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Influence of Climate Change in Implementation of Village Land Use Plans in Dodoma, Tanzania

Frida Francis and Yasin Senkondo*

Department of Urban and Regional Planning, Ardhi University, P. O. Box 35176 – Dar es Salaam

* Corresponding author: yassin.senkondo@aru.ac.tz;kangero70@gmail.com

ABSTRACT

Drought exacerbated by climate change has affected agricultural production in Sub-Sahara Africa. Land use plans can be used to attenuate climate hazards by enhancing adaptive capacity of farmers. However, most land use plans have put emphasis on conflict resolution and have inadequately considered issues regarding climate change. This study assessed whether Chenene village land use plan enhanced adaptation capacity of farmers in the village and how indigenous knowledge contributes to the enhancement of effective operationalization of the developed plans. Household interviews, focus group discussions and resource mapping were used to collect data. Additionally, satellite images were used to analyse land cover types and different existing land and maps were produced using ArcGIS software. Results show that the developed land use plans were not informed by indigenous knowledge, land capability classification and climate threats facing the village. As a result, villagers did not follow the plans as they did not realise any benefits by following such plans as compared to the past and therefore the adaptation capacity of farmers against effects of climate change was impaired. It is therefore recommended that for land use plans to be responsive to climate change and enhance adaptive capacity of farmers, the Guidelines for Participatory Land Use Plans ought to establish a mechanism of ensuring that indigenous knowledge, socio-economic factors of villagers, and land capability/suitability assessments are adequately considered before plans are approved and that the methodology of assessing suitability of a particular land unit for a particular use as inputs of land use planning in Tanzania is revised.

Keywords: Indigenous knowledge; climate; adaptation; agriculture

1. INTRODUCTION

Climate change impacts pose serious challenges to sustainable livelihoods and economic development especially in developing countries (Bedeke et al., 2020). Adverse impacts of climate change such as drought, desertification and flooding have already exerted negative impacts on many least developed countries including Tanzania (Smucker et al., 2015). Sub Saharan African Countries are more vulnerable to climate hazards as compared to developed countries because the former has poorly developed infrastructure (Hameso, 2018), limited resources, high poverty levels; and are over-dependent on rain-fed agriculture and natural resources for their livelihood (Antwi-Agyei, Dougill & Stringer 2015). Drought, exacerbated by climate change has grossly affected agricultural production and threatened food security in Tanzania (Magesa & Pauline, 2019).

As part of the adaptation strategies to climate change, farmers constantly carry-out agricultural production on land units that can be productive amid vagaries of climate change (Joyce, Simpson & Casanova, 2016). This means that the farmers may change land uses to suit their production goals. Some parts of Sub-Saharan Africa are experiencing land-use changes where the natural systems are converted to agricultural land (Näschen et al., 2019) and the rate of the conversion is expected to increase. In Tanzania, climate change has negatively impacted land-uses especially agriculture land uses (Kangalawe & Lyimo, 2013). Unguided land-use change can cause land degradation (Kangalawe & Lyimo, 2013). In recognition of the importance of guided uses of land, Tanzania developed Guidelines for Integrated and Participatory Village Land Use Planning, Management and Administration (NLUPC, 2020). These guidelines call for the analysis of the capacity of land units for a particular use and consideration of climate change resilience of the units. Climate change, which is characterized by droughts, affects the implementation of approved land uses (Naiposha & Nzunda, 2021; Wang et al., 2021). For example, agricultural land may be abandoned if drought is anticipated (Yegbemey, 2021). Furthermore, lowland areas dominated by clay soils allocated for grazing may not be fit for such use and may be abandoned as a result of water logging (Naiposha & Nzunda, 2021). Therefore, land uses ought to be guided by land use plans which offer a crucial avenue to adjust uses that can be allocated to different land units in order to reduce vulnerability to impacts emanating from the changing climate (Tang et al., 2011). For a long time, farmers have been able to carry-out various activities on land using their indigenous knowledge. Indigenous knowledge and practices can be a very useful tool, which can help communities to arrest the effects of environmental hazards, especially those limiting agricultural production (Apraku et al., 2021). The knowledge of local communities, when blended with modern climate change adaptation measures can contribute to improved land-use planning and resource management (Gowing et al., 2004; Ifatimehin, 2009).

Chenene village in Dodoma region in Tanzania has a village land use plan, which was prepared and implemented in 2019. The village and the region in general are facing a problem of high intensity rains lasting for a short period. Further, the area is encountering irregular rainfall patterns, prolonged drought periods and an increase in temperature. At Chenene village, farmers have traditional systems of conserving forage for use during drought. These systems are known as Alalili and Milanga (Selemani, 2020) in which a land unit of specific cultural significance is reserved during favourable weather conditions (mainly rainy seasons) and is used for grazing during dry periods. Alalili is a specific zone used for forage production (Saruni, 2016). This zone is characterized by good quality grasses, the presence of ritual sites, and the historical attachment (Saruni, 2016). The zones become a source of wood, poles and traditional medicine and are used as soil conservation strategies (Mwilawa et al., 2008). A plethora of literature exists on the role of land use plans in conflict management (Benjaminsen et al., 2009; John Walwa, 2017; Kajembe; et al., 2009; Kaswamila, 2009). However, there is inadequate scholarly work on the contribution of indigenous knowledge to land use planning as a tool of enhancing resilience of particular land units for particular uses amid vagaries of climate change. Studies on the impact of climate change adaptation to land use planning are scarce (Xu & Yao, 2021). Participatory village land use planning process needs knowledge on participatory mapping of the existing land uses to provide the database for proposing new land uses (Mavhura & Mushure, 2019). Therefore, this study explored the role of indigenous knowledge in enhancing the implementation of the Chenene village land use plan. The study further investigated the contribution of Chenene village land use plan in enhancing climate change adaptation capacity of the villagers.

2. MATERIALS AND METHODS

2.1 Description of a study area

This study was conducted in Dodoma region, Chamwino District, Chenene village (Figure 1). Dodoma region was selected because it is the driest region in Tanzania (Mseli et al., 2023), and has a village land use plan, which is rich in indigenous knowledge thus enabling farmers to continue with their agriculture and livestock keeping amid vagaries of climate change. Household interviews were used to explore how villagers use their local knowledge in allocating different uses to their pieces of land. Furthermore, key informant interviews and focus groups, which involved Village Land Use Management Committee (VLUMC) and Participatory Land Use Management (PLUM) team were also employed. This was meant to explore the awareness of the committee members on climate change and variations (rainfall variations, drought, and increase in temperature) as inputs to the plans preparations.

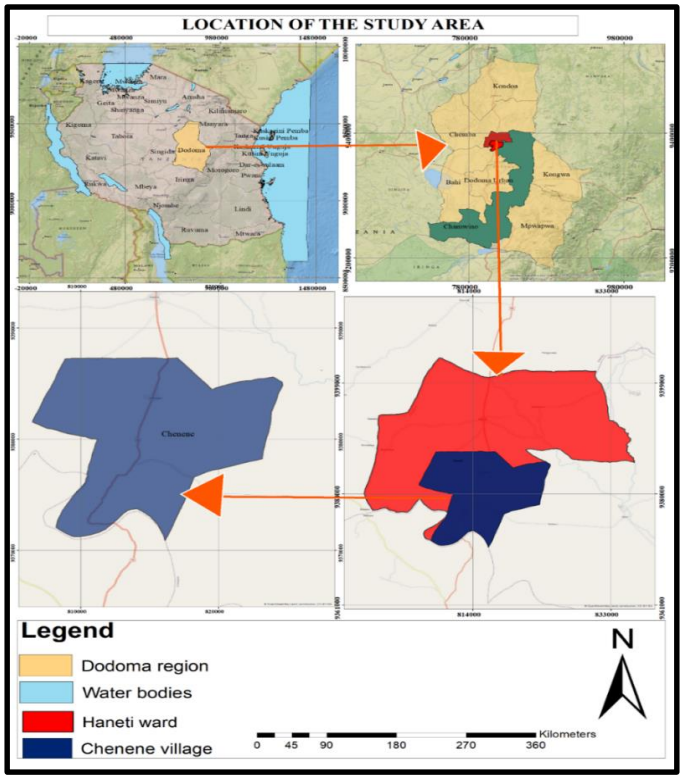

Figure 1: Locational map showing a location of Chenene village

Resource maps prepared in collaboration with VLUMC and PLUM teams were used to identify different land units and their corresponding use before and after the plans. Further, satellite images of the area were used to

analyse land cover types and different land uses existing in the village. Field surveys were carried out to validate and supplement the information obtained from remote sensing. Field surveys were used to map the areas where indigenous knowledge is practiced. Maps were produced using ArcGIS software.

3. RESULTS AND DISCUSSION

3.1 Development of Land use plans, biophysical features and indigenous knowledge

In land use planning, different land uses are allocated based on land characteristics such as slope angle, topography, vegetation, soil types (Gebre et al., 2021) and soil depth (Li et al., 2022**)**. Such land characteristics ought to contribute to making decisions on what land uses would suit a certain land unit. Results of the present study from key informants and 95 per cent of the respondents revealed that different land uses were allocated to specific land units based on land characteristics, which included topography, vegetation and soil texture. Further, lowland areas and areas dominated by clay and sandy clay soils were allocated for agricultural uses whereas gentle sloping areas and sandy soils were allocated for residential, agriculture- residential and social services uses. The analysis of the land use maps reveals that systematic resource assessment to identify potentials and limitations of different land units that would lead to land capability classification was not carried out. This means that the land use planning that was carried out did not use land capability classification as one of the inputs. Further, factors such as social, economic and technological aspects were not considered in developing the Chenene land use plan. Better understanding of land use changes requires better understanding of the complex interactions between the environment, socio-economy, political environment, institutions available and culture of the local communities. This stems from the fact that people and their biophysical environments have complex interactions that keep an equilibrium between population, resources and productivity (John et al., 2014). Reports from other studies show that most land use planning decisions are made based on scientific knowledge and seldom takes on board indigenous knowledge (Steenwerth et al., 2014) as observed in the present study. This is attributed to a belief that the former is believed to operate in logical interpretation of information through well-established protocols while the latter bases on instincts and empirical evidence to draw inferences (Agrawal, 1995). It has been observed that land use plans can be effectively implemented if they are able to take on-board the varied composition of smallholder farmers, their traditional values, and farming systems (Westermann et al, 2018). Farmers' experience and their indigenous knowledge can be used to inform land use planning (Jones, 2024) because villagers/farmers have acquired skills through experience regarding their natural environment and have been using such skills to manage their land. The current study reveals that before developing the Chenene land use plan, villagers were using their land based on their experience in determining the potential of a particular land unit to support a particular use. In this regard, for example, based on their knowledge, farmers were using units dominated by clay soil in areas found in lowlands for agricultural uses (for both field crops and vegetable cultivation). Also, areas with coarse textured soils were allocated for settlements and agriculture (agriculture-residential). Villagers developed settlements (residential) and small commercial activities on gently sloping areas.

The rationale of considering indigenous knowledge by the local community in land use planning is further consolidated by experience they have acquired based on productivity of different land units during different seasons under different weather extremes. A particular land unit can give reasonable productivity in seasons of good rains and other units can have very low productivity in the same season. On the other hand, productivity of different land units during adverse weather conditions such as droughts and floods also differs. Farmers interact with their land daily and therefore they are in a position of taking relevant land management measures, which cannot appear in modern land evaluation reports. The accumulation of all these experiences with time put farmers at a better position in determining capability of a land unit for a particular use and suitability of the unit for a particular crop under different weather extremes. The decision for allocating a particular land unit to a particular use ought to be reached by integration of all these factors. Therefore, the integration of indigenous knowledge/ farmers' experiences with modern knowledge for land use planning forms a synergy and indeed can inform land use planning decisions. It is worth noting that technical knowledge that experts have is very important in informing land use plans but a lack of engagement of local communities by ignoring traditional knowledge and experiences can lead to the development of plans that are irrelevant to the villagers who may ignore such plans as discussed in sections 3.2 and 3.3. Further, it can be recommended that the whole methodology of assessing suitability of a particular land unit for a particular use as inputs of land use planning in Tanzania needs to be revised. Furthermore, drought and awareness were part of the identified constraints to effective implementation of the plan. A model that can integrate the improved water use, adapted crop varieties and practices, soil and water conservation practices, and public awareness of climate change and variability (Adimo et al., 2012), local knowledge and socio-economic aspects of farmers need to be developed and used to evaluate suitability of different land units for particular uses. This will necessitate a review of the Tanzania Guidelines governing land use planning.

3.2 Climate change impacts and land uses

Climate change is considered as one of the contributing factors for non-adherence to the developed land use plans (Voss, 2022). Despite this factor, issues of climate change are seldom considered as important inputs to land use plans because villagers focus more on immediate issues such as resolution of land use or border conflicts (Picketts et al., 2014a). About 70 per cent of respondents in focus group discussions revealed that the prepared village land use did not consider climate change and adaptation issues despite the fact that members of the Village Land Use Management Committee (VLUMC) and 77per percent of the household respondents reported to have been noticing climate change impacts in the village. All respondents (100%) in the study area reported to have experienced unpredictable rains, 82.5per cent experienced extreme heat while 98.75 per cent experienced drought. Furthermore, the respondents reported to have experienced short rain seasons, late or early onset of the rainfall periods and severe droughts with an increase in temperature. Villagers showed that their main focus was on immediate issues, which were to solve boundary conflicts facing them (conflict between Chenene village against Haneti and Solou villages) and to protect the village forest from deforestation. When the plan was developed, there was no proposed area for grazing land, and this compelled villagers to encroach the area designated for forests even after the plan was developed. Literature shows that the priority of most local governments is economic development and solving boundary conflicts and low priority is given to issues such as protecting the environment and climate change issues. Further, most rural communities are concerned with issues such as meeting basic needs, thus little priority is given to long-term risks such as climate change (Nkoana, 2020). Focus group discussions with VLUMC and key informants interviews revealed that the plan did not consider climate change adaptation measures. This, as a result, led to the abandonment of the areas allocated for agricultural uses especially during severe droughts and floods (Figure 2). Water availability for crop production is one of the crucial issues in determining success or failure of developed land use plans and management under the background of drought emanating from the effects of climate change (Wu et al., 2018).

These results show that the VLUMC and the PLUM teams did not anticipate the impacts of climate change while developing plans and therefore the teams did not consider issues of climate change and adaptation. Failure to predict the appropriate use of different land units during land use planning is attributed to the lack of land capability and suitability classification that would detail the potentials and limitations of different land units for a particular use. If land capability classification was considered, limitations such as hazards of water logging during rainy seasons would be considered as a limitation, thus appropriate use of the land would be allocated to the land unit (Girmay et al., 2018).

Therefore, in anticipation of high intensity rains, the areas would be assigned to a crop like paddy that tolerates water logging conditions. Indeed, weather forecasts should be very efficient to enable farmers to plan for the land utilization types. Land use plans that are adapted to climate change should detail land utilization types. Land utilization types detail the type of crops, expected yields, the technology to employ and the specific farm management practices, which are required to counteract the effects of climate change. These factors were not adequately considered in developing the Chenene village land use plan. It is therefore advised that currently, where the effects of climate change are expected to continue impacting different land uses and productions, land use planning should be geared towards enhancing adaptive capacities of villagers taking into consideration future needs instead of only responding to past and present problems. The latter can be achieved through generating planning intelligence regarding hazard risks and vulnerability of the local population (Berke & Stevens, 2016). Rural human livelihoods depend on the success of adaptation measures that address climate change hazards. Therefore, strategies that can lead to enhanced adaptation to the changes in climate and integrated into land use planning can enhance livelihood issues and improve resilience of villagers in response to climate change (Adimo et al., 2012). Therefore, the VLUMC and the PLUM ought to gather information on the nature, location, and severity of local climate-related hazards and how those hazards are likely to affect local residents and that the information be part of planning considerations (Berke & Stevens, 2016).

In the present study, 93.75 percent of the respondents who developed the land use plan reported that the developed plan did not help to reduce their vulnerability to climate change. The land units allocated for agriculture are the most affected leading to the drying out of their crops before reaching maturity. Agricultural land use is the most affected by climate culminating into the reduction of crop production (Aguiar et al., 2018). Proper land use plan can help to minimize the impacts of climate change on agriculture where the losses emanating from climate change can be greatly avoided by optimizing the management of land use (Praveen, 2019). The failure of the plans to help farmers to enhance crop productivity in the present study is attributed to the lack of foreseeing effects of climate change during plan preparation. Further, farmer's knowledge and the indigenous knowledge were not taken into consideration either (see section 3.1).

Data from the Tanzania Meteorology Agency revealed that despite a general increase of rainfall over the past 30 years (Figure 3) in Chenene village, villagers have continued facing a problem of crop failure due to drought. This can be attributed to high intensity rains that last for a short period and increase in temperature as validated by

farmers during interviews. Therefore, land use plans should carry-out land suitability analysis that considers issues of climate change. Land use plans therefore ought to have strategies of mainstreaming adaptation measures against the impacts of climate change through incorporating adaptation measures into the Guidelines for Participatory Village Land Use Planning leading to an effective blanket solution thereby improving chances of implementation (Picketts, Déry & Curry, 2014). Indeed, as pointed out earlier, climate action was not a driver of the Chenene land use plan, and it was not foreseen as a factor that would hinder effective implementation of the village land use plans. If the village land use planning team had considered climate change or adaptation as their top priority, climate adaptation measures would have featured as an important criterion in the development of the plan. It is important for researchers and policy makers to appreciate the synergy between climate change and community priorities that may be affected by climate change to increase the justification for and scope of adaptation measures. Further, the process of developing the plans could be used as a stage of promoting climate adaptation awareness thereby enabling to develop strategies of enhancing adaptation (Picketts et al., 2014b). Chenene villagers, through their indigenous knowledge have demonstrated to have indigenous technologies that can help them arrest the effects of climate change. These technologies, when blended with the modern techniques can help farmers increase agricultural production amid vagaries of climate change.

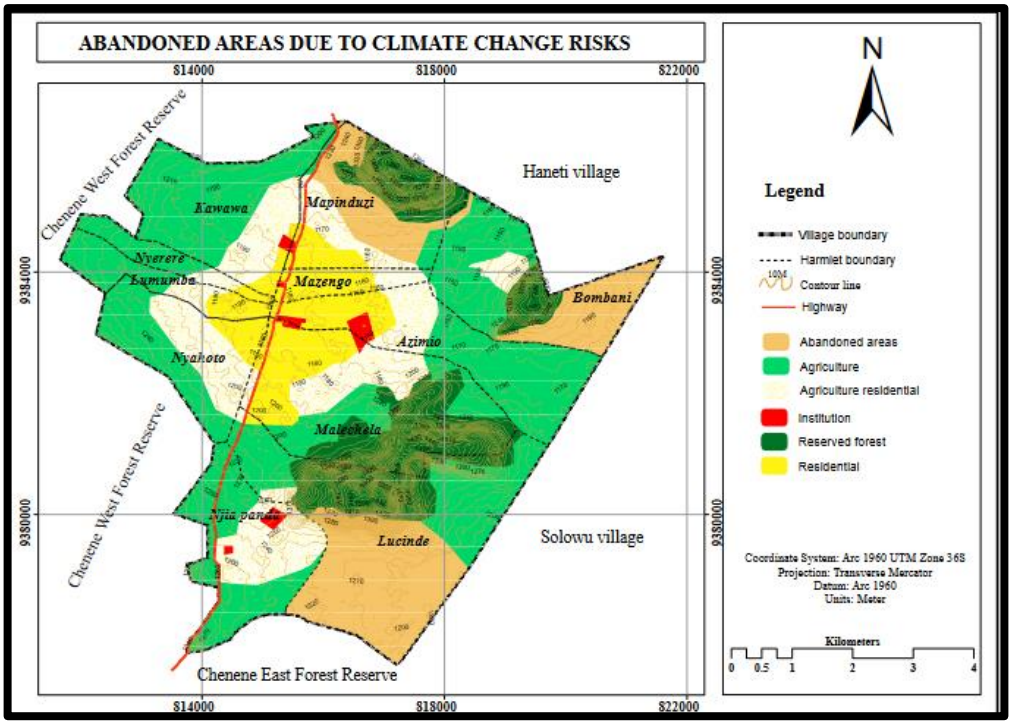

Figure 2: Map showing areas that were designated for agriculture but not used for the purpose

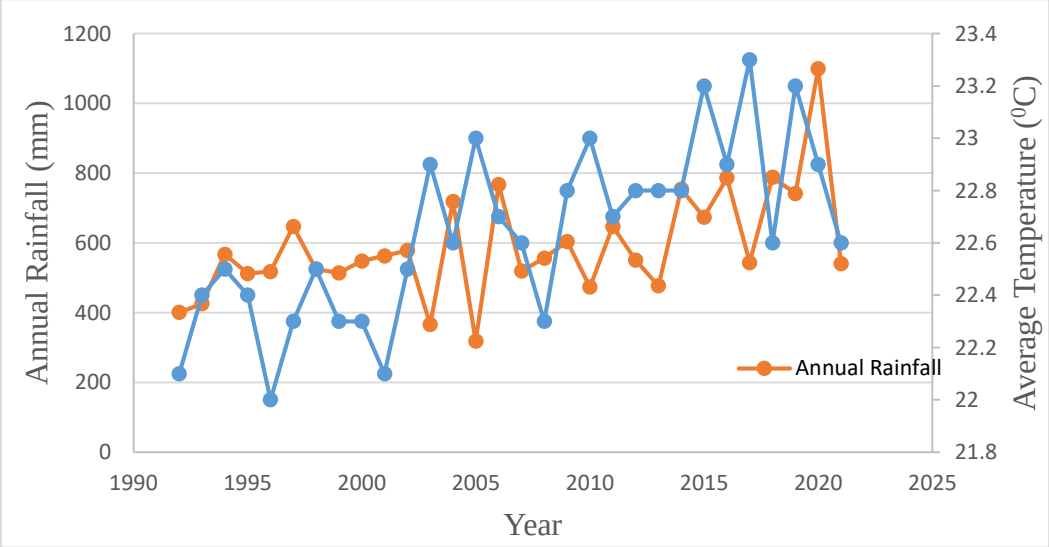

Figure 2: Rainfall pattern and Temperature trend *Source: Tanzania Meteorology Agency*

3.3 Indigenous knowledge in land use planning

Land use plans can be used as a tool of reducing vulnerability against the effects of climate change (Tang et al., 2011). Employment of indigenous knowledge is one of the tools that can enhance climate change adaptation measures by the smallholder farmers (Mapara, 2009; Theodory, 2016). In the study area, several types of farming systems and indigenous knowledge that are used by the farmers to adapt to climate change are in place. These include, fallowing, intercropping, crop rotation, Alalili and Milanga. Under Alalili and Milanga, pastoralists and agro pastoralists in Chenene village use part of pastureland and reserve other parts for future use. Another strategy is pasture conservation, where part of the land is conserved for grazing during the wet season and used during dry season. These practices are found in areas such as Nyahoto, Lumumba, and Nyerere hamlets (Figure 4).

Due to the failure of the developed land use plan to ensure sustained crop productivity, farmers decided not to adhere to the uses specified in the plan. For example, farmers decided to use areas allocated for agriculture-residential in the plan for agriculture only and employ traditional practices such as crop rotation, fallowing and intercropping. It was found that 77 percent of the respondents reported using the areas for agricultural purposes because the areas have moderate soil fertility and are not prone to floods. Such areas support a variety of crops such as cassava, ground nuts and millet. Respondents reported abandoning residential use in the area because they considered it irrational not to use the areas for crop cultivation as they have always given them productivity amid climate stressors. Further, the pastureland, which was used by villagers was allocated for agriculture only. Part of the allocated area is suitable for agriculture, but part is marginal land thus it is anticipated to yield marginal productivity. Farmers therefore decided to ignore the plan and used the land unit for pasture production through their traditional practices, Alalili and Milanga (pasture conservation).

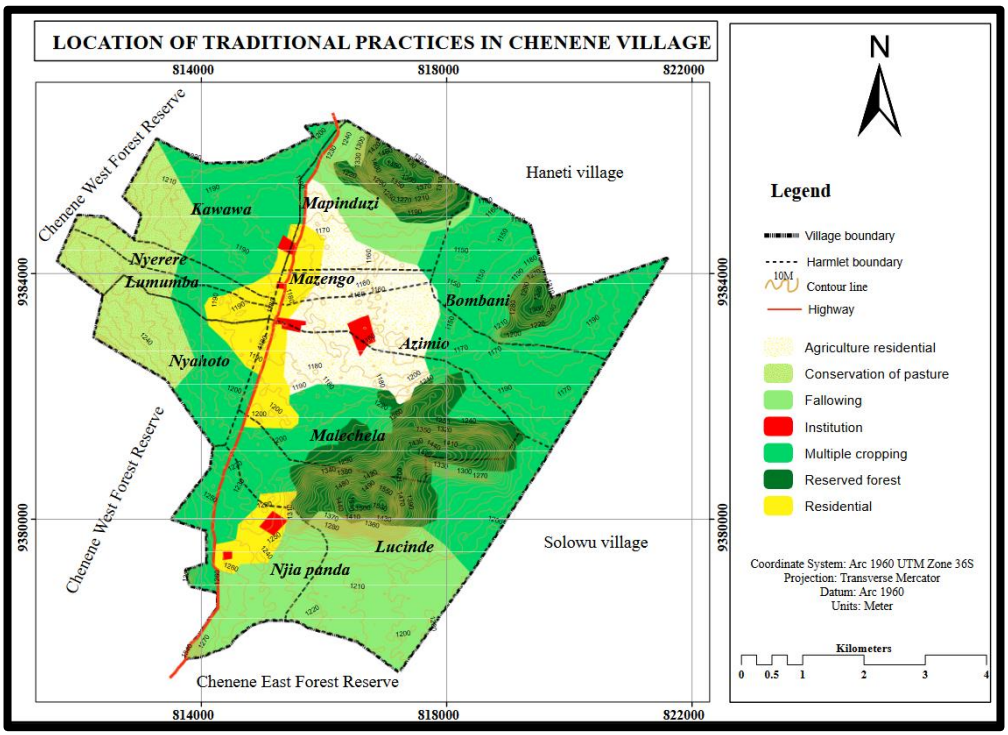

Figure 4: Locations for traditional practices in Chenene village

According to villagers, when they cultivated crops on areas allocated for agriculture as was the case in some parts of Nyerere, Lumumba and Nyahoto (Figure 4) (formerly used for Milanga), they did not get production due to erratic rains. Therefore, they experienced crop failure. At the same time, they stopped conserving pasture under Milanga practices thereby encountering double losses. One of the key informants who was a member of the Village Council had this to say,

Listen, researcher, I normally inspect my area. I found some of the signboards indicating agriculture land uses have been removed. I called a meeting to explore the reasons. The villagers pointed-out that they are compelled to carry-out agriculture on land units that can give them some production. Land allocated for agriculture in the plan is not giving the production."

This shows that traditional knowledge is part of the answer to the environmental challenges, which cannot be addressed by conventional agricultural practices. The use of traditional knowledge as the basis for land use planning has been reported in North-Western part of Tanzania where the Ngitili traditional method has been

identified as one of the effective traditional management systems used to manage rangelands and restore forests (Selemani, 2020).

3.4 Constraints to mainstreaming climate change adaptation measures in land use planning

Adherence to village land use plans is still minimal because of climate change impacts. Farmers' reluctance to adhere to the plan results from the planned initiatives to have negative impacts on productivity. For example, villagers abandoned areas affected by floods in Bomani hamlet and shifted to areas comprising sandy and loamy soils such as Azimio, Malecela, Mazengo and Njia Panda (Figure 4) since such areas are not prone to flooding. Also, marginal areas such as Lucinde and Mapinduzi hamlets were abandoned by farmers who relocated to other areas such as Nyahoto hamlet, which support farming. One of the participants in the focus group discussion revealed,

I have a farm at Lucinde hamlet but in that area during the period of severe drought I don't realize any yield because all the crops dry before maturity. During that period, I do shift to other areas such as Azimio and Njia panda hamlets that are not much affected by drought.

Furthermore, about 75per cent of the respondents reported that agricultural land has been more affected as a result of short rain seasons due to the late onset of rainfall period and severe droughts. This phenomenon, therefore forced farmers to informally change land uses. For example, agricultural-settlement areas were solely used for agriculture because farmers could get harvests when they cultivate on such areas, as the land units are more suitable for agricultural activities. In addition, some of the areas allocated for agriculture have been abandoned due to climate change risks (some of the areas become flooded). This implies that in the study area, the implementation of the plan is minimal due to the experienced threats of climate change. Literature also shows that several land uses, especially the agricultural land, have been abandoned as a result of the effects of climate change, particularly severe drought (Salkin, 2010). Therefore, more efforts to educate land use planners and communities are needed to improve the situation and thus increase understanding on the effects of climate change on agricultural productivity so that they can make informed decisions about farming and land use planning taking into consideration effects of climate change. The capacity of local authorities to incorporate large-scale climate change information when developing land use plans may be inadequate. Most current climate change studies are normally conducted at regional, national, or global levels. This poses a challenge for the authorities to figure-out the best way of incorporating the climate change information in land use plans (Tang et al., 2011). This calls for government and Non-Governmental Organizations to help to bridge this gap.

A number of barriers limiting incorporation of climate adaptation into land use plans have been reported in literature. These include limited policy frameworks, lack of different types of capacities at local levels, lack of political will, human resources, expertise, knowledge and information (Westerhoff et al., 2011) and lack of coordination among different institutions. It is therefore prudent to carry-out studies on the type of barriers hindering incorporation of climate change adaptation measures in preparing land use plans.

In conclusion, mainstreaming indigenous knowledge and adaptation into Participatory Village Land Use Plans is a plausible approach in preparing a plan that addresses the needs of villagers, which include sustained productivity amid climate hazards. It is therefore recommended that Guidelines for Participatory Land Use Plans should establish a mechanism of ensuring that indigenous knowledge, socio-economic factors of villagers and land capability/suitability assessments are adequately considered before plans are approved. Further, the guidelines for Participatory Land Use Planning and Management ought to establish a mechanism of mainstreaming climate change adaptation measures when preparing village land use plans. The guidelines ought to be improved to incorporate crop varieties, public awareness on climate change, local knowledge and socio-economic characteristics of villagers. Further, the methodology of assessing suitability of a particular land unit for a particular use as inputs of land use planning in Tanzania need to be revised.

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