature reserves in EAM, Uzungwa SNFR is doing great in ecotourism activities as it receives a high number of tourists per year when compared to other reserves. For instance in 2016/17 they received 16 tourist, in 2017/18 they received 66 tourists and in 2018/19 they received 190 tourists and the number of tourists in anticipated to increase in the coming years. Most of these tourists came from European countries such as Germany, Italy, Spain and Belgium while very few were local visitors coming from Tanzania. Some of the tourists were students who came to do their masters research in the reserve. The duration of stay of these visitors ranged from 1 to 20 days. Eco tourism charges as per the ministry's directives were TZS 2000 per day for the natives, USD 10 per day for foreigners, camping fee is TZS 5000 per day, research fee is TZS 2500 per day and TZS 5000 per day for academia. The reserve management disclosed that in last year, they collected total revenue of TZS 11,496,633 from ecotourism activities in their reserve and they are targeting to generate more revenues through increasing number of visitors in their reserve.

During the interview Chome NFR conservator, disclosed that in last year, their reserve received only 17 tourists who came from Spain and Germany in between July to December. The maximum stay of these tourists ranged from 1 to 4 days. Similar trends were observed to other nature reserves for instance Kilombero NFR received a total of 16 tourists of which 11 came from Netherlands and 5 were local tourists. This tells that ecotourism activities in EAM are still low hence there is the need for ministry of tourism to join hands with other stakeholders to advertise the tourism potential of nature reserves within EAM. Ecotourism was mentioned by the conservators as the only source of revenue to all nature reserves in EAM. The low development of ecotourism in EAM implies that all reserves in the area will not develop as they lack enough funds to reinforce/ manage conservation activities since they collect very little from ecotourism activities.

The study further noted that there are recreational/traditional sites in some of the villages where villagers do visit for their various purposes. Visitation/entrance to these sites is usually free of charge. These sites include water caves and falls in Mshewa ward and Ndivankundu shrine for rituals in Same district , Lukwangula in Mvomero district. The ministry of natural resources and tourism needs to cooperate with responsible villages and advance these sites.

Plate 4: Colobus monkey found in Uzungwa SNFR

4.5Agriculture in Eastern Arc Mountain Areas

The findings of this study revealed that about 97.03% of the households in the study area are engaging in agriculture activities where by 68% are involving in crop cultivation only, 0.6% are keeping livestock and 28.43% are doing both crop cultivation and livestock keeping (Table 14). The percentage of households who are doing crop cultivation only is almost the same in the three nature reserves but Uzungwa scarp nature reserve had the highest percentage (31.5%) of households who are doing both crop farming and livestock keeping which exceeded the average percent in all nature reserves (28.43%). Households who are keeping only livestock (1.8%) were found only from communities in Mvomero district and these were made up of Sukuma people who migrated to Morogoro region. The main crops which are cultivated by farmers in EAM are maize and beans while the main livestock kept are goats, pigs, cows and chicken.

Table 20: Percentage of Households involved in crop cultivation in Eastern Arc Mountain area

Crop cultivated	% of households in Same district	% of households in Mvomero and Morogoro rural districts	% of households in Kilolo and Mufindi districts	Average % of households in EAM areas
Maize	100	96.4	100	98.9
Beans	90.9	71.4	95.4	86.4
Potatoes	55.5	10.7	74.6	47.7
Banana	54.2	48.1	0.4	32.4
Njegere	0	8.9	58.5	24.4
Vegetables	40	28.9	3.1	22.7
Paddy	0	13.2	1.1	4.5
Ginger	23.6	0	0	7.4
Coffee	38.2	0	0	11.9
Others	23.6	44.6	24.6	26.9

Table 20 shows that farmers in Same, Mvomero, Morogoro Rural, Kilolo and Mufindi districts are mostly cultivating maize (98.9%) and beans (86.4%). Other crops grown by farmers in these areas include potatoes (47.7%), banana (32.4%), njegere (24.4%), vegetables (22.7%), paddy (4.5%), ginger (7.4%), coffee (11.9%) while other crops like cassava, yams, cocoyams, cowpeas, vanilla, olive, groundnuts are grown by 26.9% of the farmers. The findings further revealed that potatoes both sweet and irish potatoes are mostly cultivated by farmers in Kilolo and Mufindi districts (74.6%) which exceed the average percent inall EAM areas (47.7%). Banana is mostly grown by householdsin Same district (54.2%) and Mvomero and Morogoro Rural districts (48.1), farmers in Kilolo and Mufindi districts grow a very small amount of banana. Table 20 also presents that ginger and coffee are only grown by farmers in Same district. Paddy is mostly grown by farmers in Mvomero and Morogoro Rural districts (13.2%). Njegere is mostly grown by farmers around Kilolo and Mufindi (58.5%) but it is not grown by farmers in Same district. Other crops like cassava, yams are grown by 26.9% of the farmers in EAM. The study observed that crops like cowpeas, vanilla and olive are mostly grown by farmers in Mvomero and Morogoro Rural districts.

The study observed that most of farms where crops grown are located within the villages at a distance of 0 to 3 Km. In most cases, crop farms are located within or near farmers' residential places due to scarcity of arable land in mountain areas. Farms not located around residential places are also within a walkable distance which on average do not exceed 3 Km. An average farm size

for all farmers in EAM was estimated to be 0.908 acres. The minimum and maximum farm sizes recorded in this study were 0.3 acre and 9.6 acres respectively. The average size for maize and beans farms were 2.2 acres since in most cases maize and beans are planted together, the average farm sizes for other crops were; irish potatoes (1.03 acres), paddy (1.16 acres), ginger (0.1 acre), coffee (0.28 acre), njegere (0.49 acres), banana (1.44 acres), vegetables (0.18 acre) other crops (0.18 acre). The study identified that farmers in Kilolo and Mufindi districts own larger farms in comparisons to farmers in Same, Mvomero and Morogoro Rural districts.

Table 21: Crop Farm Sizes in Eastern Arc Mountain Area

Crop grown	Average farm size in Same district	Average farm size in Mvomero and Morogoro rural districts	Average farm size in Kilolo and Mufindi districts	Average farm sizes in EAM areas
Maize	1.44	2.4	2.77	2.2
Beans	1.43	2.38	2.83	2. 2
Irish	0.7	0.68	1.73	1.03
paddy	0	3	0.5	1.16
ginger	0.34	0	0	0.1
coffee	0.85	0	0	0.28
njegere	0	0.1	1.37	0.49
vegetables	0.17	0.15	0.23	0.18
banana	2.47	1.05	0.8	1.44
others	0.1	0.25	0.2	0.18

4.5.1 Crop Harvest in the Past 12 Months in Eastern Arc Mountains

4.5.1.1 Crop Production in Same District

Table 22: Crop Production in Same District

Crops	Harvested/household/year		Consumed/household/year		Sold/household/year	
		Mean for EAM areas		Mean for EAM areas		Mean for EAM areas
Maize (Kg)	266	357	194	211.3	67	133.66
Beans (Kg)	218	195.3	129	115.33	85	83.33
Irish (Kg)	681	1349.66	350	548.67	331	437
Rice (Kg)	0	156.5	0	98.5	0	42.66
Ginger (Kg)	67	22.33	8	2.66	56	18.66
Coffee (Kg)	83.3	27.76	3	1	80	26.66

Njegere (Kg)	0	224	0	26.66	0	46.66
Vegetables (no. of bundles)	108	223.66	72	92.67	26	160.66
Banana (no. of bunches)	56	30.6	22	12.2	32	20.3
Other crops (no. of bunches)	32	40.3	2.26	4.99	27.29	35.95

Table 22reveals that irish potatoes (681 Kg/household/year) and maize (266 Kg/household/year) were the mostly produced crops by farmers in Same district in the past 12 months. However, irish potatoes and maize production was below the average production value for EAM areas which was 1349.66 Kg/household/year and 357 Kg/household/year for irish potatoes and maize respectively. Ginger (67 Kg/household/year) and coffee (83.3 Kg/household/day) production was above the average value for EAM areas, 22.33 Kg/household/year and 27.76 Kg/household/year for ginger and coffee respectively. The study observed that, in EAM areas ginger and coffee are mostly grown in districts which are in Kilimanjaro and Tanga regions.

Table 22propounds that irish potatoes, maize and beans were the mostly consumed by households in Same district for the past 12 months. The consumption value of beans (129Kg/household/year) was above the average production in EAM areas (115Kg/household/year) while the consumption values for irish potatoes and maize were below average in EAM areas.

Selling of beans (85Kg/household/year), ginger (56 Kg/household/year), coffee (80 Kg/household/year) and banana (32 bunches/household/year) was above the average value in EAM areas which were (83.33 Kg/household/year), (18.66 Kg/household/year), (26.66 Kg/household/year) and (20.3 bunches/household/year) for beans, ginger, coffee and banana respectively.

Table 23: Revenue from Crop Selling in Same District for the Past 12 Months

Crop sold	Quantity sold/ household	Average price per unit (TZS)	Amount obtained (TZS)/household/ year
Maize (Kg)	67	470.85	56502

Beans (Kg)	85	1457.69	123903.65
Irish (Kg)	331	277.05	91703.55
Ginger (Kg)	56	692.3	38768.8
Coffee (Kg)	80	494.67	39573.6
Vegetables (no. of bundles)	26	489	12714
Banana (no. of bunches)	32	8363.63	267636.16
Other crops (no. of bundles)	27.29	1247.82	34053.01
TOTAL			**664854.8**

The study findings estimated that each household engaging in crop cultivation in Same district earned an average of about TZS 664,854.8/year from crop selling. Table 23 also depicts that selling of banana brought more revenue to the households (of about TZS 267,636.16/household/year) followed by beans (TZS 123903.65/household/year) and irish potatoes (TZS 91703.55/household/year) while vegetables brought a least amount (TZS 12,714/household/year). Other crops also contributed a significant amount to the household income (Table23). The study observed that most of these crops are sold within the villages and very few are taken to markets located in urban areas such as Same town and Moshi municipal.

4.5.1.2 Crop Production in Mvomero and Morogoro Rural Districts

Table 24: Crop Production in Mvomero and Morogoro Rural Districts

Crops	**Harvested/household/year**		**Consumed/household/year**		**Sold/household/year**	
		Mean for EAM areas		**Mean for EAM areas**		**Mean for EAM areas**
Maize (Kg)	320	357	186	211.3	114	133.66
Beans (Kg)	152	195.3	99	115.33	65	83.33
Irish (Kg)	171	1349.66	97	548.67	44	437
Rice (Kg)	278	156.5	162	98.5	115	42.66
Ginger (Kg)	0	22.33	0	2.66	0	18.66
Coffee (Kg)	0	27.76	0	1	0	26.66

Njegere (Kg)	0	224	0	26.66	0	46.66
Vegetables (no. of bundles)	477	223.66	150	92.67	300	160.66
Banana (no. of bunches)	23	30.6	12	12.2	9	20.3
Other crops (no. of bundle)	63	40.3	10	4.99	50	35.95

Table 24 portrays that vegetables (477 bundles/household/year), maize (320 Kg/ household/year) and rice (278 Kg/household/year) were the mostly produced crops by farmers in Mvomero and Morogoro Rural districts in the past 12 months. Production of rice and vegetables was above the average production in EAM areas which was (156.5 Kg/household/year) and (223.66 bundle/household/year) respectively while that of maize was below the average production which was (357 Kg/household/year). Production of other crops like cassava and yams (63 bundle/household/year) was above the average production in EAM areas (23 bundle/ household/year) while production of irish potatoes (171 Kg/household/day) was far away from the average production of (1349.66 Kg/household/day).

Table 24 further presents that maize and rice were the mostly consumed crops by households in Mvomero and Morogoro Rural districts. The consumption of rice (162 Kg/household/year) was above the average consumption in EAM areas (98.5 Kg/household/year) while the consumption of maize (186 Kg/household/year)was below average in EAM areas (211.3 Kg/household/year).

Selling of rice (115 Kg/household/year) and vegetables (300 bundles/household/year) was above the average sale in EAM areas which were (42.66 Kg/household/year), and (160.66 bundles/household/year) for rice and vegetables respectively.

Table 25: Revenue from Crop Selling in Mvomero and Morogoro Rural Districts in the past 12 months

Crop sold	Quantity sold/ Household/year	Average price per unit (TZS)	Amount obtained (TZS)/household/year
Maize (Kg)	114	787.5	89775
Beans (Kg)	65	1200.9	78058.5

Irish (Kg)	44	211.61	9310.84
Rice (Kg)	115	1259.83	144880.45
Vegetables (no. of bundles)	300	382.55	114765
Banana (no. of bunches)	9	4111.11	36999.99
Other crops (no. of bundles)	50	1000.98	50049
TOTAL			**523838.8**

The study findings estimated that on average each household engaging in crop cultivation in Mvomero and Morogoro Rural districts earned about TZS 523,838.8/year from crop selling. Table 19 also depicts that selling of rice brought more revenue to the households (of about TZS 144, 880.5/year) followed by vegetables (TZS 114,765/year) while irish potatoes brought a least amount (TZS 9,310.84/year). Other crops also contributed a significant amount to the household income (Table25). The study observed that most of these crops are sold within the villages and very few are taken to markets located in urban areas such as Morogoro Urban, Dumila, and sometimes to Dar es Salaam.

4.5.1.3 Crop Production in Kilolo and Mufindi Districts

Table 26: Crop Production in Kilolo and Mufindi Districts

Crops	**Harvested/household/year**		**Consumed/household/year**		**Sold/household/year**	
		Mean for EAM areas		**Mean for EAM areas**		**Mean for EAM areas**
Maize (Kg)	485	357	254	211.3	220	133.66
Beans (Kg)	216	195.3	118	115.33	100	83.33
Irish (Kg)	3197	1349.66	1199	548.67	936	437
Rice (Kg)	45	156.5	30	98.5	13	42.66
Ginger (Kg)	0	22.33	0	2.66	0	18.66
Coffee (Kg)	0	27.76	0	1	0	26.66
Njegere (Kg)	224	74.66	80	26.66	140	46.66

Vegetables (no. of bundles)	86	223.66	56	92.67	156	160.66
Banana (no. of bunches)	13	30.6	2.6	12.2	20	20.3
Other crops (no. of bunches)	26	40.3	2.73	4.99	30.57	35.95

The study found that irish potatoes (3197 Kg/household/year), maize (485 Kg/ household/year) and njegere (224 Kg/household/year) were the mostly produced crops by farmers in Kilolo and Mufindi districts in the past 12 months. Production of these crops was above the average production in EAM areas which was (1349.66 Kg/household/year) for irish potatoes, (357 Kg/household/year) for maize and (74.66 Kg/household/year) for njegere. Production of rice (35 Kg/household/day) was far away from the average production in EAM areas which was estimated at (156.5 Kg/household/day).

Table 26 further presents that irish and maize were the mostly consumed food crops by households in Kilolo and Mufindi districts. The consumption of irish (1199 Kg/household/year) and maize (254 Kg/household/year) was above the average consumption in EAM areas (548.67 Kg/household/year) for irish potatoes and (211.33 Kg/household/year) for maize crop.

Selling of irish potatoes (936 Kg/household/year), maize (220 Kg/household/year), vegetables (300 bundles/household/year), njegere (140 Kg/household/year) and beans (100 Kg/household/year) was above the average crop sale in EAM areas.

Table 27: Revenue from Crop Selling in Kilolo and Mufindi Districts for the past 12 Months

Crop sold	Quantity sold/ Household/year	Average price per unit (TZS)	Amount obtained (TZS)/household/year
Maize (Kg)	220	388.88	85553.6
Beans (Kg)	100	1440.9	144090
Irish (Kg)	936	198.70	185983.2
Rice (Kg)	13	1285.54	16712.02
Njegere (Kg)	140	1169.23	163692.2

Vegetables (no. of bundles)	156	352.88	55049.28
Banana (no. of bunches)	20	4576.22	91524.4
Other crops (no. of bundles)	30.57	932.72	28513.25
TOTAL			**771118**

The study findings estimated that on average each household engaging in crop cultivation in Kilolo and Mufindi districts earned about TZS 711,118/year from crop selling. Table 21 also summarizes that selling of irish potatoes brought more revenue to the households (of about TZS 185, 983.2/household/year) followed by njegere (TZS 163,692.2/household/year) while rice brought a least amount (TZS 16,712.02/household/year). Other crops like beans, banana, maize, vegetables, cassava and yams also added a significant amount to the household income (Table 27). The study observed that most of these crops are sold within the villages and very few are taken to markets located in urban areas such as Kilolo town, Mafinga, and Iringa town.

Table 28: Total Revenue from Crop Selling in EAM Areas

Crop sold	Quantity sold/ Household/year	Number of households in EAM areas cultivating that crop	Average price per unit (TZS)	Amount obtained (TZS) for all households/year
Maize (Kg)	133.66	899040 (98.9%)	549.07	65,979,373,432
Beans (Kg)	83.33	785410 (86.4%)	1366.49	89,434,331,725
Irish (Kg)	437	433612 (47.7%)	229.12	43,415,592,289
Rice (Kg)	42.66	40906 (4.5%)	1272.69	2,220,907,634
Njegere (Kg)	46.66	221805 (24.4%)	1169.23	12,100,853,867
Coffee (Kg)	26.66	108175 (11.9%)	1169.23	3,371,995,597

Vegetables (no. of bundles)	160.66	206352 (22.7%)	408.14	13,530,866,378
Banana (no. of bunches)	20.3	294528 (32.4%)	5683.65	33,982,079,564
Other crops (no of bundles)	35.95	244531 (26.9%)	1060.5	9,322,738,262
TOTAL				**273,359,000,000**

From the Tanzania Population and Housing Census (2012) total population in all districts within Eastern Arc Mountains was estimated to be 4309581 people. The study estimated the household size in EAM areas to be 4.6 persons/ household, which advocates that a total population in EAM areas (4309581) have about 936865 households. Out of these households, this study revealed that 97.03% which is equivalent to 909040 households are involving in crop cultivation activities.

Table 28 presents the total revenue which can be collected from crop selling in Eastern Arc Mountain areas. Based on the study findings, the total number of households engaging in cultivation of each crop was computed to help to capture the total revenue that can be earned from each specific crop (Table 28). Table 28further depicts that a total of about TZS 273,359,000,000 can be earned per year from selling of crops produced by households in all districts within EAM areas. Beans and maize selling contributed the highest revenue in EAM areas (Table 28).

4.5.2 Tree Farming in Eastern Arc Mountains

The study found that on average about 28.66% households in EAM are involving in tree farming practices, in which they have established their tree farms. The study observed that afforestation farms are mostly established by residents in the lower side of EAM in Kilolo and Mufindi districts (73.1% of the households), followed by residents in the upper side of EAM in Same district (9.1%) while in the middle parts of EAM in Mvomero and Morogoro rural districts, few households (3.8%) have tree farms. Tree species mainly grown in the EAM are pine, eucalyptus and black wattle. Study respondents from Iringa region (Kilolo and Mufindi districts) explained that in their area each household is encouraged to have a tree farm of at least a 1 acre in the village, and sometimes males(youth) are not allowed to marry until they have established tree farms. Tree farming in these districts is considered an important economic activity. The estimated average

tree farm sizes in Kilolo and Mufindi districts was 4.98 acres/ household in which the recorded minimum and maximum tree farm sizes were 1.1 acres and 12 acres respectively. The study noted that tree farms in Same, Mvomero and Morogoro Rural districts were of small size when compared to those of Kilolo and Mufindi. The calculated average tree farm size/ household in Same district was 0.35 acre while in Mvomero and Morogoro Rural districts were 0.78 acre. This induces that the average tree farm size/ household in EAM area is about 2.03 acres.

4.5.2.1Tree harvesting in EAM area

The study findings report that 61.01% of the tree farmers in EAM areas harvested timbers in the past 12 months, the rest of tree farmers did not harvest timbers in their trees because their trees are still young and cannot be harvested. Others mentioned that they harvest their tree farms in intervals of 2 years or 3 years so last year was not planned for tree harvesting.

On average, the number of timbers harvested per household in EAM was 878.57 timbers/ household in the past year. However, it should be noted that most of timbers were harvested from Kilolo and Mufindi districts, very few timbers are harvested from Same, Mvomero and Morogoro Rural districts (less than 48 timbers/ household). The estimated price of timber in EAM was TZS 3250 (farm gate price). This tells that each household in EAM earned about TZS 2855352.5 from selling of harvested timbers. A total of TZS 2,412,509,693 could be earned from 742310 households (61.01% of tree farmers in EAM) who harvested and sold timbers in last year. The study further, observed that timbers in Kilolo and Mufindi districts are sold at a low price and others are abandoned in farms. The respondents from these areas explained, this is due to poor transport infrastructures which limit transportation of timbers from their villages to town areas where the demand of timber is high. The situation is much worse during rainy seasons.

4.5.3 Livestock Keeping in Eastern Arc Mountains

Table 29: Household Keeping Livestock in EAM Areas

Livestock kept	% of household in Same District	% of household in Mvomero and Morogoro Rural Districts	% of household in Kilolo and Mufindi Districts	Average % for households in EAM areas
Cattle	47.3	26.2	21.5	31.67
Goat	34.5	51.3	42	42.60

Sheep	39.1	12	28	26.37
Chicken	76.4	56.8	92.4	75.20
Pig	9.1	17.9	40.5	22.50
Fish farming	4.1	1.8	1.5	2.47

Table 29 shows that households in EAM areas are mostly keeping chicken (75.2%) and goats (42.6%). Kilolo and Mufindi districts recorded the highest number of households who are keeping chicken while Mvomero and Morogoro Rural districts led in keeping goats. Fish farming (aquaculture) is done only by 2.47% of the households in EAM areas. This may be because fish farming is regarded as a modern/new agricultural farming activity so most farmers are still new to aquaculture farming and most of them require technical assistances. Table 29 potrays that Same district is leading in fish farming activity. The study found that Kilolo and Mufindi districts are leading in pig farming practices in EAM areas, and this could be attributed by the fact that farmers in these districts are receiving technical support from EAMCEF to start piggery projects in their villages. The respondents from these areas narrated that they are being given technical assistance from EAMCEF team to start pig farming in their villages.

Table 30: Livestock Kept by Households in EAM for the Past 12 Months

Livestock kept	Average No. of livestock/household in Same district	Average No. of livestock/household in Mvomero and Morogoro Rural Districts	Average No. of livestock/household in Kilolo and Mufindi Districts	Average No. of livestock/household in EAM areas
Cattle	1.66	0.60	1.19	1.15
Goat	4.34	4.77	2.25	3.78
Sheep	5.63	2.35	3.67	3.88
Chicken	29.00	7.41	12.68	16.36
Pig	0.33	1.46	3.23	1.67
Fish farming	76.67	12.94	123.33	70.98

Table 30reveals that in terms of quantities, number of fish from fish farming practices (fish ponds) led in average number of livestock kept by households in EAM area. This was followed by chicken, in which each household kept an average of 16.36 chicken/ year. The average number of goats and sheep kept in EAM areas was more less the same (3.78/household/year) and (3.88/household/year) respectively. The average number of cattle kept per household was very low

(1.15/household/year). The study observed that zero grazing technique is used to keep cattle in EAM areas, this could be argued is because of lack of grazing land and the landscape of mountain areas which could not allow easy movement of livestock in high altitude/slope areas.

Table 31: Livestock Sold by Households in EAM for the Past 12 Months

Livestock sold	Average No. of livestock/household in Same district	Average No. of livestock/household in Mvomero and Morogoro Rural Districts	Average No. of livestock/household in Kilolo and Mufindi Districts	Average No. of livestock/household in EAM areas
Cattle	0.24	0.12	0.33	0.23
Goat	0.15	3.00	0.67	1.27
Sheep	1.40	0.2	0.5	0.7
Chicken	9.94	4.33	3.75	6.01
Pig	0.07	1.54	0.78	0.79
Fish farming	36.67	19	22	25.89

Table 32: Revenue from Selling Livestock in Same District for the Past 12 Months

Livestock sold	Average No. of livestock sold /household/year	Average selling price for each livestock (TZS)	Income obtained in (TZS) /household/year
Cattle	0.24	531250.00	127500
Goat	0.15	90000.00	13500
Sheep	1.40	73333.33	102666.66
Chicken	9.94	10687.33	106232.06
Pig	0.07	150000.00	10500
Fish from fish farms	36.67	200.00	7334
TOTAL			**367732.72**

The study findings estimated that on average each household engaging in livestock keeping in Same district earned about TZS 367,732.72/year from selling livestock. Table 32 also depicts that selling of chicken brought more revenue to the households (of about TZS 106, 232.06/year) followed by sheep (TZS 102,666.66/year) while fish brought a least amount (TZS 7,334/year). Other livestock also contributed a significant amount to the household income (Table32). The study observed that most of these livestock are sold within their villages and very few are taken to markets located in urban areas such as Same town and Moshi.

Table 33: Revenue from Selling Livestock in Mvomero and Morogoro Rural Districts for the Past 12 Months

Livestock sold	Average No. of livestock sold/ household	Average selling price for each livestock (TZS)	Income obtained in (TZS) /household/year
Cattle	0.12	620183.10	74421.97
Goat	3.00	90000.00	270000.00
Sheep	0.2	60000.00	12000.00
Chicken	4.33	10166.67	44021.68
Pig	1.54	120659.44	185815.54
Fish farming	19	288.34	5478.46
TOTAL			**591737.61**

The study findings estimated that on average each household engaging in livestock keeping in Mvomero and Morogoro rural districts earned about TZS 591,737.61/year from selling livestock. Table 33 also depicts that selling of goat brought more revenue to the households (of about TZS 270,000/year) followed by pig (TZS 185,815.54/year) while fish brought a least amount (TZS 5,478.46/year). Other livestock also contributed a significant amount to the household income (Table33). The study observed that most of these livestock are sold within the villages and very few are taken to markets located in urban areas such as Morogoro town and Dumila.

Table 34: Revenue from Selling Livestock in Kilolo and Mufindi Districts for the Past 12 Months

Livestock sold	Average No. of livestock sold/ household/year	Average selling price for each livestock (TZS)	Income obtained in (TZS) /household/year
Cattle	0.33	883333.33	291500.00
Goat	0.67	78947.00	52894.49
Sheep	0.5	64000.00	32000.00
Chicken	3.75	8903.67	33388.76
Pig	0.78	193333.33	150800.00
Fish farming	22	466.67	10266.74
TOTAL			**570849.99**

The study findings estimated that on average each household engaging in livestock keeping in Mvomero and Morogoro rural districts earned about TZS 570,849.99/year from selling livestock.

Table 28 also presents that selling of cattle brought more revenue to the households (of about TZS 291,500/year) followed by pig (TZS 150,815.54/year) while fish brought a least amount (TZS 10,266.74/year). Other livestock also contributed a significant amount to the household income (Table34). The study observed that most of these livestock are sold within the villages and very few are taken to markets located in urban areas such as Kilolo town, Mafinga, Mufindi and Iringa.

Table 35: Total Revenue from Livestock Selling in EAM

Livestock sold	Number of livestock sold/ Household/year	Number of households in EAM keeping the livestock	Average price per unit (TZS)	Amount obtained (TZS) for all households/year
Cattle	0.23	86133 (31.67%)	678255.48	13,436,641,230
Goat	1.27	115859 (42.6%)	86315.67	12,700,567,957
Sheep	0.7	71718 (26.37%)	65777.78	3,302,215,578
Chicken	6.01	204522 (75.2%)	9919.22	12,192,479,264
Pig	0.79	61193 (22.5%)	154664.24	7,476,851,382
Fish farming	25.89	6717 (2.47%)	318.34	55,360,322
TOTAL				**49,164,115,734**

Basing on the Tanzania Population and Housing Census (2012), total population in all districts within Eastern Arc Mountains was estimated to be 4309581 people. The study estimated the household size in EAM areas to be 4.6 persons/ household, which means that total population in EAM areas (4309581) have about 936865 households. Out of these households, as revealed by this study about 29.03% are involving in livestock keeping activities which is equivalent to 271971 households.

Table35 outlines the total revenue which can be collected from selling of livestock in Eastern Arc Mountain areas. Based on this study findings, the total number of households involving in keeping each type of livestock was computed to help to capture the total revenue that can be earned from each livestock type sold in EAM area for the past 12 months (Table35). It was found that a total

of about TZS 49,164,115,734 can be earned per year by households in all districts within EAM areas from selling of livestock. High livestock sales are obtained from cattle, goat and chicken while fish farming contributed the lowest amount (Table35). Low sales from fish selling can be argued is because currently farmers in EAM are starting this business, most have not yet started to harvest matured fish. They are just selling seed (young fish) to their fellow farmers. However, this study observed that very low technology (traditional) is used in fish farming practices in EAM which could impact the productivity and quality of fish.

5.VALUES OF NON-MARKETED ECOSYSTEM GOODS AND SERVICES IN EASTERN ARC MOUNTAINS

The study also involved valuation of non-marketed ecosystem services which are provided by Eastern Arc Mountains to the communities around the area. Choice experiment method (CEM) which is an environmental valuation technique was opted to value the ecosystem services supplied by Eastern Arc Mountain.

5.1 Preferences for Ecosystem Services for Households in Same District

Table 36: Preferences for Ecosystem Services for Households in Same District

	Conditional logistic regression model		
Variable	**Coefficient**	**Standard error**	**P > [Z]**
Water	1.881492	0.373560	0.000
Soil fertility	3.162012	0.617662	0.050
Climate	-0.807090	0.384926	0.036
Biodiversity	0.2800197	0.5648359	0.042
Recreation	-0.832425	0.5428022	0.125
Payment	-0.000731	0.002361	0.002
ASC	-0.1881492	0.195798	0.033

Number of observations =999; LR chi^2 (7) =142.69; Prob >chi^2 =0.000; Pseudo R^2 = 0.1451

Log likelihood = -420.42884

Results in Table 36 shows that coefficients for soil conservation for enhancing agricultural productivity, climate regulation and carbon sequestration and biodiversity conservation were significant at 5% level while the coefficient for water supply and protection of water sources was significant at 1% level. The coefficient for provision of recreation and landscaping amenities was insignificant. The estimated coefficients of soil conservation for enhancing agricultural productivity, biodiversity conservation and supply of water and protection of water sources had positive signs (Table 36). The positive signs on these attributes imply that improvements in the

levels of these ecosystem service attributes will increase utility of households in Same district. The significance and positive signs on these attributes imply that these ecosystem service attributes are significant in the choice of provision of ecosystem services in EAM areas. The estimated coefficient for the attribute of climate regulation and carbon sequestration was significant but has a negative sign (Table 36). This means that even though climate regulation and carbon sequestration is an important ecosystem service but it is not preferred by households in Same districts.

The estimated coefficient for the attribute of provision of recreation and landscaping amenity was insignificant had a negative sign (Table 36). This implies that, provision of recreation and landscaping amenities is not important and not preferred by respondents from Same district. The estimated coefficient for the cost of provision of ecosystem services (payment attribute) has a negative sign, indicating a decrease in utility of respondents as the monthly ecosystem services provisional charge increases. The ASC which captures the element of the choice which cannot be explained by the ecosystem service attributes is negative and significant. In this Choice Experiment the ASC was specified to account for the proportion of participation in management of ecosystem services provided by EAM. With regard to Sasao (2004), a negative ASC means that respondents prefer to select any improved plan for this case improved ecosystem services provision in EAM options than to select the status quo option (current provision of ecosystem services in EAM), while a positive ASC means that it is preferable for the respondents to select a status quo option than any improved plan.

5.2 Preferences for Ecosystem Services for Households in Morogoro Rural and Mvomero Districts

Table 37: Preferences for Ecosystem Services for Households in Morogoro Rural and Mvomero Districts

Conditional logistic regression model			
Variable	**Coefficient**	**Standard error**	**P > [Z]**
Water	0.921104	0.3914082	0.019
Soil fertility	1.113769	0.475889	0.045
Climate	0.689023	0.349959	0.049
Biodiversity	0.673247	0.5292905	0.020
Recreation	-0.791287	0.5601705	0.158
Payment	-0.000562	0.0002216	0.01
ASC	-0.0848804	0.212677	0.69

Number of observations =1017; LR chi^2 (7) =135.71; Prob >chi^2 =0.000; Pseudo R^2 = 0.136

Log likelihood = -431.13194

It was found that coefficients for water supply and protection of water sources, soil conservation for enhancing agricultural productivity, climate regulation and carbon sequestration and biodiversity conservation were significant at 5% level and all have positive signs (Table 37). The significance and positive signs on these attributes imply that these ecosystem services are important and are preferred by the communities. Furthermore, improvements in the levels of these ecosystem service attributes will increase utility of households in Mvomero and Morogoro Rural districts.

The estimated coefficient for the attribute of provision of recreation and landscaping amenity was insignificant had a negative sign (Table 37). This implies that, provision of recreation and landscaping amenities is not important and not preferred by households in Mvomero and Morogoro Rural districts. The estimated coefficient for the cost of provision of ecosystem services (payment attribute) has a negative sign, indicating a decrease in utility of respondents as the monthly ecosystem services provisional charge increases. The ASC which captures the element of the choice which cannot be explained by the ecosystem service attributes is negative and insignificant. In this Choice Experiment the ASC was specified to account for the proportion of participation in management of ecosystem services provided by EAM. A negative ASC means that respondents prefer to select any improved plan for this case improved ecosystem services provision in EAM options than to select the status quo option (current provision of ecosystem services in EAM).

5.3 Preferences for Ecosystem Services for Households in Kilolo and Mufindi Districts

Table 38: Preferences for Ecosystem Services for Households in Kilolo and Mufindi Districts

Conditional logistic regression model			
Variable	**Coefficient**	**Standard error**	**P > [Z]**
Water	0.2002714	0.325686	0.000
Soil fertility	0.0996647	0.4081	0.024
Climate	-0.0540787	0.345322	0.176
Biodiversity	0.0449702	0.463595	0.048
Recreation	-0.184479	0.461252	0.168
Payment	-0.0001971	0.00019	0.031
ASC	-0.0342259	0.15167	0.821

Number of observations =1169; LR chi^2 (7) =82.92; Prob >chi^2 =0.000; Pseudo R^2 = 0.0720

Log likelihood = -534.14021

Results in Table 38 outlines that coefficients for soil conservation for enhancing agricultural productivity and biodiversity conservation were significant at 5% level while the attribute of water supply and protection of water sources was significant at 1% level. All the three attributes had positive signs. The significance and positive signs on the three attributes advocate that these ecosystem services are important and are preferred by the communities. Furthermore, improvements in the levels of these ecosystem service attributes will increase utility of households in Kilolo and Mufindi districts.

The estimated coefficients for the attributes climate regulation and carbon sequestration, provision of recreation and landscaping amenity were insignificant had negative signs (Table 38). This implies that, climate regulation and carbon sequestration, provision of recreation and landscaping amenities are not important and not preferred by households in Kilolo and Mufindi districts. The estimated coefficient for the cost of provision of ecosystem services (payment attribute) had a negative sign, indicating a decrease in utility of respondents as the monthly ecosystem services provisional charge increases. The ASC which captures the element of the choice which cannot be explained by the ecosystem service attributes is negative and insignificant. In this Choice Experiment the ASC was specified to account for the proportion of participation in management of ecosystem services provided by EAM. A negative ASC means that respondents prefer to select any improved plan for this case improved ecosystem services provision in EAM options than to select the status quo option (current provision of ecosystem services in EAM).

5.4 Preferences for Ecosystem Services for Households in Eastern Arc Mountains

Table 39: Preferences for Ecosystem Services for Households in Eastern Arc Mountains

Conditional logistic regression model			
Variable	**Coefficient**	**Standard error**	**P > [Z]**
Water	0.818250	0.19466	0.000
Soil fertility	1.238730	0.82362	0.013
Climate	-0.536302	0.20047	0.028
Biodiversity	0.257480	0.276277	0.035
Recreation	-0.400485	0.27687	0.148
Payment	-0.000431	0.00116	0.000
ASC	-0.532558	0.102023	0.602

Number of observations =3176; LR chi^2 (7) =266.83; Prob >chi^2 =0.000; Pseudo R^2 = 0.0854

Log likelihood = -1429.482

When data from the 5 districts, namely Same, Mvomero, Morogoro Rural, Kilolo and Mufindi were analyzed together, results were slightly different from the ones obtained when each study site was analysed separately. Unlike the preferences of individual study site, results from a combined analysis of all 3 study sites are more representative in estimating the average preferences for households in EAM. The results show that coefficients for soil conservation for enhancing agricultural productivity and biodiversity conservation were significant at 5% level while the attribute of water supply and protection of water sources was significant at 1% level (Table 39). All the three attributes had positive signs. The significance and positive signs on the three attributes advocate that these ecosystem services are important and are preferred by the communities. Furthermore, improvements in the levels of these ecosystem service attributes will increase utility of communities around Eastern Arc Mountains.

The estimated coefficients for the attributes climate regulation and carbon sequestration was significant at 5% level and had a negative sign (Table 39). This implies that even though this attribute is considered important ecosystem service is not preferred by communities around the Eastern Arc Mountains. The estimated coefficient for provision of recreation and landscaping amenity was insignificant had negative sign (Table 39). This implies that, provision of recreation and landscaping amenities is not considered important and is not preferred by communities around Eastern Arc Mountains. This implies that communities around Eastern Arc Mountains prefer ecosystem services of soil conservation for enhancing agricultural productivity, water supply and protection of water sources and biodiversity conservation. But they do not prefer ecosystem services of climate regulation and carbon sequestration and provision of recreation and landscaping amenities.

The estimated coefficient for the cost of provision of ecosystem services (payment attribute) had a negative sign, indicating a decrease in utility of respondents as the monthly ecosystem services provisional charge increases. The ASC which captures the element of the choice which cannot be explained by the ecosystem service attributes is negative and insignificant. In this Choice Experiment the ASC was specified to account for the proportion of participation in management of ecosystem services provided by EAM. A negative ASC means that respondents prefer to select any improved plan for this case improved ecosystem services provision in EAM options than to select the status quo option (current provision of ecosystem services in EAM).

5.6 Estimation of Implicit Prices for each Ecosystem Service Attributes

The implicit prices for each ecosystem service attributes were calculated using the coefficient parameters from results of CL model. Using estimated CL model results, implicit prices were first calculated for each ecosystem service attributes for households in the three study areas which were Kilimanjaro region (Same district) Morogoro region (Mvomero and Morogoro rural districts) and Iringa region (Kilolo and Mufindi district) . After that, implicit prices for each ecosystem service attribute were calculated for all groups (5 districts) when combined together in order to get representative average implicit prices which can be inferred to all households in Eastern Arc Mountains. Referring to Alpizar *et al*. (2001) the implicit price or marginal willingness to pay per month for each ecosystem service attribute was estimated by finding a ratio of non-marketed ecosystem service attribute to the cost attribute as shown in theequation below;

Marginal WTP = _ ($\beta_{attribute}/\beta_{monetary}$)

Where;

($\beta_{attribute}$) is the estimated coefficient on the non-market attribute (ecosystem service attribute) such as soil conservation for enhancing agricultural productivity, water supply and protection of water sources, biodiversity conservation, climate regulation and carbon sequestration and provision of recreation and landscaping amenities

($\beta_{monetary}$) is the estimated coefficient on the cost attribute (payment for provision of ecosystem services per month)

Households' preferences for non marketed ecosystem services were determined from the calculated values of implicit prices. The calculated implicit prices (marginal WTP) for each ecosystem service attribute were used to identify household's preferences for ecosystem service attribute, whereby an ecosystem service attribute with higher implicit price is more preferred than the one with lower implicit price.

5.6.1 Implicit Prices for each Ecosystem Service Attribute for Households in Same District

Table 40: Implicit Prices for each Ecosystem Service Attribute for Households in Same District

Ecosystem service attribute	Estimated coefficient	Implicit price in TZS
Water	1.881492	2573.86

Soil fertility	3.162012	4325.59
Climate	-0.807090	-1104.09
Biodiversity	0.2800197	383.06
Recreation	-0.832425	-1138.75
Payment	-0.000731	N/A

Implicit prices (marginal WTP per month) of each ecosystem service attribute for households in Same district are presented in Table 40 above. The implicit price (marginal WTP) for the attribute of water supply and protection of water sources is TZS 2573. 86. This implies that households are willing to be charged TZS 2573.86 to ensure all water sources originating in the forest reserve are well protected through introduction of water protection programs in their villages. Protection of water sources will in turn increase the quantity and quality of water which are used to support their lives for instance domestic water uses and traditional irrigation farming. Good water conservation programs will increase volume of water in their discharge point Pangani river basin (Pangani river) thus enhancing fishing and hydroelectric power production.

The implicit price (marginal WTP) for the attribute of soil conservation to enhance agriculture production is TZS 4325. 59. This means that on average households in Same district are willing to pay TZS 4325. 59 per month to ensure that there are improvement in soil conservation practices in the Eastern Arc Mountains which will in turn improve their agricultural activities.
The implicit price for biodiversity conservation is TZS 383.06. This means that households are willing to pay TZS 383.06 per month to support conservation of biodiversities in their area i.e. Chome nature forest reserve. This advocates that communities are recognizing the values of biodiversities as sometimes biodiversity support their lives for instance through beekeeping practices which are currently done in areas adjacent to the nature reserve.

Table 40 also shows the ecosystem service attributes of climate regulation and carbon sequestration and provision of recreation and landscaping amenities have negative implicit prices TZS -1104.09 and TZS -1138.75 respectively. This means that households are not willing to pay for provision of these ecosystem services in Eastern Arc Mountains and they believe provision of these services do not increase their utility.

5.6.1.2Households'Preferences for Ecosystem Services in Same District

Implicit prices are important in demonstrating the trade-offs between individual attributes. A comparison of implicit prices of attributes gives some understanding on the relative importance that respondents hold for them. Usually, most preferred attributes have higher implicit prices than least preferred ones. On the basis of such comparisons, policy makers are better placed to design resource use alternatives so as to favour those attributes having higher implicit prices.

Based on calculated implicit prices in Table 38, it can be seen that the attribute of soil conservation for enhancing agricultural production is the most preferred ecosystem service by households in Same district. This attribute has the highest implicit price (TZS 4325.59), which implies that communities in this are more interested to see improvements in quality of their soils through practicing soil conservation programs. Improvement in soil conservation will increase fertility in their soils which will then raise their agricultural productivity since majority of the respondents are engaging in agricultural production.

Table 40 further shows that water supply and protection of water sources is the second preferred attribute as its implicit price was TZS 2573.86. This means that respondents are also more concerned to see water sources in their area are well protected so that they can sustain to supply water to the villages. Almost all water sources around their area originate from Chome nature forest reserve, which tells that communities can support payment for conservation of this nature reserve where their water sources originate. Protection of water sources will increase supply of water which will increase the communities' utility. The high preferences attached to this attribute may be due to the fact that water sources from natural forests are the main supply of domestic water for household uses also they support farming practices during dry seasons.

The attribute of biodiversity conservation was least preferred as its implicit price is TZS 383.06. This tells that communities also are concerned to see biodiversity in their area are well conserved and not impacted by human activities. However, it should be noted that most of the biodiversity in their area are found in the forest reserve area, which means communities are more than willing to support forest conservation practices for the betterment of their biodiversity. Preference of biodiversity conservation attribute might be attributed by the fact that some of the biodiversity are

supporting their livelihood activities. For instance bees are supporting apiculture farmers who are producing honey through bee keeping activities in areas adjacent the nature reserve.

Ecosystem service attributes of climate regulation and carbon sequestration and provision of recreation and landscaping amenities had negative implicit prices (Table40), therefore are not preferred by households in Same district. Community non- preferences on these ecosystem services may be attributed by the fact that community are not well informed on climate regulation and carbon sequestration functions played by natural forests or they are not aware on the role of forests in counteracting climate change effects. Furthermore, their non preference on provision of recreation and landscaping amenities attribute may be because they do not see the benefits of having recreation activities in Chome nature forest reserve. This is a wakeup call to the reserve management to engage communities in recreation activities and sharing the benefits accrued from eco tourism activities to the surrounding communities. The current ecotourism promotion initiatives for Chome nature forest reserve will not be fruitful if the surrounding communities are not integrated in the process.

5.6.3 Implicit Prices for each Ecosystem Service Attribute for Households in Mvomero and Morogoro Rural Districts

Table 41: Implicit Prices for each Ecosystem Service Attribute for Households in Mvomero and Morogoro Rural Districts

Ecosystem service attribute	Estimated coefficient	Implicit price in TZS
Water	0.921104	1638.79
Soil fertility	1.113769	1981.79
Climate	0.689023	1226.02
Biodiversity	0.673247	1197.94
Recreation	-0.791287	-1407.98
Payment	-0.000562	N/A

Implicit prices (marginal WTP per month) of each ecosystem service attribute for households in Mvomero and Morogoro Rural districts are presented in Table 41 above. The implicit price (marginal WTP) for the attribute of water supply and protection of water sources is TZS 1638.79. This implies that households are willing to be charged TZS 1638.79 to ensure all water sources originating in the forest reserve are well protected through introduction of water protection programs in their villages. Protection of water sources will in turn increase the quantity and quality

of water which are used to support their lives for instance domestic water uses and traditional irrigation farming.

The implicit price (marginal WTP) for the attribute of soil conservation to enhance agriculture production is TZS 1981.79. This means that on average households in Mvomero and Morogoro Rural districts are willing to pay TZS 1981.79 per month to ensure that there are improvements in soil conservation practices in the Eastern Arc Mountains which will in turn improve their agricultural activities.

The estimated implicit price for climate regulation and carbon sequestration is TZS 1226.02 (Table41). This is contrary to households in Same, Kilolo and Mufindi districts where climate regulation and carbon sequestration had negative implicit prices. The implicit price of TZS 1226.02 notifies that households in Mvomero and Morogoro Rural districts are recognizing the value which forests play to climate regulation and carbon sequestration services and they are willing to pay that amount per month to improve provision of this ecosystem service attribute.

The implicit price for biodiversity conservation is TZS 1197.94. This means that households are willing to pay TZS 1197.94 per month to support conservation of biodiversities in their area i.e. Uluguru nature forest reserve. This advocates that communities are recognizing the values of biodiversities as sometimes biodiversity support their lives for instance through beekeeping practices which are currently done in areas adjacent to the nature reserve.

Table 41 also shows the ecosystem service attribute of provision of recreation and landscaping amenities have negative implicit prices TZS -1407.98. This indicates that households are not willing to pay for provision of this ecosystem service in Eastern Arc Mountains and they believe that improvement in provision of this ecosystem service will not increase their utility.

5.6.3.1Households'Preferences onEcosystem Services in Mvomero and Morogoro Rural Districts

Based on calculated implicit prices in Table 41, it can be argued that the attribute of soil conservation for enhancing agricultural production is the most preferred ecosystem service by

households in Mvomero and Morogoro Rural districts. This attribute had the highest implicit price (TZS 1981.79), which signifies that communities in this are more interested to see improvements in quality of their soils through practicing soil conservation programs. Improvement in soil conservation will increase fertility in their soils which will then raise their agricultural productivity since majority of the respondents are engaging in agricultural production.

Table 41further shows that water supply and protection of water sources is a second preferred attribute as its implicit price was 1638.79. This means that respondents are also more concerned to see water sources in their area are well protected so that they can sustain to supply water to the villages. Almost all water sources around their area originate from Uluguru nature forest reserve, which tells that communities can support programs for payment for ecosystem services, to be specifically payment for conservation of Uluguru nature reserve. Protection of water sources will increase supply of water which will add value to households' utility. The high preferences attached to this attribute may be to the fact that water sources from natural forests are the main supply of domestic water for household uses andsupport farming practices during dry seasons.

The attribute of climate regulation and carbon sequestration was a third preferred ecosystem service attribute and its implicit price was TZS 1226.02. This advocates that communities living around Uluguru nature reserve are well informed on the importance of forests in providing climate regulation and carbon sequestration services and they are willing to pay TZS 1226.02 per month to ensure these ecosystem services are improved. This is contrary to communities living in Same, Kilolo and Mufindi districts where communities attached a negative value to this ecosystem service.

The attribute of biodiversity conservation was least preferred as its implicit price is TZS 1197.94. This tells that communities are also concerned to see biodiversity in their area are well conserved and not impacted by human activities. However, it should be noted that most of the biodiversity in their area are found in forest reserve area, which means communities are more than willing to support forest conservation practices for the betterment of their biodiversity. Preference on biodiversity conservation might be attributed by the fact that some of the biodiversity are supporting their livelihood activities. For instance bees are supporting apiculture farmers who are producing honey through bee keeping activities in areas adjacent the nature reserve. In comparison

to other 3districts, households in Mvomero and Morogoro Rural districts attached the highest value on biodiversity conservation. The highest implicit price for biodiversity conservation was estimated from communities around this nature reserve (TZS 1197.94) when compared to TZS 383.06, TZS 228.1593 for Same district and (Kilolo and Mufindi districts) respectively.

Ecosystem service attribute of provision of recreation and landscaping amenities had a negative implicit price (Table41), therefore is also not preferred by households in Mvomero and Morogoro Rural districts. Community non- preference on provision of recreation and landscaping amenities attribute may be due to the fact that they are not recognizing the benefits of having recreation activities in Uluguru nature forest reserve. This could serve as awakeup call to the reserve management to engage the surrounding communities in recreation activities and sharing the benefits accrued from eco tourism activities to the surrounding communities. The current initiatives of promoting ecotourism activities in Uluguru nature forest reserve will not serve anything if the surrounding communities are left behind.

5.6.4Implicit Prices for each Ecosystem Service Attribute for Households in Kilolo and Mufindi Districts

Table 42: Implicit Prices for each Ecosystem Service Attribute for Households in Kilolo and Mufindi Districts

Ecosystem service attribute	Estimated coefficient	Implicit price in TZS
Water	0.2002714	1016.09
Soil fertility	0.0996647	505.65
Climate	-0.0540787	-274.37
Biodiversity	0.0449702	228.15
Recreation	-0.184479	-935.96
Payment	-0.0001971	N/A

Implicit prices (marginal WTP per month) of each ecosystem service attribute for households in Kilolo and Mufindi districts are presented in Table 42above. The implicit price (marginal WTP) for the attribute of water supply and protection of water sources is TZS 1016.09. This implies that households are willing to pay TZS 1016.09 per month to ensure all water sources in their areas are well protected through introduction of water conservation programs in their villages. Protection of water sources will in turn increase the quantity and quality of water which are used to support their lives for instance domestic water uses and traditional irrigation farming. Relevant water

conservation programs will increase volume of water in rivers around Uzungwa scarp nature forest reserve thus enhancing availability of domestic water, fishing, irrigation farming and production of hydroelectric power.

The implicit price (marginal WTP) for the attribute of soil conservation to enhance agriculture production is TZS 505.65. This means that on average households in Kilolo and Mufindi districts are willing to pay TZS 505.65per month to ensure that there are improvements in soil conservation practices in the Eastern Arc Mountains which will in turn improve soil fertility and increase their agricultural productivity.

The implicit price for biodiversity conservation is TZS 228.15. This means that households are willing to pay TZS 228.15 per month to support conservation of biodiversities in their area i.e. Uzungwa scarp nature forest reserve. This advocates that communities are recognizing the values of biodiversities as sometimes biodiversity support their lives for instance through beekeeping practices which are currently done in areas adjacent the nature reserve.

It can be concluded that households in Kilolo and Mufindi districts attached low values for their three preferred ecosystem service attributes when compared to households from Same, Mvomero and Morogoro Rural districts. This is justified by the calculated values of implicit prices for soil conservation to enhance agricultural productivity, water supply and protection of water sources and biodiversity conservation attributes which were small when compared to the same values estimated from households in Same, Mvomero and Morogoro Rural districts. The study anticipate the reason for attaching low values is attributed to the fact that Iringa region has not experienced much climatic change effects in terms of loss of soil fertility, water shortages, loss of biodiversity and their habitats when compared to the other two regions (Kilimanjaro and Morogoro). Scarcity of ecosystem services is not usually pronounced in Southern parts of EAM. This could be a factor on why the households in this region they do not see a reason of attaching high value to these ecosystem services since they are still receiving and enjoying the availability of these ecosystem services, moreover at a free cost.

Table 42 also reveals the ecosystem service attributes of climate regulation and carbon sequestration and provision of recreation and landscaping amenities had negative implicit prices TZS -274.34 and TZS -935.96 respectively. This means that households are not willing to pay for provision of these ecosystem services in Eastern Arc Mountains and they believe provision of these services do not increase their utility.

5.6.4.1Households'Preferences on Ecosystem Services in Kilolo and Mufindi Districts

Based on calculated implicit prices in Table 42, it can be seen that the attribute of water supply and protection of water sources is the most preferred ecosystem service by households in Kilolo and Mufindi districts. This attribute had the highest implicit price (TZS 1016.09), This means that respondents are most concerned to see water sources in their area are well protected so that they can sustain to supply water to the villages. Most of the water sources in their area originate from Uzungwa scarp nature forest reserve, which tells that communities can support payment for ecosystem services to conserve this nature reserve where most of their water sources originate. Protection of water sources will increase supply of water which will increase the communities' utility. The highest preferences attached to this attribute may be due to the fact that water sources from natural forests are the main supply of domestic water for household uses and they support farming practices during dry seasons

The attribute of soil conservation for enhancing agricultural productivity was second preferred (Table 42). This is contrary to community preferences in Same, Mvomero and Morogoro Rural districts where soil conservation attribute was the most preferred attribute. The calculated implicit price for soil conservation attribute is TZS 505. 65which imply that households in Kilolo and Mufindi districts are interested to see improvements in quality of their soils through practicing soil conservation programs. Improvement in soil conservation will increase fertility in their soils which will then raise their agricultural productivity since majority of the respondents are engaging in agricultural production.

Ecosystem service attributes of climate regulation and carbon sequestration and provision of recreation and landscaping amenities had negative implicit prices (Table 42), therefore are not preferred by households in Kilolo and Mufindi districts. Households' non- preferences on these

ecosystem services may be attributed by the fact that community are not well informed on climate regulation and carbon sequestration functions played by natural forests or they are not aware on the role of forests in counteracting climate change effects. Furthermore, their non preference on provision of recreation and landscaping amenities attribute may be because they are not recognizing the benefits of having recreation activities in Uzungwa scarp nature forest reserve. This is a wakeup call to the ministry of natural resources and reserve management to engage the communities in recreation activities and using some of the benefits accrued from eco tourism activities to support community activities. The current initiatives to promote ecotourism activities in Uzungwa scarp nature forest reserve will not be successful if the surrounding communities are left behind.

5.6.5 Implicit Prices of each Ecosystem Service Attribute for Households in Eastern Arc Mountains

Table 43: Implicit Prices of each Ecosystem Service Attribute for Households in Eastern Arc Mountains

Ecosystem service attribute	Estimated coefficient	Implicit price in TZS
Water	0.818250	1898.49
Soil fertility	1.238730	2874.08
Climate	-0.536302	-1244.32
Biodiversity	0.257480	597.40
Recreation	-0.400485	-929.20
Payment	-0.000431	N/A

Implicit prices (marginal WTP per month) of each ecosystem service attribute for households in EAM are presented in Table 43 above. The implicit price (marginal WTP) for the attribute of water supply and protection of water sources is TZS 1898. 49. This implies that households are willing to be charged TZS 1898. 49 to ensure all water sources originating in the forest reserve are well protected through introduction of water protection programs in their villages. Protection of water sources will in turn increase the quantity and quality of water which are used to support their lives for instance domestic water uses and traditional irrigation farming. Good water conservation programs will increase volume of water to their discharge points.

The implicit price (marginal WTP) for the attribute of soil conservation to enhance agriculture production is TZS 2874.08. This means that on average households living around all three nature

forest reserves are willing to pay TZS 2874.08 per month to ensure that there are improvements in soil conservation practices in the Eastern Arc Mountains which will in turn improve their agricultural activities.

The implicit price for biodiversity conservation is TZS 597.40. This means that households are willing to pay TZS 597.40 per month to support conservation of biodiversities in their areas. This advocates that communities are recognizing the values of biodiversities as sometimes biodiversity support their lives for instance through beekeeping practices which are currently done in areas adjacent to the nature reserve.

Table 43 also shows the ecosystem service attributes of climate regulation and carbon sequestration and provision of recreation and landscaping amenities have negative implicit prices TZS -1244.32 and TZS -929.20 respectively. This means that households are not willing to pay for provision of these ecosystem services in Eastern Arc Mountains and they believe provision of these ecosystem services do not increase their utility.

5.6.5.1Households'Preferences on Ecosystem Services in Eastern Arc Mountains

Implicit prices are important in demonstrating the trade-offs between individual attributes. A comparison of implicit prices of attributes gives some understanding on the relative importance that respondents hold for them. Usually, most preferred attributes have higher implicit prices than least preferred attributes. On the basis of such comparisons, policy makers are better placed to design resource use alternatives so as to favour those attributes having higher implicit prices.

Based on calculated implicit prices in Table 43, it can be seen that the attribute of soil conservation for enhancing agricultural production is the most preferred ecosystem service by communities living around three nature forest reserves. This attribute had the highest implicit price (TZS 2874.08), which implies that communities are most interested to see improvements in quality of their soils through practicing soil conservation programs. Improvement in soil conservation will increase fertility in their soils which will then raise their agricultural productivity since majority of the respondents are engaging in agricultural production.

Table 43further shows that water supply and protection of water sources is the second preferred

attribute as its implicit price is TZS 1898. 49. This means that respondents are also more concerned to see water sources in their area are well protected so that they can sustain to supply water to the villages. Almost all water sources around their area originate from Eastern Arc Mountains, which tells that communities can support payment for conservation of EAM where their water sources originate. Protection of water sources will increase supply of water which will increase the communities' utility. The high preferences attached to this attribute may be due to the fact that water sources from natural forests are the main supply of domestic water for household uses also they support farming practices during dry seasons.

The attribute of biodiversity conservation was least preferred as its implicit price is TZS 597.40. This tells that communities also are concerned to see biodiversity in their area are well conserved and not impacted by human activities. However, it should be noted that most of the biodiversity in their area are found in the forest reserve area, which means communities are more than willing to support forest conservation practices for the betterment of their biodiversity. Preference of biodiversity conservation attribute might be attributed by the fact that some of the biodiversity are supporting their livelihood activities. For instance bees are supporting apiculture farmers who are producing honey through bee keeping activities in areas adjacent the nature reserve.

Ecosystem service attributes of climate regulation and carbon sequestration and provision of recreation and landscaping amenities had negative implicit prices (Table 43), therefore are not preferred by communities around the three nature reserves. Community non- preferences on these ecosystem services may be attributed by the fact that community are not well informed on climate regulation and carbon sequestration functions played by natural forests or they are not aware on the role of forests in counteracting climate change effects. Households, non- preference on climate regulation services may also be attributed to the fact that EAM regions have not experienced much of climate change effects like other regions in the country for instance Singida, Dodoma. Presence of forest nature reserves in EAM has contributed to stabilization of the climate in the region thus people do not recognize the importance/ value of this service as they are receiving it at a free cost.

Furthermore, their non preference on provision of recreation and landscaping amenities attribute may be because they do not see the benefits of having recreation activities in Eastern Arc

Mountains. Their non-preference on provision of recreation and landscaping amenities could be argued is because in most cases the household responded that they are not being involved neither in planning eco tourism programs nor in sharing of benefits accrued from ecotourism. Respondents complained that the reserve managements are not supporting their livelihood activities or socio economic infrastructures like it is being done in other places with eco tourism activities like in areas surrounding Ngorongoro Conservation Area, Serengeti National park etc. The nature reserve managements in Chome, Uluguru, Kilombero and Uzungwa scarp reacted to this allegation by saying that currently they are not sacrificing much to their surrounding communities because the business is not good, they are not receiving many visitors to their areas, but once their reserves will begin to create more revenue, they will devote a lot in supporting development of local communities. The study thinks that a participatory approach would increase community appreciation and valuation of provision of recreation and landscaping amenities services. This could be a wakeup call to the ministry of natural resources and nature reserves management to engage the communities in recreation activities and sharing the benefits accrued from eco tourism activities to the surrounding communities. The ongoing ecotourism promotion campaigns in nature reserves within EAM will not yield anything if surrounding communities are excluded in the process.

5.6.6 Implicit Price of each Ecosystem Service Attribute for Same, Mvomero, Morogoro Rural, Kilolo and Mufindi Districts versus average Implicit Prices for Eastern Arc Mountains

Table 44: Implicit Price of each Ecosystem Service Attribute for Same, Mvomero, Morogoro Rural, Kilolo and Mufindi Districts versus average Implicit Prices for Eastern Arc Mountains

Ecosystem service attribute	Implicit price for households in Same District	Implicit price for households in Mvomero and Morogoro Rural districts	Implicit price for households in Kilolo and Mufindi districts	Implicit price for all households in EAM area
Water	2573.86	1638.79	1016.09	1898.49
Soil fertility	4325.59	1981.79	505.65	2874.08
Climate	-1104.09	1226.02	-274.37	-1244.32
Biodiversity	383.06	1197.94	228.15	597.40

Recreation	-1138.75	-1407.98	-935.96	-929.20

Table 44highlights that estimated implicit price for water supply and protection of water sources attribute for households in Same district (TZS 2573.86) exceeded the average implicit price for EAM which was TZS 1898.49. The estimated implicit prices for water protection inMvomero, Morogoro Rural, Kilolo and Mufindi districts were below the average value (TZS 1898.49).

Again households in Same district attached the highest value to soil conservation attribute (TZS 4325.59) which was higher than the average implicit price (TZS 2874.08) whilsthouseholds in Kilolo and Mufindi districts attached the lowest value (TZS 505.65) which is far less from the average value (TZS 2874.08).

Households in Mvomero and Morogoro Rural districts attached the highest value to biodiversity conservation attribute (TZS 1197.94) which exceeded the average implicit value for the three nature reserves while households in Kilolo and Mufindi districts attached the lowest value which was below the average value (TZS 597.40).

Climate regulation and carbon sequestration attribute is only appreciated and valued by households in Mvomero and Morogoro Rural districts and its implicit price was TZS 1226.02.it has to be noted that, the overall preference for climate regulation services was negative has shown in Table 44, the negative implicit price for climate regulation services means that community do not prefer this service and they are not willing to pay anything for its provision.

Provision of recreation and landscaping amenities attribute is not appreciated and valued by any household in EAM area and this could be justified by its negative preference and negative implicit price (Table 44). Reasons for households' non preference on recreation services have been explained in previous section.

In general, households in Same district attached the highest values for the preferred ecosystem service attributes whilst households in Kilolo and Mufindi districts attached the lowest values. The difference could be attributed to their socio economic settings as communities in Northern part of Tanzania are usually considered richer than the ones in Southern part of the country. Also it could be attributed to differences in their environmental quality as Southern parts of Tanzania are believed to have good climatic conditions in terms of soil fertility, richness in biodiversities and water availability than Northern part of the country that is why they are less shocked on the need

to improve these ecosystem services. In Northern part of the country their soils are not of good quality as in Southern parts that could be a reason why they attached highest values for ecosystem services improvements.

5.6.7Estimated Values of Non Marketed Ecosystem Services in Eastern Arc Mountains

Using the study findings in Table 44above it can be seen that, on average households in Same districts are willing to pay TZS 7,282.51 per month (TZS 2,573.86 + TZS 4,325.86 + TZS 383) to ensure the continued provision and improvements of their preferred ecosystem services (water supply and protection of water sources, soil conservation and soil fertility and biodiversity conservation). Households in Mvomero and Morogoro Rural districts are willing to pay TZS 6,044.54 per month (TZS 1638.79 + TZS 1981.79 + TZS 1226.02 + TZS 1197.94) to ensure the continued provision and improvements of their preferred ecosystem services (water supply and protection of water sources, soil conservation and soil fertility, climate regulation and biodiversity conservation). Households in Kilolo and Mufindi districts are willing to pay TZS 1,749.8 per month (TZS 1016.09 + TZS 505.65 + TZS 228.15) to ensure the continued provision and improvements of their preferred ecosystem services (water supply and protection of water sources, soil conservation and soil fertility and biodiversity conservation).

In general, households living in EAM area are willing to pay an average of TZS 5, 369.92 per month (TZS 1898.49 + TZS 2874.08 + TZS 597.40) to ensure the continued provision and improvements of their preferred ecosystem services (water supply and protection of water sources, soil conservation and soil fertility and biodiversity conservation). It can be concluded that the household's willingness to pay per month for provision of ecosystem service in EAM (TZS 5369.92) is lower than the household's willingness to pay value in Same district (TZS 7282.51), Mvomero and Morogoro Rural districts (6044.54). Contrary to this, the average household's WTP value for EAM exceeds that of households in Kilolo and Mufindi districts (TZS 1749.8 per month). This implies that if payment for provision of ecosystem services program is introduced in EAM, households in Kilolo and Mufindi districts will be required to increase their ecosystem service payments while households in Same, Mvomero and Morogoro Rural district will lower their payments for ecosystem services to match with the average ecosystem service price in EAM.

5.6.8 Revenue which can be collected from Payment for Non Marketed Ecosystem Services in Eastern Arc Mountains

Table 45: Revenue which can be Collected from Payment for Non Marketed Ecosystem Services in Eastern Arc Mountains

Ecosystem service attribute	Implicit priceper month in TZS	Amount collected per month in TZS	Amount collected per year in TZS
Water	1,898.49	1,778,628,834	21,343,546,006
Soil fertility	2,874.08	269,2624,959	32,311,499,510
Biodiversity	597.40	559,683,151	6,716,197,812
TOTAL		**5,030,936,944**	**60,371,243,329**

Total number of households in Eastern Arc Mountains =936,865

The study found that households in EAM are willing to pay a total of TZS 60,371,243,329 per year to ensure continued provision and improvements of their preferred ecosystem services (Table 45). Specifically, households are willing to pay TZS 21,343,546,006 per year to ensure protection of water sources in EAM which will in turn increase the quality and quantity of water. They are also willing to pay TZS 32,311,499,510 per year to ensure their soils are well conserved through conserving forest resources, introducing soil conservation programs which will in turn enhance the quality of their soils thus increasing their agricultural productivity and reducing stresses associated with loss of soil fertility to agrarian societies. The willingness to pay also is signifying that they are recognizing there is loss of soil fertility in mountains area thus they are willing to support soil conservation interventions. Households are also willing to pay TZS 6, 716,197,812 per year to ensure biodiversity in EAM are well conserved. This intuitively tells that communities are willing to support the conservation of natural forests where most biodiversity are hosted. Communities' willingness and valuation of ecosystem services is a promising message to natural resource management institutions in the country as the communities in EAM are more than willing to also participate in conserving their supporting ecosystem services from natural ecosystems. The amount accrued from households' payment for ecosystem services can be used to support conservation activities in forest nature reserves within EAM and some can be channeled to support community development activities i.e. construction of social economic infrastructures. Based on the findings of this study, policy and decision makers in forestry and water resources can design and introduce appropriate payment for ecosystem services programs to communities in EAM. The PES programs are anticipated to support natural resource management initiatives and fuel sustainable development in the country.

6.VIABILITY OF ECOSYSTEM SERVICES IN EASTERN ARC MOUNTAINS

6.1 Quality of Ecosystem services provided by Eastern Arc Mountains in the past 10 years

The study found that, in the past 10 years supply/ availability of most ecosystem services was almost good in Eastern Arc Mountain area. However, provision of recreation services, wildlife for hunting, availability of pasture for livestock grazing, availability of natural fruits and natural vegetations, research and education activities were not of good quality (Fig. 5).

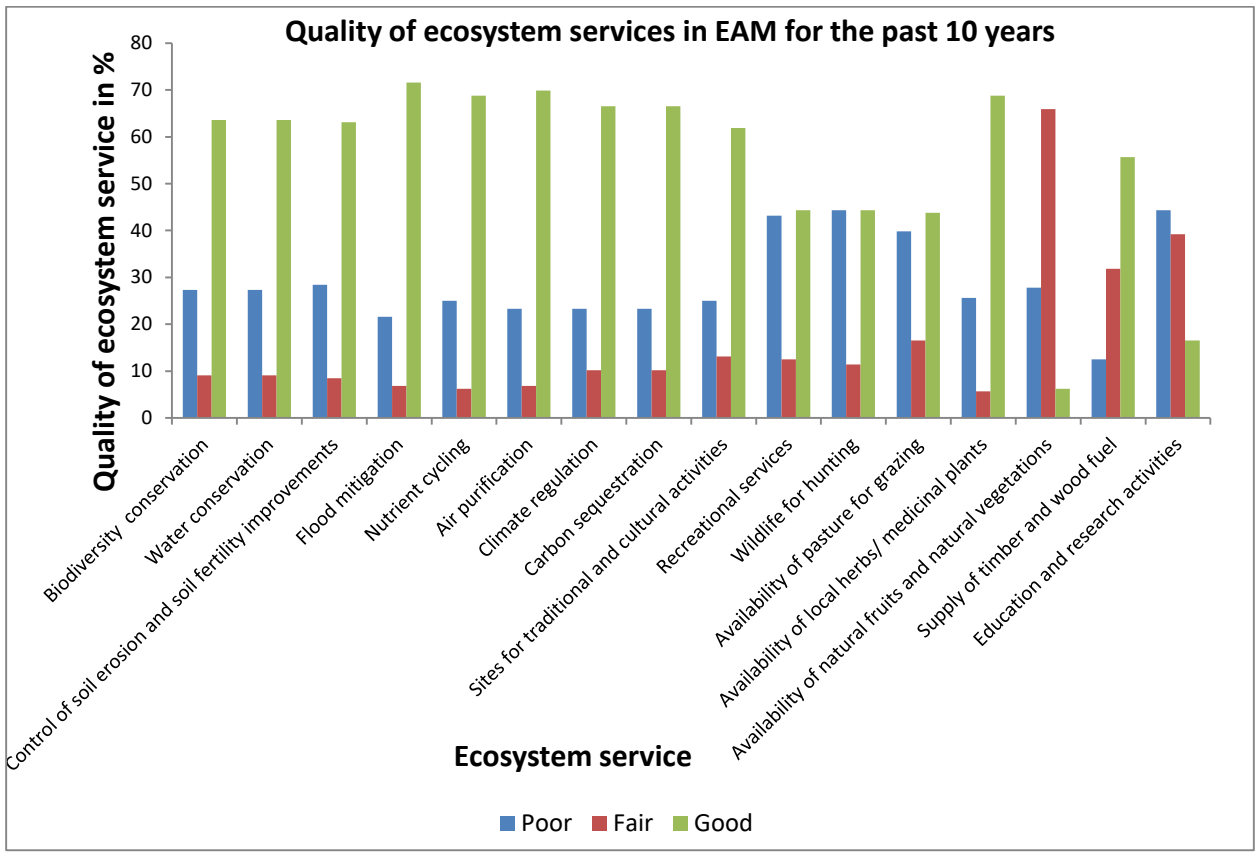


Figure 5: Quality of ecosystem services in EAM areas for the past 10 years

6.2Quality of Ecosystem services provided by Eastern Arc Mountains in the coming 10 years

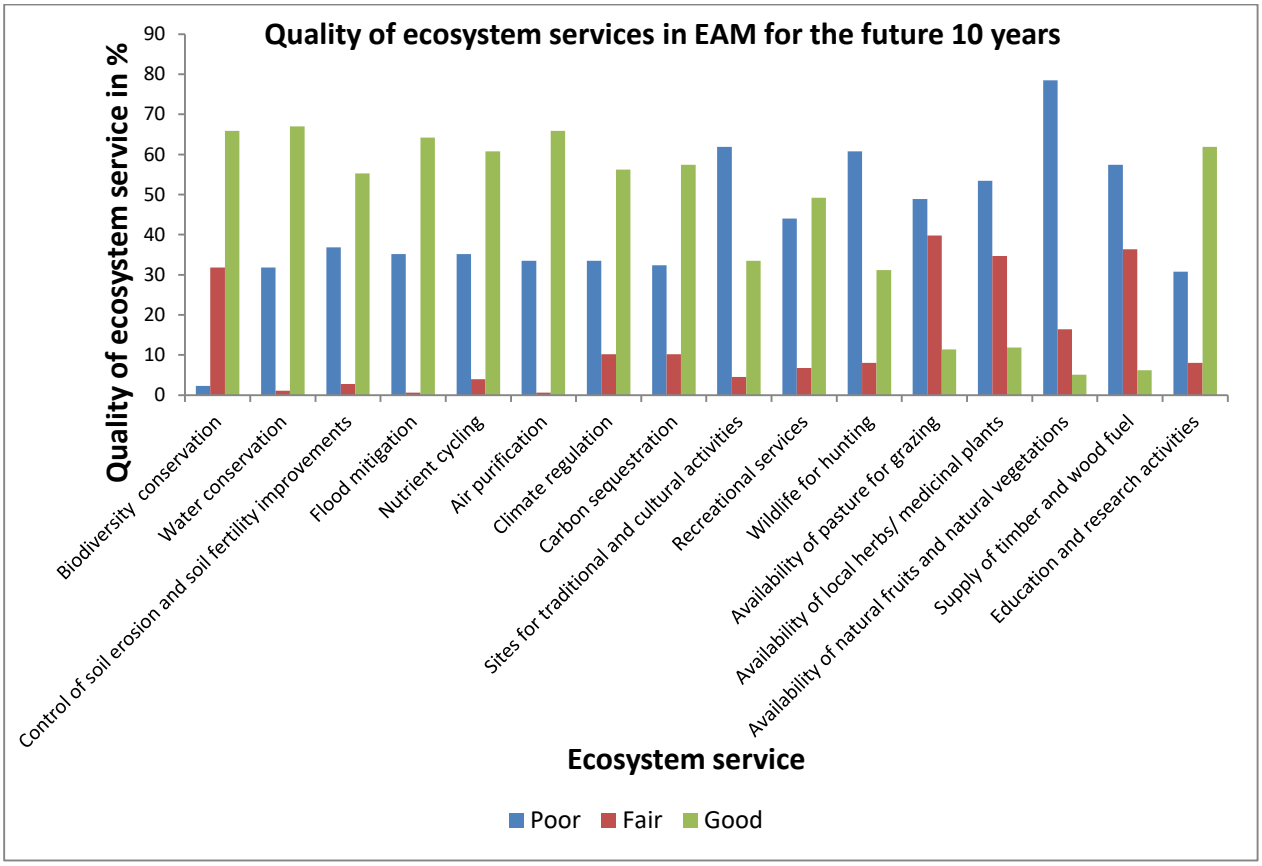


Figure 6: Quality of Ecosystem Services in EAM areas for the coming 10 years

The study findings reveal that households in EAM anticipate decrease in quality of most ecosystem services provided by EAM in the coming 10 years (Fig 6). Reduced ecosystem services quality will be observed more on the availability of natural fruits and natural vegetation, supply of timber and wood fuel, availability of pasture and grazing land and availability of local herbs. The ecosystem service quality of soil erosion control and improvements of soil fertility, flood mitigation, nutrient cycling and climate regulation services will also reduce significantly. Reasons for reduction in ecosystem services quality may be attributed to increased human population which has imparted more stress on environmental resources within EAM and climate change effects which have impacted on the health and availability of ecosystem services. Deterioration in quality of these ecosystem services signifies a need for policy and decision makers to introduce natural resource management programs in EAM.

The quality of conservation of water sources, biodiversity conservation and education and research activities are anticipated to increase in the coming 10 years (Fig 6). The reason for increase in quality of these services may be attributed to the establishment of forest conservation activities through nature forest reserves in EAM. Established nature forest reserves for instance Chome nature forest reserve, Uzungwa scarp nature forest reserve, Uluguru nature forest reserve have greatly enhanced conservation and protection of water sources which mostly originate from these nature reserves. Good forest management increases the number of biodiversity as forests provide habitats for various biodiversities. Most of these biodiversities such as collabus white, red and black, tree climbing frogs are source of attractions to tourists thus they support recreation (eco tourism) activities in all nature reserves within EAM areas. Education and research activities in EAM areas are envisaged to increase in the coming years due to development of science and technology which necessitates more researches to be conducted in various aspects i.e forest resources, wildlife etc. The conservators from nature reserves within EAM acknowledged an increase in number of students and researchers from within and outside the country who are coming to conduct their studies/research in nature reserves. The number of students and researchers is anticipated to increase in the coming years.

6.3 Factors Influencing the Proper Provision and Functioning of Ecosystem Services in Eastern Arc Mountain Areas

During the study, it was noted that most of the ecosystem services in EAM are available and well functioning in supporting lives of human kind. Respondents explained that the proper provision and functioning of ecosystem services in their area have been influenced by the following factors;

Good Environmental Governance

Respondents acknowledged existence of good environmental governance which has set some rules, regulations and policies to guide the management of environmental resources in the country for instance the Environmental Management Act 2004, Forest Management Act 2002, Forest Management Policy 1998, Water Resources Management Regulations 2009, Wildlife Management Regulations 2003 etc. All these show guidelines and directions on how human beings should manage their supporting environmental resources. Implementation of these environmental regulations where mentioned to be a reason for proper functioning of most ecosystem services in

EAM. Majorities of residents in EAM are somehow aware of these environmental guiding directives.

Establishment of Forest Nature Reserves

Establishment of forest nature reserves in EAM areas such as Chome Nature Forest Reserve, Uluguru Nature Forest Reserve, Uzungwa Scarp Nature Forest Reserve and Kilombero Nature Forest Reserve has enhanced the proper provision and functioning of ecosystem services in EAM. This is due to the fact that, nature reserves have minimized human disturbances to the forest resources and other ecosystems within the forests as communities are restricted from harvesting forest resources or doing anthropogenic activities in forest nature reserves. Strictly rules to enter the reserves and penalties are in place to minimize peoples' access to forest reserves. Furthermore, reserve management has employed conservators who help to manage the forest reserves and provide awareness to surrounding communities on forest conservation practices. However, it should be noted that reserve management have provided limited and controlled access to some of the surrounding communities to harvest forest products such as collecting dry fuel woods, natural fruits, vegetables and mushrooms. Others are allowed to do beekeeping activities in areas adjacent these nature reserves. Controlled access helps to minimize human impacts on nature reserve forests thus ensuring the continued flow of ecosystem services in EAM. Also, establishment of forest nature reserves has helped most communities in EAM to comply with forest management regulations.

Provision of Environmental Awareness Education

The government in collaboration with the Tanzania Forestry Services (TFS) is doing a recommendable work in providing environmental sensitization education to the people in EAM , especially the ones surrounding the forest nature reserves. Communities are being educated on sustainable ways of managing their natural resources so that the same resources can continue to support their lives plus the future generations. Environmental awareness education is provided on forest conservation, water resources conservation, soil conservation, sustainable agricultural practices, sustainable energy sources etc. All these, increase people's understanding on environmental issues thus they act responsible in minimizing harm to our mother nature. The study observed that households in EAM are very cognizant with their environment and they are

applying good soil conservation practices i.e. afforestation, terraces, mulching etc. Respondents concluded that environmental awareness education has positively influenced management of their environmental resources thus proper functioning and flow of ecosystem services in their areas.

Introduction of Alternative Income Generating Activities

Households admitted that the introduction of alternative income generating activities in their villages has significantly helped to reduce the pressure of harvesting forest products/resources as these resources were previously harvested to generate household income. Established income generating activities such as pig farming, goat keeping, bee keeping among others have helped the households to earn income which does not directly depend on harvesting of forest resources.

Households acknowledged the support they are getting from donors and NGO's such as EAMCEF in establishing alternative income generating activities which have lessen their dependency on forest ecosystems. Respondents added that establishment of non-farm activities would enhance the proper functioning and provision of ecosystem services in their areas as the natural environment will be less disturbed by human beings. Conservator from Uzungwa SNFR commented that in order to minimize human disturbances to their nature reserve, they have introduce alternative income generating projects such as beekeeping, dairy farming, piggery projects, goat keeping projects, energy saving stoves, tree farming and supply of tree seeds in the villages. These projects will help to reduce the household poverty, as poverty is among the key driver of environmental degradation especially in developing countries like Tanzania.

6.4 Factors for the Loss of Ecosystem Services in Eastern Arc Mountains

Despite the continuing flow of environmental goods and services, respondents explained some of the factors which are contributing to the loss of ecosystem services in EAM. Literatures reveal that more than 70% of the original forest cover in EAM has been destroyed and only about 5,400 sq km of forest remain on the mountains. Most of the forest has been lost in the past 100 years due to anthropogenic activities carried out in the area. Respondents stressed that if appropriate measures are not taken, these factors will lead to great reduction and loss of ecosystem services in their area. These factors are explained below;

Increased human population

The increase in human population in EAM areas has increased pressure on the need of environmental resources such as land, water, forest resources, energy sources etc. This leads to over exploitation of the available resources. Over exploitation of environmental resources results into decrease in quality and quantity of environmental resources.

Climate change effects

It was pointed out that climate change has greatly impacted the flow of ecosystem services in EAM, for instance long spell of dry season affect the growth of plants, reduce water volumes in rivers, natural springs, natural streams, reduce vegetation covers which all in turn compromise the availability of ecosystem service goods and services.

Poverty

This was mentioned as the main driver of environmental degradation in EAM, as poor people resort on harvesting/ over utilizing the available environmental resources in order to earn a living. Poor people cannot conserve well their surrounding natural resources as they over stretch these resources, thus efforts to eradicate poverty in EAM will result in improved environmental management.

Poor forest management

This was mentioned to affect the sustainability of forest resources in EAM. Some households are over harvesting forest products from natural forests i.e in searching for fuelwood and building materials. Others are setting fire (bush fires) in natural forests for instance in Lukwangura area while others are clearing trees for charcoal production and doing illegal hunting of forest wildlife.

Poor farming practices

Unsustainable farming practices are significantly contributing to the deterioration of environmental goods and services in EAM, as they accelerate loss of vegetation cover, soil erosion, emission of air pollutants and pollution of water sources.

Low environmental literacy

Environmental literacy usually enhance conservation and management, as people are aware on importance of environmental conservation, how to manage their environmental resources and the likely consequences which may results once the environmental resources are not well managed. Respondents argued that some of their fellows in EAM lack environmental awareness that is why they are not managing well the environmental resources in their area. Low environmental literacy could lead to deterioration of ecosystem service goods and services in EAM. This was supported by conservator from Uzungwa SNFR, who stressed that some of the people from the villages surrounding the reserve are ignorant about forest conservation and the benefits of having a nature reserve in their area that is why they keep on degrading the available forest ecosystems.

Poor sharing of benefits from ecotourism activities

Some respondents complained that they are not receiving anything from the available nature reserves in their areas. They are actually interested to see equal sharing of benefits which are accrued from ecotourism activities which are being conducted in the nature reserves within EAM. Poor sharing of benefits have discouraged them to engage in conservation activities as they are not benefiting anything from the available reserves. Respondents argued that the reserves need to support their socio-economic infrastructures such as building of schools, health centres, roads, markets like it is done in other places where tourism activities are conducted. For instance Ngorongoro conservation area and Serengeti national parks where various socio-economic infrastructures have been constructed in the surrounding villages by the park managements. They added that, the park managements are even helping to pay school fees and provide school uniforms to students in the surrounding. One respondent stressed that, "I wish all these to be done by Chome NFR management". Transparency in sharing ecotourism benefits would enhance conservation of forest ecosystems in EAM.

The conservators from the nature reserves in EAM, reacted to this allegation by saying that, the ecotourism activities in their reserves are not yet developed like in the other areas mentioned by the villagers. They are currently receiving few visitors who are visiting their reserves, which impact ecotourism revenue. However, they stressed that their reserves are devoting the little income they are having to support community activities for instance establishment of income generating activities like goat keeping, piggery projects, bee keeping etc. They promised once their

ecotourism will be improved and they receive more tourists, they will support socio economic infrastructures in their surrounding communities.

6.5 Ways of Improving the Conservation and Flow of Ecosystem Services in Eastern Arc Mountains

Study respondents and conservators from forest nature reserves proposed the following strategies to be used for improving the conservation and flow of ecosystem services in EAM;

- Provision of environmental conservation education to the communities
- Protection of all water sources within EAM
- Protection of forest form deforestation and encourage afforestation in marginal areas
- Introduce alternative livelihood opportunities to the surrounding communities, preferably the ones which do not depend on direct natural resources harvesting
- Respect cultural norms
- Provide family planning education so as to slow the rate of population increase
- Empower forest management institutions such as Tanzania Forestry Services, Tanzania Forest Research Institute; the government needs to institute Payment for Ecosystem Services policy as it is stipulated in Environmental Management Act 2004/5. Since there is positive WTP for important ES from the mountains this imply the funds through PES can empower these institutions more than what they depend/collect from extraction of goods from forests including timber and charcoal.
- Encourage farmers to practice smart and sustainable agriculture
- Integrate conservation projects to other development activities since they provide a base for economics including finances
- Equal sharing of benefits accrued from ecotourism activities

7.ECOSYSTEM MAPPING

The mapping was done through Landsat 8 (OLI). Characteristically, Landsat 8 has eleven channels and is equipped with its Operational Land Imager (OLI) and Thermal Infrared (TIRS) sensors. The OLI supplements the image spectral resolution. In addition, Landsat OLI has a deep blue and a cirrus band whereas, TIRS adds a second thermal band to the scene (Young et al., 2017). Using

the Landsat images, land use and land cover were characterized to (i) bareland, (ii) cultivation, (iii) settlement, (iv) water, (v) grassland, (vi) shrubland, (vii) forest. Procedures for land use and land cover classification are shown in figure 1.

Data sources and Acquisition: Landsat 8 (Operational Land Imagery) were freely obtained from the United States Geological Survey (USGS) website. These images are from the Landsat World Reference System (WRS 2) path and rows no 168/066, 167/063 and 167/065 for Uzungwa, Chomme and Mt. Uluguru Nature Reserves respectively. The effect of vegetation phenology was minimized by downloading scenes captured on similar satellite overpass times or seasons (Dry periods spanning July-November), and the downloaded images were either cloudless or with low percentage cloud cover (<10%).

Pre-processing: Radiometric and Geometric Correction

Prior to analysis, images were corrected for geometric and radiometric effects (Chander et al., 2009; Pons et al., 2014; Young et al., 2017). Such pre-processing facilitates comparison of multi-temporal images and field-based data (Franklin and Giles, 1995; Chavez, 1996), and ensures the corrected images are of sufficiently high quality for analysis (Pons et al., 2014). Image and/or sensor differences within and between scenes were normalized by converting the brightness values of each pixel (Digital Number (DN) to actual reflectance (Top of Atmosphere Reflectance (TOA)) in order to obtain the actual ground reflectance (Amro et al., 2011). Topographic normalization is a crucial part of atmospheric corrections (Pons and Solé-Sugrañes, 1994; Riaño et al., 2003; Shepherd and Dymond, 2003) as it enhances representation of the original image, hence improving spectral signatures, classification and overall accuracy (Jensen, 1996; Amro et al., 2011).

Cloud Removal

None of the selected images was 100% cloud free, as some images had cloud pop corns. As a result, sections of a scene with cloud pop corns were first removed and the resulting gaps filled using the Smart GeoFill tool with corresponding sections of cloud-free images for taken close in time, or in the same season, (PCI, 2015).

Topographic correction

The topography and terrain of the study areas varies, therefore, it was important to normalize the images for topographic (radiometric) effects before classification. Topographic normalization becomes an important part of atmospheric corrections (Pons and Solé-Sugrañes, 1994, Riaño et al., 2003, Shepherd and Dymond, 2003) as it enhances representation of the original image, hence improved spectral signatures, classification and its overall accuracy (Jensen, 1996, Amro et al., 2011). Digital Elevation Model (DEM), with a spatial resolution of 30 m, derived from the Shuttle Radar Topography Mission (SRTM) was used to correct image topographic effects (Ekstrand, 1996). Terrain correction (geometric) was not performed as Landsat Level-1 products are terrain corrected (Young et al., 2017).

Processing: Image classification is the process of using specific criteria (classifiers) to order or arrange objects (land cover) into groups or sets on the basis of their relationships (Maimaitijiang et al. 2015). According to Kelly et al., (1999), classes should be defined such that they are distinct at the temporal and spatial grain of analysis, clearly identifiable in reference datasets, and based on discrete types in reality. In this study, therefore, the image classification was performed using the Random Forest (RF) Package in the R software. RF is a powerful machine learning classifier that has received wide acceptance in land-based remote sensing, with advantages such as; high classification accuracy, robust to noise compared to other classifiers and a non-parametric classifier (Cutler et al. 2007, Frakes et al. 2015). Furthermore, it is able to impute missing values and rank variables in order of their importance, allows reliable assessment of the predictive accuracy of classification (Rodriguez-Galiano et al. 2012, Frakes et al. 2015).

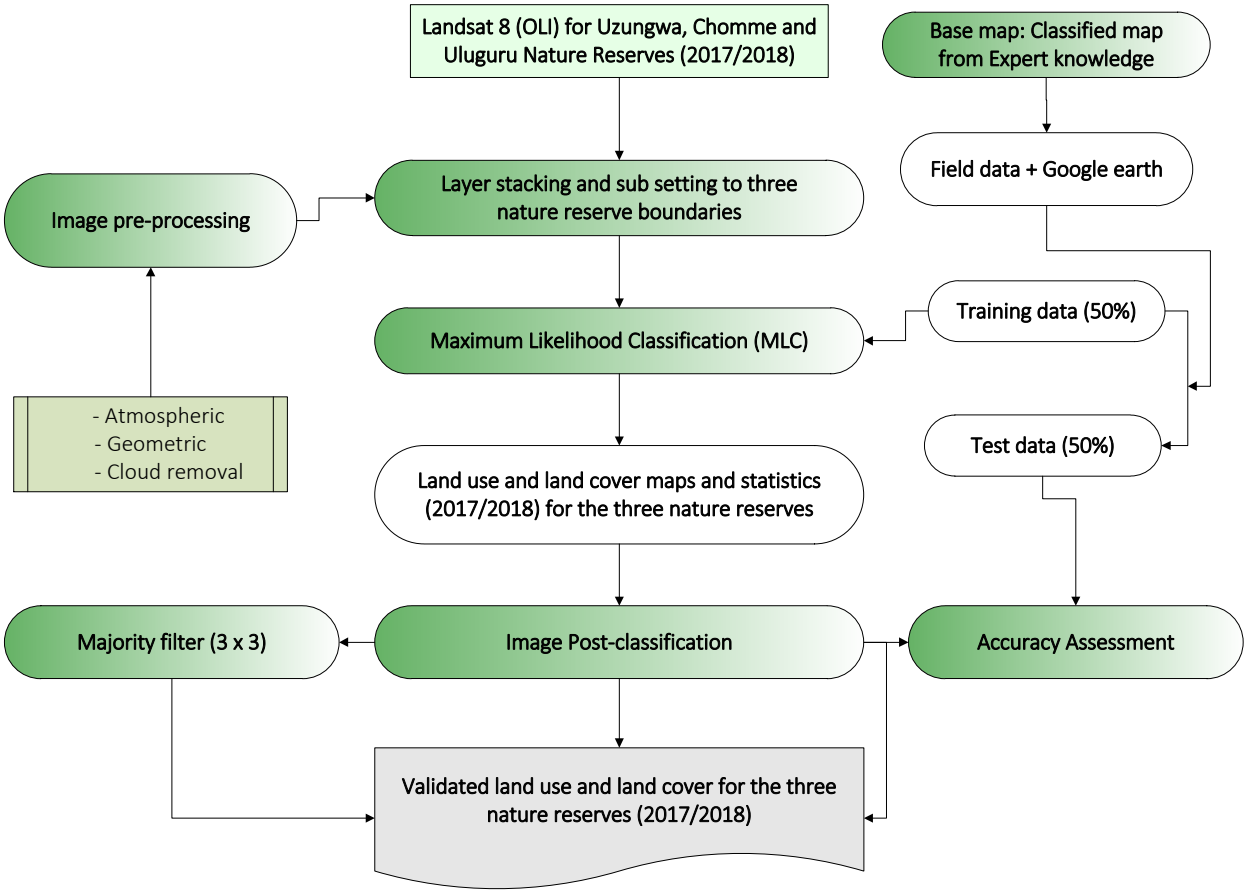
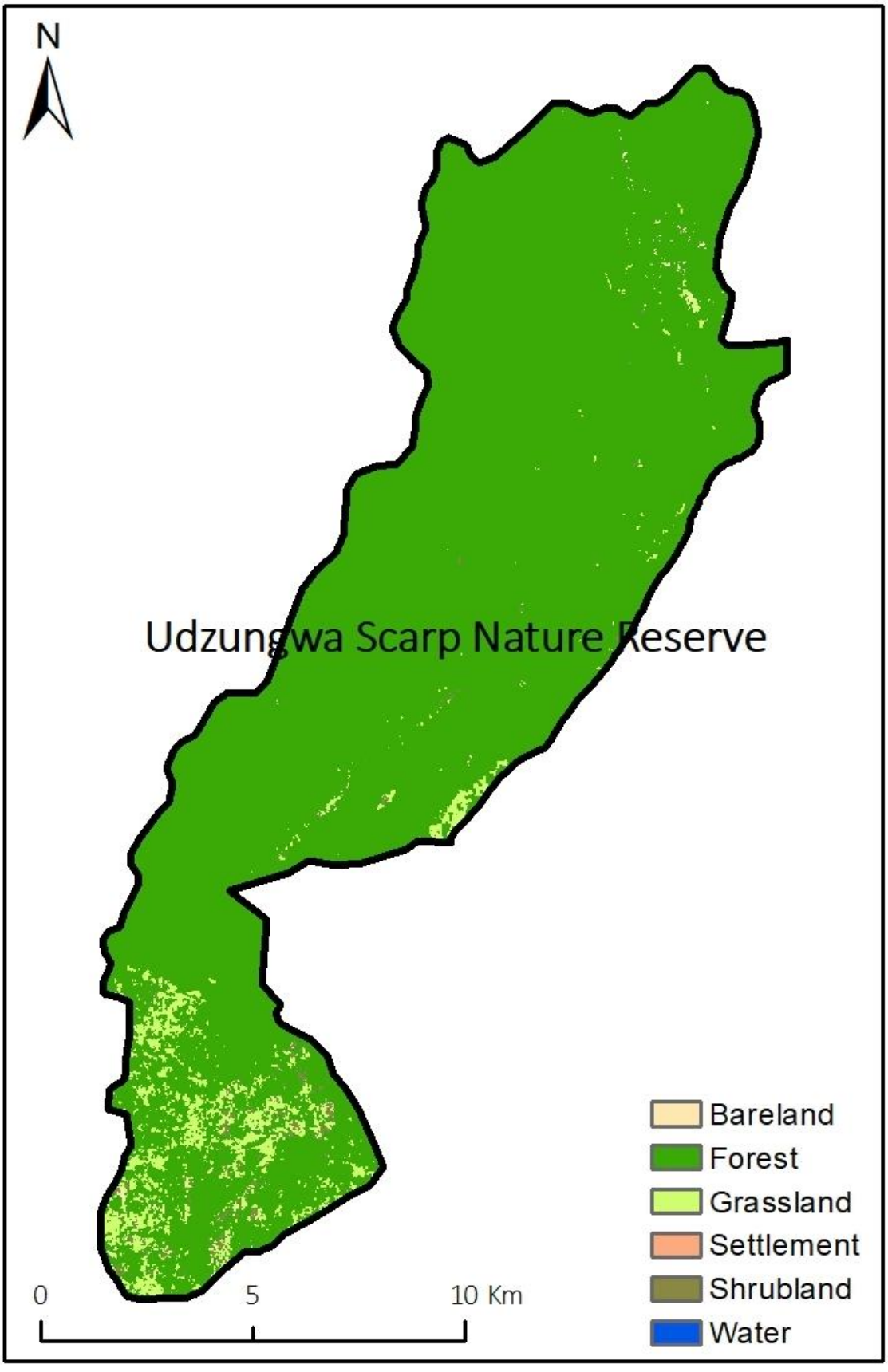
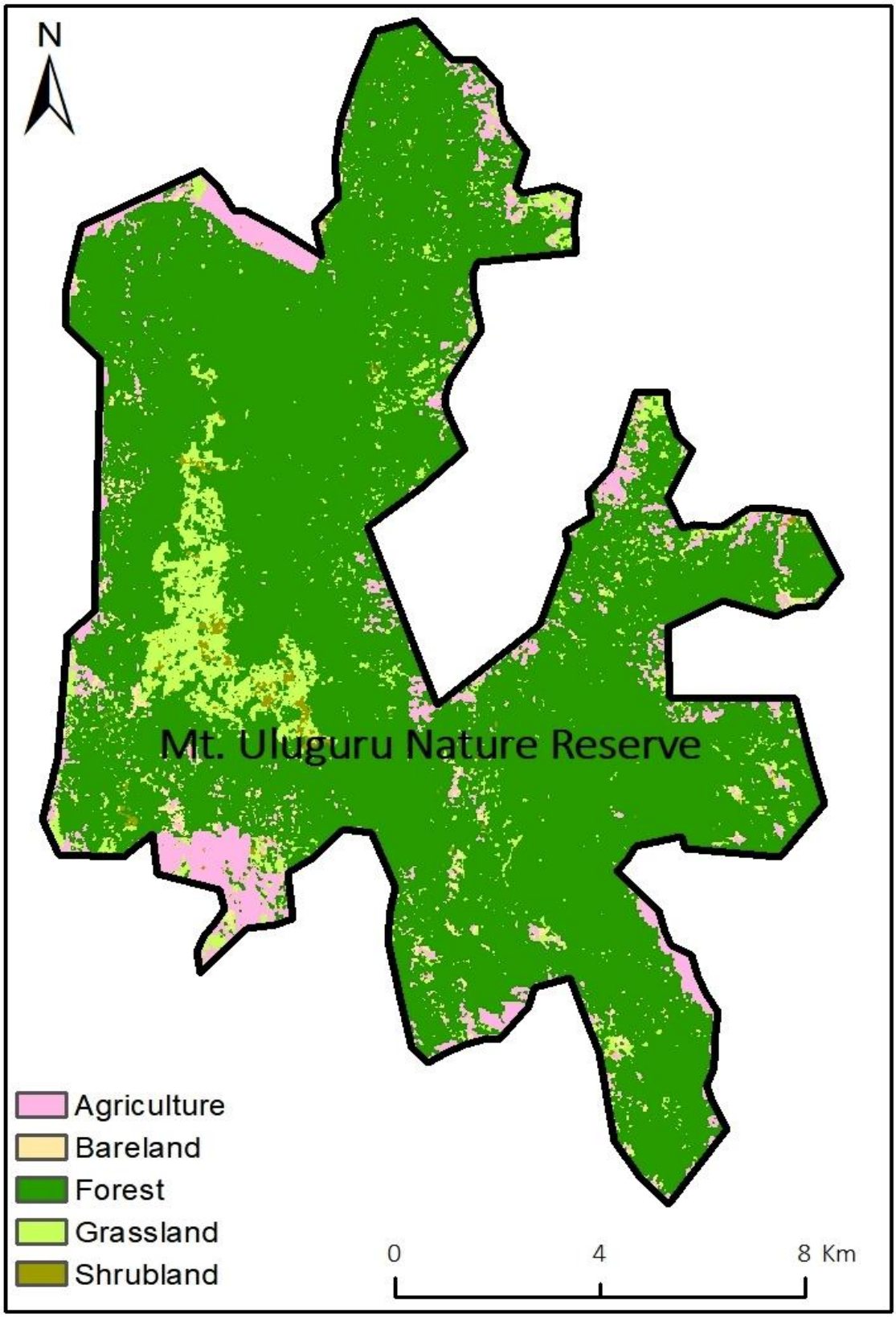
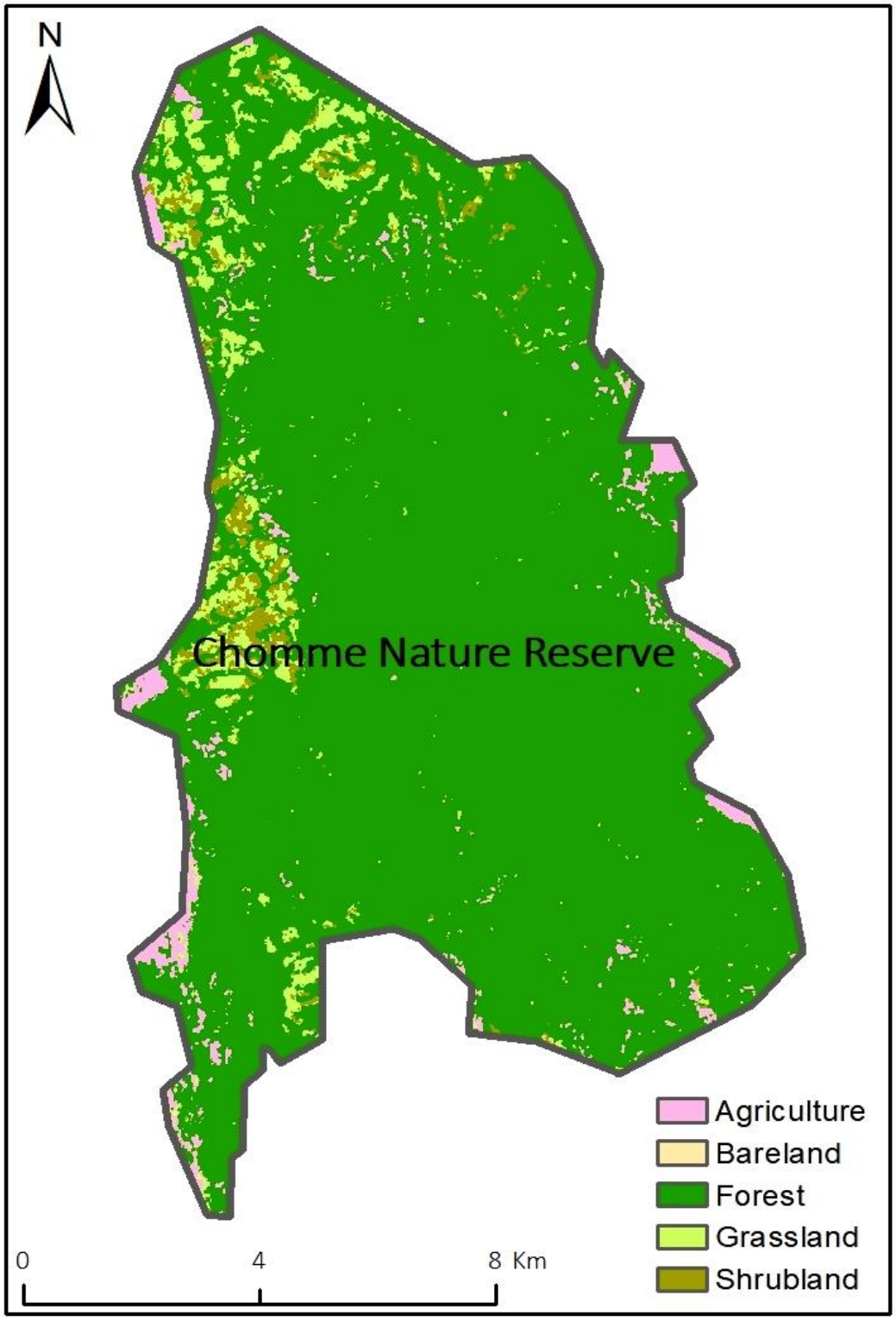


Figure 7: Flow chart of land use and land cover classification

We still are synthezising the maps to realise our objectives of extracting information that we shall use in the second phase of valuation. The maps are as presented here under this paragraph.


N
Udzungwa Scarp Nature Reserve
0
5
10 Km
Bareland
Forest
Grassland
Settlement
Shrubland
Water


N
Mt. Uluguru Nature Reserve
Agriculture
Bareland
Forest
Grassland
Shrubland
0
4
8 Km



This component was not well done because of limitation in financial resources

8. CONCLUSION AND POLICY IMPLICATIONS

The study findings suggest that the EAM are very valuable and form the economic base for the country since they provide basic ingredients to development. The most important and useful ingredients are water resources which are mostly used for energy provision which fuels this country's development. The water is also useful for both industrial and domestic uses; it is important for ecology because most plants and animals depend upon for their survival and thence contributing to biodiversity protection and enhancements. Apart from water and its associated resources, the ecosystems are the main sources of services that are directly linked to communities' welfare including soil nutrients fixation and transportation to the valley where crop farming is being practiced. The soil fertility is showed to be most preferred attribute by the locals. It is therefore evident that the values that these ecosystems provide are enormous and therefore need to be sustained for the country's general welfare.

However, with all these values that the study has managed to establish, the revealed preferences of the communities,' portrayed as *soil fertility attribute* which stands on behalf of marketed crops (*Proxy to crop farming*) in this study, showed to be higher than the perceived value of *biodiversity attribute* that stands as a proxy to conservation of EAMs. Contrary to what is common understood, the Conservation or ecological values as argued by Boyd and Banzhaf (2007), functions dependently. This implies that if one function is impaired the efficiency of the other also gets weak. The ecological functions in an ecosystem are generally the habitat and regulation services hereby given low preferences whereas socio-economic perceived values which reflect the monetary or marketed values of services are given higher price simply because are directly transacted in the market framework as put forward by Groot et al., (2002). These functional relationships between ES values and Market/Economic Values have policy implications and if not properly instituted they tend to have indirect and direct links to the economy respectively. Unfortunately the ES values have demonstrated to have direct negative impacts to the economy other than the market values that are transacted through the market framework. This is what the environmental economists (e.g Groot et al.,2002; MEA, 2000, Brink, et.al, to mention a few) argue to be the shortcoming in neo-classical economic theories that is blamed for ecosystems undervaluation; for instance timber, water (when transacted as good) and agricultural crops are perceived in this study by market agents, to be more valuable versus soil fertility or water services maintenance that are compromised through deforestation and tilling of lands for crop productions. These findings are

amply documented elsewhere (e.g in Groot et al., 2002, DEFRA, 2007, Boyd,2011 and Mombo, 2013 to mention a few). It is from this perspective we understand that the **perceived values** are given by **market institutions** a lesser price/value (less preferred when compared to marketed goods) due to the fact that most of Ecosystem Services i.e **ES** do not have price tags and are not specified, so they are mostly considered freely (i.e *Zero price*) provided by nature because they are not directly accessed or paid for in the market frame work where the economic agents make their transactions of marketed goods and services. This is the main reason as to why scholars argue the ecosystems values are under-valued and therefore given a low priority in the market frameworks (Groot et al., 2002, Costanza 2005, Rebelo et al. 2010 and Mombo, 2013). As a result they are over exploited because it is cheaper (i.e perceived zero cost/frely given) to do so as compared to the marketed goods and services. **This is an important finding which all stakeholders should be made aware of.** Consequently, it is high time now we change our policy perspectives and try to integrate our practices whereby our market institutions should also include the non-marketed goods in the market frame work for people to pay for these ES; one of the easiest and direct way is the enforcement of Payment for Ecosystem Service (PES) which fortunately is enacted in EMA, 2004/05. The practice of this is not full instituted in our development endeavors including in crop farming, water abstractions, energy provision and timber products extractions. In conclusion the study argues that, the viability of the enormous values that are demonstrated to exist in EAC Mountains need policy orientation whereby there would be greening of our economy through application of Environmental Policy Instruments including PES and Environmental Taxation to goods and services that are directly linked to ecosystems degradation when exploited to enhance the ecosystems sustainable management, specifically the EAMs.

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