Institutional and land use dynamics of Chagga homegardens in Kilimanjaro Region, Tanzania

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ABSTRACT

This study examined the dynamics of institutions in managing homegardens and land use changes in the pre- and post-independence Tanzania, specifically by the Chagga people, dwellers of slopes of Mt Kilimanjaro. Socio-economic data were collected using household questionnaires, key informants, checklist and focus group discussions. Spatial data were analyzed by using ERDAS Imagine 2011 and ArcGIS 10.0 software programs. Qualitative and quantitative data were analyzed using content analysis and descriptive statistics respectively. Results indicate a decline in importance of informal institutions due to changes in political landscape from the pre- to the post-independence era. We observed, through land cover change between 1987 and 1995 and between 1995-2013 that the Chagga homegardens declined in size by 70.42%, a trend that is likely to continue. We conclude that changes that have taken place in management of the home gardens is an alarm calling for strategies to protect the traditional agro forestry practices that have contributed significantly to livelihood and food security of the communities. We recommend that homegarden land use systems be identified, protected and promoted to tap the rich indigenous knowledge and skills that were used in balancing and sustaining agricultural production, food and livelihood security with environmental conservation.

INTRODUCTION

Indigenous agroforestry system practiced for many decades have been documented in Tanzania (ICRAF 2011). Some of these land use systems that have drawn scientists' attention include traditional agroforestry system on the slopes of Mt. Kilimanjaro known as Chagga homegardens *(kihamba)* (Soin 2002, Fernandes *et al*. 1984), Mara region homegardens known as *Obohochere* (Kitaly, 2004), Kagera region homegardens known as *Kibanja* (Kitalyi and Soin 2004), and Wasukuma silvopastoral system found in Shinyanga called *Ngitili* (Kamwenda 2002). The common salient feature in all the aforementioned indigenous agro forestry system and their practices is the role of local institutions in managing and sustaining the system through their moral economy.

The Chagga homegarden agroforestry system is a multi-storeyed land use system evolved over several decades through a gradual transformation of the natural forest on the foot slopes of Mount Kilimanjaro. As part of traditional agroforestry system from pre-independence survived to the post-independence era with some changes, is well suited to contribute to the desired outcomes of Tanzanian National Strategy for improved food security, URT 2017. The prime objective for agro forestry research and

development for years has been to increase food production, provide raw materials and raise cash income (O'Kting'ati 1985, Soini 2005, Chamberline and Jayne 2017, URT 2017). Similarly, Chagga homegarden allows farming families the opportunity to integrate trees into their farms, enhancing diversity and increasing overall productivity without taking agricultural land out of production and consequently help to achieve the Millennium Development Goals number 1 and 2 to end extreme poverty in all forms by 2030 and end hunger, achieve food security and improved nutrition and promote sustainable agriculture (UNDP 2020).

Sustainable management of the Chagga homegardens land use system is a major concern because of the diversity of products emanating from it and the impending threats due to increasing human population and other development issues such as infrastructure development. Several key policy aspects and questions about which strategies to pursue for Chagga homegardens development remain unanswered mainly because of inadequate research on the roles of local institutions on performance of the system. On-farm technological options should be supported by local institutional and policy aspects which can provide an enabling environment for the development of Chagga homegardens land use system (ICRAF 2004).

North (1990) defines institutions as formal rules, informal constraints (norms of behaviour, conventions, and self-imposed codes of conduct), imposed by the rules of the game in society. They include any form of constraint that human beings devise to shape human interaction and the interaction with their environment. They comprise of policies, laws, rules regulations, and core values of an organization, operational plans and procedures, incentive mechanisms, accountability mechanisms, norms, traditions, practices, and customs (Mbeyale 2009). Therefore, institutions encourage order in a society by shaping human interaction in social, economic and political life (Farjoun 2002). Institutions are diverse and dynamic. They involve constitutional code, organizational order as well as normative/ customary behavioral changes. Whereas the constitutional order characterizes the rule-making process that includes the making of the national constitution and the related governance framework, the organizational arrangements are determined by the institutional code that is characterized by by-laws, regulations, associations, contracts and conventions that are created within and by the constitutional order (North 1990 and Ostrom 1990). The normative behavioral code, on the other hand, relates to cultural values, customs and norms that legitimize the institutional arrangements and constrains the behavior of individuals and groups in the society.

Institutions play a central role in facilitating livelihood outcomes which include more income, improved well-being, reduced vulnerability, improved food security and more sustainable use of homegarden resources (Carney 1998). Since the Chagga home gardens agroforestry system has been in existence from the pre-independence era, and that there has been several changes from that time to the post-independence time in terms of political organization, government practices, population changes and other changes in the human development it is interesting to examine the institutional changes and the performance of the Chagga home gardens in maintaining such land use that supported local livelihoods from pre-colonial to the present. The study also aimed to trace the institutional changes from pre-independence to the present and evaluating the patterns of land use and cover changes that is attributed to institutional changes. Such is the gap that this study would fill. Specifically, the study aimed to map the institutional dynamics underlying the Chagga home gardens from pre-independence to the post-independence era and to examine the implication of the institutional dynamics on land use and cover

changes within the Chagga home garden areas from 1987 to 2013 in two periods.

Conceptual Framework

The historical, political, economic and biophysical context and trends represent the drivers of change within which local livelihoods and land use practices are nested, and with which livelihoods and land use practices interact through both long-term trends and short-term disturbances (shocks and surprises). The interaction is not a one-way exchange from the macro to the micro level of institutions as indicated by the two-way arrows connecting local livelihoods and land use (Figure 1). Local institutions at various scales mediate the allocation and use of homegarden resources by people. They determine the ways in which the external context and trends influence local livelihoods and therefore patterns of resource use which affects land use changes. Local institutions strengthen and weaken through interactions with factors outside of the local context and are constantly negotiated and readjusted through a process of social learning and adaptation in response to changes in the local environment and through interactions with the wider social-ecological environment.
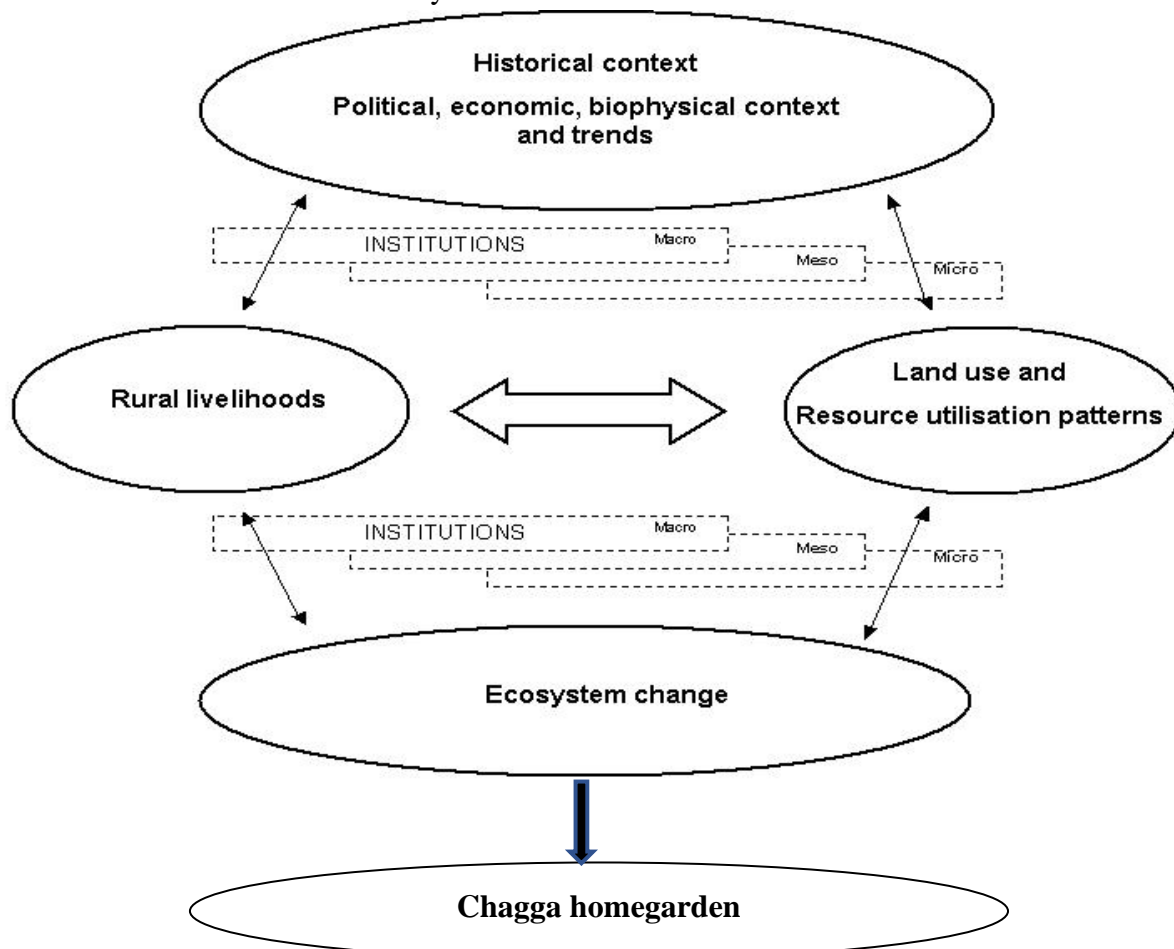

Figure 1: Conceptual framework modified from Cundill (2005).

MATERIAL AND METHODS

Geographical location and demographic

The study was conducted in Tema and Korini Juu villages in Mbokomu Ward in Moshi Rural District, Kilimanjaro Region (Figure

2). Moshi Rural District is between longitude 37° and 38° East and latitude 2°30' and 2°50' South. On the North it borders Rombo District, on the East it borders Kenya on the South it borders Mwanga and Simanjiro districts and to the Western side it borders Hai district. The district is inhabited by 466,737 people of whom 225,767 are males and 240,970 are females with average household size of 4.2, while in Mbokomu ward the population is 14,606 people, of whom 7,036 are males and 7,570 are females with an average household size of 4.1 (Tanzania National Bureau of Statistics 2013).
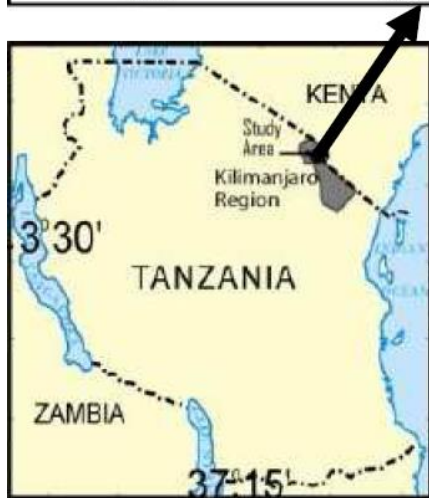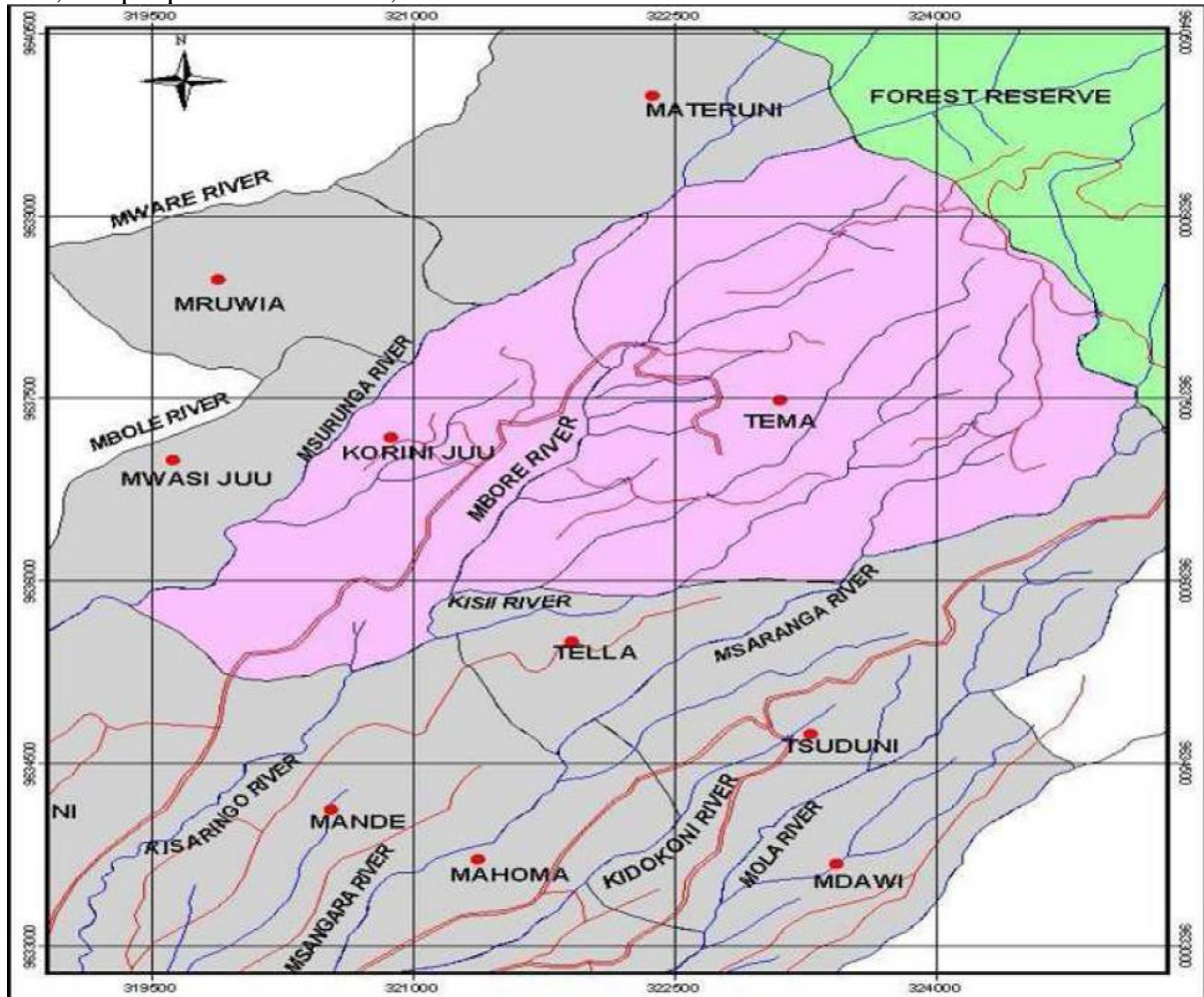
Figure 2: Map of the study Area

Research Design and sampling

A cross-section research design was adopted during data collection whereby data were collected once at a single point in time (Creswell, 2003). A village in the Tanzanian context is considered as the lowest administrative unit and a focal point for any development intervention (Mbeyale, 2009). A household on the other hand is a smallest unit within a village. Two villages namely Tema village and Korini Juu village which are administered in Mbokomu Ward were purposively selected as study area. Selection of the study area was based on various factors but mainly geographical location, economic activities (intensive smallholder production i.e. homegardens) biophysical features i.e. ecological condition, as well as socio-cultural context. Depending on the household population in the selected villages, the study adopted a sample size not less than 30 respondents for the household survey as recommended by Bailey (1994), in which data obtained can be subjected to statistical analysis without difficulties. Households were Randomly selected in each village Based on that, total number of households sampled for the two villages were 90 (35 from Tema and 55 from Korini Juu based on differential population size of two villages)

Data collection

Socio- economic data collection

Both Primary and secondary data were collected. Semi-structured questionnaires were administered to sampled households in the two study villages. Information collected related to local perceptions on institutional roles, homegardens performance, and socio-economic implications. Participatory GIS techniques were also used which combined tools such as sketch maps, GPS, discussions, information exchange, analysis and decision making. Existing data sets and historical records to collect quantitative, qualitative and spatial data through primary and secondary data sources were also used.

Three Focus Group Discussions in each village were conducted with participant blessed with broad knowledge of the subject matter. These included: traditional elders and leaders, home garden farmers with extensive knowledge of the local environment, villagers with long-time residence and history, government extension staff and agricultural officers, retired ex-government leaders with broad knowledge on the environment and history of the area.

Spatial data collection

Landsat TM satellite imageries (Path 167 Row 63) of 1987, 1995 and 2013 covering the study area were downloaded from the U.S. Geological Survey (USGS) website (http://glovis.usgs.gov) and used as the base for describing land use status. The ERDAS Imagine 2011 and ArgGIS 10.0 software were used for all satellite image data visualization and manipulation. Arc catalog were used to visualize the unzipped dataset and Erdas imagine 2011 was used to stack together all seven bands in unzipped dataset in order to have a single image with band combination "1234567" for easy interpretation and manipulation. Then satellite imageries were pre-processed to assist collection of ground truthing information. A geometric correction procedure was used to register each pixel to real world coordinates. In this process images were rectified to a Universal Transverse Mercator (UTM) coordinate system using Erdas imagine analysis software in ArcGIS 10.0 software. The reference system used to geo-reference the image was UTM coordinate system, Zone 37. The imageries were projected to the common coordinate system and resampled to the same spatial resolution. Prior to field

visit, a preliminary land cover map of the study area was produced from image of 2013 to assist ground truthing assessment.

Data Analysis

Historical trend analysis was used to understand how local institutions were working and how their importance has changed overtime. Historical records are well known to provide detailed accounts of resource management strategies, and how they influenced local land use and resource management strategies (Rao and Pant, 2001). The combination of remote sensing data, household survey and participatory GIS research methods was used to understand local land use change (Cousins 1999, Leach and Fairhead 2000, Mertens *et al*. 2000).

Qualitative data was subjected into content analysis. Content analysis is a set of methods for analyzing the symbolic content of any communication. The basic idea as suggested by Singleton *et al*. (1993) is to reduce the total content of communication to some set of categories that represent some characteristics of research interest. According to Kajembe and Luoga (1996), this technique helps the researcher in ascertaining values and attitudes of the respondents thereby generating themes and tendencies. Qualitative information from observation, verbal discussions, reports and other documents were first sorted and summarized, then analysed using content analysis. Data from questionnaires was

summarized and coded. Both descriptive statistics (frequencies, percentages, mean, standard deviation, and cross tabulation) and inferential statistical analyses were applied using computer data processing software i.e., Statistical Package for Social Sciences (SPSS) version 16.0. Findings from the analysis were then presented in the form of tables.

Digital image classification was done by combining both unsupervised and supervised classification. The unsupervised classification was done first followed by supervised classification by using Erdas imagine 2011 software (Mbilinyi 2000). In this study, post-classification change detection approach was used whereby comparison of independently classified land cover maps of 1987, 1995 and 2013 was carried out. By using post-classification change detection approach, the classified imageries of 1987, 1995 and 2013 (in shape-file format) were labeled cover 1987, cover 1995 and cover 2013. The area of change was then extracted through the direct comparison of the classification results (Biging *et al*. 1999). The technique used for change detection was GIS overlay in ARC VIEW (intersect operation) with mathematical algorithm as presented in equations 2 and 3. The output tables were then exported to MS EXCEL and further processed by using pivot table function to summarize the land cover changes.

$$\% Cover\ change_{1987-1995} = \frac{Land\ cover_{1987} - Land\ cover_{1995}}{Land\ cover_{1987}} * 100\% \qquad (1)$$

$$\% Cover\ change_{1995-2013} = \frac{Land\ cover_{1995} - Land\ cover_{2013}}{Land\ cover_{1995}} * 100\% \qquad (2)$$

RESULTS AND DISCUSSION

Pre- and Post-independence Local Institutions Responsible in Managing the Chagga Homegardens

Historically local institutions both formal and informal were important in managing the

Chagga home gardens. Five main local institutions were identified with some having more than one function associated with managing Chagga homegarden. These were leadership, conflict resolution, land and livestock-based, health and beliefs and recreational institutions. Table 1 gives the

summary of pre- and post-independence major local institutions found in the study area.

Table 1: Summary of pre and post-independence local institutions in the study area

S/N	Roles of institutions	Informal	Formal
1	Leadership	Traditional leaders	Local government authorities
2	Conflict resolution	*Mangi* and Council of elders	Sub-village leaders, Village leadership, ward land tribunal, primary court
3	Land management and Livestock-based	Inheritance ownership, Half-sharing of livestock (*kopa ng'ombe/mbuzi lipa ng'ombe/mbuzi*)	Village land committee, Village agriculture extension officer (VAEO) and Village livestock extension officer (VLEO), ward land tribunal
4	Health and Beliefs	Traditional beliefs	Village health committee, Churches
5	Recreational	Traditional dances (*Mtingo*)	Village leadership dealing with sports and culture

Pre- and post-independence leadership institution

Informal and formal leadership

Pre-independence Informal leadership as reflected in Figure 3 consists of traditional leaders. *Mangi* (Chief) who has high status in the traditional belief system and serves as the ultimate authority of the Chagga, he has a territory equivalent to a size of current division. He was supported by sub-chief (*Mlao*) who subordinate to the chief and performing most functions in the absence of *Mangi*. Under him there was *Mchili* who organizing his subjects within a territory size equivalent to a village.
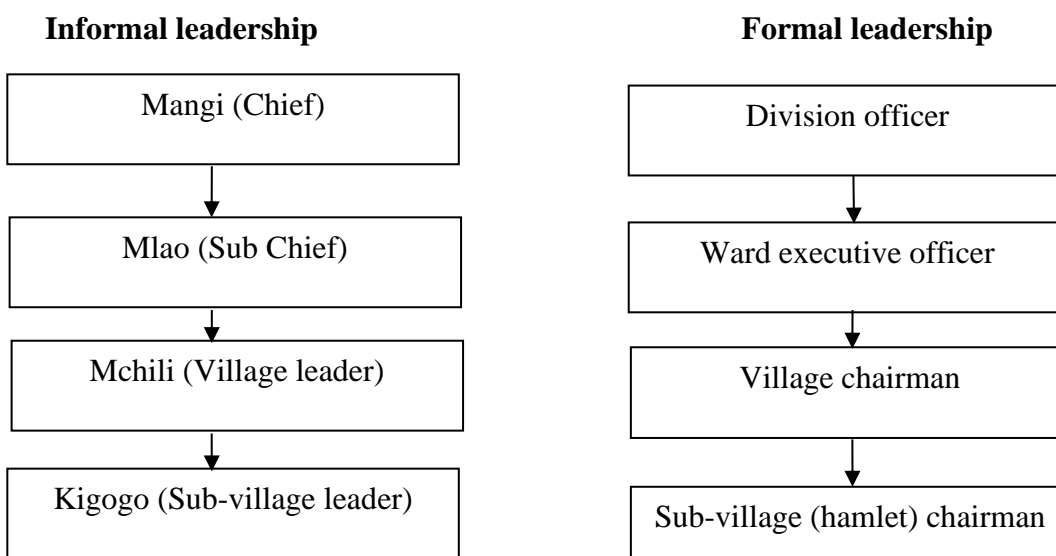
Informal leadership

Formal leadership

Figure 3: Informal and formal leadership institutions at Chagga homegardens

Traditional leaders had powerful influence on their subjects by functioning as diviners, rainmakers and judges. They were also considered as spiritual leaders, integrating spirituality with homegarden resource governance. Through the legitimate powers bestowed on them by the community, social harmony and the spirit of unity were ensured and this could be exploited to include aspects of homegarden management in their

activities. In this case the homegardens were regarded as an important component within the Chagga social, spiritual and economic system and therefore its management was a key aspect in the community. The efficacy of the informal leadership in the study area has been downgraded since when all the chiefdoms were abolished after independence in the 1970s (Mbeyale 2009). Chiefs continued with their roles until the repeal of the African Chiefs Ordinance was repealed in 1963 (Tordoff 1967), after which, their influence became increasingly overshadowed by the Tanganyika African National Union (TANU) political party leadership and the government officers. In the process, the government through Native Authority Act No 32 of 1963, abolished the position and functions of the chiefs, who were considered to be instruments of the colonial administration, most of them became political figures under the then ruling party TANU. At the local level, TANU dismantled the chiefdoms by renaming the chiefdom councils as Divisional committees without altering their territories or composition (TNA 204/NA/8/7). According to Sheridan (2000) TANU and the government completed its takeover of the institutional structure of indirect rule in the study area between June 1962 and August 1963.

Furthermore, the Rural Lands (Planning and utilization) Act, No. 14 of 1973 and the *Ujamaa* Village (village registration, designation and administration) Act No 21 of 1975, were instruments that consolidated powers to the village governments particularly the village councils. The Act increased the tenure security for a village as a corporate entity ignoring informal institutions that operated before. This was also exacerbated by the spread of Christianity and Islamic religions.

Post-independence formal leadership

Local government authority is the formal leadership institution existing in the study area (Figure 3). With reference to the informal leadership the formal leader at the division level is the division officer who is entitled to ensure peace and harmony within the division. The Ward Executive Officer (WEO) is the chief executive officer for a ward. WEO works with Ward Development Committee which consists of the councilor representing the ward, chairmen of all village councils within the ward and a member of the district council. The Village Assembly is the supreme authority on all matters in relation to the affairs of the village. It is responsible for the election of the village council. Ward Development Committee (WDC) is responsible for ensuring the implementation of the decisions and policies of the district council. The Village Council is responsible for making by-laws and ensuring the implementation of the decisions approved by village assembly. It is also responsible for ensuring the implementation of the decisions and policies of the district council brought by WDC. Sub-village (hamlet) consists a number of households headed by sub-village chairman who ensures the implementation of the decisions from village council. In the study area, the district council by-laws on environmental, soil and water conservation that are implemented, on the other hand the Ward Development Committee with the help of government extension officers enforces the practices such as use of terraces in and ridges. Every person on his/her homegarden has to ensure the use of terraces for soil and water conservation. Farmers are not allowed to cut trees nearby water sources.

Conflict resolution institutions

Pre- and post-independence Informal conflict resolution arenas

During the pre-independence era conflicts over management and use of homegarden resources were generally resolved by *Mangi* (Chief) through his subordinate and the council of elders. The council of elders was used by *Mangi* for advice on important issues such as land conflicts and conflicts with neighboring villages. At clan level there was a clan head, who performed roles of

leadership for the clans includes conflict resolution and resource allocation e.g., water distribution for homegarden. A clan head was an overseer of clan ritual places and performs all ritual. The use of *Isale* (*Dracaena fragrans)* plant which was commonly found in the home gardens was one the important symbols of conflict mitigation and resolution.

Formal conflict resolution

In the study area the formal conflict resolution system over management and use of homegarden resources were managed by hamlet chairman on which the failure to reach reconciliation push the matter to the higher levels which are the village land council, ward land tribunal and primary court.

Land and livestock-based institutions

In pre-independence era land was regarded as a Chief's (*Mangi*) property and whoever wanted to use it was required to get a permit from him (Moore, 2011). A village member who wanted to use land was supposed to prepare a gift in form of a goat (*Ndafu*) and tradition drink (*Mbege*) for *Mangi* through *Mchili*. On getting permission to that land *Mchili* with some elders was responsible to put boundaries around the land using a respected leaves *Isale* (*Dracaena fragrans)* highly respected landmarker. From there a land is the property of that member and is free to split among his married sons. *Mchili* was responsible to make sure a given land was developed. Discussion with elders point out some people whose land was taken by *mchili* and given to other needy persons within the clan. During interview it has been found that land was acquire mainly through inheriting, renting and borrowing/contracting as it is shown in Table 2.

Table 2: Land acquisition in the study area

Method of obtain land	Frequency	Percentage
Inheritance	67	89.3
Renting	3	4.0
Borrowing/Contracting	5	6.7

Under inheritance, traditionally a son was to be given land by his father as soon as he marries. The father was responsible for his sons' beginning of his homegarden by identifying his boundaries using respected leaf *Isale* and providing him with some banana, coffee, shading trees and a goat/cow for him to get manure. As the indication of better performance of homegarden a son is responsible for thank giving to his father by preparing a traditional party known as *Kiruhuo mawoko* with drinks prepared from son's farm. This is believed that when the farther is happy for the son's success will enable the continuation of his homegarden performance. At the same time a son has to work hard for the success of his homegarden so as to give a return to his father. Since land size is fixed and the number of people has increased over time in the post-independence era traditional practices of splitting family land among sons has stopped. Most people have either migrated to other areas, rented or borrowed unutilized lands.

Few households are involved in annual land renting arrangements. When long contract is practiced, the renter is motivated to make long-term investments in homegarden management such as soil conservation and tree planting. The short-term contract (annual) discourages farmers from taking long-term land improvements, thus greatly contributing to land degradation. It was observed that the rented homegardens were

not performing well compared to the inherited ones. The reason for the above could be that individual land tenure gives the individual complete rights to use land in whatever way he/she likes. Farmers do not have interest in planting trees on land that belongs to another person. This is because tree-planting is a long-term investment and before the trees mature, the owner might have taken over his/her land. Borrowing/Contracting involves a person transferring land use rights to another person through either cash payments covering a certain period of time or by providing farm production to the owner e.g., a bag of maize harvested from the borrowed plot. This type of arrangement has been in existence from pre-independence time, is commonly practiced by those who own land while they are far away like staying in towns. In order to protect the property rights the owner either hire a person to work on the land or give it to some relative to do so. A homegarden that fall under this institutional arrangement fails to get daily management practice and long-term investment hence suffers land degradation. Agricultural innovations i.e., newly introduced crops (like maize, cassava, sweet potatoes and coffee), inputs and technology led to intensification and expansion of cultivation in the study area. Changing existing indigenous tree species to more valuable or fast-growing trees e.g., *Grevillea robusta, Eucalyptus spp* and *Albizia ssp* is common and typical in the study area. Table 2 show the important tree species found in homegardens.

Table 1: Important tree species in homegardens

Important tree species	Importance	
	Most important%	**Important%**
Grevillea robusta	72.6	27.4
Albizia spp.	34.2	65.8
Persea Americana	63	37
Mangifera indica	36	64
Margaritaria discoidea	48.7	51.3
Olea welwitchii	22	78
Rauvolfia caffra	45	55
Cordia holstii	39	61
Carica papaya	41.8	58.2

Extensionists serve as a catalyst of local innovation and as information "broker" who bring together local and externally derived knowledge in improving agricultural technology. Farmers in the study area claimed that farm extension services were more available and inputs cheaper during the period of socialism in Tanzania (1967-1983) than the present time. Table 3 indicates that only 20% of the respondents have been visited by the extension agents and these agents were more inclined to disseminating information on arable crops under agriculture than on agroforestry.

Table 2: Frequency of visit by extension agent since last three farming years

Extension agent Contact/visit	Frequency	Percentage
Yes	15	20
No	60	80

For livestock-based, farmers have improved cattle especially dairy breeds (*Fresian, Jersey, Ayrshire* and crosses involving these and local breeds) a phenomenon which has become a common trend in the area. Due to land scarcity farmers keep their livestock indoors without ever getting to move freely and get exercise while often animals are kept in small shelters built of poles with an iron sheet roof on top. As farms are small and fodder scarce farmers usually have one or

two goats, some have pigs and few cows which are kept for milk and manure. There is half-sharing of livestock ownership between two individuals or households (e.g. *Kopa mbuzi lipa mbuzi*). The aim was to pool limited resources and own the animals together. The offspring remain the property of the livestock owner while the one managing the animal benefits from milk and manure. Together with those benefit, a first calf belongs to the owner while the second belong to the one managing the animal. Today this is partly done among some households within a clan. This type of institution represents an important social capital with respect to homegarden management. It enables farmers with no livestock to access manure, which is an important ingredient in soil fertility improvement in the homegarden where soil nutrient levels are depreciated.

Health and beliefs institutions

Health institutions for promoting traditional medicine, purification from evil spirits and invoking supernatural powers of traditional spiritual were common during the pre-independence era Clack, (2009) and fading away during the post independence time. Discussion with key informant reveled traditional medicine are still used by individuals and some tree species provide herbal medicine for treatment of various human and livestock diseases are exist. The medicine was extracted without destroying the trees hence conserve tree and land together. Some of medicinal plants include *Itolo* which is used for stomach ache, to get an upset stomachs or diarrhoea; they bite its leaf or drink powder of the dried leaves. In the past people in the study villages used to plant it just around the outer circumference of the traditional house, in order to prevent soil erosion under the basement of buildings in the case of heavy rain, with or without known they preserve soil erosion. *Rumex abyssinicus* (*Ilimilimi*) is used for stomach disorders; *Mnemvu* and *Tabenaemontana pachysiphon* (*Irahacha*) are act as anti-

thrombin hence effective for cut wound for both animal and human. They mush leaf into paste and apply to the affected part. *Todallia asiatica* (*Mkananga*) which used for stomach ache and cancer prevention. *Solanum incanum* (*Ndulele*) and *Vernonia adoensis* used for persistent cough. *Cassia didymobotrya* (*Latangao*) is an ethno-veterinary for treating constipation.

Interview with elders reveled cleansing from evil spirits (*Tambiko*) was done under sacred tree found in home garden known as *Mchihiyo/Loliondo* where the bone of dead person was used to be buried under this tree. This tree is considered as a sacred tree with important religious value including traditional rituals and worship which revered by Chagga people as the tree dwelled by God. The selection of homegarden with sacred tree *Mchihiyo/Loliondo* to perform traditional rituals (*Tambiko*) was done by clan leaders who were believed to be the media through which their god (*Ruwa*) made contact with his people. This place which known as *Mbuonyi* is considered as clan ancestral area/clan where the bone of ancestors and bones of important person of the clan who passed away were buried under the tree. The areas and trees considered sacred are predominant in the agricultural landscape as giant trees, and unauthorized people are not allowed to approach or cut such trees. Most people were afraid going near such places which protected the trees resulting to land conservation. In Tema village *Albizia schimperiana /Gummifera /Lebbeck* (*Muruka*) was the tree adored by Materu clan.

Formal health and beliefs institution in the study area is religions which predominated by the Christianity. Protestants had established missions in the study area together with schools and dispensary which change people from traditional beliefs to new Christian beliefs. Apart from spiritual work the church help beginning of SACCOS, where members contribute a specific amount and been able to borrow some money with

low interest which help in managing homegarden. In Korini Juu village, a church helped the starting up of Mbokomu dairy company which ensures farmers milk market.

Land use changes characterizing the dynamics of the Chagga homegarden

The major land cover classes for 1987, 1995 and 2013 were quantitatively analyzed for the area covered by each land cover categories. For a clear and informative comparison of the land cover change in the study area, area value for the two periods 1987- 1995 and 1995- 2013 for the three thematic maps as shown by Figure 4, 5 and 6 are summarized in Table 4.

Table 4: Mbokomu land cover changes from 1987 to 2013

| Land cover classes | Proportional area coverage in (ha) | | | | | | Cover change | | | |
| | 1987 | | 1995 | | 2013 | | 1987-1995 | | 1995-2013 | |
	(ha)	%	(ha)	%	(ha)	%	(ha)	%	(ha)	%
Settlement	6,697.47	8.89	8,287.09	11	11,541.65	15.32	1597.15	2.12	3247.03	4.31
Riverine vegetation	5,145.53	6.83	6,780.35	9	4,580.50	6.08	203.41	0.27	4105.88	5.45
Mixed cropland	13,990.11	18.57	10,517.07	13.96	16,333.10	21.68	-3480.6	-4.62	5823.56	7.73
Homegarden	15,911.21	21.12	19,150.71	25.42	11,571.79	15.36	2192.31	2.91	-6531.7	-8.67
Agriculture field	8,942.52	11.87	8,309.69	11.03	5,642.75	10.53	-632.83	-0.84	-2666.9	-3.54
Forest	13,063.47	17.34	12,724.45	16.89	14,916.76	16.76	-2139.6	-2.84	-5160.6	-6.85
Bare land	11,586.68	15.38	9,567.82	12.7	10,750.61	14.27	-2019	-2.68	1182.79	1.57
Total	**75,337.17**	**100**	**75,337.17**	**100**	**75,337.17**	**100**				
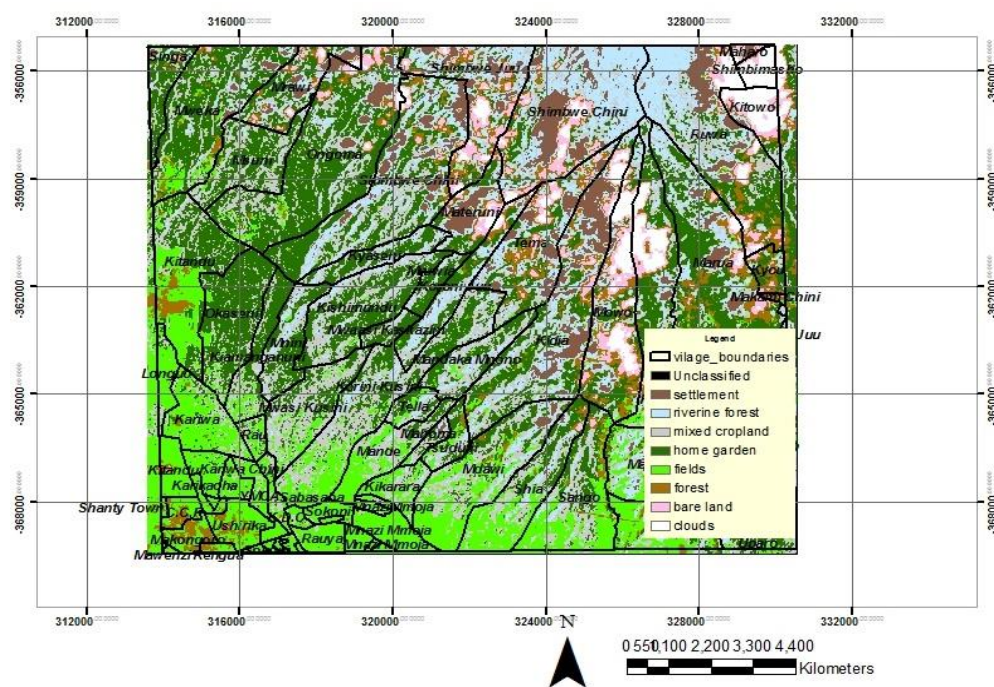
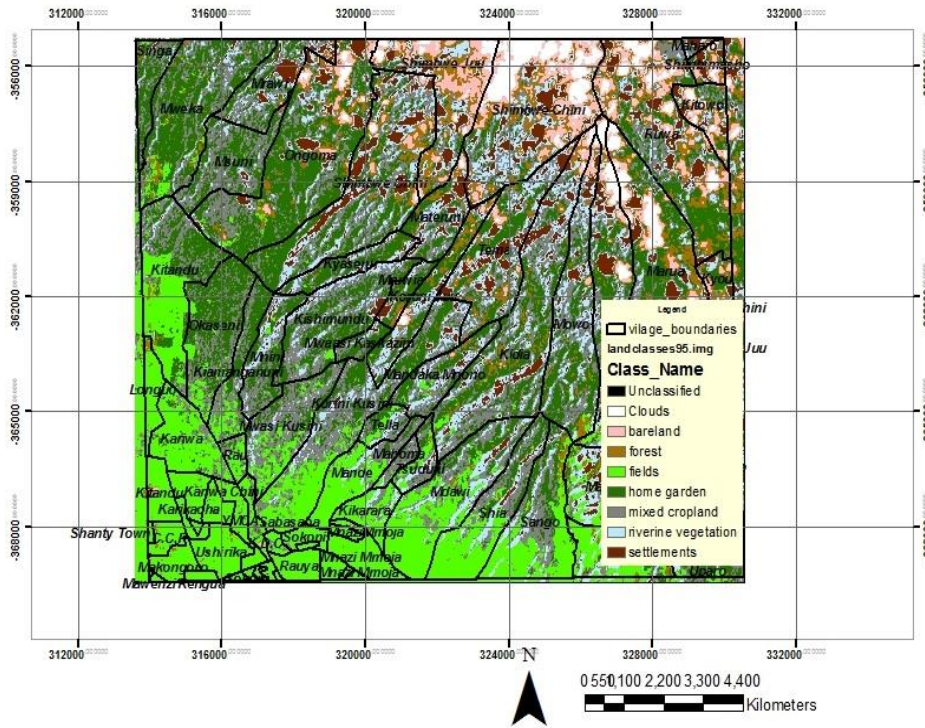**Figure 4: Mbokomu land cover map for the year 1987**

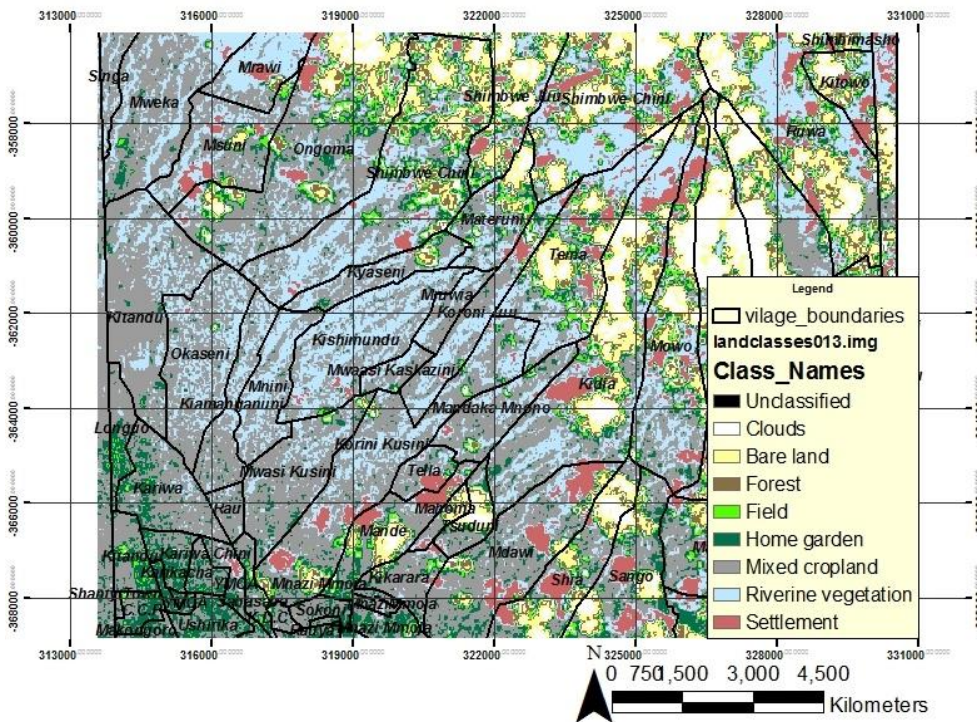**Figure 5: Mbokomu land cover map for the year 1995**

Figure 6: Mbokomu land cover map for the year 2013

Based on Table 4, in the first period (1987 - 1995) settlement, riverine vegetation and homegarden increases by 2.11%, 2.1% and 4.30% respectively, while mixed crops, agriculture field, forest and bare land decreased by 4.61%, 0.84%, 2, 84%, 0.45%

and 2.68% respectively. During the second period (1995 - 2013) settlement increased by 4.32% while forest cover and agriculture field decreased by 0.13% and 0.5%. Moreover, mixed crops and bare land increased by 7.72% and 1.57% respectively while homegarden and riverine decreased by 10.06% and 2.32% respectively.

Post-classification change detection matrix

To assess the change from one date to the other, each raster cell from 1987 was compared with the corresponding cell in the 1995 and the raster cell from 1995 with the corresponding cell in 2013. This procedure creates a table showing the initial value of each cell of 1987 and the final value of each cell of 1995 for the first period. Similarly for the second period the initial value is the 1995 cell value and final value is the 2013 cell value (Table 6 and 7).

A change matrix with initial year data in the rows and the final year data in the columns was created for the two periods (1987 -1995) and (1995 -2013). In the matrix table the class total value of the column indicates the initial stage image total percentage area of each land cover classes and the row total represents the final stage percentage area of land cover classes. Whereas the class change tells the total percentage areas of each land cover classes that were transformed to other land cover type. The image difference is the total net change of the two-time images. The negative image difference indicates a certain land cover is in a state of decrement and the positive value indicates increment.

Change detection between 1987 and 1995

In Table 5, the image difference indicated mixed cropland, agriculture field, forest and bare land decreased by 32.27%, 5.88%, 44.17% and 18.76% respectively. Settlement, riverine vegetation and homegarden land showed an increase of 14.77%, 30.1% and 15.19% respectively. Although 46.54% of the area covered by homegarden in 1987 has not changed, about 32.12% of the total transformation of homegarden cover had occurred to settlement cover due to population increase. Figure 7 indicates the population increase of Moshi rural district from 316 920 people in 1978, 342 553 people in 1988 to 391 281 people in 1995.

Table 5: Change detection matrix of land cover types in Mbokomu between 1987 and 1995 (% ha)

| | Land cover type | 1987 (Initial year) | | | | | | | Row total |
		Settlement	Riverine vegetation	Mixed cropland	Homegarden	Agriculture Field	Forest	Bare land	
1995 (Final year)	**Settlement**	**19.89**	17.83	29.57	32.12	22.87	28.34	26.38	177
	Riverine vegetation	17.89	**15.83**	27.57	30.12	20.87	26.34	24.38	163
	Mixed cropland	22.85	20.79	**32.53**	35.08	25.83	31.3	29.34	197.72
	Homegarden	34.31	32.25	43.99	**46.54**	37.29	42.76	40.8	277.94
	Agriculture field	19.92	17.86	29.6	32.15	**22.9**	28.37	26.41	177.21
	Forest	25.78	23.72	35.46	38.01	28.76	**34.23**	32.27	218.23
	Bare land	21.59	19.53	31.27	33.82	24.57	30.04	**28.08**	188.9
	Class total	162.23	147.81	229.99	247.84	183.09	221.38	207.66	
	Class change	142.34	131.98	197.46	201.3	160.19	187.15	179.58	
	Image difference	14.77	15.19	-32.27	30.1	-5.88	-44.17	-18.76	
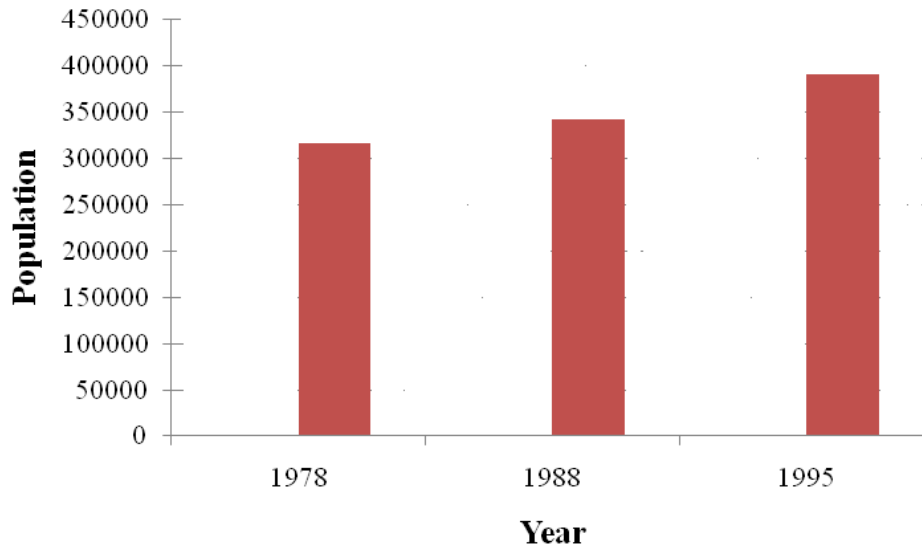
Figure 7: Population trend of Moshi rural district. *Source*: (NBS, 2013).

The other changes of homegarden to other land use type include riverine vegetation 30.12%, mixed cropland 35.08%, agriculture field 32.15%, forest cover 38.01% and bare land 33.82%. It has been revealed that institutional changes are among the factors influencing those land use changes. The establishment of cooperatives during the colonial period, abolition of chiefdoms in 1962, changes of local government authorities (LGAs) in 1972 and their re-establishment in 1982, as well as the abolition of cooperatives in 1976 and their re-establishment in 1984 are among institutional factors mainly related to the above land cover changes as all affected in different way coffee production and marketing the main cash crop from the home gardens. These institutions had been central to the development of the local economy and management of resources. During the colonial period, the traditional rulers (chiefs) were the custodians of natural resources (Clack, 2009). The abolishment of chiefdoms in 1962 changed completely the structure of the local government and land tenure as the traditional rulers no longer had powers or control over the management of the resources. This opened doors for abuse of the resources particularly in the half-mile forest strip on which people in the study area

depend. Its management focus changed from a social to a commercial forest with more trees being cut than planted (as indicated by decreases in forest cover by 44.17% from 1987 to 1995).

On the other hand, the information from former village leaders' show that re-establishment of Local Government Authorities (LGAs) in 1982 facilitated the management of homegarden especially on tree cutting practices and water sources protection. At village level the study prevailing land-based institution was used, where by people used to put up terraces on the steep slopes known as '*Makinga maji*' and this practice was embedded in their farming system. Farmers used to have songs and slogan encouraging each other to make terraces hence conserve soil and sources of water along the slopes. No one was allowed to cut a tree without replacing it by planting another tree. A tree like *Ficus* spp was grown close or along the water sources and in catchment areas. Ever though it was estimated that a Chagga homegarden supplies 1/4 to 1/3 of the fuelwood requirements of a family (Fernandes *et al.,* 1984), a tree like *Grevillea robusta*, was a one of the classical example of an exotic tree introduced for productions of timber and

poles in Chagga homegardens and harvesting were done traditionally through selective wood harvesting that do not involves complete removal of tree cover (OK'tingati and Kessy, 1991) which on turn resulted into an increase in homegarden cover and riverine vegetation cover as reflected in Table 5.

Change detection between 1995 and 2013

The changes detected in this period indicated that homegarden cover decreases by 70.42%

in 1995-2013 as shown in Table 6. The decline in homegarden cover indicates the presence of human disturbances which is the result of an increase in population in Moshi rural from 391281 people in 1995 to 402 431 people in 2000 and then to 466 737 people in 2012 (NBS, 2013). The increase in population results to an increase in settlement cover by 30.24% between 1995 - 2013.

Table 6: Change detection matrix of land cover types in Mbokomu between 1995 and 2013 (ha)

| | Land cover type | 1995 (Initial year) | | | | | | | |
		Settlement	Riverine vegetation	Mixed cropland	Homegarden	Agriculture field	Forest	Bare land	Row Total
2013 (Final year)	**Settlement**	**26.32**	24.32	29.28	40.74	26.35	32.21	28.02	207.24
	Riverine vegetation	17.08	**15.08**	20.04	31.5	17.11	22.97	18.78	142.56
	Mixed cropland	32.68	30.68	**35.64**	47.1	32.71	38.57	34.38	251.76
	Homegarden	26.36	24.36	29.32	**40.78**	26.39	32.25	28.06	207.52
	Agriculture field	21.53	19.53	24.49	35.95	**21.56**	27.42	23.23	173.71
	Forest	27.76	25.76	30.72	42.18	27.79	**33.65**	29.46	217.32
	Bare land	25.27	23.27	28.23	39.69	25.3	31.16	**26.97**	199.89
	Class total	177	163	197.72	277.94	177.21	218.23	188.9	
	Class change	150.68	147.92	162.08	237.16	155.65	184.58	161.93	
	Image difference	**30.24**	**-20.44**	**54.04**	**-70.42**	**-3.5**	**-0.91**	**10.99**	

It was learnt during the visit that due to the decreased productivity and profitability of homegardens, farmers are adopting alternative livelihood options including clearing of shade trees for sale of timber, cultivation of alternative cash crops like Vanilla and organic coffee farming. These resulted in increase in mixed crops cover 54.04% in 1995 - 2013 as indicated in Table 6 above.

Moreover, discussion with elders revealed that there are fewer trees in homegarden than before. In a study to determine the effect of replacing indigenous species with exotic ones, Kisanga (1998) observed that despite some advantages, the introduced tree species have not replaced the total land cover that the natural vegetation covered which has resulted in an increase in bare land by 10.99% between 1995 and 2013.

Cooperatives as formal institutions that facilitate intensification have played a big

role by supporting farmers in terms of making inputs available to them and establishing markets as revealed through discussion with KNCU workers. The cooperatives were able to buy inputs in bulk at subsidized prices from well known suppliers and thus helped to reduce production costs for the coffee growers. They also established reliable markets for their members so as to cushion them in years of low demand. This in turn encouraged farmers to clear more land for planting more coffee trees. However fluctuating coffee prices on the world market and the rise of production costs, have forced many farmers to shift from coffee production to horticultural crop production and other income generating activities (Lambrechts 2004) which resulted in a decrease in homegarden cover by 70.42% between 1995 and 2013.

As land is getting scarcer due to increase in population, even the most marginal land is being brought under cultivation. In many places riverbanks have been cleared to water's edge (Kisanga 1998) and riverine vegetation is in danger of disappearing since it decreased by 20.44% from 1995 to 2013 despite the by-laws. Farmers need to devote their efforts to firewood and fodder production including growing their own timber and medicinal trees. But with limited priority is given to food crops as verified by an increase of mixed crops cover by 54.04% from 1995 to 2013.

The extent of forest coverage on the upper boundary of the study area has remained approximately the same over the study period. This area belongs to the "Half-mile zone" which is part of the Kilimanjaro forest reserve. Even if the forest edge has stayed approximately in the same place in the study area, a survey reveals illegal logging, burning of forest, cultivation, landslides and quarries in the protected forest reserve (Lambrechts *et al*., 2002) which result into decrease in forest cover by 0.91% between 1995 and 2013.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the findings the study draws the following conclusions. Many local institutions existed in the pre independence era in the study area they include leadership, conflict resolution, land and livestock based and health and beliefs institutions. Most of these institutions had diverse functions associated to the moral economy of managing the Chagga home gardens. However, over the year there has been gradual changes in the post-independence to the extent that now the local institutions that used to manage the home gardens are fading away which affects production system which was the fulcrum of the Chagga moral and cultural economy. Local institutions are important structures that guided the lives of local communities. This is an alarm to device strategies to protect the traditional agro forestry practices that for the past have contributed significantly to livelihood and food security of the communities.

The Chagga homegarden has undergone drastic changes which can be depicted by land cover change between two periods 1987-1995 and 1995-2013. In the first period 1987-1995, despite an increase of homegarden cover by 30.1%, 32.12% of the total homegarden cover was transformed into settlement cover 30.12% was transformed into riverine vegetation, 35.08% was transformed into mixed cropland, 32.15% was transformed into agriculture field, and 38.01% was transformed into forest cover while 33.82% was transformed into bare land. During the time between 1995 and 2013 homegarden cover decreased by 70.42% a trend that is likely to continue in the foreseeable future if not checked, leading to disappearance of home garden in the future.

1.1. Recommendations

The traditional agroforestry systems (homegardens) together with the rich indigenous ecological and management knowledge can provide solutions to many agricultural challenges that we are facing today including food insecurity and the impacts of climate change.

i. Homegarden land use systems should properly be identified and promoted to tap the rich indigenous knowledge and skills that were used in balancing and sustaining agricultural production with environmental conservation. Since agroforestry generates significant public environmental services such as watershed protection, biodiversity, and carbon sequestration there is need for the government to provide incentives to the private sector to get

involved in promotion of Chagga homegarden practices.

ii. Indigenous species in a given area should be well defined and properly documented and archived in order to give guidance and inform farmers on its importance through conducting research and establishing indigenous tree nurseries. The selective custodian and passage of this rare and vital knowledge has relied on word of mouth and it is likely that most of it may have been lost with the death of individuals who possessed it.

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