Comparing perceptions and realities of non-timber forest products extraction, agricultural practices and land use change along the southern slopes of Mt. Kilimanjaro, Tanzania

Vergleich der Wahrnehmungen und der Realität der Nutzung von Materialien und Nahrungsmitteln aus Wäldern, der landwirtschaftlichen Nutzung und dem Landnutzungswandel auf den südlichen Hängen des Kilimandscharo, Tansania

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Summary

Research studies aiming at integrating socio-economic and ecological factors are increasingly being used in order to improve our understanding of the causes and effects of environmental changes. The major objective of this study is to identify important factors and drivers of ecosystem use, changes and their complex relationships within the Mt. Kilimanjaro ecosystem. In this study perceptions of land use/cover change, collection of non-timber forest products (NTFPs), and agricultural activities are highlighted. The study also focuses on the extent of changes in ecosystem services that result from land use in six villages on the southern slopes of Mt. Kilimanjaro, Tanzania.

In order to understand the complex relationships between people´s livelihoods and the ecosystem services provided by the foothills of Mount Kilimanjaro, the following objectives were formulated: (i) to identify factors influencing decisions and perceptions on agricultural land use among small holder farmers in Kilimanjaro, (ii) to review perceptions and realities of water and land resources on the foothills of Mt. Kilimanjaro, and (iii) to determine the socio-economic factors leading to the extraction of non-timber forest products on the slopes of Mt. Kilimanjaro.

The study was conducted in Hai District of the Kilimanjaro Region, in the northern part of Tanzania mainland. Data were collected through a questionnaire survey of 313 households in six study villages surrounding the Kilimanjaro National Park (KINAPA). The study was undertaken along a transect on the slopes of Mt. Kilimanjaro covering different ecological zones and a number of altitudinal and agro-ecological zones. It included (1) a lowlands zone of extensive livestock farming and open crop fields, with remnant woodland patches comprising the villages of Wari and Nshara; (2) a midlands maize-bean belt which is a mosaic of home gardens and open fields, with few woodland patches interspersed between, represented by the villages of Shari and Nkuu-Ndoo; and (3) the villages of Foo and Nronga, located in a highland traditional Chagga home garden area which is dominated by coffee and banana with many large shade trees. The lowlands zone extends up to about 900 m, midlands up to 1200 m and the home garden area to about 1800 m above sea level, up to the lower Kilimanjaro National Park border.

Socio-economic explanatory variables were used in the analysis namely gender, marital status, age, education, income, distance to the forest, land cultivated and land owned. The responses by the household heads to the individual questions were processed and analysed using standard univariate and bivariate statistical techniques (frequency tables, multivariate regression, cross-tabulations and chi-square analysis) using the software SPSS v24.

The first objective is to model the dependence of the frequency of forest resource extractions on multiple socio-economic parameters. As the dependent variables consisted of count data, i.e. the number of forest visits per year, a negative binomial regression was chosen. The second objective is to measure the perceptions of land degradation on multiple socio-economic parameters. The chi-square test for independence is used to discover if there is a relationship between two categorical variables. The third objective is to measure factors influencing the adoption of agricultural practices. In this case chi-square test was used to test the influence of various socio-economic factors on agriculture. In some cases, a multivariate regression analysis is conducted in order to identify key assets that play an important role in livelihood outcomes and to outline if there are correlations within the variables.

Generally, findings indicate that both positive and negative relationships among different variables were found. This leads to socio-economic relations depending on specific contextual factors such as agricultural land, water use and forest use. Education is the main variable that could explain various social relationships related to agricultural land and water use. Whereas all respondents strongly agreed on ongoing land use change and declining water resources, there were differences on the perceived causes and consequences. Neither age, income nor gender could explain these differences. Interestingly, people with primary education voted more for causes and consequences of land use change and declining water resources that could be considered as external, i.e. not under their direct control, such as deforestation or drought. On the other hand, people with secondary education demonstrated stronger reflection and concern on actions and practices under direct responsibility of the own community, such as unsustainable farming practices. Respondents with primary education level were more often unsatisfied with the local water management than those with secondary education, indicating a lower participation in community decisions on water management.

Results on the perceptions on the declining water and land resources revealed that perceptions on the declining natural vegetation cover versus education showed a higher significance**.** Perceptions on the state of water use and availability also proved to be highly significant**.** The female gender however showed a correlation to all of the perceptions on declining natural vegetation although the relationship is not strong. Contrary to expectation the age groups and income levels did not show any strong relationship with perceptions on declining natural vegetation and declining in water sources.

Lastly, results on the socio-economic factors determining extraction of non-timber forest products revealed the following: extraction of fodder and firewood was significantly related and showed a positive correlation to gender (in this case females) and a negative correlation to the number of household members. Firewood collection decreased with increasing distance between household and forest. Medicinal plants were collected more by men than women, of older age, and if the distance was closer. Neither household income nor property size contributed to the explanation of forest product extraction. The most relevant factors were gender, age, household size and distance to forests. For firewood and fodder extraction, inter-village variation was stronger than intra-village variation, suggesting that differences in access to infrastructure and alternative sites to produce fodder were stronger determinants of NTFPS extraction than household income or the size of the cultivated land.

These findings highlight the need for conservation and development projects to pay attention to the specific household factors that influence land use change including forest use, rather than relying on assumptions that poverty and forest extraction are always interlinked. New arrangements need to be put in place to ensure that a portion of the forest is given to villagers to enable communities to extract forest resources legally as opposed to the ongoing illegal harvesting**.** Also, investment in education for both men and women is important for general environmental awareness. Last but not least, stronger strategies to promote forest conservation, and effective regulation/modification of community forest uses need to be established to improve the vegetation and water conditions.

Zusammenfassung

Die Integration von sozial-ökonomischen und ökologischen Einflussfaktoren ist ein zunehmendes Ziel von wissenschaftlichen Untersuchungen, um das Verständnis von Gründen und Auswirkungen von Umweltveränderungen zu verbessern. Das übergeordnete Ziel dieser Studie ist es, wichtige Einflussfaktoren und Treiber vom Nutzen der Ökosysteme sowie Ökosystemveränderungen und ihre komplexen Zusammenhänge in der Mt. Kilimanjaro Region zu identifizieren. Dazu werden insbesondere Wahrnehmungen gegenüber Veränderungen von Landnutzung und Bodenbedeckung, das Sammeln von forstwirtschaftlichen Erzeugnissen (non-timber forest products, NTFPs) sowie landwirtschaftlichen Aktivitäten untersucht. Der Fokus dieser Studie liegt zudem in der Analyse des Ausmaßes von landnutzungsbedingten Veränderungen in der Bereitstellung von Ökosystemdienstleistungen.

Um die Veränderungen der komplexen Zusammenhänge zwischen Lebensverhältnissen und Ökosystemdienstleistungen zu verstehen, die von den Gebirgsausläufern des Mt. Kilimanjaro bereitgestellt werden, werden folgende Ziele formuliert: (i) Identifizierung der Einflussfaktoren, die Entscheidungen und Wahrnehmung hinsichtlich landwirtschaftlicher Nutzung durch Kleinbauern in Kilimanjaro beeinflussen, (ii) Überprüfung von Wahrnehmungen und Zuständen der Wasser- und Landressourcen an den Gebirgsausläufern des Mt. Kilimanjaro, (iii) Bestimmung der sozial-ökonomischen Einflussfaktoren, die zu der Gewinnung von NTFPs an den Hängen des Mt. Kilimanjaro führen.

Die Studie wurde im Hai District der Kilimanjaro Region durchgeführt, welcher im nördlichen Teil von Tansania liegt. Die Daten wurden mittels einer fragebogenbasierten Umfrage erhoben, insgesamt wurden 313 Haushalte in 6 Dörfern an den südlichen Hängen des Mt Kilimanjaro befragt. Die Dörfer wurden entlang eines Transekts, welches verschiedene ökologische und agrarökologische Systeme sowie Höhenstufen umfasst, ausgewählt. Eingeschlossen werden (1) eine Tiefebene mit extensiver Beweidung und offenen Getreidefeldern sowie vereinzelten Rest-Waldbeständen (Dörfer **Wari** und **Nshara**); (2) Midlands mit einem Mais-Bohnen Gürtel, die durch ein Mosaik aus Gärten und offenen Feldern mit wenigen und vereinzelten Waldbeständen gekennzeichnet sind (Dörfer **Shari** und **Nkuu-Ndoo**); und (3) die Dörfer **Foo** und **Nronga**, die im Hochland liegen und traditionelle Chagga Hausgärten repräsentieren, die von Kaffee- und Bananenpflanzen und vielen großen, schattenspendenden Bäumen geprägt sind. Die Tiefebene

erstreckt sich bis 900 m Höhe, die Midlands bis 1200 m, das Hausgartengebiet liegt bis zu 1800 m über dem Meeresspiegel und grenzt an den Kilimanjaro Nationalpark.

Als erklärende sozial-ökonomische Variablen werden in dieser Studie Geschlecht, Familienstand, Alter, Ausbildung, Einkommen, kultiviertes Land und Landeigentum betrachtet. Die Antworten des Haushaltsvorstands zu den jeweils gestellten Fragen werden mit Hilfe von univariaten und bivariaten statistischen Methoden (Häufigkeitstabellen, multivariate Regressionen, Kreuztabellen und Chi-Quadrat-Analyse) und der Software SPSSv24 bearbeitet und analysiert.

Dabei ist das erste Ziel, die Abhängigkeit der Häufigkeit von Waldressourcenentnahme zu verschiedenen sozial-ökonomischen Variablen zu modellieren. Da abhängige Variablen aus der Erhebung von Häufigkeitsdaten bestehen, zum Beispiel die Anzahl der Waldbesuche pro Jahr, wird eine binominale Regression gewählt. Das zweite Ziel ist, die Wahrnehmung der Landdegradation durch verschiedene sozial-ökonomische Parameter zu messen. Dabei wird der Chi-Quadrat-Test beispielsweise auf zwei kategorische Variablen angewendet. Das dritte Ziel ist, die Einflussfaktoren, die zur Anpassung von landwirtschaftlichen Praktiken zu messen, ebenfalls mit Hilfe des Chi-Quadrat-Tests. In einigen Fällen wurde eine multivariate Regressionsanalyse angewendet, um Schlüsselfaktoren, die eine wichtige Rolle bezüglich der Lebensumstände spielen, zu identifizieren und zu überprüfen, ob es Korrelation innerhalb der Variablen gibt.

Im Allgemeinen zeigen die Ergebnisse, dass sowohl positive wie auch negative Verbindungen zwischen den verschiedenen Variablen gefunden werden können. Die führt zu sozial-ökonomischen Beziehungen, die von speziellen kontextabhängigen Einflussfaktoren, wie beispielsweise landwirtschaftlich genutztes Land, Wassernutzung und Waldnutzung, abhängig sind. Dabei ist die Ausbildung die wichtigste Variable, die zahlreiche soziale Zusammenhänge, die in Verbindung mit landwirtschaftlicher Landnutzung stehen, erklären kann. Obwohl alle Befragten übereinstimmen, dass es Veränderungen in der Landnutzung gibt und die Wasserressourcen sich verringern, gibt es Unterschiede in der Wahrnehmung über die Gründe und Konsequenzen. Weder Alter, Einkommen noch Geschlecht können diese Unterschiede erklären. Interessanterweise wählten Menschen mit Primarschulbildung überwiegend Gründe und Konsequenzen von Veränderungen in der Landnutzung und verringerten Wasserressourcen, die als extern betrachtet werden können, die nicht unter direkter Kontrolle stehen, wie

beispielsweise Entwaldung oder Dürren. Auf der anderen Seite zeigen Menschen mit Sekundarausbildung eine stärkere Reflektion und Bedenken bezüglich Handlungen und Praktiken unter dem direkten Einfluss der eigenen Gemeinschaft, wie beispielsweise nicht- nachhaltige landwirtschaftliche Aktivitäten. Befragte mit Primarschulbildung sind öfter unzufrieden mit dem lokalen Wassermanagement als Befragte mit höherer Schulbildung, sie geben eine geringere Partizipation in Gemeinschaftsentscheidungen in Bezug auf Wassermanagement an.

Die Ergebnisse der Wahrnehmung auf schwindende Wasser- und Landressourcen zeigen, dass die Wahrnehmung bezüglich der sich verringernden natürlichen Vegetationsdichte gegenüber dem Ausbildungslevel eine höhere Signifikanz zeigt. Auch die Wahrnehmung bezüglich des Zustands der Wassernutzung und Verfügbarkeit haben eine hohe Signifikanz. Das weibliche Geschlecht zeigte eine starke Korrelation in Bezug auf zurückgehende natürliche Vegetation, obwohl der Zusammengang nicht stark ist. Altersgruppen und Einkommenshöhen zeigen keinen starken Zusammenhang mit Wahrnehmung in Bezug auf zurückgehende natürliche Vegetation und Wasserquellen.

Die Ergebnisse der sozial-ökonomischen Einflussfaktoren, die die Entnahme von NTFPs bestimmen, zeigen folgendes: die Entnahme von Futtermitteln und Feuerholz steht im signifikanten Bezug, zeigt eine positive Korrelation zum weiblichen Geschlecht und ist negativ korreliert zu der Anzahl der Personen, die im Haushalt leben. Das Sammeln von Feuerholz sinkt mit zunehmender Distanz zwischen Haushalt und Wald. Medizinpflanzen werde öfter von älteren Männern als von Frauen gesammelt, wenn die Distanz nicht zu groß ist. Weder das Haushaltseinkommen noch die Größe des Eigentums tragen zu der Erklärung von der Entnahme von NTFPs bei, die relevantesten Einflussfaktoren sind Geschlecht, Alter, Haushaltsgröße und Distanz zum Wald. Für Feuerholz und Futtermittelgewinnung ist die inter-Dorf Variation stärker als die intra-Dorf Variation, dies deutet darauf hin, dass Unterschiede im Zugang zu Infrastruktur und alternativen Gebieten zur Futtermittelproduktion stärkere Einflussgrößen bezüglich der Entnahme von NTFPs ist als Haushaltseinkommen oder die Größe vom kultivierten Land.

Auf Grundlage der Ergebnisse lässt sich der Bedarf an Naturschutz und Entwicklungsprojekten hervorheben, um den spezifischen Einflussfaktoren in Bezug auf den Haushalt mehr Aufmerksamkeit zu geben, die Veränderungen in der Landnutzung beeinflussen, eingeschlossen

der Waldnutzung, vielmehr als die Annahme, dass Armut und die Entnahme von NTFPs immer in Verbindung stehen. Neue Regelungen sollten getroffen werden um sicherzustellen, dass das degradierte Land und die degradierten Wasserquellen wieder hergestellt werden und dass ein Teil des Waldes den Dorfbewohnern zugesprochen wird, um legal NTFPs zu entnehmen, im Gegensatz zu der derzeitigen illegalen Situation. Zudem werden Investitionen in Ausbildung für Männer und Frauen, Strategien, die den Waldschutz fördern, und effektive Regulationen /Modifikationen der Waldgemeinschaft in Bezug auf Waldnutzung den Zustand der Vegetation und des Wassers verbessern.

Most Important Definitions

Deforestation: Deforestation occurs when the forest is converted to another land cover or when the tree canopy cover falls below a minimum percentage threshold—10% for the United Nations (U.N.) Food and Agriculture Organization (F.A.O.).

Non-timber forest products: Non-timber forest products (NTFP's) are any products or services other than timber that is produced in forests. In our case, these include fruits and vegetables, medicinal plants, firewood and fodder.

Climate Change: Climate change, also called global warming, refers to the rise in average surface temperatures on Earth. An overwhelming scientific consensus maintains that climate change is due primarily to the human use of fossil fuels, which releases carbon dioxide and other greenhouse gases into the air. The gases trap heat within the atmosphere, which can have a range of effects on ecosystems, including rising sea levels, severe weather events, and droughts that render landscapes more susceptible to wildfires.

Land use: Land use is defined by the purposes for which humans exploit the land cover. There is high variability in time and space in biophysical environments, socio-economic activities, and cultural contexts that are associated with land-use change. Examples include 'Park', 'Intermediate Density Residential', and 'Industrial'.

Land use change: Land-use change is always caused by multiple interacting factors originating from different levels of organization of the coupled human-environment systems. The mix of driving forces of land-use change varies in time and space, according to specific human-environment conditions

Land cover: The Land cover is defined by the attributes of the earth's land surface and immediate subsurface, including biota, soil, topography, surface and groundwater and human structures.

Livelihood: A livelihood is a means of making a living. It encompasses people's capabilities, assets, income and activities required to secure the necessities of life.

Agriculture: Agriculture is the utilization of biological processes on farms to produce food and other products useful and necessary to man. Both a “way of life” and a “means of life” for the people involved in this industry.

Agriculture Extension Service: Cooperative (Federal, State, and County) agency doing research and education for rural and urban producer and consumer groups, located in each county with specialist personnel for each particular area.

Cash Crop: A cash Crop is any crop that is sold off the farm to yield ready cash.

Ecosystem: An ecosystem can be visualized as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment. An Ecosystem varies greatly in size from a small pond to a large forest or a sea. The products of ecosystem processes are named as ecosystem services, for example, healthy forest ecosystems purify air and water, mitigate droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values.

Drivers of ecosystem change: For terrestrial ecosystems, the most important direct drivers of change in ecosystem services in the past 50 years, in the aggregate, have been land cover change (in particular, conversion to crop-land) and the application of new technologies, which have contributed significantly to the increased supply of services such as food, timber, and fibres.

Acronyms and Symbols

ANOVA	Analysis of Variance
FAO	Food and Agriculture Organization of the United Nations
GHGs	Green House Gases
GIS	Geographical Information Systems
IPCC	Intergovernmental Panel on Climate Change
Tshs	Tanzanian Shillings
NTFP's	Non-timber Forest Products
TANAPA	Tanzania National Parks
KINAPA	Kilimanjaro National Parks
CC	Climate Change

Statistical Abbreviations

Abbreviation	Answers
Def	Deforestation
For	Forest fires
Dr and Lanexh	Drought or land exhaustion
Redfopro	Reduced food production
RedInc	Reduced Income
Decrain	Decreased rainfall
Def	Deforestation
Soer and exh	Soil erosion and exhaustion
Insuf. suppl	Insufficient supply
Chg	Change
Well mgd	Well managed
Moderately mgd	Moderately managed
Poorly mgd	Poorly managed
Better mgd	Better than before
Unsust. farng	Unsustainable farming systems
Deforestation	Deforestation
Drought	Excessive drought
Env. education	Environmental education
Better mgt of res.	Better management of natural resources

Chapter 1

Introduction and background to the study

Hawa Kaisi Mushi

1.1 Introduction

Society benefits from a wide variety of resources and processes that are provided by ecosystems. These benefits are known as ecosystem services, and they result from the functioning of ecosystem interactions of plants, animals, and microbes with the environment (NRC, 2011). The Millennium Ecosystem Assessment (MEA) defines ecosystem services as "the benefits provided by ecosystems to humans, which contribute to making human life both possible and worth living" (MEA, 2005). Moreover, the MEA defines explicit categories of ecosystem services, including provisioning services (e.g., material goods such as food, feed, fuel, and fibre) as well as regulating services (e.g., climate regulation, flood control, water purification).

This study has used the ecosystems services approach which combines the concerns of ecology and the broadly defined geographical and socio-economic benefits that nature provides. It regards environmental issues as both ecologically and socially defined, and allows for such issues to be evaluated (MEA, 2005). In assessing factors or indicators for forest resources' utilization, agricultural land use and general land use change a multi-step methodology is used. This included collecting data through questionnaires, observing real situation in the villages as well as focus group discussions. With this concept it is easier to explain the benefits of conserving natural resources in these villages. The concept provides a possibility to address ecological issues, also from the perspective of economics and service production. It helps in conserving nature that is threatened or endangered. In our case for instance, the concept helps in explaining how the conservation of a forest including threatened species can bring more value to the neighbourhoods, in the form of physical ecosystem services or how conservation could be experienced as an opportunity to build uniqueness or identity of an area, instead of seeing conservation as a threat to urban development.

reflect a certain necessity or is it a choice? Can their varying perceptions be explained by socio-economic, demographic and geographical determinants? The ecosystem services framework lends itself to understanding the relationship between ecosystems and human behaviour. A profound understanding of how people perceive, acquire and use ecosystem services can help influence behavioural compliance with management and policy prescription (Vedeld *et al*., 2004).

Historical evidence suggests that the Chagga people have occupied the southern slopes of Mt. Kilimanjaro at least since the 1600s. They developed the complex Kihamba land use system that included permanent home gardens around the homestead, some fed by irrigation systems, seasonal fields, and livestock. They grew bananas, vegetables and grains. They also kept livestock that provided manure that was used as fertilizer (Wimmelbücker 2002). The region is also endowed with a number of natural resources such as fresh water, rich volcanic soils, wildlife and various natural vegetation species (Majule, 2003).

All over the world, humans have increased agricultural output mainly by bringing more land into production. The greatest concentration of farmland is found in Eastern Europe, with more than half of its land area in crop cover (Ramankutty *et al.,* 2002). Despite claims to the contrary, the amount of suitable land remaining for crops is very limited in most developing countries (Young, 1999), where most of the growing food demand originates. Underlying causes are formed by a complex of social, political, economic, demographic, technological, cultural, and

biophysical variables that constitute initial conditions in the human-environment relations and are structural (or systemic) in nature (Geist *et al*., 2002). Proximate causes generally operate at the local level (individual farms, households, or communities). The harvesting and consumption of plant products from natural forests is known to account for a large proportion of the livelihood of people living close to such habitats (Carpentier et al., 2000). The majority of these plant products are non-timber forest products (NTFP's), a term that encompasses biological materials used for purposes other than for commercial timber.

In Africa attitudes towards protected areas are often shaped by the socio-economic landscape (Masozera *et al*., 2004). Tens of millions of rural households in Sub-Saharan Africa rely heavily on forest products for subsistence and to supplement their cash incomes. The poorest households, women and children rely on them most (Kideghesho *et al*., 2007). Less clear is whether attitudes translate into behaviours (Holmes, 2003), because illegal extraction from protected areas is often shaped by the surrounding socio-economic landscape. Land use is defined by the purposes for which humans exploit the land cover. There is high variability in time and space in biophysical environments, socio-economic activities, and cultural contexts that are associated with land-use change. Identifying the causes of land-use change requires an understanding of how people make land-use decisions and how various factors interact in specific contexts to influence decision making on land use (Warriner and Moul, 1992). Decision making is influenced by factors at the local, regional, or global scale. Proximate (or direct) causes of land-use change constitute human activities or immediate actions that originate from intended land use and directly affect land cover (Somda *et al*., 2002). They involve a physical action on land cover. In addition to the characteristics of farm operators and their households, assessments of the adoption of cultivation practices have often paid attention to a variety of biophysical characteristics of the farm itself. Ryan and Gross (1943) first showed that the adoption of agricultural innovations is typically uneven from farmer to farmer. Researchers have directed attention to certain characteristics of farmers and their households in an effort to explain this unevenness. For example their dependence on forest products increases even more during crises and when food is scarce.

In this thesis, the link between ecosystem services and human behaviour is illustrated. The important role of understanding the human motivations to acquire and use ecosystem services

is explained. The main objective of this study is to identify important factors and drivers of ecosystem changes and their complex relationships within the Mt. Kilimanjaro ecosystem, by comparing perceptions' in forest resources' utilization, agricultural land use and general land use changes along gradients on the southern slopes of Mt. Kilimanjaro. In order to understand this, the following specific objectives were formulated:

(i) to determine the socio-economic factors leading to the extraction of non-timber forest products on the slopes of Mt. Kilimanjaro.

(ii) to review perceptions and realities of declining water and land resources in Kilimanjaro and lastly:

(iii) to identify factors influencing agricultural decisions and perceptions among small holder farmers in Kilimanjaro. This information could contribute to development of tools for more effective land use planning.

1.2 Factors Influencing agricultural decisions

The study analysed the farm-level adoption of a number of cultivation practices in order to explain, in general terms, how the socio-economic variables like gender, income, age and education , tend to influence adoption of certain agricultural practices. The education level of a farm operator often has been assumed to influence adoption decisions because of the assumed link between education and knowledge. Indeed, education, be it specific or general, commonly correlates positively with the adoption of conservation agriculture practices (e.g. Rahm and Huffman, 1984): however, some analyses have found education to be an insignificant factor (e.g. Saltiel *et al*., 1994), or even to negatively correlate with adoption (Okoye, 1998).

A farmer's age also has been regularly assessed but is similarly difficult to link to the adoption of conservation agriculture given that studies have shown positive (e.g. Okoye, 1998), and insignificant correlations (e.g. Neill and Lee, 1999). Lastly, assessments of the role of experience in adoption reveal both positive correlations (e.g.: Clay *et al*., 1998) and insignificant ones (e.g. Traore *et al*., 1998).

Another common factor, assessed is cultivated farm size (or sometimes planted area). It is regularly hypothesized that owners of larger operations are more willing to invest in new technologies such as artificial fertilizers application. However, given the observance of positive (e.g. Fuglie, 1999), negative (e.g. Clay et al., 1998) and insignificant correlations (e.g. Agbamu, 1995), the overall impact of farm size on adoption is clearly inconclusive.

With respect to land tenure, conventional wisdom suggests that owned land is better maintained by farmers than leased land (Herrera and Sain, 1999). With respect to wealth, it is regularly hypothesized that the adoption of new agriculture practices, or indeed any new technology, requires sufficient financial well-being, especially if new equipment is required. In support of this view, a majority of analyses that investigated the impact of gross income and farm profitability on adoption revealed a positive correlation (e.g.Gould *et al*., 1989). However, the identification of a negative correlation by Okoye (1998) and a number of instances of insignificance (e.g.Warriner and Moul, 1992) preclude an unqualified conclusion to this effect.

Complicating this picture is the fact that the presence of off-farm activities/income was found to positively (e.g. Napier and Camboni, 1993), negatively (e.g.Okoye, 1998) and insignificantly (e.g.Nowak, 1987) correlate with agricultural practices adoption in equal measure. However, such a result might not be surprising when it is considered that alternative income sources could provide additional resources for new adoption or, otherwise, diminish the priority of agriculture within the household, thereby reducing interest in conservation.

1.3 Dynamics of land-use and cover change

Concerns about land-use/cover change emerged in the research agenda on global environmental change several decades ago. This was with the realization that land surface processes influence climate (Neumann & Hirsch 2000).Underlying causes are often exogenous to the local communities managing land and are thus uncontrollable by these communities. Only some local-scale factors are endogenous to decision makers (Holmes, 2003). An important system property associated with changes in land use is feedback that can either accentuate or amplify the speed, intensity, or mode of land change. It can constitute human mitigating forces, for example via institutional actions that dampen, impede, or counteract

factors or their impacts. Examples are the direct regulation of access to land resources, market adjustments, or informal social regulations (e.g., shared norms and values that give rise to shared land management practices). Place-based research followed by systematic comparative analyses of case studies of land-use dynamics have helped to improve understanding of the causes of land-use change.

In an attempt to find factors leading to land degradation, taking an example of forest clearing; it can be caused by a variety of actors. With differing effects, recent in-migrants practice slash-and-burn agriculture, their children's families shift to fallow agriculture. Long-settled families have diversified production, small families have crop/livestock combinations (associated with high rates of forest losses) while large families have perennial production modes (associated with low rates of forest losses); and upland croppers are displaced by lowland ranchers (Clay *et al*., 1998). Life-cycle features arise from and affect rural as well as urban environments. They result from households' strategic responses to both economic opportunities (for example, market signals indicating higher crop profitability) and constraints (due to economic crisis conditions, for example). They shape the trajectory of land-use change, which itself affects the household's economic status (Fuglie, 1999).

1.4 Factors determining non-timber forest products' extraction

It is globally known that tropical rainforests are being degraded at an alarming rate (Buchholz, 1993). It is estimated that each year the world loses about 13 mil. hectares of forest and up to 40,000 forest-dependent species (Kremen *et al.,* 2000). The Global Forest Resources Assessment (2000) estimated that the world's natural forests decreased by 16.1 million hectares per year on average during the 1990s: that is a loss of 4.2% of the natural forest that existed in 1990 (Clay *et al.,* 1998).

While extraction of forest products poses a threat to the forests it is a necessity to the people (Naughton-Treves *et al*., 2007). This is more so because threatened forests are located in regions of poverty (Sunderlin *et al*., 2005). The harvesting and consumption of plant products from natural forests is known to account for a large proportion of the livelihood of people living close to such habitats (Carpentier *et al*., 2000). The majority of these plant products are non-timber forest products (NTFP's). Households often need resources available in protected

areas, such as wood for cooking, heating and construction and grasslands for livestock grazing (Kideghesho *et al*., 2007). Thus, subsistence-based livelihoods are often perceived as a threat to conservation (Mbile *et al*., 2005).

Forested landscapes dominated by humans in tropical developing countries provide many different and important ecosystem services (Belcher *et al*, 2005). They also sustain the livelihoods of large numbers of poor people (Sunderlin. D *et al*. 2005). Many millions of households continue to harvest forest products to enhance their livelihoods (Byron & Arnold 1999). A better understanding of why some households harvest forest goods while others do not may help explain some of the problems encountered in NTFP's promotion, such as whether the poor or rich are more likely to benefit from commercialization schemes (Marshall *et al*.2003).

Forest resources' dependency has been linked to household wealth and education, suggesting illegal extraction from protected areas could be mitigated by economic development (Adams *et al*., 2004). Increased wealth can result in more positive attitudes towards protected areas (Gillingham & Lee, 1999) but also an increased desire to extract protected area resources for profit (Fisher & Shively, 2005). Lack of education, for example, is sometimes correlated with negative attitudes toward conservation and a desire to de-gazette parks (Infield, 1988).Recent research has highlighted key socioeconomic characteristics of forest-dependent households that can play roles in explaining forest use. For example, in a study in the Philippines, elderly people were more likely to collect forest goods because of their more extensive knowledge of forest plants and wildlife (Lacuna-Richman 2002). Elsewhere, younger households are more dependent on wild-collected products, as they set out to start families and have lower agricultural assets than older better-established households (Coomes *et al*. 2004).

Another key variable of interest is the relationship between income and forest use. Siebert and Belsky (1985) found the households with the lowest level of rice self-sufficiency relied most on rattan harvesting for income in the Philippines. Gunatilake *et al*., (1993) found that contributions of NTFP's to incomes in Sri Lanka declined as incomes rose. Similar arguments have been made elsewhere that the poor are more dependent on forest goods than better-off

households, and the poor particularly rely on forest income in times of particular need(Hegde & Enters 2000).

Poverty has always been linked to agricultural choices, land use changes and forest uses. In sub-Saharan Africa it is serious especially in rural areas where more than 90% are poor. It is also estimated that 60% of the rural Africa live below the poverty line. See **Figure 1.1** for various facts about the state of African economy.

Figure 1.1: The General African Context.

Source: Adopted from (Kaimowitz, 2003)

Other studies have noted the importance of land tenure. The landless and land-poor are often more dependent on forest product collection than the land-rich (Lacuna-Richman 2002). For those who have no access to land for agriculture, NTFP's can provide a much-needed source of support, especially when they are collected from common or open lands. In Orissa (India) dependence on forest, income was strongly correlated with the size of land holdings, with the landless being most dependent (Fernandes & Menon (1987).

Other social variables may also influence forest use. In one study, NTFP's exploitation was positively correlated with household debt, labour availability and male to female ratios and negatively correlated with income, education, distance to forest, involvement in non-agricultural activities and incorporation into the market (Gunatilake 1998).

This thesis generally analyses the causal relationship patterns among agricultural production, forest products extraction and the state of land use change. In the Figure 1.2 all the major questions for this study are highlighted as well as their corresponding hypotheses. The figure portrays a tropical mountainous ecosystem whose peoples' livelihoods depend majorly on agricultural activities and the extraction of forest products. As a result, land use activities change, and so is the land cover. The causes for use of these natural resources (livelihood option) is determined by factors like gender, income, education, marital status, distance to the forest, age, natural resources management and so on.

For the first objective, the determinants of agriculture production were examined. It was assumed that:

(i) Poor households use poor farming inputs because of their in ability to buy more expensive inputs as compared to richer households.

(ii) The female gender has a higher agricultural efficiency because of the social notion that women are more involved in farming activities than men.

(iii) Older people have a low adaptive capacity to modern agricultural inputs than younger ones because of the low capacity to adapt.

(iv) Educated people do not cultivate as much because of their higher possibility to get other income generating activities as compared to less educated people whose options to work are limited to mainly agriculture.

(v) Crop cultivation depends heavily on modern agriculture inputs and rainfall.

For the second objective, factors behind the harvesting of forest products were modelled. It was assumed that:

(i) Poor households harvest more forest products than the ones with higher incomes. This is probably because people with less income will always opt for cheaper sources of income.

(ii) Female gender cultivate more forest products than the male gender because of the societal social constructions.

(iii) Older people cultivate more medicinal plants than younger ones because they are either more reluctant to adapt to modern medicine or they are the only ones who posses the local medicinal knowledge.

(iv) Educated people do not extract as much as forest products as less educated ones. This could be caused by the fact that environmental knowledge that normally less educated people do not posses.

For the third objective, the causes for the decline of water and land resources were examined. It was assumed that:

(i) There have been a massive decrease in land and water resources due to ecosystem degradation.

(ii) Land Use Change has affected the society and environment at various levels.

(iii) There are poor perceptions of water management in the village contributing to the water crisis.

(iv) There has been a decline in forest cover in general contributing to forest degradation

However, in the case where these natural resources (land, water, forest) are properly used and managed sustainable ecosystems will be achieved.

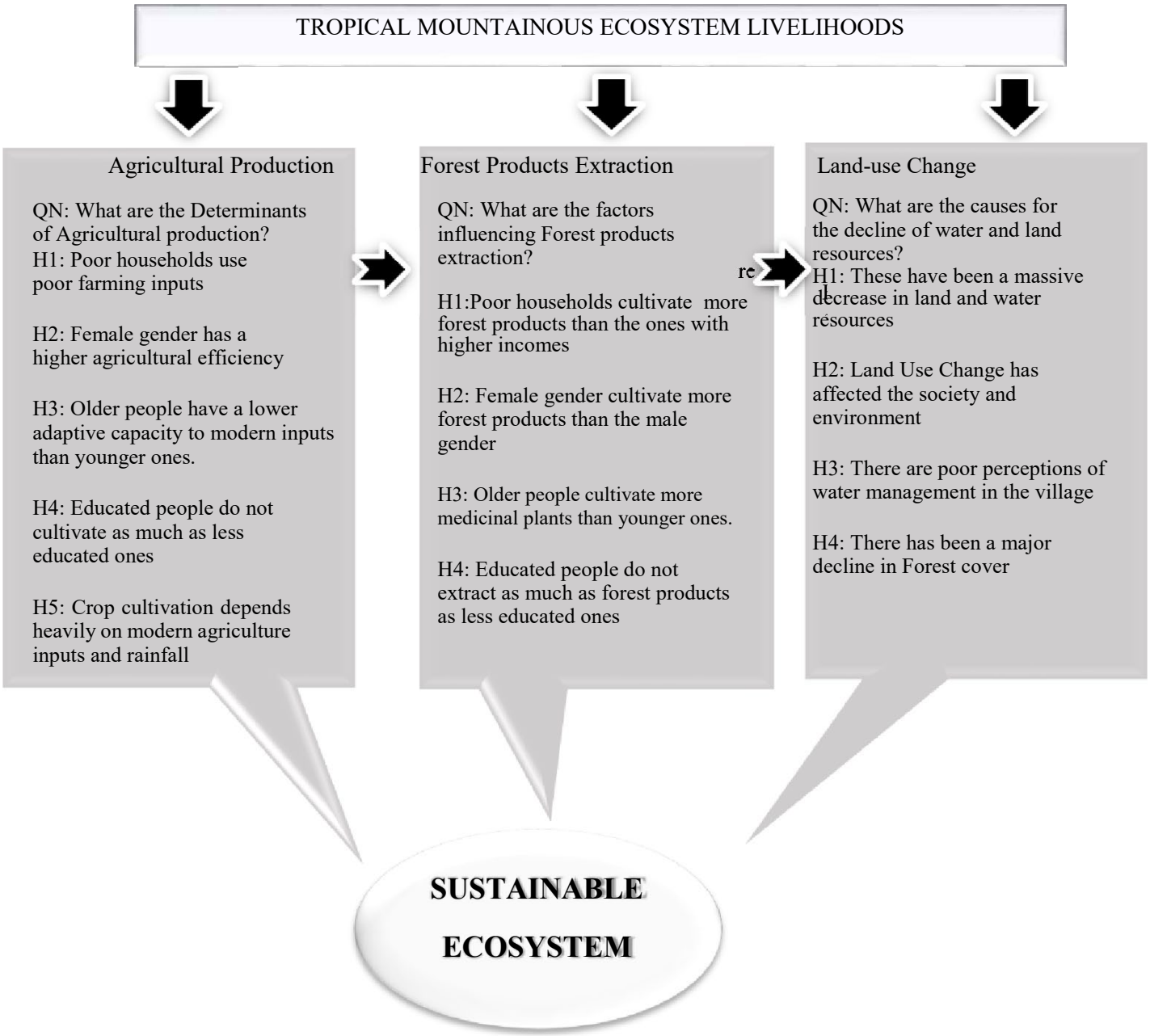

Figure 1.2: A Summary of Key Questions and Hypothesis

1.5 Conceptual framework

This study applies the environmental societal dynamics as the domain of synthesis in understanding the interaction between biophysical and societal processes. This domain refers to the way human beings impact the environment and the way the environment shapes human activities (NRC, 1997). It also refers to the way human beings perceive and respond to the changes of the environment as being caused by themselves and the way their responses impact/change that environment. Land use and land cover change, thus form a complex and interactive system. They link human actions to land use/cover change, and environmental feedbacks to their impacts and human responses. Land use patterns, driven by a variety of social, economic, political and natural processes, result in land cover changes that affect biodiversity, water, land productivity and other factors that cumulatively affect the biosphere (Arunyawat *et al*, 2016). As such, an understanding of current and future land use/cover dynamics and their environmental consequences requires an understanding of these dynamics at various times in the past (a historical dimension) and the diverse set of forces/processes driving these dynamics (*ibid*). These forces must also be put into historical and cultural contexts. According to Turner *et al*. (1995), cultural practices are important sources of variation in land management (proximate causes) at the level of the unit of production, and may endure over long periods of time, transcending shorter-term historical periodization.

In **Figure 1.3**, the framework of analysis that guided the study is presented. It is a hypothetical livelihood situation where the key variables interact. The frameworks demonstrates the interacting situations of forest use and agricultural land use at the same time. This thesis presents the forest use situation where deforestation on one hand plays a major role for forest degradation (as well as forest fires) but on the other hand agriculture land use is taking place. The forest use situation has led to the extraction of the non-timber forest products such as firewood, fodder, medicinal plants etc. Another type of deforestation also takes place when parts of the forest is deforested to make new areas for agriculture. As a result this has led to land use change resulting into decline in soil quality or exhaustion, decline in water resources as well as loss of natural vegetation. At the very end, this kind of social livelihood has resulted into a total degradation of the ecosystem as perceived by the respondents.

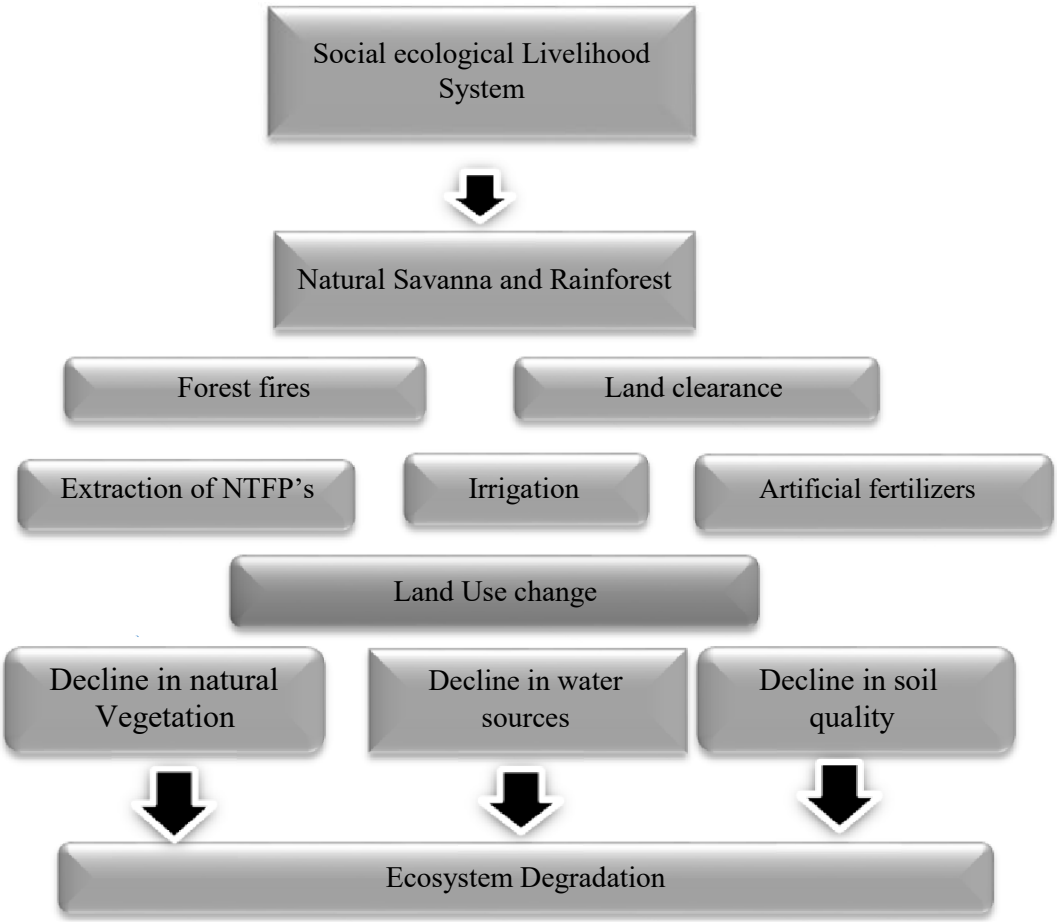

Figure 1.3: Conceptual framework for the study describing a typical livelihood ecosystem that resembles the one where the study villages are found.

1.6 Description of important Terms used in Data collection

This study mainly used interviews as a major tool for data collection. The interviews were conducted in a Swahili language. In this language, ecological terms may have a different meaning than in English. A short glossary of the meaning of the most important terms used in the interviews is provided below.

Land use refers to the purpose to which humans use land (i.e. protected areas, forests, plantation, crop or agricultural land, pasture land, settlement and construction) while land cover is ecological state and physical appearance of the land surface (i.e. forest, grassland, wetland) (Turner and Meyer 1994). The changes are influenced by human population and their associated activities on the land (Dale *et al*., 2000). *Change* in use may or may not cause a significant change in *land cover*. For example transforming a cultivated or agricultural land to grassland or forest will not cause much *cover change* in the short time. On the contrary, land use change that involves conversion of natural forest or grassland to cultivated land will cause a large change in cover. (Turner *et al*., 1994). The latter change has significant consequences for land cover, and for many aspects of the local environment including climate, vegetation biodiversity and livelihoods.

In this study the term "*land use change*" was translated as "mabadiliko ya matumizi ya udongo" in Swahili. It sums up all the activities and inputs that people undertake in a certain land cover type. In our case, these activities were related to agriculture. "*Forest cover change*" was translated as "mabadiliko ya misitu ya asili". It refers to observed physical and biological changes of cover of the earth's land, as vegetation or man-made features. In this case, it refers to forest cover change. Also "*natural vegetation*" was translated as "uoto wa asili": a word used in ecology to describe the overall characteristics of plant cover in an area by referring to dominant plant growth forms or structural characteristics, e.g., forest vegetation, grassland vegetation. Natural forest cover originates from the original forest cover, i.e. a forest reproduced naturally. Natural forest is thus a forest which has spontaneously generated itself on the location and which consists of naturally immigrant tree species and strains. Lastly, deforestation is the clearing of virgin forests, or intentional destruction or removal of trees and other vegetation for agricultural, commercial, housing, or firewood use without replanting

(reforesting) while soil exhaustion is the situation which occurs when poorly managed soils are no longer able to support crops or other plant life as before because of lack of some minerals.

1.8 Structure of the Thesis

This PhD thesis is organized into six chapters. With the exception of Chapter 1, 2 and 6 other chapters (i.e. 3, 4 and 5) are based on individual papers soon to be published. A more detailed order of the thesis is displayed hereunder:

Chapter 1: Presents an introduction of the research topic. It offers a clarification of the problem and the justification. It also elaborates the main and specific objectives of the study. It further describes the socio-economic framework in a diagram format.

Chapter 2: Elaborates the Methodology used in the study. It clearly states the sampling size and design. It describes the statistical methods used and reasons behind their selection. It also offers an elaborate knowledge about the study area and justification for its selection.

Chapter 3: Examines factors influencing agricultural decisions and perceptions among small holder farmers in Kilimanjaro. It also gives insights on the reasons behind these perceptions. Also the study elaborates on the Chagga agricultural system and their ways of farming.

Chapter 4: Reviews perceptions and realities of declining water and land resources at Mt. Kilimanjaro. It also gives information on the state or art of the water systems in Kilimanjaro.

Chapter 5: Identifies socio-economic factors leading to the extraction of non-timber forest products on the slopes of Mt. Kilimanjaro. It gives detailed information on the type of products collected and how much is collected. It shows a very important link between the social economic conditions of the villages vs. the ecosystem.

Chapter 6: Delivers a general discussion of the methods and key findings, limitations, conclusion and recommendations. This is basically a synthesis of the key issues and the conclusions of the entire thesis. It also describes the implications of the key findings of the study and recommends areas for further research.

Chapter 2

Research design and Methodology

Hawa Kaisi Mushi

2.1 Research design

The nature of this study involved a homogeneous socio-economic environment of various stakeholders with different perceptions. The research design for this study was a case study. Case studies usually consist of identifying and exploring in detail critical cases, which enable to build up knowledge on social phenomena in a very context-sensitive way (Flyvbjerg, 2001). This study applies the environmental societal dynamics as the domain of synthesis in understanding the interaction between biophysical and societal processes and includes ecosystem services. It is urged that the case study approach emphasizes depth of study, is based on assumptions that reality can only be understood through social constructions and interactions, and the context in which the phenomena under study are situated is complex (Biggam, 2008). The information that was gathered from the respondents on their attitudes, perceptions and opinions in relation to the ecosystem was ideal to capture the extent of realities in those villages.

2.2 The Kilimanjaro National Park (and the surrounding villages) and the justification of the study area

The gazzetement of the Mt. Kilimanjaro National Park has restricted forest resources extraction to a large extent. As of nowadays, the area has become even smaller, a result of the "Kihamba System" which allows the subdivision of the family owned farm, among the sons of the family. Since the establishment of the National Park in 1973, the locals were allowed to collect forest products from a belt of land of about a half mile into the forest called the Half Mile Forest Strip. The strip was set aside in 1941 with emphasis on production of wood and non-wood forest products for local use (Katigula, 1992). Thus, the villagers settling in the lowland and midland zone rely mostly on forested gorges and other small woodland patches to extract non-timber forest products, whereas the people inhabiting the highland zone use mostly the Half Mile Strip. This study was undertaken along a transect on the slopes of Mt. Kilimanjaro covering different ecological zones with a number of altitudinal and agro-ecological zones: (1) a lowlands zone of extensive livestock farming and open crop fields, with remnant bush land patches in villages of Wari and Nshara, (2) a midlands maize-bean belt which is a mosaic of home gardens and open fields, with few bush land patches interspersed between in villages of Shari and Nkuu-Ndoo, and (3) a highland traditional Chagga home garden area dominated by coffee and banana, with many large trees in villages of Foo and Nronga. The lowlands zone

extends up to about 900 m, midlands up to 1200 m and the home garden area to about 1800m above sea level, up to the lower forest boundary (**see Figure 2.1 below**). In this regard, communities neighboring half-mile strip down to communities on the foot slopes were covered in this study. Transects also covered areas where tourism is being practiced and those where there is no tourism. This was meant to provide a diversification and a comparative study on the different land use types, people's livelihood options and different ecosystem's services accrued from the natural ecosystems such as food, fodder, medicinal supplements etc. Importantly, transects have also documented how climate variability and change affects ecosystems services and consequently community livelihoods along transects.

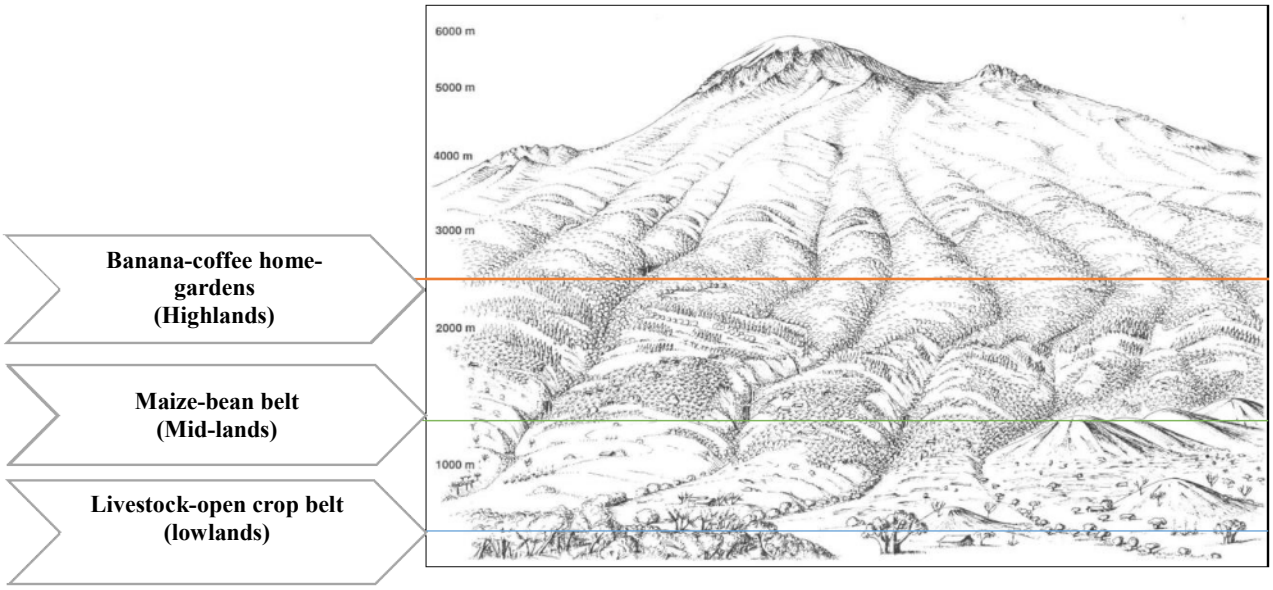

Figure 2.1: A hypothetical diagram of village location

Source: Andres Hemp

2.3 Study Location

Mt. Kilimanjaro is located 300 km south of the Equator in Tanzania, on the border with Kenya, between 2º45' and 3º25' S and 37º00' and 37º43' E (see **Figure 2.2.**). It is the highest mountain in Africa, composed of three extinct volcanoes, Kibo, Mawenzi and Shira, which reach, respectively, altitudes of 5,895, 5,149 and 3,962 metres. Kilimanjaro is also the world's highest freestanding mountain, looming 5,000 metres above an open undulating plain that averages around 800 metres above sea level. The mountain's topography features deep V-shapedradial valleys, particularly on the western and southern slopes, as well as major Barrancos south of Kibo and east of Mawenzi (TANAPA, 1987). Annual rainfall received during two rainy seasons (March-May, September-October) varies according to the altitude, being 400-900 mm in the lowlands, 1000-1200 mm in the midlands and 1200-2000 mm in the home garden area (Zongolo *et al*. 2000). The area provides a distinction of three agro-ecological zones: the high-land zone (coffee-banana belt and home-garden area), the mid-land area (the maize-beanbelt) and the lowland (the savanna maize and livestock farming belt). Kilimanjaro mountain slopes have variety of natural resources upon which people depend for their livelihoods. These resources include land, water, forests, etc. Amongst the variety of resources, land is the most important since the majority of the local Chagga people are farmers whose livelihoods depend on cultivating the land. Since centuries, the Chagga cultivate the upper southern slopes of the mountain in form of home-gardens, representing an agro forestry system comprising shade trees, banana, coffee, maize, legumes and staple intercropping (Hemp, 2006). This agricultural system has historically been one of the most productive of the whole country and the Kilimanjaro area is now one of the most densely populated areas in Tanzania.

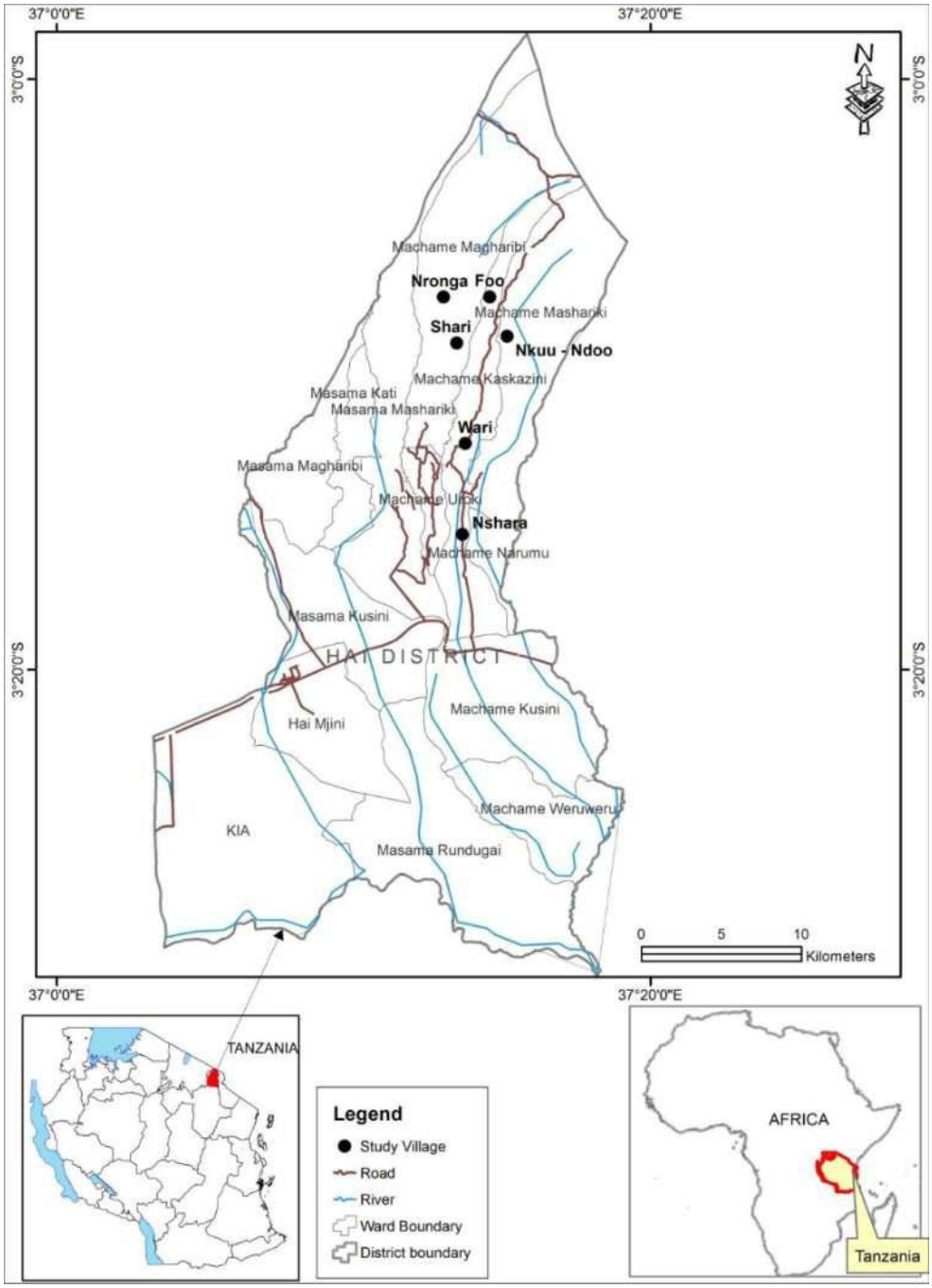

Figure 2. 2: The study area is located on the northern part of Kilimanjaro region in Tanzania.

The villages were distributed along the Machame road and formed a transect. The black-colored points indicated villages were socio-economic data were collected.

Source: GIS Unity, Institute of Natural Resource Assessment. University of Dar es salaam

2.4 Description of the Chagga society

From an outsider's perspective, the use of the word "Chagga" to describe all the people of Kilimanjaro seemed to make sense. After all, the people lived in the same region on the slopes of the mountain, practiced the same forms of agriculture and animal husbandry, had very similar cultural practices, spiritual beliefs, and social structures, and spoke what were considered to be dialects of the same language. The Chagga people of Kilimanjaro, like several other groups in the highlands of north-eastern Tanzania (e.g. Sambaa, Pare, Meru), have developed specialized and intensive ways to manage and utilize the zone where home gardens (banana trees, vegetables and local tree species) thrive in combination with other upland and lowland resources. The slopes of Mt. Kilimanjaro have some of the highest rural population densities in eastern Africa and people there have attempted to deal with the challenges of relatively intense pressure on their resources for some time. Observers described the area as being severely overpopulated more than 75 years ago (Chagga Land Tenure Report 2012). However, farmers have been able to intensify production and accommodate substantial growth since then. Local knowledge together with innovation have made continued growth possible. Hydraulic control, zero grazing, terracing, and the *kihamba* system of agroforestry based on plantains and coffee in combination with other crops under shade-providing trees are lessons of survival from this area. The fertile, well-watered slopes of Mount Kilimanjaro have for millennia been home to various societies. Ancestors of the present Bantu-speaking populations began to settle the lower slopes of the mountain in successive waves beginning more than 1500 years ago (Bender, 2013).

These migrants likely came from nearby highland areas and settled on the mountain's southern and eastern slopes (at altitudes between 4000 and 8000 feet). Settlements tended to be located on ridges, separated by deep valleys formed by the fast-moving rivers and streams headed toward the plains. These peoples developed an agrarian economy based upon intensive cultivation of yams, bananas, finger millet, and other crops in small homesteads called kihamba. Over several centuries, each ridge of the mountain developed into an autonomous political space comprised of several different clans, each led by ranking headmen and ritual specialists (Dereck, 2013). Though politically independent, clans on the same ridge often forged alliances for purposes such as defence, and also had regular contact with those on

neighbouring ridges through both warfare and markets. As a result, though politically distinct, people across the mountain came to share common agricultural techniques and cultural practices. In terms of language, numerous minor dialects of a single language are spoken on the mountain, the dialects falling into three major groups defined geographically from west to east: West Kilimanjaro, East Kilimanjaro, and Rombo. These comprise a dialect continuum, meaning that people in neighbouring areas could understand one another well while those at the far reaches would have found much of one another's speech unintelligible. One of the more revealing similarities among the mountain's disparate communities is how they defined themselves and others according to the physical spaces they inhabited. It is discussed that through the observations of early European explorers. For example, Johannes Rebmann, in his diaries and letters to Johann Krapf and the Church Missionary Society, claims that people referred to themselves as Wakirima, meaning 'mountain people', and in turn referred to people living beyond the mountain as Wanyika or "people of the plains". (Wimmelbücker, 2001). Another term of classification, one noted by Moritz Merker (2002), was wandu wamndeny or people of the banana groves. People used this to contrast themselves from Thewasi or hunter-gatherers, and humba and kuavi, meaning pastoralists. These terms indicate the extent to which landscape influenced how people thought of themselves and others. Wakirima and Wanyika imply the importance of the mountain in juxtaposition to the plains. The people living on the mountain believed themselves to be the beneficiaries of divine benevolence, living in a lush, well-watered landscape, in contrast to the peoples living in the semiarid steppe, such as the Maasai.

2.5 Main economic activities

The major land based economic activities in the study area are agriculture, forestry and livestock keeping. Agriculture is the main economic activity in the district, and about 20 percent of the land is suitable for cultivation. Both smallholder peasant farmers and large-scale producers practice agriculture. Crops cultivated include both cash and food crops such as maize, beans, cassava, millet, sunflower, Irish and sweet potatoes, onions, banana and vegetables are also cultivated. Men and women participate in agricultural production. Because of semi-aridity, dependence on rain fed agriculture is very high. The most prevalent production system among the smallholders, who constitute the majority of the population, is agro-

pastoralism. Agricultural technology and practices range from the traditional hand hoe to modern farm machinery such as tractors. The division of labour in agriculture is such that both men and women work together from farm preparation, planting and harvesting of crops. It is common for the men to control revenues from cash crop production. Villagers are also involved in petty trade as small businesses such shops local markets, local brew selling, restaurants, and kiosks are spotted in most areas. Household questionnaires were mainly used to identify demographic and socioeconomic characteristics of communities in the study area. In this particular study: age, gender, education level, origin of birth, occupation and ethnic characteristics of respondents and their relevance to the study were identified and discussed.

2.6 Socio-economic survey

This sections includes methods of data collection and instruments. Although field observation was conducted directly in the field investigation but the socio-economic survey deemed to be necessary also (Kothari, 2008). This is because the causes and consequences across a rangeof spatial and temporal scales generally required the integration of natural and social scientific methods, such as interviews with villagers and expert knowledge (Ellis, 2010). In this study, two methods of data collection were used: (1) intensive literature reviews, and (2) socio-economic surveys using questionnaires, focus group discussions and observations were used to obtain socio-economic information. Additional information supporting the interpretations is from focus group discussion.

2.6.1 Sampling and the Sampling Strategy for the study area

Sampling is a “selection of some part of an aggregate or totality on the basis of which a judgment or inference about the aggregate or totality is made”: a sampling strategy is a procedure for acquiring a sample and its items from a given population of concern (Kothari, 2008). The election of six study villages at Machame area as a case study was purposive. Community based forest management development in this area begun in 1974 facilitated by the KINAPA administration. The villages are among a few villages that are bordering the National Park which makes them unique. Building on existing awareness and knowledge of villagers, and on existing local decision-making structure, communities in the six villages have taken full responsibility for the use and management of the forests. The villages bordering

KINAPA are best described as community based organization of local villagers actively engaged in agriculture, forest products extraction and biodiversity conservation activities. Therefore they were considered to demonstrate a successfully case where rights, responsibilities and practices of the forest communities are displayed. Lastly, the area was part of the study area for a larger project called "Kilimanjaro ecosystems under global change: Linking biodiversity, biotic interactions and biogeochemical ecosystem processes (KiLi)".

2.6.2 Sampling of study villages

A purposive sampling technique was used to select six villages, two in each transect. In purposive sampling, the sample is chosen by the researcher with explicit attributes in mind, with the intent of providing in-depth analysis of those attributes and how they relate to the selected individual (Berg,1998). In our case, this helped to locate those villages which were rich in information for the study**.** The villages were selected with the help of the District Forest Officer (DFO) and based on knowledge obtained during the researcher's previous visit. This was meant to provide a diversification and a comparative study on the different land use types, people's livelihood options and different ecosystem's services accrued from the natural ecosystems such as food, fodder, medicinal supplements etc. The six sample villages were selected to represent different ecological zones along transects.

2.6.3 Sampling of households

Names of households were identified with the assistance of members of village governments, as well as their respective "ten cell" leaders (leaders of Tanzania's smallest administrative units each consisting of ten households) within each cluster. Random selection of households was conducted applied to ensure that the selected household members reflected a true representation of the studied population. In household surveys, the heads of households was the main respondents: however, other members of household were also involved to supplement information wherever necessary. The selection was done by ensuring equitable representation of all the sub-villages found in the villages. Each questionnaire was completed in approximately 50 minutes in a single visit. Kothari (2004) pointed out that a sample of 5% and above is adequate and recommended for researchers. Participants for focus group discussions were selected with the help of village leaders.

In some cases, Purposive sampling was also used to select knowledgeable participants for key informant interviews. These were drawn from the district council, village committee and non-governmental organizations. A sample size of 10% was selected in each village for household interviews. Clarke (1986) suggests that, for a sample to be representative enough for statistical analysis, it should be at least 10%. This sample size is considered to be adequate since this was not the only method used, as different methods such as key informants' interviews and focus group discussions were employed to complement each other in capturing the required information. The actual number of households covered in a village depended on the total number of households in each village. A sample of 313 households was finally selected.

Table 2. 1: Household Questionnaire Sample Size in the Study Villages

No.	Village Name	Total Number of Households	Number of Respondents		% of Respondents
			Males	Females	
1.	Foo	45	32	13	14
2.	Nronga	46	40	6	14
3.	Shari	45	8	37	14
4.	Wari	50	0	50	16
5.	Nkuu-Ndoo	41	13	28	13
6.	Nshara	86	50	36	27

Source: Field data, 2014

The sample of interviewed persons in the different villages mainly differed in terms of gender and distance to forests, whereas its mean age, agricultural and economic background expressed in household size, owned land and cultivated land was very similar (see **Table. 2.1** above). The gender of interviewed persons differed strongly among villages. In Wari and Shari, most interviewed persons were males, whereas in Nronga and Foo, the majority of interviewed persons were females. Only in Nkundoo and Nshara, the sample was almost equally distributed among males and females.

2.6.4 Sampling of key informants

Key informants are usually familiar and informative individuals who have lived or worked in an area for a considerably long time to be acquainted with the issues under investigation. These

can be the mature as well as young informants, depending on their history, occupational activities and life experiences. The consulted key informants were ward executive officers, heads of villages, sub-village heads and elders. They also included specific forest users such as pastoralists, farmers and forest products' collectors. Key informants were selected purposively due to their various positions and experiences as described above. These helped to get information on the history of the area.

2.7 Data Collection

The data collection for this study was conducted for a period of one year between October 2013 and October 2014. A mixed approach involving both qualitative and quantitative methods was used in data collection. The reason for adopting the approach was for triangulation purposes and also for credibility and completeness. As noted by Bryman (2004), the researcher can bring together a more comprehensive account of the area of enquiry in which he or she is interested if both quantitative and qualitative research techniques are employed. He further suggests that employing both approaches enhances the integrity of findings. Both primary and secondary data were collected based on their applicability and usefulness towards achieving the research objectives in the case study villages. Therefore, the justification for mixed methods was an attempt to minimize the biases of any particular approach by combining both approaches to triangulate the most accurate answer to the questions (Creswell, 2003).

2.7.1 Secondary data collection

Secondary data collection was carried out continuously for almost all the study period. Data were collected through documentary review. The researcher spent time searching for relevant information from books, journals and other published materials related to the study. Secondary sources of information on rural agriculture, forest product extraction and land use change across the world and several other appropriate literatures were reviewed as part of the study. These reports and studies provided a rich understanding of the local context and conditions as far as perceptions and realities on land use change and agriculture are concerned.

2.7.2 Primary data collection

Participatory Rural Appraisal (PRA) tools including questionnaire interviews, key informants interviews, focus group discussions (FGD), transect walks and field observations were used in this study to obtain qualitative data from the community living adjacent to the forest. Normally, point out that participatory tools help to make the study more conversational, and more responsive to a given situation, while being still focused and structured. All these tools were applied to collect quantitative and qualitative data. They are presented below as follows:

(i) Key informant interviews

The key informant interviews involved interviewing a selected group of people who are likely to provide needed information, ideas and insights on a particular subject. The key informants were selected based on their knowledge and experience on issues of interest for the study. A semi-structured checklist was used to interview district council staffs, ward leaders, village and sub-village leaders. A special checklist interview was conducted to forest users, farmers and animal keepers. (see Appendices).

(ii) Focus group discussion

According to Chambers (1992), focus group discussion (FGD) helps to facilitates building of collective and creative enthusiasm, which leads to information sharing and familiarization with new ideas and concepts with outsiders. The number of participants (eight) was considered convenient for effective management of the discussion. Open ended questions were posed on a wide range of issues including among others current use of the forests, observed land use changes over the years and the agricultural practices in general. FGD was conducted mainly to validate most of the information gathered by the earlier methods, and gather comprehensive information that was impossible to get through other techniques. A checklist of semi-structured questions was used to guide the discussions (see Appendices).

(iii) Transect walk and field observations

Transect walks and field observations were undertaken after having had in-depth discussions with key informants and FGD participants. A walk from the villages to the forest was done accompanied by a few members of the village to see the extent of forest use, land use change and agricultural practices. The method of transect walk and observation is known to be an

effective supportive technique in the in-depth research methodologies as it allows one to reach an area, observe, ask questions and also be an eye-witness of an environmental issue. During the walk around forests and home gardens, the researcher observed various tree species, selling of forest products (fuel wood edible wild products) and evidence of encroachment in the forest.

(iv) Questionnaires

Open and close ended questionnaires were developed and administered face to face to the respondents. This approach was used to get responses from household heads. A total of 313 questionnaires were administered in all six villages. The total number of people interviewed per village varied depending on the total number of people in that village. The questionnaires were closed and open ended and provided space for clarification of more detailed and wide-ranging explanations. A good introduction was made by the interviewer aimed at building rapport with the respondent's as described by Kothari (2004). The brief introduction was used to explain the purpose of the research and to seek respondent's prior consent before the interview. It was also done to guarantee the confidentiality of information gathered from respondents. The tool was used to better understand forest benefits accrued to the community and how they are shared among them. Efforts were made to capture all different aspects of the three study objectives, where this was not possible information was left to be collected using other techniques. The questionnaires were designed in advance: but a preliminary visit to the study site helped in improving them to a great deal. It was also used as a major tool for primary data collection

The socio-economic data were obtained from the heads of households by using closed and open ended questionnaires, which captured the main economic activities of the people, land ownership, migration, land use change and drivers of change. In this context, a household is a residence that comprises a husband and/or wife (wives) including children and other dependents living under the same roof or a cluster of several huts around a single compound, answerable to the same head and sharing common sources of income and livelihood (Mung'ong'o, 1995). Both male and female household members were interviewed making a total of 313 interviews. The interviews were performed in Kiswahili language where all respondents provided qualitative information on the nature of forest resource use over time, particularly since the 1950s and causes of such changes. Such key informants included owners

of farms and long-time residents in the area, as well as village officials. Important additional information was the distance of the village to adjacent forests, which we retrieved from satellite imagery.

The questionnaire was pre-tested in one of the villages and subsequent modifications were made on some questions which seemed to be difficult or unclear to the respondents. These questions were rephrased in order to make them much easier to understand. Pre-testing was done in order to enable the researcher to have understanding of various concepts used in the questionnaires. Before starting the household interviews, meetings with village leaders were held at each village executive officer office. During those meetings the discussion was centered on briefing the leaders on the aim of the research as well as the logistics issues, including how to locate the households to be interviewed. (see Appendices).

2.8 Data Analysis and Presentation

Data analysis consists of processing, description analysis and interpretation of the collected data. Data processing was an important part of analysis which ensured realistic results and generalizations. Subsequently, data collected was analysed based upon specific objectives addressed by this study. Given that mixed (qualitative and quantitative) approaches were applied in this study, data processing and analysis techniques varied according to approaches used. However, presentations of all data collected were in form of tables, charts, figures and narratives from respondents interviewed which was also supplemented with responses from the open-ended questionnaire and checklist used in the study.

2.8.1 Approaches in analysing data and justification

This study involved the collection mainly qualitative data obtained through oral interviews. The responses to the individual household questionnaires with respect to individual technologies were processed and analysed using standard univariate and bivariate statistical techniques (frequency tables, cross-tabulations and chi-square analysis) using the software SPSS v25 (Pallant, 2007: Kinnear & Gray, 2008: Bryman & Cramer, 2009).

Table 2.2: Independent Variables that were used in the analysis and their respective codes

Independent Variables	Analysis Code
Income	0=Low, 1=High
Education	0=Primary, 1=Secondary
Gender	0=Females, 1=Males
Age	0=Young, 1=Older
Farming techniques	0= Traditional, 1=Modern/Efficient
Fertilizers	0=Artificial, 1= Natural
Means of Ownership	0=Rent, 1=Bought or Inherited

Socio-economic explanatory variables were used in the analysis namely: gender (males and female), age (younger and older), education (primary and secondary) and income (high and low) (see **Table 2.2** above). However, they were changed to create dummy variables for two main reasons as articulated by Halvorsen, R. and Palmquist, R. (1980):

(i) To pool differing samples which are being brought together in one bigger sample.

(ii) To 'proxy' the measurement level of some variable which is difficult to measure on a numerical ratio scale.

2.8.2 Quantitative data analysis

Quantitative data analysis for this study was done using Statistical Package for Social Science (SPSS) version 24 and Microsoft Excel. Data collected through questionnaire interviews was carefully cross-checked to detect errors such as incomplete questionnaires. Although during fieldwork, proofing was done on each day after completing the interviews and was

supplemented by further editing after the fieldwork. After editing, coding was done by assigning values to responses to enable answers to be put into a limited number of classes for convenient and efficient analysis (Kothari, 2004). Coded data were entered into a SPSS programme for analysis whereby regressions, percentages, frequencies and cross tabulations were computed and used for analysis. During analysis of 313 questionnaires, in order to ensure the quality and reliability of data, data cleaning was done for the purpose of detecting and removing errors and inconsistencies from data. According to Erhard and Hong (2008), data cleaning is essential step as it helps to detect and remove all major errors and inconsistencies both in individual data sources and when integrating multiple sources and for a researcher to ensure elimination of duplicate information and guarantee accurate and consistent data, cleaning of data becomes necessary. After cleaning and analysis of data was done: quantitative data were presented in tables, charts, figures and graphs.

Our first objective was to measure agricultural productivity on multiple socio-economic parameters. The chi-square test for independence, also called Pearson's chi-square test or the chi-square test of association, was used to discover if there is a relationship between two categorical variables. The chi-square test of independence is denoted χ^2, and is computed as:

Equation 1*:* $\chi 2=\sum i=1R\sum j=1C\ (oij-eij)\ 2eij$ where: *oij* is the observed cell count in the i^{th} row and j^{th} column of the table *eij* ∗is the expected cell count in the i^{th} row and j^{th} column of the table, computed as *eij*=row *i* total col *j*. Socio-economic explanatory variables were used in the analysis namely gender (males and female), age (younger and older), education (primary and secondary) and income (high and low). The responses to the individual household questionnaires were processed and analysed using standard univariate and bivariate statistical techniques (frequency tables, cross-tabulations and chi-square analysis) using the software SPSS v25 (Pallant, 2007: Bryman & Cramer, 2009). A multivariate regression analysis was conducted in order to identify key assets that play an important role in livelihood outcomes (Kinnear & Gray, 2008). Independent variables such as fertilizer use, number of crops grown, contribution from outside the farm, off-farm job, land size, farmer's age, and fertilizer use can be affected by farmer's education level, by off-farm income or by farm size, and in the same way farmer's education level may correlate with having an off-farm job. These relations were studied separately.

Our second objective was to measure the perceptions of land degradation incidences on multiple socio-economic parameters. The chi-square test for independence (refer to the **Equation 1** above) above. We also used the Phi – measure of association for nominal variables with more than two categories. This measure divides the chi-square statistic by the sample size and takes the square root of the results. For some other questions the non-parametric test also often referred to as assumption free tests or distribution free tests can be used with ordinal (ranked) or nominal (categorical) data and with small or uneven sample sizes. It is computed as

Equation 2: $\chi^2_{c-1} = \Sigma (O_j - E_j)^2 / E_j$, where $E_j = Np_j$. Acceptance region: Accept H_0 if $P(\chi^2_{c-1} \# \chi^2_{c-1}) = 1 - \alpha$. Our third objective was to model the frequency of forest resource extractions on multiple socio-economic parameters. As the dependent variables consisted of count data, i.e. the number of forest visits per year, we chose a negative binomial regression. This technique is more robust than Poisson regression when count data are over-dispersed, i.e. the variance exceeds the mean. The model takes the form of: **Equation 3**: $Y = \exp(b_0 + b_1X_1 + b_2X_2 + ... + b_kX_k)$, where Y is the collection frequency of a forest resource, and X_{1-k} are the socio-economic predictors, i.e. gender, age, number of household members, household income, land size owned by a household, and distance to the nearest forest. Modelling and descriptive analyses were performed with the Statistical Package for Social Sciences (IBM SPSS Statistics 24).

Table 2. 3: Socio–economic Variables in the studied Villages

Village	Gender				Age [yrs]				HouseholdIncome [TSH]				Educational level			
	Females		Males		<45		>45		<650000		>650000		Primary		Secondary	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Foo	32	71	13	29	24	53	21	47	31	69	14	31	37	82	8	18
Nkuundoo	13	32	28	68	30	73	11	27	29	71	12	29	32	78	9	22
Nronga	40	87	6	13	29	63	17	37	33	72	13	28	32	70	14	30
Nshara	50	57	37	43	54	62	33	38	60	69	27	31	53	61	34	39
Shari	8	18	36	82	31	70	13	30	34	77	10	23	29	66	15	34
Wari	0	0	50	100	35	70	15	30	35	70	15	30	33	66	17	34

As it can be observed in **Table 2.3,** the sample of interviewed persons in the different villages mainly differed in terms of gender, whereas its mean age, agricultural and economic background expressed in household size, household income, owned land and cultivated land was very similar. The gender of interviewed persons differed strongly among villages. In Wari and Shari, most interviewed persons were males, whereas in Nronga and Foo, the majority of interviewed persons were females. Only in Nkundoo and Nshara, gender of the sample was almost equally distributed

2.8.3 Qualitative data analysis

Qualitative information collected through FGD and key informant interviews were triangulated according to themes and objectives of the study and also used in providing explanations for the statistical observations discerned from the quantitative data. Narrative analysis was used in analysing qualitative data. A narrative analysis suits qualitative data as such data consists of "direct quotations from respondents about their experiences, opinions, feelings and knowledge" (Shahbaz *et al*., 2008).

2.8.4 Content analysis for the Interviews

Content analysis was employed to explain in detail the contents of verbal discussion held with different respondents during FGD's and semi-structured interviews. Interviewed dialogue with key informants was broken down into smallest meaningful units of information or theme and tendencies to ease the analysis.

2.9 Limitations of the Study

In the course conduction the research, this study encountered several limitations. The major limitation of this study was methodological. This is based on the research design (case study design) selected for the study. Case study research design has received enormous criticism for its bias and lack of generalization. (Flyvbjerg, 2006). I am in agreement with the criticism related to generalization due to the fact that not all results can be generalized as it focused only on six out of many villages in the study area. Therefore the six case study villages in this study may not include all aspects of forest and land use change in Tanzania.

The issue of bias was dealt with by incorporating a variety of methods and techniques for data collection. Apart from key informant interviews with a wide range of actors from different interests (villagers, government officials, researchers and forest practitioners), Household questionnaires were administered to supplement and minimize bias from data collected by other methods. The approach methods and data sources used were correct and very effective: however, the study design and implementations had some shortcomings and presented some issues. During interviews it was noted that some people were not quite open depending on what they were asked. The amount of income one receives in a month and a number of times that one goes to the forest proved to be one sensitive issue. However, literature advices that a researcher can maximize chances of getting appropriate responses by remaining neutral on statements made by the respondent in an interview (Denscombe, 2010).

Chapter 3

Factors influencing perceptions on agricultural intensification among small holder farmers in the Kilimanjaro region, Tanzania

Hawa Kaisi Mushi, Michael Kleyer and Pius Z. Yanda

Abstract

Most farmers in Tanzania operate at the subsistence, smallholder level in an extensive agricultural system: hence in their hands lays the country's food security and agricultural development. As land scarcity hinders both expansions of cultivation and animal keeping, more intensified and diversified production and off-farm activities have become crucial. Intensive farming has been crucial at this time when the land is unproductive and rains unpredictable. As a result, land degradation has been inevitable in this area. This paper reports the findings of a study that was carried out to measure agricultural productivity on multiple socio-economic parameters. Household interviews through field visits enabled data collection on the state of agriculture in the villages as well as perceptions in relation to socio-economic factors like age, income, gender as well as education. The chi-square test for independence (also called Pearson's chi-square test) was used for analysis. We found out that intensive cultivation of land is a reason behind land exhaustion. The explanation behind modern ways of farming (livestock keeping as well as cultivation) is a high level of education. We conclude that, land exhaustion problems is caused by lack of proper education on farming as well as scarcity of land. We recommend, more research to determine factors that positively influence farmers' adoption of modern agricultural production technologies to revive the existing agricultural system without destroying the environment.

Keywords: Agriculture, Agro-forestry, Gender, Household economy, Mt.Kilimanjaro and subsistence farming.

3.1 Introduction

The economy of sub-Saharan Africa is basically agrarian, with a large majority of the farmers operating at the subsistence, smallholder level, with intensive agriculture being uncommon (Yemisi, 2009). A characteristic feature of the agricultural production system in such countries is that a large fraction of the agricultural output is in the hands of these smallholder farmers whose average holding is about 1.0-3.0 hectares (Yemisi, 2009). Also, there is very limited access to improved agricultural technologies and their general circumstance does not always merit tangible investments in capital, inputs and labour (Harper *et al.* 1990). Nevertheless, smallholders may need to adopt new agricultural methods to improve their yields. These methods can entail planting new crop varieties, change of crops according to changing market conditions, application of fertilizers or pesticides, new machinery to improve production techniques, or access to land. Different factors determine the adoption of new agricultural methods, such as available innovations and technologies as well as perceptions. Much empirical adoption literature focuses on farm size as the probably the most important determinant (Green and Ng'ong'ola, 1993). The effect of farm size on adoption could be positive, negative or neutral. Kasenge (1998) found farm size to be positively related to adoption of new farming practices, whereas Yaron *et al*. (1992) found a negative relationship. Interestingly, Mugisa-Mutetikka *et al* (2000) found that the relationship between farm size and adoption is a neutral one.

Income is an important factor, because poor farmers are likely to have different needs, lower resources than better-off farmers and less ability to adopt new technologies (Grandin, 1988). Female-headed households are poorer than male-headed house-holds and have the additional problem that most research and extension systems are biased towards male farmers (Gladwin et al., 1997). Gender issues in agricultural production and technology adoption have been investigated for a long time. Most of such studies show mixed evidence regarding the different roles men and women play in technology adoption. Doss and Morris (2001) in their study on factors influencing improved maize technology adoption in Ghana, and Overfield and Fleming (2001) studying coffee production in Papua New Guinea show insignificant effects of gender on adoption. In addition, age may influence the probability of adoption of new farming technologies because it is said to be a primary characteristic in agricultural decisions. However, there is contention on the direction of the effect of age on adoption. Age was found to positively

influence adoption of sorghum in Burkina Faso (Adesiina and Baidu-Forson, 1995) and chemical control of rice stink bug in Texas (Harper *et al*, 1990). In contrast, age has been found to be either negatively correlated with adoption, or not significant in farmers' adoption decisions. In studies on adoption of land conservation practices in Niger (Baidu-Forson, 1999), rice in Guinea (Adesiina and Baidu-Forson,1995), fertilizer in Malawi (Green and Ng'ong'ola, 1993), Hybrid Cocoa in Ghana (Boahene *et al*, 1999), age was either not significant or was negatively related to adoption. A number of studies that sought to establish the effect of education on agricultural behaviours in most cases relate it to years of formal schooling (Tjornhom, 1995). Generally, education is thought to create a favorable mental attitude for the acceptance of new practices, especially information-intensive and management-intensive practices (Caswell *et al*, 2001). According to Ehler and Bottrell (2000), technology complexity has a negative effect on agricultural decisions and this could only be dealt with through education. Furthermore, access to funds including credit is expected to increase the probability of adoption. For instance, it has been reported that most small scale farmers in the country are unable to afford basic production technologies such as fertilisers and other agrochemicals resulting in low crop yields due to poverty and limited access to credit (Ministry of Food and Agriculture 2010).

Our model system is the traditional Chagga agriculture at Mt. Kilimanjaro in Tanzania. As in other African countries, agriculture is one of the most important sector of the Tanzanian economy. It accounted for 45.1% of GDP in 2000 (World Bank, 2002). More than 80% of the population of the country relies directly on agriculture of one sort or another for their livelihood. Only 3.3% of the cropland was irrigated as of 1999 (World Bank, 2002). The three most important crops are maize, coffee and cotton – with maize being a major food staple, coffee a major cash crop grown in large plantations (and contributing significantly to the GNI), while cotton is another cash crop grown largely by smallholder farmers.

On the lower slopes of Mt. Kilimanjaro, the Chagga people have cultivated the fertile volcanic soil for centuries in small so-called home gardens as an agroforestry system (Hemp 2000), comprising bananas, coffee, beans, cocoyams and other legumes under shade trees. Many families also own fields in the plains surrounding Mt. Kilimanjaro, where maize is cultivated as the major crop.

From the above literature review, it is concluded that though a number of studies have been conducted across the world on agricultural technology adoption and farmer behaviours. But there is a shortage of studies that compare and evaluate the relevance of the socio-economic factors influencing adoption and behaviour. It was deemed important to find out which factors lead to the adoption of new farming techniques among smallholder farmers.

Our main objective is (i) to investigate the socio-economic structure of the communities, their farming activities and tendencies to adopt more modern agricultural methods. Furthermore, our research question is whether factors such as gender, age, income or education are significantly related to the adoption of new methods.

The major hypothesis of this study were:

(i) poorer households less frequently use modern farming methods than the richer ones

(ii) the female gender is more involved in the cultivation of activities than the male gender hence a higher agricultural efficiency for the female gender

(iii) older people retain traditional methods of farming more frequently than the younger ones

(iv) educated people do not involve as much in agriculture as a primary activity as those with low education because of alternative sources of income.

3.2 Analysis

Our objective was to measure agricultural productivity and perceptions on multiple socio-economic parameters. The chi-square test for independence, also called Pearson's chi-square test was used to discover if there is a relationship among multi-variables. This section is described in detail in Chapter 2 in the Methodology section.

3.3 Results

The sample of interviewed persons in the different villages mainly differed in terms of gender, whereas its mean age, agricultural and economic background expressed in household size, household income, owned land and cultivated land was very similar. The gender of interviewed persons differed strongly among villages. In Wari and Shari, most interviewed persons were

males, whereas in Nronga and Foo, the majority of interviewed persons were females. Only in Nkundoo and Nshara, gender of the sample was almost equally distributed.

Table 3.1: Some farmer and farm characteristics in Foo, Wari, Nronga, Shari and Nshara villages on Mt. Kilimanjaro, Tanzania, according to the interview survey of 313 households.

Socio-economic indicators	Proportion of households or area
Primary School Education (seven years)	68.7%
Vocational training (e.g. on farming, carpentry, mechanics, tailoring)	1.6%
Average number of persons living in a household	5
Farm size per household	2.7 ha
Farmers renting plots	10.5%
Average total cultivated area	4 ha
Farming as a primary activity	94.9%
Farming as a secondary activity	4.2%

Table 3.1 above summarizes basic information on farmers' education, off-farm activities, plots and housing. A Chagga farm is a very independent family enterprise with the majority depending on farming as a primary activity. At the same time the majority have only primary education level. Inaccessibility to vocational training is a challenge with less than 2% access to trainings on farming. Access to irrigation water could not be well documented because it varied according to a scheme and time of a year, from half an hour once a week, three times a week up to no regulation at all. The lowland farmers are suffering from decreasing water supply or complete drying up of streams and rivers.

Table 3.2: Description of the most important variables used in analysis summarized in Mean and Standard Deviation

Name Description	Measurement		Mean	Mean STADEV
Crops cultivated				
Maize and Beans	Counts	316		
Coffee	Counts	152		
Vegetables	Counts	66		
Others	Counts	241		
Input variables				
Land Area owned	Ha		1,31	0,93
Land Area Cultivated	Ha		2,03	0,8
Farm Specific Variables				
Gender of the Farmer	1 for Males , 0 for Females		0,54	0,49
Age of the Farmer	1 for older, 0 for younger		0,35	0,47
Family size	persons per household		4,78	2,17
Education	1 for over secondary school, 0 for others		0,31	0,46
Marital Status	1 for married, 0 for not married		0,23	0,41
Income of the Farmer	1 for over 500,000 TSHS, 0 for others		0,29	0,45

The average farm size owned was small while the average land cultivated is slightly higher (see **Table. 3.2**). Average highest educational level of both male and female members is generally low, an indication of lack of general agricultural knowledge, apart from personal experience. Income levels are generally low which indicates high level of poverty. The family size is 4.7 persons per household, which is very close to the national average of 4.8 according to the research by (Bauer *et al*; 2015). Dominant crops are modern varieties of maize, beans, banana and coffee.

Table 3.3: Inheritance, subdivision, renting and buying of land based by Maro (1974) and an interview survey of 313 people done in 2013

Inheritance, subdivision, renting and buying of land and the interview survey 313			
Relation to Land	1970[1]	2001[2]	2013
Farmers living on	82%	70%	57%
Farmers who are	43%	51%	10%
Farmers who have	11%	29%	31%

[1]Maro, 1974

[2]Soini, 2005

As it can be seen in **Table 3.3** above, only a few farmers were cultivating a plot they had bought themselves. This can also imply that people who sell land move out of the area. As compared to 1970s and 2000s farmers are now buying more land and therefore renting less. Inherited farms have become less prevalent since the 1970s because inheritance led to plot subdivision until using them has become increasing unfeasible. Most of these extremely small farms were found in the lowlands. Farmers on these farms rely on cultivating rented plots and doing casual work on others' fields. It is extremely difficult for the poor farmers to get capital to buy land. Especially during long droughts and family disasters one can, as a last resort, offer one's land for sale. More well-off farmers use these circumstances to buy the land and expand their lands.

Table 3.4: Intensification and diversification methods farmers use to adapt to poor rains and small plot size

Intensification/diversification mentod	% of farmers
Using improved maize seeds, either mixed with home seeds or alone	41.2%
Applying commercial fertilizers	47.3%[1]
Appling herbicides and pesticides	1.3%
Growing groundnuts or vegetables	51.8%
Abandoning traditional cocoyam	16.6%
Abandoning old millet variety	12.1%
Changing banana varieties'	1.3%

[1]only in lowlands and mid-lands

Farmers used several adaptation measures to intensify agricultural production and to compensate decreasing land size and low coffee price (**Table 3.4** above). Almost half of the farmers interviewed used commercial maize seeds and applied fertilizers, particularly on the maize fields on the plains surrounding Mt. Kilimanjaro. A significant proportion of farmers started growing groundnuts or vegetables that could be sold on local markets. Fewer farmers started abandoning the cultivation of traditional cocoyam (*Colocasia esculenta*) and finger millate (*Eleusine coracana*) varieties in their home gardens or shifted to improved banana varieties (*Musa acuminata*).

Table 3.5: Farming techniques, fertilizer uses' and means of acquiring land

Abbreviations: Income: 0=Low, 1=High: Education: 0=Primary, 1=Secondary: Gender: 0=Females, 1=Males: Age: 0=Young, 1=Older: Farming techniques: 0= Traditional, 1=Modern/Efficient, Fertilizers: 0=Artificial, 1= Natural: Means of Ownership: 0=Rent. 1=Bought or Inherited. Same subscript letters denote subsets of categories whose column proportions do not differ significantly from each other at the 0.05 level.

	Total	Gender		Income		Education		Age	
		Males	Females	Low	High	Primary	Secondary	Young	Old
Total		170	143	222	91	216	97	203	110
					Farming techniques				
Both	291	158a	133a	207a	86a	197a	94ba	187a	104a
		54.3%	45.7%	70.4%	29.6%	67.7%	32.3%	64.3%	35.7%
Modern	20	10a	10a	15a	5a	**18a**	**2b**	14a	6a
		50%	50%	75%	25%	**90%**	**10%**	70%	30%
Traditional	2	2a	0a	2a	0a	1a	1a	2a	0a
		80%	0%	100%	0%	50%	50%	100%	0%
					Primary economic activity				
Small business	7	3a	4b	5a	2a	7a	0a	5a	2a
		42,9%	57,1%	71,4%	28,6%	100,0%	0,0%	71,4%	28,6%
Farming	297	163	134	212a	85a	202a	95a	194a	103a
		54,9%	45,1%	71,4%	28,6%	68,0%	32,0%	65,3%	34,7%

Formal employment (e.g. teacher)	9	4a 44,4%	5a 55,6%	5a 55,6%	4a 44,4%	7a 77,8%	2a 22,2%	4a 44,4%	5a 55,6%
					Secondary economic activity				
Farming	13	7a 53,8%	6a 46,2%	10a 76,9%	3a 23,1%	12a 92,3%	1a 7,7%	9a 69,2%	4a 30,8%
Livestock keeping	147	84a 57,1%	63a 42,9%	101a 68,7%	46a 31,3%	**65a** **44,2%**	**82b** **55,8%**	100a 68,0%	47a 32,0%
Small business	153	79a 51,6%	74a 48,4%	111a 72,5%	42a 27,5%	**139a** **90,8%**	**14b** **9,2%**	94a 61,4%	59a 38,6%
					Means of Acquiring Land				
Bought	99	57a 57.6%	42a 42.4%	69a 69.7%	30a 30.3%	**25a** **25.3%**	**74b** **74.7%**	69a 69.7%	30a 30.3%
Inheritance	181	95a 52.5%	86a 47.5%	129a 71.3%	52a 28.7%	**162a** **89.5%**	**19b** **10.5%**	112a 61.9%	69a 38.1%
Rent	33	18a 54.5%	15a 45.5%	24a 72.7%	9a 27.3%	**29a** **87.9%**	**4b** **12.1%**	22a 66.7%	11a 33.3%

The majority of all interviewed persons responded that their farm was their primary activity (see **Table 3.5**). They used a mixture of modern and traditional farming practices, with no significant differentiation among age, gender, income or education groups. The most frequent secondary activity was either livestock keeping or small business activity, such as trading. There was a significant difference in educational levels, with people with primary education mainly engaged in small businesses while people with secondary education kept more livestock. Likewise, more people with primary education lived on inherited farms whereas people with secondary education had more often bought farms. All other socio-economic factors, i.e. gender, income or age could not significantly contribute to the explanation of primary or secondary activities, farming practices or acquisition of land.

3.4 Discussions

These discrepancies between farmers' perceptions and evidence from the statistical data analysis are best explained by the great number of survival strategies or development pathways. Also by a combination of assets of the farms, which make it impossible to delineate any clear patterns or combinations of coping strategies and assets that would lead to certain livelihood outcomes: which would then reflect on farm revenue. Each family has a unique and changing set of assets and incentives. This has clear implications on finding suitable development interventions as one or few intervention options would not address the multiple problems and development questions that the area faces.

We found that the large majority of all interviewed households did farming as primary occupation, with most of the farmers having primary school education. Very few people had some vocational training and less than 30% had an income above 500,000 TSHS (approx. 200 Euro) per month. Most of the farmers lived on inherited land, with decreasing tendency over the last 40 years, whereas the number of farmers increased who live on a farm they had bought. Almost half of the farmers have used at least one technique considered "modern", such as improved maize seeds, commercial fertilizer or cultivating vegetables as cash crop. This also means that more than half of all households still employ the traditional farming techniques, prevalent in the area for long time. Whether farmers use traditional or modern or combinations of traditional and modern farming practices, did not depend on gender, income, education or

age, contrary to our hypotheses. Educational level was the only factor producing significant differences between secondary economic activities and means of acquiring land. From the interviews, farmers complain that farm extension services is no more available. Due to lack of efficient extension services there is little information on best practices and new crop options. There is also little follow-up of by laws on prohibitions on riverbank cultivation, cultivation on steep slopes, or cutting of wood in the riverine forests. The intensive farming system would require more inputs in order to keep the productions level.

3.4.1 Education

Education is one of the variables that tested to see if there is any correspondence to agricultural efficiency. Our findings have shown that, adding basic education on top of the typical seven years at school does have an impact on practiced farming techniques. Although became clear from the interviews that most of the farmers miss proper farm extension that could work as a source of knowledge of best practices in small hold farming. The use of the education level of the farmer as a technical efficiency shifter is fairly common (e.g., Asadullah and Rahman, 2009: Wadud and White, 2000). The education variable is also used as a surrogate for a number of factors. At the technical level, access to information as well as the capacity to understand the technical aspects related to crop production is expected to improve with education, thereby, influencing technical efficiency. It was reported also in Bangladesh that education was important in improving technical efficiency by Asadullah and Rahman (2009) and Sharif (1996).However, Wadud and White (2000), Coelli et al. (2002), and Rahman and Rahman (2009) did not find any significant effect of education on production efficiency.

3.4.2 Age

Farmers' age is used to account for his/her experience in farming and its consequent influence on technical efficiency, where the results in the literature are mixed. In this particular study, one of our hypothesis was that, age is very important as far as determining efficiency in agricultural practices. It is expected that the older or experienced farmers are relatively technically more efficient compared with their younger peers. Our study however suggest that no age group of the farmers improves technical efficiency. This is in consistent with the findings of Llewelyn and Williams, (1996) and Battese et al., (1996) but not with Asadullah

and Rahman, (2009). Although Rahman (2003) and Asadullah and Rahman (2009) conclude that older farmers tend to be technically inefficient compared with their younger peers; Battese *et al*., (1996) conclude otherwise for Indonesian and Pakistani farmers, respectively.

3.4.3 Gender and Income vs. farming techniques

Our findings show that neither income nor gender has an association with framing techniques which would contribute to low or high productivity. Some literature supports this finding suggesting that women as farm managers are equally productive with men (Quisumbing, 1996). Other literatures suggest that female-headed households are poorer than male-headed households throughout sub-Saharan Africa (Quisumbing *et al.,* 1995). Lack of capital to purchase and apply fertilisers is considered the biggest problem in farming, yet there is no indication that farmers who apply fertilizer would obtain better yields. One explanation to this can be that no information on how much fertilisers were used was obtained through the interviews. And this concludes although women are farm managers but they are also the poorest gender and that might have influenced their inability to be efficient to adopting better farming techniques

3.4.4 Secondary activities (off-farm income) Vs. Technical efficiency

In addition the study looked at correlations between social variables and use and off-farm income. For example off-farm jobs and education level. This was aimed to understand whether more educated farmers use more fertilisers than less educated farmers. The notion here was that, although there are many other ways to use off-farm income, only educated ones can invest on being technically efficient in agriculture. But on the other hand, jobs that are mostly available in the area are not depended on one's education level. Finally, our findings suggest that secondary activities reflect on farming techniques, mainly because the more engaged the farmer is with his job outside the farm he is likely to leave the farm management activities for his wife and children. Further, having an off-farm job is considered to allow higher farm inputs and thus leading to higher farm production.

3.5 Conclusions

For decades the Chagga home gardens had remained almost unchanged and were under little "environmental threats (Nair & Kumar, 2004) but this statement hold no truth as of today. The early immigrants started to transform the original forests on the slopes of Mt. Kilimanjaro by cutting less important trees, keeping useful tree species, and by adoption of new tree and crop species (Kisanga 1998). There has been a lot of environmental changes and the cash crop production system on which the whole system was built on in the 1930s has transformed, the farming system is still functioning with only little adaptations made.

Farms have been extremely subdivided to the point that under present management most of them are too small to sustain a family. Some of the plots have just enough space for a house and cannot function as farms any more. Further, decreasing water supply in rivers and furrows (due to decreasing rains) are a serious problem affecting farming on the lower slopes and the adjacent plains.

Large scale adoption of coffee cultivation in the 1930s, led to major modifications of the system. Work load increased considerably, rangelands in the uplands were converted to coffee cultivations necessitating stall-feeding of the cattle, food production in the up- lands declined due to the expanding coffee production pushing it gradually to the lower slopes (Maro 1974). Since 1960s coffee price in the world market has continuously declined.

High quality extension with current knowledge of best practices and a variety of new opportunities and innovations could be one important entry point to build up capacity in human capital. The results were when possible compared with a socio-economic study by Maro 1974 and a study by Fernandes *et al.* 1984.The overall aim was to study current opportunities that the Chagga have, and to identify new opportunities to enhance coping strategies of the Chagga.

Quantitative studies from other home garden sites have suggested negative nutrient budgets in home garden systems (Beer *et al.* 1998) But it is difficult to invest into farming as times of supply and demand of cash do not often coincide. To an average rural household in the area, cash is most available from August to December. This is the time when harvesting starts and crops can be sold. The most difficult months for the farmers are from January to June when

school fees are to be paid and farmers do their planting and weeding. Even though the whole family takes part in farming, cash is often needed to hire casual labour for the fields. Furthermore, investment in education and for males and females could improve technical efficiency of the Kilimanjaro farming system.

Chapter 4

Declining water and land resources at Mt. Kilimanjaro? Perceptions and Realities

Hawa Mushi, Michael Kleyer, Pius Z. Yanda

Abstract

Ten percent of the world's population lives on mountain ecosystems but more than40 percent is dependent on mountain resources. While land and water degradation has been cited as a major problem to the efficient management of natural resources, there are more than 20 million Tanzanians that depend on natural ecosystems (land and water included) for their livelihoods. This paper reports the findings of a study that was carried out to evaluate perceptions of land and water use on multiple socio-economic parameters. Household interviews on the state of agriculture in the villages as well as perceptions in relation to socio-economic factors including age, income, gender as well as education were conducted. The chi-square test for independence (also called Pearson's chi-square test) was used for analysis. It was found out that, education showed a strong correlation on the perceptions on declining natural resources (e.g., water, land, natural vegetation). With people with a higher education showing a more clear understanding to natural resources degradation issues. However, the age groups and income levels did not show any strong relationship with perceptions on declining natural vegetation and water sources. We conclude that, land, water and natural forest degradation is caused by poor arrangements for use and management, the limited options for energy and the ever increasing population that creates pressure on land. We recommend, new arrangements need to be put in place to ensure that the degraded land and water sources are restored**.** Also, investment in education for both men and women, strategies to promote forest conservation, and effective regulation/modification forest-community forest uses will improve the vegetation and water conditions.

Key words: Land use, Land change, Land degradation, Forest Cover

4.1 Introduction

Worldwide, more than 700 million people live in mountain areas, of these, 625 million are in developing countries. Although mountains are essential for the survival of humankind because of their resource endowments and thus have a long history of human settlement, mountain ecosystems have been threatened by an array of anthropogenic changes. Many ecosystems, particularly on the lower slopes, have undergone rapid transformation in land and water uses (Agarwal *et al*., 2002) such that their ability to provide critical goods and services both to mountain inhabitants and lowland communities has been impaired (Misana, 2001). With population growing at a high rate, a mismatch between the supply and demand of ecosystem services can arise leading to increasing forest conversion to agricultural land and intensification of agricultural land uses (Armentaras *et al*., 2003).

There has been growing concern over the human destruction of forests, especially in the tropical and subtropical countries' mountain environments and the associated consequences on soil and water quality as well as biodiversity (Noss, 2001). Furthermore, land use change (LUC) may imply lost opportunities to meet rural needs through extraction of forest products, such as wood production, non-timber forest products, wildlife habitat and water. Poor communities often rely on natural resources but lack the reserves and capacity to cope with changes in their environment (Kreuter *et al*., 2001).

For the sustainable management of mountain ecosystems and their resources, it is necessary to monitor and understand the changes in land cover and water resources on the slopes of mountains. This could be done by direct surveys of the extent of LUC, using e.g. chronosequences of aerial photos or satellite imagery (e.g. (Misana, Sokoni & Mbonile 2012)). Indirect sources of information on LUC may come from local knowledge, i.e. by interviewing the inhabitants of the mountain areas. In contrast to direct surveys, the information collected from local communities entail subjective, personal judgments on the changes of land and water resources. They represent perceptions on change, rather than objective data. While it is undoubted that objective data are required for sound decision making, gathering local perceptions of environmental change is advantageous in several ways. First, local awareness of the extent and causes of environmental change is necessary to promote local sustainable

land management that alleviates the negative effects of forest conversion. Second, the degree of local agreement or disagreement on the extent and causes of environmental change can inform about potential social barriers constraining sustainable land management. Third, understanding the social and economic context of differences in perceptions (Cebrián-Piqueras, Karrasch & Kleyer 2017) allows to identify relevant target groups for efficient counselling on sustainable land management options.

Generally, perceptions on environmental change can be shaped by various factors like knowledge and education, political and world views, goals, felt responsibility, cognitive biases, place attachment, age, gender, education, profession, income, wealth, social class, religion, proximity to and dependence on sites undergoing LUC, population density, and other cultural and social factors (Lyons & Breakwell, 1994).

Education is among factors that plays a very important role in individual perceptions. Individuals with higher education in general are more concerned about the environment (Arcury & Christianson, 1993): although a study in Norway found the opposite (Grendstad & Wollebaek, 1998). On the other hand, individuals who are more people-oriented and less authoritarian (Schultz & Stone, 1994), have higher levels of moral development (Swearingen, 1990), and believe their actions will make a difference (Axelrod & Lehman, 1993), tend to be more environmentally concerned.

Age on the other hand also plays an important role across childhood and youth (age 4–18), the ability to sustainably manage a resource increases, presumably as a result of growing cognitive ability (Gifford, 1982). Less obviously, girls seem to manage better at early ages, and boysdo better at later ages. Somewhat surprisingly, younger people seem to be less eco-centric than older people, at least in one Norwegian (Grendstad & Wollebaek, 1998) and one Australian study (Casey & Scott, 2006). Early studies (Hines et al., 1986–87) on adults as well as more recent ones (Añaña, & Herter, 2011) find that older people report engaging in more pro-environmental behaviour than younger people.

On the other hand, various research reviews on Gender differences in environmental attitudes and behaviours (Hines *et al*., 1986–87) concluded that the literature was inconsistent: that no clear differences could be discerned. However, a clearer but not entirely uniform picture seems

to have emerged more recently, in which women tend to report stronger environmental attitudes, concern and behaviours than men (Blocker & Eckberg, 1997). An explanation related to income as advanced by Inglehart (1997), has also explained that increased wealth and welfare generate a change from materialist to post-materialist values. When people no longer need to devote so much time to meeting their basic material needs, a shift occurs from material values, such as striving for increased income and property, to values that are more strongly linked to self-development and well-being. In Botswana for example, wealthier personsbetter recognized environmental issues than poorer persons, although this may be the result of educational differences that stem from wealth differences (Chanda, 1999).

In this study, perceptions on the extend and causes of changes of forest and agriculture cover as well as water resources among the inhabitants of the southern slopes of Mt. Kilimanjaro, Tanzania are reported. We also investigated the social and economic contexts of disagreement or agreement on these changes. For centuries, fertile volcanic soils and favorable climate have favoured a productive agroforestry system on the lower flanks of the mountain (Hemp 2006). Still, the region has witnessed extensive land use changes for more than 100 years (Soini, 2005), impairing hydrological and ecological functions. The upper montane vegetation has changed from forests to shrubs due to recurrent fires (Hemp 2005), affecting the water resources available for the communities inhabiting the lower slopes of the mountain and the north-eastern part of Tanzania at large (Molg *et al.* 2012). Natural and agricultural ecosystems at Mt. Kilimanjaro differ in many ecological functions and properties, such as soil carbon, nitrogen and microbial biomass (Gerschlauer *et al.* 2016), vegetation structure and biomass and biodiversity (Vollstadt *et al.* 2017).

An important factor causing recent land use change is population increase in the area, as elsewhere in tropical Africa. Since 1921, the population of the Kilimanjaro region has increased from approx. 129,000 to 1,050,000 in 2002 (Misana, Sokoni & Mbonile 2012). The southern slopes between 1200 to 1800 m a.s.l. belong to the most densely populated zone. Almost three quarters of the population in the Kilimanjaro region are dependent on the resources provided by the mountain ecosystem (Soini, 2005). One of these resources is stream water, which is abstracted for furrow irrigation of much of the agricultural land. We assumed that population increase and the associated pressure on land and available water resources had

risen the awareness of diminishing forest area and LUC in the local communities. Availability of water and land resources for individual households should have decreased and have negatively affected household income or size of the land owned. We also assumed that the perceptions on LUC were influenced by gender, education, income and age.

4.2 Analysis

Our objective was to measure the perceptions of land use and land change situations on multiple socio-economic parameters. The chi-square test for independence, also called Pearson's chi-square test was used to discover if there is a relationship among the categorical variables. This section is described in detail in Chapter 2 in the Methodology section.

4.3 Results

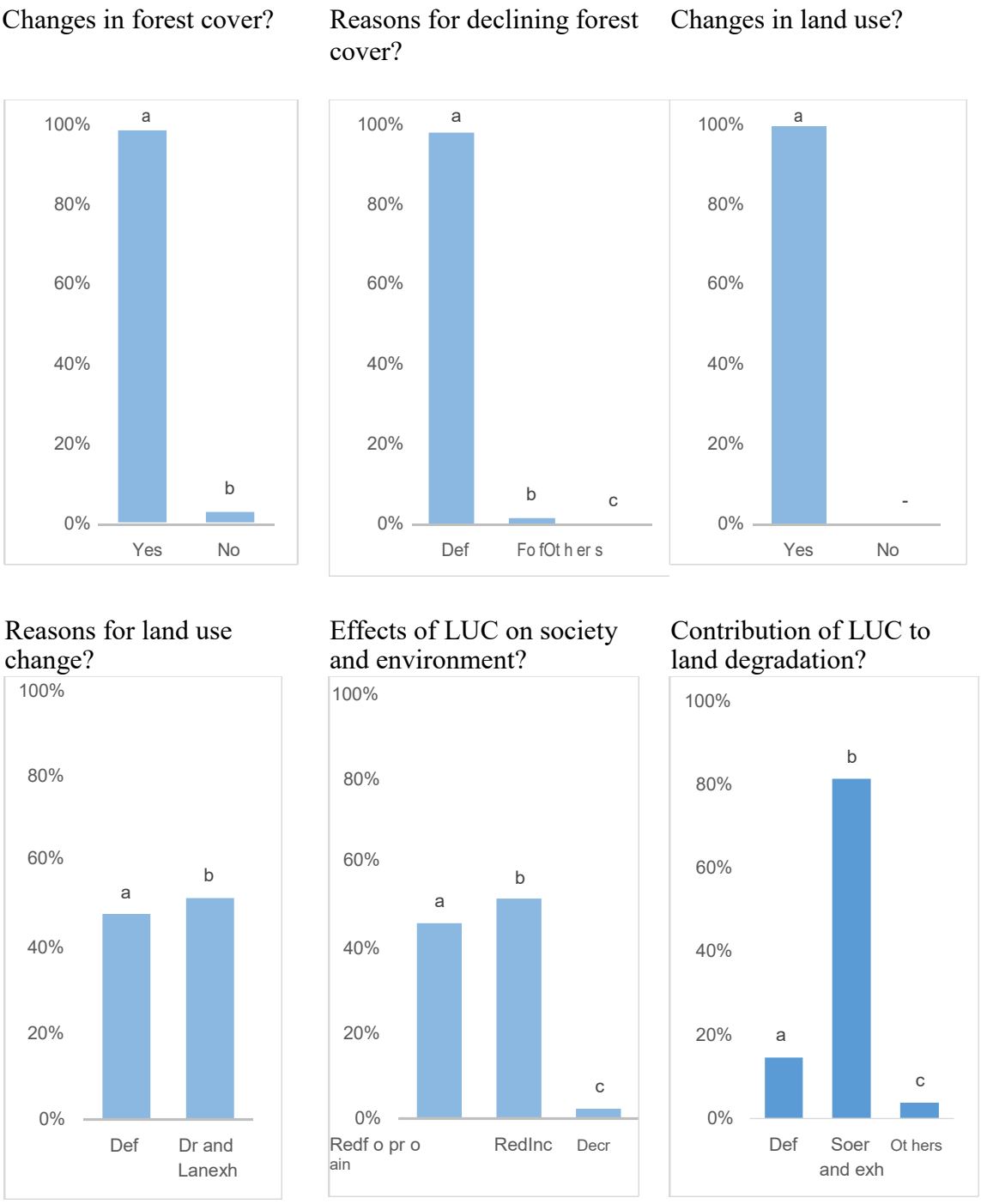

Figure 4.1: The figure shows the Perceptions on land cover changes for all respondents interviewed.

Abbreviations: Def: Deforestation: Fof: Forest fires: Dr and Lanexh: Drought and Land exhaustion: Redfopro: Reduced food production: RedInc: Reduced Income: Decrain: Decreased rainfall: Soer and exh: Soil erosion and exhaustion.

Almost all respondents agreed that they have observed changes in forest cover (see **Figure 4.1)**. These changes were attributed almost exclusively to deforestation, not to forest fires. Likewise, all respondents agreed that they have observed changes in agricultural land use that they attributed to either deforestation or drought and land exhaustion. Most respondents agreed that agricultural land use change increased problems of erosion and land exhaustion, questioning the environmental sustainability of land use changes. Furthermore, land exhaustion and erosion led to decreasing food production and reduced income. Most respondents could not see an effect of land use change on rainfall. There was no significant disagreement among respondent groups differing in gender, age or income regarding their answers (also see **Table 4.1**). Significant differences occurred mainly among respondents differing in educational level. Those with primary education more often specified deforestation as reason for LUC and reduced income as effect of LUC, whereas persons educated on a secondary level voted for land exhaustion as reason for LUC and reduced food production as effect of LUC. Significantly more respondents with lower income voted for deforestation as the main effect of land use change on land degradation.

Table 4.1: Responses to the questionnaires on the declining natural vegetation cover Vs. Gender, Income and Education responses

Test: Chi-square test, N=313. Same subscript letters denote subsets of categories whose column proportions do not differ significantly from each other at the .05 level. Results indicated in bold letters are the significant ones

Answers		Gender		Income		Education		Age	
		Males	Females	High	Low	Primary	Secondary	Younger	Older
	Total	170	143	91	222	216	97	203	110
				***Changes in forest cover**?*					
Yes	**311**	169a (54.3%)	142a (45.7%)	**89a (28.6%)**	**222b (71.4%)**	214a (68.8%)	97a (31.2%)	201a (64.6%)	110a (35.4%)
No	**2**	1a (0.6%)	1a (0.7%)	**2a (2.2%)**	**0b (0%)**	2a (0.9%)	0a (0%)	2a (100%)	0a (0%)
				Reasons for declining forest cover					
Deforestation	**140**	166a (54.2%)	140a (45.8%)	90a (29.4%)	216a (70.6%)	210a (68.6%)	96a (31.4)	197a (64.4%)	109a (35.6)
Forest fires	**6**	3a (50%)	3a (50%)	5a (83.3%)	1a (16.7%)	5a (83.3%)	1a (16.7%)	5a (83.3%)	1a (16.7%)
Others	**1**	0a (0%)	1a (100%)	1a (100%)	0a (0) %)	1a (100%)	0a (0%)	1a (100%)	0a (0%)

				Reasons for LUC?					
Deforestation	**152**	75a (50%)	75a (50%)	44a (29.3%)	106a (70.7%)	**131a (87.3%)**	**19b (12.7%)**	95a (63.3%)	55a (36.7%)
Drought/land exhaustion	**163**	67a (41.6%)	94a (58.4%)	46a (28.6%))	115a (71.4%)	**83a (51.6%)**	**78b (48.4%)**	108a (67.1%)	53a (32.9%)
Others	**2**	1a (50%)	1a (50%)	1a (50%)	1a (50%)	**2a (100%)**	**0b (0%)**	1a (50%)	1a (50%)
				Effects of LCC to socioeconomic and physical Environment?					
Reduced Income	**144**	72a (50%)	72a (50%)	45a (31.3%))	99a (68.8%)	**126a (87.5%)**	**18b (12.5%)**	90a (62.5%)	54a (37.5%)
Reduced food production	**162**	95a (58.6%)	67a (41.4%)	44a (27.2%)	118a (72.8%)	**83a (51.2%)**	**79b (48.8%)**	108a (66.7%)	54a (33.3%)
Decreased rainfall	**7**	3a (42.9%)	4a (57.1%)	2a (25.6%)	5a (71.4%)	**7a (100%)**	**0b (0%)**	5a (71.4%)	2a (28.6%)
				Contributions of LUC to land degradation?					
Deforestation	**46**	29a (63%)	17a (37%)	**13a (28.3%)**	**33b (71.7%)**	43a (93.5%)	3a (6.5%))	27a (58.7%)	19a (41.3%)
Soil erosion/exhaustion	**255**	135a (52.9%)	120a (47.1%)	**76a (29.8%))**	**179a (70.2%)**	161a (63.1)	94a (36.9%)	167a (64.5%)	88a (34.5%)
Others	**12**	6a (50%)	6a (50%)	2a (16.7%)	10a (83.3%)	12a (100%)	0a (0%)	9a (75%)	3a (25%)

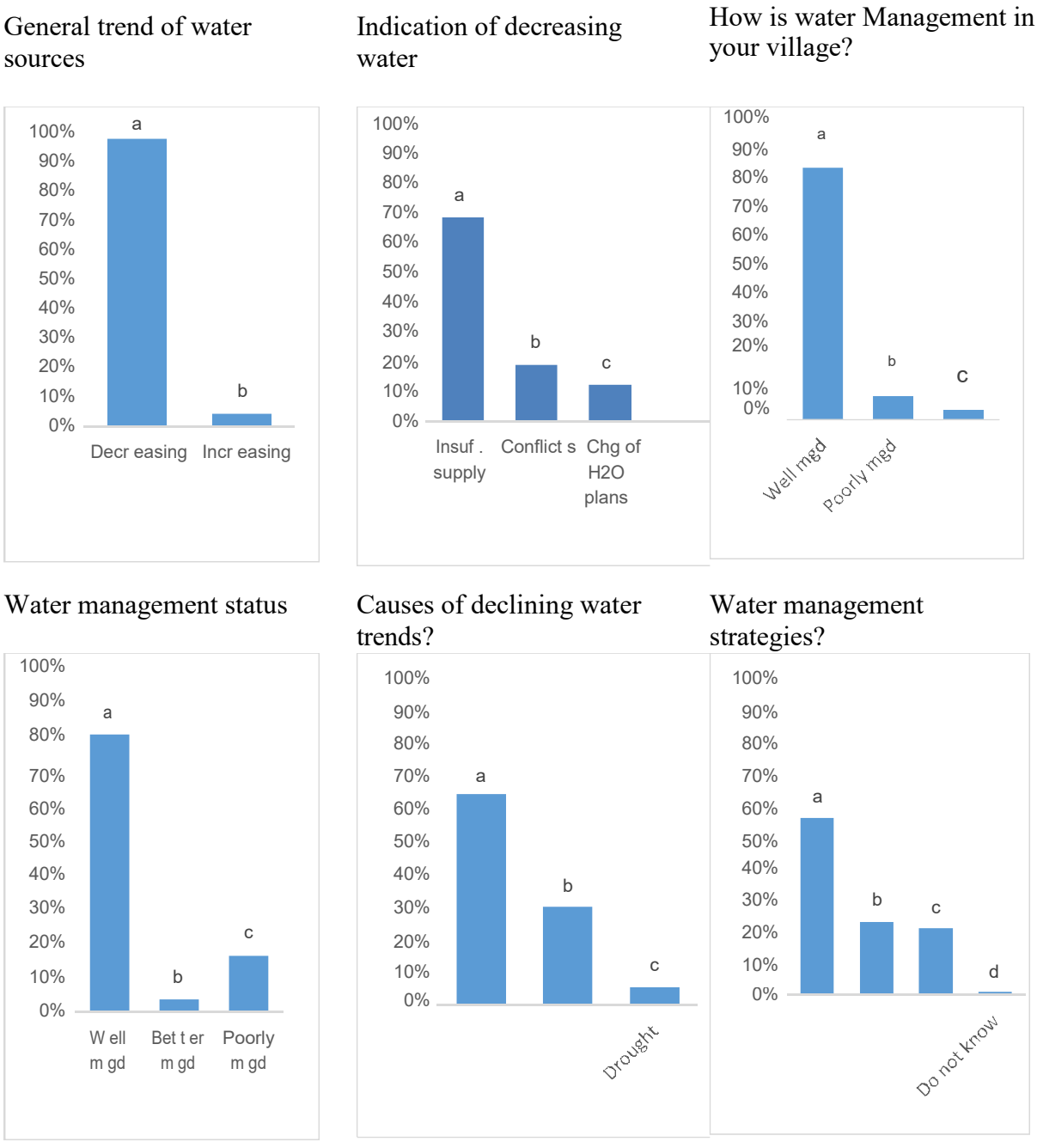

Figure 4.2: Responses on the general perceptions on the state of water use and availability.

Abbreviations: Insuf. Suppl: Insufficient supply among user groups: Chg of H2o plans: Change of water allocation plans: Well mgd: Well managed: Poorly mgd: Poorly managed: Better mgd: Better managed: moderately mgd: Moderately managed: Unsust. Farng: Unsustainable farming: Env. Education: Environmental education: Better mgt of res.: Better management of resources.

The majority of all people perceived the water resources as declining and attributed this decline mainly to unsustainable farming practices for example, the cultivation along water sources which pollutes water with chemicals fertilizers resulting from crop cultivation). A lower number of people said that deforestation was the main cause of declining water resources and very few respondents opted for drought. The decreasing amount of water allocated for individual households was also perceived as a consequence of insufficient supply among different user groups for purposes like irrigation, feeding animals, household users etc. People observed increasing conflicts among user groups, as well as changes in water allocation plans. In contrast to these answers, the majority considered the local distribution of water as well managed. Suggestions for a better management of water resources included strict by-laws and a better management of land resources, and natural forests in particular. The by-laws are locally formed laws which guide people on the proper use of water resources and at the same time punish whoever goes against them. They also educate the people on the proper use of the natural resources (see **Figure 4.2**).

Again, these perceptions were largely consistent among groups divided by gender, age and income, but signicantly differed among people with either primary or secondary education. In response to causes for declining water resources, significantly more respondents with primary education voted for deforestation or drought, whereas respondents with secondary education mentioned unsustainable farming practices. Persons with primary education saw conflicts among user groups and changes of water plans as more relevant for declining water resources than insufficient supply among user groups, and vice versa for persons with secondary education. The latter group considered the local water management as well managed, whereas the people with primary education more often assessed it as only moderately or even poorly managed. Finally, people with primary education more often suggested better education and the need for better management to improve the situations, while those with secondary education opted for strict by-laws.

Table 4.2: Responses to the questionnaires on the declining water resources Vs. Gender, Income and Education responses

Test: Chi-square test, N=313. Same subscript letters denote subsets of categories whose column proportions do not differ significantly from each other at the .05 level. Results indicated in bold letters are the significant ones

Answers	Total	Gender		Income		Education		Age	
		Females	Males	Low	High	Primary	Secondary	Younger	Older
What is the general trend of water sources?									
Decreasing	**300**	164a (54.7%)	136a (45.3%)	86 a (28.7%)	214a (71.3%)	**203a (67.7%)**	**97b (32.3%)**	194a (64.7%)	106a (35.3%)
Increasing	**13**	6a (46.2%)	7a (53.8%)	8a (61.5%)	5a (38.5%)	**13a (100%)**	**0b (0%)**	9a (69.2%)	4a (30.8%)
What indicates the decreasing Trends of water?									
Insufficient supply among	**214**	115a (53.7%)	99a (46.3%)	62a (29%)	152a (71%)	**124a (57.9%)**	**90b (42.1%)**	141a (65.9%)	73a (34.1%)
Conflicts among	**60**	33a (55%)	27a (45%)	18a (30%)	42a (70%)	**58a (96.7%)**	**2b (3.3%)**	38a (63.3%)	22a (36.7%)
Change of water	**39**	22a (56.4%)	17a (43.6%)	11a (28.2%)	28a (71.8%)	**34a (87.2%)**	**5b (12.8%)**	24a (61.5%)	15b (38.5)
What are the perceptions of water management in your village?									
Well managed	**274**	152a (55.5%)	122a (44.5%)	193a (70.4%)	81a (26.9%)	**178a (65%)**	**96b (35%)**	179a (65.3%)	95 (34.7%)
Poorly managed	**28**	14a (50%)	14a (50%)	22a (78.6%)	6a (28.4%)	**28a (100%)**	**0b (0%)**	8a (72.7%)	3a (27.3%)
Moderately managed	**11**	4a (36.4%)	7a (63.6%)	7a (63.6%)	4a (36.4)	**10a (90.9%)**	**1b (1.9%)**	16a (57.1%)	12a (42.9%)

What is the water management status in the village?									
Well managed	**251**	115a (45.8%)	136a (54.2%)	72a (28.7%)	179a (71.3%)	**177a (70.5%)**	**74b (29.5%)**	162a (64.5%)	89a (35.5%)
Better than before	**11**	6a (54.5%)	5a (45.5%)	3a (27.3%)	8a (72.7%)	**10a (90.9%)**	**1a (9.1%)**	7a (63.6)	4a (36.4%)
Poorly managed	**24**	22a (43.1%)	2a (56.9%)	16a (31.4%)	35a (68.6%)	**29a (56.9%)**	**22b (43.1%)**	34a (66.7%)	17a (33.3%)
What are the causes of declining water trends?									
Unsustainable farming	**202**	95a (47%)	107a (53%)	140a (69.3)	63a(30.7%)	**114a (56.4%)**	**88b (43.6%)**	129a (63.9%)	73a (33.1%)
Deforestation	**94**	41a (43.6%)	53a (56.4%)	70a (74.5%)	24a(25.5)	**85a (90.4%)**	**9b (9.6%)**	63a (67%)	31a (33%)
Excessive drought	**17**	7a (41.2%)	10a (58.8%)	12a (70.9%)	5a (26.4%)	**17a (100%)**	**0b (0%)**	11a (64.7%)	6a (35.3%)
What could be the best water management strategy?									
Environmental education	**175**	83a (47.4%)	92a (52.6%)	122a (69.7%)	53a (30.3%)	**131a (74.9%)**	**44b (25.1%)**	112a (64%)	63a (36%)
Strict bi-laws	**72**	29a (40.3%)	43a (59.7%)	51a (70.8%)	21a (29.2%)	**22a (30.6%)**	**50b (69.4%)**	50a (69.4%)	22a (30.9%)
Better management of	**63**	28a (44.4%)	35a (55.6%)	48a (76.2%)	15a (23.8%)	61a (96.8%)	2a (3.2%)	38a (60.3%)	25a (39.7%)
Others	**3**	3a (100%)	0a (0%)	1a (33.3%)	2a (66.7%)	2a (66.7%)	1a (33.3%)	3a (100%)	0a (0%)

4.4 Discussions

A remarkable awareness of forest cover change was found, land use change and decline in water resources among the people inhabiting the slopes of Mt. Kilimanjaro. Our results indicate strong land cover changes in the area affecting the livelihoods of most people in the area. We also found that the perceptions of causes and consequences of changes in land use and available water resources were unaffected by gender, age or income, with the exception of educational level. These results need to be evaluated against the background that (i) deforestation has already started centuries ago and (ii) the stream water originates from the undisturbed upper montane forests of the mountain. These facts suggest that (i) the demand for agricultural land is still increasing whereas its supply is diminishing, and that (ii) water resources for individual households decline mainly because of increasing demand, rather than diminishing supply. This is exemplified by a comment was made by one of the respondents from the Foo village:

"We used to have a lot of water enough to use at home and throughout the dry season. To date water has become scare which has also disturbed our water allocation plans. Several local water sources have dried out which is something we never experienced in the past. Again the number of people is increasing which makes the water situation worse. With the increasing number of people also comes the demand to cut down trees for timber and firewood."

4.4.1 Causes and consequences of land cover / land use change

Much of the present day cultivated land on the lower slopes of Mt. Kilimanjaro was initially forestland (Soini 2005). The first immigrants transformed the original forests into an agroforestry system for settlement and cultivation of bananas, which were introduced into the area by early traders between the 8 and 16th Century (Montlahuc and Philippson, 2006). Useful tree species from the natural forests such as *Cordia abyssinica*, *Albizia schimperana*, *Caesalpinia decapetala*, *Rauvolfia caffra* and *Datura arborea* were retained in the farms mainly as shade trees or for timber, fuel wood, fodder and mulch production, bee forage, as live fences and as pest repellents. Hence, most colline and lower montane forests up to 1500 m a.s.l. were converted to agricultural land long ago. However, the conversion of woodland to agricultural land is still ongoing. A remote sensing survey by Yanda and Shishira (2001) showed a forest decrease of about 41square km between 1952 and 1982. Some areas that were under natural forest are now under cultivation or degraded types of vegetation. The most

affected areas are the edges of the Kilimanjaro National Park forest reserve, particularly the half-mile forest strip. This strip was supposed to function as a buffer zone for the reserve, but has been seriously affected by timber harvesting and different forms of encroachment. A belt of cultivated grassland and cropland has replaced virtually the entire lower part of the montane forest belt, pushing the boundary of the forest to 1800 m a.s.l. William (2002) reported that the forest cover in the half-mile strip on the southern slopes of Mt. Kilimanjaro declined from 194.41 km in 1952 to 15 to 5.8 km in 1982.

These studies corroborate the perceptions of loss and conversion of forests to agricultural land by the local communities. A major cause for the ongoing loss of forests is a strong population increase around Mount Kilimanjaro. In 1921, a census counted a population of 128,443 inhabitants. In 2002 the population had increased to1, 049,819, while estimates for 2010 showed that the population will be 1,636,000 (Mbonile *et al.,* 2003: National Bureau of Statistics, 2011: 2006). The population growth rate increased from 1.9 to 4.5% in the region. Because of population growth caused by both local fertility and immigration, population density increased tremendously over the years from 26 persons per km² in the 1920s to over 200 on the lowland and midland zone and 650 in home garden area in 2002 (Soini, 2005).

Increasing population density has likely increased the demand for natural resources, resulting in loss of natural habitats, a drastic decrease in farm size, scarcity and fragmentation of land, out-migration and expansion of agriculture into the less fertile lowlands, which previously were used only for supplementary food production (Soini, 2005). Apart from the ongoing deforestation, all respondents attributed these changes to land exhaustion and erosion, which led to decreasing food production and reduced income. Land fragmentation is also enhanced by the traditional kinship and land inheritance system of the local Chagga people, where plots are equally divided among male children of a family.

Many studies have shown that population pressure is negatively associated with total farm income due to smaller landholdings per capita (Headey *et al*, 2014: Jayne *et al*., 2014). Apart from local population pressure, changes in global markets of agricultural commodities have affected the region. Specifically, low coffee prices have rendered the traditional coffee-banana farming system unprofitable and required changes in cultivated crops (Soini, 2005).

4.4.2 Causes and consequences of changes in water resources

Mt. Kilimanjaro has been called the „water tower“ of Northeast Tanzania, with multiple streams, rivers and springs providing surface water runoff to lower slopes and to the Pangani, the most important river of Northeast Tanzania. Most of the water is intercepted around 2200 m a.s.l. where rainfall peaks with 2,500–3,000 mm year^{-1} (Hemp 2006). Provision of surface water is likely the most important ecosystem service of the mountain rain forests. A considerable part of the runoff is abstracted by the local Chagga people. They have developed approx. 1800 km of channels, distributing approx. 200 million m³ of water on the southern slope of Mt. Kilimanjaro (McKenzie *et al.* 2010) for the irrigation of the home gardens. Nevertheless, nearly all respondents observed a decline in water resources available for their households.

In principle, declining water resources can also result from a decreasing total supply from the upper vegetation belt. (Hemp 2005) provided evidence for increasing forest fires at Mt. Kilimanjaro above 3000 m a.s.l., resulting in a change from forest vegetation to bush land. This may have decreased fog water deposition considered to contribute up to 5% of the total amount of water discharged to the groundwater and to streams running from the middle slopes down to the settled area (Hemp 2006).

However, it appears unlikely that a decrease in total water supply is responsible for the people´s perception of declining water resources. The rainforest belt between 2000 and 3000 m a.s.l. is protected by the Kilimanjaro National Park. Most of the respondents attributed the decline to unsustainable farming practices and to a lesser extent to deforestation, but not to an overall decrease of water supply from the upper vegetation belts. They also mentioned problems of equality in water allocation to individual households, or even conflicts among user groups, suggesting that the perceived decline mainly can be attributed to the demand side rather than the supply side and to an unsustainable management of the water resources. Still, the majority of the respondents considered the general water allocation as well managed which points to strong social cohesion in the villages and a coincidence of interests to approach the increasing demand for water. For example studies by (see Yanda and Shishira, 2001) provide evidence of replacement of disruption of water sources and the drying up of rivers.

Increasing water demands in the midland and home garden zone go together with increasing water demands further downstream. Major water users in the Pangani basin include coffee,

sugar cane, rice and flower plantations. All operating large irrigation schemes, consumption by urban inhabitants and industry, small-holders operating small-scale irrigation schemes, and hydropower (Turpie, Ngaga & Karanja 2005). This aggravates mismatches between demand and supply of water in terms of (i) scale – large irrigation users have more power to enforce water rights than farmers using small-scale irrigation; (ii) tenure-newly established governmental water board authorities are in conflict with traditional water rights hold by village councils; and (iii) location – downstream water users are dependent on the amount of water that upstream user pass on (Tropp *et al*. 2006). People also perceived an interrelationship between land use change and water availability by stating that the natural vegetation has strongly decreased as compared to 10 years ago and this has greatly affected the availability of water. This statement is supported by a comment was made by one of the respondents, as was coated saying:

"Many years ago the forest was so thick that we use to hear wild animals roaring at night from our homes. But as days went by the forest was cut down little by little to give space to build houses and cultivate as well as for obtaining timber and firewood. As a result all the natural vegetation was cleared down and has resulted in decreased rains and drying up of water sources. (Respondent, Nkuu-Ndoo village)

4.4.3 Impact of socioeconomic factors on perceptions of land use change and water resources

Whereas all respondents strongly agreed on ongoing land use change and declining water resources, there were differences on the perceived causes and consequences. Neither age, income nor gender could explain these differences. There is mixed evidence on the effect of gender on the perception of environmental issues. Many studies have found significant differences between the attitudes of males and females, other no differences (e.g. (Shibia 2010) and references therein). The only significant and consistent factor was educational level. Studies conducted in developed countries found that people with higher educational level were more aware of and concerned with environmental changes than those with a lower level (Twenge, 2004). In our study, all respondents were aware of land use change and decreasing water resources, pointing to rather homogenous communities in terms of dependency on the goods and services the ecosystems produce. Interestingly, people with primary education voted

more for causes and consequences of land use change and declining water resources that could be considered as external, i.e. not under their direct control, such as deforestation or drought. On the other hand, people with secondary education demonstrated stronger reflection and concern on actions and practices under direct responsibility of the own community, such as unsustainable farming practices. Respondents with primary education level were more often unsatisfied with the local water management than those with secondary education, indicating a lower participation in community decisions on water management. These results can be related to the locus of control concept (Rotter, 1966) that assesses the extent of control that people have over the events in their life. People with a strong external locus of control tend to perceive outside factors which they cannot influence as relevant for outcomes in their lives, whereas people are characterized as internal, when they account success or failure primarily to their own actions and control. Locus of control studies have been mainly undertaken in developed countries and in education science or business administration (Sandler, 1992) where a positive relationship of internality with higher educational level was found (Majzub, 2009). We are not aware of any studies applying the locus of control concept to local communities in developing countries and their perception of water distribution.

4.5 Conclusions

The environmental supply of agricultural land and surface water is often finite, whereas the social demand can increase ever more, thereby surpassing the supply and creating strong competition among community members. With strong social cohesion and fair distribution, each competitor may obtain an equally partitioned amount of farmland and water, although not the amount needed for a sustainable and acceptable livelihood. On the other end of the gradient, competition can result in a “winner takes it all” situation, where few people take all the resources, forcing other people to emigrate from the area or to shift to other sources of income.

On the slopes of Mt. Kilimanjaro, population increase has created competition for land and water, resulting in the ongoing conversion to agricultural and urban land. Moreover, water resources available for the individual household declined, likely due to a higher demand for irrigation among the increasing population. There was a remarkable agreement among all respondents on these processes, indicating that they affect the whole community in a way that everybody receives a little bit less of the total supply. With regard to water supply, our results

suggest that the distribution of the declining resources is fair, although people with lower educational level appear to be more unsatisfied with their share, pointing to frictions in social cohesion of the communities facing dwindling resources.

An ongoing land use change and intensification has lead to an increasing pace of deforestation and forest degradation, particularly in the once designated buffer zone around the Mt. Kilimanjaro National Park, the home garden zone, and in the lowland zone, where savanna vegetation is rapidly declining at the expense of maize fields, grasslands and urbanization. The latter is a consequence of emigration from the home garden and midland zone. However, the plains have limited resources, particularly water for agricultural production. As a result, land fragmentation is also evident in the lowland zone. Savanna woodlands are the most rapidly declining land cover type in the plains (Hemp 2006): and also harbors the highest share of traditional medicinal plants (Mollel, Fischer & Hemp 2017). The conflicts between the ongoing agricultural and urban land and water demand and the strongly diminishing forest resources are a source of strong concern among the local people as assessed by our study. They warrant further action to conserve forest and water resources and to provide alternative income sources for the local people. Furthermore, significant differences in perceptions of causes and consequences of land use change and declining water resources highlight the relevance of education to efficiently target such actions.

Chapter 5

Socio-economic factors determining extraction of non-timber forest products on the slopes of Mt. Kilimanjaro

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Abstract

The uncontrolled utilization on the slopes of Mt. Kilimanjaro has substantively impaired ecosystem functions and the flow of socially and economically valuable goods and services from live forests. Some factors governing the extraction of forest products are still unknown. It was assumed that the extraction of forest products is directly or indirectly related to poverty, small property size, gender, distance to the forest and age. A Generalized Linear Model with a negative binomial log link function was used to test the significance dependent and independent variables. Extraction of Fodder and Firewood was significantly related and showed a positive correlation to gender (in this case females) and negatively to the number of Household members. This indicates that more females of older age extract fodder and firewood than their male counterparts and smaller households extract more fodder than larger households. Firewood collection decreased with increasing distance between household and forest. Medicinal plants were collected more by men than women, of older age, and if the distance was closer. Neither household income nor property size contributed to the explanation of forest product extraction. The most relevant factors were gender, age, household size and distance to forests. Firewood collection frequency decreased with increasing distance between village and forest but was unrelated to other socio-economic factors. Medicinal plants were collected more by men than women, of older age, and if the distance was closer. For firewood and fodder extraction, inter-village variation was stronger than intra-village variation, suggesting that differences in access to infrastructure and alternative sites to produce fodder were stronger determinants of NTFPs extraction than household income or the size of the cultivated land. We can conclude that, Non-timber forest products (NTFPs) constitute significant benefits rural people regardless of their socio-economic status. We recommend that in order to improve participatory forest management and to foster a sustainable flow of socially and economically valuable goods and services from live forests, the socio-economic conditions governing the extraction of forest products should be considered. Our results can also help to better target participatory forest management.

Keywords: Non-timber Forest Products (NTFPs), Climate Change, Land cover Changes, Kilimanjaro, and Livelihood

5.1 Introduction

Each year the world loses an estimated 13 m ha of forest and up to 40,000 forest dependent species (Kremen *et al*., 2000). On the other hand, natural forests also provide multiple ecosystem services to the communities living in the forest surroundings (Costanza *et al*., 1997). Households often need resources available in protected areas, such as wood for cooking, heating and construction (Naughton-Treves *et al*., 2007) or forage for livestock (Kideghesho *et al*., 2007). Many protected forests are located in regions of poverty (Sunderlin *et al*., 2005) and subsistence-based livelihoods are often perceived as a threat to forest conservation, due to the extraction of forest products (Mbile *et al*., 2005). The dependency of products from natural forests through harvesting and consumption accounts for a large proportion of the livelihood of people living close to such habitats (Padoch, 1992). In 2001 the World Bank assessed the number of forest-dependent people globally, attaining a figure of some 1.6 billion people (World Bank., 2001 and World Bank., 2004).

NTFPs embody all biological matter of wild plants and animals other than timber extracted from forests and woodlands, e.g. fruits, nuts, vegetables, game, medicinal plants, resins, bark, fibers, palms, grasses as well as small wood products and firewood, amongst others (CIFOR, 2011). Different types of plants are harvested for non-timber forest products (NTFPs) in tropical forests in Africa (Peters, 1996). Non-timber-forest-products (NTFPs) contribute significantly to maintain livelihoods in rural Africa, Asia and elsewhere in developing countries (Campbell and Luckert, 2002). Wild fruits and vegetables are an important source of edible fruits, leafy vegetables, and herbs, and are particularly important in ensuring food security and maintaining the nutritional balance in people's diets (FAO, 1995). In some societies, during famine, wild plants become essential to human survival, and at other times they both prevent the need for cash expenditure and provide a source of income to cash-poor households (Emerton, 1996).

Recent case studies from Africa found NTFPs to be an essential income source in total household economy. In Malawi, planted wild and fruit trees on common land make up to 15% of total income (Kamanga et al., 2004). In the Republic of Congo, wild plants contribute 10% to households' total food consumption (De Merode *et al*., 2004)) calculated that the provision of consumptive forest environmental products (i.e. fuel wood, farm implements, construction

materials, wild food items, herbs, medicines) constitutes 27% of the income in northern Ethiopia. A comprehensive study of forest environmental income in Zimbabwe conducted by Calendish (2000) found wild foods (plants and animals), medicinal plants, various wood and grass uses, forage plants as well as soil and termite uses even to account for 35% of the average rural income. Although the comparability of these studies is difficult since most of them merely investigated a certain set of forest products, they underpin the economic relevance of NTFPs. Meta-studies indicate that as much as 20-25% of rural people's income may be derived from environmental resources in developing countries (WRI, 2007).

Dependence on forest resources differs greatly between individuals in terms of tribe, caste, class and also between and within communities and households by gender and age (Babulo *et al*., 2009). Women have traditionally gathered a wide range of non-timber forest products (NTFPs) for both subsistence and income generation through processing and sale (Carpetier et al 2000). Female-dominated families for example are more likely to harvest fuel-wood and male dominated timber. Sometimes gender roles in forest use can be dynamic and women can take up traditionally male activities. Older people may possess superior knowledge about medicinal uses, and may collect more medicinal plants and wild foods (Ndagalasi et.al 2005).

Besides gender and age, forest resource dependency may decrease with increasing household wealth and education, suggesting illegal extraction from protected areas could be mitigated by development (Adams *et al*., 2004). More land yields higher agricultural income than for households with less land, relaxing the pressure on the forest as an additional source of resources. Increased household wealth can result in more positive attitudes towards protected areas (Gillingham & Lee, 1999) but also an increased desire to extract protected area resources for profit (Holmes, 2003). Owing to improved off-farm employment opportunities (Kaimowitz, 1999) and access to credit (Godoy *et al*., 1997), total household income may be associated with reduced forest clearance as a supplementary income-generating activity. Households with higher education levels often have more reliable sources of non-farm income opportunities (Ellis, 2000) and may therefore not depend as much on NTFPs as people with lower education levels.

Distances to forests or markets are common external forces that may often increase or decrease forest extraction, respectively (Mamo *et al*., 2007). In contrast, forest policy and traditional

rules governing forest use may impose excessive control over the use of forest resources in some developing countries (Neumann, 1998). While the relevance of these different social factors is principally acknowledged in different studies worldwide, there is still a lack of knowledge regarding their interplay at the local community level. In the face of an increasing concern about the preservation of natural forests in the Tropics is important to identify the social groups that most strongly rely on forest resources for their well-being. These groups can then be better targeted by education and aid towards forest use which is sustainable on the long term. (Misana, 2001). To further our knowledge in this field, we ask how extraction of forest resources depends on the social structure of local communities. Specifically, we ask whether social groups structured by age, gender and income can be identified that extract more resources than other groups and whether this changes with regard to the resources, e.g. fodder, firewood or medicinal plants.

In Tanzania, forests provide over 90% of the national energy supply through wood fuel and charcoal (Milledge *et al.,* 2007), which shows that forest degradation by biomass extraction is an important issue. Due to heavy dependence on firewood and charcoal for cooking and heating since the early 1990s, Tanzania has made significant steps towards improving the management of its forest resources: some important steps being the implementation of Community Based Forest Management and Joint Forest Management Programmes (URT, 2010). The contribution of forests to local livelihoods and the Tanzanian national economy as a whole is significant, but is largely unrecorded and consequently not accounted for. This study therefore aims at quantifying trends of forest products extraction and reasons for such trends.

The southern foot slopes of Mt. Kilimanjaro are highly endowed with fertile soil, abundant rainfall and water for irrigation during dry seasons and the villages are fully dependent on these resources. We assume that communities in the upper part of the settled landscape depend more on forest products for their livelihoods than those on the lower foot slopes that are located farer away from the forested area uphill and have better access to the arable land in the plains surrounding Mt. Kilimanjaro. We further assume that larger households extract more NTFPs than smaller ones. Another assumption is that there is less dependence on forest products in families where the size of agricultural fields and home gardens are larger than in families with

smaller ones and there is more dependency of forest products to the families with lower income than the ones with a higher income.

Forest products addressed in this study are firewood, fodder, medicinal plants and fruits and vegetables. Most people in the villages rely on either firewood or charcoal for cooking. Whereas charcoal is a commercial product, firewood can be collected in forests, mostly be cutting down large branches or small trees. Fodder can be collected from the forest-under storey vegetation or from small forest gaps covered with herbaceous vegetation. However, fodder was also collected on grassland patches. These patches are found either uphill, i.e. close to the border of the Kilimanjaro National Park, on the slopes of the steep gorges intersecting the cultivated foothills of Mt. Kilimanjaro, or on less fertile sites in the plains below Mt. Kilimanjaro. Herbal medicines are used to prevent, calm and even treat diseases.

5.2 Statistical analysis

Our objective was to model the dependence of the frequency of forest resource extractions on multiple socio-economic parameters. As the dependent variables consisted of count data, i.e. the number of forest visits per year, we chose a negative binomial regression. A more detailed description of a statistical analysis is found in Methodology section in Chapter 2.

5.3 Results

5.3.1 Differences in socio-economic parameters per village

Table 5.1: Means of socio-economic parameters per village.

Abbreviations: DF: distance to forest [km], Gender: proportion of males interviewed, Age: age of interviewed persons [years], HI: household income of interviewed persons [Tanzanian Shilling], HS: household size of interviewed persons [number of persons in household], TL: total land owned by interviewed persons [acres], TLC: total land cultivated by interviewed persons [acres].

Village	DF	Gender	Age	HS	HI	TL	TLC
Foo	2.5	0.29	45.13	5.11	613333	3.10	4.22
Nkuundoo	1	0.68	39.56	4.80	610975	2.80	4.14
Nronga	2.5	0.13	42.07	4.22	590217	2.16	3.72
Nshara	1	0.43	41.30	4.83	566666	2.58	3.93
Shari	1.2	0.82	38.48	4.98	480681	2.56	4.03
Wari	1.5	1.00	40.68	4.72	575000	2.67	3.97
All	1.6	0.54	41.24	4.78	571884	2.64	3.99

The sample of interviewed persons in the different villages mainly differed in terms of gender and distance to forests, whereas its mean age, agricultural and economic background expressed in household size, owned land and cultivated land was very similar (see **Table 5.1**). The gender of interviewed persons differed strongly among villages (also see **Table 5.1)**. In Wari and Shari, most interviewed persons were males, whereas in Nronga and Foo, the majority of interviewed persons were females. Only in Nkundoo and Nshara, the sample was almost equally distributed among males and females.

Table 5.2: Frequency of forest product extractions per study village and year

Villages	Firewood	Fodder	Fruits and vegetables	Medicinal Plants
Foo	87.82	1.64	2.27	3.67
Nshara	92.05	101.61	2.71	2.92
Nkuundoo	87.51	98.93	3.78	2.80
Nronga	99.48	101.74	1.43	2.72
Wari	0.94	2.52	2.30	4.16
Shari	93.36	0.41	1.48	21.27

There were strong differences in the average extraction frequency of forest resources between villages (see **Table 5.2**). For instance, people from Wari rarely go to the forest to collect firewood, whereas people in other villages go two times a week. Likewise, people from Foo, Wari and Shari rarely collect fodder in the forests, whereas people from Nshara, Nkundoo and Nronga do this frequently

Table 5.3: Relationships between the extraction frequency of forest resources and socio-economic predictors. Abbreviations: Coef: predictor coefficient: P: probability. Significant predictors printed in bold ($p < 0.05$).

Social variables	Firewood		Fodder		Medicinal plants		Fruits and vegetables	
Predictor	Coef	P	Coef	P	Coef	P	Coef	P
Gender= Females	**0.38**	**0.00**	**0.80**	**0.00**	**-0.52**	0.00	0.10	0.50
Marital Status= Married	-0.11	0.42	**-0.25**	**0.07**	0.10	0.55	0.02	0.92
Age	-0.003	0.47	0.001	0.89	-0.01	0.12	0.01	0.18
Household size	0.01	0.71	-0.03	0.39	**0.11**	**0.03**	**-0.08**	**0.03**
Household income	-9.4E-8	0.50	5.5E-9	0.96	**-4.6E-7**	**0.00**	-4.3E-8	0.80
Land owned	-0.07	0.51	-0.14	0.19	**-0.62**	**0.00**	0.24	0.06
Land cultivated	0.05	0.69	0.09	0.48	**-0.69**	**0.00**	-0.21	0.14
Distance to forest	-0.08	0.42	**-0.57**	**0.00**	**-0.32**	**0.01**	**-0.31**	**0.00**

Across all villages, females collected more firewood and fodder than males, particularly if villages were close to the forests (see **Table 5.3**). The frequency of fodder extraction also increased when persons were married. Except for firewood, less distance determined more extraction of fodder, fruits and vegetables and medicinal plants. Families with less income and with less land owned and cultivated extracted more medicinal plants. Other socio-economic parameters were not significant at the $p<0.05$ level. On the contrary, age or marital status did not influence the extraction of fruits and vegetable or medicinal plants. Extraction of medicinal plants increased with household size and decreased household income. Males more frequently collected medicinal plants than females. Medicinal plants, fruits and vegetables were more frequently collected when the forests were close to the villages. All other parameters were not significant at the $p<0.05$ level.

Generally, our results show that the main variation in the extraction of fodder and firewood is between villages, not within villages, and particularly not between wealthy or less wealthy people. To determine whether these result remain consistent, we repeated our analysis based on subsamples of villages with almost equal collection frequencies (see **Table 5.3**). For firewood extraction, we pooled interviews from all villages except Wari. No social economic variable could significantly explain the variation in firewood collection in this subsample (data not shown). For fodder extraction, we pooled the interviews from the villages Nkuundoo, Nshara and Nronga data not shown) and no social economic variable emerged that could explain the variation in fodder extraction in these villages (data not shown). We also pooled the interviews from the villages of Foo, Shari and Wari. Here, married females of households owning small properties collected more fodder at a shorter distance.

5.4 Discussion

Our results suggest that households in all villages extracted forest products. One respondent was quoted agreeing to this saying:

"We collect almost all that is useful from the forest. This ranges from dry firewood, vegetables, fodder and also medicinal plants. These forests can be our own small forest gorges nearby or the Kilimanjaro National Park forest. We cannot imagine life without the forests considering that firewood is our main source of energy" (Respondent, Nronga village).

However, extraction frequencies differed strongly between villages, particularly for firewood and fodder. Apparently, households within villages display a relatively homogeneous behaviour in terms of firewood and fodder extraction. In contrast to our expectations, neither firewood nor fodder extraction depended on intra-village variation in household wealth or size, indicating a uniform dependency on firewood and fodder from forests within villages. This is in contradiction to other studies showing that the extraction of forest resources can strongly contribute to the income of the poorest farmers (Kamanga et al. 2008). In our study, the most important factor explaining inter-village differences in all resources extracted was distance to the forests, with the exception of firewood. Other socio-economic factors varying both at the inter- and intra-village level provided significant additional explanation, but only on selected forest resources, such as medicinal plants or fruits and vegetables.

5.4.1 Inter-village variation: distance to forests and other factors

With decreasing distance to forests, extraction frequency of fodder, vegetables and fruits as well as medicinal plants increased. Proximity to the forest allows households to extract more forest resources with reduced labour and transportation costs (Ndagalasi *et al.,* 2005). Remoteness impedes extraction not only through increased extraction costs but also through lower probability of entitlement to the resource. Other studies have found an influence of age in relation to distance, as younger persons can mobilize more energy to walk long distances for firewood collection (Piland, 1991, cited in Godoy *et al*., 1997).

Age of the head of household may be positively related to forest resource utilization until a peak of physical strength is reached. In our study, however, extraction of NTFPs did not depend on age. Besides distance, access to grassland sites could explain some of the inter-village variation, particularly differences between firewood and fodder extraction frequencies. Households of Foo and Shari rarely collected fodder in forests, but frequently visited the forest to extract firewood. The difference may be due to fact that forests are the only resource for firewood extraction, whereas fodder can also be produced on meadows. Meadows are scarcely found in the main settlement area of the Chagga people on the lower slopes of Mt. Kilimanjaro. Here, almost all of area is devoted to home gardens which produce more diverse agricultural goods, including cash crops such as coffee. Meadows are mainly found on very steep slopes along gorges and on the upper border of the settled area where the population density is lower. People living close to sites with meadows are less inclined to visit forests for fodder collection (Naughton, 2007).

An additional factor creating inter-village differences is proximity to the main roads that connect the study area with the larger settlements surrounding Mt. Kilimanjaro. Roads also serve as marketplaces where commodities such as charcoal are sold as an alternative to firewood. Wari is located close to the main road which may provide an additional explanation why households in Wari collected very few firewood, apart from the distance to the nearest forest. Charcoal producers often prefer old-growth hardwood trees which has a much stronger impact on the forest than local consumers which prefer fast-growing species for firewood collection (Naughton-Trevesa et al. 2007).

5.4.2 Fodder and firewood extraction in relation to gender and marital status

Fodder and firewood were the most frequently collected forest products. In some villages, people visited forests on average three times per week to collect fodder and firewood. Thus, these forest products contribute important additional household resources, as reported elsewhere in Africa (e.g. Kamanga et al. 2008). Females more often collected fodder in forests than males or unmarried females. Married women are likely to have larger households, which in most cases also means larger land. Normally, fodder grown in home gardens is not enough to cater for all cows in the household so they have to extract additional fodder from the forest. While it is a commonplace that women in rural areas work just as hard as men do, much of their work in maintenance tasks of the family, such as collecting fuel and water, cooking, looking after children, goes by unnoticed. An investigation conducted in Gujarat revealed that a substantial portion of women's working time and energy is devoted to such tasks (Nagbrahmam & Sambran 1983). Women often have a higher work load which is due to social traditions (e.g. Kamanga *et al*. 2008). There is however no general consensus that females collect more forest resources than males. A study in Malawi did not find any significant relationship between sex of household heads and income from forest products (Kamanga et al. 2008). They are also often poorer than their male counterparts. This is partly due to social traditions that do not allow female involvement in income generation activities as much as males do. In an interview one female respondent explained further that:

"We women are more concerned with almost all household activities, from cooking, collecting firewood, feeding cows, tending to chickens, cleaning. Sometimes we are also involved in income generating activities like when we cultivate a little more and sell out the rest of the harvest but all the income is for the man. He plans how to spend it for all of us. It has always been like that, from our ancestor's time up to now" (Respondent, Nkuu-Ndoo village)

As a caveat, we note that collection of firewood in the Half Mile Strip was considered illegal by the National Park administration. Hence, many of the firewood extractors were not very open in revealing the frequency of firewood they collected from the forest. To overcome this problem, efforts were made to give a clearly and elaborative introduction about the research and introduce the motives of the interviews. This made respondents more comfortable in answering the most critical questions about forest extraction activities and created mutual trust.

Efforts were also made to conduct some focus group interviews with village leaders and elders to ensure the answers given were as close as possible to the ones given by the respondents.

5.4.4 Extraction of fruits, vegetables and medicinal plants in relation to household size and income

Both fruits and vegetables and medicinal plants were much less frequently collected than firewood or fodder. On average, people visited forests one to four times a year to collect these items. This may be due to the fact that fruits and vegetables are only available during certain seasons. Medicinal plants can be collected once and processed and stored for later use, in contrast to firewood and fodder that is needed daily. The extraction frequency of medicinal plants increased with increasing household size, decreasing income and increasing distance to forests. This was in line with our expectations and found in other African communities as well (e.g. Leßmeister *et al*. 2018). We found no general relationships with age, although Ndagalasi *et.al* (2005) stated that age is an important factor to explain the extraction frequency of medicinal plants. This is exemplified by a comment was made by one of the female elders who collects medicinal plants for family and village use:

"This is the knowledge I inherited from my grandmother from when I was a young girl. I still practice it up to now that I am 56. I collect all sorts from barks of trees, seeds, fruits and leaves. I have to go far into the forest to collect them. Usually once to twice a year. I mostly have to boil and smoke-dry to preserve. My medicinal options heal a range of diseases from simple stomach complications to joint pains and even malaria. Most people are not concerned with traditional medicine any more, there are better health options and people have better income nowadays to accommodate other health benefits. It is unfortunate that very few young people are showing interest to alternative medicine, these are people who would otherwise teach the next generation about this kind of knowledge" *(Respondent, Nronga village).*

5.4.5 Additional factors affecting the extraction of forest products

Observation showed that the Kilimanjaro National Park administration exerted control over which resources were allowed to be extracted especially at the former half mile strip. A general exploitation of the forest was considered illegal. This has not stopped the villagers from extracting non-timber forest products. As a result of these activities part of the lower montane

forest has some patches of harnessed and unharnessed trees. The effect of this massive deforestation has led to severe soil erosion and a decrease in water discharge from the mountain. According to Yanda and Shishira (2001), there have been strong changes in land cover on the slopes of Mt. Kilimanjaro since the 1950s. Natural forest on the southern slopes of Mt. Kilimanjaro has decreased by about 41.04 km square. Some areas, which were under natural forest in 1952, were already under cultivation or degraded types of forests in 1982. This may be due to the relatively high population density of the region (124 persons per km² National Bureau of Statistics (2013), the reason for the deforestation in the area may both population increase and weak governance in forest conservation.

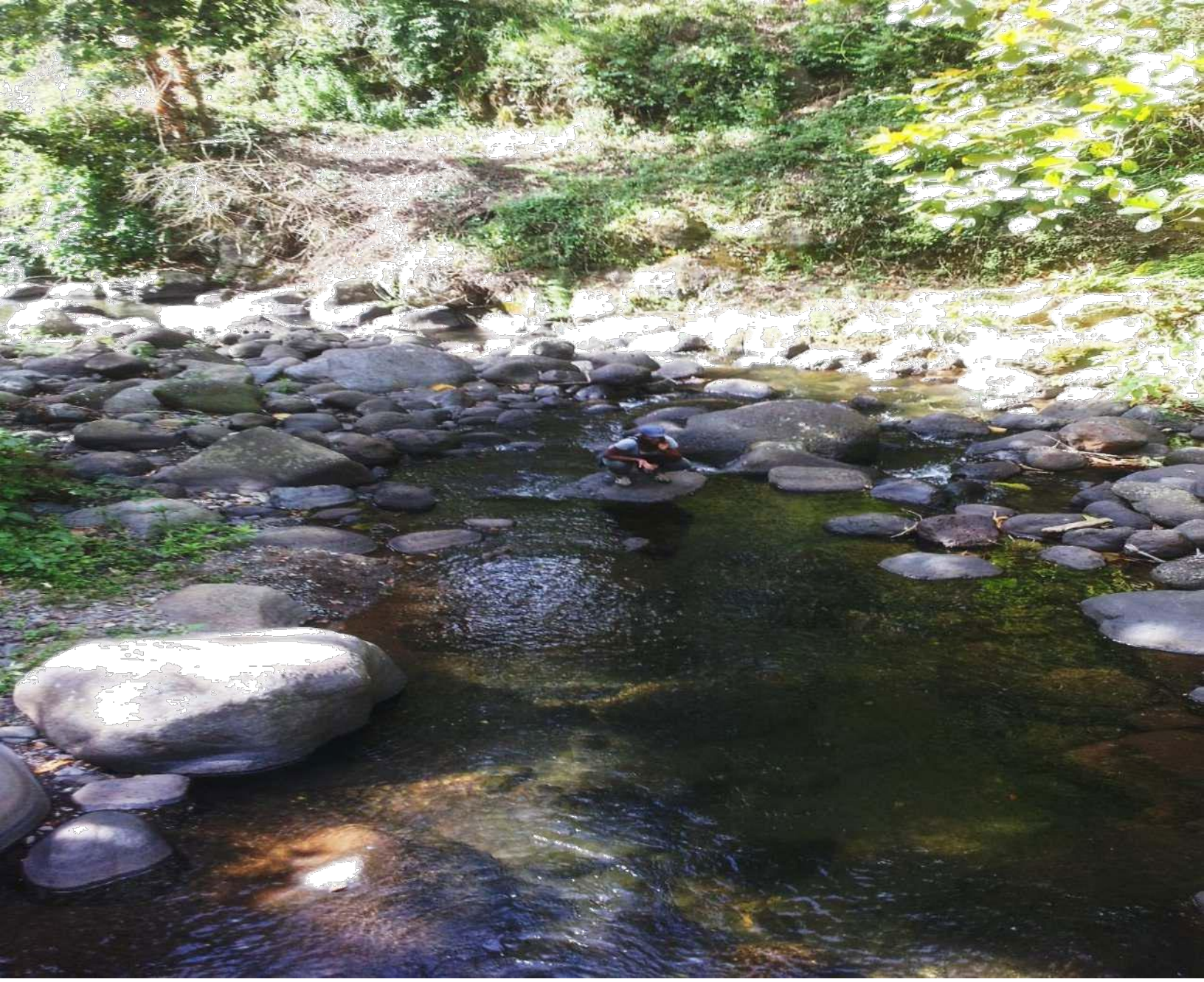
Education plays a big role in forest products extraction where educated individuals may be in a better position to tap into income flows from natural stocks. Godoy and Contreras (2001), however, found that a higher level of formal schooling is associated with less forest cutting. Adhikari et al. (2004) argued that a higher level of education makes fuel wood collection increasingly unprofitable due to higher opportunity costs of labour. Improved off-farm employment opportunities and access to credit may reduce forest clearance as an income-increase activity. On the other hand, greater access to forests and markets may often accelerate forest extraction (Angelsen and Kaimowitz, 1999). The World Bank (1992) however, suggested that markets enhance conservation when there are secure property rights. At the farm level, promotion of other income-generating activities such as such as beekeeping, mushroom farming and agro-forestry may reduce the exploitation of forest resources. Communities should be facilitated to plant their own trees on home gardens and on the use of energy saving stoves to reduce their energy dependency on the forest.

Cavendish (2000) has noted that the contribution of forest resources to the welfare of rural households is regularly overlooked in poverty surveys. Empirical investigation of dependency on forest resources may help to improve macro-level poverty estimates and improve policy planning and execution. The quantification of environmental income (Sjaastad *et al.* 2005) may serve as an input into conservation policy, and particularly establishment of protected areas, by determining the potential loss to rural dwellers of reduced access to environmental resources.

5.6 Conclusion

We found evidence for a strong community dependence on non-timber forest products along the slopes of Mt. Kilimanjaro. Firewood was collected frequently in the forests, underlining the need for energy in almost all households. With the exception of a single village, charcoal, gas or electricity had not replaced firewood as the primary source of energy for cooking. Forests provide over 90% of the Tanzanian national energy supply through wood fuel and charcoal (Milledge et al., 2007). In three out of six villages, people also visited forests on average two times a week to collect fodder for livestock. Fruits and vegetables as well as medicinal plants were collected less frequently, probably due to their seasonal availability. This demonstrates that natural forests can provide important provisioning services for local communities. On the other hand, extraction of non-timber forest resources can strongly impact the structure and biodiversity of natural forests (Ticktin 2004). Apart from logging, firewood collection belongs to the most detrimental uses of natural forests as it weakens adult trees, destroys young trees and diminishes nutrient fluxes by biomass removal. Conservation methods should be inbuilt in forest resources utilization in order to ensure sustainability. Community members should be encouraged and motivated to be aware about their rights and obligations in extracting forest products as per the existing regulations. Sustainable forest management requires capacity building, awareness rising and participatory involvement of the local communities (e.g. Agarwal 2001). Tanzania has made significant steps towards improving the participatory management of its forest resources by the implementation of Community Based Forest Management and Joint Forest Management Programmes (URT, 2010), Blomley et al. 2008). Our study may help to better target local community participation. Regarding the sustainable

Management of firewood and fodder collection, all households should be addressed, and women in particular. For other non-timber forest products, households with lower income should be given priority. Socio-economic and infrastructural contexts at both the inter- and intra-village level are important to understand the benefits local communities obtain from natural forests.



Chapter 6
A Synthesis

Hawa Kaisi Mushi

6.1 Synthesis

This section delivers a general discussion of results from Chapter **2**, **3** and **4** by highlighting the key issues and conclusions. It also describes the implications of the key findings of the study and recommends areas for further research. The focus is mostly on the linkages between agricultural land use, the current forest use issues as well as land degradation aftermath. It evaluates the feedbacks of changes and addresses the linkages between biodiversity and land degradation.

In this thesis, the concept of ecosystem services is described in connection with peoples' dependence on it. The major livelihood dependence on ecosystems being agriculture for food and forests for energy and animal fodder. The agricultural system (through cultivation) and forest use (harvesting of forest products) is responsible for land use change. This whole concept describes the human-nature relationship, which reconnects society to ecosystems. It emphasizes human dependence on nature but at the same time exposing the harmful nature of humans towards the environment. The dependent relationship between human communities and forest ecosystems is very clear. However, this relationship does not always respect the resilience and carrying capacity limits of these ecosystems, which places the delivery of essential ecosystem services in risk. Problems of soil exhaustion, water pollution, deforestation and environmental degradation arises which threatens the ecosystem integrity. This Synthesis is led by the following specific questions:

(i) What is the justification for the selection of the study villages?

(ii) What is the relationship between forest use and land use: what is the most influencing factor for forest use?

(iii) What are the effects of land use on land and water degradation: how are farmers affected?

(iv) What are the linkages between land degradation and poverty?

6.1.1 Justification for the selection of the Study Villages

A total of six villages was selected covering different ecological and altitudinal zones. Two villages were selected in a lowland zone of extensive livestock farming and open crop fields,

with remnant bush land patches in villages of Wari and Nshara. Midlands maize-bean belt which is a mosaic of home gardens and open fields, with few bush land patches interspersed between in villages of Shari and Nkuu-Ndoo, and a highland traditional Chagga home garden area dominated by coffee and banana, with many large trees in villages of Foo and Nronga. The lowlands zone extends up to about 900 m, midlands up to 1200 m and the home garden area to about 1800 m above sea level, up to the lower forest boundary. This was meant to provide a diversification and a comparative study on the different land use types, people's livelihood options and different ecosystem's services accrued from the natural ecosystems such as food, fodder, medicinal supplements etc. (see **Figure 2.1** in Chapter 2).This study can prove that gender, age and distance to the forest were the most coherent variables for the explanation for forest use as well as land use change and agricultural land use. For future studies more variables and a bigger sample could be studied to involve more studies. The choice of transects was not very helpful in showing differences in responses because major differences exists among villages and not along villages along different altitudes.

Table 6.1: Means of socio–economic parameters per village.

Abbreviations: DF: distance to forest [km], Gender: proportion of males interviewed, Age: age of interviewed persons (years), HI: household income of interviewed persons [Tanzanian Shilling], HS: household size of interviewed persons [household], TL: total land owned by interviewed persons [acres], TLC: total land cultivated by interviewed persons

	Village	DF	Gender	Age	HS	HI	TL	TLC
Banana-coffee home-gardens (highlands)	Foo	2.5	0.29	45.13	5.11	613333	3.10	4.22
	Nronga	2.5	0.13	42.07	4.22	590217	2.16	3.72
Maize-bean belt (Mid-lands)	Shari	1.5	1.00	40.68	4.72	575000	2.67	3.97
	Nkuundoo	1	0.68	39.56	4.80	610975	2.80	4.14
Livestock-open crop belt (lowlands)	Wari	1.2	0.82	38.48	4.98	480681	2.56	4.03
	Nshara	1	0.43	41.30	4.83	566666	2.58	3.93
All villages		1.6	0.54	41.24	4.78	571884	2.64	3.99

The Chagga community is very homogenous in terms of socio-economic indicators. (see **Table 6.1** above). The income earned by all respondents did not differ a lot and so is the land owned as well as the total land cultivated. The most outstanding difference is the distance to the main forest where forest resources were collected. The distance was estimated from the centre of the village to the closest forest where forest products were collected. To most villages it was the KINAPA forest but to some villages (Nshara and Wari) it was the closest community forests or gorges with forests. In either case these forests had some form of restrictions that were known to the villagers. Despite this homogeneity in economy and other social variables there were other differences in response to frequency of harvesting forest products: as well as differences in perceptions as far as the state of natural resources is concerned. This is discussed in detail in the following sub-sections.

6.1.2 The relationship between forest and land use and determining the most influencing factor for both uses

Clearing the natural forest in most parts of the upper zones for various forest products (see **Chapter 5**), crop cultivation involving massive amounts of artificial fertilizers and grazing has contributed significantly to general land degradation. It has reduced levels of important soil nutrients like potassium, phosphorous and nitrogen. Reduction in soil nutrients and acidification has forced farmers to abandon their fields and have converted them into woodlots dominated with *Eucalyptus* spp., usually planted for the purpose of demarcating field plot boundaries and to provide shade to coffee plants. The majority of respondents reported to have noticed land use changes caused by different environmental, social, economic, political and infrastructural developments. These changes were accompanied by massive deforestation turning forested areas into farming lands. In turn this has resulted into soil exhaustion, decrease in water quality and quantity, food insecurity etc. This has had an impact in the biophysical environment. It was also reported that, there is a major decrease in the natural vegetation now compared to 10 years ago and this has greatly affected the availability of water (see **Chapter 4).**

The trends of households' forest resources extraction shows a lack of compliance to the forest protection laws in the area. With exception of the few households who extracted from private forests. Awareness of forest rules and exceptions was high, but peoples' needs for various

NTFPs are also high. Some products were highly extracted as compared to others due to them being used on a daily basis such as firewood and fodder. While medicinal plants and fruits and vegetables were collected as much. These changes occur especially in low altitudes especially when villagers convert land for various purposes. In most cases, forest areas are turned into more open landscapes by burning, or clearing areas for cultivation. But in other cases for settlement (see more on **Chapter 5).** These changes are highlighted because they represent the largest impacts that people have on the land.

Findings in **Chapter 4** indicate that the most influencing factor for land use change responses was education, showing a less educated population and a more educated population responding differently to the effects of land use change. The comparison among all factors that support land use change was found to not vary at all zones. On the other hand a comparison in grass species cover between different land uses in the middle and lower elevation zones was found to vary in some areas while in others there was no variation. This difference in distribution and cover of plant species could be due to variation in production systems and land use intensities between study sites.

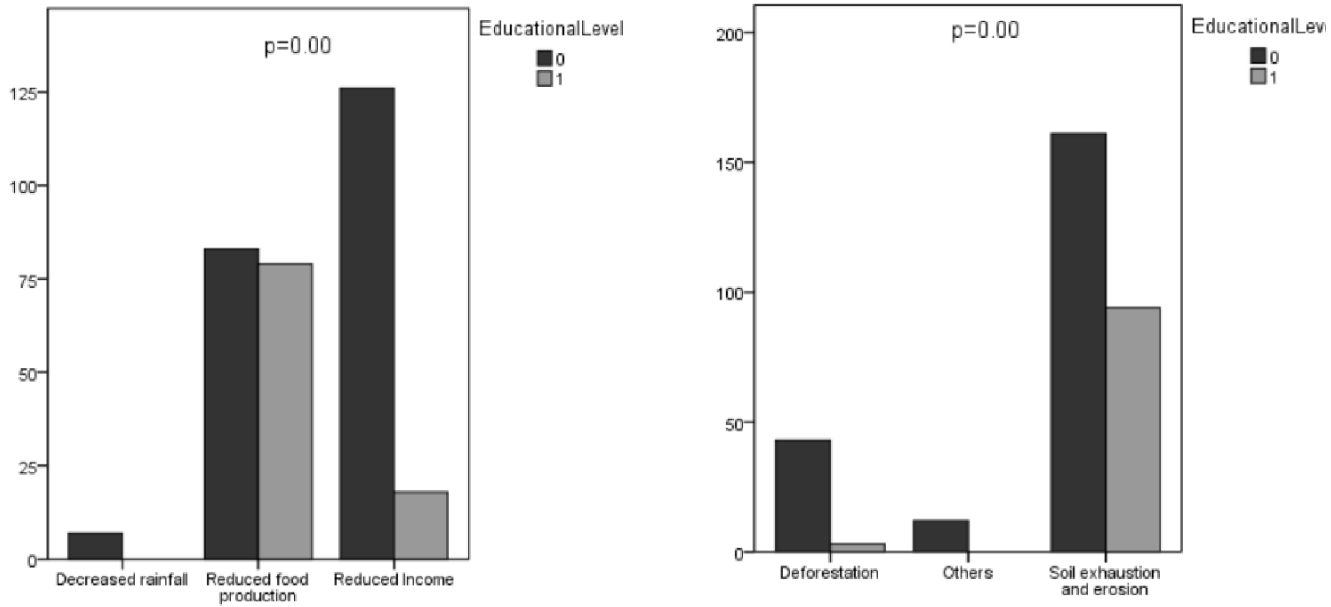


Figure 6.1: Contribution of Land Use Change to the physical and socio-economic environment based on Education levels

Abbreviations: 0=Primary school level: 1= Secondary school level and above

As far as the effects of land use change to the socio economic environment (see **Table 6.1**) less educated people were more concerned with reduced income and reduced food production. People with a higher education opted for reduced rainfall. On the other hand, there have been effects on the physical environment with less educated people commenting on soil exhaustion, probably because they depends more on agriculture than the educated persons (also see **Figure 6.1**).

6.1.3 Effects of land use on Land and Water

Agriculture remains an important livelihood strategy to majority of households in the study area: therefore, to achieve sustainable livelihood strategies, cultivation lands should be maintained. But at the same time, crop cultivation depends on rainfall to a larger extent. In a Chagga society where the study was conducted, animal husbandry is dominant where animals are kept in house. In this case the keeping of animals maintains native vegetation more effectively than crop cultivation. The type of agriculture conducted involved modern farming techniques. These include the use of artificial fertilizers, pesticides, herbicides etc. see **Chapter 3**. It is only in a few cases where traditional ways of farming are used like the use of animal manure and natural pesticides. In the process of expanding more croplands soil fertility and moisture drops and the soils erode more easily. Farmers who grow many crops on the same field conserve native plant species better than those who grow only one crop. This is because increased crop diversity encourages regeneration of indigenous plant species. Most farmers' combine livestock rearing with cropping and use livestock manure to replenish soil nutrients in their farms (this is the case in highlands) and are thus able to maintain higher productivity. Farming in grasslands and woodlands (this is the case in low lands) areas where there are fewer trees, increases the diversity of habitats due to introduction of agro systems that attract new species of birds. However, if the farming is intensified and the diversity of habitats is reduced biodiversity is also reduced. The use of artificial fertilizers and pesticides (more especially in lower altitudes) has been happening for a long time, the interviewed population has perceived a remarkable decline in soil nutrients (also described as a decline in soil productivity) due to deterioration of chemical, physical and biological properties of the soil. The main reasons for the decline, besides soil erosion, are: i) Decline in organic matter ii) Degradation of soil structure iii) Reduction in availability of major nutrients like Nitrogen (N), Potassium (K) and

Phosphorous (P) iii) Increased toxicity, due to acidification. The decline in soil productivity in most cultivated soils has led to decline in yields. This decline in yield has in turn led to heavy dependence on forests for supplementary income which in turn has contributed to forest erosion.

In the lower zone of slopes of Mount Kilimanjaro in Tanzania, there is a marked regeneration in soil organic carbon in soils under pasture and maize/bean cropping, respectively, due to application of animal manure. The ability of farmers to combine livestock rearing with cropping activities is important to increase manure availability. In order to increase farm incomes, intensification and diversification of crop enterprises is very important due to small land holdings in some of these areas. Respondents were asked to compare the changes on water status in their villages, from 1960s to the time when the interviews were conducted (2014). The majority of respondents reported a declining water trend indicating major causes to be deforestation and unsustainable farming practices. Also the present irrigation system has led to increasing competition over water resources among users especially in lowlands. The production has been decreasing especially on major crops like maize, beans and bananas whose growth depends on timed rainfall. In some households, there has been a change in crops grown for at least the past 5 years. Some crops, like millet have been abandoned due to drought. At the same time, some new varieties of drought resistant and highly marketable crops like vanilla have been adopted. Some new maize varieties have also been adopted: these only require three months to mature and don't require a lot of rainfall.

Also in this study: analysis on six villages was conducted differentiating them by two different transects based only on altitude. Three groups of villages were obtained. Perceptions on status of water availability and quality in the upper most villages, mid villages and lower villages did not differ a lot. Findings indicate that the quantity of water has decreased in villages at all altitude levels (see **Figure 6.2**). What is interesting is that villages in the lower altitude also named as the livestock open crop belt indicated the colour of water to have changed. This indicates a form of water pollution which could be because of a high number of artificial fertilizers, pesticides, herbicides and other water uses coming from the upper transects.

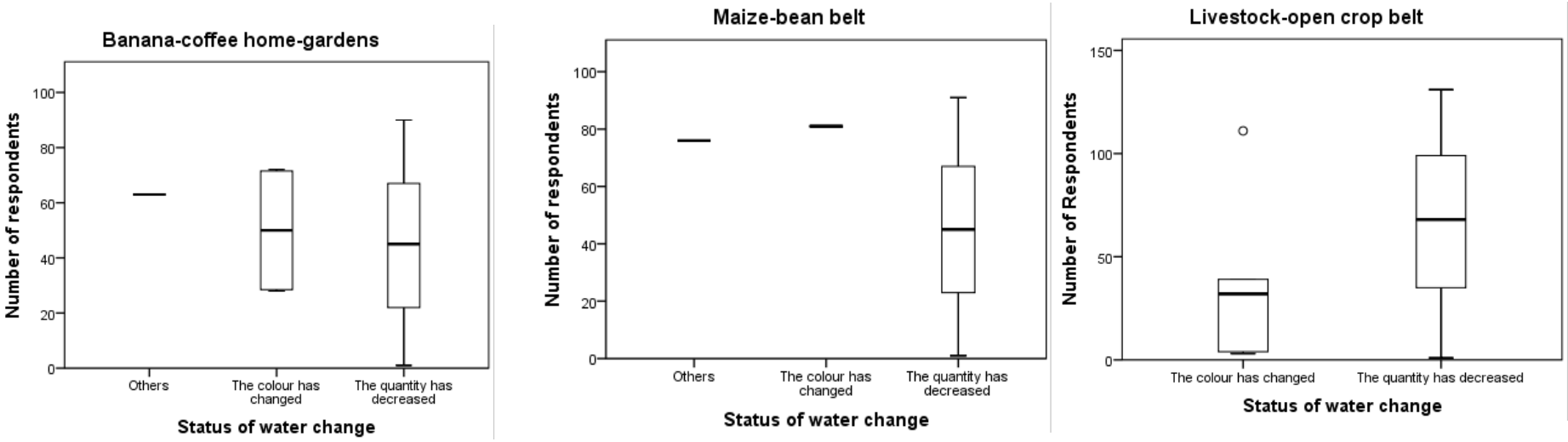


Figure 6.2: Water perceptions based on high altitude, mid altitude and low-altitude villages

As we have seen in **Chapter 4**, Land use changes have appeared in various forms and have transformed land cover to farmlands, grazing lands and human settlements all at the expense of natural vegetation. These changes are associated with forest activities through deforestation for firewood, collection of fodder, fruits and vegetables and medicinal plant, as discussed in **Chapter 5**. In turn, land cover change had manifested itself into biodiversity loss and land degradation all in forms of soil exhaustion, water pollution and decline in forest cover. This reveals the linkages between land use change, agricultural activities, and biodiversity loss and land degradation. In the process of land use change it is indicated that native vegetation and plant cover are lost.

6.1.4 Linkages between land degradation and poverty

Land degradation is defined as the long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided (Bai *et al*, 2008). In our study case this means a loss of soil nutrients that causes the land to be unable to support crop production as before. It normally occurs slowly and cumulatively and has long lasting impacts on rural people. The impacts of land degradation include a reduction in crop and pasture productivity, also fuel-wood and non-timber forest products, which are closely linked to poverty and food insecurity. The damage to soil, loss of habitat and water shortages reduce biodiversity and ecosystem services and have economic consequences. The result is a loss of land productivity with impacts on livelihoods and the economy. The bigger question was, are there linkages between land degradation and poverty? It was important to know whether respondents in various villages respondent differently about this. Associations were made to see if there is a relationship between responses to land degradation perceptions and the level of income. (see **Figure 6.3**).

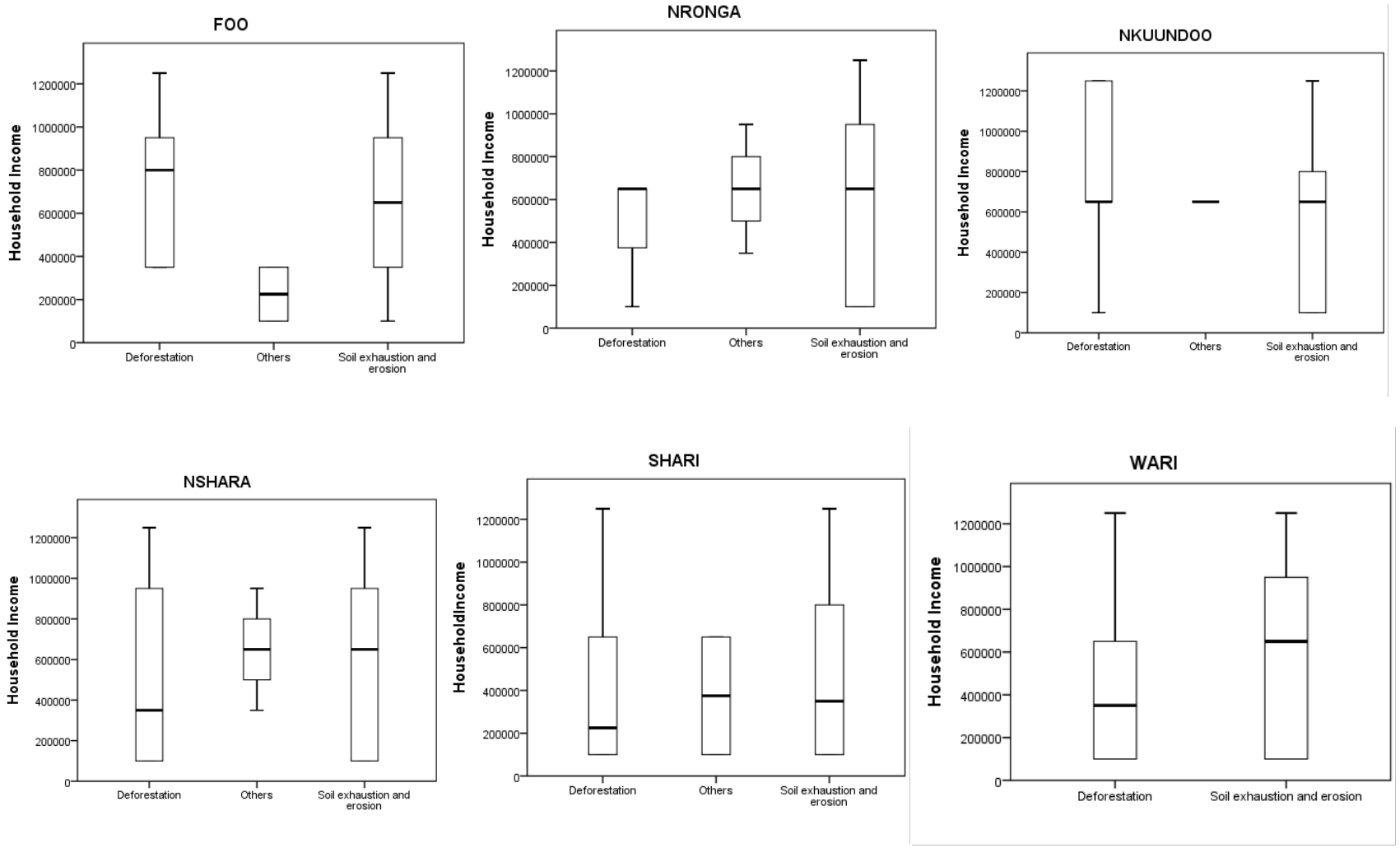


Figure 6.3: Contribution of Land use change to degradation based on levels of Income.

Findings on the contribution of land use to degradation in all six study showed that: a larger percentage of the respondents indicated soil erosion and exhaustion as a problem, especially the mid-income people. (see **Figure 6.3**). This could be because the majority of the respondents are farmers and land is the most valuable asset they have. In villages of Foo and Nronga, which lies right at the border of the larger forest which is part of the KINAPA: deforestation ranked high as well. This could be because regardless of income levels these two villages depend entirely on the forests especially for energy needs. All in all income levels did not influence so much the perceptions on land degradation, this could be simply because in these villages income levels are almost homogeneous.

6.2 General conclusions

Some of the recommendations provided are policy-related while others suggest further research. This thesis has produced a comprehensive information about the dynamics in forest and land use in the area. The study has established the link between peoples' perceptions versus real socio-economic situations present in the study villages. It also highlighted the extent of forest extraction and factors for such. The study also examined the how the expansion of forest land into cultivation and grazing land could affect land use change. In concluding the interpretation of the findings of this study, the methods were effective but further steps are suggested:

(i) Harnessing the local knowledge and integrating it with scientific information is crucial for understanding ecosystems dynamics in a holistic way.

(ii) Farmers need to devote more efforts in being more self-sufficient e.g., in firewood and fodder production, growing their own timber and medicinal trees.

(iii) Observation has shown that there is passive control over which resources are allowed to be extracted especially at the former half mile strip/lower montane forest. But this has not stopped the villagers from extracting common everyday needs like firewood, poles and animal fodder into the forest. As a result of these activities part of the lower montane forest has some patches of harnessed and unharnessed trees. The effect of this

massive deforestation has led to severe and soil erosion and exhaustion and the decrease in water quantity. One of the key informants stated that "water for the cultivation is more important than the forest products we obtain from the forest".

(iv) In all villages surveyed, land is acquired mainly through inheritance, which leads into land fragmentation, intensification and decline in land productivity. Increased migration into the lowlands is inserting pressure on natural resources resulting in cultivation replacing livestock keeping and land shortage as the case for the highlands. In both uplands and lowlands, more than 50% of households own less than 2 acres of land (see more on **Chapter 3**). This adds more pressure to the available resources because the number of people does not match the technology and natural resources available for use.

(v) The major consequence of the rapid population growth has been dwindling natural resources. As a result, the same process of land fragmentation is evident in the plains. It is recommended that, policies should aim at introducing alternative livelihoods that would draw people away from complete dependence on working on land.

6.3 Recommendations

In the light of the above findings, some recommendations can be made. Tanzania as a country is endowed with many natural resources and most of its people depend on them. This leads to the increasing rate of deforestation, land and forest degradation which is alarming. While this provides clear picture of the need to take immediate action to address these issues, we must also understand that people are in desperate need to use these resources because of limited energy and food options. Forested land is constantly being encroached upon and converted into agricultural land and other uses, posing a serious challenge to its sustainable resources management. But better plans needs to be in place for a conducive and effective engagement of the locals in environmental management plans. These should include:

(i) Local authorities should facilitate tree planting on home gardens, also encourage the use of energy saving stoves to reduce their energy dependency on the forest. This will facilitate forest restoration and reduce forest dependence.

(ii) Some of the money anticipated from the Kilimanjaro National Park (KINAPA) should also be used to finance various income generating activities such as beekeeping, mushroom farming and agro-forestry to compensate the villagers for the reduced access to forests. This could help to alleviate poverty in long run.

(iii) Environmental trainings should be extended to villagers. It also important that all the villagers receive training in order to be able to participate in forest management and conservation. Although there may not be enough resources to train all community members, it would crucial to ensure that those who receive training related to forest management and related trainings would share their knowledge with the rest of the villagers.

(iv) Formation of extensive network of experienced local forest management institutions and a supportive legal and policy framework for the devolution of forest management: strong ongoing donor support for initiatives in the forestry sector: significant biophysical potential for reducing deforestation, growing experience and capacity in measuring and monitoring forest carbon stocks and significant opportunities for reducing poverty and strengthening livelihood resilience and preserving biodiversity.

(v) Last but not least, much more research is required to better understand the nexus between livelihoods and forests, and the specific forces driving deforestation and degradation.

Future research should focus on the following:

(i) Research on gender issues will be very important. This is because forest rules impose additional restrictions in accessing forests among community members. These restrictions are likely to affect men and women differently. Therefore further research is recommended to explore how these bi-laws affect the gender situation.

(ii) Research on climate change and its extremes is also crucial. The community is aware of the changing climate indicating mainly extreme weather conditions. It

would be interesting to learn about impacts and perceptions of the people on climate change.

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Appendices

Checklist for focus group discussion

Elderly people who have lived in the village for at least 20 years

A. Rainfall and Drought

Tell me your perception about climate i.e. rainfall, temperature etc.

1. What is the trend of rainfall during the last 20 years?

2. When did you have unusual rainfall/drought events?

3. What coping Strategies in place in case of drought or excessive rainfall?

4. How do you deal with inter-seasonal dry spell especially during January and February?

5. What is the condition of water sources now compared to 20 years ago?

B. Crops and its biodiversity

1. What are the Crops grown in the area?

2. What are the Crops used to be grown but no longer existing?

3. What are the reasons of extinction of such crops?

4. What are the recently established crops?

4. What are the reasons for their adoption?

6. What is the production trend of key crops in the last 20 years?

C. Growing Season

1. What are the growing seasons during the last 20 years?

2. When did you use to plant and harvest?

3. Is there any change on plants and harvest dates? 4. What might be the reason for any change? E. Information and Communication

1. How do you access to information on weather?

2. Have you received any information on climate change in your village?

3. Have you received any information on drought or flood before they occur? If yes who provided that information?

Checklist for Village Chairmen, Village Executive Officers and Village Natural Resources Committee Members

Location Village: Ward: ---------- Division: ----------

District Date of interview: ----------

GENERAL INFORMATION

1. How many households does the village have?
2. Is the number of people increasing or decreasing in the village?
3. If it's increasing, why? And can it be affecting the resource extraction?
4. If it's decreasing, why?
5. What are the main economic activities of the village?
6. How important is agriculture compared to other economic activities?
7. What is the level of dependence on agriculture for the people of the village?
8. How dependent is the community to the natural ecosystem for their livelihood?
9. How many forests are present in the village and are owned by the village or government currently?
10. Have you ever experienced forest fires?
11. Do you think Climate is affecting the natural resources/peoples livelihoods? How?

WATER RESOURCES

1. Is the current state of water resources (improving or Worsening/deteriorating) why?
2. How do you compare the state of water quantity/supply) during these period

(i) 1971-1980 (ii) 1981-1990 (iii) 1991-2000 (iv) 2001-2009

(v) 2011 to the present?

3. Is there relationship between the influx of migrants and changes in water resources in your area?
4. Are the current land use patterns affecting water management/conservation in the basin? How?
5. In your opinion, what do you think will be the impact of increasing influx of immigrants under the changing climate on sustainability of water resources in the village?

LAND RESOURCE

1. Are there changes in land uses in the village due to influx of migrants?
2. What are the problems associated with land use changes on land resources in the village?
3. What plans exist to minimize current impacts of rapid population growth?
4. What do you think hinders sustainable management of land resources?
5. What should be done to improve productivity of the deteriorated land resources?

NATURAL VEGETATION AND FORESTRY RESOURCES

1. Are there land uses changes related to human activities that have affected natural vegetation in the village? If yes, how?

2. How is the community involved in conservation of natural forest/vegetation resources?

4. If yes what types of plants have been disappearing from your village?

5. When do you think degradation of natural forest/vegetation resource was severe in your village and why?

6. What are the strategies to facilitate forest resources management at village /district level?

7. What policies, laws, legislation, by laws and programs that guide utilisation of vegetation/forests in your area?

Household questionnaire

INTRODUCTION

This study is an assessment of the Implications of Land Cover Changes on Community Livelihoods along the Slopes of Mt. Kilimanjaro in the Changing Climate. The general objective of this study is to establish how communities on the slopes of Mt. Kilimanjaro depend on the natural ecosystems for their livelihoods under the changing climate.The study's foundation is laid by recent reports on dwindling of the natural resource base due to population increase and associated resources over-extraction, and partly due to the effect of the changing climate. Natural resources under focus in this study are forest products both in the upper forest as well as in the savanna, water resource, and land. The study will be implemented in six villages of Foo, Nkuu-Ndoo, Wari, Shari, Nshara and Nronga between late 2013 and April 2014.

BACKGROUND INFORMATION OF HOUSEHOLD HEAD INTERVIEWERS START BY CLARIFYING THE OBJECTIVE OF THE RESEARCH, AND REASSURING THE RESPONDENT THAT ALL INFORMATION THEY PROVIDE WILL BE STRICTLY CONFIDENTIAL AND WILL NOT BE USED AGAINST THEM AND THAT THEY SHOULD FEEL FREE TO TALK ABOUT THE FOREST AND BENEFITS DERIVED FROM IT EVEN THOSE THAT ARE ILLEGAL, LAND USES AND USERS ETC…

Appendices

A: LOCATION

Village ---------- Ward ----------

Division---------- District ---------- Region ----------

B: BACKGROUND INFORMATION OF HOUSEHOLD HEAD

1. Sex

1.1 Male---------- 1.2 Female---------- 1.3 Name ----------

2. Age---------- (years)

5. For how long have you been staying in the village (years) ----------

6. If you were not born in this village when did you move in? ----------

7. What was the main reason for your migration to this area?

(1)Search for grazing land (2) Agriculture. (3)Trade on agricultural crops

(4) Availability of water. (5) Search for employment

(6) Marriage. (7) Follow relatives (8) Government policies/resettlement programs

8. What ethnicity are you? ----------

9. Marital status

8.1 Single------- 8.2 Married------8.3 Divorced-------- 8.4 Widow------- 8.5 Widower----

9. How many people are living in this household? ----------

10. Education level

10.1 Non formal -------10.2 Primary education --------- 10.3 Secondary education --------

10.4 Tertiary education------- 10.5 others ----------

11. Occupation

11.1 Primary occupation---------- 11.2 Secondary occupation----------

-

C. THE STATE OF LAND IN THE VILLAGE

12. What are your household income generating activities and time spent everyday

Type of crop	Time spent (in hrs.)	Rank
Crop farming Livestock keeping Beekeeping Selling building poles Charcoal burning Business/shop/ tailoring. Fire wood selling Tourism Formal employment Others		

13. How many acres of land do you cultivate each year? ……

14. How many acres of land do you own in total? (1) 1≤ Acres---- (2) 5 ≥ 10Acres---- (3) 10 ≥ 20 Acres -------(4) 20 ≥ 50 Acres -------(5) Above 50 Acres--

15. How did you acquire your piece of land?

(1) Bought ---- (2) Inheritance ---- (3) Rent ----- (4) Others------

16. What kind of crops do you grow? Where do you grow? and how much do you get?

Type of crops	Where grown?		Farm size (acreage)	Average yield/acre	Market value	Total income
	Upland	Lowland				

15. What are the type of crops are grown/cultivation practices?

Crop	Cultivation Practices (traditional/modern methods)	Use of inputs	
		Fertilizer (types)	Pesticides (types)

15. If you use the above pesticides and/ or herbicides in your farms, how often do you 1apply them?

Type of pesticide/Herbicide	Frequency (per month)	Quantity (per kilo)

D: IMPACT OF LAND USE CHANGE ON SOCIO-ECONOMIC ENVIRONMENT

16. Do you notice any changes in land use now compared to 5 years ago?

Yes ---------- (2) No ----------

16.1 If yes, can you elaborate why?

17. Has land use change affected socio-economic status of the people in your village?

(1) Yes (2) No

18. To what extent Land use change has contributed to Socio-economic environment?

(1) Income generation. (2) Reduced poverty. (3) Employment creation. (4) Growth of market.

(5) Improved living standard (6) Improved education (7) Improved health (8) Others

(7) Development of tourism. (8) Improved social services. (9) Increased food production

19. What are the negative consequences of Land use change on Socio-economic environment in the area?

(1) Increase in human population/Livestock. (2) Increased pressure on resource use

(3) Shortage of farm/arable land. (4) Shortage of water for different uses

(5) Conflicts over resource use (6) Affected life style of hunting society

(7) Shortage of fuel wood. (8) Growth of market for commercial crops and other items

(9) Increase in intense agricultural activities (10) Others

E. IMPACT OF LAND USE CHANGES ON BIOPHYSICAL ENVIRONMENT

20. How is the state of biophysical environment in relation to changes in land use in the village?

(1) Has changed. (2) No change. (3) Not aware.

21. How has land use changes contributed to Land degradation in your village?

(1) Soil exhaustion

(2) Soil erosion

(3) Pollution

(4) Others

---

22. What could indicate that land biodiversity has been adversely affected by changes in land use?

(1) Crop failure

(2) Decrease in water quality

(3) Unreliable rainfall

(4) Others

-

23. Are there impact of land use changes on Natural vegetation in your area?

(1) Yes---------- (2) No----------

If yes in 23above, how was the impact for the periods in the table below?

Time Frame	Vegetation status
1960-1970	1. Increasing. 2. Decreasing. 3. No change
1971-1980	1. Increasing. 2. Decreasing. 3. No change
1981-1990	1. Increasing. 2. Decreasing. 3. No change
1991-2000	1. Increasing. 2. Decreasing. 3. No change
2001 -2008	1. Increasing. 2. Decreasing. 3. No change
2009 to the present	1. Increasing. 2. Decreasing. 3. No change

23.1 If the natural vegetation decreases what do you think are the factors for the decrease?

(1) Deforestation

(2) Forest fires

(3) Others

--

24. Has land use changes affected water resource in your village?

1. Yes ---------- 2. No ----------

24.1 If yes in 24 above how do you think water resource has been affected by land use changes?

(1) The quantity has decreased

(2) The colour has changed

(3) Others

---

25. What is the status of water sources (Lake, rivers, streams, and natural springs) in your village?

(1) Increasing. (2) Decreasing. (3) No change.

26. Compare the change of water status at different periods in your village

Status of water	1960-1970	1971-1980	1981-1990	1991-2000	2001 -	2010 to the
Increased/good						
Decreased/worse						
No change						
Not aware						

26.1 In your opinion what do you think is the cause of the declining trend of water?

(1) Expansion of human settlements (2) Unsustainable farming practices

(3) Increased overgrazing practices (4) Unsustainable use of agro-chemicals

(5) Inadequate agricultural extension services (6) Expansion of human settlements

27. Explain the management of water resource in your village?

(1) Well managed

(2) Poorly managed

(3) Better than before

(4) Others

28. What indicates the changes in quantity and quality of water resource?

(1) Conflict among different user groups.

(2) Insufficient supply of water for irrigation.

(3) Change in water allocation and /distribution time table.

(4) Others

29. If water resource is improving, what might have been the reasons?

(1) Sound management practices. (2) Sustainable utilisation.

(3) Low level of environmental Degradation.

(4) Increasing environmental education and awareness.

(5) Others

---

30. What are your perceptions about the management of natural resources in your area? Well managed. (2) Poorly managed. (3) Moderately managed.

30.1What indicates well/positive management of natural resources in your village?

30.2What indicates poor/negative management of natural resources in your village?

---

31. What strategies can be undertaken to manage natural resources under pressure of the fast growing population?

F. COMMUNITY DEPENDENCE ON NATURAL ECOSYSTEMS FOR THEIR LIVELIHOODS

32. What kinds of benefits does the village derive from the natural ecosystem?

32.1Tangible Benefits

Item/Issue/benefits	Frequency (week, month, year)	Tick	Rank
Firewood			
Medicine-medicinal timber			
Fodder			
Wild Vegetable			
Building Poles			
Game meat			
Honey and beeswax			
Thatching grasses			
Wild Fruits			

32.2 Financial Benefits

Item/Issue/benefits	Tick	Rank
Community Development Projects		
Eco-tourism		
Employment		
Revenues		

32.3Environmental Services Benefits

Item/Issue/benefits	Tick	Rank
Micro- Climate Regulation		
Rainfall		
Fresh water supply		
Erosion Control		
Aesthetic values/scenic vistas		
Watershed protection		

32.4Social Benefits

Item/Issue/benefits	Tick	Rank
Improved relationships and networks		
Training and Skills (Political empowerment)		

-Type of training benefited		

G. STAKEHOLDERS PERCEPTION ON SHARING OF ECOSYSTEM BENEFITS

33. What stakeholders are supposed to get shares of the ecosystem benefits (water, land, forest etc.)? ---------- -- ----------

34. Describe how are the benefits distributed among villagers?

---------- ----------

35. Who decides how these benefits should be distributed?

----- ---------- ---------- ----------

36. How do you find the management and distribution of forest income at the village level?

---------- ---------- ----------

37. Is there any criterion used for sharing forest benefits?

1. Yes---------- 2. No ----------

38. If yes, explain ---------- ---

39. If no, why is there no criterion?

---------- ----------

40. What criteria should be considered to ensure proper benefit sharing among the various stakeholders? ---------- ----------

H. THREATS THAT MIGHT UNDERMINE THE REALIZATION OF BENEFITS FROM THE FOREST

41. What are the challenges related to forest benefit sharing?

---

42. What issues need to be addressed to ensure effective benefits sharing is realized for all participating stakeholders? ----------

---

I. COMMUNITY AWARENESS/PERCEPTIONS ON CLIMATE CHANGE AND INDICATORS OF CHANGE

43. What do you understand by the term climate?

(1) Rainfall (1. Yes, 2. No), (2) Temperature (1. Yes2. No)

(3) Humidity (1. Yes, 2. No) (3) Drought (1. Yes2. No)

(4) Wind (1. Yes, 2. No) (5) Clouds (1. Yes2. No)

(6) Others specify (1. Yes, 2. No)

43.1 Are you aware that climate has changed or is changing?

1. Yes ----- 2. No--------

43.2 What is the trend of rainfall during the last 5 years?

(a) Increasing (b) Decreasing (c) Extreme weather (d) No change (e) Do not know

43.3 Have you observed any changes in temperatures during the last 5 years?

1. Yes ---------- 2. No----------

43.3.1 If yes, what kind of changes: 1. Increasing---------- 2. Decreasing ----------

Do not know----------

J. IMPACTS OF CLIMATE CHANGE ON CROP PRODUCTION

44. What crop does your household grow and for what purpose

(a) Maize 1. Food, 2. Cash, 3. Food & Cash, 4. Do not grow

(b)Millet1. Food, 2. Cash, 3. Food & Cash, 4. Do not grow

(c) Rice 1. Food, 2. Cash, 3. Food & Cash, 4. Do not grow

(d) Beans 1. Food, 2. Cash, 3. Food & Cash, 4. Do not grow

(e) Coffee 1. Food, 2. Cash, 3. Food & Cash, 4. Do not grow

(f) Animal fodder 1. Food, 2. Cash, 3. Food & Cash, 4. Do not growth

Other----------

45. Historical patterns of crop production (per acre, during the last 5 years)

(a) Maize 1. Increasing, 2. Decreasing, 3. Fluctuating, 4. Do not know

(b) Sorghum 1. Increasing, 2. Decreasing, 3. Fluctuating, 4. Do not know

(c) Rice 1. Increasing, 2. Decreasing, 3. Fluctuating, 4. Do not know

(d) Beans 1. Increasing, 2. Decreasing, 3. Fluctuating, 4. Do not know

(e) Coffee 1. Increasing, 2. Decreasing, 3. Fluctuating, 4. Do not know

(f) Animal fodder 1. Increasing, 2. Decreasing, 3. Fluctuating, 4. Do not know

(g) Others ----------

46. Has there been any change in types of crop grown by your household for the past 5 years?

1. Yes ---------- 2. No ----------

46.1 If yes, mention the new crops adopted?

1 ---------- 2---------- 3----------

46.1.1Reasons for adopting new crops

1. Drought

2. Market factor

3. Pests and diseases

4. Others----------

46.2 Also, if no, mention the crops abandoned

1---------- 2---------- 3----------

46.2.1 Reasons for abandoning these crops

1. ----------

2. ----------

3. ----------

K. IMPACTS DWINDLING OF NATURAL RESORUCE BASE ON COMMUNITY LIVELIHOOD AND ENVIRONMENT

47. What are the coping and adaptation strategies employed by community due to the fluctuation of the income resulting from dwindling of natural resources?

1. Growing more cash than food crops

2. Charcoal making/Timber

3. Intensive farming

4. Others

--

47.1 Do the above coping and adaptation strategies affect natural resources?

Yes---------- 2) No----------

47.1.1 If yes, please explain how they affect?

1. Land exhaustion

2. Food insecurity

3. Massive deforestation

--

47.1.2 If no, please explain why? ---------- ----------

--

THANK YOU

List of figures

List of tables

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Dedication

I wish to dedicate this work to my late father and mama who unfortunately have not lived to see the fruits of their encouragement and guidance. May God rest their souls in eternal peace.

To the family of Mr. and Mrs. Rengua, words cannot fully describe how thankful I am for you. All your support and efforts in making sure that I live a better life despite my parent's absence are the motivations why I have made it this far in education.

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Are complete and will soon be submitted

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Erklärung

Sehr geehrte Damen und Herren,

hiermit erkläre ich, dass ich die beigefügte Dissertation selbstständig verfasst und keine anderen als die angegebenen Hilfsmittel genutzt habe. Alle wörtlich oder inhaltlich übernommenen Stellen habe ich als solche gekennzeichnet.

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