The Role of Indigenous Knowledge in Biodiversity Assessment and Monitoring: A Case Study in Uganda

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Abstract—Biodiversity is being lost at unprecedented rates through destruction of habitats and ecosystems for short-term economic gain. Concern about this has led governments, multilateral organizations, scientists, environmentalists, and others to look for ways to promote the conservation of biodiversity. This concern has led to the development of rapid biodiversity assessment approaches based on indigenous knowledge of the local people to provide information on biodiversity suitable for use in conservation planning and environmental monitoring.

The study, which was funded by UNDP/GEF Cross-Border Biodiversity Project in Uganda and implemented by myself on behalf of Makerere University Institute of Environment and Natural Resources (MUIENR), was carried out in the communities living in Moroto forest reserve and those living adjacent to the forest reserves of Sango Bay area. Moroto forest reserve is found in the Northeastern part of Uganda, while Sango Bay area is found in Southern part. The study was meant to identify, select indicators for biodiversity assessment and monitoring, and determine the trends of the resources since 1950 to 2001 using indigenous knowledge of the local people. The criteria for the selection of biodiversity indicators based on the following resource categories: Resources whose alternatives cannot be obtained from outside the forest; Medicinal and food plants; Resources with considerable pressure from the people; Sources of income; rare resources and large mammals. The results obtained indicated that there has been biodiversity loss based on the selected categories since 1950 to 2001, due to mainly change of peoples' livelihoods, over-harvesting, policy, and institutional failures. The major conclusion drawn from the study was that, the use of indigenous knowledge is a cheaper method in biodiversity assessment and monitoring, and it encourages the participation of local communities in resource management decisions thus empowering them to undertake sustainable management initiatives. However there is use of a unified knowledge system for effective biodiversity assessment and management.

Introduction

Most of Uganda's biodiversity can be found in the natural forests, but a considerable amount is found in open waters, wetlands, and dry/moist savannah. The major biodiversity ecosystems in Uganda include forests, woodlands, savannah, wetlands, and aquatic biodiversity (NEMA, 2000/2001). The biodiversity hotspots in Uganda include Mgahinga Gorilla and Bwindi Impenetrable National Parks, Rwenzori Mountain National Park, Sango Bay wetlands and forest ecosystem, Kibaale National Park, dry mountains of Karamoja (Napak, Morungole, Kadam, Timu and Moroto), Lake Victoria and papyrus swamps of Lake Edward, George and Bunyonyi (NEMA, 2000/2001).

Uganda is well known for the richness of its biodiversity, both terrestrial and aquatic, and it has a comprehensive system of protected areas under the management of the forestry department and Uganda Wildlife Authority (Pomeroy and others 2002). Despite this, the report on the state of Uganda's Biodiversity 2000 showed that the rate of biodiversity loss was high estimated at 1 percent per year.

A value and threat analysis conducted by UNDP/GEF Cross-border biodiversity project in the Sango Bay forests showed that the people were aware of the threats they impose on the forests. The following are some of the perceived threats to the Sango Bay forests by the communities: cutting young trees for poles and firewood, poor harvesting palm leaves, debarking trees for medicines, over harvesting of timber, selective harvesting of tree species, over harvesting of palm leaves, over harvesting of Marantochloa spp for baskets and poor pastoral practices (Nabanyumya and others 1999).

Figure 1. Map of Uganda showing location of study sites.

Biological diversity, the variability among living organisms from all sources is of critical value to the world. It forms the basis of our food supplies and provides raw materials for our pharmaceuticals and a growing number of industrial products (Tamanga and Bhattachan 1999). Unfortunately, biodiversity is being lost at unprecedented rates through the destruction of habitats and ecosystems for short-term economic gain. Concern about this has led governments, multilateral organizations, scientists, environmentalists, and others to look for ways to promote the conservation of biodiversity.

As concern about the loss of biodiversity has risen, so has the appreciation for the knowledge of the indigenous peoples about the natural resources they have lived with for centuries. This knowledge has an important scientific and strategic value. The majority of the worlds' people rely on indigenous knowledge of plants, animals, insects, microbes, and farming systems for either food or medicines. Eighty percent of the worlds' population depends on indigenous knowledge to meet their medicinal needs

(Tamanga and Bhattachan 1999). It is therefore likely that the people closely watch and know how the resources are consumed and change.

Since the rate of biodiversity loss in Uganda is very rapid, methods by which trends in biodiversity may be assessed rapidly and efficiently are urgently required (Burley and Gauld 1994.). This need has led to the development of rapid biodiversity assessment approaches such as PRAs which aim to provide information on biodiversity suitable for use in conservation planning and environmental monitoring, in situations where detailed taxonomic investigations of the species concerned are not necessarily available (Oliver and Beattie, 1993).

Furthermore, Basemera quotes Gadgil and others (1993) as recognising the awareness of local people of the variety of uses of local biodiversity, such as medicines, which has been incorporated in the modern pharmacopoeia. Rural indigenous people are often knowledgeable about plant and animal species, including their identification and ecology (Hellier and others 1998).

Materials and Methods

Study Areas

The study areas were Mt. Moroto Forest reserve in the Northeastern part of Uganda and Sango Bay in the southern part of Uganda.

Selection of Indicators for Assessing Biodiversity Loss

A study carried out by MUIENR and funded by UNDP/GEF Cross-Border Biodiversity Project in Uganda designed criteria for selection of biodiversity indicators for monitoring and evaluation in Moroto and Sango Bay cross border biodiversity sites (Nanyunja 2001). The current study adopted some of these criteria and made some modifications to suit its objectives. They included the following resource categories (not necessarily mutually exclusive):

- Medicinal plants
- Food Plants
- Plants
- Resources with considerable pressure from the people
- Sources of income; rare resources
- Large mammals.

Sampling Procedure and Data Collection

Participatory rural appraisals (PRAs)

Participatory Rural Appraisal (PRA) has become an established procedure for investigating indigenous resource management systems (Webber and Ison 1994). It is defined as an "intensive, systematic but semi-structured learning experience carried out in a community by a multidisciplinary team which includes community members" (Theis and Grady 1991). One of the main advantages of PRAs is that they help provide a holistic vision from the perspective of the end-user, and makes use of their experience, which is integrated with that of the researchers, in order to broaden the common knowledge-base (Chambers, 1994a,b).

A PRA technique can include rapid surveys of local knowledge as tools for investing human perceptions to biodiversity loss. In this study, group interviews were used as information gathering tools for assessing trends in biodiversity loss (changes in abundance and changes in the use of indicator species from 1950 to 2001). These tools were earlier designed and used to develop a biodiversity monitoring and evaluation framework for Moroto,

Napak and Sango Bay cross-border biodiversity sites in Uganda (Nanyunja 2001). The PRAs consisted of local histories/time lines, resources rankings, and abundance scores. I collected data using these tools with prepared data sheets (figs.2-5).

The people in Bukora parish of Sango Bay were predominantly pastoralists while those in Kanabulemu and Minziro parishes were predominantly cultivators. The people in Lwamuhuku Parish adjacent to LMNP were predominantly pastoralists while those in Kiribwa were predominantly cultivators. In Rubaale, the people of Kaina Parish were pastoralists while those of Katooma and Kyobwe Parishes were cultivators.

One PRA was carried out in each of the three parishes of Sango Bay and Moroto. Each PRA consisted of a group of 15 to 20 men and women participants—some cultivators and others pastoralists—ranging in age between 20 to 80 years. Community mobilization and the selection of participants for others were done with the help of the community forest officers.

Local histories/time lines

This technique taps participants' memories to recall local important historical events to help date other changes, such as changes in the environment in this case (Nabasa and others 1995). I used this method to collect information on trends of indicator species use, and changes and reasons for those changes in species frequency from 1950 to 2001. Elders were very much involved and played a large role in providing this historical information. Old people possess most of the indigenous knowledge and therefore provide the best (Basemera 2002) hence the exercise included elders and long-term residents.
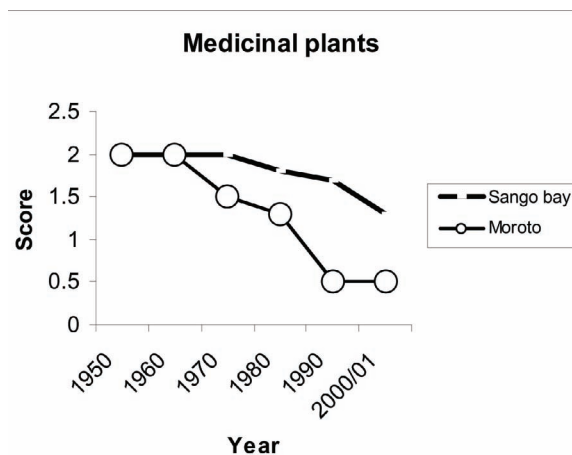

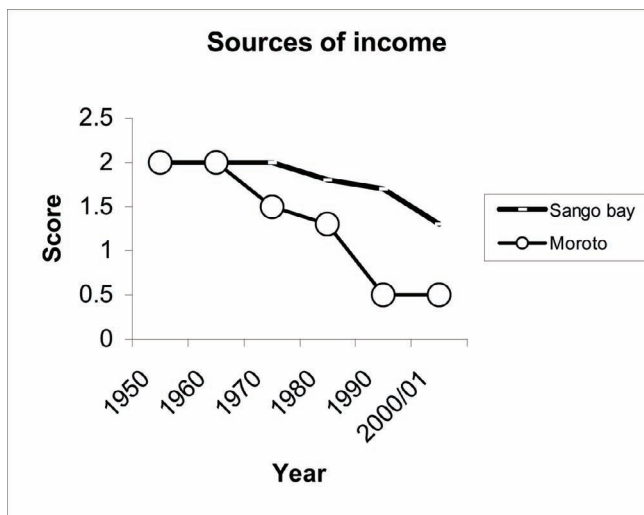**Figure 2.** Trends of medicinal plants.
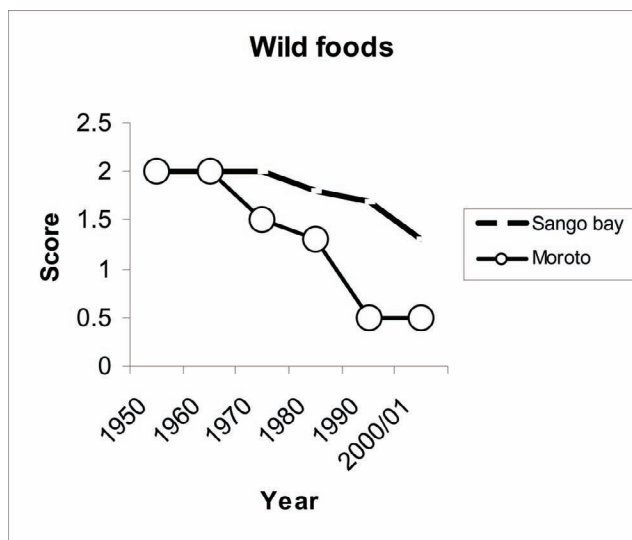
Figure 3. Trends of sources of income.

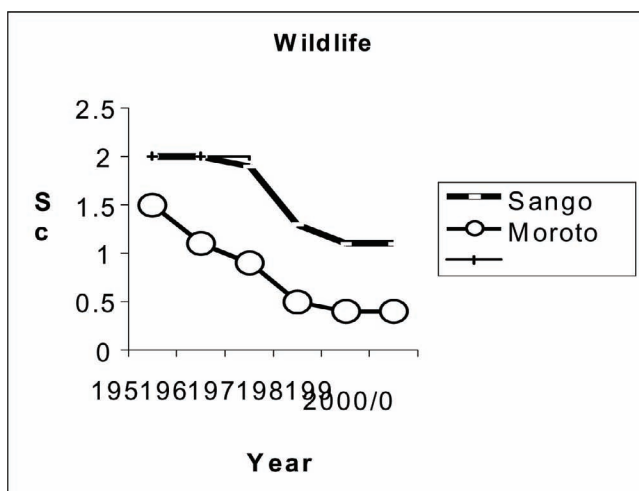**Figure 4.** Trends of wild food plants.

Figure 5. Trends of wildlife.

Resource rankings

During the discussions, the participants were asked to list about 10 to 15 resources (plant or animal species) in each category. Among these, I asked them to choose the 5 key resources. One person would suggest a resource name, and this would be subjected to debate. The people in support of it would then put up their hands. If the number supporting it exceeded the others, then we would accept it as a key resource. Indicator species and abundances were established in a similar manner.

Abundance scores

Abundance scores reflected the availability of indicator species during periods from 1950 to 2001. I asked the participants to score the availability an indicator species. The scores ranged from 0 to 2 where: 0 reflected none or nearly none; 1 a few or some; and 2 many or readily available (Nanyunja 2001). Comparing these scores between time periods would reflect a trend in change in biodiversity.

Data Analysis

The data collected in form of scores were entered and analysed, and graphed in Microsoft Excel by use of descriptive statistics. These illustrations show the trends of the biodiversity categories. The abundances of all the indicator species for a corresponding year (for example, 1950) were summed and averaged across parishes for each site.

Results

Figure 2 shows trends of medicinal plants. Of the medicinal plants trends' rapidly in Moroto Forest Reserve and least rapidly in the Sango Bay.

Figure 3 shows trends of sources of income of the plants being lost that people use as sources of income. The Moroto forest reserve is losing them more quickly than the Sango Bay site.

Figure 4 shows trends of wild food plants. Plants that people use as wild foods are being lost more quickly in Moroto than in Sango Bay.

Figure 5 shows trends of wildlife. In Moroto, wildlife is decreasing more steadily than in Sango Bay.

Therefore, the results clearly show that Moroto forest reserve is more degraded than Sango Bay.

Discussion

The trends in biodiversity loss as identified by human perceptions are illustrated in the graphs above. A general trend of biodiversity loss is found in all the sites. However, the magnitude of change varies within sites, and considerable variation is found between the study sites. The reasons for the change across the sites are related to the land use changes and statuses.

Trends of Medicinal Plants

The medicinal plants in Moroto forest Reserve were being lost faster than in Sango Bay. The rapid loss in Moroto Forest Reserve can be related to the fact that there are communities living within inside the forest reserve, where as in Sango Bay forest reserves, people are living adjacent to the forests. The need for charcoal burning, settlement and expansion of agriculture has contributed to the clearance of vegetation within Moroto Forest Reserve. This shows a contrast in biodiversity status between the Park, which is a protected area, and the adjacent community, which is a non-protected area.

The medicinal plants, in both study sites, besides performing their medicinal roles, are mainly trees, which are harvested for timber, charcoal burning, firewood, and building poles. The diversity of roles these plants perform exposes them to a higher harvesting pressure.

Trends of Plant Sources of Income

The plants being used as sources of income are declining more rapidly in Moroto Forest Reserve than in Sango Bay. The plant sources of income, in both study sites, are mainly trees, used for commercial purposes such as for timber, charcoal burning, firewood, and building poles. The diversity of roles these plants perform exposes them to a higher harvesting pressure.

During the 1960s and 1970s, the market for wood products was very selective. High value tree species such as Mvule (Melicea exelsa), Mahoganies, Elgon olive and Lovoa spp were depleted from the natural forests through selective logging. Large volumes of what at the time were considered 'undesirable' or 'weed' species were cleared using the charcoal refining method or poisoned with arboricides. The logged areas were later enriched with desirable tree species. Much biodiversity was lost through this process of exploitation. Uncontrolled harvesting and poor harvesting methods from the 1960s to the mid 1980s also contributed to biodiversity loss although estimates of such losses have not been documented (NEMA, 2000/2001).

Pressures on biodiversity from habitat loss, climate change and other causes are particularly high in East Africa (Groombridge and Jenkins 2002). Globally, the living planet index (WWF, 2002) shows a decline of 37 percent of biodiversity from 1970 to 2000, with the rate per decade at about 15 percent in the 1980s and 1990s.

Trends of Wild Food Plants

Wild foods are being lost more rapidly in Moroto forest reserve than in Sango Bay. In Moroto Forest Reserve, communities were gazetted inside and wild food plants contribute a significant role in their food security. In Sango Bay area, which is comprised of protected reserves of grasslands, wetlands and forests, communities, don't depend on wild food plants for food. The difference in the two land management statuses, for example, Sango Bay under reserves and Moroto being inhabited, explains the difference in change in biodiversity.

Through domestication and direct harvesting from the wild, Ugandans derive food, medicines, and a wealth of raw materials from plants. The importance of biodiversity to Ugandans is therefore not confined to natural ecosystems but includes agro-biodiversity especially in altered or anthropogenic ecosystems such as Rubaale (NEMA 2000/2001). Meanwhile, human settlements are encroaching on protected areas such as national parks, forest reserves, and wetlands. Uganda's population is growing very fast, at about 2.5 percent per annum, and this population is largely rural. Increased demand for food is resulting in new land being cleared for agriculture. Hence, large tracts of land are deforested annually (NEMA 2000/2001).

Trends of Wildlife

The numbers of wildlife species have been declining more rapidly in Moroto Forest Reserve than Sango Bay. The factors, which could have led to the significant reduction of in Moroto Forest Reserve, include:

- Hunting for meat which supplement food sources
- The clearance of forests, woodlands, bush and swamps, which had been habitat for wild animals, for expanded agricultural settlement
- Massive killing for settlement

Within wildlife-protected areas, poaching for both subsistence and commercial trade has been responsible in the past for the drastic reduction in wildlife populations. Fines for various wildlife offences are insufficient to act as effective deterrents, and the enforcement of the wildlife protection laws is weak (NEMA 2000/2001).

The loss of wildlife has been significant in Uganda. Although wildlife management was relatively efficient up to 1970, thereafter particularly during the 1970-1986 period, the status of wildlife was seriously undermined through indiscriminate poaching. This resulted in major

reductions in the number of species and populations, for example, between 1960 and 1998; Uganda lost 71 percent and 76 percent of its antelope and other large mammals (UWA 1999).

Although wildlife and wild plant resources in Uganda constitute a great asset, the country risks losing them altogether. Uganda's biodiversity decline is being experienced at the ecosystem, species and genetic levels. For example, both the northern white and the black rhino have been hunted for commercial purposes to extinction. Biodiversity is also being lost through the disappearance or alteration of habitats, and the introduction of alien species (NEMA 2000/2001). Examination of a composite index of biodiversity (1970=100) revealed that Uganda's biodiversity richness declined steeply from the 1960s to the 1990s (NEMA 2000/2001). Losses of biodiversity have been registered in forests and woodlands, wildlife-protected areas, wetlands, and aquatic ecosystems.

Conclusions and Recommendations

The results of this study of changing biodiversity based on local human perception reveals a decline in all biodiversity categories across the study sites, with Moroto being more degraded than Sango Bay. To counteract this, tree-planting programmes may be initiated in the study areas with immediate attention being given to Moroto Forest Reserve. Trees of high interest to the community, such as those that are used as sources of income or medicine, may be prioritised.

The methods used in the study are important tools for monitoring and assessing change in biodiversity based on human perceptions. However, we cannot rely on one data source to assess and monitor biodiversity. There is therefore a need to use a unified knowledge system involving biodiversity inventories, both ground truthing and aerial surveys, besides the indigenous knowledge for effective sustainable biodiversity assessment and monitoring.

Acknowledgments

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