Participatory mapping in Lushoto district, Tanzania

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Background

The Acting together now for pro-poor strategies against soil and land degradation (AGORA) project aims: to improve the lives of the rural poor by mitigating or reversing the land degradation that threatens their livelihoods and the underlying natural resource base; and to sustain long-term productivity of their landscapes. Working in Malawi and Tanzania to identify the factors that drive land management decisions, especially those that influence the adoption of sustainable land management (SLM) practices, AGORA seeks to facilitate a process by which farmers are empowered to work together with other stakeholders to design and implement equitable solutions to land degradation and associated development problems.

Lushoto district is situated in the Eastern Arc Mountains in the Tanga region in northeast Tanzania (Figure 1). About 80% of the district is covered by the Western Usambara Mountain Range which has a steep and rugged topography (Peterson et al. 2014) where steep slopes of 45–55% are commonplace (Lushoto District Council, 2016). Rainfall is divided into two seasons: the long rains ('masika') from March to June, and the short rains ('vuli') from October to December. Although predominantly rural, the district is heavily populated. The 2012 average population density of 120 persons per km^2 was almost twice as high as the national average for mainland Tanzania (NBS, 2013).

Although classified as a biodiversity hot spot, the Eastern Arc Mountains have always had disproportionately large human populations who have been attracted by the high annual rainfall and soils that are generally more productive than the adjacent lowlands (German et al., 2012). They are important water towers for lowland populations, contributing to irrigation and the generation of hydroelectricity (German et al., 2012). The Lushoto landscape has multiple land uses including intensive vegetable production, subsistence maize, bean and cassava cultivation, as well as exotic tree plantations and natural forest fragments. Agriculture dominates the economy, forming the main occupation for an estimated 85% of the rural population (Lushoto District Council, 2016). Farms in Lushoto provide a steady supply of fruits, vegetables and other products that are sold in other towns and cities in northern and central Tanzania.

Lushoto district has been the recipient of numerous SLM programs, including afforestation programs designed to limit demand on State forests which have been ongoing since the 1950s (German et al., 2012), the Mlalo Basin Rehabilitation Scheme (1930s), the Soil Erosion Control and Agroforestry Project (SECAP) (1981–1999), the Traditional Irrigation & Development Organisation (TIP) and the African Highlands Initiative (AHI) (from 1995 onwards) (Mekuria et al., 2008; German et al., 2012). There have also been a number of smaller initiatives. Currently, Lushoto is also a climate-smart village in the Climate Change, Agriculture and Food Security (CCAFS) CGIAR Research Program, whose focus is climate adaptation and mitigation in agriculture in the region and includes promoting climate-smart practices (Sijmons et al., 2013). There are numerous other programs aimed at improving value chains and promoting livestock rearing, as well as businesses that are employing contract farmers.

However, the long-term impacts of many of the programs are not well documented. In Lushoto, participatory mapping was used as part of the AGORA project to obtain a broad understanding of the challenges faced by farmers on their farms, as well as the impacts of other land uses in the surrounding landscape on farmer's livelihoods. The four focus villages in Lushoto district are: Tema, Sunga, Malindi and Mwangoi.

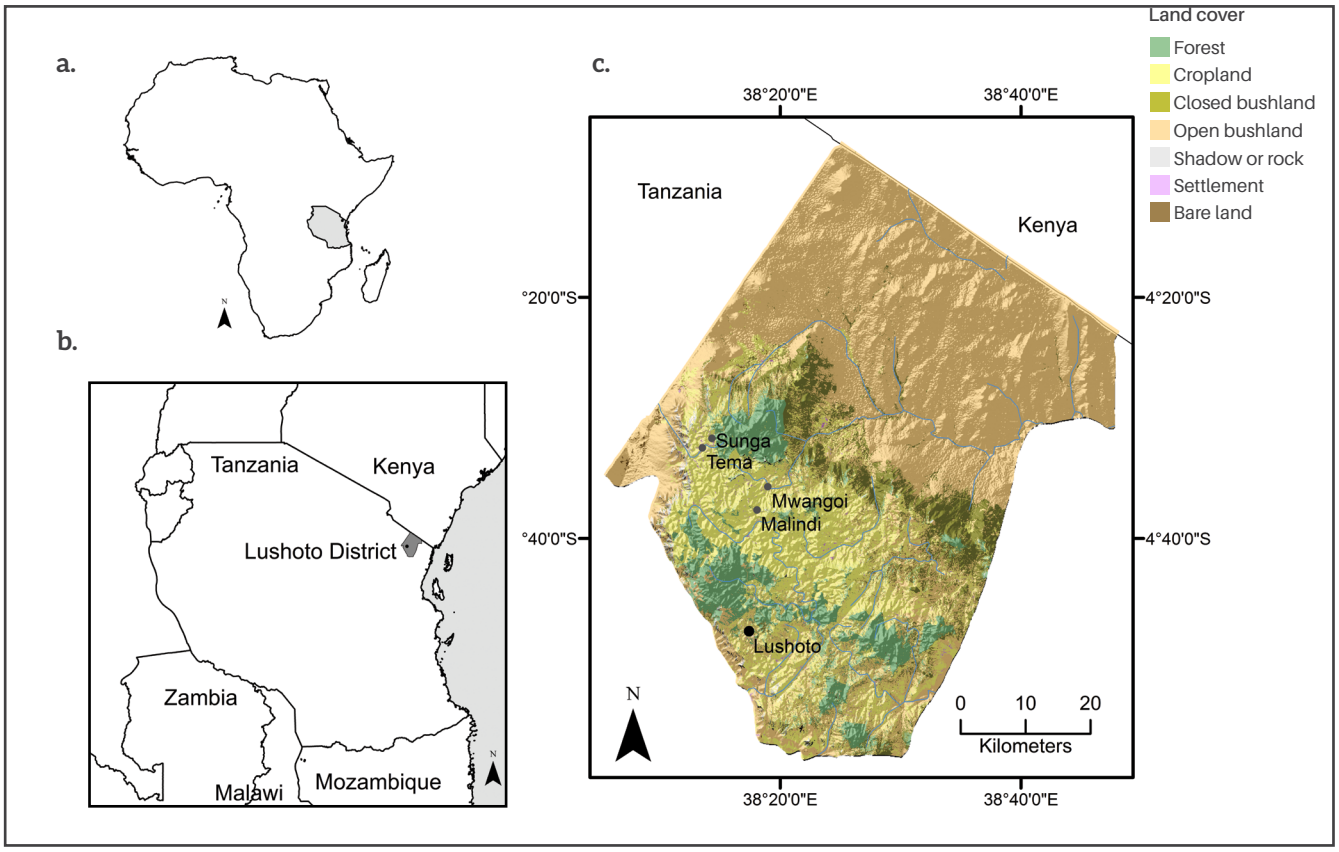


Figure 1. Location of the case study site in Africa (a), and in Tanzania (b), with Lushoto district shaded in gray. The location of Lushoto town and the four focus villages are shown within Lushoto district (c). Land cover was mapped in 2014 and shows the major land-cover categories.

Approach

Focus group discussions (FGDs) and interviews with individuals were conducted in September 2014 and used to inform the participatory mapping of ecosystem services exercise that was carried out in the four focus villages in Lushoto district in May 2015. In each community, the mapping was completed with three separate groups – men, women and youth (except in Sunga where mapping included two men's and one women's group).

Aims

PA participatory mapping of ecosystem services approach was used in this research to get a broad view of the local agricultural, social and biophysical context of this area in order to understand how communities and groups within those communities (men, women and youth) use and access resources across the landscape and the implications this has for the implementation of SLM measures.

How the mapping was adapted for this case

- Maps showing the extent of the area within 2 km of each community were used, instead of 3 km as recommended in the manual. This was based on individual interviews where maps showing each village and its surrounding area up to 2, 3 and 5 km were presented. Interviewees reported the communities tended to conduct livelihood activities more locally because of the mountainous terrain in Lushoto.

- Maps and legends were laid on tarpaulins on the ground or taped on to the wall and groups of 7–11 community members sat or stood around the map and legend.

- In some cases, participants moved the transparent overlay as the reflection of the overlay was blocking

the features on the underlying map. However, this meant that the markings made with pens could not be erased.

- Legends were presented in both English and the local language (Kiswahili).

- During this exercise, the list of questions (Appendix 3 of the participatory mapping guide) was adapted after the FGDs took place to ensure the questions were relevant to Lushoto. The mapping exercise still focused on water, livestock, uncultivated areas (such as forests) and cultivated areas (including plantation forestry). We knew that forest areas would be important resources and points of discussion while livestock would not and the questions were adapted to reflect this.

- New symbols were often used to represent information not already captured in the legend. When this happens, it is essential the facilitator ensures that the note taker has recorded what the symbols mean.

Participants map resources with marker pens and stickers on the transparencies overlaying the base maps.

Process
How the step should be implemented

Results

Challenges

- In Sunga, there were not enough individuals to form a youth group. It is important to make sure that no other activities, involving a particular group such as market days for women or youth activities, are planned for the same day as the mapping activity. In some cases, individuals had to leave early to attend religious ceremonies.

- Point sources such as taps, boreholes and springs were often difficult for participants to pinpoint and their location could result in heated arguments. In cases where these types of resources were not important to the aims of the mapping, these questions could be removed or captured in a way that did not involve mapping i.e. asking how many springs participants had access to without actually mapping them.

- The lack of clear topography on the map in this hilly landscape posed a challenge as many people oriented themselves according to the hills and valleys and not by 2D maps. Methods trialed by others which may address this include 3D landscape mapping (Baker et al., 2015).

- Mapping areas where specific crops are grown was generally not possible and so in most cases, general areas were marked for different crops. In Lushoto, maize was grown on the hillsides whereas horticultural crops were grown in valley bottoms. In some cases, this was discussed but not mapped. It is important to plan with facilitators and note takers what to do in these cases, depending on the intended outcome of the mapping e.g. whether to map generalities or just record them in the notes.

- All three groups in any given village may locate specific resources in slightly different places, which can make consolidating the maps at the digitization stage challenging. All markers were digitized and then if necessary, a central point was used for any one cluster. However, ground truthing will be necessary to confirm location and condition if the maps are to be used for specific planning or investment purposes.

What worked well

- Some important resources were not captured within the area of the map presented to the community. These were still discussed and carefully recorded in the notes as well as marked on the map boundaries.

- Good facilitation is key to this process and some questions elicited laughter and good humor from participants. It is important to encourage this to keep participants engaged. In one village there was much laughing over cats being described as livestock as well as discussions of past spiritual practices. The facilitator must be aware that community members may hesitate to share spiritual information with outsiders.

- The opportunity to compare maps from each group facilitated discussions about the drivers of change for different resources across the landscape and potential solutions for addressing these.

Key learning points

Differing perspectives of women, men and youth on resource use and access

- In Tema and Sunga, women said that scarcity of water impacted their lives as they could spend 2 to 3 hours a day fetching water for domestic use and livestock either from boreholes or springs that were still running. The women of these villages were greatly affected by this scarcity of water as they were unable carry out their daily activities normally.

- Men often helped women to collect water in times of scarcity.

- In general, men attributed the decline in seasonal river flows to pine plantations whereas women reported that irrigation, deforestation and inadequate rainfall contributed to this decline.

- The youth in the village reported that various types of soil that could be found in a single field. They had difficulty in identifying the areas with different kinds of soil.

- There were varied perspectives from men, women and youth with regard to the sufficient supply of tree seedlings for planting.

Water

- Water availability for drinking and nondrinking purposes, rearing livestock and irrigating crops differed amongst the four villages. Boreholes and taps provided water for drinking and other nondrinking purposes and rearing livestock while river water was used for both rearing livestock and irrigating crops.

- All communities had access to taps, which were sourced from springs.

- During the dry season (July–October), boreholes and taps in Tema and Sunga dry up and water scarcity is a major issue. Springs found in the natural and plantation forests became an important source of water during this time. In Malindi and Mwangoi, water was available from boreholes and taps during the dry season with only some of them drying up.

- All villages had rivers running through them, but in most areas these rivers had become seasonal and dried up in the dry season. Only Mwangoi had a permanent river (Umba), which flows throughout the year although the water quantity has declined over time.

- In Tema, Sunga and Malindi, these changes were perceived to have begun 40–50 years ago and in Mwangoi these changes were thought to have begun relatively recently – in the last 20 years.

- Previously, irrigation allowed cultivation during the dry season, which enabled farmers to produce two to three crops per year. Currently, irrigation is not practiced during the dry season in Tema, Sunga and Malindi, although in Mwangoi it is practiced all year-round.

- In Tema and Sunga, changes in river water quantity were attributed to replacement of natural forests by pine plantations north of the villages, deforestation and to a lesser extent to over-extraction of water.

- In Mwangoi, declines in river water quantity were attributed to pine plantations replacing natural forest, deforestation, irrigation and an increase in population.

- The scarcity of water has financial implications, as access to springs in the natural and plantation forests was restricted so that only those who had permits could collect water and others bought the water from them.

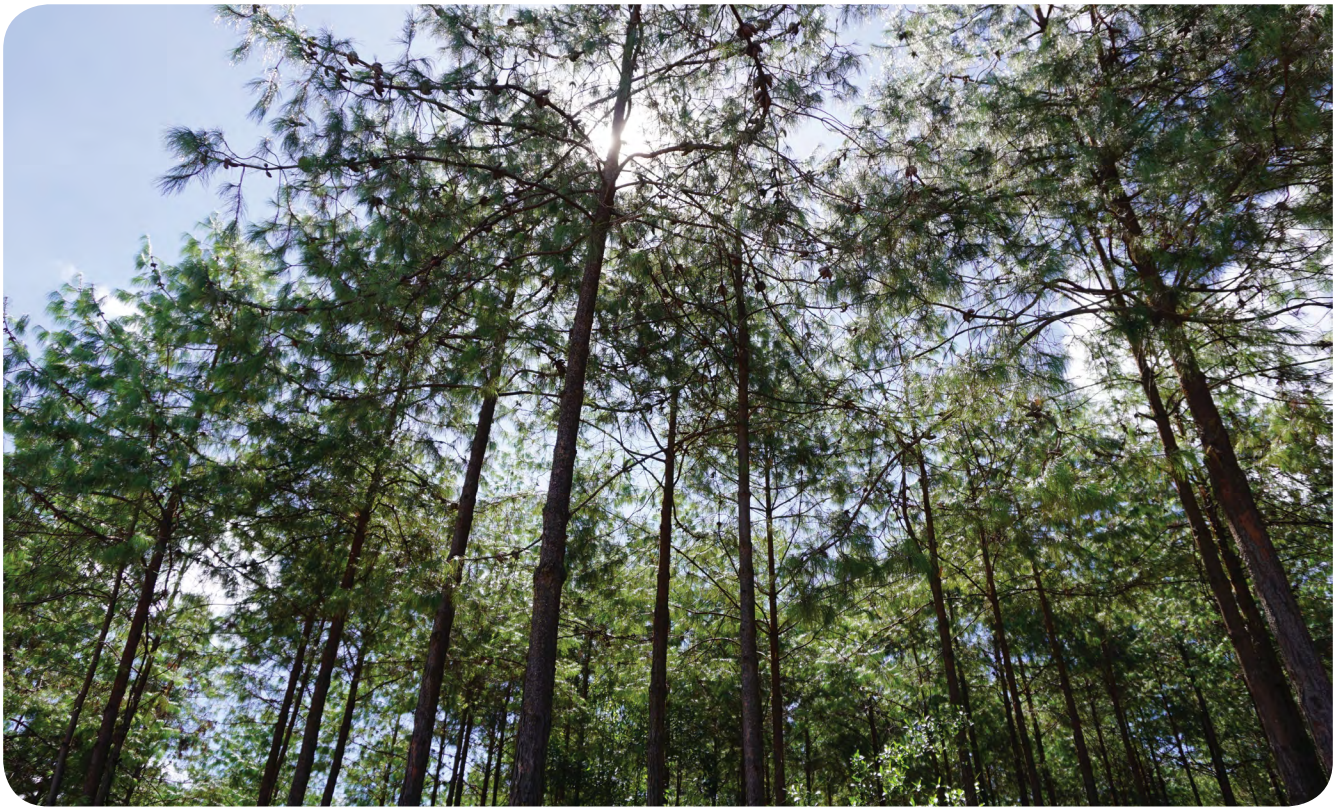
Uncultivated areas and goods

- Timber and fuelwood were the most important uncultivated products. These products were no longer sourced from natural forests because access was restricted and the remaining natural forests were protected.

- Currently almost all timber and fuelwood were sourced from farms or from plantations. Participants said that exotic tree plantations were first introduced around 30 years ago. Most were privately owned with a few larger pine plantations, notably the pine plantation to the northeast of Tema and Sunga, belonging to the government. Government plantations could be accessed for fuelwood and water in the dry season. Privately owned plantations often had fewer restrictions and permission could be sought to access them. Lack of access to wood from a common pool of resources was driving individuals to plant more trees on their land. In some cases, trees were planted on hillsides where soil fertility had declined to the extent that crops could no longer be grown.

- Wild vegetables used to be sourced from natural forests but have declined due to over-exploitation by increasing human populations and because of a drier climate.

- Although tree nurseries were present in all villages, some individuals said tree seedlings, cuttings and seeds were expensive and they could not afford to



Pine plantation in Lushoto such as those the community members identified as causing declines in river water.

buy them. Others grew their own seedlings. Exotic species were common, but some participants believed that planting indigenous trees was better for the environment.

- If individuals do not have or grow enough trees on their properties, timber and fuelwood had to be purchased and many purchased these materials from the plantations, particularly those with sawmills. In Mwangoi, certain individuals had arrangements with plantation owners to keep beehives and so benefited by producing and selling honey.

- Tourists came to cycle and hike in the forests of Lushoto but the benefits from tourism often only went to the lodges where tourists stayed and not to the community.

Livestock

- Livestock (particularly cattle) numbers have declined in the last 10 years. Zero-grazing systems began at about the same time as the availability of communal grazing areas declined to almost none on the current landscape.

- The ability for a household to engage in zero-grazing livestock rearing depended on the availability of fodder and livestock. Households in Mwangoi, in general, had more cattle and keep sheep and goats in addition to chickens because these resources are more available. Most households grew their own fodder (Napier grass or Guatemala grass) in grass strips across hillsides, which also contributed to erosion control. Supplementary feeding with crop residues and sugarcane leaves was also practiced.

- Zero-grazing systems were preferred to free-range grazing. They are perceived to reduce disease, reduce the time taken for tending livestock and provide manure, which can be collected from within stalls.

- During the dry season, households buy fodder for their livestock if they cannot produce enough.

Cultivated areas

- The main food crops were: maize, potatoes, beans, cassava and bananas. Important cash crops were vegetables (including Irish potatoes) and fruits.

- The plots of land on the hillsides were cultivated only during the rainy seasons. Crops were grown along valley bottoms when there was enough water in the rivers for irrigation.

- Normally all individuals had access to hillside farms but fewer community members had plots along the valleys.

- Soil fertility decline reduced crop production. SLM practices, such as terraces and grass strips, are known to reduce soil erosion and manure and mineral fertilizers are used to increase soil fertility. Although terraces and grass strips were put in place during the SECAP project and so much of the area, particularly in Tema and Sunga, are under these SLM practices, more are needed to increase the area under cultivation.

Soil

- Soil fertility decline was attributed to soil erosion on hillsides, which was more likely to occur when there were no SLM practices in place such as terraces and grass strips.

- Soil erosion was perceived in some cases to wash fertile soil into valley bottoms and in other cases, where fertile soil has already been washed away, to wash infertile soil into valley bottoms, reducing the fertility of valley bottom soils.

- Sedimentation of rivers was only discussed in Mwangoi and a build-up of sediment was perceived to reduce water quantity in the main river. Increased sedimentation was attributed to run-off from roads, settlements and cultivated areas.

Overall learning points

- Water scarcity impacts communities differently depending on land use in the surrounding landscapes and has economic implications because it impacts the number of cropping seasons in a year; collecting water in the dry season can use up time that is usually spent on other activities.
- Loss of grazing areas led to an overall reduction in livestock, but communities preferred zero-grazing systems when they could source sufficient fodder for their animals.
- Community members recognized the importance of natural forests in contributing to water provision.
- Community members recognized the importance of SLM interventions but were constrained from implementing these for numerous reasons.
- A reduction in available fuelwood and timber has increased tree planting on farms (where farmers have the resources to do so) or has increased the need to purchase these resources.

Who was involved?

CIAT worked in collaboration with the Selian Agricultural Research Institute and Lushoto District Council.

How was it funded?

AGORA is funded by the German Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) and the CGIAR Research Program on Water, Land and Ecosystems (WLE).

Outputs

A detailed report including notes and insights from all the maps was produced. Below we present examples of how the information collected during the participatory mapping activity could be interpreted and presented. mapping activity could be interpreted and presented.

Tip

As human activities become more intense across a landscape, resources become harder to access and farmers do not rely on the wider landscape in the same way as before. In these types of landscapes, the specific questions and resources mapped may not be as useful because farmers are either buying or growing resources that they need, such as fodder and fuelwood on their own farms and this is difficult to map. However, it may also depend on whether there has been a rapid transformation of the landscape in recent times, in which case it is useful to document the changes. In Lushoto, farming began over 100 years ago and so capturing changes over this time frame in this type of exercise is difficult.

Overall use of the landscape

The participants from all four communities identified a total of 561 land-cover, land-use and ecosystem services markers. From these, 458 markers were classified into one or more ecosystem services (Table 1), which gave a total of 12 classes of ecosystem services mapped and one additional class of abiotic materials, such as sand and stones. Of these 12 classes, 8 were related to provisioning services, two related to regulating and maintenance services and two to cultural services. The maps in Figure 2 show that in general, communities use the entire landscape and no particular service is clustered or associated with a particular land-cover type.

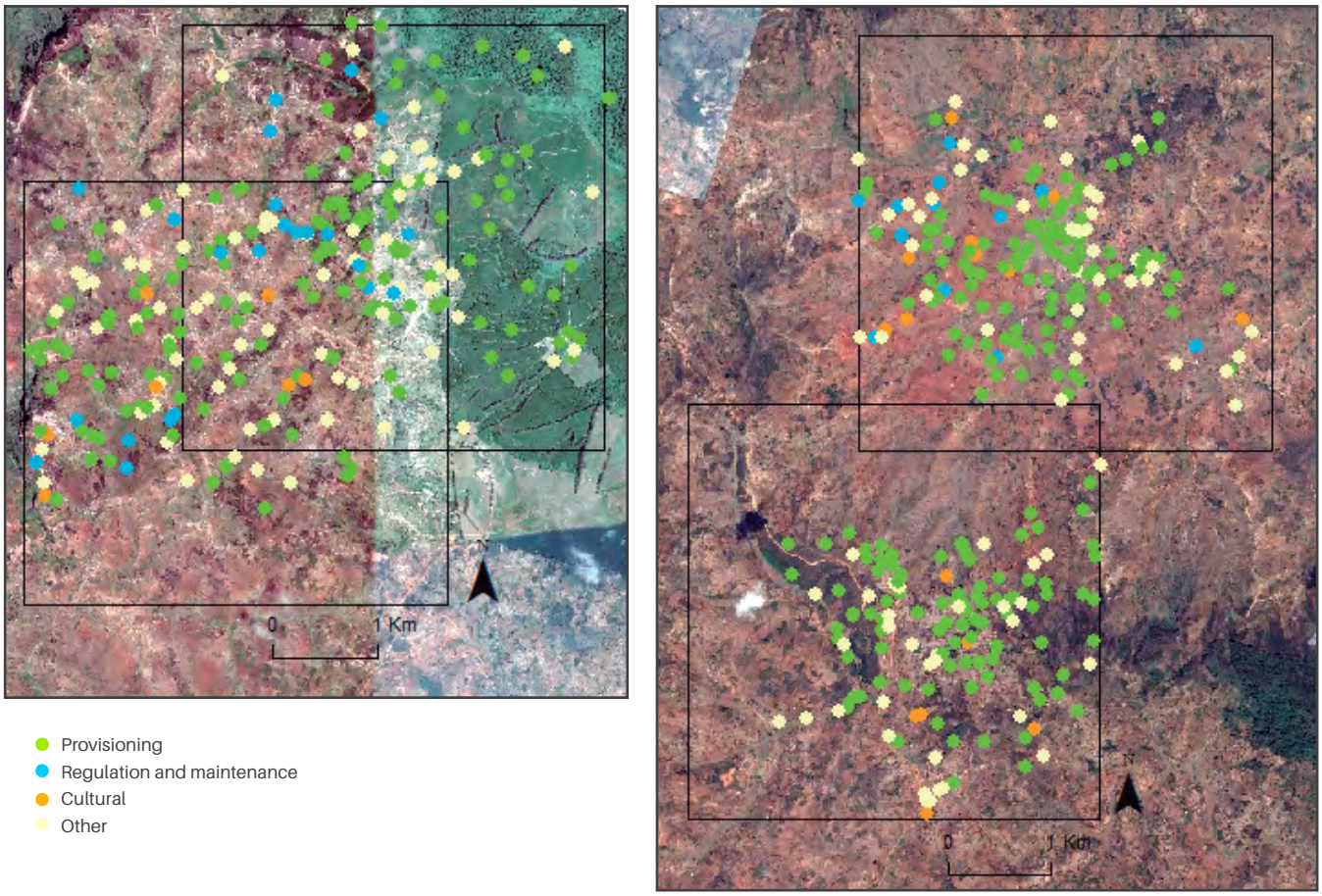


Figure 2. Map of ecosystem services across the landscape.

These maps show the spatial distribution of mapped ecosystem services across the landscape for each of the four villages with a base map from Google Earth Pro. Here, markers are classified into the major categories of ecosystem services: provisioning, regulation and maintenance and cultural services. The black squares show the area the map covered for each village. The category 'other' represents those markers that could not be classified as an ecosystem service. Ecosystem services markers were mapped based on the Common International Classification of Ecosystem Goods and Services (CICES) developed by the European Environment Agency (www.cices.eu).

Section	Division	Group	Class	Discussed	Notes
Provisioning	Nutrition	Biomass	Cultivated crops e.g cereals, vegetables, fruits	x	
			Reared animals and their outputs e.g meat, milk, honey	x	
			Wild plants and animals and their outputs e.g. wild berries, fruits, mushrooms, honey, freshwater fish, game meat	x	
		Water	Surface water for drinking e.g. collected precipitation and abstracted surface water from rivers/dams	x	
			Ground water for drinking e.g. freshwater abstracted from groundwater layers	x	
	Materials	Biomass	Materials from plants and animals for direct use or processing e.g. fibers, wood, timber, natural remedies and medicines, materials for ornamental uses	x	
			Materials from plants and animals for agricultural use e.g. fodder, manure	x	
			Genetic material (DNA) from wild plants and animals for biochemical industrial and pharmaceutical processes e.g. medicines, bio-prospecting activities		
		Water	Surface water for non-drinking purposes e.g. domestic use, irrigation, livestock consumption	x	
			Ground water for non-drinking purposes e.g. domestic use, irrigation, livestock consumption	x	
	Energy	Biomass-based energy sources	Plant and animal-based resources e.g. wood fuel, straw, crops and dung for burning and energy production	x	
		Mechanical energy	Animal-based energy e.g. physical labour provided by animals e.g. cows		

Section	Division	Group	Class	Discussed	Notes
Regulation and maintenance	Mediation of waste, toxics and other nuisances (Regulation of wastes)	Mediation by biota	Bio-remediation by micro-organisms, plants, and animals		
			Filtration/sequestration/storage/accumulation by micro-organisms, plants, and animals		
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems		
			Dilution by atmosphere and freshwater ecosystems		
			Mediation of smell/noise/visual impacts e.g. trees to hide transport structures		
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates e.g. erosion control	x	
			Buffering and attenuation of mass flows e.g. transport and storage of sediment by rivers	x	Sedimentation of rivers discussed but not as an ecosystem service
		Liquid flows	Hydrological cycle and water flow maintenance e.g. capacity of maintaining baseline flows for water supply and discharge	x	Baseline flows of rivers discussed and mapped but areas associated with maintaining these flows not mapped
			Flood protection e.g. flood protection by appropriate land coverage	x	Flooding discussed
		Gaseous / air flows	Storm protection e.g. natural or planted vegetation that serves as shelter belts		
			Ventilation and transpiration e.g. natural or planted vegetation that enables air ventilation		
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal		
			Maintaining habitats for plant and animal nursery and reproduction e.g. microstructures of rivers etc.		

Section	Division	Group	Class	Discussed	Notes
Regulation and maintenance	Maintenance of physical, chemical, biological conditions	Pest and disease control	Pest control	x	Pests discussed but not in relation to ecosystem services
			Disease control	x	Diseases which impact cattle and crops discussed
		Soil formation and composition	Weathering processes e.g. maintenance of bio-geochemical conditions of soils including fertility, nutrient storage, or soil structure; includes biological, chemical, physical weathering and pedogenesis	x	Soil fertility discussed and mapped
			Decomposition and fixing processes e.g. maintenance of bio-geochemical conditions of soils		
		Water conditions	Chemical condition of freshwaters e.g. maintenance / buffering of chemical composition of freshwater column and sediment to ensure favourable living conditions for biota		
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations e.g. greenhouse gas/carbon sequestration by terrestrial ecosystems, water columns and sediments and their biota	x	Changes in climate discussed but not ecosystems which contribute to a reduction of greenhouse gas concentrations
			Micro and regional climate regulation e.g. modifying temperature, humidity, wind fields; maintenance of air quality and regional precipitation/temperature patterns	x	Regional climate regulation discussed but not mapped
Cultural	Intellectual and experiential	Physical and experiential interactions	Experiential use of plants, animals and landscapes in different environmental settings e.g. bird watching	x	
			Physical use of landscapes in different environmental settings e.g. walking, hiking, climbing, boating, leisure fishing (angling) and leisure hunting		
		Intellectual and representative interactions	Scientific e.g. subject matter for research both on location and via other media		

Section	Division	Group	Class	Discussed	Notes
Cultural	Intellectual and experiential	Intellectual and representative interactions	Educational e.g. subject matter of education both on location and via other media		
			Heritage, cultural e.g. Historic records, cultural heritage e.g. preserved in water bodies and soils		
			Entertainment e.g ex-situ viewing/experience of natural world through different media		
			Aesthetic e.g. sense of place, artistic representations of nature		
	Spiritual, symbolic and other interactions with biota, ecosystems, and landscapes	Spiritual and/or emblematic	Symbolic e.g. emblematic plants and animals e.g. national symbols such as American eagle, British rose, Welsh daffodil		
			Sacred and/or religious e.g. spiritual, ritual identity e.g. 'dream paths' of native Australians, holy places; sacred plants and animals and their parts	x	
	Spiritual, symbolic and other interactions with biota, ecosystems, and landscapes	Other cultural outputs	Existence e.g. enjoyment provided by wild species, wilderness, ecosystems, landscapes		
			Bequest e.g. willingness to preserve plants, animals, ecosystems, landscapes for the experience and use of future generations; moral/ethical perspective or belief		
Abiotic Provisioning	Abiotic materials	Non-metallic	e.g. minerals, aggregates, building materials (mud/clay/sand)	x	

Table 3. Ecosystem services markers were mapped based on CICES developed by the European Environment Agency (www.cices.eu). X = mapped during participatory mapping; x = discussed during FGDs or participatory mapping but not mapped; - = not mapped or discussed. All marine references were removed from the table.

Perceived changes in the stock of identified ecosystem services, drivers of change and impact of these changes on livelihoods

The mapping activity revealed perceived trends in the quality and availability of ecosystem services (Table 2). Time since changes had occurred were recorded for individual markers, so perceived trends were not identified for a set period of time. Declines were mapped for 9 of the 12 ecosystem services identified. Surface water provision was perceived to have declined the most i.e. 10 out of the 12 groups that mapped this service identified areas of decline. The next ecosystem service perceived to have declined by most groups was erosion control and 8 out of the 9 groups that identified erosion control as a benefit also observed that it had declined. Ground water was perceived to have declined by half of the 12 groups that mapped this service. Crop production was perceived to have declined by 5 of the 10 groups that mapped this service. Reared animals (livestock) and soil fertility was perceived to have declined in three groups. Materials from plants, fuel wood and products from wild plants were perceived to have declined by only one group for each of the groups that mapped them.

Ecosystem services	Benefit	Number of groups discussing ES	Number of groups mapping ES	Perceived change (number of groups)*			Drivers of change	
				—	↓	↑	Direct	Indirect
Cultivated crop	Cereals, vegetables, fruits	12	10	9	5	0	Soil fertility decline, less water for irrigation	Decline in fruit markets
Reared animals and their outputs	Meat, milk, honey	12	7	6	3	0	Loss of grazing areas, disease	
Ground water drinking/ non-drinking purposes	Freshwater abstracted from groundwater layers	12	12	8	6	0	Pine plantations, over-extraction	
Surface water drinking/ non-drinking purposes	Abstracted surface water from rivers/ dams	12	12	11	10	0	Pine plantations, over-extraction, rainfall variability, deforestation	
Materials from plants for direct use/processing	Fibers, wood, timber, natural medicines	11	11	11	1	0	Deforestation	
Plant-based energy resources	Wood fuel	11	8	8	1	0	Deforestation	
Wild animals and their outputs	Honey, freshwater fish, game meat	6	6	6	0	0		Restricted access

Ecosystem services	Benefit	Number of groups discussing ES	Number of groups mapping ES	Perceived change (number of groups)*			Drivers of change	
				—	↓	↑	Direct	Indirect
Maintenance of soil properties including fertility	Maintenance of bio-geochemical conditions	9	6	0	3	4	Unsustainable farming practices (no SLM)	
Mass stabilisation and control of erosion rates	Erosion control	10	8	0	8	0	Unsustainable farming practices (no SLM)	
Sacred and/or religious	Spiritual identity	8	7	7	0	0		
Physical and experiential interactions	Tourism and recreation	5	3	3	0	0		
Abiotic materials - non-metallic	Building materials (mud/ /sand/stone)	6	4	4	0	0		

Table 4. Trends in the stock of ecosystem services and drivers of change identified by four communities during the participatory mapping exercise in Lushoto District, Tanzania. Ecosystem services markers were mapped based on CICES developed by the European Environment Agency (www.cices.eu). Perceived change is represented by - = no change; ↓ = decrease, ↑ = increase.

*Services in different areas could be stable while others could be labelled as declining within the same map which is why totals do not add to the number of groups mapping a service.

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Citation

Braslow Juliet; Cordingley Justine. 2016. Participatory mapping in Lushoto district, Tanzania. A case study. International Center for Tropical Agriculture (CIAT). 18 p.