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Wood Usage in Rural Tanzania: An Investigation Into the Sources and Accessibility of Fuelwood and Polewood for the Residents of Kizanda Village, West Usambara Mountains

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Acknowledgments

First of all, I would like to thank Baba Jack for helping me develop ISP after ISP until I developed one that truly suited me. To my translator Abu, thank you for allowing me to smoothly conduct my study in Kizanda village and for helping me measure hundreds of trees on the steepest of slopes. I am extremely appreciative of the constant work done by Richard and David and the rest of the Mazumbai staff to keep the Mazumbai Crew very well fed, comfortable, and able to continue with our studies. Thank you Mr. Kiparu and Mr. Mrecha for your abundant stores of knowledge concerning forestry and your invaluable insight into the current situation of Tanzania and more specifically the West Usambaras. Thank you Courtney, Benji, Laura, Sam, Jake, Grace, Kristen, Amanda, and Lele for the passionate and hilarious conversations, the friendships that are bound to last, and for helping make my time at Mazumbai one of the most memorable experiences of my life. I would most of all like to thank the residents of Kizanda village for allowing me to enter their community, their houses, hike throughout their farms and woodlots, and for making me feel welcome.

Abstract

This study was conducted over the course of 16 days between April 8th and 28th in Kizanda village, which borders the protected Baga Government Forest Reserve, in the West Usambara Mountains in Northern Tanzania. The goals of this study were to investigate the actual sources of fuelwood and polewood reported by the people of Kizanda village, to determine if these sources offer a sufficient amount of fuelwood and polewood, and to identify possible sustainable alternatives to wood products from the Baga Government Forest Reserve and other protected forest areas near Kizanda village. Key informant interviews (n = 9) and 151 structured interviews were completed with the help of a translator. Respondents for structured interviews were chosen non-randomly and biomass data was only collected if the interviewee (n = 34) was willing to show the location of trees that would be used for fuelwood and/or polewood. Results show that the majority (66% (100/151)) of the respondents utilized wood that was collected from the forest. More than half (56% (17/31)) of the respondents that were willing to allow the trees they would use for wood to be measured only had enough wood to last them for less that 15 weeks. The greater part (82% (105/128)) of respondents who stated that they did not have enough wood said that tree seedlings to plant amongst their crops or in woodlots would be the most helpful for them to gain access to a sufficient amount of wood. Based off of these finding it can be seen that the majority of the respondents do not have enough wood available from legal sources and are therefore resorting to the nearby Baga Government Forest Reserve, Mazumbai University Forest or other forested areas in order to collect a sufficient amount of wood. If the rural populations in Tanzania are not given alternatives to wood from these highly valued areas, the detrimental effects of wood collection on the forests within the country will continue to degrade these regions that are essential for the people, flora, and fauna that live throughout the nation.

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Introduction

Deforestation is a prevalent issue around the globe. Within both high and low-income countries the over-utilization and clearing of forests has extremely detrimental effects on the stability of forests and the biodiversity that they help to sustain. If this trend continues the beneficial factors of forests that help to offset previous environmental damage will no longer be effective. According to the World Bank (2004) the average annual deforestation rate between 1990 and 2000 for the globe lies at approximately 0.2%. This decline in forested areas is ultimately due to the utilization of forest resources by humans, which leads to the fact that this overexploitation of resources has only to continue and most likely worsen since the world's population is expected to increase to around 7 billion by 2015. Since approximately 95% of this population growth will take place within low and middle-income countries, this increase in population will only serve to amplify the effects of harvesting wood from already endangered forested areas (World Bank, 2004).

The decreased potential of forests in terms of sustaining biodiversity, carbon sequestration, water catchment effectiveness, preventing desertification, and other functions has come as a result of this decrease in forested areas. As forests decrease in size and become more fragmented their ability to maintain biodiversity decreases, which promotes a cycle that leads to more negative effects on the health of the forest. Decreases in biodiversity only contribute to the downfall of forests due to the loss of species that serve to pollinate and spread the seeds of plants within the forest (Terborgh, 1992). Deforestation has led to the crippling of forests in terms of carbon sequestration as well. With increasing inputs of the greenhouse gas CO_2 into the atmosphere and the decreasing amount of plants available to incorporate this gas into their tissues, it is now less likely that the process of photosynthesis will offset the amount of anthropogenic CO_2 entering the atmosphere (Kaye, 2000). The issues resulting from the exacerbation of climate change will only be worsened by the lessened effectiveness of forests that act as water catchment areas. With less area to foster the absorption of water into groundwater flow paths, less water will be available for people that depend on the water that enters the ground within these areas (Kalaghe, 1988). Forests help to prevent desertification as well. A decrease in the amount of forested areas throughout a landscape lessens the amount of moisture and nutrients within the area since the ability of forests to retain these elements within

the environment is lessened and fertile land can often become a desert. These issues will continue to affect the health of the world's forests if proper management techniques are not implemented and alternative options in terms of access to wood resources are not developed (Kalaghe, 1988).

Many low-income countries are currently facing this predicament. Numerous countries have found that forests can serve as an excellent way to attract tourism and have tried to raise their GDP with this industry. However, the goals and methods behind the sustenance of these resources often does not take into account the people that depend on these forests and many within numerous low-income countries have found themselves without sufficient fuelwood and polewood to feed their families and build themselves shelter.

Attempts to remedy this situation have ranged from Participatory Forest Management to completely restricting communities from having access to forests. Participatory Forest Management consists of the legal management of forest resources by community-level institutions that are recognized by the government (MKUKUTA, 2007). Both of these methods have been found to work to conserve the area of forests, however there are drawbacks to both. Completely restricting communities from access to forests can prevent them from accessing fuelwood and polewood, which can devastate the surrounding communities who may rely on these resources. Due to the need for continued access to these resources, people are forced to engage in illegal activities and collect wood from these forests. This places them in danger of being caught and given fines that may be as much as twice they make in a year (Mtali, 2011). On the flipside Participatory Forest Management places the management of forests in the hands of the people. This can work, but often times it does not because people do not experience any direct benefits from managing the forest in terms of monetary gains so they are forced to continue harvesting from the forest that they are trying to protect (Mrecha, 2011). This entire assortment of issues can be found within Tanzania.

The low-income country of Tanzania has taken advantage of its unique natural resources and has made approximately 29.8% of its total land area protected land (World Bank, 2004). This number is currently increasing as well (Matthews, 2011). The majority of this protected land is not accessible to people as well, restricting them from utilizing the natural resources of these lands that they often times previously had access to. From the Maasai that lost the lands on

which they grazed their cattle to Tarangire National Park, to the people living near forest reserves in the Usambara Mountains many rural populations have lost access to the resources on which they have depended for many years. This problem is bound to worsen as well since the population of Tanzania is expected to double in the next 17 years (Matthews, 2011). With nearly double the population, the strain on Tanzania's natural resources is going to be compounded, especially since as of 2002, 66% of Tanzania's population was found to live in rural areas and approximately 87% of this rural population relies on fuelwood as well, which leads to issues concerning their access to fuelwood and polewood that they are allowed to collect (World Bank, 2004; MKUKUTA, 2007). These issues of access to forest resources are exemplified by the situation of Kizanda village, located in the West Usambara Mountains within Northern Tanzania.

Kizanda village lies adjacent to the government forest reserve of Baga Forest, which serves as a buffer zone for Mazumbai University Forest. The people of Kizanda village are included within the 87% of the rural population that rely on wood as their source of fuel to cook food for their families. Therefore, the surrounding forested areas of Baga and Mazumbai are exposed to the need for the villagers of Kizanda to harvest fuelwood and polewood. This harvesting places environmental pressure on the forests within the area, which some other studies have attempted to explore by examining the forest edge and quantifying the extent to which trees have been harvested (Lenth, 1999).

In order to lessen the affect that the collection of fuelwood/polewood has on the forests in the proximity of Kizanda village, certain strategies have been applied in coordination with the village in order to establish other sources from which they can collect wood. One of these has been the strategy of incorporating sources of wood into crops. Since the majority of the villagers within Kizanda village engage in agriculture as their main livelihood this strategy, also known as agroforestry, sounds like an excellent idea that would help to prevent villagers from using forest resources and instead utilize wood that is growing amongst their own crops. The NGO, Tanzania Forest Conservation Group, is a major advocate of agroforestry and has promoted this within Kizanda village as well. The main goal of the Tanzania Forest Conservation Group is to conserve forests, especially those with high levels of biodiversity, which include Baga forest (Tanzania Forest Conservation Group, 2011). Some of the methods used to prevent people from collecting polewood/fuelwood from forests include supplying seedlings to people that they will

be able to plant amongst their crops. The main types of seedlings that they provide include *Gravellea robusta* and *Albizia schimperiana.* *Albizia schimperiana* is a nitrogen-fixing tree, which helps to retain the nitrogen within the soil and aid in the growth of surrounding crops (Mrecha, 2011). Along with supplying seedlings that will eventually be usable as polewood/fuelwood, the Tanzania Forest Conservation Group also gives people the supplies that allow them to make their own bricks, which helps to prevent them from resorting to the surrounding forested areas for polewood. Other ways that the Tanzania Forest Conservation Group try to benefit the communities is by giving them other means by which to provide an income for themselves, one of these being goats that give milk that they can sell. The introduction of improved agriculture has been one of these methods as well. This style of agriculture promotes minimal tillage, which helps to prevent the excess erosion of soils, cover crop, which advises people to grow trees amongst their crops so that shade is provided, and crop rotation, which is the rotation of crops throughout the year so that the soil does not become depleted in specific nutrients (Tanzania Forest Conservation Group, 2011).

Another method that the village of Kizanda has experienced is the planting of *Eucalyptus grandis.* *Eucalyptus grandis* is often planted within woodlots or along the borders of peoples' land and/or agricultural plots (Personal Observation, 2011). This plant serves as an excellent alternative, instead of collecting from the forest, for a source of fuelwood and polewood. Since it is able to grow up to around 2 meters per year and able to survive in harsh conditions, *Eucalyptus grandis* is an excellent option for people within Kizanda village to be able to grow their own supply of wood that they could use for both fuelwood and polewood (Mrecha, 2011). Some of the major issues associated with this alternative lie in the amount of seedlings that have been given to villagers and in the amount of water and nutrients that *Eucalyptus grandis* tends to drain from the surrounding land. There simply are not enough *Eucalyptus grandis* within Kizanda village that would be able to sustain the amount of fuelwood/polewood the villagers need and *Eucalyptus grandis* tends to make the surrounding land unsuitable for the growth of crops and other plants (Mrecha, 2011; Personal Observation, 2011)

The goals of this study were to investigate the actual sources of fuelwood and polewood reported by the people of Kizanda village, to determine if these sources offer a sufficient amount of fuelwood and polewood, and to identify possible sustainable alternatives to wood products

from the Baga Government Forest Reserve and other protected forest areas near Kizanda village. Preliminary data suggested that many of the households interviewed utilize species of wood that they do not grow in either their woodlot or amongst their crops. Data also suggested that the majority of the families that claim to gather wood solely from private sources do not own a sufficient amount of trees that would be able to sustain the amount of wood they claim to use per week.

Study Site Description

Kizanda village is located in the West Usambara Mountains in Northern Tanzania (Fig. 1). Before 2009 Kizanda village was considered to be a part of Mayo village, however at this time Mayo was split into two villages because of the increased population within the area and for government jurisdiction reasons. The current population of Kizanda is 2,031 and Mayo is 817 (Kizanda Council Meeting, 2011). This change due to an increasing population is not surprising due to the fact that the region of the West Usambara Mountains has one of the highest fertility rates within Tanzania, which lies at approximately 8 children per woman, while that of Tanzania as a whole is 5 children per woman (Matthews, 2011; World Bank, 2004).

The Shambaa ethnic group is the majority within Kizanda village. The Shambaa were historically a culture that practiced mainly small-scale agriculture and have continued this form of livelihood to this day (Conte, 2004). The main cash crops that are grown within Kizanda village include tea, coffee, cardamom, and clove while the main food crops that are grown within the village include corn, beans, bananas, and cassava (Kizanda Council Meeting, 2011). The majority of the people within Kizanda village practice agroforestry, which was introduced approximately 10 years ago by the Tanzania Forest Conservation Group. The tree that is most often grown amongst their crops is *Gravellea robusta* (Kizanda Council Meeting, 2011; Personal Observation, 2011). Through the sale of their crops the average agriculturalist within Kizanda village is able to make approximately 100,000 shillings per year (Mrecha, 2011).

Due to the history of colonialism, first by Germans and then the British within the region, there are lingering effects, spanning from environmental to ideological, within the village and greater Western Usambara region. Environmentally, the exploitation of the forest resources of the Western Usambaras was catalyzed by the extraction done by the colonial powers, which further increased the patchiness of the original forest so unique to the Usambara Mountains (Conte, 2004). Ideologically, the people within Kizanda village have been influenced by the presence of Caucasians as well, in the form of colonists, doctors, NGO workers, and in other roles. One of the interesting outcomes of the interactions of the people within the region of the Western Usambara Mountains and Caucasians has been the idea that white people are vampires because of the tendency of doctors to take blood in order to diagnose patients (Matthews, 2011; Mrecha 2011). Because of the interesting dynamic that this idea and others related with *wazungu*

(white foreigners, singular being *mzungu*) create, my interaction with the villagers of Kizanda will instantly be affected in one way or another, therefore biasing my data.

As a rural population within Tanzania's West Usambara Mountains, the people of Kizanda belong to the 87% of the population that rely on fuelwood as their main energy source and according to the Kizanda Village Chair (2011) 100% of the population within Kizanda relies on wood for reasons ranging from cooking food to providing a livelihood for themselves. Because of this and the fact that they do not have access to alternative forms of energy, many within the village are left to collecting resources from the surrounding forests. The Baga Government Forest Reserve is one of these forested areas and is often considered to be a "biodiversity hotspot", increasing its value within the international community (Conte, 2004). Despite the fact that this government owned forest reserve has a high level of biodiversity it is still in mixed condition because of the harvesting of forest resources due to public demand along it edges (Iversen, 1991). Currently there are 25 guards that monitor the portion of the Baga forest that is next to Kizanda village (See Appendix A). Out of these approximately 15 of them regularly attend to their duties, which consist of them standing most often hidden at the edge of the forest in an attempt to catch people as they collect wood or other resources from the forest (Baba Rashid, 2011). All of these guards are volunteers and if they catch someone collecting wood from the forest that person can be charged up to 50,000 shillings, half of what the average citizen of Kizanda makes in a year (Kizanda Village Chair, 2011).

Attempts have been made to introduce the people of Kizanda village to alternative forms of fuelwood and polewood. One of these is agroforesty, which as discussed above was introduced by the Tanzania Forest Conservation Group. This attempt to grow alternative sources of wood has helped to provide people with their own source of this essential resource and has lessened the impact that collecting wood from the forest has on the Baga Government Forest Reserve (Kizanda Village Chair, 2011).

Woodlots have also been incorporated into the landscape of Kizanda village because of the Tanzania Forest Conservation Group. This NGO informed the residents of Kizanda village about this manner in which to provide their own wood resources at approximately the same time they notified them of the benefits of agroforestry. Once people in Kizanda learned of the possible benefits of woodlots, residents who could afford seedlings started to plant their own.

The trees that are most often planted in this manner have been *Gravellea robusta, Eucalyptus grandis,* and *Albizia schimperiana.* However, some are now trying to lessen the amount of *Eucalyptus grandis* that they grow on their land because of the ecological effects discussed above. This strategy to curb the amount of wood that people take from the forest has been somewhat effective as well. But despite these benefits of agroforesty and woodlots, the people of Kizanda village are still forced to resort to the trees of the forest in order to sustain themselves.

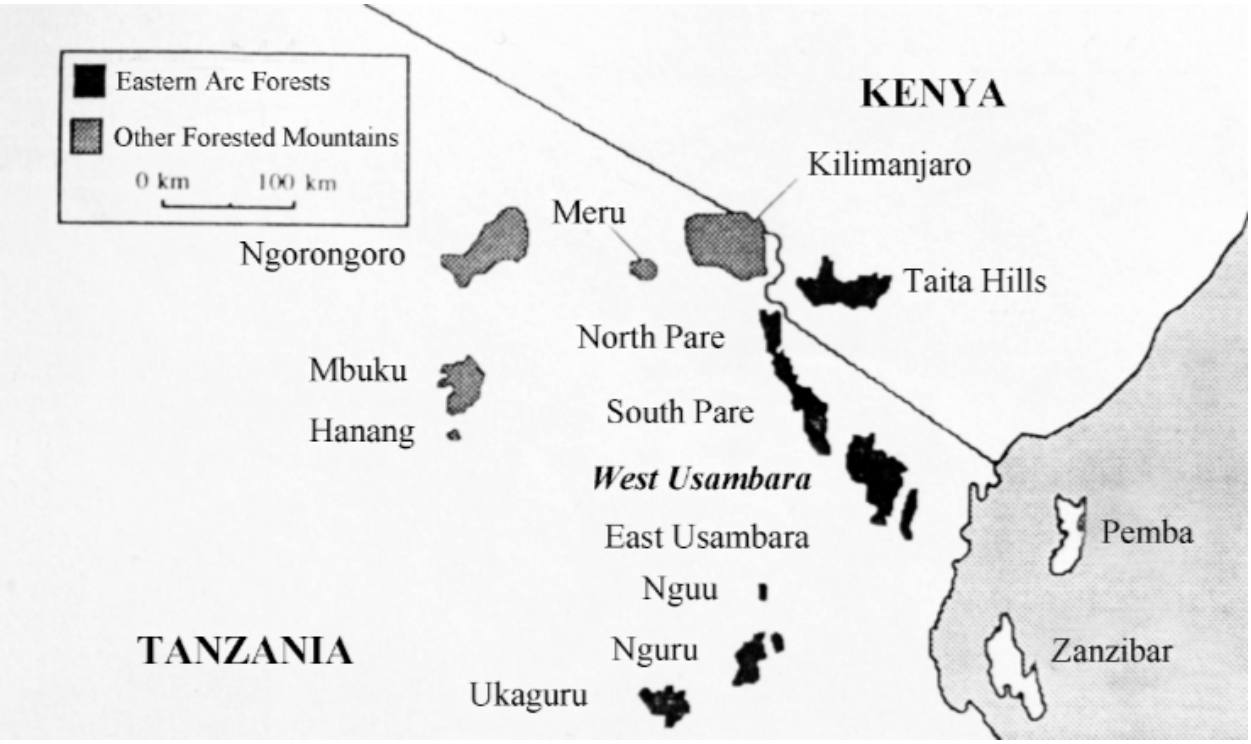


Figure 1. Map of the Eastern Arc Mountains. Kizanda village is located in the West Usambara Mountains in Northern Tanzania.

Methods

The methods used throughout this study include structured interviews, key informant interviews, and biomass data collection. All interviews were conducted in either Kishambaa or Kiswahili with the help of my translator Abraham "Abu" Mtali. This data was then compiled and analyzed in order to determine the sustainability of available wood sources, to investigate the actual sources of wood used by interviewees, and to identify possible alternatives to wood products from the Baga Government Forest Reserve, Mazumbai University Forest, or other forested areas.

Structured Interviews: 151 interviews were conducted using designed interview questions, with only 34 interviews followed by biomass data collection, over the course of 16 days. The sample population was the mothers and fathers of households within Kizanda village. Interviewees were chosen opportunistically and therefore non-randomly, due to the unavailability of a village roster, within Kizanda village between the hours of 9:00 am and 1:00 pm every day of the week except for Sundays.

Interview questions were structured in a manner that helped to limit certain questions influence on others, which is why questions concerning the forest reserve are at the end of the interview sequence (See Appendix B). The main purpose of the questions was to determine the source of the wood used by the people interviewed, to be able to quantify their total usage of wood products, and to identify possible alternatives that would lessen the utilization of forest resources from the Baga Government Forest Reserve, Mazumbai University Forest, or other forested areas. Due to the similarity between the questions used during preliminary data collection and the questions used during the actual study, data that was collected during the preliminary period of the study was incorporated into data analysis.

One detail that may have influenced the results collected during this portion of the study and some key informant interviews as well, is the fact that I was an *mzungu* vampire affiliated with the Mazumbai University Forest at my study site. According to Abraham "Abu" Mtali (2011) and my interactions with many residents of Kizanda village, people within the village may not trust me, and therefore respond in a manner that they believe I want to hear. My affiliation with the Mazumbai University Forest was likely the most significant contribution to

this bias due to the long history between the people of Kizanda village and forest officials. An example being that nearly everyone responded "no" to the questions concerning whether or not people or they themselves enter the forest. This bias most likely affected the willingness of respondents to show me the location of the trees that they would use as fuelwood and/or polewood as well.

Key Informant Interviews: Key informant interviews were conducted with the Kizanda Village Chairman, forest guards that live within Kizanda village, the Kizanda village council, Wycliffe Peter Massolwa (Agricultural Officer) and Simon C. Lugazo (Project Officer) of the Tanzania Forest Conservation Group, and my translator, Abraham "Abu" Mtali. Questions asked during the interviews with the Kizanda Village Chairman and the Kizanda village council mainly addressed the history of Kizanda village and its affiliation with the neighboring Baga Government Forest Reserve. Questions also aimed to identify the agents behind the introduction of alternative sources of wood like agroforestry and woodlots and the ways these alternatives have affected the relationship between Kizanda village and the forest. Interviews with forest guards were conducted after structured interviews where the guards would mention that they enter the forest because of their duties. Questions during these interviews aimed to identify the motivation behind being a volunteer guard, the consequences for collecting resources from the forest, and to determine if they have witnessed people collecting resources from the forest. Interview questions for the representatives of the Tanzania Forest Conservation Group aimed to examine the role that the NGO has played in the establishment of alternative means of producing both fuelwood and polewood within Kizanda village. The questions that Abraham "Abu" Mtali was asked were meant to clarify the inconsistencies in many of the interviewees' answers and to learn more about the influence that my presence may have had on the people that I interviewed during my study.

Biomass Data Collection: This portion of data collection took place after structured interviews with people in Kizanda village and was completely based on the willingness of the interviewee to lead me to their farm and/or woodlot and show me the trees that would be used for fuelwood and polewood. Because of this factor, few interviews were followed by data collection that allowed for the calculation of the available biomass within their farm and/or woodlot. This lack of biomass data and the fact that the methodology behind the measurement of trees within

respondents' farms and/or woodlots remained the same throughout both the preliminary and main portion of the study led to the incorporation of preliminary biomass data into data analysis.

If interviewees were not willing to lead me to the location of their trees than I would ask them to approximate the amount of trees that they have available for fuelwood and/or polewood. If led to the location of people's trees, than the species and the amount of trees in each species was recorded. The area in which the trees were planted (either woodlot, amongst crops (agroforestry), or both) was recorded. After this, the circumference (measured 1.3 m from ground or corpus of trees) and height of trees (measured using geometric principles similar to those used during the isosceles triangle method) was measured. Only trees with a stem greater than 30 cm in circumference were measured. The circumference was then divided by pi in order to calculate the DBH of sampled trees. If the farm or woodlot had more than 15 trees of one species then data was collected for 15 of the trees present and the average of this data was extrapolated to the other trees in the farm or woodlot.

The volume of a tree within a woodlot or amongst crops was calculated using basal area, height, and form factor (Fig. 2). Basal area was calculated using DBH and the formula used to determine the area of a circle.

$$V=ghf$$

Figure 2. Equation used to determine volume of trees (V). Variables include basal area (g), height (h), and form factor (f). Form factor is the ratio of the true volume of a tree to the volume of a cylinder with the same height and specified diameter as the tree. The value used for form factor was 0.33 (Kiparu, 2001).

The calculated volume of a tree was then used in conjunction with the density of that type of wood in order to determine the biomass of the tree (See Appendix C). The total biomass available to an interviewee's family was then estimated by totaling the biomass calculated for trees within their farm and/or woodlot. This value was then compared to the amount of wood that the respondent's family reported that they use per week, which was estimated by multiplying the bundles of wood that a family said they use per week by 30 kg, the weight of an average bundle of wood as estimated by Modest Mrecha (2011), former manager of the Mazumbai University Forest.

Results

Throughout the data collection period 119 mothers, 23 fathers, and nine couples (both a mother and father) were interviewed, totaling 151 interviews and representing approximately 833 residents of Kizanda village. Biomass data was only collected during 34 interviews, however calculations were only done for 31 households due to a lack of tree densities. Out of the respondents 92% (139/151) main source of income was from agriculture (Fig. 3).

In terms of the source of this wood, the majority (28% (43/151)) of the respondents claimed to acquire their wood from trees that are planted amongst their crops. Approximately a quarter (26% (39/151)) of the people interviewed collected their wood from their own private woodlot and another quarter (24% (36/151)) stated that they collect their wood from natural trees that are not in the forest (Fig. 4).

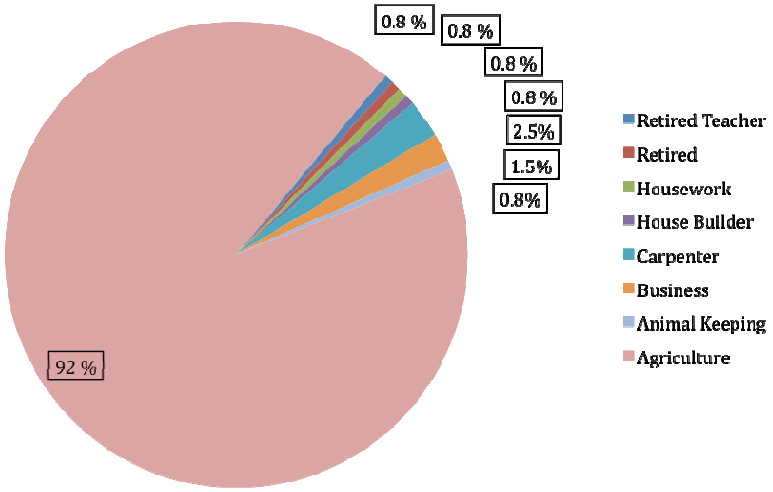


Figure 3. Occupations of interview respondents. Data was collected non-randomly in interviews (n=151) during April 2011 in Kizanda village, West Usambaras, TZ.

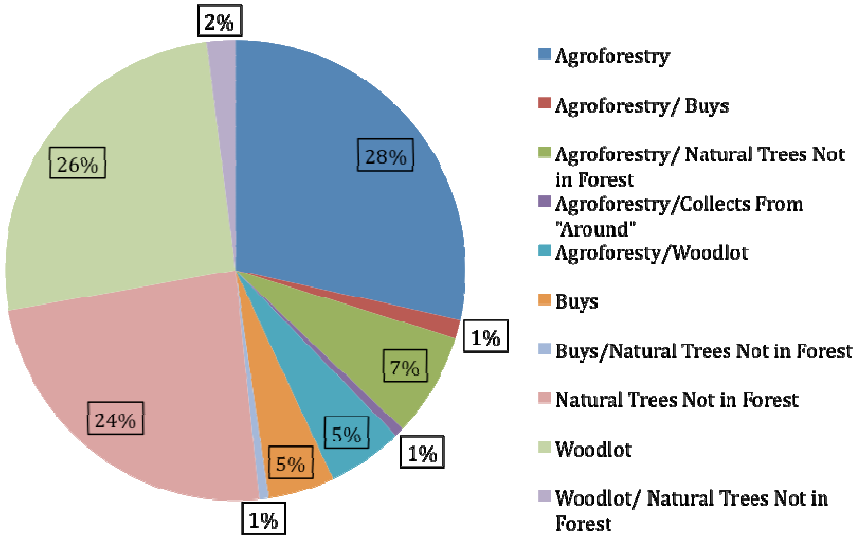


Figure 4. Source of wood as stated by respondent. Data was collected non-randomly in interviews (n=151) during April 2011 in Kizanda village, West Usambaras, TZ.

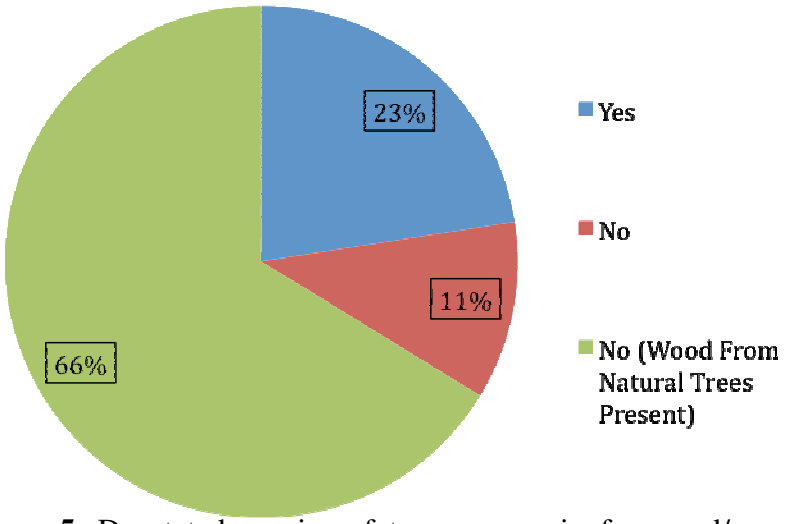


Figure 5. Do stated species of trees grown in farm and/or woodlot match the species of trees in supply of wood? Data was collected non-randomly in interviews (n=151) during April 2011 in Kizanda village, West Usambaras, TZ.

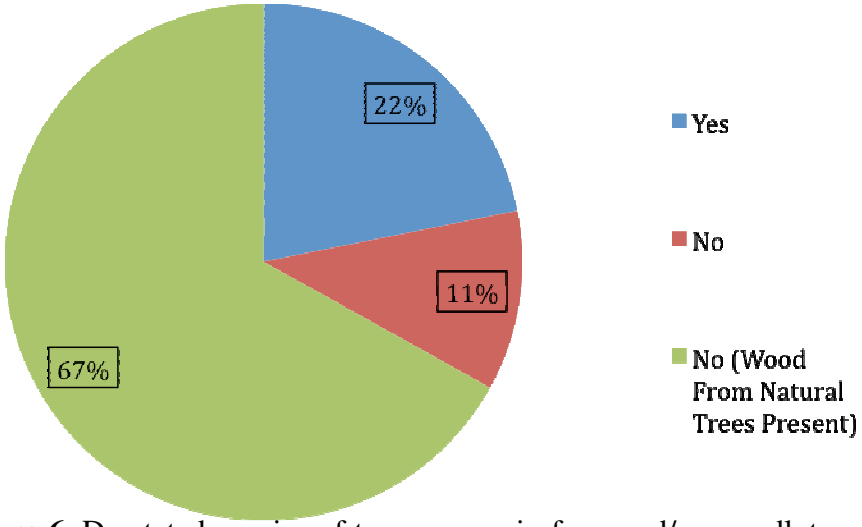


Figure 6. Do stated species of trees grown in farm and/or woodlot by people who claim to not enter the forest match the species of trees in supply of wood? Data was collected non-randomly in interviews (n=142) during April 2011 in Kizanda village, West Usambaras, TZ.

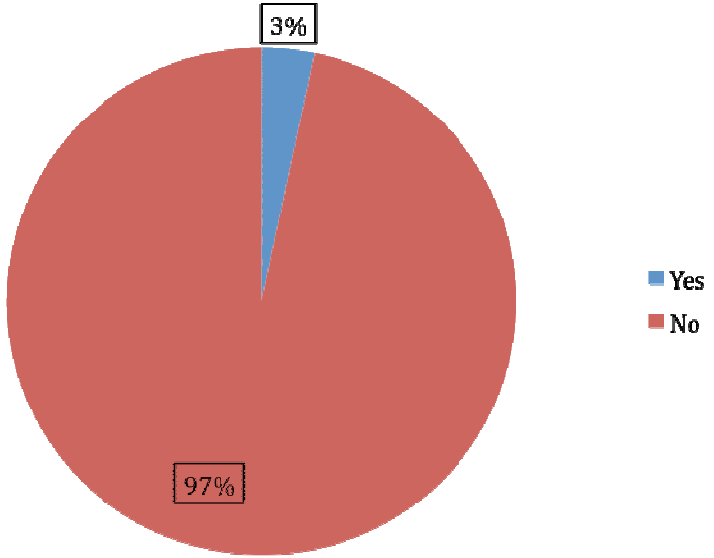


Figure 7. Do you know if anyone goes into the forest? Data was collected non-randomly in interviews (n=151) during April 2011 in Kizanda village, West Usambaras, TZ.

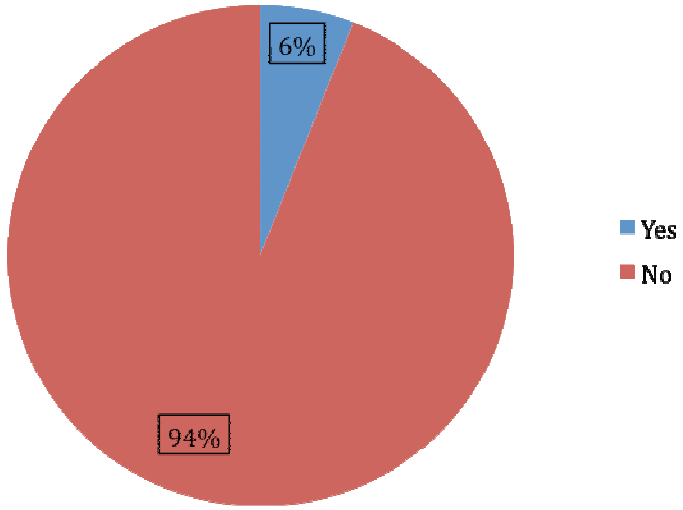


Figure 8. Do you ever go into the forest? Data was collected non-randomly in interviews (n=151) during April 2011 in Kizanda village, West Usambaras, TZ.

The reported species of trees grown within respondents' farms and/or woodlots was compared with the species of trees within the supply of wood for their household. Out of those interviewed, 77% (117/151) of respondents had wood species that could not have been collected from the trees that they claimed to have within their farm and/or woodlot and 66% (100/151) of the respondents had wood from trees that are indigenous to the Western Usambara Mountains (Fig. 5).

Out of the people that claimed to not enter the forest, 67% (95/142) had wood from tree species natural to the West Usambaras that could not have been collected from the trees that they claimed to have within their farm and/or woodlot (Fig. 6). The data represented in both Figures 5 and 6 accounts for the possibility that families can purchase a species of wood that they may not grow, however this is only taken into account if the interviewee identifies buying wood as one of their wood sources.

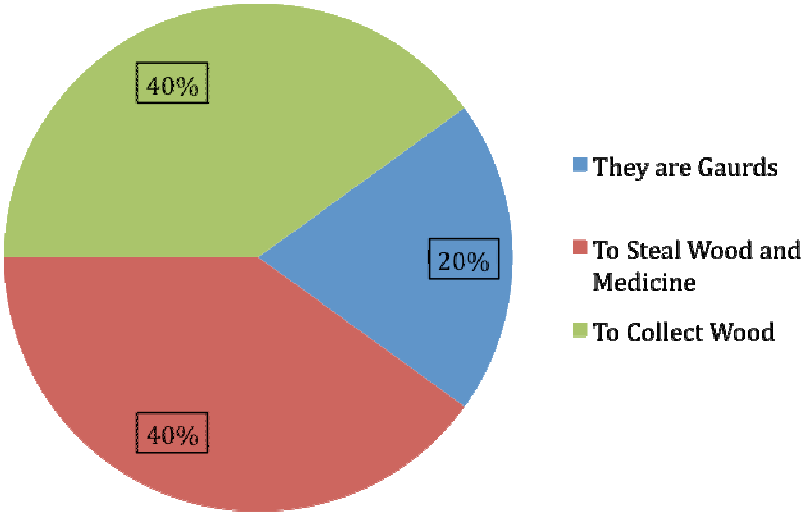


Figure 9. Why do people enter the forest? Data was collected non-randomly in interviews (n=5) during April 2011 in Kizanda village, West Usambaras, TZ.

When asked "Do you know if anyone goes into the forest?" 97% (146/151) of respondents said that they do not know of anyone that enters the forest (Fig. 7).

When asked "Do you ever go into the forest?" 94% (142/151) of respondents said that they do not enter the forest (Fig. 8).

Out of the respondents that said that people do enter the forest, 40% (2/5) said that they do so in order to "collect wood" and another 40% (2/5) said that they go into the forest to "steal wood and medicine". The other 20% (1/5) said that the only people to go into the forest are the gaurds (Fig. 9).

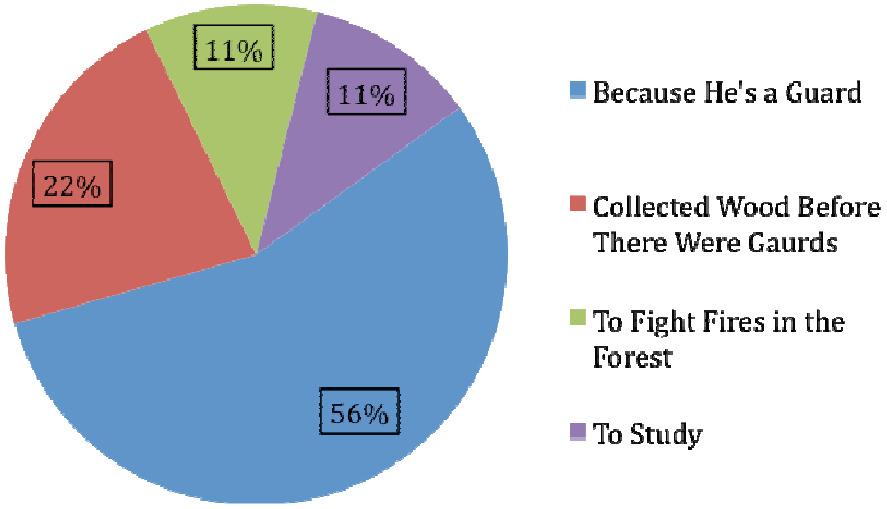


Figure 10. Why do you enter the forest? Data was collected non-randomly in interviews (n=9) during April 2011 in Kizanda village, West Usambaras, TZ.

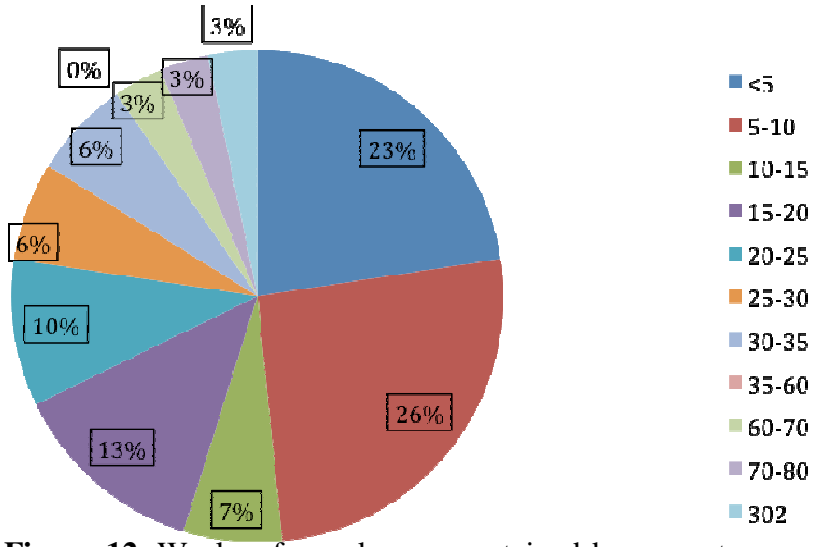


Figure 12. Weeks of wood usage sustained by current amount of biomass available amongst crops and/or woodlots. Data was collected non-randomly in woodlots and/or farms of interviewees (n=31) during April 2011 in Kizanda village, West Usambaras, TZ.

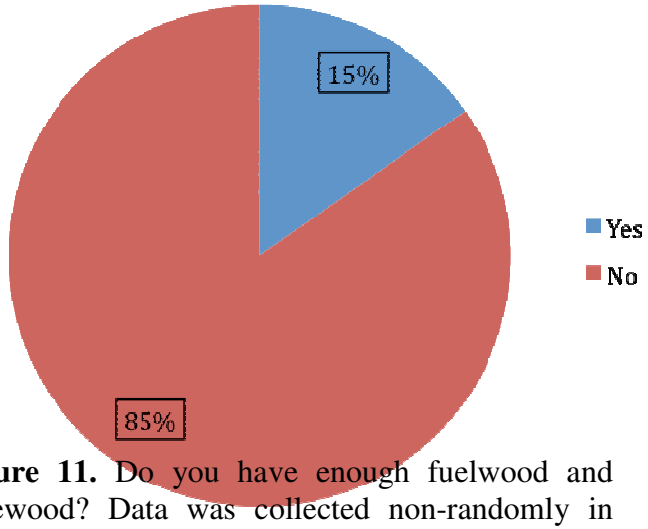


Figure 11. Do you have enough fuelwood and polewood? Data was collected non-randomly in interviews (n=151) during April 2011 in Kizanda village, West Usambaras, TZ.

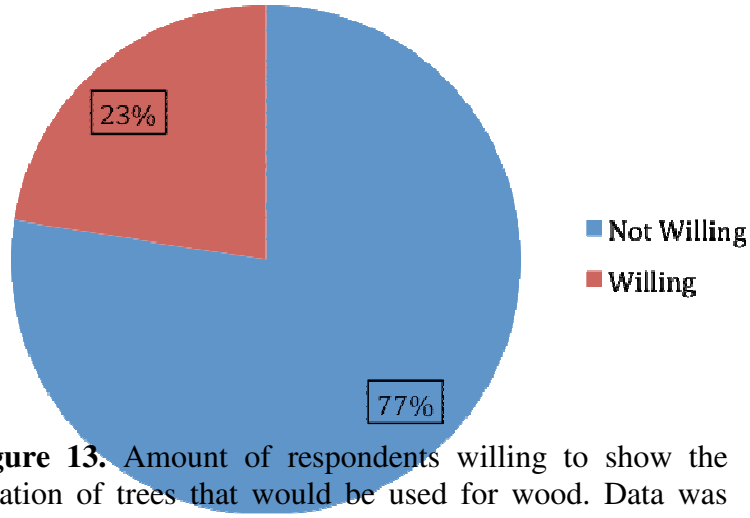


Figure 13. Amount of respondents willing to show the location of trees that would be used for wood. Data was collected non-randomly in interviews (n=151) during April 2011 in Kizanda village, West Usambaras, TZ.

The respondents that stated that they do enter the forest gave reasons, ranging from being a forest guard (56% (5/9)) to admitting that they had collected wood from the forest before there were guards (22% (2/9)) (Fig.10).

Data shows that the majority (85% (128/151)) of respondents feel that they do not have enough wood (Fig. 11).

Biomass data was used in conjunction with the stated amount of wood used per week by the respondent's family to estimate the amount of weeks that a household would be able to maintain normal wood usage habits if only collecting wood from trees planted amongst their crops or in woodlots. Fifty-six percent (17/31) of respondents whose trees were measured would only be able to sustain their usage habits for less than 15 weeks (Fig. 12).

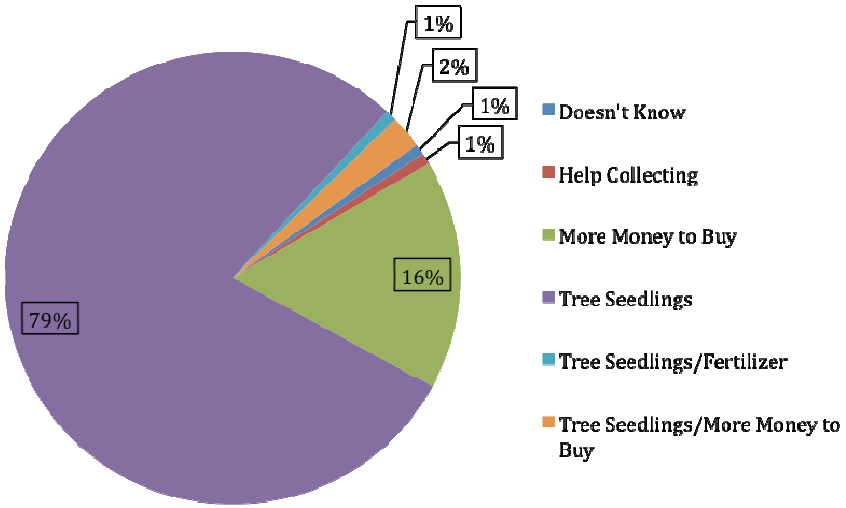


Figure 14. What would help you get access to enough wood? Data was collected non-randomly in interviews (n=128) during April 2011 in Kizanda village, West Usambaras, TZ.

Only 23% (34/151) of interviewees were willing to show the location of the trees from which they collect wood (Fig. 13).

Out of the respondents that stated that they did not have enough wood, when asked "What would help you get enough fuelwood/polewood?", 82% (105/128) of the respondents had responses that included tree seedlings, most often *Gravellea robusta* or *Eucalyptus grandis*, that could be planted amongst crops or in woodlots, as the best solution for their lack of access to a sufficient amount of wood (Fig. 14).

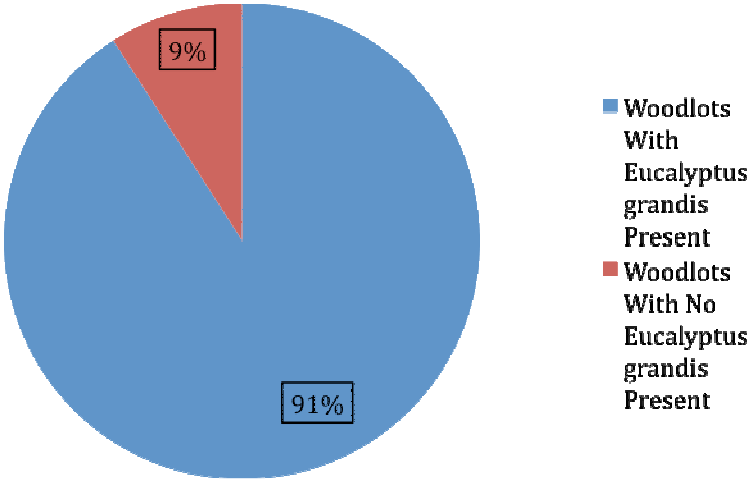


Figure 15. Woodlots measured for biomass that had *Eucalyptus grandis* present. Data was collected non-randomly in woodlots and/or farms of interviewees (n=22) during April 2011 in Kizanda village, West Usambaras, TZ.

Out of the woodlots that were measured, *Eucalyptus grandis* was present in 91% (20/22) (Fig. 15).

Discussion

Despite the fact that the majority of the respondents claimed to collect fuelwood and polewood from either trees planted amongst their crops (28% (43/151)) or within their privately owned woodlots (26% (39/151)), there were large inconsistencies between the species of wood that they said they grow within their farms and/or woodlots and the species of wood that were present in the supply of wood for their household (Fig. 4; Fig. 5). Out of the people interviewed 66% (100/151) had wood from tree species that naturally occur within the West Usambara Mountains, meaning that they would have had to engage in illegal activity to collect the wood that was present (Fig. 5). It is illegal to collect wood from any natural tree within the area, whether it is in the forest or outside of the forest, even if the natural tree is located in the middle of one's farm. The fine for breaking this law can be up to 50,000 Tsh (Kizanda Village Chair, 2011; Baba Rashid, 2011). This suggests that the people interviewed resort to collecting from natural sources, even when these activities can result in a fine that equates to approximately half the earnings of the average Kizandan (Mrecha, 2011).

Even though these resources were collected from species indigenous to the area, 97% (146/151) of respondents stated that they did not know of anyone that enters the forest and 94% (142/151) said that they themselves do not enter the forest (Fig. 7, Fig. 8). These responses do not correspond with the fact that out of the 94% (142/151) of respondents that claimed to not enter the forest, 67% (95/142) had wood from tree species indigenous to the West Usambaras that could not have been collected from the trees that they claimed to have within their farm and/or woodlot (Fig. 6). It is assumed that if wood from species native to the area was present, then it was most likely collected from trees within the forest due to the decreased chance of getting caught within a more concealed area that is further from the eyes of fellow villagers and forest gaurds. However, assuming that the respondents with wood from native tree species collected this wood from the forest does not agree with many of their responses since 24% (36/151) of interviewees claimed to collect their wood from natural trees outside of the forest (Fig. 4). These results hint towards the bias that being affiliated with the Mazumbai University Forest may create in that villagers may have been reluctant to admit to collecting wood from the forest despite the fact that there would be less of a chance of getting caught.

Several respondents confirmed the likelihood that people are collecting some, if not all of their wood from the forest. These interviewees include both normal residents from Kizanda village and volunteer forest gaurds that live within the village. Out of the five people who said that villagers do enter the forest, four of them stated that they go into the forest to either "collect wood" or "steal wood and medicine" (Fig. 9). Out of the 6% (9/151) of respondents that did state that they themselves enter the forest, only 22% (2/9) said that they entered the forest to collect wood, however they also said that they only did this before there were gaurds (Fig. 8, Fig. 10). According to four of the five forest gaurds that were spoken to, people from Kizanda village do collect wood from the Baga Government Forest Reserve. One of them even stated that he catches people collecting wood from the forest three times per week (Baba Muhammed, 2011). Despite the fact that the main goal of the gaurds is to protect the forest, three out of the five gaurds interviewed had species of wood that are indigenous to the forest reserve they are trying to protect yet did not mention the forest as one of their sources of wood. The bias created by my affiliation with the Mazumbai University Forest is further supported by the fact that when interviewing the Kizanda Village Chair (2011), he stated that people from the village do not collect wood from the forest, even when the only type wood in his house was from a tree species indigenous to the forest. These interactions and witnessing people collect wood from the forest myself all point towards the effect that my presence may have had on the responses of interviewees.

The presence of wood from species of trees natural to the area is not surprising, especially when considering the amount of wood that is available to the owners of the woodlots and trees planted amongst crops that were measured. The majority (85% (128/151)) of respondents reported that they did not have enough fuelwood and/or polewood available to them, meaning that they have to resort to sources that they might not use when they have a sufficient amount, like wood from species native to the area (Fig. 11). The biomass available, for the interviewees that allowed for the necessary measurements to be taken, would last for less than 15 weeks for 56% (17/31) of the respondents, which would not allow for them to plant new saplings and allow them to grow enough for them to be harvested and used for fuelwood and/or polewood (Fig. 12). Therefore these respondents, and most likely the majority of the other 77% (117/151) of interviewees that were not willing to lead me to their trees, do not have enough wood

available to them and likely have to resort to wood from sources outside of their woodlots and/or farms (Fig. 13).

When the respondents who said that they did not have enough wood were asked if they knew of any ways to remedy this shortage of wood resources 82% (105/128) had responses that involved tree seedlings, most often in the form of *Gravellea robusta* or *Eucalyptus grandis*, as the most helpful (Fig. 14). The incorporation of trees amongst peoples' crops and into woodlots was already evident within Kizanda village; however overall there seems to be an insufficient amount of these tree seedlings being planted. Some of the issues surrounding the planting of these two main species of trees relate back to the fact that the majority of the people of Kizanda village rely on the volatile and relatively unprofitable livelihood of agriculture and therefore are often times unable to afford an amount of tree seedlings that would be able to sustain the amount of wood that they need. With a *Gravellea robusta* seedling priced at approximately 400 Tsh and a *Eucalyptus grandis* seedling around 200 Tsh, it is most likely that a family who must live day to day will concentrate on feeding themselves and collect wood from the forest or other natural trees on their way home from the farm instead of making the investment to buy trees to plant amongst their crops or in a woodlot that won't be a viable source of fuelwood or polewood until several years have passed (Mtali, 2011).

The issue of land scarcity comes into play as well when considering the decision to plant trees amongst crops, which would most likely be *Gravellea robusta,* or plant trees in a woodlot, which would most likely be *Eucalyptus grandis* (Personal Observation, 2011). The tendency for one to buy the cheaper plant in this situation, *Eucalyptus grandis*, leads to the planting of more woodlots, which occupy land that could otherwise be used for agricultural purposes. This leads to the worsening of the land scarcity problem that is present within Kizanda village (Kizanda Village Chair, 2011). The fact that 91% (20/22) of the woodlots that were measured had *Eucalyptus grandis* in them shows the inclination for respondents to plant this species of tree within woodlots, which can lead to certain issues (Fig. 15). Some of the issues associated with the planting of *Eucalyptus grandis* over large areas are related to the fact that the *Eucalyptus spp.* utilizes large amounts of water when available and lots of nutrients along with this water. This inhibits the growth of other plants within the area and therefore makes it inadvisable to plant these trees amongst crops because they tend to monopolize the water and nutrients within portion

of land on which they are planted (Myers, 1996; Mrecha, 2011). The Kizanda Village Chair (2011) brought up this issue as well and mentioned that people are being informed of the possible consequences of planting *Eucalyptus grandis* and being encouraged to plant other trees like *Gravellea robusta.* However, the price difference between these trees may discourage some from trying to plant *Gravellea robusta* amongst their crops and continue to plant *Eucalyptus grandis* in woodlots.

If this data holds true for the rest of Kizanda village then the forests, both the Baga Government Forest Reserve and the Mazumbai University Forest, near the village are at risk of experiencing a possibly detrimental loss of biomass that can exacerbate many of the issues associated with deforestation described above. Promoting the incorporation of trees like *Gravellea robusta* and *Albizia schimperiana* into the crops of the people of Kizanda village would be a way to offset the amount of wood that is being collected from the surrounding forests and would also help to lessen the scarcity of land that is bound to worsen with the projection of Tanzania's population doubling within the next 17 years (Matthews, 2011). However, the strategy of agroforestry alone will not help to mitigate the effects of deforestation and land scarcity. The potential of *Eucalyptus grandis* woodlots (or any other species) to provide fuelwood and polewood without exacerbating land scarcity is still high because there are portions of land within Kizanda that are no longer viable for agricultural purposes. With these options as viable alternatives, the people of Kizanda village need to be given the capabilities to act on their willingness to plant woodlots or trees amongst their crops. Whether this assistance comes from the Tanzanian government or from NGOs within the region does not matter as much as the need for forests like that of the Baga Government Forest Reserve to be protected in order to ensure that their environmental benefits can be prolonged for as long as possible.

Limitations

- The short amount of time that was allowed for data collection limited the amount of data and the depth of the data, in terms of lack of details concerning the situation of each interviewee, therefore limiting the degree to which conclusions can be made concerning the topic of study.

- The manner in which interviews were done opportunistically between the hours of 9:00 am and 1:00 pm holds a bias towards interviewing villagers whose farms are closer to their homes.

- Language barriers affected how well I was able to communicate with my translator, the extent to which interview questions could be accurately translated into Kishambaa and Kiswahili and then asked to respondents, and whether or not answers to interview questions were correctly translated back into English and not homogenized into a set of common responses, which is what seemed to happen during the data collection period when Abu started to group respondents' answers into categories before translating them back to me and then giving me a generalized response.

- The presence of other people during interviews, which peaked at 36 people present for one interview, influenced the answers that I received. Several times during interviews people nearby would say possible responses aloud, undoubtedly influencing the responses given by the interviewee. Even if people watching the interview did not try to give the respondent ideas aloud, their presence may have had an effect as well. Respondents may have felt the need to respond in a certain way to questions, especially those concerning the forest, and people watching, if interviewed later would most likely be influenced by the interview(s) that they had previously been present for.

- The distance people live from their farms and/or woodlots greatly limited the amount of biomass data that I was able to collect. Abu said that this was contributed to by the fact that some may not trust me and that others are "lazy".

- The techniques used to measure the circumference and height of trees inherently led to error concerning biomass calculations.

- Since the point of biomass data collection was to calculate all biomass available for fuelwood/polewood, I needed to measure all trees belonging to a household. However, the opportunity to do this was limited by the fact that families often stated that trees they would use for fuelwood and/or polewood were planted in two different areas, one of them often being at a distance too far away for them to show me, therefore preventing me from calculating the biomass for wither of their wood sources.

- There was no way for me to verify if trees were actually owned by the interviewee, which would have allowed them to point to any tree near their woodlot and/or farm and claim that it was theirs.

- Since the weight of an average bundle of wood (~30 kg) was based off of the estimate of Mr. Mrecha my biomass calculations were subject to additional error.

Recommendations

- Spending additional time Kizanda village and collecting data would possibly help to decrease the lack of trust that may have influenced both interview and biomass data and would allow for more data to be collected. Allowing more time for data collection would also make traveling to people's farms that are far away more feasible.

- Translating the interview questions into Kishambaa and Kiswahili beforehand would have lessened the chance for questions to become warped during the translation process.

- Doing interviews in private would help to remove the bias that the presence of others creates.

- The usage of more precise biomass measurement techniques would allow for less error to result during biomass calculations. Consulting with Mr. Mrecha and/or Mr. Kiparu would possibly lead to some ideas to improve these measurement techniques.

- Additional work that could be done with this project includes interviewing people within Sagara village, measuring the amount of biomass that they have available, and exploring the extent to which they have embraced alternatives to collecting resources from the nearby Sagara Forest and Baga Government Forest Reserve.

Conclusion

The situation of Kizanda village offers an excellent way to explore the social and environmental implications of deforestation. This study helped to better understand some of the many factors behind this issue. It was found that the majority of the respondents utilized wood that was collected from the forest. This is most likely due to the fact that more than half of the respondents that were willing to allow the trees they would use for wood to be measured only had enough wood to last them for less that 15 weeks and this most likely applies to the majority of the other respondents and people within Kizanda village. In order lessen the discrepancy between the amount of wood needed by the residents of Kizanda and the amount of wood available, the majority of respondents said that tree seedlings to plant amongst their crops or in woodlots would be the most helpful. However, it seemed that people were unable to afford an amount of seedlings that would eventually be able to provide a sufficient amount of wood and if seedlings were an option villagers would most likely purchase cheaper *Eucalyptus grandis* seedlings that are planted as woodlots, which take away from land that could be used for agricultural purposes.

The issues of both land scarcity and deforestation permeate the globe and are especially evident within many areas in low-income countries like Tanzania where most people rely on agriculture as a livelihood and wood as a main source of energy. In order to offset the effects of these problems, changes in land use strategies should be encouraged. Ways to utilize land for multiple purposes, like agriculture and forestry, can help to conserve land and give people alternatives sources of energy, instead of collecting from forested areas that often host high levels of biodiversity and serve to counteract other environmental issues.

References

Baba Muhammed. Personal Communication. 2011.

Baba Rashid. Personal Communication. 2011.

Beentje, Hank. 1994. *Kenya Trees, Shrubs, and Lianas.* Kenya: National Museums of Kenya.

Conte, CA. 2004. *Highland Sanctuary: Environmental History in Tanzania's Usambara Mountains*. Athens, Ohio: Ohio University Press. Pp. 1-40.

Iversen, ST. 1991. *The Usambara Mountains, NE Tanzania: History, Vegetation, and Conservation*. Uppsala universitet.

Kalaghe, AG, Msangi TH, and Johansson L. 1988. *Conservation of Catchment Forests in the Usambara Mountains*. Journal of the Tanzania Association of Foresters. Vol. 6.

Kaye, JP, Resh, SC, Kaye, MW, and Chimner, RA. 2000. *Nutrient and Carbon Dynamics in a Replacement Series of Eucalyptus and Albizia Trees*. Ecology. 81: 3267-3273.

Kiparu, SS. 2001. *Forest Mensuration Assignment.* Sokoine University of Agriculture. Morogoro, TZ.

Kizanda Council Meeting. Personal Communication. March 14, 2011.

Kizanda Village Chair. Personal Communication. April 14, 2011.

Lenth, B. 1999. *The Baga Saga*. School for International Training.

Lovett, JC, Chris, KR, Roy, EG, and Taplin, JRD. *Field Guide to the Moist Forest Trees of Tanzania*. University of York. Accessed April 2011. http://www.celp.org.uk/projects/tzforeco/.

Madding, J. 2010. *The Effect of Population Growth on Resource Conservation in Mayo Village*. School for International Training.

Matthews, Reese. Personal Communication. 2011.

Mbuya, LP, Msanga, HP, Ruffo, CK, Birnie, A, and Tengnäs, B. 1994. *Useful Trees and Shrubs for Tanzania: Identification, Propagation and Management for Agricultural and Pastoral Communities*. Dar es Salaam: Nairobi: Regional Soil Conservation Unit.

Ministry of Planning, Economy and Empowerment, Research and Analysis Working Group (MKUKUTA). *Poverty and Human Development Report*. December 2007.

Mr. Kiparu (Manager of Mazumbai University Forest). Personal Communication. 2011.

Mrecha, Modest (Former Manager of Mazumbai University Forest). Personal Communication. 2011.

Mtali, Abraham "Abu". Personal Communication. 2011.

Myers, BJ, Theiveyanathan, S, O'Brien, NDO, and Bond, WJ. 1996. *Growth and water use of Eucalyptus grandis and Pinus radiata plantations irrigated with effluent.* Tree Physiology. 16: 211-219

Noad, Tim and Ann Birnie. 1994. *Trees of Kenya*. Nairobi: T.C. Noad and A. Birnie.

Persha, L. "Trees >10 DBH Measured from Mazumbai, Baga, and Sagara Forest." PhD Dissertation Research. August, 2007.

Personal Observation. 2011.

Sangai, GRW. 1963. *Dictionary of Native Plant Names in the Bondei, Shambaa, and Zigha Languages with Their English and Botanical Equivalents*. East African National Historical Society: Nairobi, Kenya.

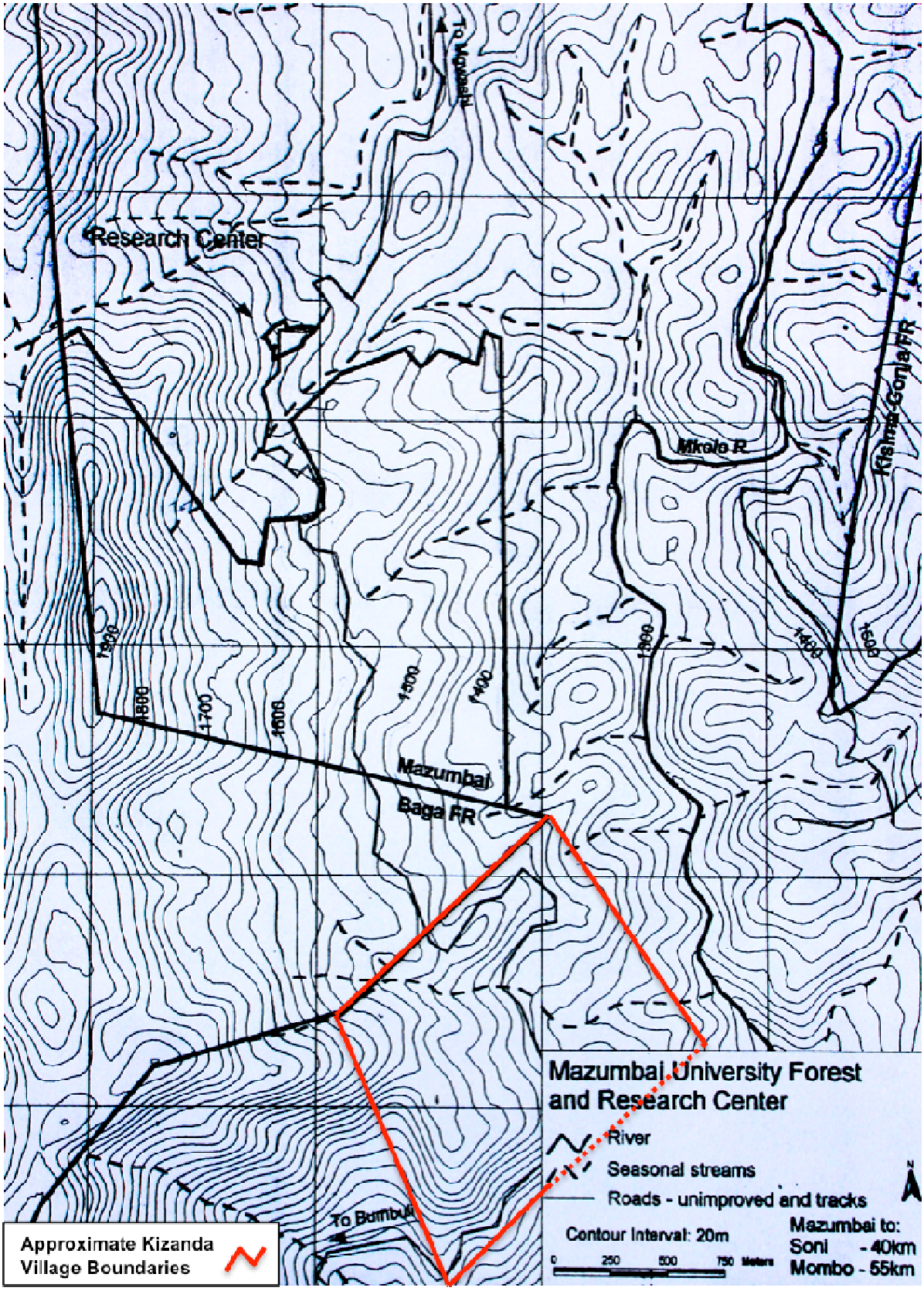
Schulman, L, Junikka, L, Mndolwa, A, and Rajabu I. 1998. *Trees of Amani Nature Reserve*. Helsinki: Helsinki University Printing House.

Tanzania Forest Conservation Group. Personal Communication (w/ Wycliffe Peter Massolwa and Simon C. Lugazo). 2011.

Terborgh, J. 1992. *Diversity and the Tropical Rainforest*. New York: Scientific American Library.

The World Bank. 2004. *2004 World Development Indicators*. Washington D.C.

Appendix A: Map of Kizanda Village, the Baga Government Forest Reserve, and the Mazumbai University Forest



Appendix B: Interview Sequence

1) Name, Baba or Mama, Occupation
2) What is the size of your household?
3) How many bundles of fuelwood/polewood does your household use per week?
4) Where do you get your fuelwood/polewood?
5) How long does it take you to get your fuelwood/polewood?
6) How many times per week do you collect fuelwood/polewood?
7) What types of fuelwood/polewood do you grow?
8) What types of fuelwood/polewood do you use?
9) How many bundles of fuelwood/polewood are in your house right now?
10) What types of fuelwood/polewood are in your house right now?
11) Do you have enough fuelwood/polewood?
12) What would help you get enough fuelwood/polewood?
13) Do you know if anyone goes into the forest?
14) Why do/don't they go into the forest?
15) Do you ever go into the forest?
16) Why do/don't you go into the forest?
17) Can you lead me to where you grow trees that you'll use for fuelwood and/or polewood? (If they were not willing to lead me to the location of their trees I asked them to approximate the number of trees that they have. If they were willing to lead me to the location of their trees than biomass data was collected.)

Appendix C: Kishambaa Name, Latin Name, and Available Densities

Kishambaa Name	Latin Name	Present in Forest	Density (kg/m^3)
agrocapasi		no	
manndai	Agarista salicifolia	yes	
mbamba	Bersama abyssinica	yes	
mchai	Thea sinensis	no	
mdongonyezi	Toddalia asiatica	yes	
mfenesi	Artocarpus heterophyllus	no	600
mfufu	Cordia abyssinica	yes	530
mhendehende		yes	
mihekra		yes	
mkaitusi	Eucalyptus grandis	no	495
mkokoko	Casearia engleri	yes	620
mkonde	Myrianthus arboreus	yes	
mkongolo		yes	
mkumba	Macaranga kilimandscharica	yes	400
mkunguma	Deinbollia adusta	yes	
mkuyu	Ficus capensis	yes	390
mkwinini	Synchona hybridas	no	
mnyasa	Newtonia buchanani	yes	480
mpalachichi	Persea spp.	no	470
msaji		yes	
msambia	Chrysophyllum gorangosanum	no	
msambu	Allanblackia stuhlmannii	yes	
msasa	Ficus exasperata	yes	390
mshai	Albizia gummifera	yes	510
mshegheshe	Myrica salicifolia	yes	
mshinga	Trema orientalis	yes	310
msongoma	Gravellea robusta	no	519
mtei	Maesa lanceolata	yes	
mueza	Senecio syringifolia	yes	
muula	Parianaria excelsa	yes	690
muuwati	Dombeya torrida	no	705
muwembe	Mangifera indica	no	550
muweti		yes	
mvumo	Ficus thonnigii	yes	510
mvuti	Lippia asperifolia	yes	
myombeyombe		yes	
mzaituni		no	
mkuti	Chrysophyllum gorangosanum	yes	
mkulo	ocotea usambarensis	yes	510

(Beentje, 1994), (Lovett, 2011), (Mbuya, 1994), (Mr. Kiparu, 2011), (Mtali, 2011), (Noad, 1994), (Persha, 2007), (Sangai, 1963), (Schulman, 1998)

Appendix D: ISP Evaluation

a) The ISP process changed my learning style by forcing me to be flexible in the way I conducted my study and in the way that I present my work. Dealing with small issues throughout my study forced me to be resourceful with both my time and resources in order to collect a sufficient amount of data. Having the opportunity to incorporate information that is gathered directly from primary sources helped to reemphasize the importance of these perspectives within a study and within the greater dialogue concerning the issues I studied during my ISP.

b) The main problem that I encountered during my ISP was gathering biomass data. I was not led to enough farms and/or woodlots. I was not able to solve this problem.

c) I used structured interviews in order to efficiently gather information that was applicable to my study and to collect data that would later be quantifiable. This method was used because of its successful usage within previous ISPs. Biomass data was calculated from information collected during the measurement of tree attributes on farms and woodlots. These methods were designed with the help of Mr. Kiparu and Mr. Mrecha.

d) N/A (no advisor)

e) I did not reach any dead ends.

f) One of the most important insights that I gained was from collecting data within Kizanda village. Having the opportunity to learn about the lifestyles of people within rural Tanzania and more specifically Kizanda village is something I would never have gained if I had not done an ISP. My study helped to emphasize the welcoming nature that pervades the majority of the people that I have met within Tanzania.

g) I would have undertaken the same project.

Appendix E: Nuts and Bolts

- Travel: The bus to Soni from Arusha costs between 12,000 and 20,000 Tsh. From there you can hire a driver for around 80,000 Tsh to drive you to Mazumbai. This amount can be split amongst the group.
- Food: You can purchase all of your food in Arusha and bring it up with you to Mazumbai, which is what we did, or you could purchase food for a week and then restock at the market on Saturdays. This decision depends mostly on whether or not it is the rainy season. Bring your own peanut butter. It's around 3,000 Tsh per day for the cooks, Richard and David.
- Accommodations: A room is 5,250 Tsh a night.
- Translators: A translator should be 7,000 Tsh per day. Translators I know of are Abu and Beatrice.
- Interviews: Each interviewee receives 500 Tsh after an interview. Try not to give interviewees more than this amount.