Journal of Soil Science and Environmental Management Vol. 3(10), pp. 237-251, October 2012
Available online at http://www.academicjournals.org/JSSEM
DOI: 10.5897/JSSEM11.065
ISSN 2141-2391 ©2012 Academic Journals

Full Length Research Paper

The use of analytic hierarchy process (AHP) for stakeholder preference analysis: A case study from Kasane Forest Reserve, Botswana

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Accepted May 21, 2012

Public participation in decision making on management of forest resources is crucial to the planning and sustainable development approach. Rarely, however, are efforts made to measure local stakeholder preferences for sustainable forest management outcomes. This paper intends to analyze the possibility of using analytic hierarchy process as a decision making tool in the process of choosing a preferred management option. A sample model was developed in order to test the method by using specialized software (Expert Choice). The stakeholders were members of communities living around the forest reserve, wildlife officers, forestry officers and tourism officer. The results of analytic hierarchy process (AHP) application in this study showed that stakeholders preferred participatory forest management (PFM) as the best management option for the Kasane Forest Reserve over community forest management (CFM) and state forest management (SFM). The most preferred guiding objective or attribute for the Kasane Forest Reserve was the collection of forest products such as fuel wood, thatching grass, wild fruits and medicinal plants as opposed to grazing management, ecotourism and biodiversity conservation.

Key words: Botswana, analytic hierarchy process, community forest management, participatory forest management, stakeholder, state forest management.

INTRODUCTION

Approaches to forest resource management have been changing. In the traditional form of forest resource management in most parts of the tropics, particularly in Africa, the governments were the only responsible authority for the management of forests, while the communities were only seen as agents of forest destruction (Shepherd, 1991). In the traditional approach of hierarchical forest resource management, an approach presented by Beckley (1998) as the 'expert approach model' or 'scientific rational model' is no longer feasible. Although the problems that beset this approach are known and are well described by Malla (1998) and Sharma et al. (1994), the major criticism of this approach is on equity grounds: that it does not take into consideration the values, perceptions, knowledge and skills of local groups and that the local legitimate stakeholders are excluded from decision-making and benefits accrued from the conservation of the forest (Woodcock, 2002).

The other extreme of the pendulum called Community Forest Management (CFM); that is turning forest management over for exclusive management by organizations of the rural people or local communities (Arnold and Perez, 2001; Fisher, 2004), also has its limitations (Anderson et al., 1999). Local groups often lack appropriate skills and the broader management perspective to manage forest resources so that they make their maximum possible contribution to sustainable development. The difficulties in implementing CFM lie mostly in defining the community that has to benefit from the management of the forest resource because local settlements that are generally regarded as 'communities' are often culturally heterogeneous and economically stratified. Therefore, the social cohesion that is so important for community endorsement is thus compromised (Murphree, 2000). A participatory forest resource management planning known as Participatory

Forest Management (PFM) is now pursued as the ideal model because it incorporates private individuals and/or opinions and objectives of interest groups. The PFM also known as Collaborative Forest Management, Joint Forest Management or Shared Forest Management aims to integrate decision-making and share responsibility between the state, local communities and other stakeholders (Bass, 2001; Wily, 2000). The PFM is also thought to be transparent, fair, equitable effective and efficient because it involves all concerned stakeholders, thus leading to a strategic common vision. It is on this basis that the PFM has been recommended as the key process that could drive the management of forest reserves in Botswana (Anton, 1997; NFS, 1992).

Devolution of forest management is a new and alien phenomenon to both the communities and the forestry sector in Botswana. Therefore, State Forest Management (SFM) is the only forest management system that has been used by the forestry sector in Botswana to manage the six (6) gazetted forest reserves since the establishment of the first forest reserve in 1968. It is against this background that this study examines stakeholders' preferences for the CFM, PFM and SFM. The stakeholder' preferences are examined in view of the increasing emphasis on community-based conservation and management structures and the consistent decline in popularity of the SFM in recent years (Bass, 2001; Hobley, 1996; Poffenberger, 1998; Wily, 2000). The question that arises is how to incorporate, account and quantify stakeholders' opinions and preferences. Although there is an awareness of the many factors that beset the choice of any management practice or option, this study bases its assumption on the multiple-resource-use theory that guides stakeholders to choose a preferred management option. The stakeholders' decision to choose whichever management option is based on their interests and amount of resources that they could collect from a protected area. Equally important is the use of tested analytic decision support methods and tools that could facilitate societal preferences in environmental attributes. The main difficulty in implementing participatory approaches is the lack of tested methods, which could facilitate stakeholder negotiations and allow greater analytical rigour. New techniques of multi-criteria decision analysis (MCDA) have been found to be particularly useful in incorporating stakeholder values in forest management (Ananda and Herath, 2003).

This paper intends to analyze the possibility of using Analytic Hierarchy Process as a decision making tool in the process of choosing a preferred management option. A sample model was developed in order to test the method by using specialized software (Expert Choice). Through the development of the model and by analyzing the results of the evaluation, the author could establish the preferred management option and some key aspects that open the door for further studies in this matter. The objective of this paper is to: (a) illustrate the feasibility of Analytic Hierarchy Process (AHP) in incorporating stakeholder preferences in choosing a preferred management strategy and (b) to assess stakeholders' preferences towards three management options for the conservation of KFR namely, Participatory Forest Management, State Forest Management and Community Forest Management. Hence in this paper, we offered one of the multi-criteria techniques known as AHP as a tool for working with many different groups and their differing opinions. First, a description or theoretical background on the use of AHP is provided. Secondly, a case study from the author's previous work portrays how effectively this approach can work.

The analytic hierarchy process

Various approaches have been used to examine societal preferences in environmental attributes. In most real-world situations, however, there is not a single simple scale for measuring all competing alternatives. More often, there are at least several scales that must be used and often those scales are related to one another in fairly complex ways. In broad-scale, participatory decision making and alternative courses of action arise from different stakeholders with different value systems, and yet this diversity must be accommodated and integrated.

Recently, research on the use of analytic decision support methods and tools in participatory planning processes has been vigorous (Kangas, 1994; Kangas et al., 2001; Pykaelaeinen et al., 1999) because they are considered to be instruments for making rational carefully reasoned and justifiable decisions in natural resource planning which often entails making choices among alternative management regimes. Furthermore, analytic decision support methods and tools are considered to be a promising framework for evaluation since they have the potential to explicitly take into account conflicts, incommensurable and uncertain effects of decisions. The most widely used analytic decision support methods include the analytic hierarchy process (AHP), multi-attribute utility theory, and goal programming. However, it is the AHP that has been widely used in multi-attribute problems and complex decision-making (Varis, 1989) such as forecasting, resource allocation, conflict resolution, input-output analysis, strategic planning, optimization and choice behaviour (Zahedi, 1986). AHP is a multi-attribute decision-making technique (MADM). It is a comprehensive framework designed to cope with the intuitive, the rational and the irrational when decision makers make multi-objective, multi-criterion and multi-factor decisions with or without certainty in any number of alternatives. The AHP approach was designed to help decision makers incorporate qualitative (intangible) and quantitative (tangible) aspects of a complex problem.

The AHP (developed by Saaty in 1980) has the advantage of measuring consumer preferences in non-monetary terms when compared with cost benefit analysis (CBA), another methodology often used for decision making on public lands that requires the conversion of all the costs and benefits into monetary values (Knopp and Caldbeck, 1990). However, many decisions in natural resources are environmental and societal in nature and are therefore often difficult to quantify in monetary terms. The AHP is designed to help with these types of decisions. It has been applied to a wide variety of problems (Zahedi, 1986). Based on mathematics and human psychology the concept of AHP was developed amongst other theories, by Thomas Saaty, an American mathematician working at the University of Pittsburgh. It is used throughout the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education.

Two important components of the AHP that facilitate the analysis of complex problems are: (1) the structuring of a problem into a hierarchy consisting of a goal and subordinate features of the problem and (2) pair-wise comparisons between elements at each level. Subordinate features which are arranged into different levels of the hierarchy may include such things as objectives, scenarios, events, actors, outcomes, and alternatives. The alternatives to be considered are placed at the lowest level in the hierarchy. Pair-wise comparisons are made among all elements at a particular level with respect to each element in the level above it. Comparisons can be made according to preference, importance, or likelihood, whichever is most appropriate for the elements considered. Saaty (1980) developed the mathematics necessary to combine pair-wise comparisons made at different levels in order to produce a final priority value for each of the alternatives at the bottom of the hierarchy. The AHP is implemented in the software of Expert Choice© and it has been applied in a variety of decisions and planning projects in nearly 20 countries (Saaty, 2001).

Uses and application of AHP

The applications of AHP to complex decision situations have numbered in the thousands, and have produced extensive results in problems involving alternative selection, planning and resource allocation. AHP concept has gradually evolved through a number of applications as diverse as resource allocation, marketing decisions, project or technology selection and strategy evaluation, new product screening, and conflict resolution and priority setting. Many such applications are never reported to the outside world because they take place at high levels of large organizations where security and privacy considerations prohibit their disclosure. Some uses of AHP are discussed in the literature such as: Berrittella (2007), "An Analytic Hierarchy Process for the Evaluation of Transport Policies to Reduce Climate Change Impacts"; (Grandzol, 2005), "Improving the Faculty Select-tion Process in Higher Education: A Case for the Analytic Hierarchy Process"; (Atthirawong, 2002), "An Application of the Analytical Hierarchy Process to International Location Decision-Making"; (Kumar, 2003), "Analytic Hierarchy Process Analyzes Risk of Operating Cross-Country Petroleum Pipelines in India"; (Larson, 2007), "Application of the Analytic Hierarchy Process to Select Project Scope for Videologging and Pavement Condition Data Collection". Published applications of AHP in forestry include forest management (Mendoza and Sprouse, 1989); forest planning and decision making (Ananda and Herath, 2003; Kangas, 1994; Kangas et al., 2001; Pukalla and Kangas, 1996); risk assessment in assessing reforestation alternatives (Kangas, 1994); risk and attitude assessment towards risks in forest planning (Pukalla and Kangas, 1996); setting priorities for restoration projects (Reynolds and Holstein, 1994); identification and prioritization of fire research needs (Schmoldt and Peterson, 1997) and assessment of criteria and indicators for evaluating forest sustainability (Mendoza and Prabhu, 2000). Recent studies have extended the use of AHP to general population survey in investigating public preferences for preserved land (Duke and Aull-Hyde, 2002).

Despite its widespread use as a decision method, the AHP has received some criticism (Hill and Zammet, 2000). First, it is argued that because no theoretical basis exists for the formation of hierarchies, decision makers when faced with identical decision situations can derive different hierarchies for different solutions. Secondly, it is also argued that the rankings produced by AHP are arbitrary because they are produced by a subjective response using a ratio scale. Thus, the decision- maker can determine a preference point on a ratio scale without a baseline reference. It is said that these arbitrary rankings can lead to “rank reversal”, that is a situation where ranks may change when another alternative is considered. Thirdly, it is said that flaws exist in the methods for aggregating individual weights into composite weights. Finally, the AHP has been criticised for the absence of a sound underlying theory.

In spite of this criticism, several studies applying AHP to incorporate public participation have concluded that AHP is worth pursuing (Kangas, 1994; Ananda and Herath, 2003). Thus, the AHP along with other public consultation procedures was used to elicit stakeholders' preferred forest management options for the multiple-use management case study of the Kasane Forest Reserve (KFR) in Botswana.

AHP was elected for use in this study for the following reasons: (1) the AHP is a structured decision process which can be documented and replicated, (2) it is applicable to decision situations involving multi-criteria, (3) it is applicable to situations involving subjective judgement, (4) it uses both quantitative and qualitative data (5) it provides measures of consistency of preference, (6) there is ample documentation of AHP applications in the academic literature, (7) commercial AHP software is available (even on-line for free 15 days) with technical and educational support and (8) the AHP is suitable for group decision making.

Steps of the analytical hierarchy process (AHP)

Decomposing

The goal is to structure the problem into humanly-manageable sub-problems. To do so, first iterate from top (the more general) to bottom (the more specific), and then split the problem which is unstructured at this step into sub-modules that will become sub-hierarchies. Next, navigate through the hierarchy from top to bottom; the AHP structure comprises goals (systematic branches and nodes), criteria (evaluation parameters) and alternative ratings (measuring the adequacy of the solution for the criterion).

Each branch is then further divided into an appropriate level of detail. At the end, the iteration process transforms the unstructured problem into a manageable problem organized both vertically and horizontally under the form of a hierarchy of weighted criteria. By increasing the number of criteria, the importance of each criterion is thus diluted, which is compensated by assigning a weight to each criterion.

Weighing

Assign a relative weight to each criterion based on its importance within the node to which it belongs. The sum of all the criteria belonging to a common direct parent criterion in the same hierarchy level must equal 100% or 1. A global priority is computed that quantifies the relative importance of a criterion within the overall decision model.

Evaluating

Score alternatives and compare each one to others. Using AHP, a relative score for each alternative is assigned to each leaf within the hierarchy, then to the branch the leaf belongs to and so on, up to the top of the hierarchy, where an overall score is computed.

Selecting

Compare alternatives and select the one that best fits the requirements.

METHODOLOGY

Study area

The KFR (total land area of 118.7 km^2) is one of the six (6) gazetted forest reserves that are located within the Chobe district in Botswana. The forest reserves were originally established to protect areas containing valuable timber-sized trees for logging operations under Concession agreements (Anton, 1997; NFS, 1992). However, due to the dwindling supply of commercially exploitable timber trees, the logging operations were suspended in 1988 (NFS, 1992). The KFR just like other forest reserves in Botswana contains most of the deciduous woodlands that occur in Botswana. The KFR is located at the extreme northern corner of the country, adjacent to the Zimbabwe international border and very close to Chobe River, which is also an international boundary between Botswana and Namibia. The reserve is bounded to the north by the Kasane town and Kazungula village, Zimbabwe to the east and Chobe National park to the west . The total annual rainfall for the district is 500 to 600 mm, which is the highest in the country.

Although, all forest reserves are equally important from an ecological point of view, the KFR will always be most affected by any development plans. This is because of its proximity to the town of Kasane, and the villages of Lesoma and Kazungula. In addition, the forest reserve has a well developed road network and therefore experiences a lot of human pressure in the form of tourism, private investors, expansion of villages and government installations. The number of threats to the future existence of the KFR is increasing. Apart from the biological threats of the forest such as fire and elephant damage (Department of Forestry and Crop Production, DCP&F, 1996; Nduwayesi et al., 2004), large areas of the forest (about 3060 ha) have already been de-gazetted for residential purposes of the Kasane town and the expansion of the Kasane airport in 2002. Land encroachment poses an even greater threat to wildlife conservation because the KFR acts as a buffer zone for the Chobe National Park, which is already under immense pressure from the large elephant population. Discussions with the DFRR and Department of Tourism in Kasane (B. Losika, Pers. Comm, July 2004) revealed that a lot of pressure is exerted on the Regional Forestry Office in Kasane by different hotels and enterprises who want to conduct mobile tourist safaris and similar activities in the forest reserve. The over-crowding by tourists in the Chobe National Park seems to be the main reason for justifying their interest in opening up the forest reserves for conducting tourism operations.

Vegetation

Chobe forests contain the only deciduous woodlands in Botswana. The forest vegetation and associated fauna is part of the Zambezian biogeographical region. In Botswana, Chobe is the only district where the rainfall is just adequate to support more or less closed canopy forest vegetation (NFS, 1993). The Mukusi (*Baikeaea plurijuga*) forests represent the southernmost extension of the natural range of this species, which is geographically restricted from southern Angola eastwards through southern Zambia to western central parts of Zimbabwe. This vegetation type has a wide distribution throughout sub-Saharan Africa and contains a large number of deciduous tree species, all of which are more or less adapted to periodic fires, low and erratic rainfall.

Fauna

The fauna in this part of Botswana is characterized by its forest habitat affinity and has a wider distribution further north. Although not only restricted to Chobe, some 40 to 50 species of birds are mainly confined to this forested part of the country as either permanent inhabitants or winter migrants (NFS, 1993; Ross, 2003). Forest-adapted wildlife species of particular importance for conservation and with potential for sustainable utilization are sable antelope (*Hippotragus niger*), roan antelope (*Hippotragus equinus*) and greater kudu (*Taurotragus oryx*). Because the area has not yet been adequately studied with respect to total fauna and biodiversity composition, it is not yet known if the forest reserves contain other endangered or rare species that require special conservation measures. The Chobe district now harbors one of the largest and most dense population of elephants on the African continent (NFS, 1993), which is estimated at approximately 100,000 to 120,000 (CDDC, 1997). The international concern for the worldwide conservation and restrictions on the trade of products of elephants has exacerbated the management problems of this species in Botswana.

Tourism

Consistent with global trends, in Botswana tourism has been growing substantially. Between 1994 and 2000, the number of recorded holiday arrivals in the country grew by an average of 8.5% per year (Central Statistical Office, 2003). The rapid expansion in tourism suggests that it has considerable potential to contribute toward Botswana's economic diversification away from dependence on diamond mining which currently forms between 65 and 75% of exports and accounts for about 30% of gross domestic product (GDP) (Republic of Botswana, 1999). Although tourism is contributing only about 5% to GDP, its contribution is considered significant as it creates employment to impoverished communities in remote areas of the country where other forms of paid employment are scarce. Botswana's tourism is concentrated in terms of both types of attractions and their geographical distribution. Wildlife is the dominant attraction and is concentrated in two areas located in the northwest part of the country. The first area is the Okavango Delta, the largest inland delta in the world, which is a unique area of lagoons, reed-fringed waterways, and islands. The second area is the Chobe-Kasane National Park. All of Africa's big five game animals (elephants, lions, buffalo, leopard, and rhinos) are available in abundance.

Chobe has a vast potential for tourism development. The major attraction in the area is wildlife but other aspects of scenery (Chobe/Linyanti, forests, Pandamatenga plains, etc) also contribute to the attraction of the district to tourists. Presently, tourism development is mainly operated by private individuals. Unlike in the previous years where tourists visited Chobe on transit, they now visit the place as a destination (CDDC, 1997). The change in the state of affairs is attributed to the developments that took place in the past five years, such as the Kasane International Airport, and developments of lodges and Hotels. Tourist activities include organized game drives, safari tours, boat cruises, hunting safaris, sports fishing and village tours. The immediate challenge is to ensure that the growth of tourism in the Okavango and Chobe-Kasane areas does not destroy the natural environment. For the purposes of this study, three communities of Kasane, Kazungula and Lesoma that surround the KFR are considered.

Management options

Base on literature survey and discussions with the Department of Forestry and Range Resources (DFRR) in Botswana, three (3) hypothetical management options were tested: Community Forest Management (CFM); Participatory Forest Management (PFM) and State Forest Management (SFM). In this study, CFM is defined as a type of management where decision-making is solely by the community and any participation of the state is at the discretion of the community. It should also be noted that stakeholder experience of CFM was limited to a system where the use of forest resources is controlled by a traditional authority such as the local chief or tribal council. It was also impressed upon the interviewees that while the definition of CFM could be similar to theirs (control through traditional leaders), the definition could also involve a policing and monitoring function of the use of the resources by the community members. The SFM is defined as a forestry practice that is characterized by a centralised and authoritarian structure that has a top-down approach to management and decision-making and excludes local communities. The PFM is defined as a joint or collaborative forest management decision-making and planning by both the state and the local communities.

Stakeholder preference analysis

Stakeholder preference analysis is a useful approach to identify the key actors in the systems and assess their respective interests (Grimble and Chan, 1995). However, in the process of developing a conceptual framework to organize the many social criteria and indicators in the KFR management plan, it was discovered that there is no mechanism for differentiating the many people with an interest or 'stake' in the forest, herein called stakeholders. Therefore, in this study, stakeholders were defined in accordance with Borrini-Feyerabend (1996) as social actors who:

(a) Have a direct and significant interest in an area's natural resources;
(b) Are aware of their own interest in the management of resources;
(c) Possess specific capacity (knowledge) and comparative advantages (proximity, mandate) for such management; and
(d) Are usually willing to invest specific resources (money, time, authority) towards some form of management.

Thus, this study did not only include the local people and officials from the DFRR as is often the case, but it also included all the other stakeholders who have an interest in the KFR. The main groups of stakeholders that were involved in this study were:

(a) Local people, whose survival may depend on natural resources provided by the KFR;
(b) Officials from the DFRR and other administrative authorities representing the government in the management of the KFR;
(c) Private tourism businesses in the concession areas surrounding the forest reserve; and,
(d) Non-Governmental Organizations (NGOs), research and educational institutions that are interested in the conservation of the KFR.

A static hierarchy model which consists of the goal, objectives and sub-objectives and agreed management options was developed by the author. The model was validated by the stakeholders before the elicitation exercise that was meant to capture all stakeholders' interests.

The objectives/sub-objectives for the management of the KFR are outlined in the Chobe Forest Management Plan (NFS, 1992), while further information was provided in the evaluation of the KFR by Anton (1997) and the Participatory Rural Appraisal (PRA) conducted by the author in June to July 2004. Figure 1 shows the proposed AHP conceptual model for the management of the KFR. The conceptual model has three (3) levels: Level I is the goal for choosing the best management option; Level II consists of objectives/criteria, which are the interests or management objectives that stakeholders care about and identified as important to the in the management of the KFR; and Level III consists of the management options or strategies that could influence or have an effect on the desired attributes.

Data analysis

Analytic hierarchy process modelling for stakeholder preference analysis

Face-to-face value elicitation sessions were carried out using the AHP model to identify stakeholders' objectives (attributes) and their

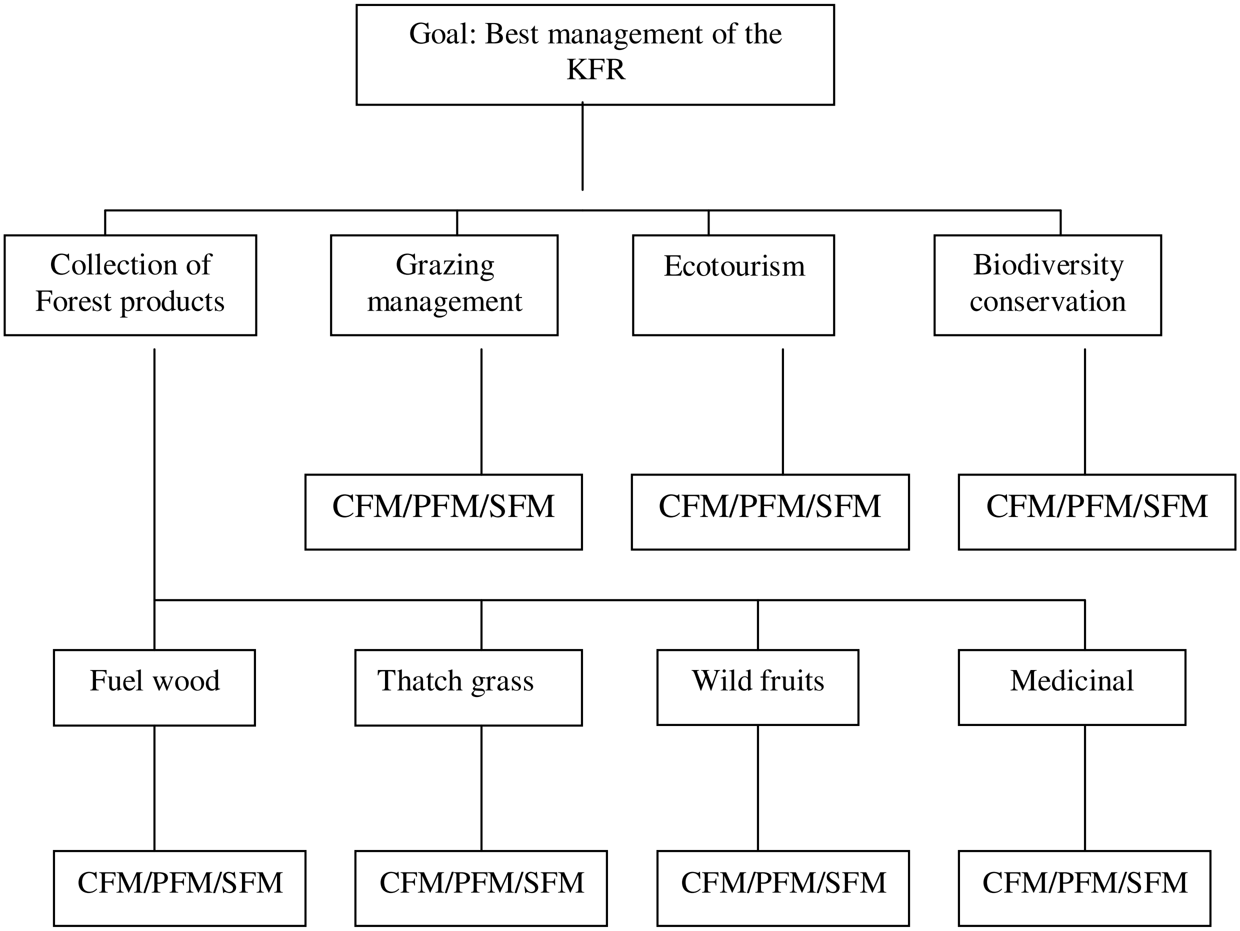

Figure 1. Hypothetical management model.

preferred management option. There were briefings and discussions with respondents about the study area, the attributes/ objectives and the management options prior to value elicitation. It was not possible to get all the stakeholders together in one (1) workshop because of schedule clashes. Therefore, the stakeholders were met separately either as individuals or as a group.

Stakeholders' preference analysis using AHP model was generated by computer software 'Expert Choice®' generated from Pair-wise comparisons to produce weights, consistency ratios and rankings by chosen respondents using representative democracy forum (Keeney, 1992). No attempt was made to prove the mathematical foundations for AHP in this study; instead, the interested reader was referred to Saaty (1980, 1990). The analyst completes a pair-wise comparison of all the elements at each level relative to each of the program elements in the next higher level of hierarchy. Pair-wise comparisons of the different factors based on a nine-point ordinal scale indicate the relative importance or the relative preferences for the factors (Table 1). These descriptive preferences would then be translated into numerical values 1, 3, 5, 7 and 9, respectively with 2, 4, 6 and 8 as intermediate values for comparisons between two successive qualitative judgments. Reciprocals of these values are used for the corresponding transposed judgments. Table 1 shows the comparison scale used by AHP. Finally, all the comparisons are synthesized to rank the alternatives. The output of AHP is a prioritized ranking of the decision alternatives based on the overall preferences expressed by the decision maker. Sensitivity analysis is used to investigate the impact of changing the priorities of the criteria on the final outcome.

Consistency of judgements

In addition to final preference weights, the AHP allows calculation of a value called consistency index (Saaty, 1980). The index measures transitivity of preferences for the person doing the pair-wise comparisons. Consistency ratio (CR) is a measure that assumes that the judgements were done at random (Saaty, 1980, 1990). According to Saaty (1980), small consistency ratios (less than 0.1 suggested as a rule-of-thumb) do not drastically affect the ratings. This means that there is an acceptable 10% chance that the decision maker made his/her judgements in a purely random way. However, if the CR is above 10%, the AHP requires that the decision-maker revises some of the judgements that are too inconsistent. The 'Expert Choice®' has a built-in feature that identifies the most inconsistent judgement in a pair-wise comparison matrix.

Group analysis

Since each stakeholder group contained 4 to 6 members, some way was needed to deal with multiple (and most likely different)

Table 1. The AHP pair-wise comparison scale.

Intensity of the relative importance	Definition
1	Equal importance
3	Weak importance
5	Essential or strong importance
7	Demonstrated importance
9	Absolute importance
2, 4, 6 and 8	Intermediate values between two adjacent judgements

Source: Saaty (1977).

judgements. There are two ways to obtain pair-wise judgements from a group of entry into a matrix. First, the workgroup could have discussed each comparison and arrived at consensus judgement. Secondly, each workgroup member could offer an individual judgement, and then all judgements would be averaged geometrically. The pooling technique of the second approach is preferred in this study for several reasons: first, it is faster than consensus; secondly, it gives each workgroup member an equal voice; thirdly, the averaging effect of pooling usually mitigates inconsistency problems and lastly, multiple judgements for each comparison provide a statistical sample of priority vectors which can then be used to test for differences in priority vector elements (Schmoldt and Peterson, 1997). Average judgements of respondents within a group were calculated using a geometric mean (Saaty, 1980; Schmoldt and Peterson, 1997).

Pair wise comparisons by AHP

Three (3) types of comparisons are used in 'Expert Choice' model: 'Importance, Preference or Likelihood'. These terms express the decision-maker's perspective of the comparisons being made at a particular point, but it does not affect in any way the calculations performed by 'Expert Choice'. The term 'importance' is appropriate when comparing one criterion with another. For example, a stakeholder is able to determine how much more important is biodiversity conservation relative to other objectives. The term 'preference' is more appropriate when comparing alternative management options. For example, in this study the stakeholders use 'preference' for comparing alternative management options/ strategies by specifying how much more preferable one management option is to another with respect to achieving a given objective. The term 'likelihood', which is more appropriate when comparing uncertain events such as probability that an event will occur, is not used in this study.

A questionnaire developed for eliciting stakeholder's values is shown in Appendix A. This questionnaire consisted of paired comparisons among the six selected decision criteria and among the different types of bridge material with respect to each decision criteria. A rating scale from 1 to 9, as recommended by Saaty (1980) was used for the paired comparisons. Each decision-maker made 40 paired comparisons to complete their individual AHP model. A laptop computer running Expert Choice was used to record responses as each respondent filled in the questionnaire. This allowed immediate feedback to the decision maker on their preferences and their overall choice of a management option. Individual results were then combined as geometric means to produce with-in group decisions.

Limitations of the AHP model

The use of selected representatives for the participation in focus group elicitation of pair-wise comparisons with AHP is also a threat to external validity. It can be argued that preference ranking will be based on the subjective and biased preferences which are not necessarily reflective of the majority of the stakeholder groups. Furthermore, biases can also occur in the process of selecting stakeholder representatives in the evaluation exercise. However, such biases can be mitigated by increasing the number of participants in a group.

RESULTS AND DISCUSSION

A total of 29 usable questionnaires were analysed. Some of the questionnaires were removed from the analysis because they were incomplete. The community stake-holder group from three (3) villages of Lesoma, Kasane and Kazungula was the largest, consisting of 15 representatives; the Department of Wildlife and National Parks (DWNP) had six (6) representatives; the DFRR had five (5) representatives and the tourism sector had 3 respondents. The majority of the stakeholders preferred PFM (weighted at 0.504) for the management of the KFR. The second ranking (weighed at 0.348) was SFM and least preferred was CFM weighed at 0.258 (Table 2). The local priorities and ranking of the three (3) management options shown in Table 3 indicate that for the Community, Tourism and Wildlife stakeholders, PFM and SFM are ranked first and second, respectively, while for DFRR Officers, SFM and PFM are ranked first and second, respectively. For all the stakeholders, CFM was ranked as the last management option. The results suggest that the DFRR Officers are reluctant to involve the com-munities in forest management.

The choice of PFM by most community members in this study is similar to a study reported by Robertson and Lawes (2005) in Kwazulu-Natal in South Africa. However, these studies are in contrast to attitudes expressed by some other South African forest communities. For example, Obiri and Lawes (2002) found that while forest users in the Eastern Cape Province supported SFM, they displayed weak support for PFM and CFM. Likewise, 89% of interviewees around Thathe forest (Limpopo Province) felt that the State was better placed to manage forests than the community, although 43% supported PFM initiatives (Sikhitha, 1999). A notable feature of each of these studies is the poor support for CFM. The question

Table 2. Descriptive statistics for stakeholders' management preferences.

Variable	Mean	St. Dev.	Min	Max
PFM	0.504	0.236	0.146	0.801
SFM	0.348	0.239	0.105	0.771
CFM	0.258	0.218	0.086	0.801

Table 3. Local priorities and ranking for management options by stakeholders.

Alternative/group	Community		Forestry		Tourism		Wildlife	
	Priority	Rank	Priority	Rank	Priority	Rank	Priority	Rank
PFM	0.6396	1	0.4680	2	0.8010	1	0.4380	1
SFM	0.2608	2	0.5262	1	0.1130	2	0.3651	2
CFM	0.2020	3	0.3048	3	0.0860	3	0.1968	3

that arises is why CFM is so poorly supported? Obiri and Lawes (2002) suggest that an important reason for this is the diminished capacity of previously re-cognised community forest management institutions, particularly traditional authorities such as local chiefs. Therefore, local communities are unwilling to accept managerial responsibility for a forest on their own. Another major reason in this area could be that the efficacy and involvement of previously recognised com-munity based natural resource management institutions for wildlife utilisation (for example, KALEPA Trust and the neighbouring Chobe Enclave Conservation Trust) have left some mistrust on the communities and government agencies because of their poor management and accountability.

Although, users adjacent to KFR identified a role for both the state and the community in PFM, they acknowledged that traditional authority had declined in the last 10 years. It is also noteworthy to consider that grounded knowledge of how communities used to contribute to the protection of natural resources is not always present at the level of the current traditional authorities. The people who still have first-hand knowl-edge are now old and younger persons who have not been adequately exposed to traditional education have come into traditional offices. In spite of the collapse of the traditional resource management methods after indepen-dence in 1966, this study showed that community members still identified a role for both the state and the community in PFM.

The results presented in Tables 3 and 4 show consis-tent preference for PFM. However, stakeholders' preference for CFM and PFM with respect to other objectives has changed. Table 4 shows that the most important of the four (4) objectives pertaining to the choice of a management option was the concern for biodiversity conservation. However, with a score of 0.287, biodiversity conservation marginally outweighs the collection of forest products which has been ranked second at 0.276, followed by ecotourism at 0.250 and lastly grazing management with a weight of 0.116.

The results in Table 4 have policy implications: Policy makers can strike a better balance between competing stakeholder interests thereby minimizing conflicts. Furthermore, it is interesting to note that all stakeholders recognised the importance of the conservation of biodiversity although the collection of forest products continues to be an important factor. Policy makers should consider the conservation effort by further evaluating the extent of the conservation values that must be preserved. This is particularly important because of the small size of the forest reserve and associated negative pressures such as wildland fires and elephant damage. It is not surprising that the grazing management attribute is considered less important to influence the choice of management options. This could be because an alter-native avenue, Ranch 256 in the adjacent forest reserve, has been allocated for grazing. The study clearly indicates that the preferences of the stakeholders should be incorporated in the decision-making process.

Moreover, while there is no blueprint for the implemen-tation of the management option that suits every situation, it could be concluded that PFM is the preferred management option for the KFR. However, its success will depend on an improved relationship between stakeholders, particularly between users and the forest owners (State). The State alone cannot effectively control forest use or other illicit behaviour such as setting up forest fires and poaching, without the help of the communities. Thus, PFM would be a useful means of managing the resources. Baland and Platteau (1996) noted that trust-building between partners is necessary for effective co-management of which a crucial step suggested by Ostrom et al. (1993) is to involve the targeted community beneficiaries at the design stage of the project. In order to reduce the trust-gap, scepticism and apathy, frequent monitoring and interactive meetings should be held with local communities. In an ideal

Table 4. Stakeholders' normalised rankings of management options with respect to objectives.

Objective	Alternative	Rank	Weight
Biodiversity conservation	CFM	3	0.032
	PFM	2	0.118
	SFM	1	0.137
Grazing management	CFM	2	0.030
	PFM	1	0.082
	SFM	3	0.004
Ecotourism	CFM	3	0.043
	PFM	1	0.125
	SFM	2	0.082
Collection of forest products	CFM	2	0.072
	PFM	1	0.175
	SFM	3	0.029

situation, dedicated on-site PFM practitioners should be deployed within communities to foster mutual understanding and strengthen relationships. Frequent and regular interaction by on-site stakeholders can reduce transaction costs of collective decision-making (Agrawal and Gibson, 1999). Thakadu (2005) reports that communities with on-site facilitators tend to perform better in administration and management than those without on-site facilitators.

The PFM enhances collaboration and understanding between forest communities and State authorities (Pokharel, 2000). However, Campbell warns that the implementation of PFM can be difficult, particularly when securing representation on joint management committees and reaching consensus on such issues as the distribution of benefits to communities are concerned. Grumbine (1994) suggested that these issues can be partly overcome if managers and resource users are aware of the forest management goals and practices and they have positive attitudes towards conservation. There is no doubt that rural economic empowerment through PFM is desirable for the successful implementation of the strategy. For example, the CBNRM programme for wildlife management in other parts of Botswana has managed to raise sufficient funds from hunting and ecotourism ventures. However, whether this success can be replicated in the KFR is yet to be seen. The economic incentives that attract local participation need to be explored, particularly due to the limited revenue-generating potential of local forests as identified elsewhere (Obiri and Lawes, 2002). In spite of this, there is support among local communities for PFM mainly because of the communities' dependency on the collection of forest products such as firewood. Nevertheless, there is a very real danger of social and economic disaster where PFM is badly managed or implemented. FAO (2001) suggest that the success of PFM and those economic incentives that underpin management should be based on the real value of the forest resources.

Conclusions

Nowadays, conservation cannot be separated from human development. This has been amply demonstrated in many Southern African countries where conservation that does not take into consideration social and economic is usually bound to fail. However, neither SFM nor CFM is a panacea to the problems of forest conservation. Instead, a comprehensive system that includes community participation and considers some protection of the resource base by the state has a better chance of achieving this goal. Therefore, the DFRR should emulate such experiences from other countries that have promoted PFM. The findings of this study clearly show that preferences towards management of the KFR vary with the interests of different stakeholders. Hence, the DFRR should be ready and willing to adopt PFM in the management of the KFR. The results further showed that the DFRR Officials were sceptical about community participation in the management of the KFR, and perceive such an endeavour as a threat to sound biodiversity management. It is therefore suggested that the DFRR Officials should be trained in community forestry so that they could be in a better position to work with the local communities.

However, working with communities in a truly participatory way is a relatively new function for Foresters the world over (Bass, 2001), and Botswana is no exception. It is therefore suggested that detailed feasibility studies should be undertaken prior to the implementation of PFM. This will place the government in a better position to plan a pragmatic approach in order to offset any challenges that may be encountered at a later stage. Such feasibility studies would also highlight the various types of heterogeneity that exist among stakeholders and how they can be harnessed and managed to ensure that they work well for the programme. Thakadu (2005) reported that the lack of feasibility studies was a major hindrance in the implementation of CBNRM projects in Botswana. Therefore, it is imperative that although SFM seems to be unpopular, it should not be discarded without undertaking feasibility studies, whose results would then inform the DFRR on how best to manage the heterogeneity among the various stakeholders.

AHP applicability on the case study

In this study, the expert team presented the relative accuracy and perceived ease of use of each of the comparison methods provided by Expert Choice to the decision-making team and let them choose which they preferred to use. Among the non-dominated elicitation methods, the decision-makers did not select graphical multiple bars because they understood that it would have low accuracy, rather they used the verbal pair-wise comparisons because of its ease of translating their judgments. We attributed our success mainly on the ease of use of AHP and the existence of easy-to use comercial software (Expert Choice). We needed a methodology well supported with a well developed-software conducive to real life applications. However, there are some limitations of the approach; AHP assumes linear independence of criteria and alternatives. If there is dependence among the criteria, Analytic Network Process (ANP) (Saaty, 2001) is more appropriate yet AHP requires far more comparisons which may be formidable in practical decision environment. This is a new area of research to explore.

In addition, we were easily understood by the stakeholders. AHP is appropriate whenever a goal is clearly stated and a set of relevant criteria and alternatives are available. When there are quite a few criteria involved, AHP is among very few multiple criteria approach capable of handling so many criteria, especially if some of the criteria are qualitative. Hence, caution should be exercised in relation to the number of criteria to be evaluated as this can be a tedious process to do many comparisons. With its Expert Choice software, AHP enables sensitivity analysis of the results which is very important in practical decision making. This study showed the researchers that the AHP can be used to manage complex problems such forest management option/ practice selection.

The structured approach offered by AHP allows different individuals and institutions to participate equally in a process that is quantitative and non-biased, rather than subjective and value-laden. If individuals can work around a table to quantify their input to decision-making, then an analytical process can provide a critical link in developing trust and true group participation. The AHP allows diverse viewpoints to be considered and integrated without the requirement of consensus. The important thing is that all participants have input to and ownership of the final evaluation. Furthermore, the method used in this analysis is shown to be effective in revealing stakeholders' preferences and can be used in the development of policy particularly with respect to establishing local acceptance. Extending the questionnaire to more stakeholders, for example, survey, will certainly enhance credibility of the results. Finally, these results join a growing body of research that brings biological and economic models together in an analytical framework.

ACKNOWLEDGEMENTS

This study was supported by WKKF KELLOGG foundation, Rufford Small Grant and Compton Fellowship Foundation.

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APPENDIX A

Assessment of preferred management options for conservation of Kasane Forest Reserve

Part I. Choice objectives

Please prioritize the following objectives with respect to your goal: CHOOSING THE BEST MANAGEMENT OPTION for KASANE FOREST RESERVE.

(1.1) Please select the OBJECTIVE in each pair below which, according to your judgment has the greatest impact, on your decision to choose between forest management strategies/options.

Compare the relative importance with respect to your GOAL. Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important OBJECTIVE. Circle one number per row below using the scale

If any pair is equally important, please circle number 1 in the middle.

Example:
1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

This objective is most significant ← → This objective is most significant

1	Biodiversity 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Grazing
2	Biodiversity 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Ecotourism
3	Biodiversity 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Forest Products
4	Grazing 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Ecotourism
5	Grazing 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Forest Products
6	Ecotourism 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Forest Products

(1.2) Forest products collection

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important OBJECTIVE.

If any pair is equally important, please circle number 1 in the middle.

Example: 1, 2, 3, 4, 5, 6, 7, 8, 9
1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

This objective is most significant ← → This objective is most significant

1	Fuel wood 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Building Poles
2	Fuel wood 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Medicinal Plants
3	Fuel wood 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Thatching Grass
4	Fuel wood 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Wild Fruits
5	Building Poles 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Thatching Grass
6	Building Poles 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Medicinal Plants
7	Building Poles 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Wild Fruits
8	Medicinal Plants 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Wild Fruits
9	Medicinal Plants 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Thatching Grass
10	Thatching grass 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Wild Fruits

Part II. Ranking forest management options

(2.1) With respect to BIODIVERSITY how do you compare the effects of CFM vs. SFM, CFM vs. PFM and SFM vs. PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

APPENDIX A Contd.:

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM

(2.2) With respect to GRAZING MANAGEMENT how do you compare the effects of CFM vs SFM , CFM vs PFM and SFM vs PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM

(2.3) With respect to ECOTOURISM how do you compare the effects of CFM vs. SFM, CFM vs. PFM and SFM vs. PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM

(2.4) Comparisons with respect to FOREST PRODUCTS collection

(a) With respect to FUELWOOD Sub-objective of FOREST PRODUCTS

With respect to Fuel wood how do you compare the effects of CFM vs. SFM, CFM vs. PFM and SFM vs. PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM

(b) With respect to BUILDING POLES Sub-objective of FOREST PRODUCTS

With respect to Building Poles how do you compare the effects of CFM vs. SFM, CFM vs. PFM and SFM vs. PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

APPENDIX A Contd.:

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM

(c). With respect to THATCHING GRASS Sub-objective of FOREST PRODUCTS

With respect to Building Poles how do you compare the effects of CFM vs. SFM, CFM vs. PFM and SFM vs. PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM

(d) . With respect to MEDICINAL PLANTS Sub-objective of FOREST PRODUCTS

With respect to Medicinal Plants how do you compare the effects of CFM vs. SFM, CFM vs. PFM and SFM vs. PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM

(e) With respect to WILD FRUITS Sub-objective of FOREST PRODUCTS

With respect to Wild Fruits how do you compare the effects of CFM vs. SFM, CFM vs. PFM and SFM vs. PFM.

Using the scale that follows, circle the one and only number in each comparison below which is on the side of the most important FOREST MANAGEMENT OPTION.

If any pair is equally important, please circle number 1 in the middle.

1 = Equal; 3 = moderate; 5 = strong; 7 = very strong; 9 = extreme

1	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SFM
2	CFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM
3	SFM 9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 PFM