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Participatory Modelling to Enhance Social Learning, Collective Action and Mobilization among Users of the Mafungautsi Forest, Zimbabwe

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Participatory modelling can be a useful process to encourage critical examination of livelihood options and foster sustainable natural resource use through enhanced social learning, collective action and mobilization. The broom-grass group in the Mafungautsi Forest Reserve serves as a case study of the process and outcomes of such participatory modelling. Innovative group facilitation methods enhanced participation in the modelling process. The modelling process complements broader efforts to achieve higher levels of adaptive collaborative management.

Keywords: participatory modelling, social learning, Zimbabwe, facilitation, broom grass, livelihood options

INTRODUCTION

Woodlands and forests are important in livelihood systems of rural households and provide key inputs to urban households (Clarke *et al.* 1996). Forests are under increasing pressure from population increase and commercialization of forest products and other factors (Campbell and Matose 2000). Rural households are also under-going changes due to modernization, macro-economic policies and globalization (Campbell and Byron 1996). This paper examines the use of participatory modelling to assist rural communities in woodland areas to adapt to such change. It is one of a series of papers (Vanclay *et al*. 2003) exploring several alternatives ranging from highly technical (e.g. Legg 2003) to collaborative approaches (e.g. Purnomo *et al*. 2003).

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Woodlands, and the way they are used by people, form a complex, interactive ecological-social-economic system. These systems are characterized by multiple scales of interaction and responses, and a high frequency of non-linearity and uncertainty. Within this context, multiple stakeholders seek to satisfy overlapping and often competing objectives with limited resources. Their ability to attain these ever shifting livelihood goals requires a high degree of flexibility and willingness to adapt new ideas and practices. The willingness of households to adapt new ideas and practices is influenced by their past experience with change, and by the responses of other households in similar circumstances. The dynamic nature of the system requires households to be proactive, and adaptive in their objectives, needs and worldview. Social learning is needed to improve the quality of decisions made by households in complex situations. Participatory modelling can be an opportune way for communities to move towards social learning.

There are many ways to enhance social learning, including feedback meetings, group discussions and joint experimentation (e.g. Roling and Wagemakers 2000). The objective of this paper is to showcase participatory modelling as an effective tool to enhance social learning. The focus is on participatory modelling, which involves the development of a shared understanding among a group of people using group modelling as an entry point.

THEORETICAL FRAMEWORK

A model is a simplified representation of our understanding of the world. Models can take many forms, ranging from personal mental models, through physical models (cf. model buildings used by architects), to mathematical equations. They are used to support decision-making, to explore new possibilities, and to facilitate understanding. This paper is concerned with the first of these purposes, and in particular with models that help groups of people to make decisions about complex systems (Axelrod and Cohen 1999).

System dynamics is a form of modelling based on understanding the information feedback structures in systems (Forrester 1961, Coyle 1996), representing them as causal loop diagrams and implementing quantitative representations of these loops as computer programs which allow the system behaviour to be simulated. In its pure form, system dynamics modelling focuses on managed systems such as organizations and is intended as a way of achieving improvement in these systems through policy change (Morecroft and Sterman 1994).

In the natural resource management domain, researchers often build models for scientific purposes with the aim of understanding the functioning of natural systems, and predicting how they will behave under particular management regimes. These models may then be disseminated to natural resource managers in the hope that they will be useful management tools. However, a comprehensive review of crop growth and yield models compiled for use in developing countries shows that of the hundreds of models developed, few are actively used to support development of policies or to improve decision-making (Matthews *et al*. 2000).

Distributing a model amongst the stakeholders is not sufficient to foster 'ownership' and encourage use of a model. Full involvement by stakeholders in the modelling process is a more reliable path to adoption. This requires participation in all stages of modelling, from the initial formulating the conceptual model to the final stage of using the model to develop scenarios.

Participation in Modelling

Participation as both a means and an end in natural resource management has diverse roots and has been promoted through the interaction of demands by grassroots activists and non-government organizations (NGOs), and the conditions imposed by donor agencies. This has led to massive confusion about appropriate principles, practices, benefits and disadvantages are of participation (Guijt 1996). Though initially intended to be flexible and contact-specific, many participatory processes have become mechanical procedures, with less focus on the underlying principles of participation.

Participatory research is a process through which members of a community identify a problem, collect and analyze data, and act upon the problem to find solutions and to promote social and political transformations (Selener 1997). Participatory modelling (PM) is a specific form of participatory research in which a model is the medium for representing and communicating ideas. PM can generate useful insights and lessons about complex issues, and help participants in the process to become more adaptive in their decision-making. PM achieves this by engaging local communities and government in developing shared visions and shared learning experiences (Haggith and Prabhu 2001, Purnomo *et al*. 2003). Modelling done in a participatory environment with the aid of effective facilitation can help to develop future scenarios, and in turn can enhance the process of social learning and lead to new insights into system function.

Facilitation and Future Scenarios

The combination of modelling and participation can create a productive environment conducive for social learning, but this is only achieved with good facilitation. The selection of participants, and the place and mode of communication, are aspects that need to be addressed before the modelling exercise starts. This means that participants should be chosen carefully to cover the broad spectrum of the issues being addressed. Facilitation then requires the creation of processes in which action-orientated learning occurs. Understanding the roles of the different participants in dealing with the issues at hand is a key aspect of facilitation in participatory modelling (Richardson and Anderson 1995).

Scenarios are stories of what might be (Wollenberg *et al.* 2000). Because of the complexity of natural resource systems, scenarios can be useful tools to assist the management of anticipated changes in the system. By shifting existing paradigms of how systems function, and by changing mental maps and habits, scenarios can help people to deal with uncertainty. Scenarios help to increase creative group learning through interaction among different resource stakeholders.

Adapting to Changing Circumstances

Societies adapt more readily to changing circumstances when there has been some form of social learning. Maarleveld and Dangbegnon (1998) defined social learning as a process of continuous dialogue and deliberation among scientists, planners, managers and users to explore problems and their solutions. It is also a collective process for accumulating new knowledge essential for problem solving, decision-making and community development. Social learning can be a powerful force for change, through collective interaction at the community level (Woodhill and Röling 1998). It involves critical thinking about the underlying assumptions concerning stakeholder actions, values, and claims to knowledge. Since it is action oriented and focuses on improving the quality of decisions made by stakeholders in complex situations like natural resource management, participatory modelling can be an opportune window for social learning.

THE MAFUNGAUTSI CASE STUDY

Mafungautsi forest is located in Gokwe South District of Midlands province, Zimbabwe. Most of the district is communal land (73%), but the forest represents a substantial area (82,100 ha, or 17% of the district), while the remainder (10%) is national park and small-scale commercial farms. The forest is a catchment area for three of Zimbabwe's major rivers, the Sengwa, Mbumbusi and Lutope Rivers. Conservation of the watershed was one of the main reasons for gazettal as a state forest in 1954. Since then the forest has been managed by the State through the Forestry Commission, without consultation with local communities, despite the fact that many of them depend on resources derived from the forest. Those who continued to derive their living from forest resources were doing so illegally, as there was no formal provision for them to do so. This was a recipe for conflict between the communities and the forest authority.

In the 1990s, it became increasingly apparent that a management regime that ignored the role of local communities would not be sustainable. This also became more apparent with reduced funding to the Forestry Commission, demands from the communities for more land and resources, and pressure from donors for more collaborative management arrangements. The Forestry Commission attempted to address the conflict arising from the exclusion of local communities from the use of forestry resources by instituting a resource-sharing programme in 1994. The programme aimed to increase participation by local people in forest management to allow them a greater harvest of non-timber products. In return, the government could reduce costs of policing and gain the respect of local communities. Some authority was devolved to democratically elected resource management committees at the village level (Sithole 2001). Through these committees, local communities could access selected resources from the forest legally. This situation created an opportunity for the Center for International Forestry Research (CIFOR) to undertake research on Adaptive Collaborative Management (ACM) of forests in Mafungautsi.

Adaptive Collaborative Management

ACM has been defined as a quality-adding approach whereby the people or groups who use, control or in some other way have 'interests' in a forest, agree through a process of participatory action research to act together when they draw up plans for their forests (CIFOR 2000). These plans are then implemented with the awareness that they may not fulfil their stated objectives, and in this process, it is important for people to observe and learn from the implementation, together as groups, as improvements in the plans are negotiated and alternatives are sought. Others (e.g. Porkony 2000) have defined ACM as an integrative approach for implementing sustainable forest management, based on a main hypothesis, namely that if there is a high degree of collaboration between stakeholders coupled with a high adaptiveness of management systems, the result will be a higher degree of human well being and ecological sustainability. As such, the research expects to explore the conditions under which ACM can succeed or fail, and develop tools and approaches that can be used to involve local communities more in management of forest resources, and explore how local people can benefit more in terms of human wellbeing from forest resources. Central to this objective is the use of participatory action research and social learning. In these approaches, facilitation that leads to local communities setting out their research agenda is undertaken, and they are taken through a series of reflection and action cycles (Figure 1), in which there is a deliberate thrust towards social learning.

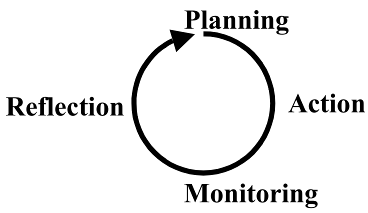

Figure 1. Reflection loop

Although this step towards re-engaging local communities in forest resource utilization and management is welcomed, several observers view the current collaboration on resource sharing as mere tokenism. The main thesis is that the State found itself in a position where it could not financially sustain its forestry activities and decided to devolve some of its costly responsibilities to local communities, whilst retaining the rights of access to the more valuable timber resources.

The Broom Grass Resource

The Mafungautsi forest is mainly miombo woodland on Kalahari sands and recieves a mean rainfall of 780 mm/yr, mainly during November to March. The miombo vegetation is characterised by *Brachystaegia* and *Julbernadia* trees. The forest provides many resources for the local communities, including pasture, thatching grass, broom grass, medicinal plants, honey, mushrooms, firewood, construction timber, game meat, Mopane worms, fruits and herbs. The present study concerns the use of broom grass (*Aristida junciformis* Trin. and Rupr.), an annual grass used for making brooms for sweeping houses. The grass matures soon after the rainy season and may be harvested by permit holders, subject to monitoring by members of the resource management committee. Traditionally, broom grass has been dug (because the roots help to hold the brooms together), but there is increasing concern that this practice is not sustainable, and that it is preferable to cut the grass and leave the roots intact (Mutimukuru *et al*. 2002).

Self-Regulation by the Broom Grass Group

This case study involves a group of individuals involved in the harvesting of broom grass from Batanai Resource Management Circle (RMC) and examines how they have taken up the challenges of group cooperation in an endeavour to attain sustainable resource use and wellbeing. The group consists of about 40 people, mainly women. After developing a series of scenarios about current and future broom grass resources, the group prepared an action plan. During the planning process, the group discovered many complex issues surrounding the broom grass resource, including several important questions central to the planning process. Some of these questions could not be answered easily:

- Why is it that people continue to dig broom grass, despite knowing that it is not sustainable?
- Can we achieve all we hope for in our future scenarios? If so, what might go well or wrong?
- What is the reasonable and sustainable price for brooms?
- How can we better understand the issues surrounding broom grass?

Trying to come up with answers to these questions provided an opportunity for the researchers to intervene and introduce participatory modelling. At this stage, participatory modelling was envisaged as an intervention that would help find answers to these questions. Rather than provide the answers directly, it was expected that the process of participatory modelling would foster social learning, which in turn would provide the knowledge and insights to be fed back into the reflection, learning and action cycle (Figure 1), so that action plans and future scenarios could be modified and made more realistic.

The objective of involving the resource user groups in PM was to gauge its usefulness in providing opportunities for learning, in helping to understand complex issues, in answering difficult questions, and in developing more realistic future scenarios.

Although the broom grass group came up with its own questions and objectives to be addressed by participatory modelling, the researchers initiating the intervention had some questions and hypotheses of their own. The hypotheses were that:

1. Participatory modelling can generate useful insights for resource users;
2. Modelling enhances sharing of information and learning by stakeholders, even when the issues are complex; and
3. PM can provide a sound basis for developing useful and innovative action plans.

The researchers and the resource user group both had similar ambitions for the modelling exercise. Such common interests are essential for successful participatory modelling.

MODELLING WITHIN A PARTICIPATORY FRAMEWORK

The broom grass group in the Batanai RMC was invited to attend the participatory modelling workshop. The group included 28 resource users, comprising seven men (including three community partners) and 21 women.

Organizers of the participatory modelling process, three CIFOR researchers and three community partners, met the day before the workshop to discuss the process and roles for each person. The organizers developed a provisional program for the workshop and the following roles were allocated to individuals: process coaching, facilitation, gate keeping, modelling and recording. These roles were based on the experience of other group modelling teams (e.g. Richardson and Anderson 1995, Anderson *et al*. 1997). Allocation of the roles was done in a way that would tap the experiences and abilities of the different stakeholders, in a way that would help the process, and make it participatory.

Setting the Scene for Model-building

The workshop started with a round of introductions. The participants were asked to introduce themselves and explain why broom grass is important to them. The most common responses were that broom grass is important because it is used for cleaning homes, because it is a source of livelihood; and because it generates income needed for paying school fees and buying food.

After the introductions, the process coach explained the purpose of the workshop, pointing out that techniques such as modelling can help people to understand issues that seem complicated and difficult to understand. The ability of models to generate future scenarios was also discussed. An illustration, familiar to all in the group, is the performance of a child in school during the term: a parent can use term-time performance to predict whether or not the child would pass the final exam. A model can also be used in a similar way, to predict outcomes such as the future abundance of broom grass. Thus, modelling can help stakeholders learn by synthesising information, and by generating future scenarios, some of which may form a basis for future plans.

Expectations of Participants

Participants were asked to share their expectations of the workshop, and these were used to formulate the following learning objectives:

- to learn a lot about broom grass;
- to learn how to deal with over-harvesting; and to
- to learn how to improve livelihoods without killing all the grass.

These objectives provided the focus for the modelling work that followed.

Learning about Modelling

To help clarify the process of modelling, a model of the bank balance of one of the organizers was offered as an example. Mr Nyirenda was asked about the balance in his bank account, and about his sources of income (sale of cattle and maize). His response formed the basis of a simple model with one compartment and two inflows (Figure 2). Two outflows represented school fees and food. Constructing and running this simple model stimulated many questions from participants. 'What would happen if Mr Nyirenda overdrew his account, increased his expenditure of food, or started drinking beer?' One person proposed that Mr Nyirenda's wages should be included as an inflow, and that a graph could be prepared to show how his bank balance changed over time during the simulation.

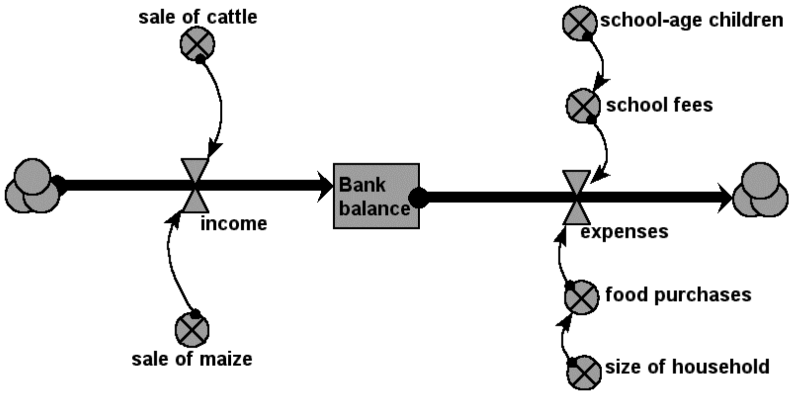

Figure 2. The model of Mr Nyirenda's bank account, used to introduce basic modelling concepts

Once participants were comfortable with this model, discussion groups were facilitated to prepare participants to model for themselves, the issues relating to the broom grass resource. Participants formed into two groups to identify factors depleting – and helping to maintain – the broom grass resource. Their findings are outlined in Table 1. They include a broad range of issues, including aspects that they can regulate themselves as a community, issues that requires action from the broader community, and external factors over which they have no control (e.g. rainfall).

Sustaining the Broom Grass harvest

Participants identified the following factors that affect the broom grass resource:

- Harvesting ripe broom grass increases grass production in the next season.
- Increasing the number of forest guards reduces theft of broom grass, and discourages poor harvesting practices (i.e. strong rule enforcement).
- Education leads people to conserve the broom grass resource.
- Burning, when done at the right time, improves germination of seeds and fosters rapid growth in the next season.
- Adequate rain increases germination of seeds.
- Harvesting by digging has the same effect as cultivating the area where the grass grows. Both activities deplete the resource as roots are removed. The effect of uprooting is similar, but depletes the resource more slowly, because more roots are left behind.
- Harvesting unripe grass results in poor growth in the next season. Unripe grass has unripe seeds, which do not germinate in the next season.

Table 1. Factors leading to the sustainability or depletion of the resource

Factors depleting resource	Factors contributing to a sustainable resource
Harvesting by digging	Harvesting by cutting
Harvesting unripe grass	Harvesting ripe grass
Grazing animals in broom grass areas	Protecting areas where broom grass grows especially at the time when seeds germinate
Early burning	Burning broom grass areas after harvesting. Burning encourages good growth in the next season.
Cultivating broom grass areas	Taking good care of the areas where broom grass grows
Too much rain	Good rain
Uprooting broom grass	Educating people about broom grass Enforcing rules with more forest guards, and by strengthening the relationship between communities and Gokwe council, so that those who sell uprooted or unripe brooms can be arrested in Gokwe.

Building a Broom Grass Model

After developing the relationships amongst the various issues, links were drawn to indicate the existence of relationships (Figure 3). Workshop facilitators helped participants to convert this diagram into a Simile model (Muetzelfeldt and Taylor 2001). Figure 4 illustrates the first attempt at an implementation in Simile, which contains several errors (e.g. three influences affecting 'Season' are inverted). It is reproduced here to illustrate the process followed by workshop participants.

The model diagram now became the focus for discussion about the model and the relationships it implied. This stage has been coined 'red modelling' by some participants, because of the Simile convention of using red to denote incomplete model components, and black to denote components that are complete and ready to run. 'Red modelling' is about creating a reliable representation of the system as it is currently understood. Figure 4 represents the first iteration of 'red modelling'. Progressing from a 'red model' to a 'black model' requires suitable parameters or equations to be given for all variables (denoted ⊗ or □ in Figure 4) in the model. Facilitators are currently guiding participants through this process, attempting to elicit realistic parameters from the participants' knowledge of the broom-grass resource.

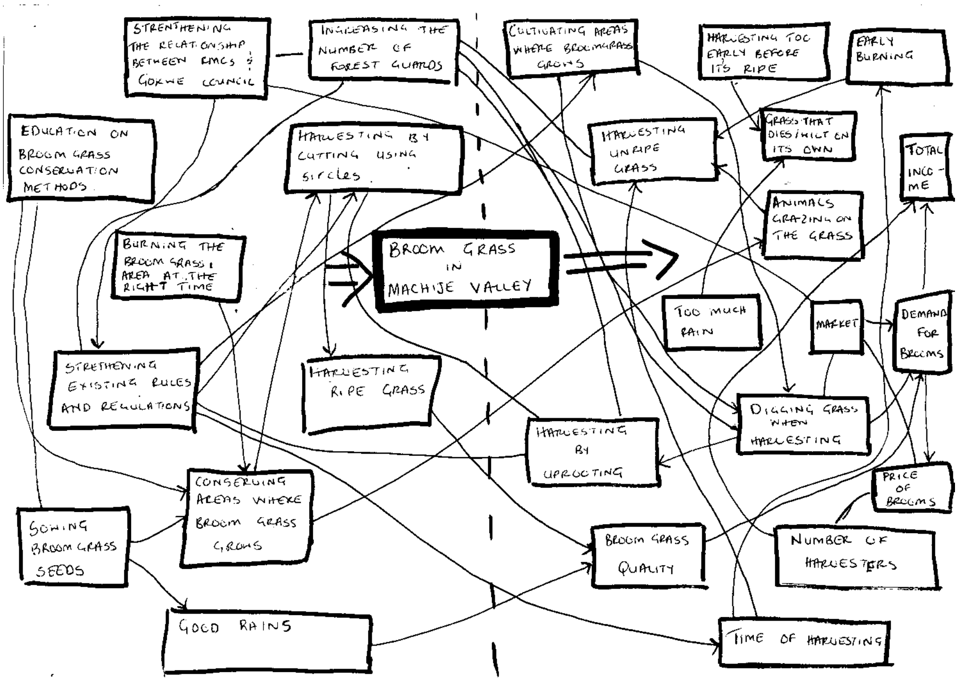

Figure 3. Linkage diagram showing relationships between selected issues concerning the broom grass resource

Insights Generated

Discussion of the above factors generated many insights, prompted by pertinent questions from facilitators and the participants alike. The questions and resulting insights included:

1. *What can be done to increase the amount of grass in Machije*? One of the workshop participants suggested that resource users could sow seeds in the area where the grass grows. This raised a lot of discussion, because there was no general agreement that the grass could grow from seed. Then one woman told the participants that in the last season she had cleaned her grass in her field. As soon as it rained, the grass seeds germinated, and were destroyed only when she cultivated the area. After this story, most participants agreed that it was a good idea to sow grass seeds. This however, led to another question.
2. *How should broom-grass seed be sown*? One participant suggested that everyone should sow seeds. According to her, there was almost no broom grass in the areas where people harvested by digging, as it has been replaced by another type of grass. She suggested that each area should be weeded before sowing to encourage good germination. Another woman, who was still not convinced that broom-grass would grow from seed, proposed that each person should establish their own trial plot in which seeds were sown and germination monitored. It was however, already too late in the season for people to carry out such an experiment as no seeds remained in the forest.

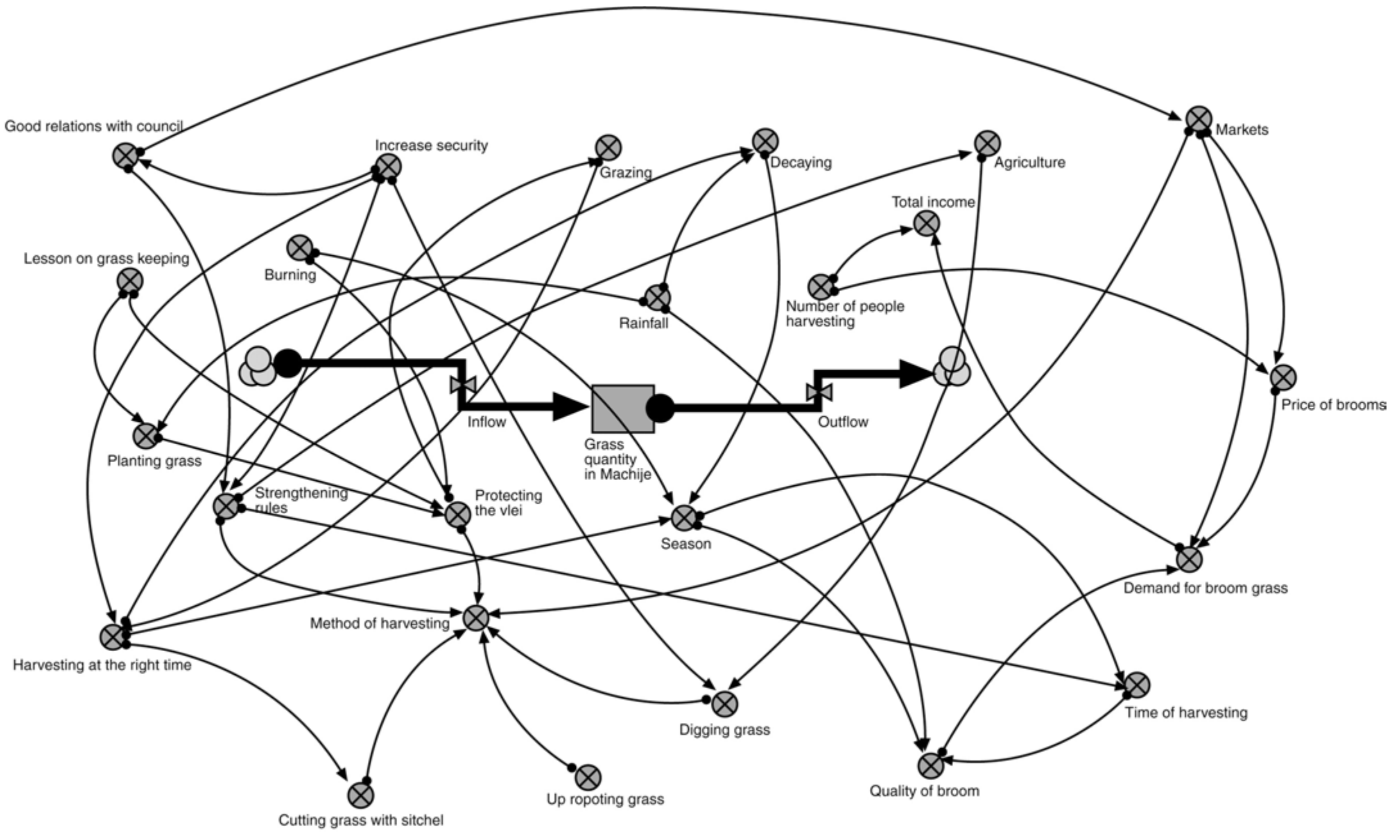

Figure 4. The initial model prepared by participants

3. *Why do people harvest the grass by digging or uprooting*? In Gokwe where most of the brooms are sold, buyers demand dug or uprooted grass. This is because uprooted brooms are thought to last longer as the grass strands are kept together by the roots and do not become loose so easily.
4. *Why do people harvest unripe grass*? Harvesting early in the season enables a person to harvest more grass before competitors arrive. The real problem is that too many people harvest the broom grass.
5. *Why do people harvest different quantities of grass each year*? Factors that affect the amount of grass harvested per season include: number of harvesters, permit price, time at which someone begins to harvest, the amount of grass available that season, and the price of grass during the previous season (if someone sold grass at a good price the previous season, they might decide to harvest more in the coming season).

Participants were also asked to discuss and evaluate, in pairs, what they learned during the workshop. Their evaluations included:

1. *We have learnt that when harvesting broom grass, we should not dig it, but should cut it using sickles.*
2. *We gained an understanding of the things we need to consider when taking care of resources such as broom grass. If some of these things are missing, the resources will be degraded. For instance, digging, cultivating, grazing and burning deplete the broom grass resource.*
3. *We have learnt that everything that we do, good or bad, may influence the status of broom grass in Machije valley. We have learnt that all these things are linked.*
4. *We learnt that we should take great care of Machije valley for we get life from it.*

CONCLUSION

The arguments given above suggest that under particular conditions participatory modelling is a promising tool for enhancing social learning, collective action and mobilization. Local communities demonstrated an ability to grasp abstract concepts and to appreciate technology. The use of the computer in the process of PM was not a hindrance for the local participants. Their understanding of the issues and their willingness to use the computer to address complex issues demonstrated that computer-aided modelling can be a useful aid even in a rural context.

In the process of developing the model, people learnt and categorically stated the issues that they thought were new to them. They were adept at developing options through scenarios arising from the model. ‘If Mr Nyirenda can add a salary to his bank inflows, why can we not include planting grass as one way of increasing the amount of broom grass in Machije’. Such sentiments revealed that people had learned from the modelling exercise and could visualize scenarios that could be evaluated with the model.

Participatory modelling with systems dynamics can produce important insights when relevant stakeholders are involved. The results from this exercise show that local people with no prior experience of modelling can identify pertinent issues and recognise them in systems dynamics notation. Participatory models are cost-effective, have the ability to address context-specific problems in a timely way, and maintain their relevance to those involved. This is in contrast to many large complex models constructed by experts, which may seem remote and irrelevant to many stakeholders.

The current exercise has demonstrated that multiple objectives can be addressed through this process. Simple but relevant models can enhance the learning ability of local communities by converting complex issues to community wide visions. However, this may not occur without skilful facilitation. The sharing of ideas and recognition of the multiple objectives of the various participants resulted in shared knowledge, which can provide the basis for developing shared visions. These visions can then be the starting point of group initiatives to manage communally accessible resources.

The objective of a participatory modelling initiative should not be to create a model as its end-product. Instead, PM should be seen as a way to help participants reach their goals. Their objectives may include:

1. enhancing cooperation within groups of people with divergent ideas,
2. building teams with shared goals, and
3. developing a shared understanding of complex biophysical, economic and social systems amongst participants.

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