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REVIEW PAPER

Participatory forest monitoring: an assessment of the accuracy of simple cost–effective methods

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Abstract International forest policies have recently increased the focus on involvement of local communities in forest monitoring and management as a strategy to improve biodiversity conservation efforts and local livelihood in developing countries. However, little is known about feasible methods, costs and accuracy of participatory monitoring schemes in developing countries. This paper examines the costs, accuracy and local reproducibility of three simple cost–effective methods for monitoring forest disturbance by local participants: (1) 20-trees method, (2) Bitterlich gauge method and (3) Disturbance Checklist transect. Using one of these methods the costs of monitoring forest habitats are only between US$ 0.04 and 0.12 ha^{-1} annually, depending on the methods used, this is significantly cheaper than the costs of traditional scientific methods for biodiversity monitoring. Results indicate that local community members without former scientific training can collect accurate data on habitat loss and forest disturbance after only a few days of introduction to the methods, and thereby contribute with valuable information for natural resource management. The strengths and weaknesses of monitoring done, respectively, by local community members and educated biologists, respectfully, are discussed. It is suggested that these approaches should be seen as supplements to each other rather than substitutes. Finally, it is argued that monitoring schemes in developing countries can be sustained after donor funds have ceased only if the local communities play a central role and clear financially and/or socially incentives for members of the local community are incorporated.

Keywords Forest disturbance · Uluguru Mountain · Participatory monitoring · Community based monitoring · Cost–effective monitoring methods · Participation · Sustainability · Developing countries

Introduction

Conservation of the world's ecosystems, their biodiversity and services is essential for humans in the future (Balmford et al. 2005). It is widely recognized that monitoring and

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development efforts in tropical developing countries need to be extended, if natural ecosystems are to be preserved for future generations (CBD 1992; Howard et al. 1998; Margules and Pressey 2000; UN 2002; Balmford et al. 2005; Birdlife 2005). Monitoring is a process of gathering information about a system to detect changes over time and space (Yoccoz et al. 2001) that aims to provide essential information for natural resource management to establish and evaluate conservation efforts and for decision makers to take rational action (Dinesen 1998; Howard et al. 1998; Yoccoz et al. 2001; Danielsen et al. 2005).

The majority of the world's countries, as parties to the Convention of Biodiversity, are obliged to monitor biodiversity according to article 7 in the convention (CBD 1992). However, many developing countries have major problems establishing monitoring schemes, as funds are extremely limited and biodiversity monitoring does not have the highest priority among the many challenges the developing countries are facing today (Dinesen 1998; Uychiaoco et al. 2005). Systematic biological field surveys are invariably the best monitoring solution from a scientific point of view. However, such surveys are often too expensive and too dependent on foreign experts to be sustained in developing countries by resources locally available (Jayasuriya et al. 1997; Margules and Pressey 2000; Danielsen et al. 2003; Hockley et al. 2005; Van Rijsoort and Jinfeng 2005). Thus, it has been argued, that monitoring schemes should involve and commit local people since management of natural resources, on a day-to-day basis, often relies on local people in developing countries (Getz et al. 1999; Danielsen et al. 2000; Sheil 2001; Danielsen et al. 2003; Hockley et al. 2005; Poulsen and Luanglath 2005). However, many traditional biodiversity data collection methods developed to be used by professional scientists are not suitable for use by uneducated local people without any scientific training (Sheil 2001; Danielsen et al. 2005). Most of the local participants in this study had not received education beyond the level of primary school.

Participatory monitoring, where local community members collect the monitoring data, may be a good alternative. However, for local people and government staff to be successfully involved, the methods must be simple (Danielsen et al. 2003; Hockley et al. 2005). It has been argued that the involvement of local community members in biodiversity monitoring may compromise data accuracy and increase biases beyond acceptable levels in comparison with data collected by educated biologists (Rodgers 1993; Firehock and West 1995; Brandon et al. 2003; Genet and Sargent 2003; Rodriguez 2003). But currently, only few studies have been done on feasible methods, costs, sustainability or accuracy of locally based biodiversity monitoring in developing countries. For this reason, the testing of accuracy, costs and local reproducibility of three simple cost–effective methods for monitoring forest disturbance, by local community members in the Uluguru North Forest Reserve in eastern Tanzania, may be relevant for other participatory forest monitoring schemes in developing countries around the world.

Study area

The Uluguru Mountains are located 170 km west of the Indian Ocean in the Morogoro region in Tanzania. They cover around 1500 km^2 of highland with a 45.5 km long main ridge running in a north–south direction. Four different sampling sites in Uluguru North Catchment Forest Reserve with different levels of disturbance were used (Fig. 1). All four sites are located in economically sensitive areas, where local people depend on the forest in and around the reserve for their livelihood, which creates conflicts regarding the use of resources. Earlier studies in the area have focused on establishing a flora biodiversity baseline by using

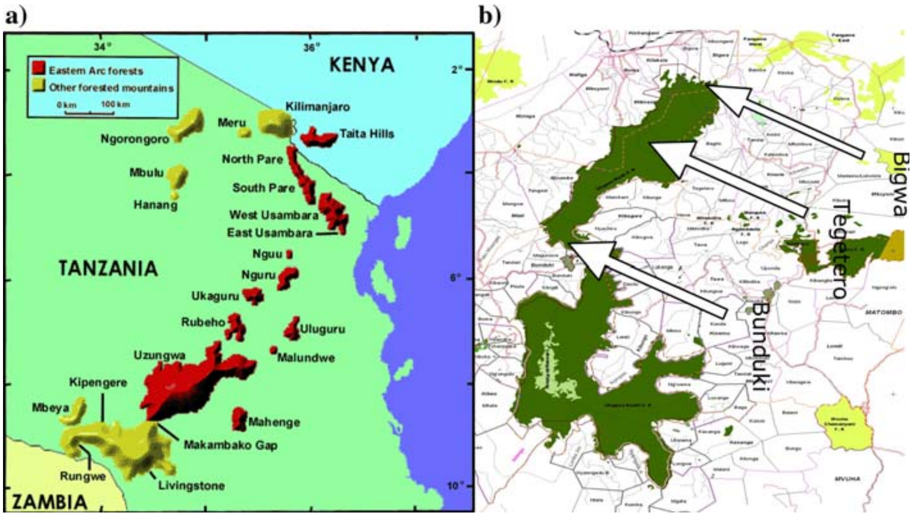

Fig. 1 (**a**) A schematic overview of the Eastern Arc Mountains of Tanzania and the southern Kenya. (**b**) Location of the study sites at the Uluguru North Forest Reserve in Tanzania

permanent vegetation plots. The main characteristics of the four sites are summarized in Table 1.

Methods

Local participation

Local participants were recruited from villages closest to the sampling sites. An introduction meeting was held prior to the fieldwork with the village chairmen, members of the local village environmental committee and local members of Wildlife Conservation Society of Tanzania (WCST) at each of the four villages in order to facilitate local participation in the study. Each team consisted of two members of the village environmental committee and two local WCST members. All participants were chosen by democratic election at the introduction meeting.

Forest disturbance

The ability of the methods to describe forest disturbance was tested on data collected by educated biologists using three simple monitoring methods in relation to permanent vegetation plots. At each site 20 randomly distributed points were established and surveyed using the 20-trees method. The 20-trees method focuses on forest structure by recording the Diameter at Breast Height (DBH) $\approx$1.3 m of 19 neighbouring trees with a circumference >16 cm (i.e. 5 cm DBH) around a randomly selected centre tree (Lovett 1996). After measuring the circumference of all the trees, the distance from the centre tree to the tree furthest away was measured, so that the basal area (m^2 ha^{-1}) could be calculated. A high basal area indicates undisturbed forest (Jans et al. 1993; Wilder et al. 1998), although not necessarily primary forest, as old secondary forests may have basal areas and species richness close to

Table 1 Main characteristics of the four sampling sites in the Uluguru Mountains, Tanzania

	Bigwa	Bunduki	Choma	Tegetero
Geographical location	06°49.9′ S 037°43.3′ E	07°00.0′ S 037°37.3′ E	07°06.0′ S 037°39.4′ E	06°56.6′ S 037°42.5′ E
Altitude (m.a.s.l.)	750–900 m	1600–1800 m	1200–1500 m	1200–1500 m
Vegetation types	Dry forestland dominated by *Brachystegia bussei* and *Margaritaria discoidea.*	Montane rainforest dominated by *Cyarthea manniana* and *Dracaena afromontana.*	Submontane rainforest dominated by *Caloncoba welwitschii, Myrianthus holstii* and *Vitex arminensis*	Submontane prehumid rainforest dominated by *Uvariodendron anisatum, Myrianthus holstii* and *Alsodeiopsis schumannii*
Disturbance level	Heavily disturbed	Intermediate disturbed	Intermediate disturbed	Undisturbed
Minutes walk from forest edge	0–5 min	15–20 min	30–45 min	60–90 min
Number of endemic tree species found in permanent plots	0	1 *Zenkerella egregia*	1 *Vitex arminensis*	3 *Allanblakia uluguruensis, Alsodeiopsis schumannii, Bertiera pouloi*
Endemic tree abundance (%)	0.0	0.4	8.7	14.3
Key threats	Collection of firewood and building poles, illegal hunting, conversion to agriculture land and human caused dry season fires	Pit sawing, collection of firewood and building poles and degraded plantation and farms occur inside the boundaries.	Collection of firewood and building poles and some local timber extraction	Rarely visited by humans

and sometimes even higher than those of primary forests (Huston 1979; Brearley et al. 2004).

Second, data was collected using a 50-cm long Bitterlich gauge (Fig. 2). The gauge is used by an observer, who operates it by holding it to the cheek and counting all trees with a diameter larger than the cross-piece. This was done in a circle from a central sampling point as described in Mueller-Dombois and Ellenberg (1974) at between 40 and 55 randomly distributed points at each site.

Third, a simple checklist was designed to describe the degree of disturbance caused by human activities for the area. The Disturbance Checklist transect covers an area of 60 × 20 m, and within this area all burns, cuts, big trees and very big trees are counted. At each site 11 randomly distributed transects were established and graded according to the system shown in Table 2.

The locals' reproducibility of the methods

The reproducibility of the methods was tested by comparing data collected by local community members with data collected by educated biologists using the same methods. The local community members received half a day of training in how to operate each of the three monitoring methods before left on their own to collect data in specially designated areas, where trained biologists had collected data using the same methods the previous day. To investigate the effect of further training, the local participants from Tegetero received an additional half a day of training and the participants from Bigwa were supervised by a local forest officer during their performance of the 20-trees method.

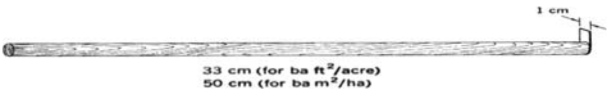

Fig. 2 A diagram of the 50 cm long Bitterlich gauge with a 1 cm wide cross piece at the one end

Table 2 The grading system of the Disturbance Checklist transect

Disturbance Checklist	Points
No burning	3
No cut	3
<9 old cuts	2
<3 new cuts	1
Three trees with Circumference ≥200 cm	3
Two trees with Circumference ≥200 cm	2
One tree with Circumference ≥200 cm	1
>8 trees 130 ≤ Circumference < 200 cm	3
5–8 trees 130 ≤ Circumference < 200 cm	2
2–4 trees 130 ≤ Circumference <200 cm	1
Total	Max. 12

The higher score the less disturbed. If the number of new cuts is three or more, no points can be granted for few old-cuts and if the number of very big trees (Circumference >200 cm) exceeds three the excess number will be counted under big trees (130 ≤ Circumference <200 cm). This checklist focuses on the results of all major disturbances from human activities in the Uluguru Mountains: burning, cutting and the number of big trees as an estimate of previous logging and disturbance

Analysis

Data collected, using the three methods, were tested in relation to forest disturbance by a one-way ANOVA (Fowler et al. 1998), and the mean value and standard deviation ($P < 0.05$) were calculated to test for differences between the mean values for the different sites. The data collected by local participants were compared to data collected by educated biologists using the same methods tested by a Mann–Whitney *U*-test (Fowler et al. 1998). A Monte-Carlo randomizing test was performed by taking the sum of numerical differences between matched pairs of data (data collected by local participants and trained biologists, respectively, at the exactly same point). Subsequently, the same procedure was repeated 100 times with numbers randomly chosen from the interval defined by the biologists' results which were compared to the data collected by local participants. The results of the summed differences between locally collected data and randomly selected values were compared with the summed differences of the matched pairs. If less than 5% of the results from the summed differences between locally collected data and randomly selected values were equal to or smaller than the reference matched pair value, the data collected by local field teams were considered statistically identical to the data collected by the trained biologists.

Costs

Local participants received TSH 7,500 (≈US$ 6.25) for each day spend in the field, whereas the professional botanist, who assisted in establishing the permanent vegetation plots received TSH 60,000 day^{-1} (≈US$ 50). The local participants were able to monitor around 300 ha day^{-1}. In comparison, it will take at least 9 days to do the same, using permanent vegetation plots, as it takes approximately 1½ day to establish each plot.

Results

Forest disturbance

Table 3 presents a summary of mean values of the three methods for each of the four sites and Table 4 shows the statistical comparison between the results of the three methods and forest disturbance using one-way ANOVA. All three methods are capable of describing the difference in disturbance. However, when comparing the three methods reciprocally, the Bitterlich gauge method and the Disturbance Checklist transect showed more unequivocal results than the 20-trees method.

Table 3 Mean value and standard deviation of the data collected using the three different methods

Method	Bigwa	Bunduki	Choma	Tegetero
20-trees method (basal area/ha)	17.43 ± 4.55	42.81 ± 21.58	41.05 ± 28.34	61.36 ± 29.41
Bitterlich gauge method (m^2/ha)	13.44 ± 2.69	21.25 ± 4.26	19.18 ± 2.11	29.34 ± 3.42
Disturbance Checklist transect	3.25 ± 1.71	7.91 ± 1.30	10.45 ± 0.82	12.42 ± 0.79

Table 4 The data collected using the three methods tested in relation to forest disturbance by a one-way ANOVA

Method	$P <$	d.f.	R^2
20-trees method (Log basal area = Disturbance)	0.0001	81	0.4884
Bitterlich gauge method (Score = Disturbance)	0.0001	169	0.7717
Disturbance Checklist transect (Score = Disturbance)	0.0001	43	0.8520

The locals' reproducibility of the methods

Tables 5 and 6 present the summary of the comparison between data collected by local participants and data collected by the educated biologists using the same methods. Figure 2 illustrates comparison of the mean values as revealed by these surveys. The results are derived from a few samples (seven samples at each site using the 20-trees method and Disturbance Checklist transect and 15 samples using the Bitterlich gauge method) and should therefore be interpreted with caution. However, it indicates that the participants, who were supervised doing the 20-trees method (Bigwa), or those who received the most training (Tegetero), also collected data most similar to the educated biologists. This suggests that local community members are capable of collecting valuable data on forest disturbance using one of the three methods, provided they receive a sufficient amount of training or supervision.

Time and costs of training and data collection

After one day of training, the local community members were capable of collecting useful data using the three methods on forest disturbance and habitat loss. After the training has been completed, data collection will be limited to one day twice a year. The costs of monitoring using the different methods are estimated below:

Permanent plots

9 days year^{-1} × (US$ 50 botanist $^{(a)}\text{day}^{-1}$ + 2 local $^{(b)}\text{days}^{-1}$ × US$ 6.25)/300 ha ≈US$ 1.88 ha^{-1} year^{-1}, where (a) = cost of one field day by a professional botanist and (b) = cost of one field day by a local participant.

Table 5 Comparison between data collected by local participants and data collected by educated biologists using the 20-trees method and the Disturbance Checklist transects

Method	Bigwa	Bunduki	Choma	Tegetero
20-trees method (Mann–Whitney *U*-test)	N.S.	$\boldsymbol{P < 0.05}$	$\boldsymbol{P < 0.05}$	N.S.
20-trees method (Monte Carlo test)	$\boldsymbol{P < 0.01}$	$P < 0.71$	$P < 0.52$	$\boldsymbol{P < 0.05}$
Disturbance Checklist transect (Mann–Whitney *U*-test)	N.S.	$\boldsymbol{P < 0.05}$	N.S.	N.S.
Disturbance Checklist transect (Monte Carlo test)	$P < 0.22$	$P < 0.43$	$P < 0.08$	$\boldsymbol{P < 0.02}$

The Mann–Whitney U-test investigates whether there are significant differences between the two dataset, whereas the Monte Carlo test investigates if the dataset can be regarded as statistically identical

Table 6 Comparison between data collected by 15 local participants and data collected by educated biologists using the Bitterlich gauge method

Person	Mann–Whitney *U*-test	Monte Carlo test
Tegetero 1	N.S.	$P < 0.26$
Tegetero 2	N.S.	$P < 0.17$
Tegetero 3	N.S.	$P < 0.15$
Bunduki 1	N.S.	$P < 0.18$
Bunduki 2	N.S.	$\mathbf{P < 0.05}$
Bunduki 3	N.S.	$P < 0.51$
Bunduki 4	N.S.	$P < 0.61$
Choma 1	$P < 0.05$	$P < 0.68$
Choma 2	$P < 0.05$	$P < 0.69$
Choma 3	$P < 0.05$	$P < 0.69$
Choma 4	$P < 0.05$	$P < 0.68$
Bigwa 1	$P < 0.05$	$P < 0.66$
Bigwa 2	$P < 0.05$	$P < 0.83$
Bigwa 3	$P < 0.05$	$P < 0.76$
Bigwa 4	$P < 0.05$	$P < 0.96$

The Mann–Whitney *U*-test investigates whether there are significant differences between the two dataset, whereas the Monte Carlo test investigates if the dataset can be regarded as statistically identical

20-tree method or Disturbance Checklist transect

2 days year^{-1} × 2 or 3 local $^{(b)}$days^{-1} × US$ 6.25/300 ha ≈US$ 0.08–0.12 ha^{-1} year^{-1}, where (a) = cost of one field day by a professional botanist and (b) = cost of one field day by a local participant.

Bitterlich gauge method

2 days year^{-1} × 1 local $^{(b)}$day^{-1} × US$ 6.25/300 ha ≈US$ 0.04 ha^{-1} year^{-1}, where (a) = cost of one field day by a professional botanist and (b) = cost of one field day by a local participant.

Discussion

In principle, monitoring provides data that describe the state of a site at a certain time. Such data may be applied as documentation for the establishment and evaluation of management activities and/or as basis for scientific investigations. The goal of monitoring, from a management point of view, is to identify the state of the system and to provide information on the system's response to management action, whereas the goal of scientific monitoring is to learn and understand the behaviour and dynamics of a system (Yoccoz et al. 2001). However, the past has shown that conventional biodiversity collection approaches by professional scientists are often considered irrelevant by local managers and, furthermore, may be far too expensive to be sustainable for continual monitoring in many developing countries (Lawton et al. 1998; Sheil 2001). As a result, decision-makers often lack the information needed to make the best decisions, which can lead to gross underestimations of the current rate of forest disturbance and deforestation (Padmanaba and Sheil 2007; Pandit et al. 2007).

To overcome these impediments, and to improve management strategies in developing countries, conservationists are nowadays encouraging sustainable conservation and development interventions through the involvement and participation of the local communities (Getz et al. 1999). This requires the development of simple cost–effective monitoring tools for the assessment of human impact that are able to detect trends and can be used by local community members without substantial scientific training (Bleher et al. 2006). However, such tools are only valid if the collected data are reliable and clear. It is therefore important to test the reliability of such tools against more comprehensive monitoring methods before employing them in large scale monitoring schemes.

Comparison of the three monitoring methods

Of the three methods tested in this study, the Bitterlich gauge method and the Disturbance Checklist transect were found most suitable for community based monitoring. They are both simple and cost–effective in comparison to permanent plots, and they enable scientifically untrained community members to collect quality data on forest disturbance and habitat loss after only one day of training. However, it should be noted that there is a difference in the individual site assessments between the two methods. The results of the Bitterlich gauge method suggest that Bunduki is less disturbed than Choma, whereas the Disturbance Checklist transect done by the professional biologist suggest the opposite (Fig. 3). Although the confidence levels are insufficient to make this difference statistically significant, it emphasizes that a comparison between different sites using these methods should be carried out with caution, as both methods rely on the complexity of the vegetation, and on the skills of those people collecting data which can vary from place to place. Thus, the methods do not apply to a universal scale and should be calibrated against more comprehensive sampling

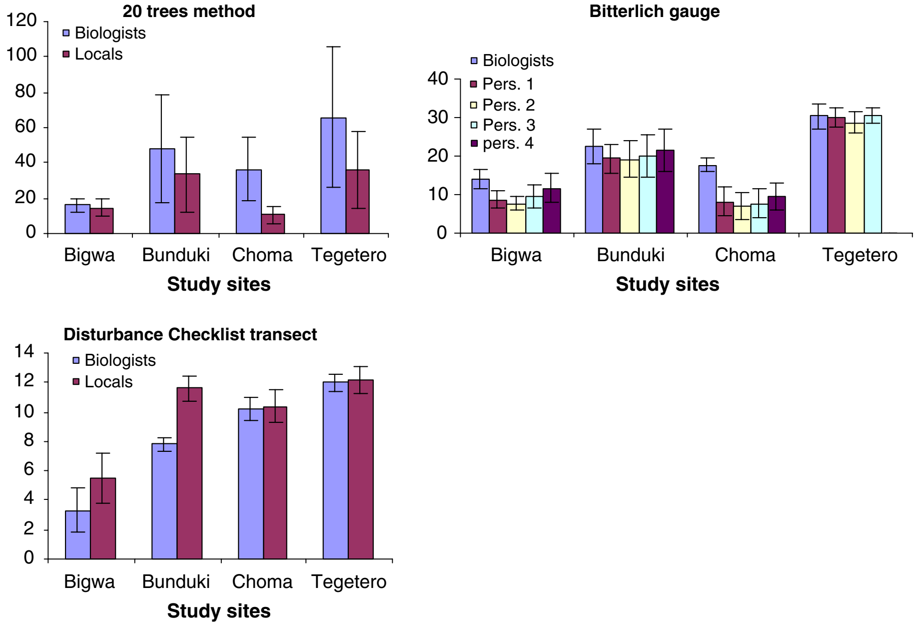

Fig. 3 Comparison of the mean values and standard deviation for data collected respectively by community members and data collected by trained biologists at the exact same points using the same three methods: 20-trees method (mean basal area $m^2\ ha^{-1}$), Bitterlich gauge method (mean Bitterlich score) and Disturbance Checklist transect (mean disturbance score). It should be noted that the persons in the comparisons of the Bitterlich gauge method are different from site to site

procedures before being used. Nevertheless, both methods can be useful in monitoring changes in the disturbance level within individual forest sites over time.

It has been argued that future conservation strategies need to focus on the quality of the protected areas rather than forest area covers in general (Sheil 2001 and Balaguru et al. 2006). Thus, it should be noted that none of the methods described in this paper are sufficient for this purpose. The selection of biodiversity priority areas needs to be established based on a scientifically acceptable ecological sampling assay of the particular forests (Balaguru et al. 2006). However, although the identification of biodiversity priority areas is important, this alone is not sufficient for long term conservation of these areas (Balaguru et al. 2006). Once the social, human and/or biodiversity significance of a forest area has been established, repeated disturbance monitoring is important to keep track of the human impact on the protected area, to evaluate past management decisions, and to set future conservation goals (Bleher et al. 2006). For this purpose both the Bitterlich gauge method and the Disturbance Checklist transect may contribute with reliable cost–effective data on forest disturbance and habitat loss, which is essential information for the local decision-makers in their efforts to preserve the particular forest area.

The results of the 20-trees method were not found clear enough to be recommended for use in the monitoring of the Uluguru North Forest Reserve. Earlier studies have used basal area based methods, similar to the 20-trees method, to describe the level of forest disturbance (Cottam and Curtis 1956; Lovett 1996; Wilder et al. 1998). However, the estimate of the true basal area depends largely on the number of trees used in the survey (Cottam and Curtis 1956), which indicates that the results of the 20-trees method might have been more accurate, had more samples been taken.

Comparison of monitoring done by local community members and professional scientists

Both participatory monitoring and monitoring by educated biologists have strengths and weaknesses, a comparison between the three simple methods used in this study and permanent vegetation plots is shown in Table 7. It is broadly recognised that monitoring by scientists can provide accurate and detailed results. However, taxonomical identification relies on educated taxonomists who are often expensive, which can cause a monitoring scheme to collapse when donor funds cease (Dinesen 1998; Getz et al. 1999; Danielsen et al. 2000; Margules and Pressey 2000; Sheil 2001; Danielsen et al. 2003). Nevertheless, surveys by scientists may play an important role in establishing baseline knowledge of biodiversity and in providing data for long term studies of trends and dynamics. Furthermore, they are independent of local interests, they are often capable of influencing national and global policies, and they may increase international funds for conservation and development efforts to an area (Danielsen et al. 2005).

On the other hand, there are also numerous advantages of participatory monitoring: Cost effectiveness, local commitment, and rapid identification of threats so prompt action can be taken. Additionally, the involvement of the local communities in the monitoring process often leads to effective long term conservation because it raises awareness and pride among the local community members, which can encourage them to take part in the protection and conservation efforts, and at the same time minimize the threats (Hellier et al. 1999; Becker et al. 2005; Danielsen et al. 2005; Poulsen and Luanglath 2005; Van Rijsoort and Jinfeng 2005). It is therefore important for a successful monitoring scheme to enhance the focus on field and village level, involve the local communities and use their expertise. For this to succeed, the monitoring methods need to be simplified to apply for local use and government officials should be involved in the process to enable reactions to pursue the monitoring

Table 7 Comparison of different monitoring methods

	20-trees method	Bitterlich gauge method	Disturbance Checklist transect	Permanent plot
Equipment	Measuring tapes, pen and paper	Bitterlich gauge, pen and paper	Rope, strings, pen and paper	Measuring tapes, pen and paper
Frequency	Every 6 month	Every 6 month	Every 6 month	Every year
Human resources	Minimum 2–3 persons	Minimum 1 person	Minimum 2–3 persons	Minimum 2–3 persons
Required training	1 day	1 day	1 day	At least one person that is scientific education in botanical taxonomy
Costs	0.08–0.12 US$ ha^{-1} $year^{-1}$	0.04 US$ ha^{-1} $year^{-1}$	0.08–0.12 US$ ha^{-1} $year^{-1}$	1.88 US$ ha^{-1} $year^{-1}$
Pros	Easy to use Cost–effective Equipment is locally available	Easy to use Cost–effective Equipment is locally available Provides useful data on disturbance on a short term scale	Easy to use Cost–effective Equipment is locally available Provides useful data on disturbance on a short term scale	Provide scientifically good data Good for detecting long term changes Can be used to establish a biodiversity baseline for the area
Cons	Less precision in the data More time consuming than the other simple methods Needs many samples to provide unambiguous conclusions Has not been shown capable to describe disturbance	Less precision in the data Requires some training of local participants Results can be individual	Less precision in the data Requires some training of local participants Requires at least three persons at the same time for sampling	Many plots are needed in order for the monitoring to work Needs expert for identification Relatively expensive Very time consuming Not suitable for short term disturbance monitoring

(Danielsen et al. 2003). However, studies of the effectiveness of participatory monitoring show that community collected data have a higher variation in comparison to data collected by educated biologists, which leads to less precision (Andrianadrasana et al. 2005; Poulsen and Luanglath 2005; Uychiaoco et al. 2005). Hence, efforts to reduce the costs are only valid if reliable and clear results can be obtained. Thus, it is equally important that the accuracy of the simplified methods is tested, so that the efficiency of the monitoring schemes is not compromised. If monitoring schemes are well planned, low cost surveys conducted by local community members can reveal useful and significant information to use for future practise (Padmanaba and Sheil 2007).

Sustainability through local participation

Sustainability for any conservation efforts in developing countries can only be ensured if the local communities play a central role (Sheil and Boissiére 2006). This can be done by incorporating benefits for the local communities into the scheme (Hockley et al. 2005; Poulsen and Luanglath 2005; Topp-Jørgensen et al. 2005; Padmanaba and Sheil 2007). The benefits may be economical but also benefits, such as social prestige, may help engage local people in conservation efforts (Padmanaba and Sheil 2007).

Financial security in the communities living around the Uluguru North Forest Reserve is generally minimal. It is difficult to argue that poor people should be responsible for the monitoring of the world's biodiversity and other resources of global importance without any trade-off. Thus, for the monitoring program to succeed, it will probably be necessary to incorporate economical compensation or other benefits for the local participants. The incentives for the community members participating in this study were partly related to the prestige of knowledge and being consulted by project staff and foreigners, but they also received financial compensation (US$ 6.25 day^{-1}) for the time spend in the field.

Another important issue for the sustainability is the amount of training provided for the local community members. Many past projects have failed because the local participants had received inadequate training or had not been sufficiently involved in the project (Sheil 2001). In this study, some community members received a full day of training in each of the methods, while others only received half a day of training to investigate the effect of extended training. After one day of training all local community members were capable of collecting data statistically comparable to that collected by the educated biologists using the same methods. On the other hand, some of the community members who only received half a day of training collected data that were significantly different from the data collected by the trained biologists using the same methods. This indicates that the local community members need to receive at least one day of training in these methods before they can be responsible for the day-to-day monitoring of forest disturbance in the Uluguru North Forest Reserve.

Conclusion

This study concludes that local community members without former scientific training are capable of collecting accurate data on habitat loss and forest disturbance, if the monitoring methods are kept simple and the local participants are provided with a sufficient amount of training. These aspects are critical for the sustainability of any participatory monitoring scheme. If scientists fail to provide locals with sufficient training, or the methods are not simple and cost–effective, the scheme will be likely to collapse when external investment ceases. Nowadays, almost every conservation or development policy strongly emphasise involvement of local people in management and monitoring, but the efficiency of such initiatives have rarely been tested. Further studies on this area need to be conducted in order to enable project designs to optimize the results of local involvement and still make priorities on the basis of reliable information.

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