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Fishing for a Future: Local Institutions, Aspirations and Agency in a Complex Climate Adaptation System

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Abstract

This study of two dryland fishing villages in northern Tanzania focuses on observed climate change adaptations, including market exchange, livelihood diversification, and mobility and their mediation by institutions and institutional interactions at various scales. We draw on the *adaptation, institutions and livelihood* (AIL) framework to highlight the key roles of local formal institutions in shaping adaptive strategies. Core contentions of political ecology inform our assessment of the origins and limitations of contemporary institutional configurations. Our household survey data suggests high levels of mobility and the potential that livelihoods are transitioning toward a persistent mode of flexible, multi-site and temporally variable livelihood engagements. The results point to the need for a closer alignment of national policy with the daily struggles of rural dwellers, and the devolution of more discretionary finance to district governments.

Introduction

Women sell dried, smoked, and fried fish in the weekly market in Mwanga, a small district headquarters town in northeast Tanzania, just off the main road from the Indian Ocean coast that rises to the regional capital, Moshi. The fish come from a reservoir behind the *Nyumba ya Mungu* ('House of God') dam on the Ruvu River, some 50km further southwest. Men have been fishing there for nearly fifty years since the dam was completed. However, the fishing is controversial and precarious. Indeed, in February 2020, the government issued evacuation orders to many thousands of residents living downstream when rains filled the reservoir to overflowing, as it had also done in June 2018. The 2018 flood and 2020 alert are suggestive of the 'new normal', with which both policymakers and local residents must understand and cope (Mjema, 2020).

Many changes have taken place over this period that nearly corresponds to Tanzania's lifetime as an independent country. There have been political, economic, administrative, technological, environmental and cultural changes. Fishing is now embedded in a complex climate adaptation system that has emerged in response to all of these interacting changes. Among these, two of the strongest drivers of change have been climate change, and the transformation of local formal institutions.

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Climate change is expected to drive major changes in hydrobiological dynamics of global fisheries, with food security and livelihood implications both within and beyond communities that engage in fishing activities. In Africa, freshwater fishing is a major component of the livelihoods of approximately 7–10m people (De Graaf & Garibaldi, 2014; Kolding, 2016), and fish are a primary protein source for 200m people in the region (Heck et al., 2007). To date, considerable research has sought to project direct impacts of climate change on the distributions and productivity of fisheries (Engelhard et al., 2014; Perry et al., 2005; Roessig et al., 2004; Weatherdon et al., 2016). In contrast, this research seeks to contribute to a smaller but growing body of research that has examined the adaptive responses of fishing-reliant communities, the views and aspirations of fishers, and institutional factors that enable or constrict their options (Badjeck et al., 2010; Coulthard, 2008; Jentoft & Eide, 2011; Niboye, 2018). We seek to bring together empirical analysis of current adaptive practices with an assessment of the institutional and policy factors that have shaped these practices to date; and which may enable new paths of adaptation in line with residents' aspirations for the future.

Theoretical Framings

Our theoretical approach is informed by the adaptation, institutions and livelihoods (AIL) framework (Agrawal, 2008, 2010; Agrawal & Perrin, 2008), nuanced by critical political ecology (Robbins, 2012; Smucker et al., 2015; Wisner, 2015), and by a cultural geographic research framework emphasizing the importance of 'everyday risks', residents' perceptions of these risks, their aspirations (Gibson & Wisner, 2016), and the role of the holistic experience of change in everyday decision-making (Wangui et al., 2012). The AIL framework focuses attention on the interaction of three elements that have been empirically established as common in rural land and resource systems under pressure from climate change: adaptation, institutions, and livelihood.

The empirical overview that resulted in the AIL framework found five kinds of adaptations to climate change to be most common: mobility, storage, diversification, communal pooling, and market exchange (Agarwal, 2008: 2). Access to natural resources, technology, and finance necessary to engage in these kinds of adaptation, and thus secure and stabilize livelihoods, were found to be influenced by local formal institutions in three ways (Agarwal, 2008: 3). Formal institutions—both government and civil society—structure exposure to climate change-related risks within a rural community, for example, by providing more equitable access to resources such as irrigation water or pasture. Secondly, institutions shape the way that communities respond to climate change by creating incentive structures for individual or collective adaptations, for example, through the creation of physical and social infrastructures that allow access to markets, secure land tenure, and availability of finance. Finally, institutions serve as intermediaries for access to external resources from central governments or non-governmental organizations.

AIL is based on a study of 118 case studies from 46 countries covered by UNFCCC data (Agarwal, 2008). AIL is particularly concerned with the role of local institutions, such as local governments, cooperatives and other civil society institutions, NGOs and charities (ibid: 1). The framework also recognizes informal institutions such as communal labour exchange, indigenous information exchanges, saving groups, and informal regulation of access to common forest and pasture resources.

We draw on insights from political ecology to modify the AIL framework by exploring the competitive dynamics within and among local institutions; and between them and national government institutions (Friis-Hansen, 2017; D'haen & Nielsen, 2017; Ribot & Oyono, 2005; Poteete & Ribot, 2011; Mascarenhas & Wisner, 2012; Ribot, 2018). This complementary political ecological framing allows the state in its devolved form to be understood not merely as a disinterested arbiter of conflicts over resource access, but rather as a reflection of underlying differences of social power operating at multiple scales (Gallarado, 2017; Green, 2003).

We begin by examining diversification, mobility, and market exchange as adaptive strategies.1 We then consider the challenges of decentralization in Tanzania as they relate to these adaptive strategies. Turning to our study area, we explore the history of the Nyumba ya Mungu dam and surrounding fishing communities in the early post-colonial Tanzania. We draw on household survey data and describe primary adaptive strategies to climate variations and related variability in fish population. Finally, we turn to expected impacts of further climate change on fishing-based livelihoods in the study area, and the role of national policy and local institutions in mediating local impacts and enabling local adaptations.

2. Diversification, Mobility, and Market Exchange as Modes of Adaptation to Change and their Institutional Mediation

Historically, rural East African societies often transcended simple livelihood-based categorizations as farmers, pastoralists, fishers, or hunger-gatherers; and there have been transitions toward and away from greater specialization from the pre-colonial period to the present (for historical examples, see Spear & Waller 1993; Conte, 1995; Kimambo, 1996). In this light, concurrent engagement in farming, pastoralism, and fishing (alongside a range of other 'non-farm activities' such as sale of casual labour) should not come as a surprise. A wide range of activities may remain in the cultural memory of rural communities.[2] For example, recent studies

[1]Two of the five types of adaptation in the AIL framework are less important in our study villages. One is storage of animals, water, and food because market access is relatively easy and water for domestic purposes is abundant. The other is communal pooling in the form of labour exchange and sharing of information. People share knowledge and information in these villages but there is little mutual aid, except for crewing larger boats. This requires up to four as a crew.

[2]To our knowledge, there is little artistic or artisanal memorialization of disaster documented in Africa and little memorialization by the state except in post-war genocide situations such as Rwanda. Nevertheless, elsewhere scholars and planners have pursued the subject of cultural memory of disaster, and this might prove an important avenue for those concerned with risk communication in Africa to pursue. See, for example, le Blanc (2012), Weesjes (2015), Dalisay (2019).

have taken up the case of people dependent primarily on pastoral livelihoods who also fish as a diversification effort (McCabe et al., 2010; Stoop et al., 2016). The Maasai and Turkana engage in farming and fishing, respectively, as strategies to manage variability in pastoralism (McCabe et al., 2010; Kolding et al., 2016). Similarly, Luo fishers have developed a substantial agricultural fallback as a means of buffering variability in fish catches from Lake Victoria (Geheb & Binns, 1997).

Such a mix and dynamism of livelihood activities was taken up by the United Nations during consultations on a future "… declaration on the rights of peasants and *other people working in rural areas*" (UNHCR, 2017, *our emphasis*). There is a need for policy and scholarship to better account for the multi-dimensional livelihoods present in small-scale fishing communities, especially in the context of rapid change, including climate change (Allison & Ellis, 2001). Research can contribute to this by exploring what Bryceson (2002) called the 'multiplex process of diversification', emphasizing the cultural and political processes that underlie greater occupational diversity in rural communities.

Some diversification literature suggests that the addition of a variety of non-farm sources of income to a household's portfolio makes it less vulnerable to a variety of market risks and natural hazards (Ellis, 2000; Coulthard, 2008). Ellis (1998) distinguishes 'survival' from 'opportunistic' diversification. Survival diversification may not, in fact, decrease risk and increase household welfare, and may even expose people to new risks (Smucker & Wisner, 2008; Niang et al., 2014). Opportunistic diversification includes investments in new activities by better-off rural households who benefit from diversification (Loison, 2015).

Because diversification is often embedded in new patterns of rural-rural or rural-urban mobility, recent research has explored spatial diversification as one important variant of livelihood diversification (Goulden et al., 2009; Tacoli, 2010; Ramisch, 2016). However, mobility also serves as an important means for more specialized fishing populations to cope with variability in fish availability (Njock & Westlund, 2010). The mobility of fishing populations may also have major implications for the nature of their engagement with local government and civil society, particularly in the light of co-management structures that have been widely diffused in small-scale fisheries across the developing world (Nunan et al., 2012).

Within the context of wider policies related to transport and marketing, local institutions shape differential access to fisheries resources and markets for fish, and value-added products. Gaining or maintaining market access can be a critical component of the adaptive strategies of fishing-reliant communities. Although fishing has sometimes been portrayed as an occupation of last resort and fallback for the most marginal rural populations, small-scale fishers' access to markets is neither barrier-free nor is it necessarily equitable (Onyango, 2011). The cost of gear and boats are substantial, and access to prime fishing locations

may be subject to formal and informal costs (Bene, 2003). For many small-scale fishers, market access provides an important means of ensuring access to nutritionally adequate food. Local formal institutions may facilitate market access generally for fishers' catch and value-added products. Additionally, self-organized cooperatives may seek to ensure fishers advantageous terms of trade (Basurto et al., 2013).

Institutional Mediation of Adaptation

It is increasingly recognized that effective governance of climate change adaptation depends on local institutional capacity, as well as collaborative and supportive multi-level governance structures (Folke et al., 2005), although such structures are not a guarantee of socially equitable outcomes. In Tanzania, governance reforms of the last two decades have been in keeping with the global governance trend of dispersing power downward to local government and outward to non-governmental actors (Reed & Bruyneel, 2010). The configuration of local formal institutions, as of 2019, was produced through a sweeping set of late 1990s donor-driven policy reforms that sought market liberalization, devolution of power, and civil society development. Most relevant to our study are two major reforms: those concerning local government; and fisheries management.

The late 1990s Local Government Reform Programme (LGRP) established village government as a focus for political devolution, with directly elected village councils that take primary responsibility for fiscal administration, social development, adjudication of resource rights, and service provision through direct engagement with constituents. Some scholars have argued that village governments in rural Tanzania regularly engage in coercion and opaque governance (e.g., Brockington, 2008; REPOA, 2008). Recent research points additionally to ambiguous objectives and poor communication leading to a lack of trust between central and local government administrations (Fjeldstad et al., 2019; Mkunde, 2019). Still others point to the deep dependency of village government on central government funding, which constituted more than 90% of local government spending nationally in 2012–13 (Masaki, 2018). For Green (2010: 26), this dependency is reflected in:

> … governance as the articulation of relationships between levels of the Tanzania political system, from the lowest tier to the next level up, making contributions upward and in adherence to form, anticipating (optimistically) the possibility of assistance from higher tiers.

Recent reforms have sought to reduce this dependency on the central government through enhanced revenue raising capacity by local government (Mgonja & Poncian, 2019).

A second reform relevant to this paper is the Fisheries Act of 2003, which sought to establish fisheries co-management through the creation of Beach Management Units (BMU), committees of local residents who would jointly carry out

management plans (URT, 2003).[3] Like water user's associations and ubiquitous agricultural improvement groups that have proliferated as a result of new legislation and World Bank-funded initiatives in rural Tanzania, the establishment of BMUs reflects a broader policy concern for developing and engaging local civil society to address social development and resource management concerns. In principle, the emphasis on civil society development has sought to create a counterweight to local government power and enhance citizen engagement in local decision-making, both of which were expected to lead to improved development outcomes (Stewart, 2007). In practice, as with devolved village government, serious concerns have been raised about the capacity and agency of Tanzanian rural civil society to address pressing rural needs in the face of substantial shortcomings in rural service provision by government (Lange 2008; Mercer and Green, 2013). In addition, unlike the other kinds of local co-management initiatives just mentioned, BMUs have been used in practice as a means of the superordinate state (e.g., national and regional fishing authorities) to discipline and punish violations of intermittent fishing bans and use of small-weave nets.

The concerns cited above about downward and outward dispersal of governance and authority in Tanzania speaks to wider questions about centre-periphery governance relations in Africa (Boone, 2003; Lind, 2018). Drawing on the work of Friis-Hansen (2017), we ask whether downward dispersal of authority in Tanzania has resulted in local government that serves merely as implementing agents of central government and NGO agendas. By examining local institutional capacity to address pressing local livelihood adaptation concerns, we consider whether the power of village government constitutes a 'superficial varnish' that masks a lack of substantive control over decision-making and financial resources related to climate change adaptation (Friis-Hansen, 2017: 148).

Study Area and Methods

The study was conducted as part of a broader collaboration between Tanzania and US-based scholars in Kilimanjaro region known as the Local Knowledge and Climate Change Adaptation Project (LKCCAP). LKCCAP examined understandings of, and responses to, change from villages at the highest inhabited altitudes and along altitudinal gradients of Mount Kilimanjaro and the North Pare Mountains that extends to the neighbouring savanna drylands. Figure 1 shows the high and middle elevation study sites (Mangio and Lambo); as well as the low elevation study sites located along Nyumba ya Mungu's south-eastern shore. The lakeshore villages of Kiti cha Mungu and Njiapanda are among the low elevation dryland sites that were selected for more intensive study, and the only sites in which fishing was a central component of peoples' livelihoods (Fig. 1).

[3]This act was still in force as of early 2019; however, there was a move in government to amend it (Stop Illegal Fishing 2020).

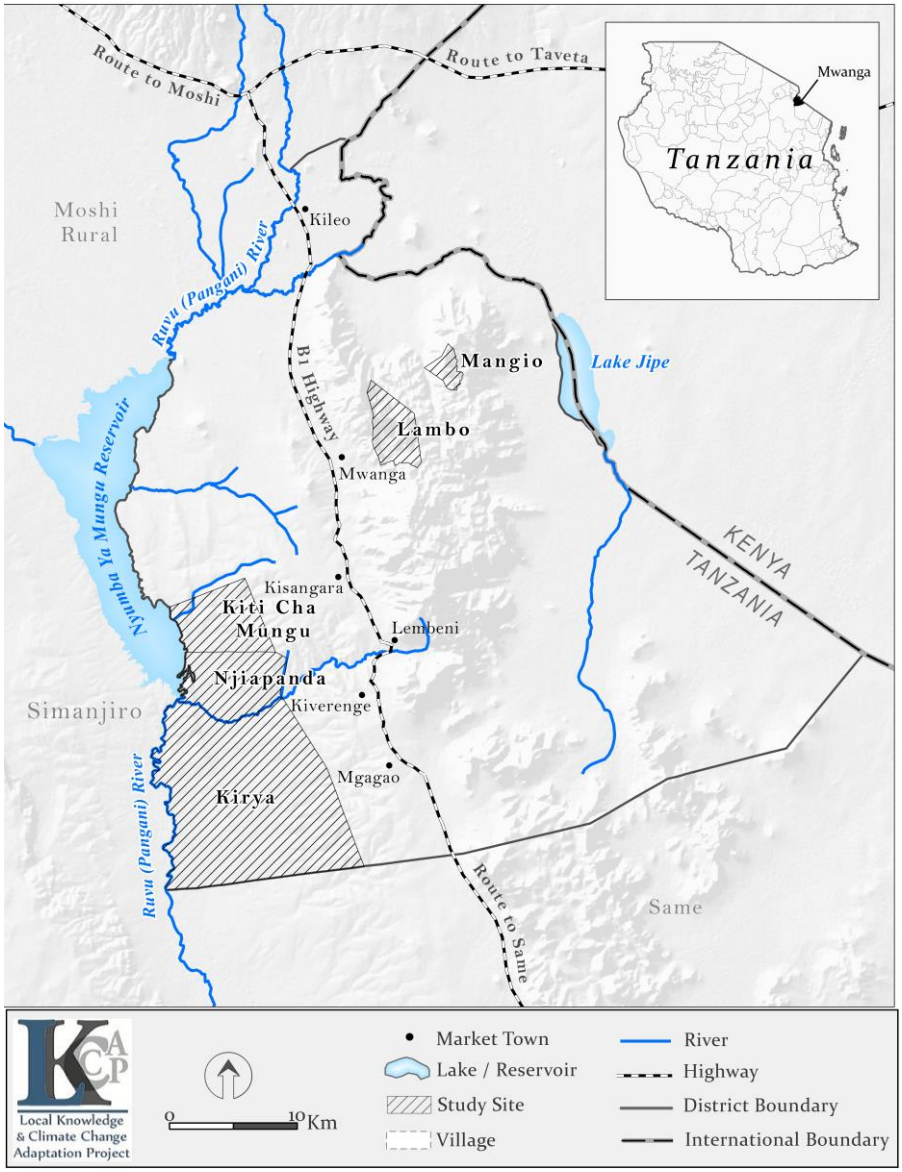

Figure 1. Lowland fishing villages and other study sites in Mwanga District
Source: ***LKCCAP Project***

These villages constitute two of the three villages making up Kirya Ward. The third is Kirya Village whose eponymous sub-village, Kirya, hosts a formal irrigation system; whilst two other sub-villages offer pasture for Maasai livestock and some small-scale irrigation sites. Kirya Ward is a component of the Mwanga District, one of the six districts making up Kilimanjaro Region.

Residents of the two case study villages include Tanzanians from 31 ethnic groups with family origins in 28 districts, some as far as 800km distant. One is tempted to call these households 'fishers', although keen observers such as early as anthropologist Daryl Forde cautioned against easy stereotyping of people by what appears to be their principal livelihood (2010 [1934]). Forde's concern about such simplified characterization of rural livelihood resonates in the context of sectoral approaches to climate change adaptation that result in narrowly technical accounts of the adaptation challenges facing rural communities in Tanzania (Smucker et al., 2015).

The present article draws on household survey and qualitative data collected in 2014 with additional key informant interviews during 2017 and 2018. It also draws on numerous conversations with civil servants and political authorities at the district level. Key local informants included fishers with particular knowledge of changes within the two villages, and leadership in the village government. A household survey (n=104) provided a characterization of rural livelihood activities of all family members, resource access, and household responses to perceived changes in climate variability. Households were randomly sampled using a numbered list of residents in each village.

Recruitment of household survey interviewees and key informants was conducted through word of mouth, and facilitated by village government officials. In our recruitment of key informants, we sought to ensure gender and age balance. Background information was also sought from officials at the district and regional level and from the Pangani Basin Water Board.

4. The Brief History of Nyumba ya Mungu Fishing Villages

The Nyumba ya Mungu reservoir was filled in 1964-5 and fishing began in 1968. The development of the fishery in a previously low population area attracted large numbers of people from other regions of Tanzania and Kenya. Fishers from lakes Victoria, Tanganyika and Malawi came to Nyumba ya Mungu and created 26 settlements around the lakeshore with a total estimated population of 25,000 people (Denny 1978, citing Ricardo 1974). Fish were abundant at first, but by the mid-1970s the catch had fallen from the 1968 high of 28,000 tons to annual production of only from 1,800 to 5,000 tons, continuing through the 1980s to recent times (Denny 1978; Turpie et al., 2005: 21). The reservoir's dimensions are highly variable, and water levels respond quickly to rainfall, which itself is quite variable. These characteristics add to the variability in yield that compound the normally expected boom in production whenever a reservoir is filled.

Early disappointments led to some people leaving, but none of the villages were abandoned. The lakeside population stabilized at about 5,000, and those that remained, including those living in our study sites, have adapted their livelihoods to a complex cycle involving swings in limnological and biological conditions and the fish population. Persistence in fishing has been made possible by the diversification of income sources.

Interviews with 104 households in the two remaining lakeside villages, Njiapanda and Kiti cha Mungu, provide a suggestion of the diversity of the people originally attracted to Nyumba ya Mungu by jobs in construction, and later by fishing opportunities. Thirty-one language groups are mentioned as the ethnicity of the father. Only a third lists Mpare, the group inhabiting the Pare Mountains to the East. Most of the others are groups from many parts of Tanzania, some hundreds of kilometers distant, and many from the South of the country. As reflected in Figure 2, the large number of connections with places near the lakes of the western Rift Valley (especially communities surrounding Lake Malawi) suggests that people may have come with a variety of fishing skills.

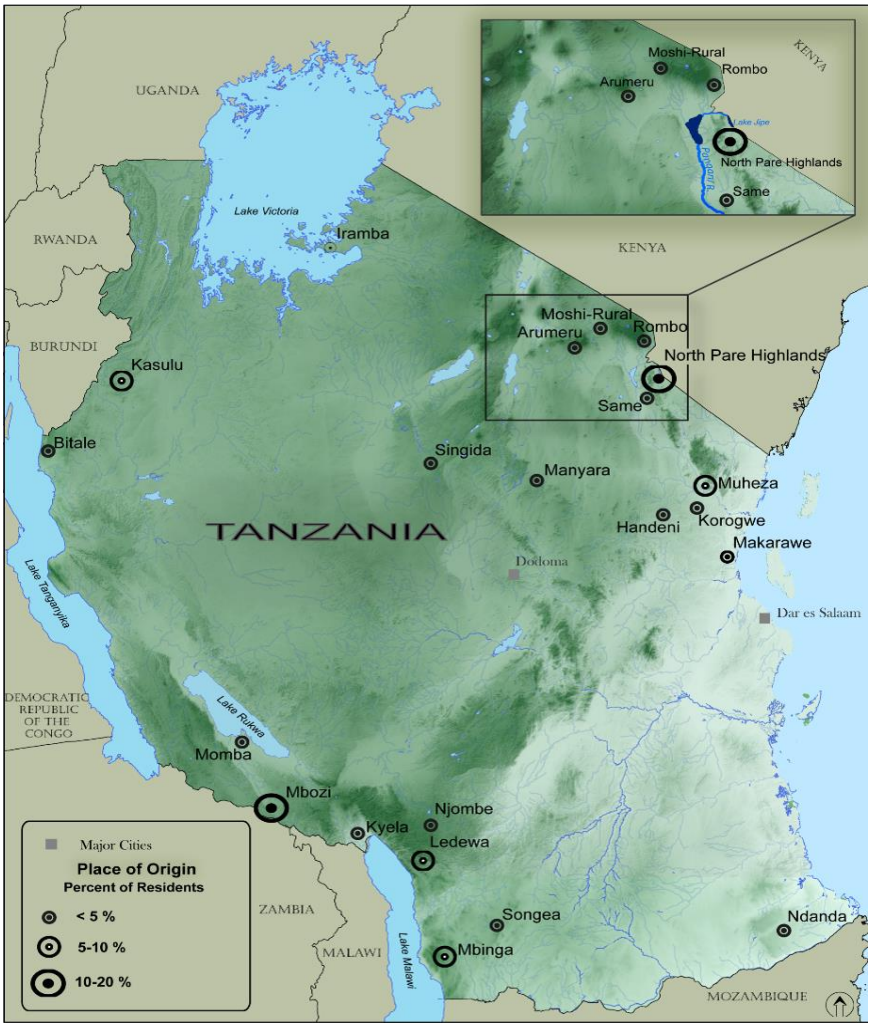

Figure 2: ***Places of Birth of Adult Residents, Kiti cha Mungu and Njiapanda Villages***
Source: LKCCAP Household Survey (2014)

5. Livelihood and Adaptation

Market Exchange

With the lifting of restrictions on trading in the late 1990s, engagement in non-farm commercial activities has accelerated. Transport has improved, and Mwanga town – which was established as the new district headquarters in the 1980s—has subsequently grown, providing a larger market for fish and other commodities, as well as employment (Wisner et al., 2015). Mwanga's weekly market also serves as a regional market hub on the main tarmac road for other larger urban centres.

Market and infrastructure changes have provided a spatial platform for managing the pressures of climate variability on fishing, farming, and livestock keeping. As elsewhere in rural Tanzania, these lakeside villages have experienced the growth of non-farm income. Household survey respondents report a wide range of income-earning activities. A small number report income from maintaining a retail shop, typically selling packaged food, sodas, phone vouchers, and other items. More frequent is the informal sale of fruits and vegetables, porridge, tea, and baked goods as a source of income. In some cases, these additional trading activities are an extension of fish sales. The sale of smoked fish is a source of income for fully 63% of the households. In addition, the processing (smoking, sun-drying, and frying) of fish, their transportation and sale, as well as repair of boats and nets provided multipliers in the form of other income sources. Twenty-nine percent of the households engaged in repairing nets and boats. Some women provided wood for smoking fish.

Sale of labour power is also a form of market exchange of importance to livelihoods in these lakeside villages. 'Off-farm' casual work in neighbouring irrigation schemes, or for a major public works project that is bringing domestic water to the area, is a primary activity for nearly 15% of the respondents, and a supplemental source of short-term income for others. Lastly, more than 20% of the households received remittances from family members elsewhere, most commonly from adult children residing in urban areas. Sales of sand, quarried stone, and firewood are declining in importance, at least partly due to the recognition of local environmental impacts, an issue that has been taken up by the village council's environment committee.

Diversification

While most households have pursued greater occupational diversity through adoption of new non-farm activities, it is the diversity of resource-dependent rural livelihood activities that is most striking in these two villages. Figure 2 provides a broad snapshot of the composition of livelihood activities among households, grouped by primary source of income. We found that each of the three major resource-based activities – fishing, farming, and herding – is the primary source of income for approximately one-third of the households. For those most reliant on fishing, secondary engagements are in either herding (10%) or, more importantly, in non-farm activities (62%). Those most reliant on farming demonstrate the greatest within household diversification, with the majority (57%) also engaged in

a combination of fishing, herding and non-farm activities (Combination FFH + Non-Farm), in addition to more than 20% engaged in herding as a secondary activity. Herders demonstrate a considerable diversity as a sub-set of households, with nearly a quarter engaged in fishing; and 35% engaged in a combination of farming, fishing, and non-farm activities (Combination FFH + Non-farm). Figure 2 indicates a great diversity of secondary livelihood activities, and, significantly, very few households rooted in these three core activities reported secondary income. This contrasts sharply with the households relying primarily on non-farm work (principally service provision, artisanal work, and petty trading); and those primarily reliant on the sale of their casual labour, the vast majority of whom had no other sources of income.

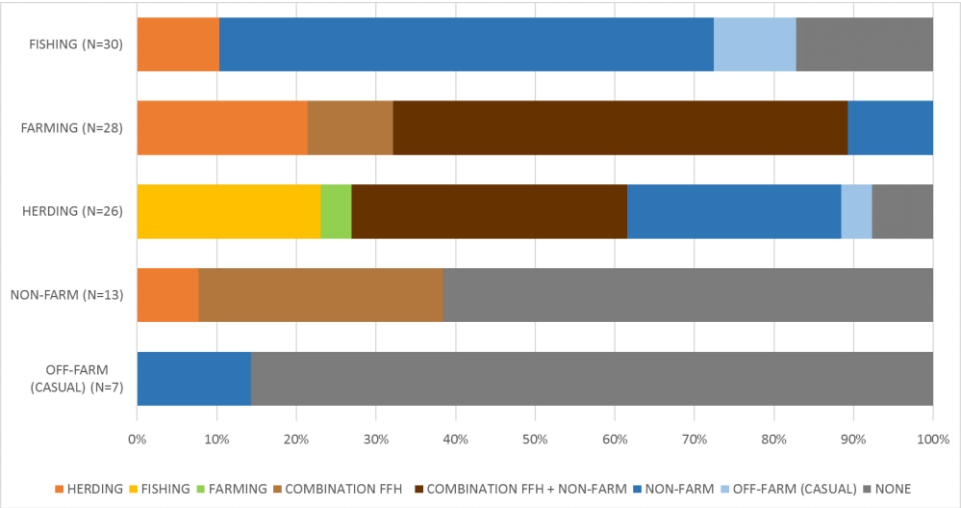

Figure 2. ***Secondary Livelihood Activities of Households by Major Source of Income in 2013, Kiti cha Mungu and Njiapanda***

Source: Study household survey data (2014)

Fourteen per cent claimed to own cattle, but not large herds such as the Maasai in nearby Kirya village. More common was ownership of goats (46%) with 34% of the households having fewer than ten goats, and another 12% possessing more than ten. Many respondents owned chickens (61%). Despite the existence of mobile phone banking and other forms of saving, livestock continued to be a family's 'bank on the hoof'; and was very important in covering expenses such as school fees, weddings, and health emergencies. For those who pursued livestock husbandry, achieving an element of livelihood security from this activity required directly learning from, and interacting with, neighbouring communities, as expressed by one resident:

> *"What we have experienced is learning by observing our neighbours. You should note that in the past years, there was no livestock keeping in our area. But as we have observed our [Maasai] neighbours herding, and the dam itself is drying, it was to our advantage to learn about herding."*

Although these lakeside herders do not travel in the patterns and distances that the neighbouring Maasai do, this aspect of diversification leads to an explicit discussion of mobility.

Mobility

A recurring theme in key informant interviews is the increasing importance of mobility to maintain these resource-dependent core livelihood activities, and to expand into new ones. Although the Nyumba ya Mungu reservoir suffers periods of very low fish availability and government-imposed six-month periods of closure to all fishing, some of those households for whom fishing is the primary activity carry on fishing at other locations along the reservoir, or at other lakes. Supplementary interviews with key informants generated a list of other lakes people use temporarily while waiting for conditions to improve at Nyumba ya Mungu. These include Lake Rukwa, one of the Western Rift Valley lakes situated between Lake Tanganyika and the northern end of Lake Malawi, and the Mtera reservoir to the South in the centre of the country. Both these sites are quite distant and possibly appear in the cultural repertoire because of past family history. One should recall that many of the residents of these villages came from such distant locations either seeking work in the construction of the dam, or later in pursuit of fishing opportunities. Lakes Eyasi, Manyara, Burungi, and Kalimawe are all within shorter distances.

Figure 3 identifies these major fishing sites accessed regularly by some of the residents of our study area. The inset identifies twenty-six villages along Nyumba ya Mungu's shoreline. Of these, four in the Northeast and North of the reservoir were said to be common resorts in times of low yields at home – but not during fishing bans (Handeni A & B, KNCU, and Mikocheni). Another five villages were listed as possible alternative, temporary sites that were less-frequently visited (Kalimawe, Kariati, Jauna, Nyabinda and Magadini). Of possible significance is the fact that four of these less-frequently visited fisheries are located in the southern portion of the reservoir and, in common with our study villages, are thus far from the extensive wetland fish breeding zone in the extreme Northeast of the reservoir. Temporary access to these alternative fishing villages is governed by networks of friendship or, in some cases, registration and payment of fee to the village government, and where they exist, application to the Beach Management Unit committee within the village council.

Mobility is similarly important for those who seek alternative livelihood activities when fish catches decline. The patterns of mobility reflect the diverse family histories and livelihood backgrounds within the two villages, as well as learning that enables engagement in new activities and unfamiliar places. Those who retain strong kinship relationships in the neighbouring highlands seek opportunities to cultivate there, while others seek to rent land in expanding irrigation schemes further south along the Ruvu river.

Figure 3. ***Informal Fishing Circuits: Nyumba ya Mungu Dam Sites and Distant Sites Used by Fishers from Kiti cha Mungu and Njiapanda***

Source: Authors' Key informant interviews (2018)

Peoples' framing of these processes reflect an assumption that rainfall variability is a central driver that has required new strategies for distributing labour and pursuing income. Importantly, identity and livelihood intersect in the peoples' interpretation

of these changes. Despite the reality of economic diversification and diverse uses of skills and labour-time, the term 'fisher' remains for some an identity and not simply an economic niche. In the words of one informant:

> *"We depend heavily on fishing activities. So, whether or not there is rain, the issue that people are most concerned with is the availability of fish. And if [sufficient] fish catch is not available; people typically move to other areas where fish are available or where people are able to practice farming. Others get engaged in herding activities or seek employment as livestock keepers as they are waiting for the rains to return. As others have said, we consider the lack of rain an act of God. When there is no rain, fish are not available. But when it rains, the water levels increase [in the dam] and fish are plentiful, which is a great benefit to fishermen."*

Those who trace their origins to agricultural villages in the highlands may continue to see fishing as an 'additional' activity, alongside the pursuit of agriculture in the lowlands. An openness to experimenting with new activities has been central to their experience:

> *"We are farmers engaged in fishing activities, and everything that we do is dependent on rainfall. We have to frame it this way if we are to understand the different ways we can grapple with the problems we face. And the challenges are many but it is not the end of the world. We have skills and we can use them to address our challenges. Even wildlife put forth every effort to get food, even if it requires them to come into proximity with humans to get water and food. It is not that they like it. They fear it, but it is required of them to do so for survival though they know they are entering a risky environment."*

Peoples' narratives do not point to a diversification driven simply by the emergence of new opportunities, but rather one that seeks to cope with multiple new pressures through a spatial strategy of multiple engagements over space and time, including seasonal and other cyclical variations in rain, lake levels, fish population, casual labour demand, and market conditions. Our findings on mobility highlight an array of longer and shorter distance movements. If indeed these indications of spatial mobility reflect a transition toward a persistent mode of flexible, multi-site and temporally variable livelihood engagements, then local institutions face myriad challenges in their three major roles vis-à-vis adaptation (as stated in the AIL framework): ensuring equitable access to resources, creating opportunities and incentives for forms of adaptation that contribute to long-term resilience, and facilitating access to external resources.

6. Aspirations, Agency, and Institutional Challenges of Adaptation

Climate change is already affecting the quantity and the quality of water in streams, lakes, and dams in our study area. Village residents observe that the rainy season is contracting. Many people perceive that rainfall is coming in fewer, more intense storms. Intense storms lead to rapid runoff—so less rainwater percolates into the soil, and later to enter into streams slowly. During and immediately after storms, a large amount of water and sediment rapidly enter streams and lakes, sometimes causing flooding. However, since there are fewer storms, the dry spells between storms are longer. If rainfall events become even more irregular in the future, these problems will continue and likely become worse.

Climate change is also leading to warmer air and water temperatures (Tadross & Wolski, 2010). This is causing the water in streams, lakes, and dams to evaporate faster. The combination of warmer temperatures, less glacier-melt from Mt. Kilimanjaro feeding springs and streams, and more irregular rainfall can be expected to lead to more flooding and longer dry spells, and generally to lower water levels especially in the dry season (PBWB/IUCN 2010). A one percent drop in annual rainfall may bring about anywhere from 0.6–5% decrease in catchment discharge. Tanzania's 2012 Climate Change Strategy anticipates falling lake levels (URT, 2012: 29). Meanwhile, farmers upstream are consuming more water. This will compound the climate change impacts leading to declining quantity and quality of water resources. The streams, lakes and dams can be expected to become shallower, and to carry more sediment.

Turpie et al. (2005: 21) estimate 13 tonnes of sediment per hectare of catchment. Indeed, there is evidence that the edge of the dam is silting up with thick beds of bulrush instead of the previous open water. Lower water levels and more sediment would reduce the size and quality of the habitat for fish. Based on these projections, fishing would be expected to decline, and what fishing remains would be more sensitive to over-exploitation. Water levels in the dam and flows to downstream irrigation schemes will principally reflect the government's imperative of energy production rather than the water needs of users along the lake shores and downstream of the dam. Below we consider how these climate change impacts, and peoples' adaptations to them, are mediated by institutions at different scales.

The Role of National Policies

National fisheries policy is more concerned with the potential of increasing the output of more than 20,000 small aquaculture ponds in the country (URT, 2015: 3) and not with freshwater capture fishing. Although fresh water, inland fishing provides 85% of Tanzania's annual fish yield (versus 15% from marine sources) (URT, 2015: 3; URT, 2012: 18), small reservoirs and lakes such as Nyumba ya Mungu account for less than one percent of fresh surface water fisheries (URT, 2015: 2). Artisanal small lake and reservoir fishing is nowhere among the nine priorities identified by the National Fisheries Policy (URT, 2015: 8). In principle, technical assistance and credit could help Nyumba ya Mungu residents begin fish farming in areas penned off along the shoreline, but there is very weak extension (there are only 436 fishery officers for the whole country versus government's estimate that 16,000 are required [URT, 2015: 22]).

Temporary displacement to other fishing villages or fishing sites in the Pangani Basin and elsewhere in Tanzania will most likely be limited by basin-wide climate change and environmental impacts of construction and land use. Fishing is mentioned in the section on water in the National Adaptation Plan of Action (NAPA) (URT, 2007: 7), but nowhere does the NAPA discuss the impact of climate change on inland fishers. Water receives a high priority among climate-related challenges (ibid: 33), but fishing has disappeared by this point in the

document. Tanzania's 2012 *Climate Change Strategy* signals the importance of wetlands and fishing livelihoods 'for millions of people', but focuses its attention on the country's four officially registered RAMSAR wetlands (URT, 2012: 13).

However, in one way, the 2015 Fisheries Act does directly impact livelihoods at these lakeside villages. It mandates the creation of Beach Monitoring Units (BMUs) as committees within village councils. These BMUs are responsible for conservation of fisheries, and, de facto, that means enforcement of regionally or nationally imposed six month bans on fishing at Nyumba ya Mungu to allow fish stocks to re-grow. Ideally, the BMUs would also facilitate fishery education and access to improved technologies, but this depends on the existence and number of fishery department staff at district level.

National policy on land tenure also can help to facilitate local adaptation, as emphasized in the AIL framework. Tanzania's policy is eventually to provide a form of private tenure to all farmers, and the Village Land Act (URT, 1999) provides the authority to survey and guide the titling process (Massay, 2016). However, implementation of the land law requires a full mapping of village land use and adjudication of claims, and although this process was begun in 2011, it is far from complete (Bryceson, 2015). Uncertainty surrounding land tenure means that the fisher-farmer-herders in our case study villages are reluctant to expand dryland farming into unsettled land upslope in the hinterland of the villages. By the same token, outside investors who have been keen to expand biofuel production into landscapes such as this have not come forward, thus, in principle, denying villagers of employment opportunities, and of possible lease income to the village council.

District Institutions

Descending from the national scale, our study asks whether devolved local institutions possess the capacity and authority to enable adaptive strategies fine-tuned to the conditions and human and natural potentials of these two lakeside villages. As the highest rung in Tanzania's local government system, the district government had limited sources of income during the period of study. The Tanzanian system devolves responsibilities but does not decentralize flexible access to financial resources. It is a flexibility that would be required for investment in partnership between village councils and district government. There are small sources such as levies on gravel and sand extracted from the district, income that is shared with the village where the excavation takes place. Fishing license fees are collected by the fisheries officer (a district fisheries office was set up near the Nyumba ya Mungu dam site in early 2018). However, collection should eventually be the responsibility of the newly-created BMU, with a percentage collected going to the district and the remainder for the village. Recent efforts of the Magufuli administration to place greater responsibility on local government for revenue collection may address these concerns, though the implications for greater agency in pursuing local priorities are not yet apparent.

Mwanga District's *Strategic Plan* lists Nyumba ya Mungu reservoir as an 'opportunity' in the section that analyses the district's strengths, weaknesses, opportunities, and challenges (URT, 2012). It mentions fishery and proposes to "assist small fishermen's groups to access better fishing tools/ facilities" (p. 62); and says a dedicated fishery officer is needed. But there is no funding for any of this. The district could also negotiate, on behalf of the lakeside villagers, with the Pangani Basin Authority for water permits. Villagers who now use buckets to irrigate small plots on the shore could pump water from the reservoir and irrigate larger plots. Elsewhere in the Ruvu/ Pagani Basin, very sophisticated negotiations over water use have been documented (Komakech et al., 2012).

Local Institutions

While the IPCC reported low agreement in the literature on the implications of diversification for livelihood resilience in the context of climate change, they find high agreement and robust evidence that land access, flexible local institutions, and gender equity serve as drivers of resilience (Dasgupta et al., 2014). Indeed, our qualitative research points to the key roles of elected village governments in marshalling of district-level resources or adjudication of resource-access to village councils. In our assessment, we find that village councils of the two villages have sought to act on residents' aspirations but are severely limited in their capacity to enable new locally-sensitive pathways of diversification. Similarly, we found that local civil society is thin on the ground, and severely dependent on short-term project funding.

The village council is the local institution most likely to assist village residents attempting to juggle fishing, farming, and livestock production. Indeed, village council members speak eloquently of the precariousness of livelihoods that depend on a single source of income. Furthermore, the importance of establishing multiple sources of income is deeply engrained in the thinking of village council members.

What overrides much of the potential for local institutions to act as intermediaries providing access to information, technology and finance is the competitive—and often contradictory—demands within the government hierarchy. Village councils are limited in their ability to enable new pathways of diversification with low entry barriers and broad appeal. They can submit no more than three proposals to the district government per year and, as has been found elsewhere in the study area (e.g., Venugopal and Yilmaz, 2010), proposals largely focus on urgent infrastructural needs such as school latrines or housing for workers in the local clinic.

Despite serious limitations in capacity, village councils in Njiapanda and Kiti cha Mungu do play a central role in fisheries conservation. We found that the elected village councils were the site of complex negotiations over fishing (especially fines for violating norms for net size and the size of individual fish

caught). However, despite these efforts to regulate, the village council has so far been unable to broker an arrangement among fishers to conserve fish stocks. Twice in recent years regional authorities have stepped in and attempted simply to ban fishing in the reservoir.

The revival of fishing as the core livelihood activities for most residents would require a more assertive role for village councils in negotiating a conservation arrangement that ensures equitable burdens and benefits. Further complicating the fish conservation issue is a fact learned in supplementary key informant interviews: that some of the village council members either own boats which they rent out, or are related to people who fish. Nevertheless, despite such potential conflicts of interest, increased participation of village councils in fishery management decisions at the higher regional level, either through direct consultation or mediated via the district, could reap the benefits of local knowledge. For example, the two village councils have discussed their preference for six-month bans in specific zones and not reservoir-wide. However, such an idea would need acceptance and coordination among all the lakeside village councils, and acceptance by regional fishery authorities.

Resource access generally rests heavily on an effective functioning of village councils (though, notably, councils were not in control of licenses provided to outsiders by the district council to mine sand and produce charcoal for nearby urban markets). As we have found elsewhere, however, Njiapanda and Kiti cha Mungu village councils assume the major responsibilities of adjudicating local resource-access with extremely limited financial and material support from district and regional governments (Smucker et al., 2015). Lastly, village councils have often struggled to access district support for initiatives to expand non-farm activities, e.g., through provision of credit to support new economic activities. Thus, the capacity of village councils to steer district resources towards village development and equitably to adjudicate resource access to an ever more diverse set of residents and newcomers remains a daunting adaptation challenge as observed in these two villages.

Along with the devolution of power to village councils, outward dispersal of institutional capacity to local civil society was to have been driven by institutional reforms of the late 1990s. Here we find a relative dearth of organizations with active leadership, and a reliable membership in the two study villages. Our investigation of local civil society in these villages found that many registered CBOs are in fact relics of past agricultural improvement initiatives that required CBO formation to receive small amounts of money for livestock or maize improvement activities. In reality, CBO activity was largely limited to brief initial periods of funding through programs such as the World Bank's Participatory Agricultural Development and Empowerment Project, which created such groups in more than 800 villages across Tanzania (World Bank, 2011). Formal CBOs are often transient: those that are active have been shaped by their heavy dependency on a parallel hierarchical system through which they pursue for support for productivity enhancement of established crop and livestock activities.

7. Conclusion

The residents of Kiti cha Mungu and Njiapanda villages have developed a dynamic, multiplex livelihood system, even as many maintain their core identity as fishers. Household income has diversified through changes in spatial mobility and market exchange that takes several forms. including the sale of labour power. This results in new ways of allocating labour across multiple locations and income-earning activities. In addition, increasing livelihood diversity depends in part on social learning of livelihood practices from neighbouring groups.

Our earlier research into livelihoods, institutions and adaptation elsewhere on the steep environmental gradient in Mwanga District revealed that people understood climate change in the context of multiple changes over the past decade: changes in administration and political power, technology such as mobile phone banking, transportation infrastructure, and economics (Smucker et al., 2015; Velempini et al., 2016; Wangui et al., 2012). While this is also the case in Kiti cha Mungu and Njiapanda fishing villages profiled here, participants cited frequent rainfall variability as the preeminent proximate cause of change. For most residents, adaptive strategies reflect responses to climate stimuli mediated by multiple social factors, rather than opportunistic strategies for accumulation.

While the AIL framework highlights the key roles of local formal institutions in enhancing adaptive capacity and shaping adaptive strategies, the broader contentions of political ecology are essential to understanding the origins and limitations of specific institutional configurations. We have documented the village councils' engagement and deep appreciation of villagers' needs, and demonstrated that district authorities face constraints on their ability to support diversification and stability of livelihoods, notably in staff shortages and few sources of revenues for discretionary funding of village-generated projects.

Our analysis suggests an urgent need for greater alignment of national policy with the daily struggles of these rural dwellers, and greater agency for district and village governments to address complex and dynamic rural livelihood needs. The development of non-governmental formal and informal institutions such as cooperatives—currently largely absent in our study villages—could spur innovation. Policy reforms pursued since our fieldwork may serve to reduce these challenges if they address the concerns related to the limited agency and financial resources of local governments addressed above.

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