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Determinants of the Availability of Non-timber Forest Products for Households' Adaptation to the Effects of Climate Variability in Iringa District, Tanzania

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Abstract

This cross-sectional study was conducted to examine determinants of the availability of non-timber forest products (NTFPs) for household use as a strategy for adapting to the effects of climate variability in the Kitapilimwa Forest Reserve (KFR) in Iringa district, Tanzania. The study involved 400 participants. Data were collected through structured interviews, in-depth interviews, focused group discussions, field observation and documentary review. Findings reveal that local communities in the study area are vulnerable to the effects of climate variability. Also, they show that 52.4% of the respondents extracted NTFPs from the KFR as a strategy for adapting to the effects of climate variability. Besides, the study found that the main determinants of the availability and effective household use of NTFPs as an adaptation strategy are anthropogenic degradation and loss of NTFPs, the implications of KFR access by-laws, effects of climate variability on the availability of NTFPs, perception of fairness of trade in NTFPs, and seasonal availability of NTFPs. The study concludes that despite the important role of NTFPs from the KFR being used as a strategy for adapting to the effects of climate variability, there are factors that limit the availability and effective household use of NTFPs as an adaptation strategy. It is recommended that the government involve local communities in developing a policy framework that promotes a sustainable harvesting of NTFPs. Also, the government and the private sector should support all efforts to diversify livelihood sources of rural households to reduce their dependency on natural forests. Lastly, the government should monitor and regulate trade in NTFPs.

Keywords: *non-timber forest products, semi-arid, climate variability, adaptation*

1. Introduction

Forests provide timber and non-timber forest products (NTFPs) needed by human beings for household and industrial use (Kalame, 2011; Endamana et al., 2016). NTFPs are all goods of biological origin, except timber, derived from forests for human utilisation (Ahenkan & Boon, 2011; Tieminie et al., 2021). NTFPs provide food, energy (charcoal and firewood), building materials, income, medicines, and cultural materials (Paumgarten & Shackleton, 2011;

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Endamana et al., 2016). Wild edible foods from NTFPs include fruits, mushrooms, vegetables, edible insects and worms, tubers and roots, honey, bush meat, seeds and eggs (Ruffo et al., 2002; Arnold et al., 2011; Russell et al., 2015; Endamana et al., 2016). Ruffo et al. (2002) observed that some wild foods are more nutritious than cultivated agricultural crops. For instance, iron content in the leaves of *Gynandropis gynandra* (L.) Briq. and *Tamarindus indica* is about 6.2mg/100g higher than some domesticated species like broccoli (1.5mg/l00g), cabbage (1mg/l00g), and cauliflower (0.5mg/l00g).

Climate variability has had devastating effects on the livelihoods of people in the world (Kangalawe, 2012; URT, 2012; Haule, 2021). Smallholder farmers in Sub-Saharan Africa (SSA) are more vulnerable to the effects of climate variability due to their great dependency on livelihood sources—such as crop production, livestock keeping and forest products—which are climate-sensitive (FAO, 2009; Tieminie et al., 2021). Similarly, due to poverty, smallholder farmers occupy more vulnerable areas and lack the necessary resources for adapting to the effects of climate variability (World Bank, 2005). In Tanzania, climate change and variability have crippled crop farming, animal husbandry, biodiversity, infrastructure and human health (Mongi et al., 2010; Kangalawe, 2012; URT, 2012).

Like elsewhere in the world, households in Iringa district, Tanzania, are vulnerable to the effects of climate variability (URT, 2013; Kihupi et al., 2015; Haule, 2019). Semi-arid conditions, coupled with households' dependency on climate-sensitive livelihoods, increase households' propensity of being affected by climate variability (Tairo, 2011; Kihupi et al., 2015; Kihupi, 2016). URT (2013) observed that crop production in the district has declined due to, among others, unreliable rainfall regimes. The majority of households in Iringa district depend on forest products for their daily livelihood needs (Tairo, 2011; Haule, 2019). Since NTFPs in Iringa district are many (URT, 2013), and are less vulnerable to the effects of climate variability (Nkem et al., 2010), their constant availability and accessibility can help households to enhance their resilience to the effects of climate variability.

For NTFPs to assist households to adapt to climatic shocks, they have to be constantly available, and households be assured of access to them (Mwaiteleke, 2015; Tieminie et al., 2021). However, the availability and access to NTFPs, and the factors that determine availability and accessibility, vary across time and space (Nkem et al., 2008; Pramova et al., 2012). Shackleton and Shackleton (2006) insist that the level of dependency on NTFPs, quantity used and the value derived differ across time and space. Thus far, little is known on the determinants of the availability of NTFPs from the Kitapilimwa Forest Reserve (KFR) in Iringa district for use in adapting to the effects of climate variability.

For instance, forest management regimes dictate ownership, control and access to forest resources, including NTFPs. For Tanzania, the National Forest Policy of 1998 and the Forest Act of 2002 give rights to local communities to participate in forest management in the form of participatory forest management (PFM), which is either Joint Forest Management (JFM) or Community Based Forest Management (CBFM) (Blomley & Iddi, 2009). Under JFM, joint management agreements (JMAs) define, among others, the duties and benefits local communities will get by co-managing a reserve, including the collection of NTFPs and a certain percent of fines and fees collected from a reserve (Blomley & Iddi, 2009; Persha & Meshack, 2016).

The KFR is owned by the central government, and is jointly managed by five (5) surrounding villages: Itagutwa, Kitapilimwa and Mfyome (in Kiwere ward); Kinywang'anga (in Kising'a ward); and Mawindi (in Nyang'oro ward) (URT, 2001; Haule, 2022). The forest was declared a reserve in 1952 by Act No. GN1952/299. It has an average size of 3,699ha (URT, 2001). The reserve is under JFM since 2002, but little is known on the extent to which NTFPs from KFR are used as a strategy for adapting to the effects of climate variability. Similarly, there is scanty information on how this management regime affected the availability and households' access to KFR for NTFPs.

Indeed, a decreased supply and access to NTFPs increases households' vulnerability to the effects of climate variability (Mwaiteleke, 2015), particularly in semi-arid areas where climate variability effects are severe (Tairo, 2011; Kihupi et al., 2015). Understanding the nature of the availability and access to NTFPs in semi-arid areas is essential for policy and putting in place strategies geared towards improving households' use of NTFPs as a way of adapting to the effects of climate variability. This study was undertaken to widen the understanding of the factors that influence the availability of NTFPs from the KFR to enhance households' resilience to the effects of climate variability in Iringa district. The study is in line with the Tanzania's National Adaptation Programme of Action (NAPA), which advocates for the use of NTFPs as an adaptation strategy.

2. Theoretical Framework

This paper is informed by the ecosystem-based adaptation (EbA) approach. According to CBD (2009), EbA refers to the use of ecosystem services for adapting to the effects of climatic disasters. Also, EbA is about the human use of ecosystem goods and services as a strategy for adapting to the impacts of climate change and variability (Travers et al., 2012; Scarano, 2017). Ecosystem services are the benefits human beings get directly or indirectly from ecosystems (CBD, 2009). These are provisioning services such as NTFPs; regulating services such as climate regulation; cultural services such as recreation and research; and, lastly, supporting services such as nutrient cycling (CBD, 2009; Scarano, 2017).

According to Andrade et al. (2010) and Pramova et al. (2012), EbA is more stressed for its effectiveness in reducing people's vulnerability to the effects of climate change and variability, its cost-effectiveness, its co-benefits for ecosystem conservation, its easy accessibility to poor rural households, and its mitigation/reduction of poverty. However, despite all these useful insights of EbA, there is a little understanding of the determinants of the availability of NTFPs from KFR for household use as a strategy for adapting to the effects of climate variability. Since NTFPs are more resilient to the effects of climate variability than agricultural crops (Nkem et al., 2010; Scarano, 2017), it was vital to examine the adaptation role of NTFPs and factors affecting their availability in semi-arid areas of Iringa district as the effects of climate variability become severe. The EbA was selected to inform this paper because it focuses on local communities' vulnerability to the effects of climate variability, and how ecosystem goods and services—in this case NTFPs—can be used to enhance the resilience of local communities, while maintaining ecosystem stability (CBD, 2009; Tieminie et al., 2021).

According to CBD (2009) and IUCN (2009), effective EbA depends on the availability and local community's access to healthy ecosystems. Hergarten (2013) insists that the needs and interests of local communities must be given special attention when implementing EbA. Due to this, this paper also examines local communities' perceptions of the availability, accessibility and use of NTFPs from the KFR as a strategy for adapting to the effects of climate variability. Nelson et al. (2007) and Nkem et al. (2008) observed that – if well managed and communities have access to them – NTFPs and forests in general are resilient enough to be used as a strategy for adapting to the effects of climate variability while maintaining ecosystem stability.

EbA is criticized for not clearly emphasizing the need for local communities to own, control and have access to ecosystem goods and services for adaptation, not being able to quantify its benefits/costs compared to hard adaptation options, and for its long waiting time. Also, EbA, is criticized for not clearly admitting the presence of barriers such as restricted access, degradation and loss of ecosystem services, unfair terms of trade in ecosystem goods and services, and impacts of climate change and variability on ecosystem services (Hergarten, 2013; Reed et al., 2013; Mellmann, 2015; Scarano, 2017). Despite these criticisms, EbA remains a useful theoretical framework for assessing the role of NTPFs as a strategy for adapting to the effects of climate variability, and factors that determine their availability.

3. Context and Methods

3.1 Description of the Study Area

This study was conducted in semi-arid areas of Iringa district (Figure 1). Iringa district lies between latitudes 7° 00' and 8° 30' S and between longitudes 34° 00' and 37° 00' east of Greenwich (URT, 2013) (Figure 1).

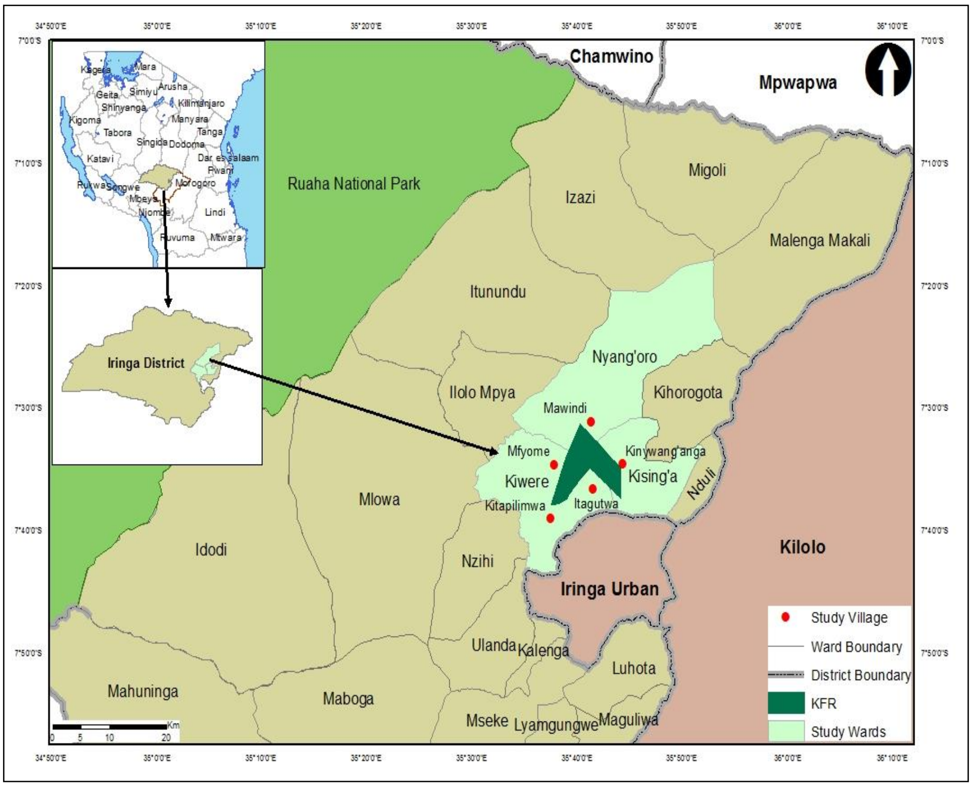


Figure 1: Location of the Study Area
Source: Field data, 2021

Figure 1 shows the five study villages that surround and jointly manage the KFR. This forest reserve was selected for the study because, first, it is jointly managed by the government and the five surrounding villages; and, second, the management by-laws permit the surrounding villages to extract NTFPs from it since it is a production forest. Besides, there was scanty information on the determinants of the availability and effective use of NTFPs from the KFR for enhancing households' resilience to the effects of climate variability.

The climate in Iringa district varies with altitude which, is divided into two (2) zones: the midland, and lowland zones. The midland zone receives moderate mean rainfall ranging from 600–1,000mm annually, with mean annual temperature of 15°C–20°C. The lowland zone receives low mean rainfall ranging from 500–600mm annually, with mean annual temperature ranging between 20°C–25°C (URT, 2013). Iringa district is predominantly covered with dry miombo woodlands (Tairo, 2011). Though vulnerable to the effects of climate variability, smallholder agriculture is the dominant economic activity in the district, contributing almost 99% of the district's GDP (URT, 2013).

3.2 Sample Size and Sampling Procedures

The study used purposive sampling to sample 40 focused group discussion (FGD) participants, 8 from each village, based on Prince and Davies (2001), who recommended that 6–12 participants are enough to form an FGD group; 32 key informants who were the district forestry officer (DFO), the Tanzania Forest Services Agency (TFS) district manager, 5 village executive officers (VEOs) and 25 members of village natural resources committees (VNRCs). Also, the studied villages were purposively sampled because they managed the KFR under JFM, and the KFR management by-laws permitted them to harvest NTFPs from the KFR. In addition, the villages were purposively sampled due to their vulnerability to the effects of climate variability (Haule, 2021, 2022). Creswell (2014) argued that purposive sampling gives a researcher a great freedom of choosing participants who have great relevance to the problem under study. Household heads constituted the sampling unit of this study, while the sampling frame consisted of 1826 households. By using Yamane's (1967) formula, a proportional sampling technique was employed to draw a sample from each village, whereby 328 household heads were sampled. Household heads who were sampled were supposed to have entered the KFR at least once in the last 10 years to forage for NTFPs. Lists of household heads obtained from the VEOs' offices were used to sample the 328 household heads systematically. Table 1 shows the total number of participants of this study.

Table 1: **Summary of Participants**

Category of Participant	Itagutwa	Kitapilimwa	Kinywang'anga	Mawindi	Mfyome	Total
Household Heads	79	46	36	38	129	**328**
FGDs participants	8	8	8	8	8	40
DFO						1
District TFS Manager						1
VNRC members	5	5	5	5	5	25
VEOs	1	1	1	1	1	5
Total	**93**	**60**	**50**	**52**	**143**	**400**

Source: Field Data, 2021

3.3 Sources of Data and Data Collection Methods

The study used both quantitative and qualitative research designs. The triangulation of the research designs was intended to increase the validity and reliability of the research findings (Creswell, 2014). Primary quantitative data were collected using structured interviews. The structured interviews helped to maintain uniformity in responses for easy coding and entering the data into the Statistical Products and Service Solutions (IBM SPSS) software, version 25, for analysis. Qualitative data were collected using in–depth interviews, field observation and FGDs, with one (1) FGD being conducted in each village. The FGD method was chosen because of its ability to gather a large volume of data from many participants at a time about participants' personal experiences, perceptions and attitudes about the problem under investigation (Prince & Davies, 2001; Nyumba et al., 2018). The in–depth interviews method was employed due to its ability to deeply explore experiences, opinions and perceptions of the key informants (Creswell, 2014). The direct field observation method was used to supplement and crosscheck the data that were collected by using the other methods. Secondary data were collected using documentary review. Temperature and rainfall data of the Iringa district for the past 31 years (1986–2016) were collected from the Tanzania Meteorological Agency (TMA). The collection of secondary data intended to triangulate the primary data, and ascertain information gaps (Haule, 2022).

3.4 Data Analysis

The IBM SPSS software was used to analyse quantitative data. Descriptive statistics (frequencies, mean and percentages) were computed to quantify data from structured interviews. The software was also used to run the Mann-Kendall test (Kendall's tau) to establish rainfall and temperature trends at 5% level of significance with $p<0.05$ for the study period (1986–2016). A chi-square (χ^2) test with 5% level of significance and $p<0.05$ was used to test the statistical relationship between the studied villages and the use of NTFPs as a strategy for adapting to the effects of climate variability. Furthermore, the study used the coefficient of determination (R^2) to analyse variability in dependent variables (Y) that may be attributed to changes in independent variables (X). An R^2 of 1 shows that all variations in Y are attributed to X, whereas an R^2 of 0 shows that there is no linear relationship between Y and X variables. A thematic analysis was employed to analyse qualitative data, in which case themes and subthemes were generated. Thematic analysis enabled data analysis to take place throughout the data collection stage, as in Dawson (2007).

4. Results and Discussion

4.1 Socio-economic and Demographic Characteristics of the Respondents

Respondents' vulnerability to the effects of climate variability and their awareness of the determinants of the availability of NTFPs for adapting to the effects of climate variability are greatly shaped by their socio-economic and demographic characteristics as observed in Kangalawe and Lyimo (2013) and Omolo and Mafongoya (2019). The study examined the socio-economic and demographic characteristics of the respondents as shown in Table 2.

The findings in Table 2 show that 28% of the respondents were aged 40–49 years, whereas 20.1% were aged 60+ years. Male and female respondents were 64.6% and 35.4%, respectively. The majority of the respondents (72%) were married. Also, respondents with primary level education constituted the majority (84.1%). About 55.8% of the households had 4–6 members.

Table 2: Socio-economic and Demographic Characteristics of the Respondents (N=328)

Characteristic	Category	Frequency	Percent
Age	30–39	84	26
	40–49	92	28
	50–59	86	26
	60+	66	20
Gender	Male	212	64.6
	Female	116	35.4
Marital Status	Married	236	72
	Single	14	4.3
	Divorced	5	1.5
	Separated	20	6.1
	Widow	39	11.9
	Widower	14	4.3
Education	Illiterate	20	6.1
	Primary education	276	84.1
	Adult education	8	2.4
	Ordinary level sec. education	23	7
	Tertiary education	1	0.3
Household size	1–3 persons	85	25.8
	4–6 persons	183	55.8
	7–9 persons	48	14.8
	10+ persons	12	3.6
Occupation	Crop farming	248	75.6
	Mixed farming	79	24.1
	Formal employment	1	0.3

Source: Field data, 2021

Also, the findings show that 75.6% and 24.1% of the respondents depended on crop farming and mixed crop farming, respectively, as their main economic activities. Heavy reliance on agriculture, which is climate-sensitive, suggests higher vulnerability to the effects of climate variability, implying high demand for NTFPs for enhancing their resilience to the effects of climate variability as noted in Kalame (2011) and Tieminie (2021).

4.2 Local Perceptions of Climate Variability

Household survey results revealed that almost all respondents (99.4%) had perceptions that climate in the study area had varied over the past 20 years. FGDs found that the experience of the local environment was the main source of households' awareness of climate variability. In-depth interviews with the VEOs of Kinywang'anga and Mawindi revealed that frequencies of drought are increasing, coupled with erratic rainfall onset and cessation. The results suggest that most of the households in Iringa district are aware of climate variability. The results are in line with those by Mwamfupe (2014), who reported that 91% of the respondents in Rufiji district were aware of climate change.

Similarly, Macharia et al. (2012) found that all immigrant farmers in semi-arid regions of Kenya were aware of climate change. An analysis of meteorological data from the TMA for 31 years (1986–2016) revealed an increasing trend in mean annual temperature (R^2= 0.543); and the increase was statistically significant (p = 0.000) as shown in Figure 2.

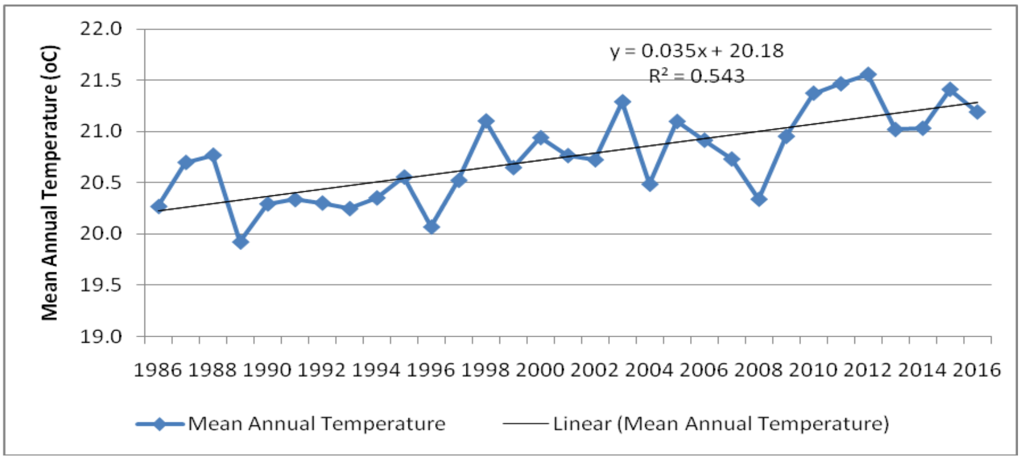


Figure 2: Mean Annual Temperature Trend of Iringa District (1986–016)
Source: TMA, 2021

Also, the annual total rainfall for the same period showed a slight increasing trend (R^2 = 0.071); and the increase was statistically non-significant (p = 0.284) as shown in Figure 3.

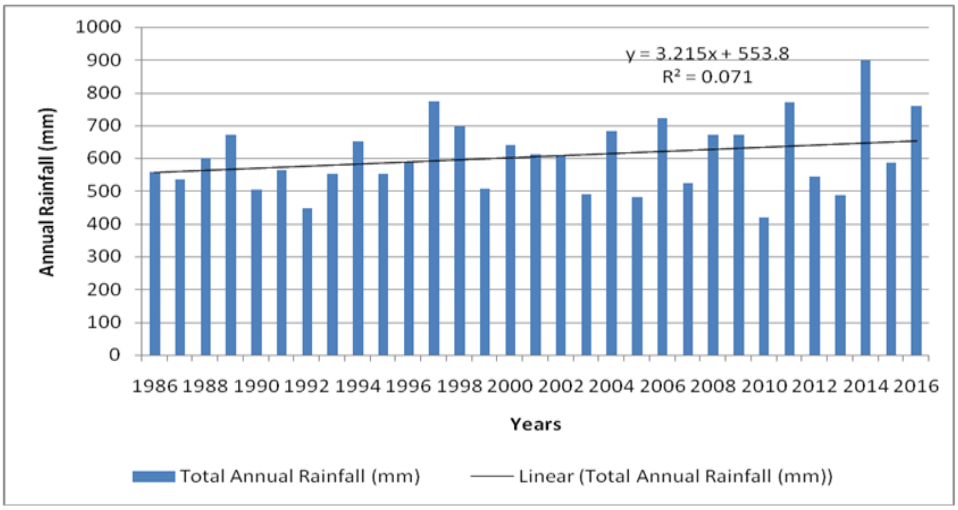


Figure 3: Total Annual Rainfall Trend of Iringa District (1986–2016)
Source: TMA, 2021

Furthermore, the study examined annual rainfall deviation from the mean (605.2mm) for the study period (1986-2016). Figure 4 presents the findings.

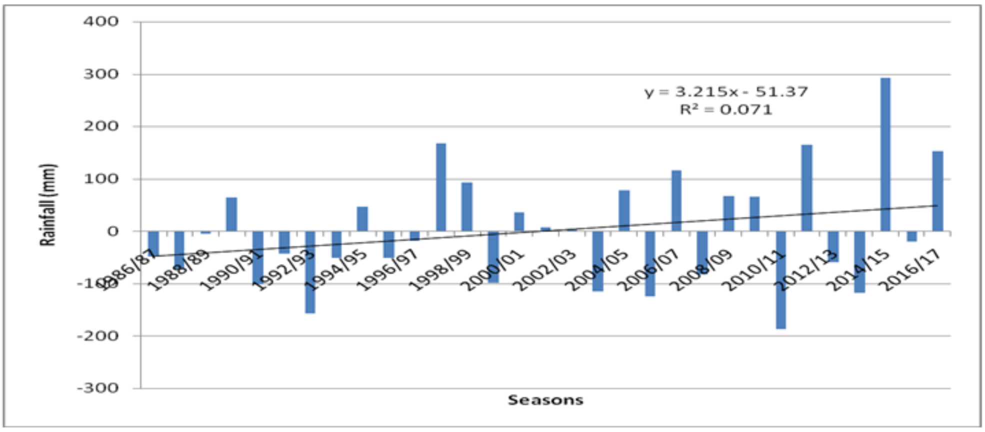


Figure 4: Rainfall Anomaly Trend of Iringa District for the 1986/1987–2016/2017 Seasons

Source: TMA, 2021

The findings in Figure 4 reveal that for the period 1986–2016 the study area received rainfall below the mean for 17 years. The findings suggest that rainfall is low and erratic in semi-arid areas of Iringa district, with considerable effects on households' climate-sensitive livelihood sources such as rain-fed crop farming. FGDs in all the study villages revealed that the effects of climate variability included reduced maize crop yields, loss of income, and increased costs of production in items such as purchasing pesticides and drought-tolerant seeds. These effects of climate variability on livelihoods compelled households to adopt different adaptation strategies, including the use of NTFPs from the KFR.

4.3 Household Use of NTFPs as a Strategy for Adapting to the Effects of Climate Variability

Healthy and accessible NTFPs can be used as one of the strategies for adapting to the effects of climate variability (Pramova et al., 2012; Msalilwa et al., 2013). This study examined household's use of NTFPs from the KFR as a strategy for enhancing their resilience to the effects of climate variability. It was found that 52.4% of the respondents were using NTFPs from the KFR as a strategy for enhancing their resilience to the effects of climate variability. The results are slightly similar with those by Msalilwa et al. (2013), who reported that 43% of the respondents used NTFPs from the New Dabaga-Ulongambi Forest Reserve, in Kilolo district, to respond to climatic shocks. However, the results are lower than those reported by Paumgarten and Shackleton (2011) who found that, in Eastern Cape and Limpopo provinces, South Africa, 70% of the respondents used NTFPs as a strategy for coping with the impacts of droughts and floods. These differences in household use of NTFPs for adaptation may be attributed to local disparities in vulnerability to the effects of climate variability, and variations in the availability and accessibility to NTFPs.

Figure 5 presents findings on the village-wise analysis of household use of NTFPs as an adaptation strategy.

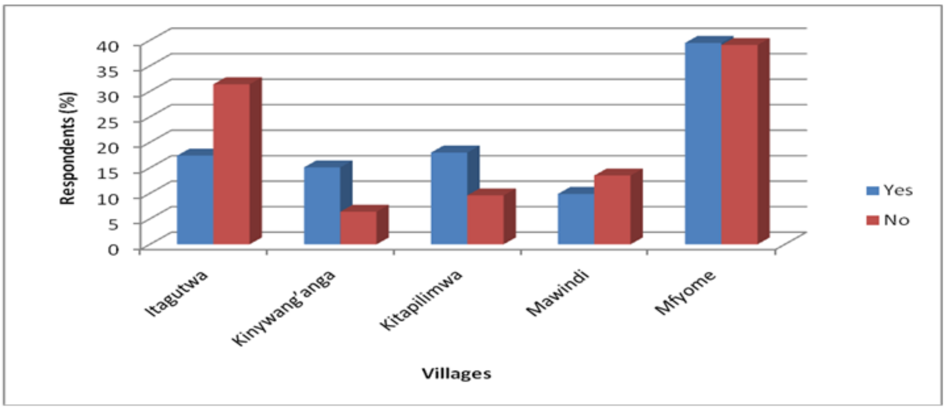
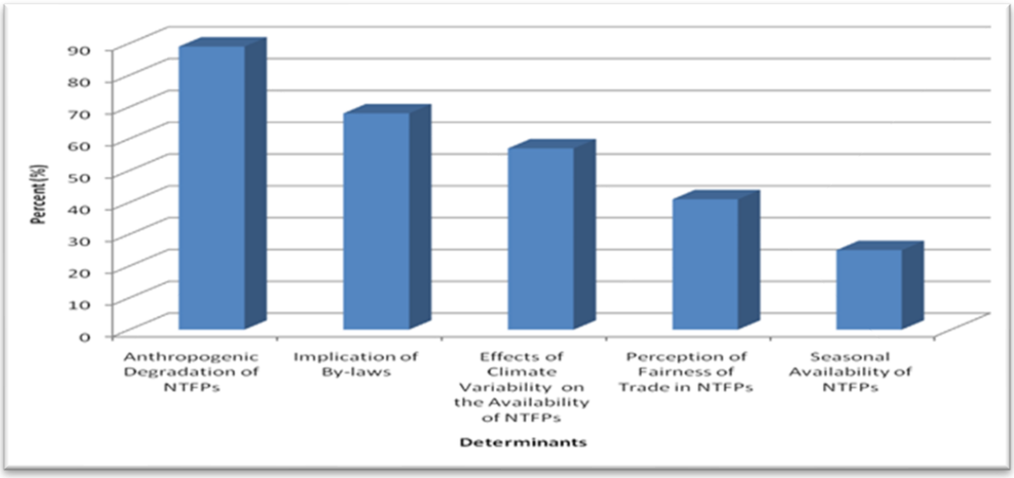


Figure 5: Household Use of NTFPs as an Adaptation Strategy
Source: Field data, 2021

According to Figure 5, about 39.5% and 9.9% of the respondents in Mfyome and Mawindi, respectively, used NTFPs from the KFR as an adaptation strategy. In-depth interviews with VNRC members in all the studied villages found that even the prohibited NTFPs—such as charcoal and poles—were also being harvested, though illegally. FGDs in Mfyome and Kinywang'anga showed that dependency on the KFR for NTFPs increased in lean seasons. The results of a Chi-square test showed a significant statistical difference in village-wise use of NTFPs as an adaptation strategy at 0.05 (χ^2 value = 17.308, degree of freedom = 4, p value = 0.002). The results revealed great village-level variations in household use of NTFPs from KFR as a strategy for adapting to the effects of climate variability. The variations may be due to differences in the extent of vulnerability, distance to KFR, access to KFR for NTFPs, and the availability of other adaptation strategies.

4.4 Determinants of the Availability and Effective Use of NTFPs as an Adaptation Strategy

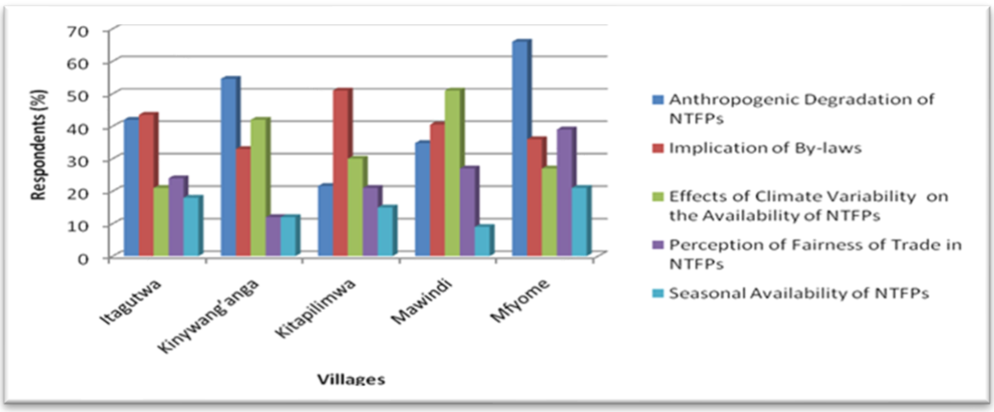
Though NTFPs contribute to enhancing households' resilience to the effects of climate variability, there are many factors that limit their availability, accessibility and utilisation as noted in Paumgarten (2007) and Mwaiteleke (2015). The study examined local perceptions of the factors that determined the availability and effective utilisation of NTFPs from the KFR as a strategy for adapting to the effects of climate variability as shown in Figure 6.



Based on Multiple Responses Analysis

Figure 6: Major Determinants of Availability and Use of NTFPs from KFR for Adaptation
Source: Field data, 2021

The findings in Figure 6 show that anthropogenic degradation of NTFPs was ranked first (89%), while seasonal availability of NTFPs was least reported (25%). The results of village-wise analysis of these factors are presented in Figure 7. It can be noted that, at the village level, respondents had different perceptions of the factors that determined the availability and effective use of NTFPs from the KFR for enhancing households resilience to the effects of climate variability.



Based on Multiple Responses Analysis

Figure 7: Village-wise Perceptions of the Determinants of Availability and Effective Use of NTFPs from KFR for Adaptation
Source: Field data, 2021

4.4.1 Anthropogenic Degradation of NTFPs

Based on Figure 7, many respondents (66%) in Mfyome, and a few respondents (21.6%) in Kitapilimwa, reported that anthropogenic activities had led to the degradation of NTFPs in the KFR. Field observation found that Mfyome is very close to the reserve (e.g., the distance to the reserve at Msosa and Matembo sub-villages was about 100 meters), rendering encroachment easy. An in-depth interview with the district TFS manager and FGDs revealed that the main anthropogenic activities degrading NTFPs in the KFR included unsustainable harvesting of NTFPs, charcoal-making, grazing, lumbering/logging, fire and settlements. One member of a VNRC in Mfyome reported that the reserve had been subjected to overharvesting and illegal harvesting of timber, charcoal, firewood and hunting. Also, fire was common in the reserve. These challenges necessitated TFS to restrict villagers from harvesting anything from the reserve for five years, beginning from 2016, to let the forest rejuvenate. An in-depth interview with the DFO revealed that the KFR is located close to the market of its NTFPs, i.e., Iringa town (about 30km), which propels overexploitation. In-depth interviews with the VEOs of Mfyome and Itagutwa found that the Maasai herdsmen encroached and settled in the reserve until 2014 when they were forcibly evicted.

These findings resonate with those of Mwaiteleke (2015), who found that anthropogenic degradation of forests was the main driver of the decline in the availability, quality and quantity of NTFPs, though his study focused on open-access forests. The results are affirmed by Haule (2010) who observed that cutting live trees for curing tobacco, logging and building materials were among the factors behind forest degradation in Namtumbo district. Also, the results echo those by Woittiez et al. (2013), who found that forest degradation and loss in Zimbabwe affected the efficient use of wild edible fruits as a strategy for enhancing people's resilience to drought, though their study focused on wild edible fruits. Due to that, the villagers had to spend more time in the wild searching for the wild edible fruits.

4.4.2 Implications of By-laws

Perceptions of the implications of by-laws were reported by 68% of the respondents (Figure 6). FGDs revealed that households in all the studied villages had different opinions on by-laws. However, the majority asserted that the by-laws were too strict, thereby compromising households' access to the KFR for NTFPs. Their laments were on the few days per week (Tuesday and Saturday) that they were allowed to enter the reserve to forage for NTFPs; access to the reserve not being determined by households' demand for NTFPs; prepayment of entry fee if the NTFPs are collected for sale; limited amount of NTFPs to be harvested; and a few types of NTFPs allowed to be harvested from the reserve. The study found that the KFR management by-laws allowed local communities to extract only five (5) types of NTFPs: fruits, wild vegetables, mushrooms, dead wood, and medicinal plants. During in-depth interviews, VNRC members asserted that since the TFS took charge of the reserve, access to it was quite restrictive. They also revealed that TFS patrol guards dealt with intruders harshly. To the households, these restrictions meant reduced access to the KFR; implying low supply of NTFPs. These findings concur with those by Robinson and Lokina (2009), and Tarimo and Ringo (2016), who observed that, though JFM reduced forest degradation and loss, local communities were on the losing side by being denied access to forest-based livelihoods. Strict forest access by-laws imply prohibition to harvest NTFPs for adaptation (Balama et al., 2016). Also, it implies displacing degradation to less protected forests (Robinson & Kajembe, 2009). The results suggest that it is important for all stakeholders of the KFR and other reserved forests to work together and pass by-laws that ensure sustainable utilisation of the forest-based resources.

4.4.3 Effects of Climate Variability on the Availability of NTFPs

Climate variability influences the availability, abundance and distribution of forest resources, including NTFPs, as noted in Onyekuru and Marchant (2014), and Scarano (2017). About 57% of the respondents (Figure 6) revealed that climate variability affected the availability and effective use of NTFPs as a strategy for adapting to the effects of climate variability. A village-wise analysis (Figure 7) indicated that Mawindi had many respondents (51%) who had perceptions that climate variability affected the availability of NTFPs, while Itagutwa had a few respondents (21%) who associated low availability of NTFPs in the KFR with climate variability. It was revealed during FGDs that droughts and high temperatures affected the availability of NTFPs. With drought, trees and plants do not blossom well, and thus bees lack flowers to extract nectar for making honey. FGDs further revealed that sometimes maize flour was given to bees to eat so as to be able to produce honey.

Besides, it was reported during FGDs that mushrooms become rare, and at times poisonous, when drought strikes. This was observed particularly in 1992, 1999, 2003, 2010 and 2013. Likewise, with low rainfall, wild edible fruits become rare and, for the few which are available, they become sour. In addition, high temperatures exacerbate bush fires that burn NTFPs and forests in general. In-depth interviews with VNRC members showed that bush fires burn litters that favour the growth of mushrooms, decreasing the availability of mushrooms. Also, in a season with low rainfall, *Hodotermitidae* and *mang'eng'i* do not appear; or appear in very small amounts. The VEO of Mfyome affirmed that the declining availability and abundance of NTFPs in the KFR compromised household food security, health and income. The findings are confirmed by Balama et al. (2013), who observed that decreasing rainfall has led to a decline in the availability of mushrooms and wild fruits in Kilombero district. Also, in Matobo district, Zimbabwe, Dube and Phiri (2013) found that climate change and variability led to the decline in the quality and quantity of wild fruits and honey, affecting local communities' food, income and health.

4.4.4 Perception of Fairness of Trade in NTFPs

About 41% of the respondents (Figure 6) revealed that trade in NTFPs was not fair. Village-wise, Mfyome had many respondents (39%) who felt that trade in NTFPs was not fair (Figure 7). FGDs with traders of NTFPs, together with in-depth interviews with VNRC members, showed that unfair trade in NTFPs compromised the usefulness of NTFPs as a strategy for enhancing household's resilience to the effects of climate variability. Low prices of NTFPs discouraged people to trade in NTFPs, hence threatening household income. For instance, field observation revealed that the price of a pile of mushrooms in Mfyome was TZS500, but the price of the same pile in Iringa town, a distance of about 30km, was TZS2,000. It was further found that the price of a bag of charcoal (though illegally harvested) was about TZS12,000 in Kitapilimwa, Mfyome and Itagutwa villages. However, the price of the same in Iringa town was TZS40,000–43,000. Similarly, the price of a cup of *Vangueria volensii* was TZS200 in Mawindi, while the price of the same cup size was TZS500 in Iringa town.[1]

The findings indicate that wholesale prices double retail prices. Even if transaction costs are included, the difference is too huge. These low prices lower household's income from NTFPs, thereby reducing the ability of income from NTFPs to enhance household's resilience to the effects of climate variability. FGDs with the sellers of NTFPs in Mfyome and Itagutwa found that they were dissatisfied with the low prices of NTFPs compared to the time and effort spent to forage and prepare them for sale. The findings are affirmed by Kalame (2011), who found that wholesalers reaped higher prices from trade in NTFPs compared to the local communities who foraged for the NTFPs. A study by Suleiman et al. (2017) in Nigeria noted that a well-regulated trade in NTFPs increases rural communities' income, thereby reducing households' vulnerability to various shocks, including climatic ones.

4.4.5 Seasonal Availability of NTFPs

Seasonality in the availability of NTFPs reduces the ability of NTFPs to improve households' resilience to the effects of climate variability as observed in Mwaiteleke (2015). About 25% of the respondents (Figure 6) reported that seasonal availability of NTFPs was one of the limiting factors in the availability of NTFPs for adapting to the effects of climate variability. A village-wise analysis (Figure 7) showed that Mfyome had many respondents (21%) who had perceptions that seasonal availability of NTFPs affected household use of NTFPs

[1]When this study was being undertaken, the value of one US dollar was equivalent to about TZS2,220.

as an adaptation strategy. FGDs in all the studied villages, and in-depth interviews with VNRC members and VEOs, found that seasonal availability of NTFPs compromised the usefulness of NTFPs as strategy for enhancing household's resilience to the effects of climate variability. The study found that some NTFPs—such as mushrooms—were plenty in the rainy season. It was also noted that many wild edible vegetables sprout new tender leaves in late December and early January (early rains). However, some wild edible vegetables such as *Maerua triphylla A. Rich.* are available throughout the year.

The results of FGDs and in-depth interviews with VNRC members revealed that the production of honey decreases in June, July and August because in these months very few plants produce flowers needed by bees for nectar. Similarly, the discussions revealed that wild edible fruits like *Strychnos cocculoides*, *Vitex doniana*, *Vitex mombassae*, *Tamarindus indica, Azanza garckeana* and *Vangueria volensii* are available during dry seasons. The results somehow resonate with those by Paumgarten (2007), who observed that 22% of households had perceptions that the ineffectiveness of NTFPs as a safety net was attributed to seasonal availability of NTFPs. The results, however, differ from Mwaiteleke's (2015), whose study revealed that 41% of the households had perceptions that seasonal availability of NTFPs affected the supply of NTFPs all the year. The variations may be attributed to edaphic and climatic factors, as well as households' awareness of the availability trends of different types and species of NTFPs.

Additionally, FGDs results revealed that households used different ways to cope with the seasonal availability of NTFPs. For example, some households in all the studied villages dried *Zanthoxylum chalybeum,* pestled it into powder, and then preserved it for future use. Similarly, wild edible mushrooms were boiled, dried under the sun, and preserved for use during dry seasons. FGDs participants in Mfyome, Kitapilimwa and Mawindi revealed that *Azanza garckeana* fruits can be boiled with salt and preserved for future use. These strategies reduced the severity of the impact of the seasonal availability of NTFPs.

4.5 Opinions on Improving the Availability of NTFPs

Opinions on improving the availability and usefulness of NTFPs as a strategy for adapting to the effects of climate variability are more effective if they come from affected households as noted in Nkem et al. (2010). The study examined household's opinions on how to improve the availability and adaptation role of NTFPs as shown in Table 3.

The results in Table 3 show that many respondents (60%) opined that sustainable forests conservation is critical for ensuring the availability of NTFPs for adapting to the effects of climate variability; while a few (9%) recommended the packaging of NTFPs. Indeed, conservation and sustainable harvesting ensure longer-term benefits from NTFPs, as it was also reported by Msalilwa et al. (2013).

Table 3: Opinions on Improving Adaptation Role of NTFPs (N=328)
(Based on Multiple Responses Analysis)

Opinions	Villages										Total	
	Itagutwa		*Kinywang'anga*		*Kitapilimwa*		*Mawindi*		*Mfyome*			
	Freq	*%*	*Freq*	*%*	*Freq*	*%*	*Freq*	*%*	*Freq*	*%*	*Freq*	*%*
Conservation of forests for NTFPs	34	17	28	14	24	12	21	11	89	45	**196**	**60**
Education on sustainable harvesting of NTFPs	19	20	11	12	19	20	15	16	29	31	**93**	**28**
Ensure accessibility to NTFPs	39	42	7	8	5	5	13	14	29	31	**93**	**28**
Marketing of NTFPs	12	19	18	29	7	11	15	29	11	18	**63**	**19**
Domestication of NTFPs	9	16	8	14	10	18	11	19	19	33	**57**	**17**
Community participation	17	38	5	11	3	7	6	13	14	31	**45**	**14**
Processing of NTFPs	9	22	8	20	5	13	10	25	8	20	**40**	**12**
Packaging of NTFPs	7	23	8	27	4	13	5	17	6	20	**30**	**9**

Source: Field data, 2021

Regarding access to NTFPs, the results in Table 3 echo those by Few et al. (2014), who noted that a sustainable management of NTFPs is only meaningful to forest-dependent households if the controls guarantee households of access to, and collection of, NTFPs. Besides, the domestication of NTFPs relieves protected areas and natural forests from human pressure and, in addition, it assures people of constant supply of NTFPs (Onyekuru & Marchant, 2014; Mwaiteleke, 2015). Households' participation in decision-making on the governance of forests allows their ideas to be mainstreamed in the decision-making process regarding conservation and utilisation of NTFPs (Kalame et al., 2008). Processing and packaging of NTFPs increase the quality and market value of NTFPs, leading to increased household income, as it was also observed by Mwaiteleke (2015). Paumgarten (2007) and Kalame (2011) similarly confirm that well-regulated markets of NTFPs improve the role of NTFPs, as a strategy for adapting to the effects of extreme climatic events, by increasing household income.

5. Conclusion and Recommendations

The study has found that households in the studied areas of Iringa district are vulnerable to the effects of climate variability. Due to that, the majority of the households use NTFPs from KFR, among other adaptation strategies, to enhance their resilience to the effects of climate variability. The study revealed that despite the role played by NTFPs from the KFR as a strategy for adapting to the effects of climate variability, there are several factors that compromised the effective adaptation role of these NTFPs. The factors are anthropogenic degradation of NTFPs, the implications of KFR management by-laws, and the effects of climate variability on the availability and use of NTFPs as an adaptation strategy. Others are the perception of the fairness of trade in NTFPs, and seasonal availability of NTFPs. Local communities in the study area presented several suggestions on improving the adaptation role of NTFPs from the KFR. These range from the conservation of forests for NTFPs, to the packaging of NTFPs for value-addition. This study recommends that timely provision of information on extreme climatic events by the government, in partnership with the private sector, will help local communities to adapt well to the effects of climate variability. Similarly, participatory approaches in the formulation of forest policies and by-laws, and forest management will ensure a sustainable utilisation of NTFPs. Besides, the government, in partnership with the private sector, should regulate NTFPs markets to ensure sound returns to local communities who trade in NTFPs.

References

Ahenkan, A. & Boon, E. (2011). Non-Timber Forest Products (NTFPs): Clearing the Confusion in Semantics. *Journal of Human Ecology,* 33(1): 1–9.

Andrade, P.A., Herrera, F.B. & Cazzolla, G.R. (2010). *Building Resilience to Climate Change: Ecosystem-Based Adaptation and Lessons from the Field*. Gland, Switzerland, IUCN.

Arnold, M.J.E., Powell, B., Shanley, P. & Sunderland, T.C.H. (2011). Forests, Biodiversity and Food Security. *International Forestry Review*, 13(3): 259–264.

Balama, C., Augustino, S., Eriksen, S., Makonda, F.S.B. & Amanzi, N. (2013). Climate Change Adaptation Strategies by Local Farmers in Kilombero District, Tanzania. *Ethiopian Journal of Environmental Studies and Management*, 6: 724–736.

Balama, C., Augustino, S., Eriksen, S. & Makonda, F.B.S. (2016). Forest Adjacent Households' Voices on Their Perceptions and Adaptation Strategies to Climate Change in Kilombero District, Tanzania. *Springer Plus*, 5: 1–21.

Blomley, T. & Iddi, S. (2009). *Participatory Forest Management in Tanzania:* 1993–2009. *Lessons Learnt and Experiences to Date*. Dar es Salaam, Forestry and Beekeeping Division.

Convention on Biological Diversity (CBD). (2009). *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series Number: 41.

Creswell, J.W. (2014). *Research Design: Quality, Quantitative and Mixed Methods Approaches*. 4th Edition. Los Angeles, SAGE Publications Ltd.

Dawson, C. (2007). A *Practical Guide to Research Methods: A Use-Friendly Manual for Mastering Research Techniques and Projects*. 3rd Edition. United Kingdom, How to Content.

Dube, T. & Phiri, K. (2013). Rural Livelihoods Under Stress: The Impact of Climate Change on Livelihoods in South Western Zimbabwe. *American International Journal of Contemporary Research*, 3(5): 11–25.

Endamana, D., Angu, K.A., Akwah, G.N., Sherpherd, G. & Ntumwe, B.C. (2016). Contribution of Non-Timber Forest Products to Cash and Non-Cash Income of Remote Forest Communities in Central Africa. *Int for Rev*, 18(3): 280–295.

Few, R., Gross-Camp, N.D. & Martin, A. (2014). *Vulnerability, Adaptation and Mitigation in the Forests of the Congo Basin: A Critical Investigation*. Working Paper Number: 48.

Food and Agricultural Organization (FAO). (2009). *Climate Change Adaptation*. Rome, FAO.

Haule, T.R. (2010). *Community Perceptions of Determinants and Consequences of Forest Resources Degradation in Namtumbo District, Ruvuma, Tanzania*. University of Dar es Salaam. M.A. Dissertation.

Haule, T.R. (2019). *Role of Non-Timber Forest Products in Communities' Adaptation to Climate Variability Effects in Iringa District, Tanzania.* University of Dar es Salaam. PhD Thesis.

Haule, T.R. (2021). Climate Variability and Feminization of Poverty in Tanzania: The Contribution of Gendered Ownership and Access to Household Assets. *Tanzania Journal of Population Studies and Development*, 28(1): 17–40.

Haule, T.R. (2022). Contextualising the Pillars of Household Food Security: Evidence from Iringa District, Tanzania. *Journal of Humanities and Social Sciences*, 11(1): 81–102.

Hergarten, M. (2013). *Forests and Climate Change Adaptation: A Twofold Approach*. Technical Report. Deutsche Gesellschaft Fur Internationale Zusammenarbeit (GIZ) GmBh.

International Union for Conservation of Nature (IUCN). (2009). *Ecosystem-Based Adaptation (Eba) UNFCCC Climate Change Talks*. 28th September - 9th October 2009: Bangkok, IUCN. Pp. 1–5.

Kalame, F. B., Idinoba, M., Brockhaus, M. & Johnson, N. (2008). *Forest Policies and Forest Resource Flow in Burkina Faso, Ghana and Mali: Conflicting Or Consistent for Adaptation to Climate Change?* TROFCCA Brief Number: 1.

Kalame, F.B. (2011). *Forest Governance and Climate Change Adaptation: Case Studies of Four African Countries*. Tropical Forestry Reports Number: 39.

Kangalawe, R.Y.M. (2012). Food Security and Health in the Southern Highlands of Tanzania: A Multidisciplinary Approach to Evaluate the Impact of Climate Change and Other Stress Factors. *African Journal of Environmental Science and Technology*, 6(1): 50–66.

Kangalawe, R.Y. & Lyimo, J. G. (2013). Climate Change, Adaptive Strategies and Rural Livelihoods in Semi-Arid Tanzania. *Natural Resources*, 4: 266–278.

Kihupi, M.L., Mahonge, C. & Chingonikaya, E.E. (2015). Smallholder Farmers' Adaptation Strategies to Impact of Climate Change in Semi-Arid Areas of Iringa District, Tanzania. *Journal of Biology, Agriculture and Healthcare*, 5(2): 123–131.

Kihupi, M.L. (2016). *Effectiveness of Smallholder Farmers' Adaptation Strategies in Improving Well-Being in Light of Climate Change in Iringa District Tanzania*. Sokoine University of Agriculture. PhD Thesis.

Macharia, P.N., Thuranira, E.G., Ng'ang'a, L.W. Lugadiru, J. & Wakori, S. (2012). Perceptions and Adaptation to Climate Change and Variability by Immigrant Farmers in Semi-Arid Regions of Kenya. *African Crop Science Journal,* 20(2): 287–296.

Mellmann, N. (2015). Ecosystem-Based Adaptation-In Theory and Practice: A Case Study of Projects Supported by the International Climate Initiative. Master Thesis, Uppsala University.

Mongi, H., Majule, A.E. & Lyimo, J.G. (2010). Vulnerability and Adaptation of Rain-Fed Agriculture to Climate Change and Variability in Semi-Arid Tanzania. *African Journal of Environmental Science and Technology*, 4(6): 371–381.

Msalilwa, U., Augustino, S. & Gillah, P.R. (2013). Community Perception on Climate Change and Usage Patterns of Non-Timber Forest Products by Communities Around Kilolo District, Tanzania. *Ethiopian Journal of Environmental Studies and Management*, 6(5): 507–516.

Mwaiteleke, D.L. (2015). Economic Valuation of Non-Timber Forest Products Under the Changing Climate Around Iyondo Forest Reserve in Kilombero District, Tanzania. MSc. Dissertation, Sokoine University of Agriculture.

Mwamfupe, A. (2014). Assessment of Local Perceptions and Potential Roles of Local Institutions in Climate Change Adaptation in Rufiji District, Tanzania. PhD Thesis, University of Dar es Salaam.

Nelson, D. R., Adger, W.N. & Brown, K. (2007). Adaptation to Environmental Change: Contributions of a Resilience Framework. *Annual Review of Environment and Resources,* 32: 395–419.

Nkem, J., Idinoba, M. & Sendashonga, C. (2008). *Forest for Climate Change Adaptation in the Congo Basin. Responding to an Urgent Need With Sustainable Practice*. CIFOR Environment Brief Number: 2.

Nkem, J., Kalame, F. B., Idinoba, M., Somorin, O., Ndoye, O. & Awono, A. (2010). Shaping Forest Safety Nets With Markets: Adaptation to Climate Change Under Changing Roles of Tropical Forests in Congo Basin. *Environmental Science and Policy,* 13(6): 498–508.

Nyumba, T.O., Wilson, K., Derrick, C.J. & Mukherjee, N. (2018). The Use of Focus Group Discussion Methodology: Insights from Two Decades of Application in Conservation. *Methods Ecol Evol.,* 9: 20–32.

Omolo, N. & Mafongoya, P. L. (2019). Gender, Social Capital and Adaptive Capacity to Climate Variability. A Case of Pastoralists in Arid and Semi-Arid Regions in Kenya. *International Journal of Climate Change Strategies and Management*, 11(5): 744–758.

Onyekuru, A.N. & Marchant, R. (2014). Climate Change Impact and Adaptation Pathways for Forest Dependent Livelihood Systems in Nigeria. *African Journal of Agricultural Research*, 9(24): 1819–1832.

Paumgarten, F. (2007). The Significance of the Safety-Net Role of NTFPs in Rural Livelihoods, South Africa. MSc Thesis, Rhodes University, South Africa.

Paumgarten, F. & Shackleton, C.M. (2011). The Role of Non-Timber Forest Products in Household Coping Strategies in South Africa: The Influence of Household Wealth and Gender. *Popul Environ*, 33: 108–131.

Persha, L. & Meshack, C. (2016). A *Triple Win? the Impact of Tanzania's Joint Forest Management Programme on Livelihoods, Governance and Forests*. 3IE Impact Evaluation Report Number, 34.

Pramova, E., Locatelli, B., Djoudi, H. & Somorin, O.A. (2012). Forests and Trees for Social Adaptation to Climate Variability and Change. *Wires Clim Change*, 3: 581–596.

Prince, M. & Davies, M. (2001). Moderator Teams: An Extension to Focus Group Methodology. *Qualitative Market Research*, 4(4): (207–216.

Reed, M.S., Podesta, G., Fazey, I., Geeson, N., Hessel, R., Hubacek, K. ... Thomas, A.D. (2013). Combining Analytical Frameworks to Assess Livelihood Vulnerability to Climate Change and Analyze Adaptation Options. *Ecological Economics*, 94: 66–77.

Robinson, E.J.Z. & Kajembe, G.C. (2009). *Changing Access to Forest Resources in Tanzania*. Environment for Development Discussion Paper Series 9–10.

Robinson, E.J.Z. & Lokina, R.B. (2009). *Spatial Aspects of Forest Management and Non-Timber Forest Product Extraction in Tanzania*. Environment for Development Discussion Paper Series 09–07.

Ruffo, C.K., Birnie, A. & Tengnas, B. (2002). *Edible Wild Plants of Tanzania*. Nairobi, Swedish International Development Agency (SIDA).

Russell, A.J.M., Foppes, J., Behr, D.C., Ketphanh, S. & Rafanoharana, S. (2015). *How Forests Enhance Resilience to Climate Change: The Case of Smallholder Agriculture in Lao PDR*. Washington DC, Program on Forests (PROFOR).

Scarano, F.R. (2017). Ecosystem-Based Adaptation to Climate Change: Concept, Scalability and a Role for Conservation Science. *Perspectives in Ecology and Conservation*. 15(2): 65–73.

Shackleton, C.M. & Shackleton, S.E. (2006). Household Wealth Status and Natural Resource Use in the Kat River Valley, South Africa. *Ecological Economics*, 57: 306–317.

Suleiman, M.S., Wasonga, V.O., Mbau, J.S., Suleiman, A. & Elhadi, Y.A. (2017). Non-Timber Forest Products and Their Contribution to Households' Income Around Falgore Game Reserve in Kano, Nigeria. *Ecological Processes,* 6(23): 1–14.

Tairo, V.E. (2011). *Utilization of Woody Plants During Times of Food Scarcity from Selected Dry Lands of Iringa District, Tanzania*. PhD thesis, University of Nairobi.

Tarimo, W. & Ringo, J. (2016). Contribution of Joint Forest Management in Improving Conservation and Local Livelihood in Rufiji District, Tanzania. *Sustainability in Environment*, 1(2): 183–199.

Tieminie, R.N., Loh, C.E., Tieguhong, J.C., Nghobuoche, M.F., Mandiefe, P.S. & Tieguhong, M.R. (2021). Non-timber Forest Products and Climate Change Adaptation Among Forest Dependent Communities in Bamboko Forest Reserve, Southwest Region of Cameroon. *Environ Syst Res*, 10(20): 1–13.

Travers, A., Elrick, C., Kay, R. & Vestergaard, O. (2012). *Ecosystem-Based Adaptation Guidance: Moving from Principles to Practice.* Working Document. Nairobi, UNEP.

United Republic of Tanzania (URT). (2001). *Kitapilimwa Government Forest Reserve-Iringa, Tanzania: Agreement, By-Law and Management Plan*. Dar es Salaam, Ministry of Natural Resources and Tourism.

United Republic of Tanzania (URT). (2012). *National Climate Change Strategy*. Dar es Salaam, Vice President's Office.

United Republic of Tanzania (URT). (2013). *Iringa Rural District Council Socio-Economic Profile*. Dar es Salaam, National Bureau of Statistics.

Woittiez, L.S., Rufino, M.C., Giller, K.E. & Mapfumo, P. (2013). The Use of Woodland Products to Cope With Climate Variability in Communal Areas in Zimbabwe. *Ecology and Society*, 18(4): 24.

World Bank. (2005). from *Action to Impact: The Africa Region's Rural Strategy*. Washington DC, World Bank.

Yamane, T. (1967). *Statistics: An Introductory Analysis*. 2nd Edition. New York, Harper and Row.