A Guide for Participatory Mapping of Ecosystem Services in Multiuse Agricultural Landscapes

How to Conduct a Rapid Spatial Assessment of Ecosystem Services

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Summary

This guide presents a step-by-step approach in using a participatory mapping method with community members to rapidly identify and map ecosystem services and changes in their supply across multiuse agricultural landscapes. Nongovernmental organizations (NGOs), government agencies and researchers can use this approach to learn from communities about how they use and access natural resources. This activity uses a landscape approach to help land management practitioners understand the ways in which people depend on and access ecosystem services and how changes in their availability impact livelihoods across the landscape.

The mapping exercise involves using free, high-resolution satellite imagery from Google Earth Pro, which presents an aerial view of the community in fine detail. Participants from the community in question identify key features on the map, which help them to understand the extent of the area the map represents. They are then led through a discussion on their resources such as water, livestock, cultivated land and uncultivated land. Through the discussion participants identify: (1) where resources are located on the landscape and how they are used; (2) changes in the supply of resources and how these changes are impacting livelihoods; and (3) restrictions to access, conflicts over use and management of each resource in question. Mapping with different groups, such as men, women and youth can show which resources are most important to different groups as well as differences in access and perceptions of change. The mapping exercise is intended to take between two and a half and three hours: including introductory and concluding discussions can add on another two hours.

This guide presents examples and tips from mapping exercises that tested this approach in Ghana, Kenya, Malawi and Tanzania. We outline how this mapping exercise could be used in research, development and planning. Additionally, this guide includes appendices that contain: (1) a detailed explanation of how to create maps for each activity; (2) a set of materials that have been developed to accompany the mapping exercise; (3) steps for digitizing the maps (4) case study examples; and (5) additional sources of information.

Understanding the participatory mapping activity

Why was this guide developed?

The approach outlined in this guide is aimed to help land management, conservation and community planning practitioners expand their focus beyond the individual farm and community level to better understand the multiple ways in which people use and benefit from their landscape.

There are a number of tools available for participatory approaches to mapping and valuing ecosystem services (Appendix 7). This guide is intended to build on many of these approaches and be used in conjunction with a range of other methods to understand how people depend on and access ecosystem services and how changes in their availability impact livelihoods across the landscape. Many current approaches are targeted at communities living in conservation areas, forests or rangeland sites. The approach outlined in this guide was developed to explore these questions in multiuse agricultural landscapes. We also incorporated free, high-resolution satellite imagery. This allows participants to more easily recognize the features of their landscape, to get an opportunity to see it from a new perspective and to more deeply engage in the discussion about their resource use. Additionally, the high-resolution satellite imagery helps when digitizing the final map, if you choose to prepare a digital map.

The challenge: addressing sustainable ecosystems across a landscape

There has been increasing recognition over the last 10 years that managing food, water and energy at the landscape level is key to achieving sustainable farming systems. Different parts of the landscape provide people with different benefits (ecosystem goods and services). Activities in one part of the landscape may impact people in another part of the landscape. A 'landscape approach'[1] aims to manage landscapes that have many different uses, as well as many different types of land users, in a way that meets the multiple objectives of supporting livelihoods, food production and ecosystem conservation.

1 A 'landscape approach' is a framework to integrate policy and practice for a number of different land uses within a given area to ensure the equitable and sustainable use of land. This includes the physical features of the landscape and all of the socioeconomic and socio-political drivers that affect land use, especially concerning agriculture, conservation and forestry (Reed et al., 2015).

What is a landscape?

A landscape consists of the visible features of an area of land, including mountains, hills, water bodies; plants and animals; and human elements including people, farms, houses, roads, mines, other structures and institutions and their cultural and spiritual values (Global Landscapes Forum)

The goal of the landscape approach is to ensure that all the users of that land are engaged in discussion and planning and their needs are addressed in an integrated way.[2] The first step to implementing a landscape approach is to understand how people use the landscape and the benefits it provides to them. This involves moving beyond simply understanding which ecosystems (e.g. forests, grasslands and croplands) are in an area and which ecosystem goods and services (i.e. ecosystem services) people use. Managing landscapes in an integrated way requires that local people identify the state and condition of their ecosystem services, how their supply has changed over time and where these changes have occurred. Additionally, integrated landscape management requires that local people have an understanding of the changes users face in accessing ecosystem services, the trade-offs involved in different land uses and how all of these changes impact on their livelihoods. This is particularly important in multiuse landscapes, such as tropical agricultural landscapes, where people rely on a range of ecosystem services for their livelihoods.

A major challenge for organizations working in sustainable land management (SLM) is to understand and address problems occurring in parts of the landscape outside their focus sites. However, land use and changes in land use occurring in other parts of the landscape will impact ecosystems and people's livelihoods across the landscape, including in the focus site. This can often affect how people cope with changing ecosystem services and how they manage the land within the focus sites. Additionally, people's activities in a focus site may be driving changes in other parts of the landscape, which may impact their own livelihoods and those of others. Identifying these interrelationships is an important first step for any organization working on SLM in order to suggest feasible options for sustainable and equitable use of natural resources for local communities.

This participatory mapping of ecosystem services approach was developed because it includes a range of essential components that were not available in any existing tool in the variety of approaches we assessed before developing it. The components include: (1) a landscape focus; (2) mapping of a range of ecosystem services, especially where changes in their provision had taken place; (3) mapping of access and restrictions to ecosystem services; (4) use of high-resolution maps; and (5) a focus on understanding how different groups within the community (e.g. men, women, youth) are impacted by the provision of ecosystem services.

Why map ecosystem services across multiuse agricultural landscapes?

In most cases, reversing land degradation will require investments by either outside investors or by communities and individuals. Information collected in this participatory mapping exercise will identify areas that could be targeted for natural resource management (NRM) and land restoration. The mapping exercise will not only identify those areas where investment may be necessary but will also identify who has a stake in any changes in land management. Changes in land, water and other natural resources will either impact users' access to resources or require individuals or communities to adopt certain NRM, both of which are likely to affect users' livelihoods. Due to the livelihood impacts these management practices can have, any proposed changes should be equitable to all potential users. The maps that result from this process can also validate previous analysis or assumptions about land use and land-cover change trajectories. The maps can also be used to target detailed biophysical data collection on current stocks of ecosystem services (quantity and quality), which will provide an indication of whether current levels of use are sustainable, and on the benefits that improved NRM could provide.

2 Global Landscapes Forum Blog on Drawing, role-playing and 3D maps: How a landscape approach can work on the ground. (Sunderland and Johnson 2013)

Using this guide: what does this guide aim to do, who is it for and when to use it

What does this guide aim to do?

This guide outlines an approach for conducting participatory mapping of ecosystem services in agricultural landscapes. This approach can provide information about: (1) which ecosystem services the communities rely on for their livelihoods and where they are provided in the landscape; (2) any changes in supply of these services over short (seasonal) and long time frames and where these changes are taking place; and (3) whether different groups within the community are particularly dependent on certain services (and therefore more likely to be affected by changes in their supply) and where conflicts may arise over the use of certain services.

Who is this guide for?

This guide is intended for use by practitioners such as NGOs, government agencies, civil society organizations and researchers who want to learn from communities about how they use and access resources and benefit from their landscape. The information can then be used as part of the participatory process that works with communities to suggest and co-create truly feasible options and opportunities for sustainable and equitable use of their natural resources.

Choosing when to use this guide

Participatory mapping can be useful if there is a spatial component to the assessment and community engagement that users wish to emphasize. There are other approaches for conducting ecosystem services assessments that don't include any mapping activity and can be used to identify many of the issues, such as changes in supply, restrictions to access and competition over use (Appendix 7). This mapping approach is especially useful for identifying degradation hot spots across a landscape or examining how ecosystem service use and degradation patterns vary across a watershed or across different communities. Maps can then be used for generating discussions on particular issues within a community or communicating spatial information to a wider group of stakeholders and decision-makers. It can also be useful for planning interventions and activities across a landscape if they aim to address problems that are spatially explicit (and can be identified as such by communities). The maps produced through this approach can help to focus the discussion and they can orient those who may not be as familiar with the landscape, which is important if engaging potential stakeholders or investors who live outside the focus site.

Key information

High resolution maps of the landscape of interest are used to map and stimulate discussion about ecosystem services

- Time required: 2.5–3 hours for one map
- Mapping can take place simultaneously with different groups in the community to understand gender or age differences in ecosystem service use
- Community members use stickers and markers to mark ecosystem services and changes in their supply and access over the short and long term
- Additional questions are used to gather information on how changes in the supply of ecosystem services impact livelihoods

Ecosystem services mapped and explored through the mapping activity

The approach outlined in this guide was originally developed for mapping ecosystems services in agricultural landscapes, but could be adapted for a range of multifunctional landscapes. It assumes that the ecosystem services that are important to a particular

community have already been identified, for example through focus group discussions or by carrying out a preliminary scoping assessment. The participatory mapping exercise outlined here would then need to be adapted to be locally relevant based on these preliminary assessments. The multiuse agriculturally relevant ecosystem services fall into the following categories outlined below. These categories and descriptions are based on the Toolkit for Ecosystem Service Site-based Assessment (TESSA) v1.2 (Peh et al. 2013). The focus of the questions in each section and the explanations below are also adapted from TESSA (Peh et al. 2013).

Water use

This approach considers water used for domestic purposes, livestock and irrigation. It focuses on identifying where water is accessed for each of the different uses and where there have been changes in water quantity and quality. There may be increases or decreases in the intensity and/or duration of seasonal shortages, as well as changes in incidences of flooding. This may impact people's livelihoods, for example, by changing the distances people have to travel to collect water. It is important to distinguish the type of changes. Changes in water quality include indirect evidence of poor water quality such as water quality-related illnesses, reluctance to use water for drinking or for recreation, fish kills or smelly water. We also want to know if there are any areas where the water turns brown with sedimentation.

Livestock

After establishing the kinds of livestock that people keep, questions focus on identifying if there are specific areas where different types of livestock e.g. cattle or goats are taken to graze and whether there have been changes in quality and quantity of forage at these sites as well as losses of whole grazing areas. It will be important to identify areas where fodder is collected for livestock feed and the type of fodder that is collected.

Cultivated goods and the status and use of cultivated areas

These include areas used to grow food crops, plantation forestry and fishponds. After establishing the type of crops people are cultivating, questions focus on identifying where these crops are grown and who is involved in their cultivation (e.g. richer landowners or women), whether cultivation patterns are changing over time and the drivers behind these changes. It is particularly important for SLM projects to identify any areas experiencing erosion or low productivity, pest and disease incidences and where SLM is currently practiced.

Wild harvested goods and use of uncultivated areas

Harvested wild goods include plants for food (wild fruits, seeds, wild roots, mushrooms, insects, wild birds and eggs) and medicine; animals hunted for food (including fish) or decoration (e.g. feathers, skins); timber, fuelwood, bamboo, rattan, reeds, other fibers used for roofing materials, charcoal, tree seedlings collected in the wild; honey; and clay/soil and sand. It is important to first identify the most important harvested wild goods for the livelihoods of people in the area, if they have not already been identified in previous activities, for example through FGDs. 'Most important products' includes not just those products that are economically most valuable, but also those that have value in terms of the role they play in local culture, their use in times of food shortages, etc. It is important to consider that not all harvesting of wild goods will be on a small scale or carried out by local communities. Some wild products may be harvested commercially and by companies that are national or even international – e.g. timber, some types of nuts and certain gums and fibers. Questions focus on establishing where these goods are produced in the landscape, where patterns of production and use are changing and the drivers behind these changes.

Cultural services

Additional questions focus on whether any areas in the landscape have particular religious or spiritual importance and whether any areas are important for either recreation or tourism.

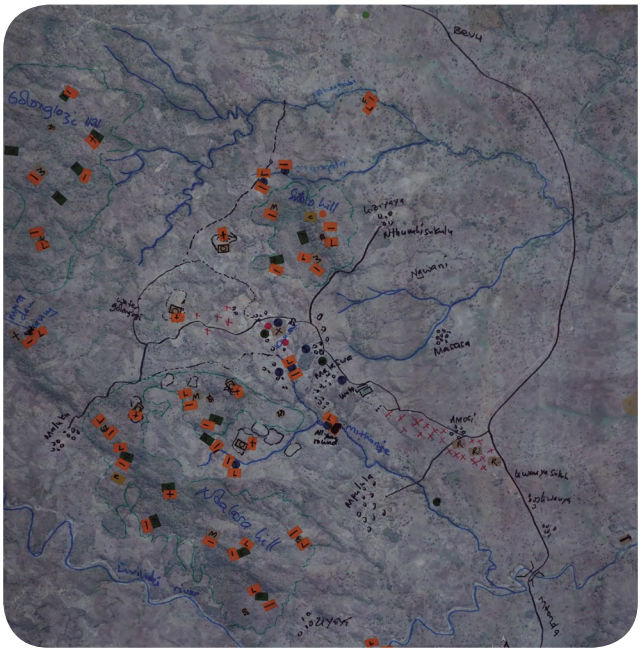
Tip

It can be a useful exercise to rank ecosystem services, particularly wild goods, to gain an understanding of how they contribute to people's livelihoods and how important they are in the local context. There are numerous sources of information on how to do this and ranking can also be used as a basic way to value ecosystem services (see resources in Appendix 7).

Expected final map

The map produced by the participants during this activity will include the following:

- Water sources and their uses (e.g. domestic, livestock, irrigation), as well as changes in the quality and quantity of these water sources, restrictions to their use and any conflicts that occur over their use.
- Grazing areas for livestock as well as changes in the quality and quantity of forage in these areas, restrictions to their use and any conflicts that occur over their use.
- Areas used for fodder collection as well as changes in the quality and quantity of fodder in these areas, restrictions to their use and any conflicts that occur over their use.
- Areas used for cultivation as well as changes in quality and quantity of production in these areas, areas with known degradation (soil erosion and soil fertility decline), newly farmed areas, areas where there are rental agreements, areas where SLM is practised and areas of pests/disease incidence.
- Areas where wild products are harvested or hunted, as well as changes in the quantity of these products, restrictions to their use and any conflicts that occur over their use.
- Areas where there is plantation forestry or woodlots, fisheries or tree planting occurring as well as changes in the supply of these resources, restrictions to their use and any conflicts that occur over their use.
- Areas that are used for spiritual purposes, changes to these areas, restrictions to their use and any conflicts that occur over their use.
- Gender and age differences in terms of use and access to the above resources.



This map shows all the resource areas marked and identified by community members.

Step-by-step guide

Throughout the document, icons are used to draw the reader's attention to individual issues or topics, including process points, needs for note-taking, and reminders in relation to that step.

Planning
Important to do before starting the mapping activity

Process
How the step should be implemented

Reminder
Please don't forget this

Documentation
Important information to record

Results

Step 1: Site scoping and community engagement

This guide assumes that this mapping activity will not be the first visit or engagement with the participating community.

Ideally you have already conducted some scoping activities with them, which might include informal interviews with key informants, gathering of secondary information and community group discussions. (see resources in Appendix 7).

Prior research on livelihoods and ecosystem management at regional, district and local levels can all provide useful background information, which is important to avoid repetition of previous studies or engagements and to adapt this mapping methodology to local conditions. Introductory discussions with district officials, local authorities and other key informants should include issues associated with the use and management of different ecosystems across the landscape (Schreckenberg et al. 2016). These discussions can also be useful for gathering information on topics such as land tenure and local governance structures.

Although key interviews and secondary data sources will provide an important overview of local context, conducting guided group discussions with communities should be done before leading any kind of mapping activity. Group discussions can be important not only for introducing the scope and aims of a project to a wider group of community members but also as a rapid way of discussing a wide number of topics in order to tease out the key issues related to local livelihoods and ecosystem management. They also provide important information in deciding whether it is necessary for a mapping exercise to be conducted (Schreckenberg et al. 2016).

Before entering a community to conduct participatory mapping, you need to contact the appropriate local authorities and follow the necessary procedure to gain permission to enter the community and directly engage with community members. This will often consist of contacting and clarifying goals and objectives with district officials, local authorities and community members (Schreckenberg et al. 2016).

It is important that you communicate the purpose of the mapping activity, the people you would like to be involved and how the information will be fed back to the community and shared with other audiences. Sharing this information will also help the appropriate individuals within the community select the participants in Step 2 below.

Step 2: Preparation for the mapping activity

2.1 Preparing the maps

You can create high-resolution maps of your selected site using Google Earth Pro (See Appendix 1 for detailed instructions). We recommend printing 'matt finish' maps at a size of 1 m x 1 m. 'Glossy finish' maps can reflect light and make it difficult for the participants to clearly see features on the map. We suggest a map showing 3 km-radius from the center of the community, but others have concluded that based on the distances of community resource use, a 2 km radius may be sufficient.

A scoping exercise with community leaders or within a FGD will identify how far people generally travel to access different resources and you can make your decision of map scale based on this.

Transparencies: Transparent sheets can be cut to the same size as the map and taped on to it for the mapping exercise. All markings and stickers added to the map during the mapping exercise will then be on these transparent sheets instead of the underlying map.

In some locations, transparencies can reflect the light making it difficult for participants to make out the features of the map underneath. If transparencies aren't readily available in your area, printing companies can create transparencies by laminating clear laminate sheets together with no material laminated in between the two layers. The advantages of using transparencies include:

- Maps can be used again.
- Drawing mistakes can be erased from transparencies using nail polish remover.
- If many markings and stickers have been used, transparencies can be removed and a new one placed on the map so that markings and stickers do not overlap.
- If maps are used for planning management or location of interventions, then a new transparency can be placed over maps and transparencies with markings and stickers already on them.

☑ If you are using transparencies, ensure they are labeled clearly at the end of the mapping exercise with the community name and group (e.g. men or women). Mark the corners of the map onto the laminate or trace over certain landmarks in order to ensure proper realignment of the map if the transparency is removed.

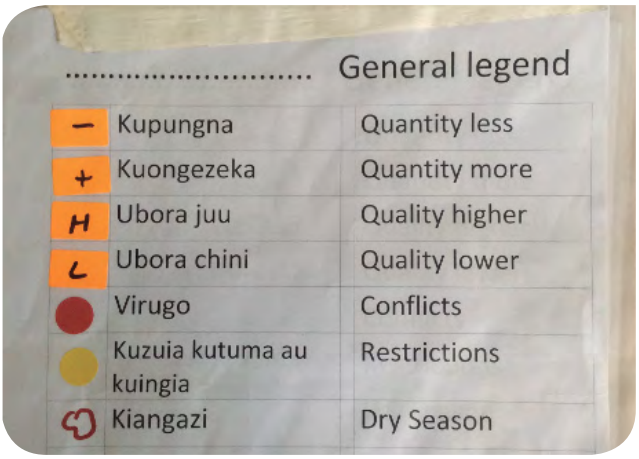
2.2 Adjusting the questions

The FGDs or other preliminary scoping activities should be used to tailor the set of questions asked during the mapping exercises. Although some questions may repeat those used in the FGDs, this can be useful as a way of triangulating answers. Additionally, using the map to elicit responses can lead the participants to engage in a subject in more depth and may elicit varied responses. We have provided a set of sample questions (Appendix 3), but these should be adapted for the context and project objectives.

⚠ You do not need to ask all of the questions we provide and it is likely it will take too long if you ask every question. During the process of training the team who will conduct the participatory mapping it is likely you will make additional adjustments to the questions.

Tip

Depending on the aim of the mapping, maps showing a larger area can be used in conjunction with the community map. This can be useful if there are components within the larger landscape that may impact local communities, such as upstream activities affecting downstream water users



The general legend used in Tanzania and Kenya. The symbols/markings are shown on the left. The legend is shown in Kiswahili and English.

2.3 Preparing the legend

A legend is used during the mapping exercise to describe what each of the drawings, stickers and symbols used to mark the map mean. In some participatory mapping exercises, legends are developed with the community. To reduce the time spent on the mapping exercise, we recommend preparing the legend beforehand.

☑ The legend should be translated into the local language so that participants can read what each

Tip

If you will be digitizing the maps (See Step 4) it is worth considering at this stage the digitization process and the final type of analysis you will want to do. Collecting data as point, line and polygon data can complicate the digitization process and the analysis. In Appendix 5, we provide a set of resources that discuss this in more detail and can help you think about the way in which you will capture your data, which will affect the different symbols you use in the legend. Below are some points to consider before you begin the mapping process:

- Some information may not be possible to capture on a map. In these cases, information will be captured in the notes, but if you are digitizing the maps you will need to take into consideration that this type of information has not been captured, which may or may not be important depending on your project aims;
- In most cases, we collected information as point data when in reality, goods such as weaving materials may be collected from the whole of a wetland area or fuelwood from a particular forest. We asked participants to outline features such as forests and wetlands that they used so that we could capture the whole area from which they were collecting these goods.

symbol means. It can be used as a guide by the facilitators and allows the participants more control over what they are mapping. The legend should include the main drawings, stickers and symbols to be mapped.

We recommend that the legend is simplified to make the activity as straightforward as possible and provide more opportunities for participants to mark points on the map. Examples of the legends we used in different mapping exercises are provided in Appendix 4.

2.4 Training facilitators

At least half a day should be set aside for training of all individuals (e.g. facilitators, notetakers, translators) involved in the mapping activity.

Before starting, it is important to emphasize that this mapping activity demands a role reversal, where the 'experts' now become uninformed 'outsiders' or 'novices,' and the fieldwork team understand their local situation and knowledge by learning from the community members.[3] This training should include the following components:

- Explain the aim of the exercise and discuss how the activity will be introduced to the community
- Based on the objectives of your project and how the mapping will help you achieve them, finalize the set of questions that will be used in the activity. A full sample set of questions has been provided in (Appendix 3) and these questions should be adjusted and can be shortened or expanded to make them locally appropriate for your context and objectives. Review and select which questions are

3 This is one of many important principles and guidelines when conducting participatory research, adapted from Participatory Data Collection for Ecosystem Services Research A Practitioner's Manual. Available at: www.espa.ac.uk/files/espa/PRA-Manual.pdf

important for your project, especially if you want to shorten the process. It is important to discuss how words can be translated into the local language. It is also worth discussing whether the questions should be translated into the local language in order to make it easier for facilitators.

- Study the base maps so that all the individuals involved in the activity are familiar with them and have an idea of what different features, such as road and rivers, look like.
- Finalize and translate the legend as appropriate (samples can be found in Appendix 4), which should reflect the questions you will target during the mapping that you decided upon above.
- Emphasize that the exercise is not just about reading through the questions rapidly to get stickers on the map, but about making sure the participants understand the map, have a chance to discuss the issues that come up and every member of the group is encouraged to actively participate by speaking, drawing and placing stickers on the map.
- Discuss an appropriate way to gauge the amount of time participants refer to when they are discussing changes in resources over time. For example, you could define a general time period (5–10 years) and use events participants can recognize or remember such a political leadership change to mark the time.
- Conduct a trial run of the mapping exercise where some individuals pretend to be farmers and other individuals ask the questions. It is useful to have either a spare map (if transparencies are not being used) or a transparency so that the maps can be drawn on within this exercise. Adjust questions, legends and translations as necessary during this trial run.
- Although we have used the word ecosystem services throughout this manual, we generally used the word resources when training the teams and when we visited the communities where we conducted the mapping, as it was easier to translate.

Planning the mapping exercise within the facilitation team

The number of people and the amount of equipment required will depend on the number of groups who will participate in the mapping exercise. For each map, we had three team members who could speak the local language. They included a facilitator to guide the questions and mapping, a notetaker to record all the discussion points and issues not captured directly on the map and a translator for individuals who did not speak the local language. This meant that when we conducted mapping with men, women and youth in three groups at the same time in a given community, we needed nine team members who could speak the local language.

Planning the mapping exercise with the community

It is important to give enough notice in order for the communities to plan for the mapping activity. The mapping activity should take 2.5–3 hours plus another 2 hours for introductions, presentations of group maps and summing up of activities. We conducted our mapping exercises simultaneously with three groups in each village: men, women and youth.

Checklist of equipment

✓ A base map of the community (additional maps if you are planning to leave one, or have multiple groups mapping concurrently)

✓ 1–2 labeled transparent sheets per map which are the same size as the map labeled (optional)

✓ A translated map legend

✓ Question guide adapted to your project objectives

✓ At least two pens colored red, green, blue and black for each mapping group

✓ Various stickers to mark resources

- ✓ Nail polish remover and cotton wool to 'erase' information if using transparencies
- ✓ Flip chart paper
- ✓ Tarpaulins for participants to sit on if the maps will be on the ground

Participant selection

After initial engagement with the community, you should ask an appropriate person to help you to select participants who would be willing to spend half a day mapping. It is important to have participants who represent the different types of community members in order to get an accurate understanding of the reality of the community's resources and access to them.

If you want to gain a better understanding of the differences in use and access to resources of various groups within the community, you can organize separate, parallel mapping groups (e.g. for men, women and youth). We recommend that each group has 8–10 people to allow space and opportunity for all the participants to see and interact with the map.

There needs to be enough space in the agreed meeting place for the mapping activity. The maps can be placed on tarpaulins on the ground but this can get uncomfortable for the participants over time. Alternatively, maps can be taped on the wall as long as all group members can see the map and participate. Maps on tables with chairs around are often the best option but the tables need to be big enough to hold the full map.

Step 3: Conducting the mapping activity

Estimated time

If the site selection, initial engagement with the community and a FGD (2–3 hours) or other scoping exercise has already been completed, the participatory mapping exercise should take 2–3 hours. The mapping activity requires continued participant engagement for the 2–3 hours, so it is helpful to let the community members know this when planning in Step 2.

Introduce the activity

Once the whole group of participants is gathered, it is important to introduce the mapping team members, explain where they are from and the aim of the activity. The following points should be carefully explained to the group:

- The aim of the activity is to learn about the landscape from the community – about the different areas and resources within their landscape and how they use them. We will be asking about

water and land use in relation to livestock, cultivated areas and non-cultivated areas, such as forests, bushlands and grasslands. We want to understand if there have been any changes in the natural resources they use within their landscape and how this has impacted their lives; we will also ask about access to and management of these natural resources.

- We will be using a satellite image, which shows a map of their community and 3 km on either side of their village – or a picture of their community from a bird's-eye view. We will be asking them to mark the map by putting on stickers and writing in pen to show where resources are found and where changes are occurring.
- We are using this mapping tool for learning and understanding; the mapping exercise is about learning, not for demarcation or to establish boundaries and not to regulate natural resources.
- We plan to use this mapping activity to understand the challenges the community faces and where in the landscape these challenges occur.
- The activity is confidential and anonymous.
- The mapping should not take longer than 3 hours.
- Ask if anyone in the community has any questions.

Mapping in smaller groups

Separate into groups if the activity is to be conducted in different groups.

The groups should not be within earshot of each other. Once they have split into smaller groups, set up the map and repeat the aims of the activity.

Note any special information about the group e.g. how many men and women are present if the group is mixed. If the map is on the ground, ensure that the participants can all comfortably sit around it.

Map orientation:

Explain that the first step of the mapping activity is to ensure that everyone who is participating understands the map. This will be achieved by working with the group to identify specific features they are familiar with and drawing these on the map for reference points, which will be used to guide the rest of the mapping exercise.

Introduce the base map by asking if any of the features on the map look familiar to the participants. Start by asking the participants to identify their village, the roads and any rivers on the map.

The participants should be given pens so that they can start labeling and drawing the different features directly on to the map.

If they have difficulty identifying features on the map, it can be tempting for the facilitator to start drawing on the map but it is important to avoid this so that the participants become comfortable with the map. Participants should not be interrupted unless they stop drawing. Follow-up questions can be answered at that point.

Tip

We found that in general participants were able to recognize and start drawing features on to maps within 10 minutes. However, we found that in hilly areas with steep terrain, participants struggled to identify features quickly. This may be because they orient themselves with the terrain and it was not easy to

distinguish their position on a 2D map. We recommend that, in cases where the area is hilly or where participants are having difficulty identifying features, participants are first asked to sketch out the major roads and rivers running through their village on to a sheet of flip chart paper. Once they have done this, they will be more confident of their location on the map and they can then transfer these details on to the map. If you find that the participants are not identifying important landmarks correctly, gently ask questions using landmarks you can see around you to help them reorient and get back on track.

Mapping of resources

Mapping resources and their state across the landscape

Explain that for this exercise, we want to know how the community uses and accesses resources across the landscape. The focus is on: water, areas used for grazing and fodder collection for livestock, cultivated areas and uncultivated areas (rangelands, bushlands and forests). We will be asking the community to map:

- where resources are found across the landscape in wet and dry seasons
- where on the map provision of these resources have changed in quantity and/or quality
- restrictions to accessing these resources and conflicts over their use.

Explain that additional questions will also be asked about how these changes have impacted their lives, whether particular groups are affected more than others and whether any of these resources are managed.

Introduce the legend

Show them the legend and explain that the symbols will be used to help make the map. Explain what the quantity and quality increasing/decreasing, conflicts, restrictions stickers mean. Then explain what the stickers mean for the first resource you will be mapping, such as water. As you start asking questions about each resource, explain the accompanying legend.

Data collection

Ensure the notetaker can record the discussion points and any necessary abbreviations of resources, species, etc. before you begin mapping. You can also record the discussion if the participants agree to it being recorded. Encourage everyone on the team who can take notes (not the facilitator) to do so in order to ensure the discussion is captured. The facilitator will guide the participants to write and stick the symbols on the map as each question about each resource is asked.

Be sure it is clear to the facilitator, which items need to be mapped (marked as *MAP* in the sample questions in the boxes below and in Appendix 2).

Photographs of every map should be taken before leaving the community to ensure the information is clearly captured in case transparencies get accidentally separated from maps.

Tip

It is important to emphasize that the first piece of information to map is the current location and state of the resource in question. Begin this process with one simple, common resource that everyone has some understanding of, such as water for domestic use. It can take some time for participants to be comfortable drawing or placing stickers on the map; you may need to offer some encouragement and remind them what the different symbols and stickers represent using the legend. It may be advisable to start with another section, such as cultivated areas, which focuses on more general questions, as there were often heated debates over water sources.

Start mapping, one resource at a time

The standard questions to ask about each resource (see Box 1) serve as a starting point for discussion in addition to serving as a guide to participants to label resources and locations on the map.

Allow for discussion among participants and ask follow-up questions if any disagreements or discrepancies within the group arise.

Box 1. Standard questions to ask about each resource – information can be captured on the map and in notes

- Where is this resource?
- How often are you accessing this resource?
- Which of these areas/resources do you rely on most in the dry season?
- Which of these sources can you not use in the dry season?
- Have there been any changes in the resource? (note time since change)
    - How is quantity changing: where has resource increased or decreased?
    - How is quality changing: where has quality become higher or lower?
- What do you think is driving these changes?
- How do these changes affect your lives?
- Does it take you longer to access resources?
- Are there any community groups particularly affected by these changes?

- Who is mostly involved in collecting/using this resource?
- Who has access to this resource – are there any restrictions?
- Who enforces these restrictions?
- Are there any conflicts over this resource?
- Note: It may be advisable to start with cultivated areas, which focuses on more general questions, as there were often heated debates over water sources.

As facilitators, it is important to encourage those who are quieter and less likely to participate; ask them specific questions or if they agree with previous statements or mapped items. It is also important to ensure various individuals in the group have marker and sticker responsibilities in order to manage the dominant group members and ensure that everyone gets a chance to mark on the map.

Follow the flow of the questions that have already been locally adapted and translated. See Box 2 for the set of questions about changes and access to each resource and the sample questions about water resources. Additional question guides and legends are available in Appendices 3 and 4.

Box 2. Sample questions about WATER resources

- Where are your water sources? Taps, boreholes, shallow dug wells, springs, rivers, reservoirs etc. MAP
- What do you use water sources for? (Domestic, livestock, irrigation) MAP
- How often are you accessing each of these resources?
- Do you use any wetlands and where are they? Who uses them? MAP
- Where has water quality changed e.g. water is dirty and don't want to drink
    - CHANGES (quantity and quality) MAP
    - DRY SEASON – use and most important MAP
    - WHAT IS DRIVING CHANGES/AFFECT ON LIVES?
    - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED?
    - WHO HAS ACCESS/ RESTRICTIONS – HOW ENFORCED? MAP
    - ANY CONFLICTS? MAP
    - ANY GROUPS MANAGING THIS RESOURCE?

Tip

Printing out these questions onto a sheet of paper and making them easily visible in the same place as the legends can help to facilitate the discussion.

Lead a final discussion after mapping and discussing all relevant resources

Lead the participants in a final discussion in order to encourage them to reflect on the activity, prepare for presenting back to the group and take the potential next steps.

Box 3: Sample final discussion questions after mapping - Sample final discussion questions after mapping

- Are there any big challenges/ problems you see emerging from the map?
- Where on this map do you think the biggest problem in terms of soil degradation and problems with water exists? (This could include the resources your project is most interested in)
- If it were possible, what would you like your community to do to try and improve them?
- Have there been attempts to address these challenges before? Where they successful or not and why?
- How might you use this map within your community? Are there planning processes this map could be useful for?

Before ending the mapping session in the smaller groups, explain to the participants that two individuals will be expected to present to all groups on the highlights of the issues that were mapped and discussed in their group.

Give them 5–10 minutes to review the map, check the meaning of each symbol and select two volunteers to prepare and present their presentation.

You can ask specific questions to get targeted feedback from the different groups; your questions will depend on the ultimate aim of the activity and the plans for next steps for the maps.

Feedback from the groups

If you separated the group into smaller groups to do the mapping activity, the groups must share their maps and the highlights of their discussions with the wider group. This also provides an opportunity for each group to reflect on their discussion and maps and to draw their own conclusions.

Allow each group about 5–10 minutes to present their maps including time for the larger group to ask questions.

If there are discrepancies or issues that stimulate lots of discussion, you might want to ask some probing questions to better understand the differing perspectives.

Regardless of whether you separated the groups or not, allow time to lead the group through the major highlights of the mapping activity and discuss any unexpected findings.

Ask any follow-up questions about the maps or resources discussed and allow the participants to ask questions and share their own insights on the main conclusions and to answer any of the remaining final discussion questions (Box 3).

Open the discussion for any questions the participants might have. Thank them for their time and input and clarify what the next steps will be with the maps they have just made.

Ideally leave a map in the community at this point or come back with a map in the near future.

Photographs of every map should be taken before leaving the community to ensure the information on the map is clearly and safely captured should transparencies get separated from maps.

> **Tip**
>
> Ensure expectations are met with regard to providing drinks and snacks for participants, especially if they are committing hours of their time to the activity. Handing out refreshments while the teams prepare or give their presentations adds an element of celebration to the final part of the mapping activity.

Step 4: Processing the map

You now have at least one map that has been drawn and labeled by the participants and 3 hours' worth of accompanying notes.

After the mapping activity, the mapping team should meet to produce a field report in which they summarize the main findings for each of the resources discussed and include photographs of the maps.

Maps can either be digitized or can be used as tools to facilitate further discussions related to your project.

We found that the mapping process was a useful tool to generate discussions and information which may not have been captured using the same questions in FGDs. We found that mapping generally engaged the communities more than FGDs.

If you decide that digitizing the maps is not necessary for your purposes, here are some ideas of what you could do with the maps:

- Give the map(s) to the community to use in discussion and planning processes. For example, we used some of the information captured on the maps in Malawi in a further exercise involving participatory scenario development.

- You can return with the maps after a period of time and use them as a natural resource use and management monitoring tool.
- With communities, assess the maps for patterns in resource use, to identify hot spots where resources are under pressure or threat and emphasize any differences in the maps each group created to help better understand different groups' access and understanding of their resources and landscape.

Maps can be digitized if it is appropriate for the scope of the project. It is important to remember that these maps are not precise tools, but they do capture general patterns, perceptions and trends in a way that can be easy to visualize and share with others.

Digitization involves using GIS software in order to place the items marked by participants into a digital map.

If you decide to digitize the map, this should ideally be done by someone who has expertise working with GIS. We do not provide a step-by-step guide to the digitization process here because GIS systems vary and experts have their own techniques. However, we outline in Appendix 5 some of the general steps we took to digitize the maps and some important points to think about during the digitization process.

Participatory maps should be analyzed and understood along with the meanings and explanations from the participants who produced them. They are not stand-alone maps; they require the detailed accompanying notes from the discussion during the mapping process and other information that was produced during their making.

Step 5: Next steps

Ideally, a feedback meeting should be organized in order to return the maps and information obtained to the communities.

In addition to presenting the key findings to the community members and local authorities, try to provide some form of printed information material (e.g. map, leaflet, poster) and a summarized report (in the local language) that contains the key findings of the study, to the community.

You can also use the maps to identify degradation hot spots across a landscape or to examine how ecosystem service use and degradation patterns vary across a watershed or across different communities by comparing various maps within your focus site.

These maps can be used for the next steps of your engagement with the community and actors in the wider landscape. This approach can help to focus the discussion and orient those who may not be as familiar with the landscape, which is important when engaging potential stakeholders or investors outside the focus site.

Here are some examples of ways in which you can use the maps:

- To inform community-level or district planning processes. The maps can serve to highlight the different impacts changes in land management can have on different communities and groups within the community.
- To target investments by sharing information on land degradation issues and unsustainable use of resources at different levels to inform planners, potential investors/implementers (e.g. donors, government and NGOs) of landscape and resource issues.
- To inform community-based and wider landscape future scenario activities.

The information can then be used as part of the process of suggesting and co-creating truly feasible options and opportunities for sustainable and equitable use of natural resources with communities.

We have provided case studies which outline how we adapted and used the methods outlined in this manual in various countries (Appendix 6). Within these case studies, we also outline the challenges we faced and highlight methods that worked well, in addition to providing examples of outputs from the participatory mapping in each case. These case studies include details about how we adapted the mapping methodology and the process we used to meet each project and community's needs. In order to ensure that the mapping activity helped us reach our project and communities objectives, we changed the methodology beforehand and on the spot as needed.

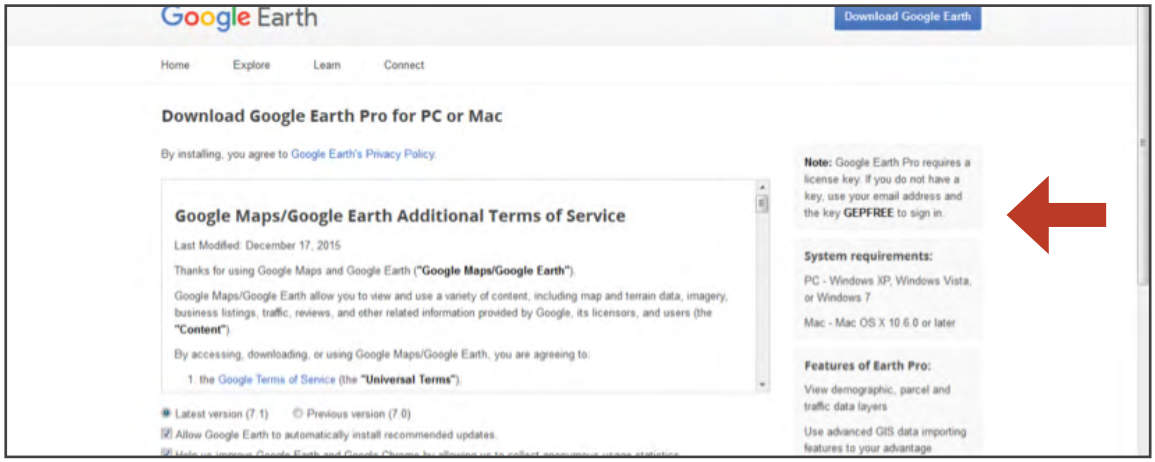
Appendix 1. A detailed explanation of how to create the maps with Google Earth Pro for the activity

Preparing the map:

1. To prepare the high-resolution map to be used during the participatory mapping exercise, you first need to download Google Earth Pro (now free) from the link below:

   www.google.com/earth/download/gep/agree.html

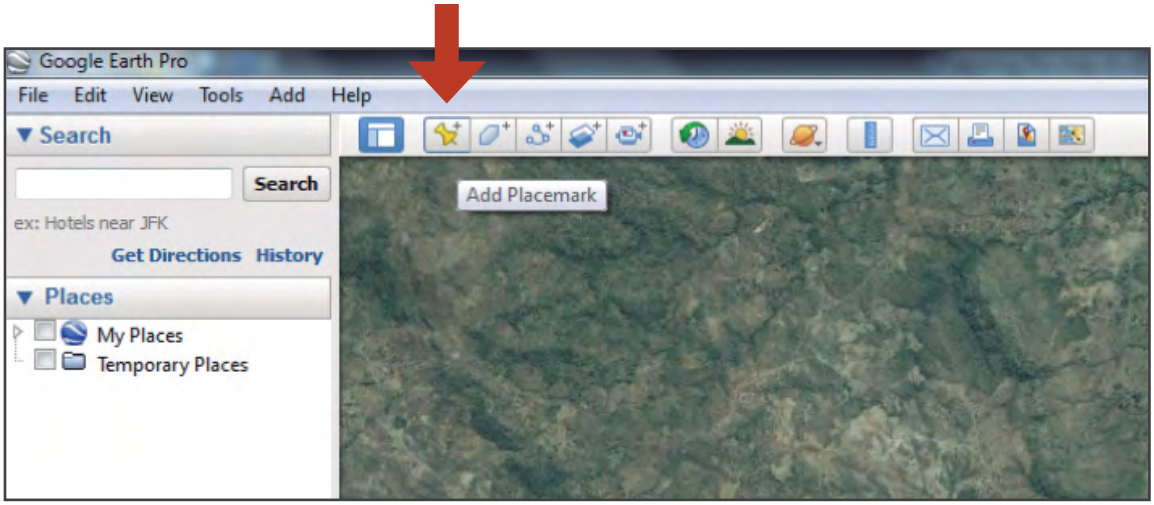
   After download and installation, use your email as username and the password GEPFREE in order to access the program. Refer to the download page to make sure this password has not changed (current as of February 2016). Unlike Google Earth, Google Earth Pro (GEP) allows maps to be saved as high quality PDFs, which can then be printed.



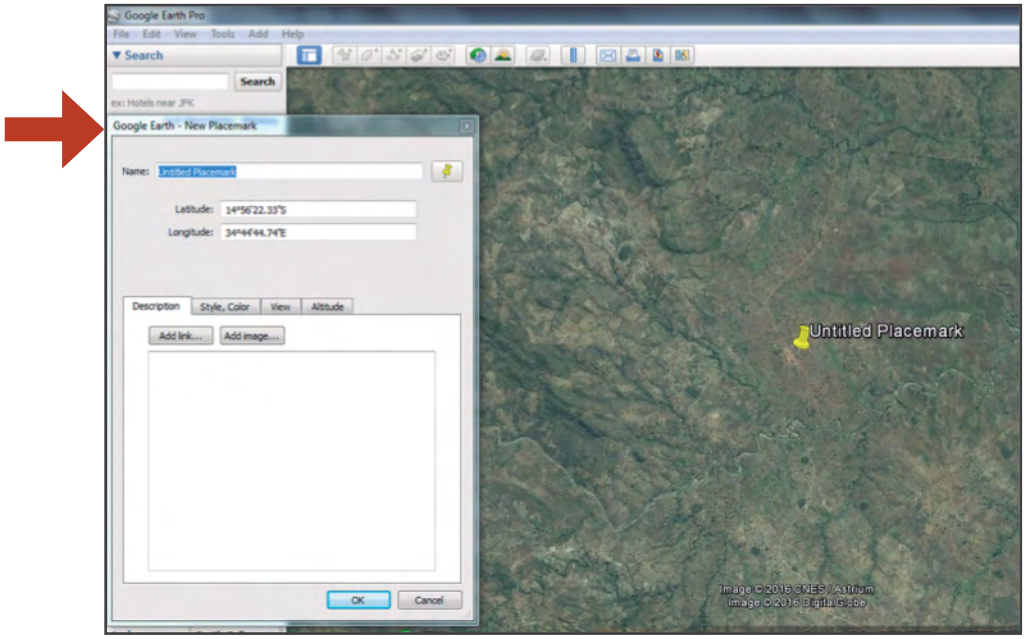
2. Open GEP. You will need to be connected to the Internet. Generally you will find that GEP automatically highlights different layers that are available within the program. These can be found under the 'Layers' tab in the left hand panel and it is better to turn these off as you will not want them on the final map. Unselect them to turn them off.

3. GEP will automatically show a picture of the earth. Locate the area that you want your map to represent i.e. the location of the village or area where you want to carry out participatory mapping. You can do this by typing the name of the village into the search box found at the top left hand side of GEP. GEP will automatically zoom to the site. If the name is not found, then you can also take the coordinates of the village or area using a GPS when you are visiting the site and enter these directly into the search box. If you do not have a GPS but are familiar with the area you could also locate your village or area visually. You can do this by placing your mouse over the earth and moving it until you are above the country you are interested in and then use the zoom slider buttons to navigate into your site. Once you are in the right location, you can follow known/familiar roads and rivers until you can visually identify your village or area.

4. The next step is to mark the village or area that you want to be in the center of the map. This will be used to measure the distance from the center to the edge of the map and it will later be removed, as you do not want this on your final map. Any points you create in GEP will appear on the left-hand side of GEP under 'Places> Temporary Places'. Locate the village or area on the map so you can see it in the GEP window. Check that you recognize all the features on the map to make sure you have the right area. To mark it, use the GEP button on the top tool panel 'Add Placemark'. Put your cursor on the 'Add Placemark' button and click your mouse; this should add a place-mark.

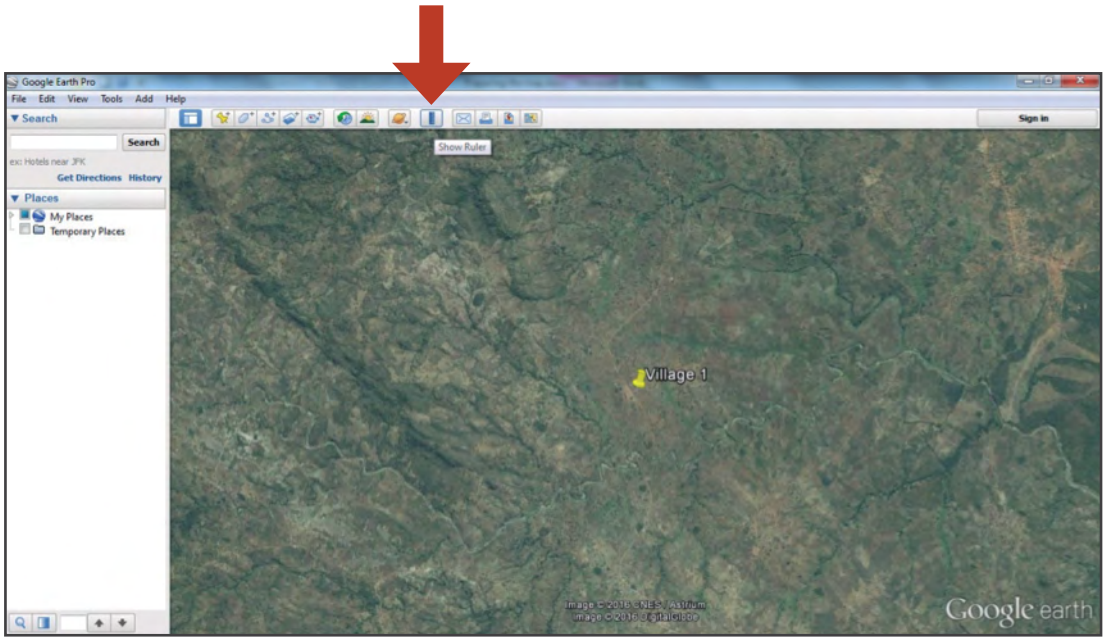


5. The place-mark will automatically appear in the middle of the GEP screen and you will have to move it to the right location. With the place-mark window still open, you can move the by place-mark by hovering over it with your mouse so that a hand cursor appears. Left click the mouse and hold it down and drag the place-mark to the correct location. In the 'New Place-mark' window, label the new place-mark box with the name of the village and press 'OK'. Once you close this box you will not be able to move this place-mark.

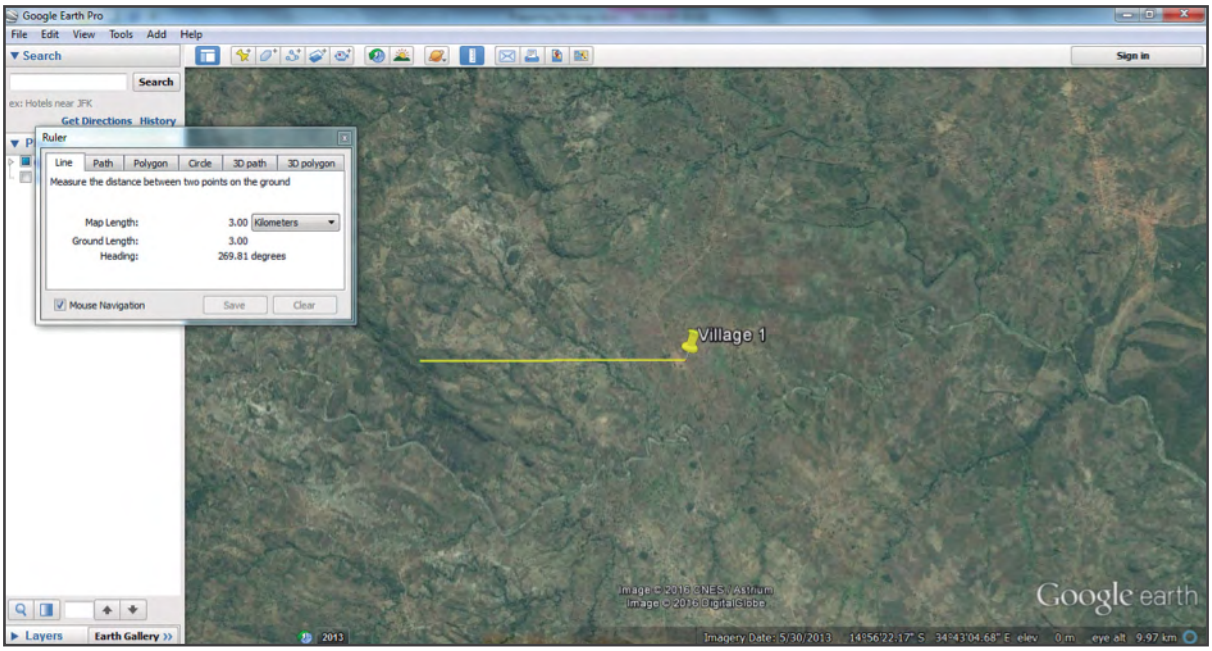


6. Before you make the map, decide the distance from the village that the map should include. Working with smallholder farmers, we used square maps that extended either 2 or 3 km north, south, east and west from the center of the village but others have suggested 2 km. Pastoralist communities may cover a much wider area. It is worth doing a scoping exercise with community leaders or within a FGD, to identify how far people generally travel to access different resources and make your decision based on this.

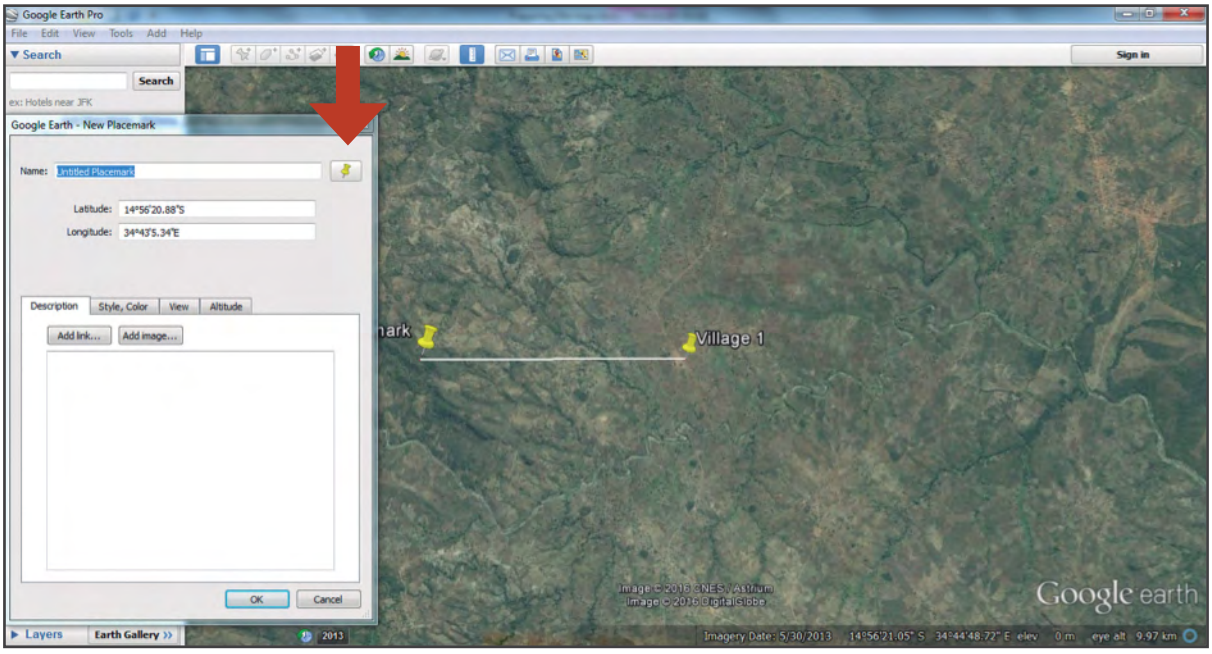
   To mark the boundary edge of your map, you can add four place-marks, which mark north, south, east and west of your target community. You can measure the distance from the village to where you want the edge of the map to be with the GEP button 'Show Ruler'.



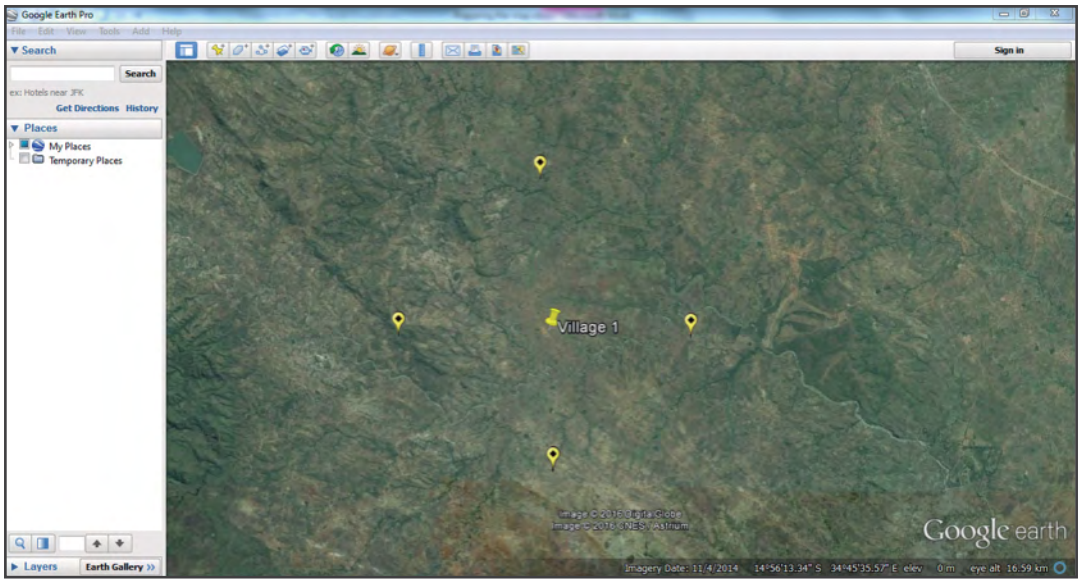
7. Click the 'Show Ruler' GEP button and a ruler box should appear on the screen. Move your mouse over your village place-mark and you should see a box appear over the place-mark. Click once and drag the cursor and it should measure the distance from the village. The distance should appear under 'Map Length' in the ruler box. You can select units of measurements in the drop down box. Measure the distance of half your map e.g. 3 km and click when the ruler box shows the right distance. The yellow line should remain on the screen.



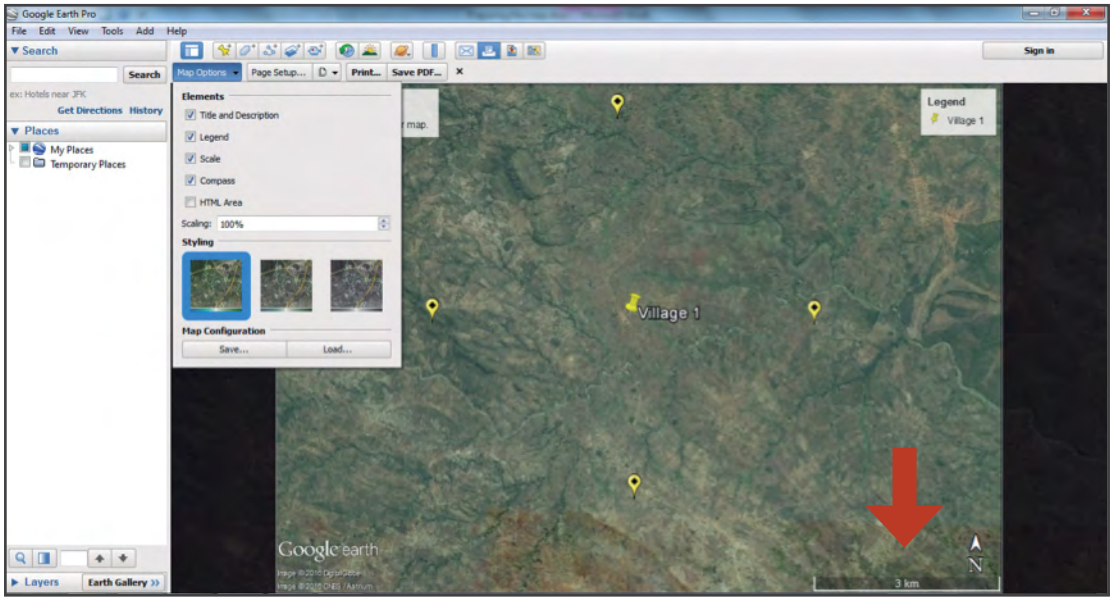
8. Mark the end of the ruler line with a place-mark by using the GEP button 'Add Placemark'. You can move the place-mark to the right location by hovering over it with your mouse so that a hand cursor appears (in a similar way to Step 5). Left click the mouse and hold it down and drag the place-mark to the right location. You can modify the place-mark symbol by clicking on the 'place-mark' box to the right of 'Name' and changing the symbol. Delete the text in the 'Name' box so that the place-marks are not labeled.



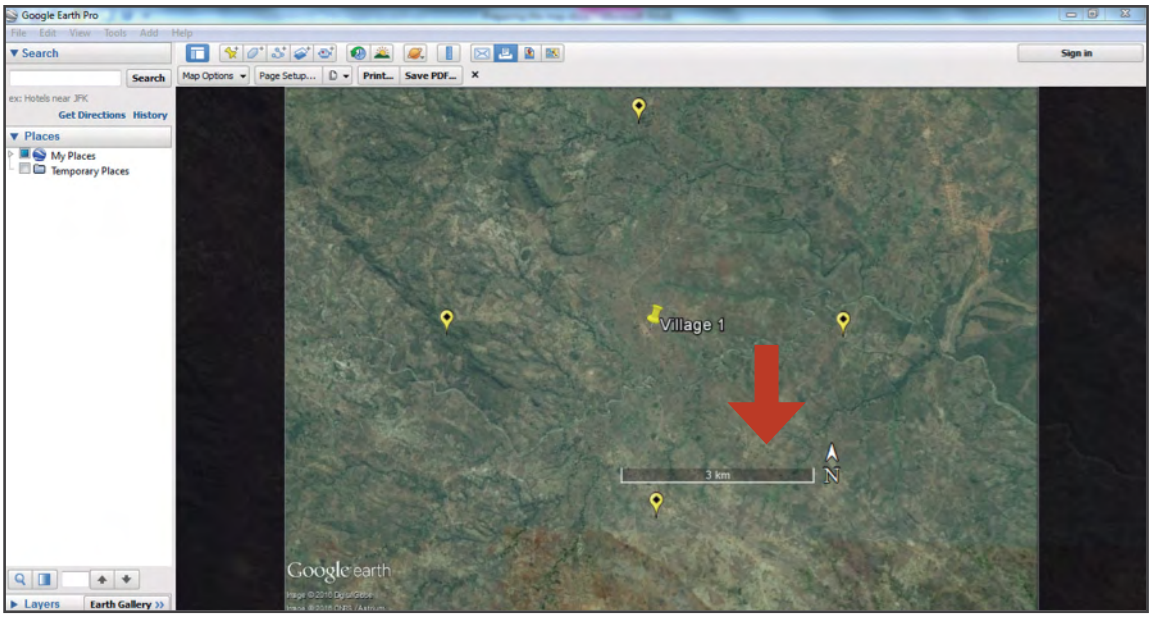
9. Repeat this for north, south and west directions. Be sure the edge markers are not labeled so words don't appear in the final map.



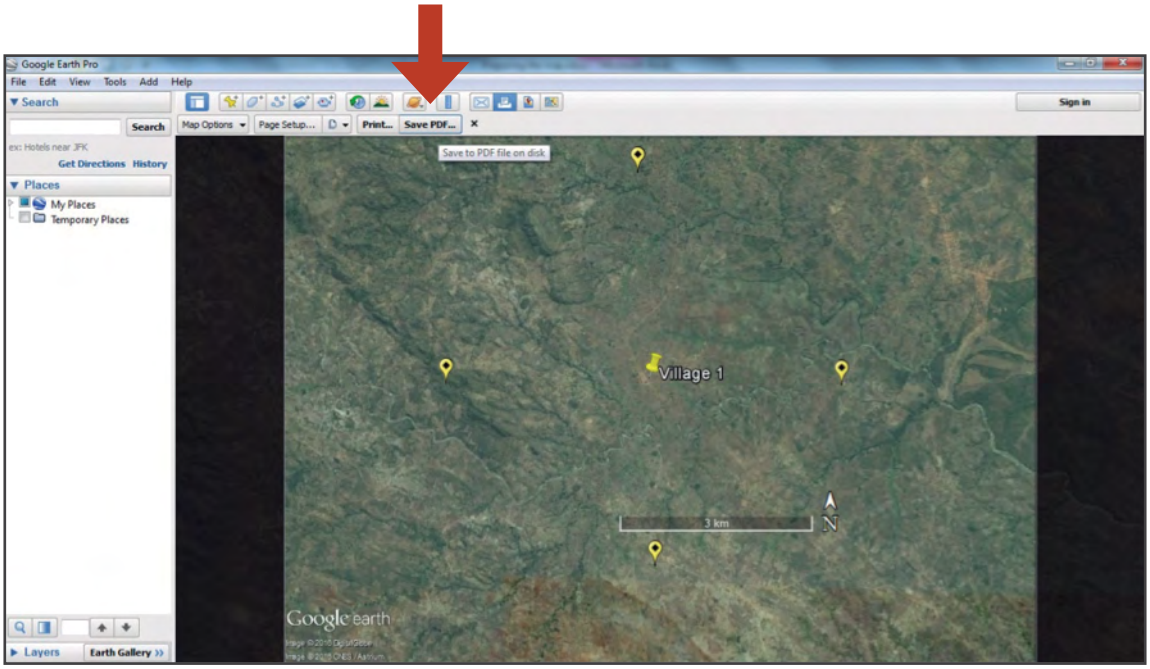
10. Once completed, remove the central place-mark showing the center of the map by unselecting it in 'My Places.'
11. Zoom in to the map as far as possible while still being able to see all four place-markers depicting the edges of the map.
12. Then go to 'File' and 'Print.'
13. Under 'Map Options,' the elements to be displayed on the map can be chosen.



14. It is useful to keep the 'Compass' and the 'Scale' elements highlighted. You can move the scale at the bottom of the map into the 'box' that the four place-marks outline by hovering your mouse over the compass so that a hand cursor appears. Left click the mouse and hold it down and drag the place-mark to the right location. Repeat to move the north arrow.



15. Under 'Page Setup' ensure that 'Print Quality' is marked as 'High'. Save the map by clicking 'Save PDF' on the print menu. Ensure the Internet connection is not interrupted and the map saves at the highest quality. The map should then be cropped to the square marked with the place-marks. This can be done by a professional printer/company printing the map or by using other software such as 'Adobe Publisher' (which is not free). If you need to crop the PDF, you can use a number of free online tools to do so.



16. We printed maps at the size of 1 m x 1 m. We recommend printing the maps as 'matt', as 'glossy' maps can reflect light and make it difficult for participants to see features during the mapping exercise.

It is also possible to create the boundaries of your map in GIS and then export these into GEP. We did this to ensure that the distances measured within GEP were correct and found they matched.

Appendix 2. Sample discussion guides to accompany and guide the mapping exercise

Short discussion guide:

This discussion and resource question guide is an example of a short version of the questions with indications of where items should be mapped (indicated by MAP). You should adapt the guide to reflect the local context and relevant resources for your project objectives. You can select the questions that are important for you.

Discussion guide whilst mapping each resource

For each resource ask the following questions:

- Where is this resource?
- How often are you accessing this resource?
- Which of these areas/resources do you rely on most in the dry season?
- Which of these water sources can you not use in the dry season?
- Have there been any changes in the resource? (note the time since change)
    - How is quantity changing: where has resource increased or decreased?
    - How is quality changing: where has quality become higher or lower?
- What do you think is driving these changes?
- How do these changes affect your lives?
- Does it take you longer to access resources?
- Are there any community groups particularly affected by these changes?
- Who is mostly involved in collecting/using this resource?
- Who has access to this resource – are there any restrictions?
- Who enforces these restrictions?
- Are there any conflicts over this resource?
- Are there any community groups managing this resource?

Resource question guide:

WATER

- Where are your water sources? Taps, boreholes, shallow dug wells, springs, rivers, reservoirs etc. MAP
- What do you use water sources for? (Domestic, livestock, irrigation) MAP
- How often are you accessing each of these resources?
- Do you use any wetlands and where are they? Who uses them? MAP
- Where has water quality changed e.g. water is dirty and don't want to drink
    - CHANGES (quantity and quality) MAP
    - DRY SEASON – use and most important MAP
    - WHAT IS DRIVING CHANGES/AFFECT ON LIVES
    - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
    - WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
    - ANY CONFLICTS MAP
    - ANY GROUPS MANAGING THIS RESOURCE

FLOODING

- Is flooding a problem? How often does flooding occur and has there been a change?
- Where is the flooding? MAP
- Are there any benefits associated with flooding?
- Do these floods cause any losses e.g. buildings, crops etc.

- Does the community have anything to try and control the flood and where is it? MAP

FISHING/FISHPONDS

- Do you get fish from any of these water sources? MAP
- Do people have fishponds? Do you use fishponds for irrigation?
    - CHANGES (quantity and quality) MAP
    - DRY SEASON – use and most important MAP
    - WHAT IS DRIVING CHANGES
    - AFFECT ON LIVES
    - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
    - WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
    - ANY CONFLICTS MAP
    - ANY GROUPS MANAGING FISHING

SOIL

- Do you notice different types of soil in your community? Can you show roughly where the different types of soil are? (Sandy, red, black, etc.) MAP

CROPS

- What are you growing on the hillsides? Who manages and cultivates? MAP
- What are you growing on the valley bottoms? Who manages and cultivates? MAP
- Are you growing other specific crops in specific areas? MAP
- Are people growing fruit trees? Are they productive? MAP
- Are there any areas that used to be cultivated but are no longer cultivated? MAP
- If land no longer used for cultivation why not and, is it being used for anything else?
- Are there any areas that have been newly cultivated? MAP
- Where is land being rented out? In valley bottoms etc.? MAP
- Are there any areas that are especially good for growing crops (productive)? MAP
- Are there any areas where soil fertility has declined? MAP
- Are there any areas where soil erosion is a problem? MAP

- Are there areas where soil and water conservation is practised? MAP
- Are there any pests or diseases that are a problem for crops? e.g. termites MAP
    - CHANGES (quantity and quality) MAP
    - DRY SEASON – use and most important MAP
    - WHAT IS DRIVING CHANGES
    - AFFECT ON LIVES
    - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
    - WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
    - ANY CONFLICTS MAP
    - ANY GROUPS MANAGING SLM

PLANTATIONS

- Are there any plantations? MAP
- What species are grown in these plantations? WRITE ON MAP
- Who do these plantations belong to and who is using them?
- When were plantations planted? What was there before?
    - CHANGES (quantity and quality) MAP DRY SEASON MAP
    - WHAT IS DRIVING CHANGES, AFFECT ON LIVES
    - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
    - WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
    - ANY CONFLICTS MAP
    - ANY GROUPS MANAGING THESE PLANATATIONS

PLANTED TREES

- Where have you planted trees? MAP Which species? Has it been successful?
- When were trees planted and why? Who is managing them? Who has access?
- Are there any tree nurseries? MAP

LIVESTOCK

- What livestock do you have (e.g. cattle, chickens, goats, pigs etc.)?
- Where do you take your livestock to drink (if not already discussed)? MAP
- Where do you take your livestock to graze? MAP
- Where are people collecting manure from? MAP
- How often do you take livestock to graze? How often do you collect manure?
    - CHANGES (quantity of grass and quality of grass) MAP
    - DRY SEASON –use and most important MAP
    - WHAT IS DRIVING CHANGES
    - AFFECT ON LIVES
    - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
    - WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
    - ANY CONFLICTS MAP
    - ANY GROUPS MANAGING LIVESTOCK
- Which plants do you collect to feed to livestock?
- Where is fodder collected from (including crop residues)? MAP Do you buy fodder? How often do you do this? For which animals?
    - CHANGES (quantity of grass and quality of grass) MAP
    - DRY SEASON – use and most important MAP
    - WHAT IS DRIVING CHANGES
    - AFFECT ON LIVES
    - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED

- WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
- ANY CONFLICTS MAP
- ANY GROUPS MANAGING FODDER

GRASSLANDS/BUSHLANDS/WOODLANDS/ FOREST– uncultivated areas

- What do you collect from non-cultivated areas and what do you use it for?
- Which are the most important products to you (up to 5)? e.g. fuelwood, wild foods
- Are some of these goods also collected from cultivated land? MAP
- Where do most people collect each harvested good? MAP
- When are these products harvested – wet or dry season?
- Are any products collected for religious or spiritual significance?
  - CHANGES (quantity and quality) MAP
  - DRY SEASON –use and most important MAP
  - WHAT IS DRIVING CHANGES
  - AFFECT ON LIVES
  - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
  - WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
  - ANY CONFLICTS MAP
  - ANY GROUPS MANAGING FORESTS/ BUSHLAND/GRASSLAND
- Does anyone do the following?
  - Make bricks – where does the soil come from? MAP
  - Sand mining – where does the sand come from? MAP
  - Quarrying – where are the quarries? MAP
- Discuss any issues with these types of resources

SPIRITUAL/RELIGIOUS

- Are there any areas in the landscape that have particular religious or spiritual importance? Where are they and what are their importance?
  - CHANGES (quantity and quality) MAP
  - DRY SEASON – use and most important MAP
  - WHAT IS DRIVING CHANGES
  - AFFECT ON LIVES

- TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
- WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
- ANY CONFLICTS MAP
- ANY GROUPS MANAGING SPIRITUAL AREAS

WILDLIFE

- Where are reserves for wildlife/forest? MAP/NAME
- Are there any tourism (wildlife or cultural?) opportunities?
  - CHANGES (quantity and quality) MAP DRY SEASON MAP
  - WHAT IS DRIVING CHANGES, AFFECT ON LIVES
  - TIME TO ACCESS/WHO IS USING RESOURCES/WHO MOST AFFECTED
  - WHO HAS ACCESS/RESTRICTIONS – HOW ENFORCED MAP
  - ANY CONFLICTS MAP
  - ANY GROUPS MANAGING THESE RESERVES

FINAL DISCUSSION

- Are there any big challenges/problems you see emerging from the map?
- Where on this map do you think have the biggest problem in terms of soil degradation and problems with water?
- Have there been attempts to address these challenges before?
- If it were possible, what would you like your community to do to try and improve them?
- How might you use this map within your community? Are there planning processes this map could be used for?

Appendix 3. Sample mapping questions and instructions to accompany and guide the mapping exercise

This version of questions is more detailed and is a useful tool for training facilitators. You will need to update the instructions to reflect the relevant resources stickers and markings you plan to use. This version of questions may be too detailed for direct use during the mapping activity, when the most useful questions are the above short questions.

Mapping water provision and use

1. Where are the water sources you use and what do you use them for? (Domestic, irrigation, livestock)
    - Mark on map wells, springs, boreholes, taps, rivers, reservoirs, ponds etc. If not marked for another use, it will be assumed that water is used for domestic purposes.
    - Mark where livestock are taken to drink
    - Mark where irrigation is practised.
2. Are there any wetland areas?
    - Mark on the map with a blue dashed line
3. Which of these water sources do you rely on most in the dry season? Which of these water sources can you not use in the dry season?
    - Circle in red those water sources that dry up in the dry season
    - Draw a red star next to those water sources that are critical in the dry season (or make a note if it is all of them except those that dry up)
4. How is the **quantity** changing: where has water supply increased or decreased?
    - Mark with an orange + or – sticker (write the date since change next to it if possible)
5. How is the **quality** changing: where has water supply increased or decreased?
    - Mark with an orange L or H sticker (write the date since change next to it if possible)
6. How has the time taken to get water changed? Where do you go now that you didn't before and how long does it take to get there?
7. What do you think is driving these changes?
8. Are there conflicts over water use?
    - Mark with a red sticker
9. Are there restrictions to water use? Who controls this and how is it enforced?
    - Mark with a bright yellow sticker
10. Are certain water sources important for different groups e.g. men/women, poor/wealthy, in the community?
11. If there have been changes described above: What impact do these changes have on people's livelihoods?
12. Are there any community groups that are concerned with water management issues?

Flooding

13. Is flooding a problem? Where is the flooding if so?
    - Mark with a large round blue sticker any recent flood events with date if possible (or note if they occur frequently)
14. Are there any benefits associated with flooding?
15. Do these floods cause any losses e.g. buildings, crops etc.
16. Does the community have anything to try and control the flood and where is it?
    - Write 'flood control' in location shown if there is a control

Fishing or fishponds

17. Do you get fish from any of these water sources?
    - Mark with white square and blue cross
18. Do people have fishponds? Do you use fishponds for irrigation?
19. Which of these fishing areas do you rely on most in the dry season? Which of these fishing areas can you not use in the dry season?

- Circle in red those fishing areas that dry up in the dry season
- Draw a red star next to those fishing areas that are critical in the dry season (or make a note if it is all of them except those that dry up)

20. How is the **quantity** changing: where has fishing increased or decreased?
    - Mark with an orange + or – sticker (write the date since change next to it if possible)
21. How is the **quality** changing: where has fishing increased or decreased?
    - Mark with an orange L or H sticker (write the date since change next to it if possible)
22. What do you think is driving these changes?
23. Are there conflicts over fishing?
    - Mark with a red sticker
24. Are there restrictions to fishing? Who controls this and how is it enforced?
    - Mark with a bright yellow sticker
25. Are certain fishing areas important for different groups e.g. men/women, poor/wealthy, in the community?
26. If there have been changes described above: what impact do these changes have on people's livelihoods?
27. Are there any community groups that are concerned with fisheries management?

Mapping areas used for grazing and fodder collection

28. What livestock do most members of the community have (e.g. cattle, chickens, goats etc.)? Are livestock herded to grazing areas or allowed to graze freely?
29. Where are livestock taken to graze? Is there enough grazing for everyone?
    - Mark grazing area with green dashed line; note if they are allowed to go anywhere in different seasons
30. Which of these grazing areas do you rely on most in the dry season? Which of these grazing areas can you not use in the dry season?
    - Circle in red those grazing areas that dry up in the dry season
    - Draw a red star next to those grazing areas that are critical in the dry season (or make a note if it is all of them except those that dry up)
31. How is the quantity changing: have any new grazing areas appeared or any grazing areas been lost?
    - Mark grazing area with an orange + or – sticker (write the date since change next to it if possible)
32. How is the grass quality changing: are there any areas where it has gotten better or worse?
    - Mark with an orange L or H sticker (write the date since change next to it if possible)
33. What do you think is driving these changes?
34. Are there conflicts over use of grazing areas?
    - Mark with a red sticker
35. Are there any grazing restrictions? Who controls this and how is it enforced?
    - Mark with a bright yellow sticker
36. Are certain grazing areas important for different groups e.g. men/women, poor/wealthy, in the community?
37. If there have been changes described above: what impact do these changes have on people's livelihoods?
38. Are there any community groups that are concerned with grazing management issues?
39. Is fodder collected for livestock and if so, which livestock?
40. What type of fodder is collected? List the names of plants if possible.
41. Where on the map is fodder collected? Is there enough fodder supply for everyone?

- Mark with a white round sticker labeled with F where fodder is collected from

42. Where on the map is fodder collected?
    - Mark with a white round sticker labeled with F for fodder collection
43. Which of these areas used for collecting fodder do you rely on most in the dry season? Which of these areas used for collecting fodder can you not use in the dry season?
    - Circle in red those fodder collection areas that dry up in the dry season
    - Draw a red star next to those fodder collection areas that are critical in the dry season (or make a not if it is all of them except those that dry up)
44. How is the quantity changing: are there any areas where fodder availability has increased or declined?
    - Mark fodder collection area with an orange + or – sticker (write the date since change next to it if possible)
45. How is the quality changing: are there any areas where fodder availability has gotten better or worse?
    - Mark with an orange L or H sticker (write the date since change next to it if possible)
46. What do you think is driving these changes?
47. Are there conflicts over use of fodder?
    - Mark with a star
48. Are there any fodder collection restrictions? Who controls this and how is it enforced?
    - Mark with a bright yellow sticker
49. Are certain fodder collection areas important for different groups e.g. men/women, poor/wealthy, in the community?
50. If there have been changes described above: what impact do these changes have on people's livelihoods?
51. Are there any community groups that are concerned with managing fodder collection?

Cultivated areas

52. Do you recognize different soil types within your community?
    - Write types of soil and demarcate with black dashed line if possible
53. What are the main crops grown by the community?
54. Where are the main cultivated areas? What is mainly grown? Are there any areas where specific crops are grown?

- Mark with a black dashed line; write in crops that are grown in specific areas

55. Who is in charge of growing different crops in different areas?

56. Which of these areas do you rely on most in the dry season?

    - Draw a red star next to those areas that are critical in the dry season (or make a not if it is all of them except those that dry up)

57. Is there enough land for everyone? If not, are people renting their land and where does this occur?

    - Mark with a white square sticker – write rented out/rented in

58. Are there any areas that used to be cultivated but are no longer cultivated? If land is no longer used for cultivation, is it being used for anything else?

    - Mark with a white square sticker – write no longer cultivated on the sticker

59. Are there any areas that have been newly cultivated (last 10 years)?

    - Mark with a white square sticker – write newly cultivated on the sticker

60. What do people think are driving these changes?

61. Are there any areas that are especially productive?

    - Mark with a white square sticker – write productive on the sticker

62. Are there any areas where soil fertility decline is a particular issue?

    - Mark with a white square sticker – write SFD on the sticker

63. Are there any areas where soil erosion is a particular issue?

    - Mark with pink circle sticker

64. Are there any areas where SLM is implemented?

    - Mark with a white square sticker and write type of SLM

65. Are there any conflicts over which crops are grown where?

    - Mark with a red sticker and write they type of crop that is grown

66. Are there restrictions to which crops are grown where? Who controls this and how is it enforced?

    - Mark with a bright yellow sticker

67. IF YOU HAVE NOT ALREADY DISCUSSED IRRIGATION, DISCUSS IT IN THIS SECTION

68. Are certain members of the community reliant on growing certain crops?

69. If there have been changes described above: what impact do these changes have on people's livelihoods?

70. Are there any community groups that are concerned with farming practices, in particular soil and water conservation measures? Give details

71. Are there any areas where pests and disease are a particular problem? E.g. termites

    - Mark with a black cross and name of pest

72. What do you collect from non-cultivated areas and what do you use it for?

73. Where do most people collect this harvested good?

    - Place a green sticker on the map and write the product next to it or on it

    - Draw a solid green line around forests/ woodlands/shrublands (and write which type of ecosystem it is next to it e.g. forest)

74. Which of these areas/products do you rely on most in the dry season? Which of these areas/products can you not use in the dry season?

    - Circle in red those areas that cannot be used in the dry season

    - Draw a red star next to those areas that are critical in the dry season (or make a note if it is all of them)

75. How is the quantity changing: is there a decrease or increase in products?

- Mark product with an orange + or – sticker (write the date since change next to it if possible)

76. How is the quality of products changing - are there any areas where it has gotten better or worse?
    - Mark product with an orange L or H sticker (write the date since change next to it if possible)
77. What do you think is driving these changes?
78. Are there conflicts over use of these areas/ products?
    - Mark with a red sticker
79. Who has access to these resources? Are there any restrictions? Who controls this and how is it enforced?
    - Mark with a bright yellow sticker
80. Who in the community uses these resources? Are certain products only harvested by the poorest people in the community?
81. If there have been changes described above: what impact do these changes have on people's livelihoods? What would people do if they could no longer access this product?
82. Do any products have great religious or cultural significance
83. Are any products important to seasonal migrants?
84. Are these wild goods used by individuals/ communities for home consumption or sold? Who is responsible for this?
85. Are there any community groups that are concerned with managing any of these goods or non-cultivated areas?

Plantations or woodlots

86. Are there any woodlots or timber plantations and what species are grown?
    - Mark on map
87. Are there areas where woodlots/plantations have been cut down or newly planted?
    - Mark area with an orange + or – sticker
88. What are driving these changes?
89. If there have been changes described above: what impact do these changes have on people's livelihoods?
90. Are there any conflicts over woodlots/plantations?
    - Mark with a red sticker

91. Are there restrictions to where woodlots/plantations are grown? Who controls this and how is it enforced?

    - Mark with a bright yellow sticker

92. Who is mainly responsible for managing woodlots? Do certain groups within the community own or rely more on woodlots?

93. Are the products from woodlots used by individuals/communities for home consumption or sold? Who is responsible for this?

94. Are there any tree nurseries?

    - Mark with a bright green yellow sticker and write tree nursery or abbreviation next to it

Spiritual areas

95. Are there any areas in the landscape that have particular religious or spiritual importance? Where they and what is their importance.

    - Mark on the map

96. Are these areas affected by the dry season?

97. How have these areas changed? Have they decreased or increased?

    - Mark area with an orange + or – sticker

98. What do you think is driving these changes?

99. Are there conflicts over use of spiritual areas?

    - Mark with a red sticker

100. Who has access to these areas? Are there any restrictions? Who controls this and how is it enforced?

    - Mark with a bright yellow sticker

101. Are spiritual areas important for different groups e.g. men/women, poor/wealthy, in the community?

102. If there have been changes described above: what impact do these changes have on people's livelihoods?

103. Are there any community groups that are concerned with managing spiritual areas?

Wildlife areas

104. Are there any areas in the landscape that are protected for wildlife conservation?

    - Mark with a bright yellow sticker

105. Are there any differences in how these are accessed seasonally?

106. How have these areas changed? Have they decreased or increased?

    - Mark area with an orange + or – sticker (write the date since change next to it if possible)

107. What do you think is driving these changes? If there have been changes described above: what impact are these changes having on people's livelihoods?

108. Are there conflicts over use of wildlife areas?

    - Mark with a red sticker

109. Who has access to these areas? Are there any restrictions? Who controls this and how is it enforced?

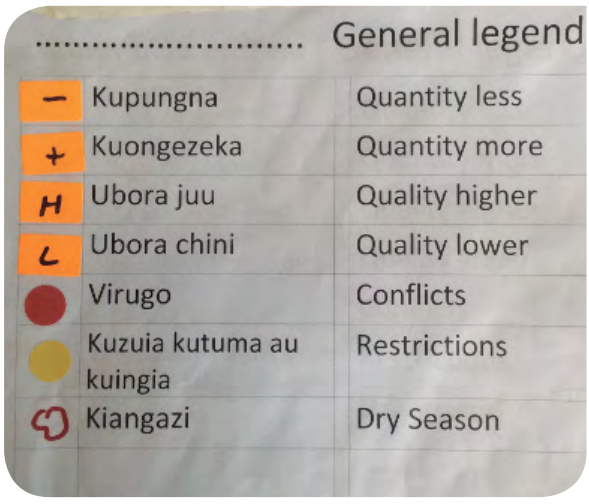
    - Mark with a bright yellow sticker

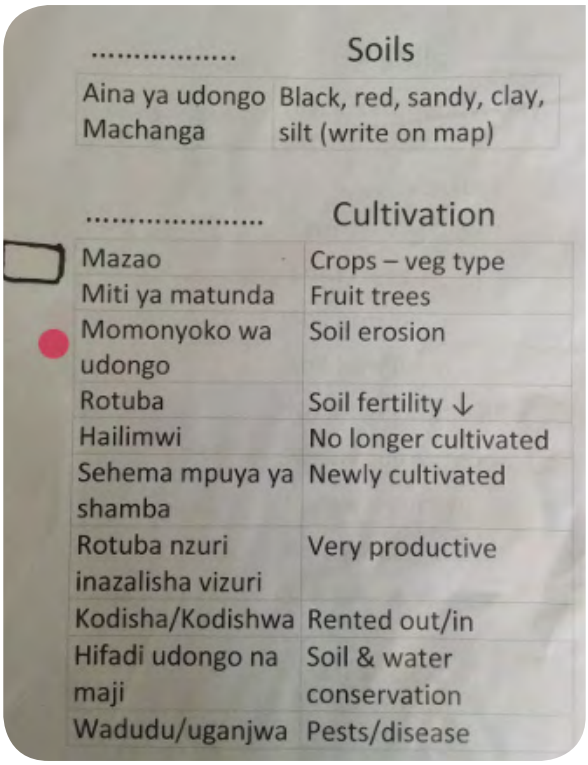
110. Are wildlife areas important for different groups e.g. men/women, poor/wealthy, in the community?

111. Do the communities benefit from any tourism revenue?

Appendix 4. Sample map legends to accompany and guide the mapping exercise

Here you can find the sample legends to adapt and print and then add the appropriate stickers and markings to guide the mapping. In addition we include a blank legend table to print. You can see the examples below (with translations) adapted to suit the local context of various communities and countries. If you plan to reuse the legends with multiple groups, it is helpful to put them in plastic folder or laminate them for protection.





General legend for each resource

	Quantity less		Quantity more
	Conflicts		
	Restrictions		
	Dry season		

Water

	Tap		River
	Spring		Lake
	Well		Domestic
	Livestock		Wetland
	Irrigation		Flooding
	Quality lower		Quality higher

Livestock

	Grazing		Fodder

Planted trees

	Planted trees		Nurseries

Cultivation

	Groundnut		Soil erosion
	Millet		Soil fertility
	Sweet potato		No longer cultivated
	Soybean		Newly cultivated
	Tobacco		
	Cowpea Pigeon pea		Very productive
			Rented land
			Soil and water conservation

Uncultivated (forest, bush, grass)

	Charcoal		Honey
	Fuelwood		
	Mushrooms		
	Wild vegetables		Spiritual or cultural
	Weaving		
	Pots		
	Sand		
	Bricks		Protected

	Fishing/fishponds

	Religious		

Appendix 5. General steps for digitizing the maps

1. If the person digitizing the maps did not take part in the participatory mapping exercise it is important that they work closely with someone who was present to ensure they are interpreting the map in the right way;

2. Take pictures of the map so that these pictures can then be brought into GIS for digitization. We found that transparencies tended to reflect light (even when no flash was used) and that the best way to take photos of the maps so that the base layer and features could be clearly seen was to stick them on a window so that the light illuminates them from behind. If you will not be using the maps again for discussions it can be useful to draw next to each symbol or for those symbols that may not be clearly seen in the photo, what they represent in black marker pen so you do not need to keep cross-referencing with the map in the digitization process. Make sure the maps are clearly marked with the community name and group identity;

3. Photos of maps can be added directly to GIS and then georeferenced using control points. Once this is done, editing tools can be used to capture all the information on the maps;

4. We used a combination of markers created in Google Earth Pro and points and tracks collected with a GPS to create reference control points, such as roads and rivers, in order to geo-reference the photographs of the maps with;

5. For each feature on the map, we captured in the attribute table information on quality and quantity e.g. declining, whether provisioning changed in the dry season, restrictions to access, conflicts, the number of years over which changes had happened and the identity of the village and group mapping the feature. In many cases, it may not be possible to produce maps showing all this information and so the type of information you choose to capture in the digitization process depends on what you want to display in the final maps. Some of this information may also be easier to summarise in tables outside of GIS. Finally, much of this information will have been captured in the notes rather than on the map, which is why it is essential that the person digitizing the maps works with someone who was at the mapping activity and understands the notes.

Important considerations when digitizing the maps:

1. During our mapping exercise, features were captured as points, polygons and lines which can complicate the digitization process. If you will be digitizing the maps, then taking this into consideration may alter how you ask communities to mark features. See the table below for useful background references which discuss this issue or use alternative methods to capture information when mapping;

2. Different groups will often map the same resource, especially in the case of water sources, such as springs. We took the approach of digitizing all symbols on all maps. You need to then give careful consideration to how you combine these features if you are creating a final single map;

3. In many cases, we found it was not possible to map some of the features we had wanted to map such as the condition of soil fertility or areas where different crops are grown except for in a very general way. In Ntcheu, Malawi, soil fertility decline was perceived as so widespread that it was not possible to pinpoint areas of poor soil quality. For crops, we found there are certain areas in the landscape associated with different crops but it was difficult to map these except for in a general way. For example, in Lushoto in Tanzania, maize is grown on hillsides whereas horticultural vegetables and potatoes are grown in valley bottoms. Similarly, in the Upper East Region of Ghana, millet is grown in the farmland around the houses whilst maize and groundnuts are grown in farms in the bush, often some distance from homesteads. This type of information can only be captured in a very general way. Much of this type of information is captured in the notes rather than on the maps and so you may need to make a decision when digitizing whether you only map the features captured on the map or also add information from the notes. We only mapped the information captured on the map as this met our project aims;

4. Participatory maps should be analysed and understood with the meanings and explanations from the participants who produced them. They do not stand alone but require the detailed accompanying notes from the discussion during the mapping process and other information that were produced in their making.

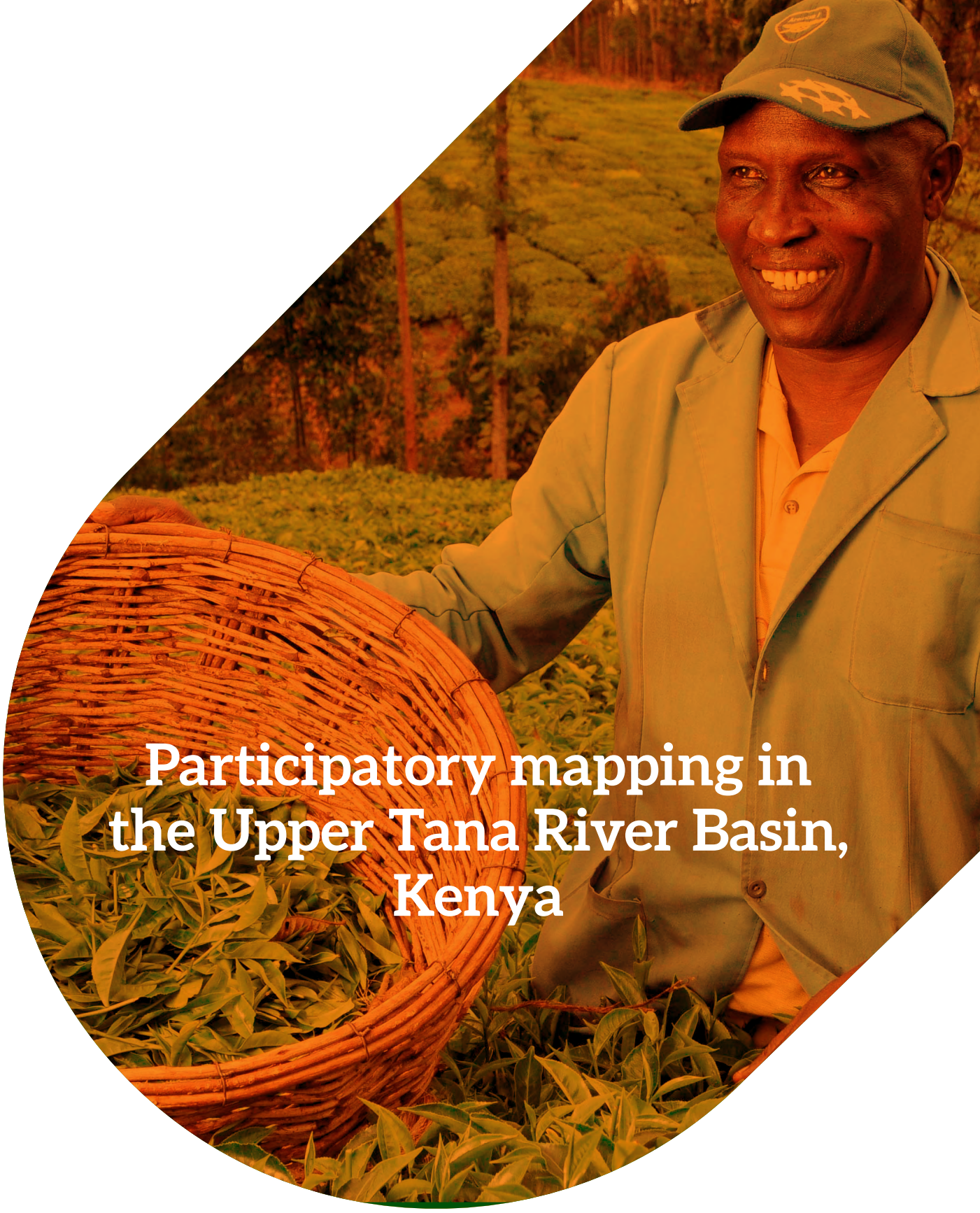
Below are some useful background references if you plan to digitize your maps as they can help guide decisions on how to collect spatial information. This list is by no means exhaustive but these references provide a starting point for thinking about the process, in addition to sources of information in Appendix 7.

Source	Description
Brown and Fagerholm (2015)	A review of public participation GIS (PPGIS) and participatory GIS (PGIS) approaches for ecosystem services to identify current and best practice. Provides a useful source for additional references.
Brown and Pullar (2012)	A comparison of the collection of spatial information using either point or polygon spatial features in public participation geographic information systems (PPGIS) and recommendations on when to use both approaches.
Fagerholm et al. (2012)	Used semi-structured interviews with individuals within the community to map landscape values on aerial images. Marked landscape values as point data.
Palomo et al. (2013)	Used participatory mapping techniques in expert workshops to map service-provision hot spots, degraded hot spots and service-benefiting areas. Locations were marked with two different sized dots of different colors.
Ramirez-Gomez et al. (2013)	A description of a participatory GIS (PGIS) mapping project to identify ecosystem services. Employed a mapping approach that used polygons.
Ramirez-Gomez et al. (2015)	Used hand-drawn polygons rather than points to represent locations of ecosystem services provisioning areas and compared differences from two time periods.

It should be noted that there is also a growing amount of literature on participatory mapping using online platforms but we have not included these here.

Appendix 6. Case study examples and experiences from Kenya, Malawi and Tanzania

These case studies include details about how we adapted the mapping methodology and the process used to meet each project and community's needs. In order to ensure that the mapping activity helped us meet our project and community objectives, we changed the appropriate elements beforehand and at the time the mapping was being done, as needed. Each case study also explains what worked well and some of the challenges we faced in carrying out the mapping activity. You can also see examples of lessons learned and outputs for each site.



Participatory mapping in the Upper Tana River Basin, Kenya

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

CGIAR
RESEARCH PROGRAM ON
Water, Land and Ecosystems

Background

The Upper Tana River Basin covers approximately 17,000 km^2 and is home to 5.3 million people (TNC, 2015). The basin covers Mount Kenya and the Aberdare highlands with elevations ranging from 4,500 m at Mount Kenya to about 400 m above sea level in the east of the catchment (Dijkshoorn et al., 2011). There are two rainy seasons and rainfall is relatively high with average annual rainfall of about 2,000 mm at higher altitudes (Hunink et al., 2013). The water this area provides is of critical importance to the Kenyan economy. It fuels one of Kenya's most important agricultural areas, provides half of the country's hydropower output, supplies 95% of Nairobi's water and is home to national parks and reserves which are important areas of biodiversity (TNC, 2015).

Derived from volcanic parent material, the soils were relatively fertile; this area has been intensively farmed since before the 1960s due to the combination of fertile soils and high rainfall. Important cash crops are tea, which is grown in the higher elevation areas, and coffee, which is grown in lower elevations but has become less important as a cash crop as market prices have fallen. Avocadoes and macadamias are other important cash crops. In most areas, farmers grow a mix of food and cash crops. Landholdings are not scattered and extend in strips from the crest of hills down into the valley bottoms to the rivers and so nearly all farms have access to rivers. In the tea zone, tea is grown on hillsides and covers about 75% of the farm while vegetables and trees are grown on the crest of the hills near the homesteads and along the river valleys. Food crops (maize, beans) are planted on the upper part of farms in rotation in the rainy season, and in the dry season English potatoes, sweet potatoes and vegetables (cabbages, green vegetables ('sukuma wiki'), arrowroot, green capsicum, pumpkins, courgettes) are irrigated on the lower part of farms along the rivers.

One of the major challenges in the Upper Tana is that upstream human activities are causing increased sedimentation in the basin's rivers, reducing the capacity of reservoirs and increasing the costs for water treatment (TNC, 2015). To address this, the Upper Tana-Nairobi Water Fund was created to help protect and restore the quality and supply of water in one of Kenya's most productive and economically important regions (TNC, 2015). Spearheaded by The Nature Conservancy (TNC), the Water Fund will establish a revolving fund, where a public-private partnership of donors and major water consumers 'at the tap' contribute to the endowment, which generates funds to support land conservation measures upstream (TNC, 2015). Water funds are founded on the principle that it is cheaper to prevent water problems at the source than it is to address them further downstream (TNC, 2015). Whilst the Water Fund is aimed at providing benefits to downstream users, ensuring that land users benefit from land conservation measures upstream is important to the long-term viability of the fund. CIAT and partners are working to better understand the benefits and beneficiaries of land conservation measures on multiuse agricultural lands.

The Upper Tana-Nairobi Water Fund activities are currently focused in three priority sub-watersheds (Figure 1). Rivers from these sub-watersheds are critical to Nairobi's water supply and Kenya's power supply. This work was focused in one of the sub-watersheds, Thika-Chania. Participatory mapping was conducted in this case to gain a broad understanding of the context within which farmers live in this agroecosystem.

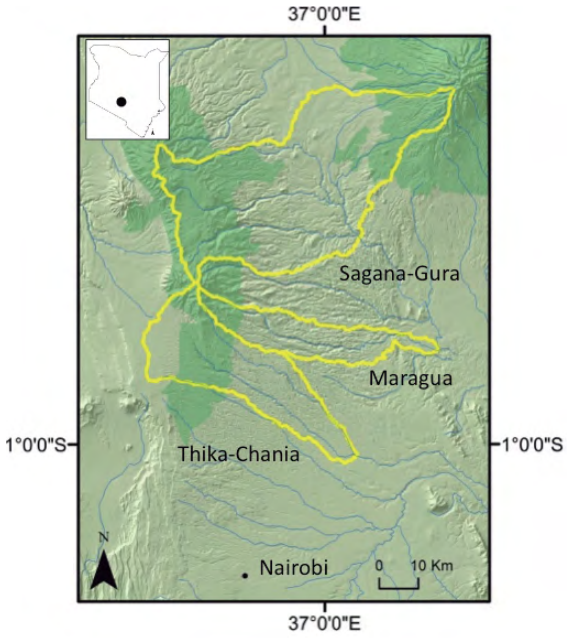


Figure 1. A map of the Upper Tana in Kenya showing the location of the three priority sub-watersheds (Thika-Chania, Maragua, Sagana-Gura) in relation to Nairobi. The green shaded areas are national parks.

Approach

Focus group discussions (FGDs), development of seasonal calendars and participatory mapping of ecosystem services were carried out with three communities (Karangi, Mbugiti and Gatunyu) in July 2015 in one of the priority sub-watersheds (Thika-Chania) identified by the Upper Tana-Nairobi Water Fund as critical for improving water quality and quantity in the basin (TNC, 2015). In each community, every activity was carried out with a group of men and a group of women. Two communities are situated in the tea zone on the edge of a forested national park (Figures 1 and 2). The third community is in the lower part of the watershed in the coffee zone.

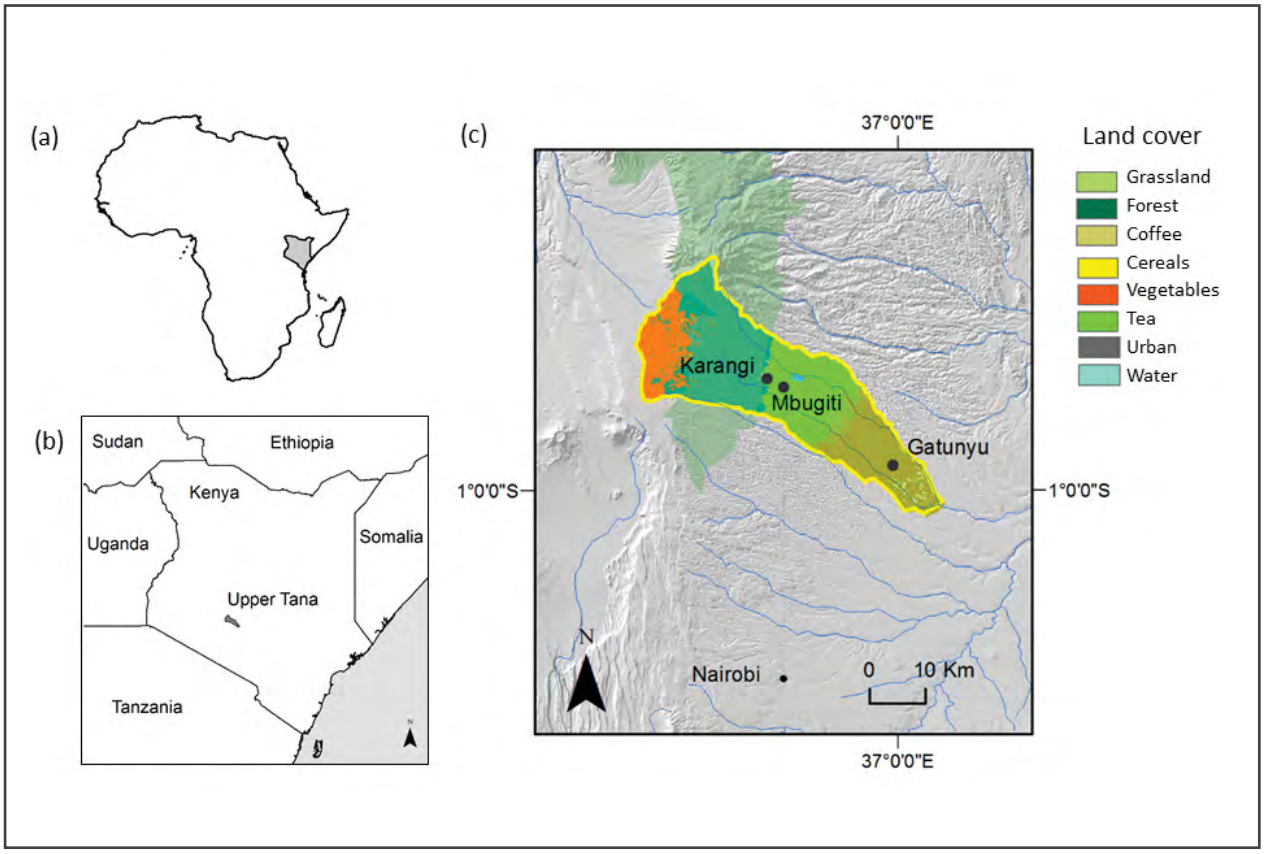


Figure 2. Schematic map with the study sub-locations showing the sites where participatory mapping was conducted in Kenya (Karangi in area 1, Mbugiti in area 2, Gatunyu in area 3). The schematic shows how water is funneled from Ndakaini Dam into the Kimakia River and then into the Chania River for intake into the water company that provides Nairobi with water.

Aims

Participatory mapping of ecosystem services was used in this research project to acquire a broad view of the local agricultural, economic, social and biophysical context of these areas and to get a sense of any differentiation in land use and access among communities and groups (men and women) that may exist and the implications this has for implementation of land conservation measures.

How the mapping was adapted for this case

- Maps showing the extent of the area within 3 and 5 km of each community were used together. In one community a map of the whole sub-watershed was also used.
- Taping the maps on to walls or on to the side of cars allowed maps to be displayed side by side so all participants in a group could view them. The legend was also taped beside the maps for easy viewing.
- The legend was simplified so that all information associated with cultivated areas was written on a white, square sticker and all information related to natural resources was written on a green, square sticker (Figures 3 and 4). This meant that communities could easily write what they were marking directly onto the sticker – all they needed to be told was the corresponding color. However, this might not work with communities where some individuals were not comfortable writing the resources on to the stickers.

Two maps showing the extent of the area within 3 and 5 km were used in each group. Here a women's group discuss the outcome of the mapping activity.

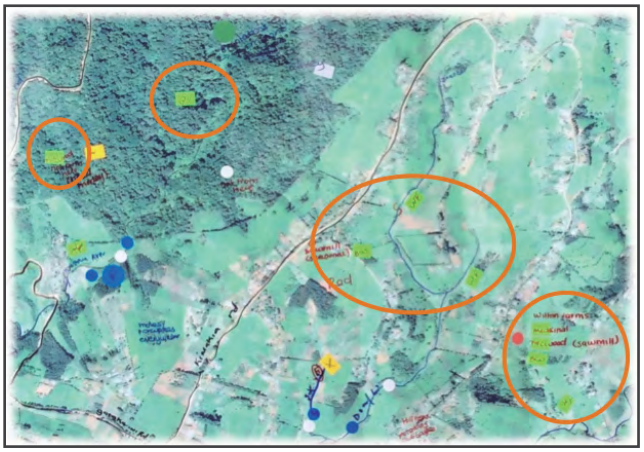


Figure 3. This map shows the green stickers (highlighted with red circles) with the related natural resources written on them using a simplified legend.

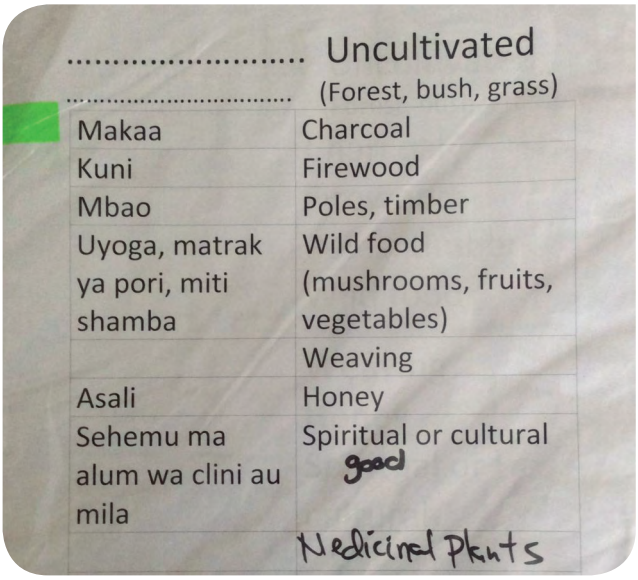


Figure 4. This simplified legend meant that participants used green stickers for all uncultivated goods and wrote the specific good on the sticker before placing it on the map (see above). This legend shows that additional items were added during the mapping activity (medicinal plants).

Tip

The facilitator should check that they understand what all the stickers say as some information may be in the local language. It is also important that the meaning of any new symbols adopted during the mapping process is recorded. This is especially important if the map is to be digitized as the person using GIS to digitize the map will need to know what all the symbols mean and may not have been present during the mapping process.

Process
How the step should be implemented

Results

Challenges

- Due to time constraints, all activities (FGDs and participatory mapping) were conducted within a day or less of each other and this limited the extent to which we could use the FGDs to adapt the mapping questions. Asking similar questions in the FGD and mapping activities can be one way of triangulating the information that is collected. However, if the activities are done within a small time frame, the questions can seem repetitive to the participants.

- It was challenging at times to get everyone involved in the mapping process. This can be overcome with good facilitation that engages all participants.

- The participants were selected by the assistant chief in charge of the sub-locations, with a criterion of representativeness across different socioeconomic backgrounds. It was difficult to ascertain whether this criterion was respected, but it is likely the villagers belonged to the medium-income group in the area.

- In this region of Kenya we found that there are few common pool resources available for use. Within the agricultural areas almost all land was privately owned, either by individual or company farms. The nearby forested area is under the control of either the Kenyan Wildlife Service or the Kenyan Forestry Service. There is restricted access to these areas, but most participants in the two communities we talked to near the forest said it was too far away for them to use. The participants said they obtain almost everything they need from their farms or they buy it. For example, they either grow or buy grass fodder for zero-grazing livestock and firewood. This means that many of the questions on the use of uncultivated areas and uncultivated products were not relevant and this part of the mapping process did not add value to the information gained in the FGDs. In this type of farming system, FGDs could be used to assess whether a mapping activity will significantly add value in terms of new information learned.

What worked well

- Sticking maps on to the wall allowed maps at different scales to be displayed side by side to help the discussion regarding the wider landscape. In all the communities, maps showing the extent of the area within 3 and 5 km of the communities were shown. In Gatunyu, an additional map showing the whole sub-watershed was shown, which elicited new conversations on water pollution within the area.

- Participants reported that they found it comfortable to be seated in chairs around a map stuck on to the wall, while sitting on the ground for 3 hours was too long and made them uncomfortable.

- Within the Gatunyu community numerous 'hot spots' were identified; these hot spots were perceived as being more prone to soil erosion.

Participants marking resources on the map. Chairs are more comfortable for the participants and good facilitation is required to draw all the individuals in the group into the conversation.

Key learning points

Differences and perspectives of women and men on resource use and access

- Both men and women tended trees although the men received the cash benefits when they sold any derived products.

- In all communities, men agreed that no crops were considered to be men or women's because both worked on the farm. However, women said that the cash crops (e.g. tea in the case of Karangi and Mbugiti and coffee in the case of Gatunyu) were considered to be men's crops because they generated higher income than other farming activities.

Water

- Both the men and women felt that their most important resource was water, for growing crops and watering livestock.

- Lack of water was highlighted as the biggest challenges faced by communities.

- River water quality decreased downstream due to farming and river water quantity has steadily declined for the past 10 years in certain rivers in the communities.

- During the dry season, the women went to the river early in the morning to fetch water. Competition was high as the river water level was very low at that time of the year. When the streams and rivers dried up, women dug holes up to 5 m deep to reach water in the riverbed.

- At the junctions of streams and where the valley was eroded, short-term flooding occurred during the heavy rains in April and May. Flooding damaged crops planted along the rivers.

Uncultivated areas and goods

- There were very few uncultivated areas within these farming communities because nearly all of the areas were cultivated or under plantation forestry. Natural areas were protected and their use was regulated.

- In the tea communities, the men said that the forest within the protected areas are used for collecting fuelwood, timber, poles, fodder and honey and for grazing and farming (using the 'shamba' system) for those who were licensed. There were restrictions however on the harvesting of these goods. Access to the forest was restricted to the dry season, but farming in the forest was allowed whenever the Kenya Forest Service cleared part of the forest. The women said that they did not collect products from the forest because it was regulated and it was far away, although they knew some people collected fodder from the forest.

- The only uncultivated area outside the forest were small grazing areas for livestock. Most products found in the forest were available on farms and the community rarely went to the forest because it was so far away.

- Most people (half of the households in Karangi) had access to electricity, but it was used for lighting only. The other main sources of energy were: kerosene, paraffin, charcoal, fuelwood and sawdust (the latter in Gatunyu only). Fuelwood was the most common source of energy due to its availability (i.e. it could be sourced from farms by pruning trees) and affordability (i.e. it was cheaper than the other sources of energy). Not many people used charcoal, as it was expensive. Fuelwood was a scarce resource due to a combination of decreased tree cover and increased population pressure. All communities used to collect fuelwood from common areas or from the forest but there are now few common areas. In Gatunyu, the community used to collect fuelwood from the coffee estates but they are now fenced off.

- Timber was usually taken from the felled trees in the farmers' compounds or bought from the sawmills.

Cultivated areas

- No areas were more productive than others – productivity depended on how the land was managed and how inputs were used.

Livestock

- Common grazing land was largely converted to agriculture in the 1980s and since that time cattle have been reared in zero-grazing systems.

- Zero-grazing systems have driven farmers to allocate areas of their farm to growing fodder crops instead of food crops (mostly Napier grass). However, dairy farming can contribute significantly to family incomes. During the dry season, farmers often had to resort to buying livestock feed. Cattle were watered from piped water supplies, but when these fail, water was obtained from rivers.

Soil

- Erosion was a major problem on all farmland and in the coffee zone. In the tea communities, soil erosion was not considered to be a major problem because the hillsides were covered in tea (which provides vegetation cover). Recently, terraces and strips of Napier grass were put in place to retain soil moisture, fertilizer and topsoil.

- In some places, erosion was so extreme that farmers could not cultivate anymore; instead they planted eucalyptus.

- Soil fertility decline was a major concern in all communities and participants attributed it to continuous cropping practices. Soil fertility decline led to a decline in yields.

Overall learning points

- Pressure on land was very intense and high population density put a strain on local resources such as farmland and rivers.

- There are currently no organizations implementing sustainable land management activities in any of the communities.

Who was involved?

The International Center for Tropical Agriculture (CIAT) through the EC-IFAD funded project *Restoring degraded landscapes through selective investments in soil quality in West, East, and Southern Africa* and the International Water Management Institute (IWMI) through the *Wise Up to Climate Change* project and its partners: the Basque Center for Climate Change (BC3), Jomo Kenyatta University and Moi University.

How was it funded?

European Commission (EC), International Fund for Agricultural Development (IFAD), CGIAR Research Program on Water, Land and Ecosystems (WLE), and the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

Outputs

Comprehensive notetaking of the discussion generated by the mapping activity was essential for interpreting the map and capturing all the information that could not be easily mapped by the participants. A detailed report including notes and insights from all the discussions (FGDs, participatory mapping and seasonal calendars) was produced.

Finalised maps from participatory mapping

Maps can be useful tools for generating discussions even if they are not captured in a GIS. Comparing maps from male and female community members can help us to understand the role of gender and use of/access to natural resources. These maps can also be incorporated into land-use planning and used to help better characterize local farming systems (Figure 5).

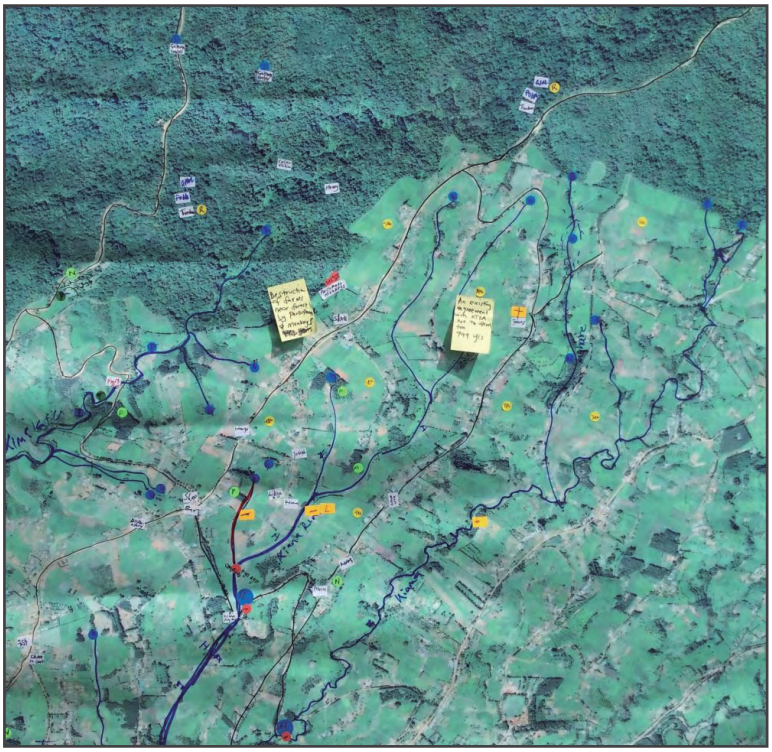


Figure 5. This map, identifying all the relevant resources and changes in their quality and quantity discussed during the mapping activity was completed by the community members in Karangi.

Identifying areas of degradation across the landscape

Once digitized, the maps could be used to identify areas of degradation across the landscape. A soil erosion hot spot map can be used to target areas for implementation of land conservation measures (Figure 6). A map showing the rivers with declining water quality can also be used to target areas for further monitoring and implementation of soil conservation measures (Figure 7). In the context of the Water Fund, the maps and insights from this activity can help incorporate farmers' perspectives in future integrated landscape planning and ensure that farmers benefit from land conservation measures upstream, helping in maintaining the long-term viability of the fund.

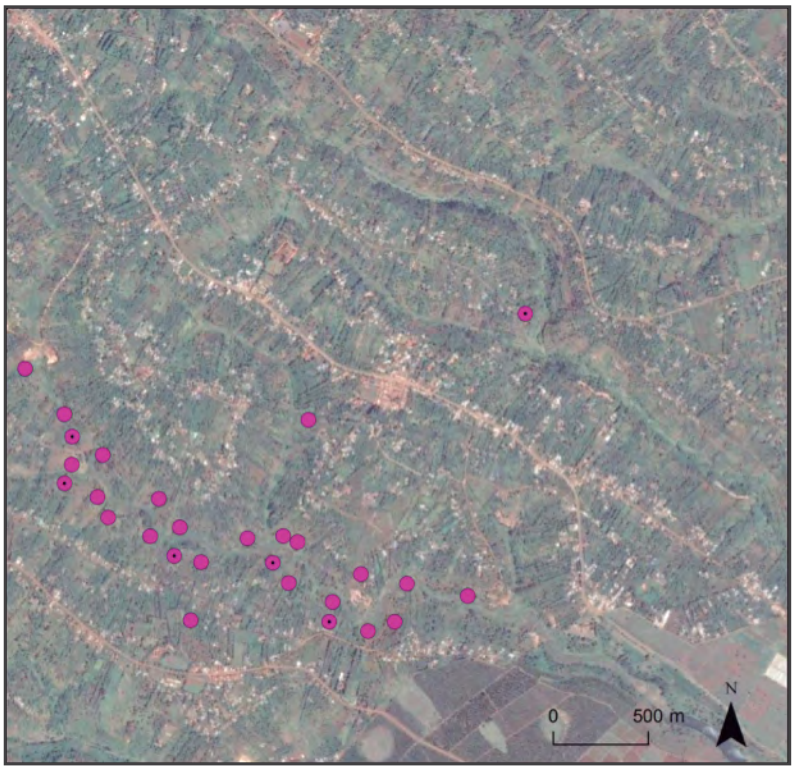


Figure 6. Soil erosion hot spots (pink circles) identified by both men (pink circles) and women (pink circles with black dots) in Gatunyu community based on the 3 km map, with a base map from Google Earth Pro.

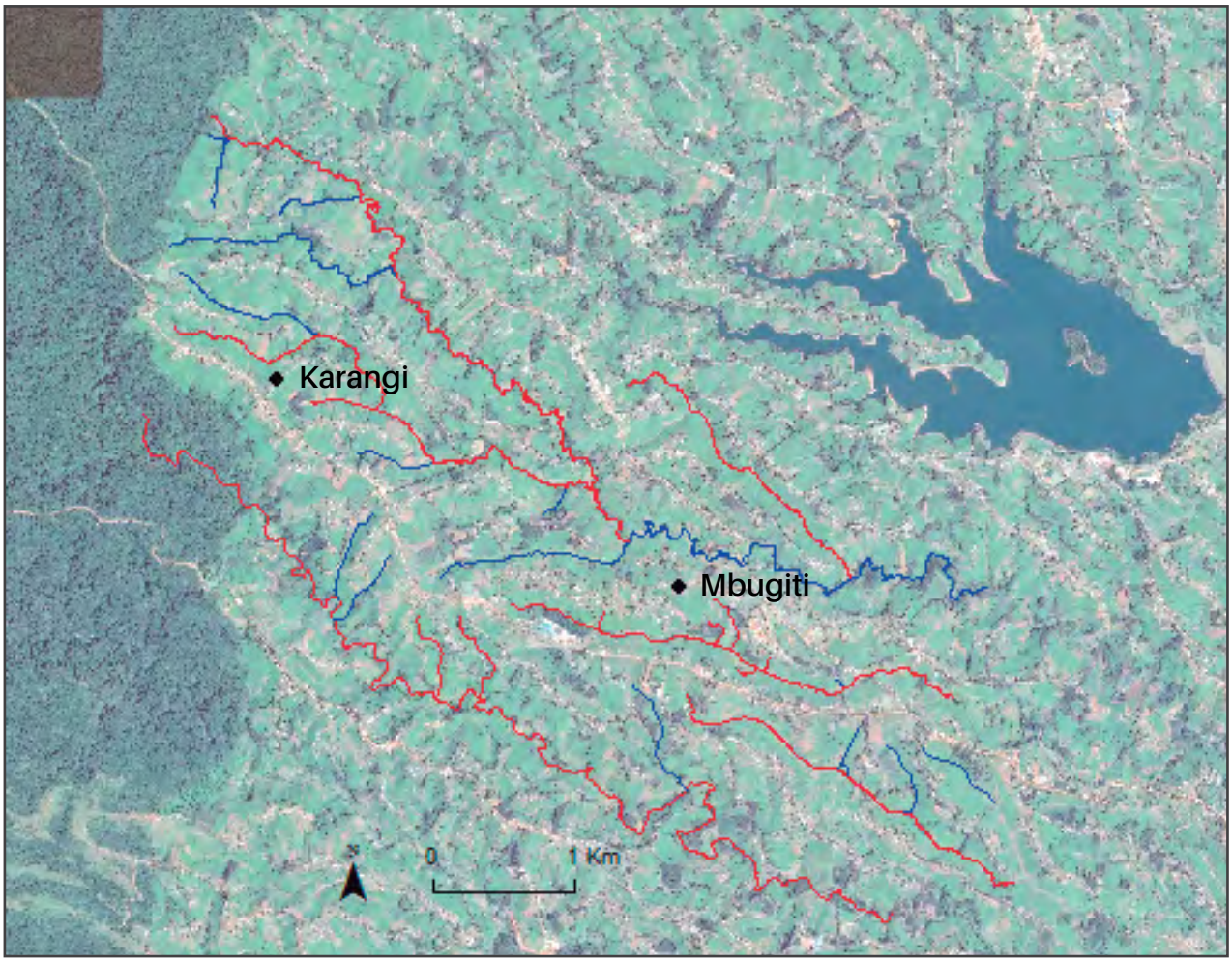


Figure 7. Rivers with declining water quality are shown in red for the two communities (Karangi and Mbugiti) in the tea zones, with a base map from Google Earth Pro. A wider area than was represented by the 3 km maps is shown to highlight proximity to the Aberdare Forest and Ndakaini Dam.

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Participatory mapping in Ntcheu district, Malawi

CIAT
International Center for Tropical Agriculture
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CGIAR
RESEARCH PROGRAM ON
Water, Land and Ecosystems

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.

The Ntcheu district of central Malawi (Figure 1), has received considerable attention in research and in development programs. In Ntcheu district there are significant constraints to production due to limited land availability, small farm size, scattered plots, poor access to inputs and expansion of agriculture into forested and riparian zones. Ntcheu district covers an area of 3,424 km^2. The population density of Ntcheu is about 108 persons per km^2 and the average landholding size is 0.91 ha. The district has two distinct terrain patterns: the upland area bordering Mozambique in the west and the Shire River Valley with alluvial soils to the east. Temperatures are warm and temperate, with mean annual temperatures of 15–20°C. The mean annual rainfall ranges from 600 mm to 1,200 mm.

In Malawi, to counter the effects of degradation, the government in collaboration with donor agencies and nongovernmental organizations, is designing and implementing various sustainable land management (SLM) reforestation and fertilizer subsidy programs. However, much remains to be done to ensure that these plans are adapted to local biophysical and socioeconomic contexts, rather than scaled-out in a uniform manner. The four focus villages in Ntcheu district for the AGORA project are: Mpulula, Malaswa, Kapalula and Gwauya.

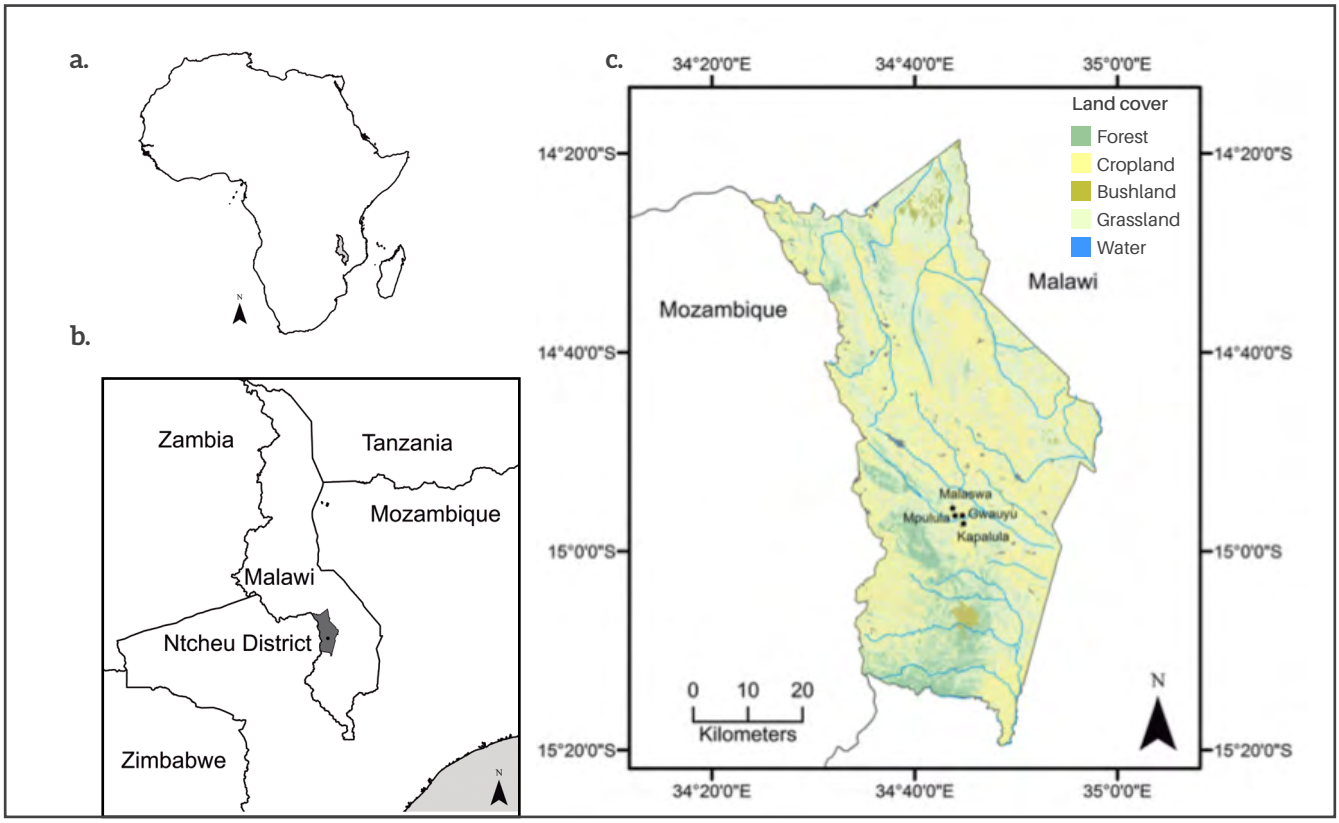

Figure 1. Location of the case study site in Africa (a), and in Malawi (b), with Ntcheu district shaded in gray. The four focus villages where the mapping was conducted are shown within Ntcheu district (c). Land cover for 2010 was obtained from GLC30.

Approach

Focus group discussions (FGDs) and interviews were conducted in October 2014 and informed the participatory mapping of ecosystem services exercise in the four focus villages in Ntcheu district in January 2015. In each community, the mapping was carried out with three separate groups – men, women and youth.

Aims

A 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) used and accessed 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 3 km of each community were used.
- Maps and legends were laid on tarpaulins or mats on the ground and groups of 8–10 community members sat around the map and legend.
- During this exercise we used the entire list of questions (Appendix 3 of the participatory mapping guide) and a detailed legend with different stickers/labels for each good/resource. The mapping exercise focused on: water, livestock grazing areas and areas used to collect fodder (to feed livestock), uncultivated areas (such as forests) and cultivated areas (including plantation forestry).
- At the end of the mapping exercise, each group elected a representative to explain the highlights of their maps in 5 minutes in front of the entire community and then an open discussion was facilitated around the differences, similarities and main lessons learned from the mapping activity.

Process
How the step should be implemented

Results

Participants sit around the maps whilst facilitators use the entire long list of detailed questions and legends to lead the mapping exercise.

Challenges

- The standard questions that were asked for each resource were printed and available for the facilitator and translators in English, but it would have made the process easier if the questions were translated into the local language.
- Many of the participants were unable to read and/or felt uncomfortable writing, so they were unwilling to label or write on the maps. This made full participation by every person challenging, but with skilled facilitation it was still possible to make everyone feel included and their perspectives validated and respected. The facilitator ensured that all participants understood what each symbol represented verbally before they were placed on the maps.
- Using the full list of resource questions required 3 hours to complete the mapping activity and by the last hour, many of the participants were tired from sitting and the discussion.
- Participants in Malaswa village, where there is hilly terrain, struggled to identify the initial landmarks and orient themselves with the map.

- Low soil fertility was listed as a major problem in all the communities, but was difficult to map as it was so chronic and widespread that highlighting it would have covered the entire map. Instead this information was captured in the notes.
- All three groups in any given village may locate specific resources in slightly different places, which can make consolidating the maps during the digitization process challenging. Ground truthing would be required to confirm the location and the condition if the maps are to be used for specific planning or investment purposes.

What worked well

- In one group, a facilitator helped prepare the appropriate stickers (based on the resource being discussed) and handed them to the participants to place on the map after the entire group had agreed upon the appropriate location.

Participants first draw major landmarks on flip chart paper to help orient them to the map.

- Participants were happy to erase their mistakes with nail polish remover on the transparencies, especially when there was discussion and disagreement about locations or names of landmarks or resources.

Tip

In cases where the area has steep terrain or where participants have difficulty in identifying features, participants should first be asked to draw major roads and rivers on to a piece of flip chart paper. Once they are confident with this, they can transfer these details to the map, which will make it easier for them to locate where they are.

Note

If you do not use transparencies and write directly on the maps, this erasing technique will not work. Additionally, if there are many erasures, it can take quite a bit of time to complete.

- We discussed the community options to address the main challenges identified in each group, which led to rich discussion and exploration of opportunities and constraints for adopting the suggested practices. For example, tree planting and nurseries as well as enforced community by-laws were suggested by nearly all of the communities.

Key learning points

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

- The youth groups reported changes in the quantity and quality of water for taps and boreholes but the men's and women's groups did not report any changes.

- The women preferred to grow maize; men focused on sweet potatoes.
- Men controlled livestock.
- Women said that they sold their labor to buy food, but men did it to get paid in alcohol… "In the past, men did not drink so much but these days when there is so little food, they turn to alcohol".
- While the men and women said there were no new areas that had recently been cultivated, the youth mentioned that there were some new plots along the river and in a wetland.
- The youth groups attributed changes in water quantity to climate change and a lack of trees.
- Women considered boreholes to be the most important source of water because they consistently had water.

Water

- Rivers were used for watering livestock and for irrigating crops.
- All groups confirmed that the quantity of water in rivers had declined and they often ran dry during the dry season (October and November).
- Participants suggested that planting trees and vetiver grass might mitigate the impacts of the floods but that no one had taken any action to do this.
- Conflicts had also arisen over wells and if people had not paid to use the taps.
- Water quality in the rivers has declined since 1992.

Uncultivated areas and goods

- In Malaswa village, villagers recognized the importance of trees for addressing land degradation. Yet in 1999, when 1,000 seedlings were planted as part of a project to set up a community nursery, all but two dried up or were eaten by termites. The community said that it had not been made clear at the start of the project who was supposed to take care of the trees and who would benefit from them.
- The community earned cash income from sand mining, bricks and labor.
- These communities use the following resources from uncultivated areas: fuelwood, timber, poles for construction, bushmeat, mushrooms (some also grew in fields), fruits, honey, grass (for weaving) and charcoal, but access to forest resources varied across villages.
- Resources were declining from uncultivated areas due to deforestation and the women said that it was taking longer to access forest resources.

Livestock

- Villagers kept chickens, ducks, doves, rabbits, pigs, goats and cattle, but numbers varied across villages.
- Livestock numbers have declined in the last 10 years because of diseases, a lack of veterinary services in the villages and because most of the grazing land has been lost to cultivation and deforestation. Now many people have to buy milk.
- The livestock population is increasing in one area (Mpulula village) because the community practices livestock loans there.
- All of the land was privately owned by the people and as grazing is limited, conflicts have arisen when cattle graze on other people's land, especially when there were crops in the fields.
- Low cattle numbers means there is not much cattle manure available. Households who own livestock used animal manure and it was usually applied on fields close to their homesteads.

Cultivated areas

- Crops grown included: maize, soybean, beans, groundnuts, millet, sorghum, tobacco, cowpea, pigeon pea, sweet potato, beans and cassava.
- Land was often rented out, but if a renter had a good crop, the owners often took their land back and grew tobacco on it, which reduced the incentives for renters to use practices that maintained productivity.
- Termites were a big problem in all the cultivated fields in the villages.
- Increasing land scarcity was leading to increasing pressure on the wetland areas for cropland.
- Fields near homesteads were more productive as people applied ash, household waste and manure to them.

Soil

- Low soil fertility and erosion were identified as a major problem in all the communities.
- In general, all cultivated fields were low in soil fertility. Low fertility was said to lead to low productivity.
- Newly cultivated areas near the river that used to be wetlands were considered to be very productive.
- Uplands have lost fertility, whilst the lower lands (near the river) were more fertile.

Overall learning points

- Participants showed that resources, from water to grazing land to trees, were declining, identifying population pressure as a major cause.
- Cropland renting patterns differed widely from village to village.
- Unavailability of jobs drove villagers to make charcoal so they could generate cash for their daily needs.
- Landscape issues: plots appear to be spread out across the landscape, though the extent of fragmentation was hard to estimate using this exercise. Accessing trees, grazing areas and land rentals required people to travel some distance, and access resources outside of their village boundaries. Different landscape niches provide different resources and livelihood benefits such as sand, clay, trees, grass and forest products, etc. These are to some extent gendered.

Who was involved?

CIAT in collaboration with Total Land Care (TLC) and Lilongwe University of Agriculture and Natural Resources (LUANAR).

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 comprehensive notes and insights from all the maps was produced. This participatory mapping exercise was designed to facilitate discussions and understand how people use the landscape, rather than as a comprehensive ecosystem service assessment. Here we present examples of how information from the mapping activity can be interpreted and used to show how people are using landscapes.

How is the landscape used?

Maps such as Figure 2 can be used as a simple way of assessing how different communities access the landscape around them. This map shows where different communities are accessing timber and non-timber forest products (NTFPs), which often lie beyond the boundaries of one individual community. You can see that potential changes in resource availability or quality in one area would affect individuals living in multiple surrounding communities.

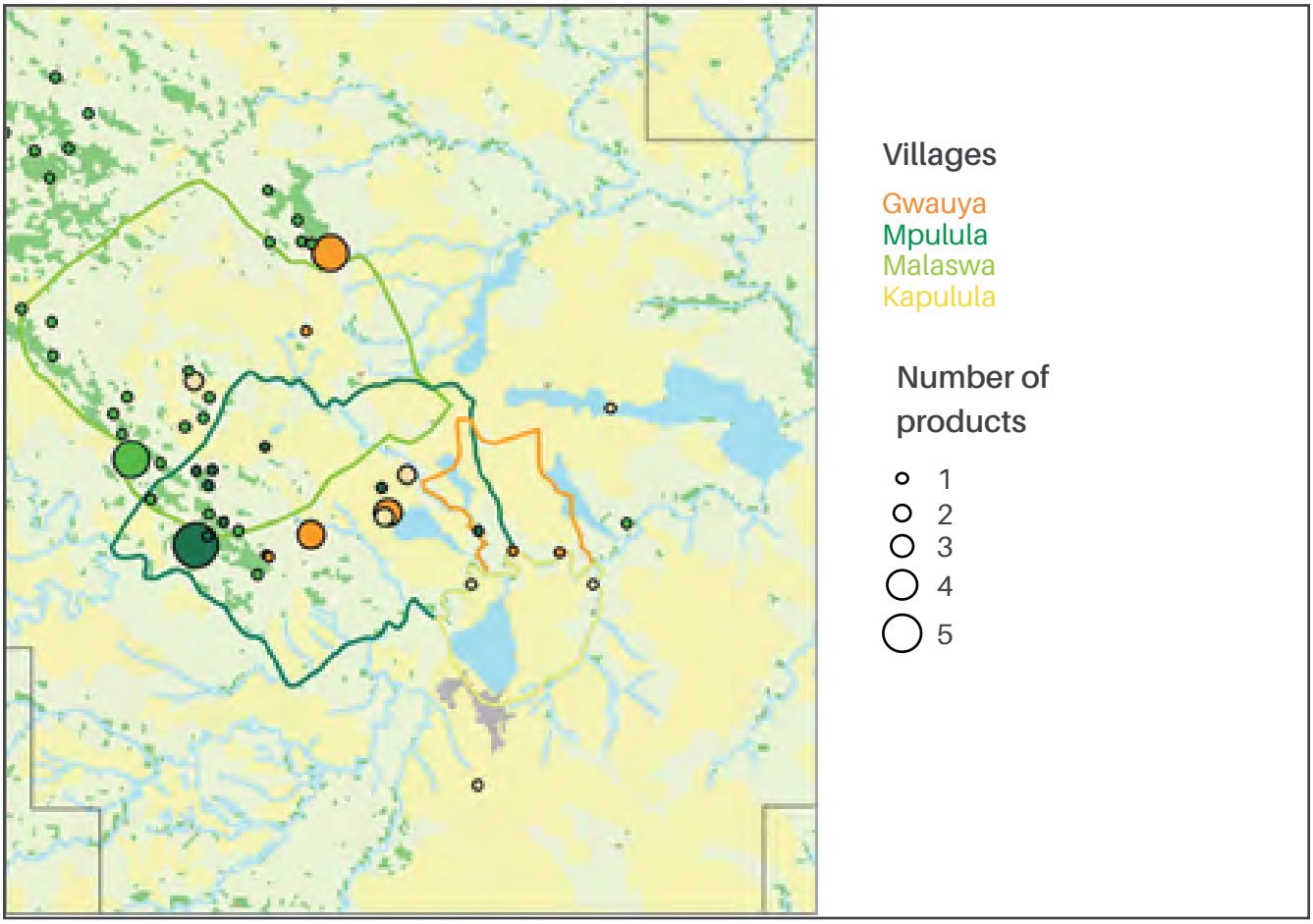

Figure 2. This map shows how communities from all four villages use timber and NTFPs, which are spread across the landscape. Black borders represent areas that fell outside of the maps used by the community during the participatory mapping exercise.

Using maps to explore general patterns of land use and access

Digitizing the maps generated during the participatory mapping exercise can generate maps, which will allow us to understand the differences among villages and across the landscape. For example, the four village boundaries are outlined in the maps shown in Figures 2 and 3, although villages did not adhere to them when accessing resources; they clearly show that some villages have access to more resources than others. For example, Malaswa and Mpulula villages have much larger boundaries that encompass forest; individuals own this forested land and they can choose to farm on it if access to land within the cultivated areas becomes scarce.

The map in Figure 3 shows land-use patterns, termite hot spots, and soil degradation hot spots among communities and renting patterns. The more marginal lands, e.g. those with soil erosion, termite infestation and waterlogging, are more likely to be rented out.

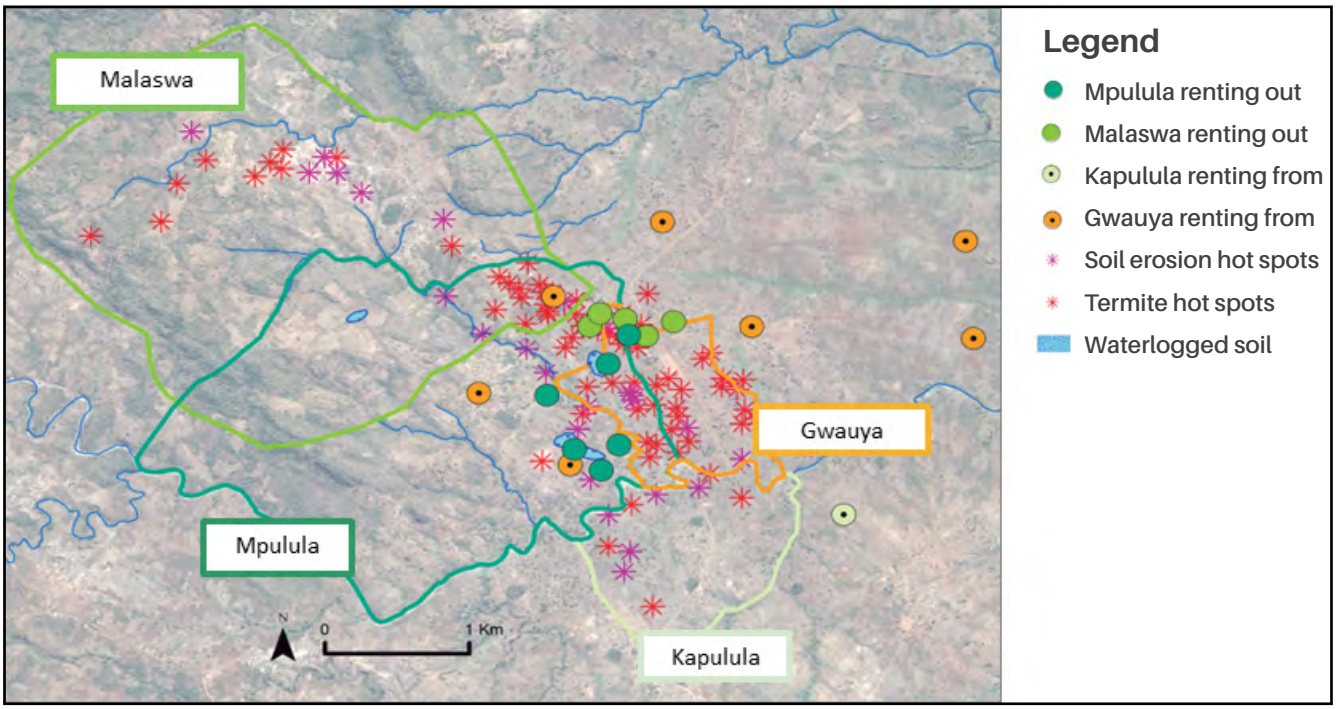

Figure 3. This map shows the areas where each of the four communities in Ntcheu district, Malawi (Malaswa, Mpulula, Gwauyu, Kapalula) either rent land to others (solid circles) or rent land from others (solid circles with center dots) as indicated by each community during the mapping exercise. It also shows areas that are waterlogged, have soil erosion or have termites.

We can interpret this map (Figure 4) to better understand the implications and patterns. For example, Gwauyu does not have enough land so farmers have to rent from surrounding villages (red arrows). Land leased out by villagers in Malaswa and Mpulula villages is often waterlogged, eroded or infested with termites (highlighted by red circles). Malaswa and Mpulula villages have new land available for cultivation in the forest (red rectangle).

This kind of map helps us to see that even within a 4 km^2 landscape communities have different challenges to investing in soil management. Farmers in Gwauyu do not have enough land so farmers have to rent from surrounding villages, which means that their fields are further away and more difficult to farm. It is also likely that this rented land is of poorer quality, leading to lower yields. In this renting scenario, farmers are less likely to invest in SLM because landowners often take back their land to grow tobacco if productivity is high. Additionally, the extra cost of renting land means they have less money available to invest in sustainable land management.

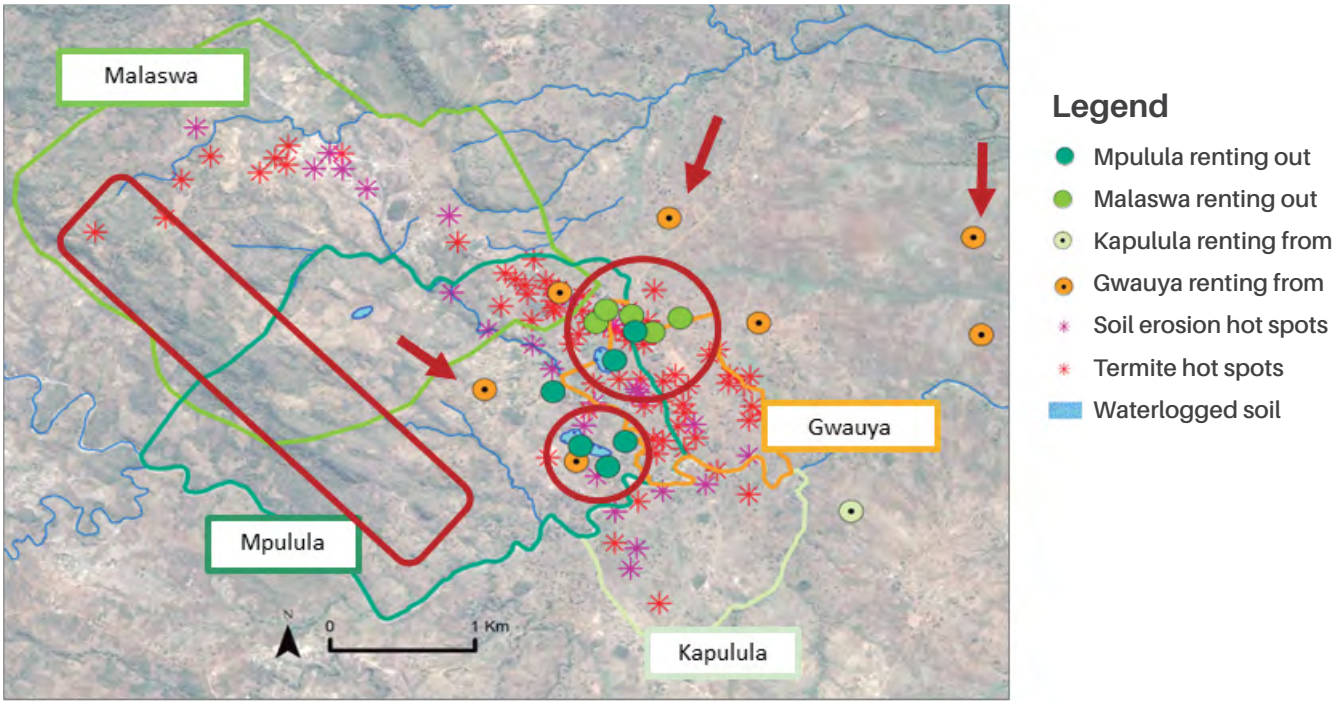

Figure 4. This map highlights areas where we interpret some of the patterns that emerge from digitizing the resources mapped by the participants.

If we keep the previous map (Figure 4) in mind and then overlay the identified newly cultivated areas, grazing areas, and forested areas as in the map below, we can see that the grazing and forested areas are at risk of over-use for cultivation, grazing and forest goods (Figure 5). This use should be managed to ensure that communities continue to benefit from uncultivated areas.from uncultivated areas.

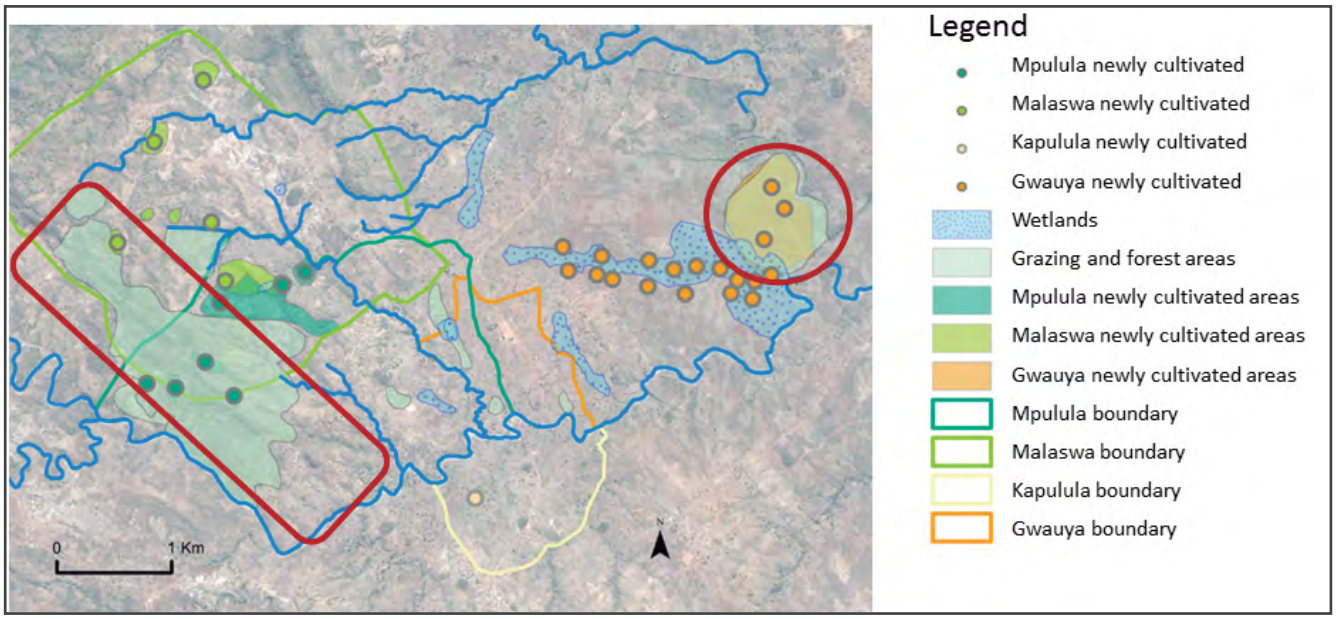

Figure 5. This map shows new cultivated areas (circles) identified by each village and the corresponding colors show newly cultivated areas. These overlap with grazing and forest areas (red circle and rectangle).

Mapping ecosystem service hot spots

We can also map ecosystem service provision hot spots by combining all the data from the four communities (Figure 6). The map shows where most ecosystem services are provided across the landscape. These maps can only be used to reveal general trends as interpreting data that was collected as points can be problematic. However, this can be used a tool to aid discussions around planning for better land use. Comparing this map with the map above (Figure 5) shows that many of these areas are potentially threatened by conversion to agriculture.

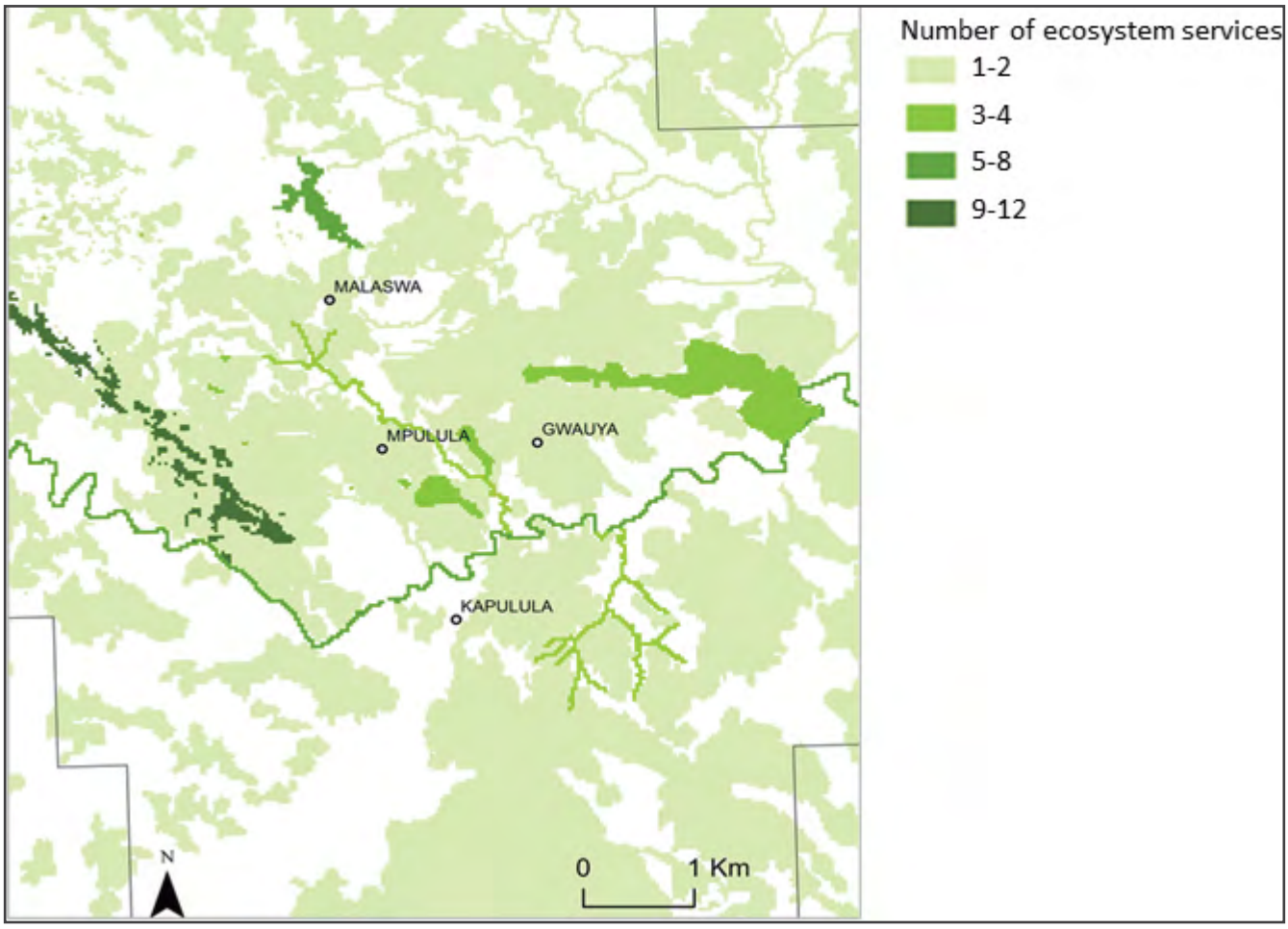

Figure 6. This map shows the number of ecosystem services associated with different areas. Ecosystem services include water, livestock grazing area, crop production, flood control, climate regulation, timber, fuelwood, NTFPs and areas of spiritual importance. The darker the green color the more communities are using the area. Black borders represent areas that fell outside of the maps used by the community during the participatory mapping exercise.

How can this information be used?

The mapping exercise led to more in-depth discussions and community members identified actions they hoped could address some of their problems. Follow-up engagement in the communities will focus on identifying incentives for community-created land management projects with a specific focus on some of the priority areas identified in the maps above.

Whilst the mapping exercise provided the research team with insight into the land and the community, participants also learned from each other. For example, younger community members learned about cultural and spiritual places used in the past. Additionally, patterns and connections that the mapping exercise revealed will help to find locally appropriate solutions. We have also used these maps to develop scenarios of plausible futures based on past changes and communities' perceptions of how conditions may change in the future.

How this participatory mapping has been used in the implementation of SLM projects in Malawi

This participatory mapping approach is being piloted by CIAT's development partner, Total LandCare, who implement large development programs across Malawi, Mozambique, Tanzania and Zambia. They are using this approach to strengthen the landscape and social focus of their development programs and help target SLM interventions

See more at: http://ciatblogs.cgiar.org/soils/land-management-matters-malawian-communities-create-maps-to-find-answers/

Participatory mapping in Lushoto district, Tanzania

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CGIAR
RESEARCH PROGRAM ON
Water, Land and Ecosystems

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.

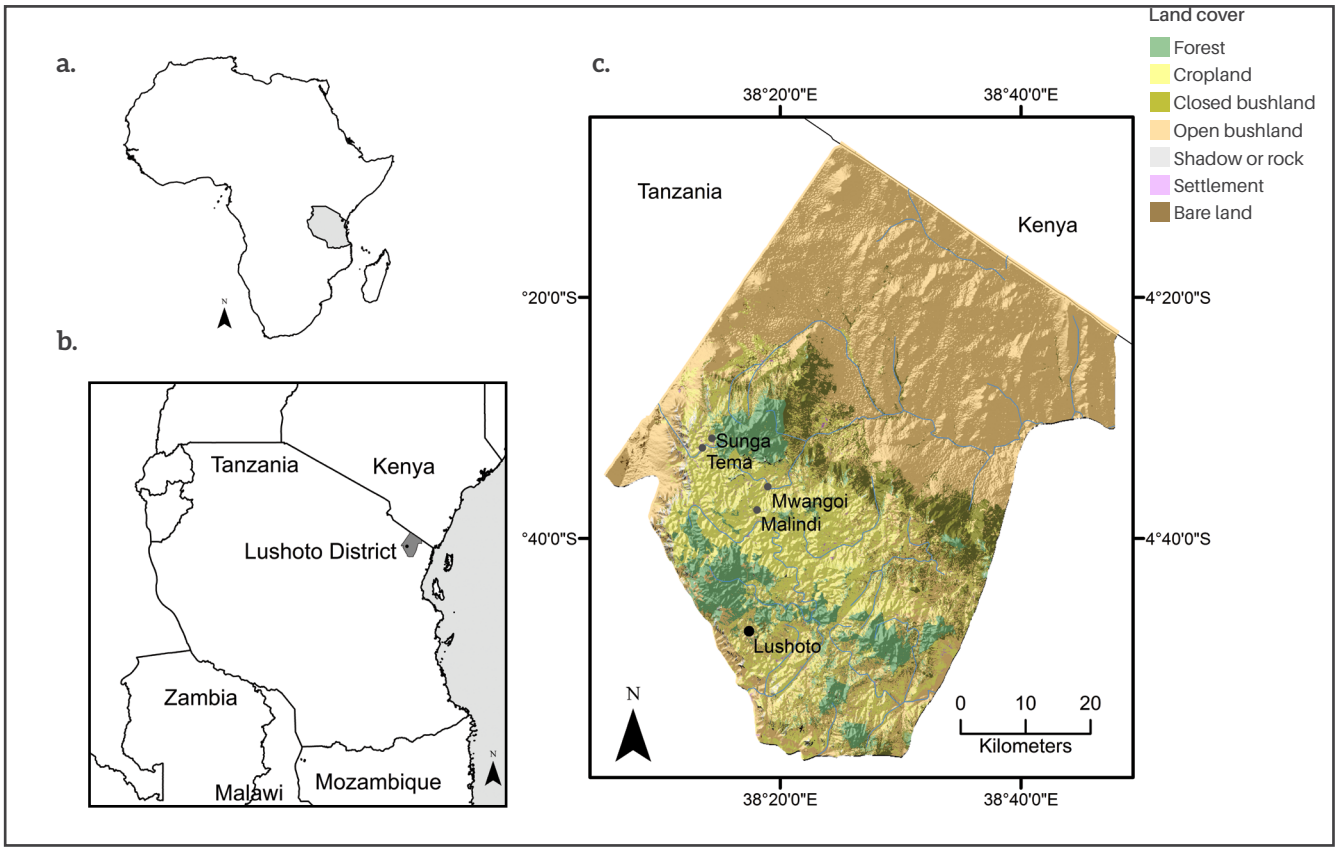

Figure 1. Location of the case study site in Africa (a), and in Tanzania (b), with Lushoto district shaded in gray. The location of Lushoto town and the four focus villages are shown within Lushoto district (c). Land cover was mapped in 2014 and shows the major land-cover categories.

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.

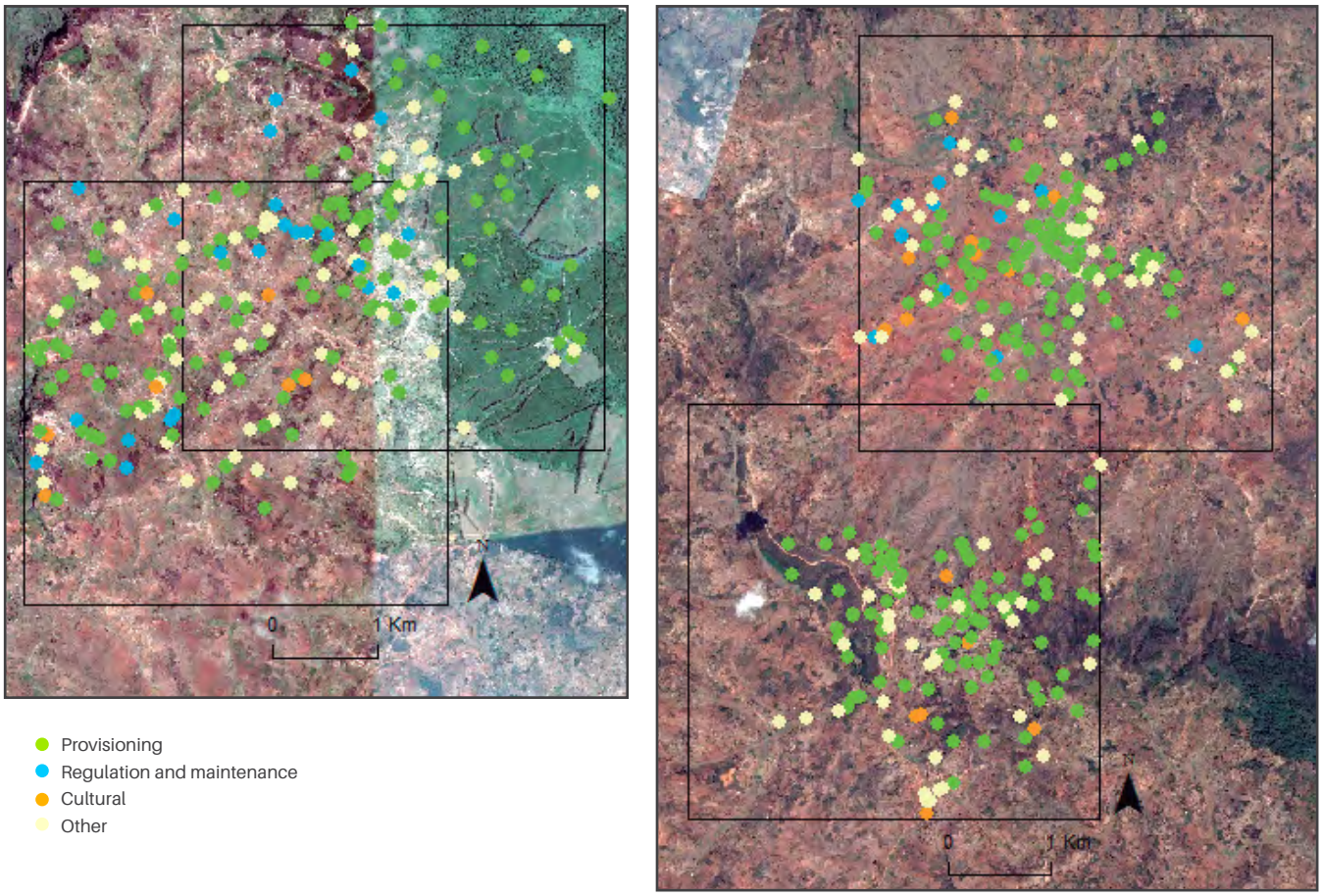

Figure 2. Map of ecosystem services across the landscape.

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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Appendix 7. Additional resources, useful information and tools

The following additional resources and tools can provide more background when considering using this mapping methodology, other ecosystem services valuation approaches or other participatory methods. This list is not meant to be exhaustive but acts as a useful starting point to gather background information.

Title	Date	Link (October 2016)	Description
Adaptation in practice: Increasing adaptive capacity through participatory mapping	2013	www.preventionweb.net/publications/view/36849	Presents case studies from multiple countries to find out whether participatory mapping – used in combination with other participatory methods – has had measurable effects on the development of local adaptive capacity.
Ecosystem services assessment: How to do one in practice	2013	www.the-ies.org/resources/ecosystem-services-assessment	Outlines principal steps in preparing for and undertaking an ecosystem services assessment (UK focused).
Ecosystem-based Adaptation Guidance: Moving from Principles to Practice	2012	www.unep.org/climatechange/adaptation/Portals/133/documents/Ecosystem-Based%20Adaptation/Decision%20Support%20Framework/EBA%20Guidance_WORKING%20DOCUMENT%2030032012.pdf	Outlines how to select, design, implement and track ecosystem-based adaptation (EBA) approaches (aimed at assisting national planners and decision-makers).
Gender and Inclusion Toolbox: Participatory Research in Climate Change and Agriculture	2014	https://cgspace.cgiar.org/bitstream/handle/10568/45955/CCAFS_Gender_Toolbox.pdf	Outlines gender-sensitive and socially inclusive participatory action research tools.
Integrating ecosystem services into development planning (IES). A stepwise approach for practitioners based on the TEEB approach	2012	www.aboutvalues.net/six_steps/	Aims to provide practitioners with a practical and policy-relevant framework for integrating ecosystem services into development planning.

Title	Date	Link (October 2016)	Description
Participatory Data Collection for Ecosystem Services Research: A Practitioner's Manual	2016	www.espa.ac.uk/files/espa/PRA-Manual.pdf	This manual presents a series of qualitative data-collection tools that can be used to obtain local information on the contributions of ecosystem services to livelihoods and food security as well as their implications for NRM initiatives.
PLA 54: Mapping for change: practice, technologies and communication	2006	www.iied.org/pla-54-mapping-for-change-practice-technologies-communication	A number of articles which focus on participatory GIS.
The Toolkit for Ecosystem Service Site-based Assessment (TESSA)	2013	www.birdlife.org/worldwide/science/assessing-ecosystem-services-tessa	The toolkit provides accessible guidance on low-cost methods for how to evaluate the benefits people receive from nature at particular sites in order to generate information that can be used to influence decision-making.

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