



Participatory mapping of environmental resources: A comparison of a Tanzanian pastoral community over time



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ABSTRACT

Community geographic features change over time, and this change can be contentious. Understanding social responses to this change is important for policies related to adaptation to climate change. This paper examines the use of participatory mapping of resources, at two time points, in a Tanzanian community. The results of our mapping (May 2015) were compared to those by a report by the United Nations Food and Agriculture Organization (2009). Differences included boundaries, land use designations and accessibility. These discrepancies may reflect actual changes in resources and livelihoods over time, but also differences in researcher trust and the enabling of participants. Findings suggest that repeated participatory maps, conducted in a trusting environment, are required for long-term planning in places experiencing both climate and social change.

1. Introduction

Community assessment of land use is important for planning and allocation, especially in areas where conflict over limited resources has historically occurred or is likely to arise given current trends in climate change or changes in social structure and livelihoods. The interaction between humans and the environment, taking into account salient cultural values, is an important part of political decisions (Fagerholm and Kayhko, 2009), including land use designation and accessibility. Ultimately, the health of the community and the livelihoods of its members are dependent upon the careful and equitable management of these resources, including water, land, and built infrastructure.

In the semi-arid savannah of sub-Saharan Africa, limited rainfall ‘pulses’ during the wet season create a pattern of competition for water resources between vegetation, wildlife, livestock and human populations. While this annual process has been taking place over centuries, this pattern of competition is currently evolving as climate change alters rainfall patterns (Chesson et al., 2004). Likewise, policies in the semi-arid savannah of East Africa including the prolific designation of national wildlife parks (e.g., Infield et al., 1993), the forced settlement of pastoralists (Fratkin and Roth, 2005), and land privatization (Kisamba-Mugerwa, 1996) have led to dramatic changes in land use

designations and access among community members. Documenting resources, and access to them, in this environment may help in long-term planning for climate adaptation or to clarify ownership to land and access to other resources. Participatory mapping has proven to be a useful tool for recording the allocation and ownership of resources in communities undergoing transition (Cronkleton et al., 2010), and for establishing the best practices in adapting to climate-related risks (Reichel and Frömming, 2014).

In a recent review of studies of ecosystem services in Africa (2005–2014), approximately 33% of such studies involved participatory mapping (Wangai et al., 2016) of biodiversity and ecosystem functions which benefit human wellbeing. Most ecosystem services mapping research was conducted at a regional scale. At this scale, two studies in Tanzania were included (Fisher et al., 2010; Swetnam et al., 2011). These studies focused on the economic aspects of ecosystem services, including payment for services and trends in socioeconomic drivers of ecosystem change with varying scenarios into the future. Only two (12%) mapping studies were conducted at a local scale, which is the most useful scale for direct local decision-making (Wangai et al., 2016). One of these studies was conducted in South Africa (Petz et al., 2014) and one in Tanzania (Fagerholm et al., 2012). Most relevant to the current research, Fagerholm et al. (2012) used local stakeholders as

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key informants to map and then rank the value of various local resources. They found that landscape services related to food (agriculture and livestock) were the most commonly mapped and highly valued resources. Interestingly, however, evaluation of water resources, as part of the landscape services important for livelihoods and wellbeing, was absent from this study. The authors also found scattered patterns of resources usage which led to pressures and conflicts.

Although participatory mapping may reveal tensions between groups regarding access to resources, a systematic evaluation of participatory mapping suggested that the mapping process, itself, does not significantly increase conflict (Reyes-García et al., 2012). A pre-existing conflict, however, may continue in spite of community mapping efforts. Shared land ownership, adjacent land, privatization or new designated uses of land are a few instances where conflict may arise within a community, requiring cooperation to ensure that resources are managed equitably and sustainably and all voices are equally heard (Schelhas et al., 2002). While participatory mapping has been highlighted as an effective tool for sharing community knowledge of resources, effectively planning resource management (Cronkleton et al., 2010), mediating conflict and empowering community members (Cronkleton et al., 2010; Fagerholm and Kayhko, 2009; Reichel and Frömming, 2014), the actors involved in the process of participatory mapping can significantly influence results (Chambers, 2006). However, the integration of participatory mapping and GIS techniques has proven to be a promising avenue for improving community representation and land use planning (Hessel et al., 2009) with its origins in participatory rural appraisal (Chambers, 1994).

The aims of this research were to: i) conduct participatory mapping and observe potential differences between the perceptions of male and female community members of resources in an agro-pastoralist village, Naitolia, in Monduli District, Tanzania; ii) digitally record resources identified in participatory maps using GPS to generate a spatially-accurate reference map for the community; iii) compare features, land uses and land area between our results (2015) and those of the UN Food and Agriculture Organization (2009); and iv) evaluate implications for participatory mapping as a utility by discussing possible reasons for identified differences including the intentions of external actors, goals of the community members, and the relationships or trust between parties. These two maps also present a unique opportunity to quantify land use change over time, with implications for climate change resiliency. This research uniquely contributes to the literature as it provides a repeated cross-section of community resources in a place experiencing both climate and social change. In addition, it is novel in that the identified changes are a direct, intentional result of the initial participatory mapping method itself.

2. Methods

2.1. Ethical approval

This study was approved by Michigan State University (IRB# x15-423e) and the Tanzanian Commission for Science and Technology (#2015-207-NA-2015-149).

2.2. Study site

Naitolia (also spelled Nyatolia), in Monduli District, Tanzania (see Fig. 1), is an agro-pastoralist village with a population of approximately 1800 people according to the most recent census (Census, 2012), although in our previous work, we estimated that Naitolia is comprised of approximately 300 households (Pearson et al., 2015) or 1410 residents (in 2012, Monduli District's average household size was 4.7 (Knoema, 2012)). Naitolia receives varying rainfall, averaging 650 mm annually (TANAPA, 2001). The major ethnic groups are the Waarusha and the Maasai, and their families live in dispersed *bomas* or household compounds. Other ethnic groups include Wabarbaig, Wambugwe and

Wambulu. Traditionally, in Tanzania, *bomas* were comprised of a number of Masaai households (Bekure et al., 1991) though in recent decades have become smaller and more often comprised of one household (Ikanda and Packer, 2008). Most households (~70%) are considered pastoralists in that they depend on livestock production for their livelihoods, as source of food (both meat and milk) and a store of wealth (University of Minnesota, 2010). A baseline survey of poverty in the Monduli District found 59% of rural households to be considered below the poverty level, where household consumption is below what is required to satisfied basic needs (EDI, 2005).

Drought in the area has led to a shrinking water supply and declining agricultural productivity, with concomitant food insecurity and health issues (TPP, 2008). Availability of water and reliable access to quality water are major priorities for sustainable community development and public health promotion in Naitolia, for which recent interventions have been implemented by Michigan State University's Tanzania Partnership Program (TPP). Naitolia was selected as a study site for this participatory mapping study to understand the current state of environmental resources, which have not only been threatened by a climate characterized by severe drought, but repeatedly subject to the intervention of external political agencies due to Naitolia's key location in the wildlife corridor. This village is an optimal setting to compare changes in land use over time due to: 1) the insecurity of water in the region; 2) the increasing shift from purely pastoral to agro-pastoral livelihoods; 3) the recent designation of many adjacent areas as conservation areas; and 4) the ability to compare contemporary land use changes using an existing participatory mapping exercise from 2009.

2.3. Data collection and map generation

Participatory mapping exercises were carried out in May 2015 with two separate groups at the village government office building in Naitolia. First, adult women (n = 10) participated in the mapping exercise followed by a group of adult men (n = 10). Thus, these 20 participants represented the optimal size of volunteer focus groups as established in other participatory mapping studies (Mapedza et al., 2003). The objective of working in these groups was to ensure freedom of expression, avoid gender bias in interpreting access to resources in the mapping activities, and to see whether the two groups perceive access and uses differently. These methods, particularly small, organized groups, have been established as both effective and integral for landscape visualization (Boedhihartono, 2012).

In each group, a table was placed in the center of the participants. A large sheet of paper and different colored markers were provided. Participants were instructed, first in English and then translated in Swahili, to create a map, using the markers and the paper, of the important features of Naitolia, including small features of the village and large areas, noting specific uses and which community members had access or were restricted. Participants were probed on the following: forest resources, farms, grazing land, water sources, tourism or other conservation areas and community amenities (e.g., church, school). During the map creation, notes were taken by field staff in English with assistance from Swahili translators related to disagreements or consensus on boundaries or features. This process lasted about one hour for each group. At the end, a photo of each map was taken and differences between the male- and the female-generated maps were noted.

Following participatory mapping activities, all features from both maps were visited to obtain GPS coordinates (using ArcCollector, ESRI, Redlands, CA, USA). Last, digital maps of all features were created, including both English and Swahili names [data available upon request]. Our digital participatory map was made from combining all features from the two hand-drawn maps, and was then used to compare with a prior participatory map, created in 2009 by the UN Food and Agriculture organization (UN FAO).

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