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The value of indigenous and local knowledge as citizen science

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Highlights

- International policies require land management to be informed not only by scientific but also by indigenous and local knowledge.
- A major challenge is how to use, and quality-assure, information derived from different knowledge systems.
- Possible data collection and validation methods include focus groups with community members and information collected on line transects by trained scientists.
- Both methods provide comparable data on natural resource abundance, but focus groups are eight times cheaper.
- Focus group approaches could increase the amount and geographical scope of information available for land management, while simultaneously empowering indigenous and local communities who generally have limited engagement in such processes.

Introduction

Countries that have ratified the Convention on Biological Diversity (CBD) are obliged to respect, preserve and maintain knowledge of indigenous and local communities (https://www.cbd.int). As part of the convention, the countries have agreed on a set of goals, the Aichi targets, which should be achieved by 2020. Aichi Target 18 states that, by 2020, traditional knowledge should be integrated in the implementation of the convention (https://www.cbd.int/sp/targets/). Moreover, the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES), which was established in 2012 and is in the process of completing the first global assessment of nature and its benefits to people, aims to bring different knowledge systems, including indigenous and local knowledge, into the science-policy interface (Diáz et al. 2015; United Nations Environment Programme 2016). Policy of this kind is one thing, but sometimes practice is another. How can the broad policy statements and the results of high-level global assessments be translated into practice in the 'real world'?

Citizen science encompasses a broad array of approaches that have in common that citizens are involved in one or more aspects of assessment and monitoring of the environment (Bonney et al. 2014; ECSA Ten Principles of Citizen Science, see Robinson et al. in this volume). In Western countries, citizen science programmes often involve community members only in data collection. The design, analysis and interpretation of the assessment results are undertaken by professional researchers (see discussion in Kennett, Danielsen & Silvius 2015). In tropical, Arctic and developing regions, experiments have been made to involve community members in all aspects of environmental assessment and monitoring, including programme design, data interpretation and use of the results for decision-making and action (Danielsen, Burgess & Balmford 2005; PMMP 2015; Johnson et al. 2016). Although there are still a number of scientific questions surrounding these approaches, and many programmes are still at an early stage of development, the new approaches show a great deal of promise.

This chapter summarises a recent case study which tested a simple approach to document and validate indigenous and local knowledge (ILK) from Nicaragua using focus group discussions, in comparison with scientific knowledge gathered from line transects (Danielsen et al., 'Testing Focus Groups', 2014). This approach provides the base evidence to support the inclusion of ILK alongside scientific knowledge. This example illustrates the issues that can arise from bringing ILK into science-based land management and the benefits that can be achieved. The conclusions also build on experiences from similar activities where ILK and community expertise in monitoring have been brought together with scientific approaches in different regions, providing valuable insights especially for tropical forest and Arctic regions, although some lessons will apply to a range of geographies (Brofeldt et al. 2014; Danielsen 2016; Danielsen et al., 'A Multicountry Assessment', 2014; Danielsen et al., 'Counting What Counts', 2014; Danielsen et al. 2017; Funder et al. 2013; Zhao et al., 'Can Community Members', 2016; www.monitoringmatters.org).

Indigenous and local knowledge

The world's approximately 370 million indigenous people include some of the world's poorest and most marginalised communities (United Nations 2009). To participate in decision-making, indigenous people need to translate their knowledge about their territories into a format through which they can be heard, for example in government land management plans (Dallman et al. 2011). Often, however, indigenous knowledge is not valued, or simply not available, in decision-making processes.

One challenge for the synthesis of information generated by different knowledge systems (Huntington 1998; Colfer et al. 2005) is that while scientific knowledge is validated primarily through peer review by other scientists, other knowledge systems have different validation approaches (Tengö et al. 2014). In other knowledge systems, for example, the concept of 'if it works, it is good' may count as an evidence (Tengö and Malmer 2012). Unidirectional scientific validation of other knowledge systems may therefore compromise the integrity and complexity of the knowledge (Bohensky & Maru 2011; Gratani et al. 2011) and promote power inequality between technocrats and communities (Nadasdy 1999; Bohensky, Butler & Davies 2013). Alternatively, validation of community-based knowledge through a respectful process of collaboration between scientists and community members could potentially facilitate mutual learning and empowerment.

Here, the term 'indigenous and local knowledge', or ILK, is used to emphasise that knowledge of resource abundance is closely linked with knowledge of resource management systems and the social institutions the management systems operate within (Berkes 2012). Indigenous and local knowledge, like scientific knowledge, implies a way of viewing the world. It is context-specific, hence may lose meaning when applied in other contexts (Stephenson & Moller 2009). In comparison, knowledge about resource abundance, bound by place and time, does not lose its meaning and is relevant to decisions about its management. Berkes (2012) used 'local knowledge' when referring to recent knowledge and 'indigenous knowledge' for the local knowledge of indigenous peoples, or local knowledge unique to a culture or society. To demonstrate how ILK on natural resource abundance can be used in environmental assessment processes, the below case study compares community-level focus group discussions against scientist-executed line transects.

Comparing ILK and scientific methods

One previous study has evaluated focus group results against direct counts of natural resources (Mueller et al. 2010). This compared assessments of species richness, diversity and height of grasses and trees by community members from a village in Niger, with direct counts made by scientists. The study found a good match on height and density for grasses and trees and tree species richness, but poor correlation on herb species richness and Simpson's *D* value for both trees and grasses. The study does, however, have a different temporal scale and different times for community members' focus group discussions and direct counts, preventing conclusions about the reliability of the focus group (Danielsen et al., 'Testing Focus Groups', 2014).

Case study location

The case study was undertaken in the Bosawás Biosphere Reserve in Nicaragua, inhabited by Miskito and Mayangna communities who use forest as their principal resource base (Koster 2007; Stocks et al. 2007). The area is a global priority for conservation (Miller, Chang & Johnson 2001). Conventional scientific knowledge is constrained by difficult access, rugged terrain and frequent heavy rains.

The research covered nine study sites located opportunistically, 2 to 15 kilometres from San Andrés and Inipuwás villages, within Bosawás Biosphere Reserve. All study sites are covered in dense evergreen tropical forest, which is used as a resource to different degrees. The area is inhabited by indigenous Miskito and Mayangna who practice subsistence agriculture and harvest non-timber forest products.

Methodology

Focus groups are not commonly used by biologists but are often part of social scientists' tool box. They involve group discussion on a particular topic, organised to improve understanding and involve participants carefully selected for their knowledge, or experience, of the topic. The discussion is guided, monitored and documented by a person from within the community and/or by an external person, sometimes called a moderator or facilitator (Kitzinger 1995). Line transect survey is a commonly used scientific method in ecology (Peres 1999; Luzar et al. 2011). It is a survey undertaken while moving on a path along which researchers count and record occurrences of the species of study (Bibby et al. 2000). The abundance assigned by the focus groups was compared to the abundance from the scientists' transects.

In this study, communities were contacted through a civil society organisation with long experience working with them. Researchers met the General Assembly of Miskitas in the two villages to obtain their advice and approval. Community members volunteered for the focus groups, based on their interest and experience with forest resources. During participatory planning workshops, members of the focus groups were involved in planning the process and deciding on the future use of the results (for more on models of participatory citizen science see Ballard, Phillips & Robinson; Haklay; Novak et al., all in this volume). This included scientists and community members agreeing on 10 resources important to the communities for food or other uses. They identified three plants, three birds and four mammal taxa to be monitored across nine sites and at the same time (three-month periods) by both the focus groups and line transects.

Focus group members included forest product harvesters, hunters, loggers, local park rangers, and both women and men. A volunteer group of 10–20 persons was established in each village to observe forest resources at study sites between discussions. From April 2007 to September 2009, these groups took part in two-to-three-hour meetings every three months. Community members had good knowledge of the forest (Koster 2007) and the resources studied were of interest to, and well known by, them.

The meetings were facilitated by a group of non-indigenous park rangers. Facilitators were selected based on their skills at communicating equitably between knowledge systems during meetings. There was no detectable political interplay between the facilitators and community members. The facilitators led community discussion on the abundance of different resources at each study site in the respective three-month period.

The following abundance categories were used (Danielsen et al., 'Testing Focus Groups', 2014):

1. Many resources: ≥10 individuals of the resource (e.g., ≥10 individuals of a plant species) were recorded in four hours of morning walks in the forest;
2. Some resources: One to nine individuals of the resource were recorded in four hours of morning walks in the forest;
3. Few resources: More than four hours of morning walks in the forest were required to record one individual of the resource, but the resource is still recorded regularly (≥4 times during the three-month period); and
4. Very few (or no) resources: Resource only recorded a few times (<4 times) during the three-month period.

During the focus group discussions, these categories were interpreted as 'many daily', 'daily', 'less than daily' and 'rarely'. Focus groups' validation was a careful process involving time and trust. Community members were in control of the process, agreeing what was right and wrong, and the facilitator assisted this process. Community members involved in focus groups had extensive experience of hunting and collecting forest products (see figures 8.1–8.3).

Line transect routes were established in the same month and year as the focus groups. Transects were surveyed for animals and plants by trained scientists.

The findings were returned to the communities so they could see how their observations connected with results from other methods, and could be used to promote indigenous and local input into reserve management. This two-way process helped underline that the study was not information 'harvesting' but a collaborative undertaking.

Outcome

The focus group discussions were unable to differentiate between what scientists considered 'very few', 'few' and 'some resources', but resources reported as plentiful ('many resources') were significantly different (more abundant) from all other categories for all types of resources.

The apparent inability of focus group reports to differentiate between the three categories of least abundance was caused by high spread out

Fig. 8.1 Tuno (*Castilla tunu*) has a fibre-rich bark. It is important for crafting clothing, bags and rope, among other things, in the Bosawás Biosphere Reserve, Nicaragua. The tree grows more than 25 metres tall and is rich in latex but, in contrast to the related species (*Castilla elastica*) also found in the area, the Tuno-latex does not have elastic properties. (Source: Sune Holt)

Fig. 8.2 Signs of the Nine-banded Armadillo (*Dasypus novemcinctus*) showing disturbed leaf litter, twigs and small holes, where ants, termites and other insects have been dug out. (Source: Sune Holt)

of the numbers (high standard deviation) within focus-group category 4 ('very few') and fairly even densities of focus-group category 3 ('few resources') and 2 ('some resources') (see figure 8.4). Reducing the number of abundance categories from four to three, by merging 'few resources' and 'some resources', delivered a clearer separation of densities for birds and plants, although not for mammals. Likewise, Spearman correlation coefficients for transect densities and focus-group categories were 0.43 ($P<0.001$), 0.06 ($P=0.32$) and 0.30 ($P=0.04$) for birds, mammals and plants respectively, suggesting a stepwise reduction in densities (high, medium, low, very low) against focus-group categories (many, some, few, very few) for birds and plants, but not for mammals.

The cost of focus groups and scientist-executed line transects was estimated as the actual expenses incurred during the training and fieldwork at each site. Across all nine study sites, measurements through focus group discussions cost significantly less than scientists' transects ($P<0.001$; $n=9$).

Fig. 8.3 A Miskito community member recording his sightings and signs of plants, birds and mammals in the Bosawás Biosphere Reserve, Nicaragua. (Source: Sune Holt)

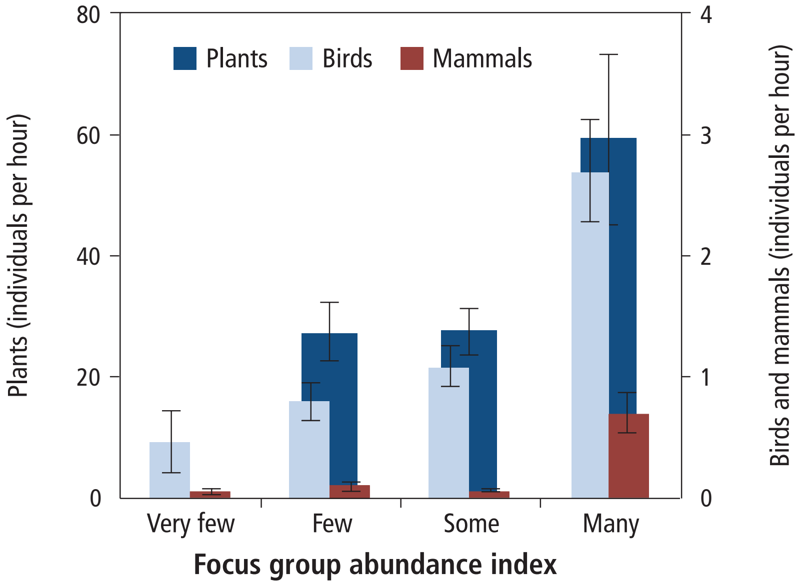

Fig. 8.4 Relationship between focus groups' statements of abundance of 10 plant, bird and mammal forest resources and the average abundance indices (number of individuals observed per hour, with SE) of the same resources obtained by trained scientists' transect walks between 2007–2009 at nine study sites in the Bosawás Biosphere Reserve, Nicaragua. Experienced community members' perceptions of forest resources, transmitted orally during focus group discussions, matched results from line transects by scientists. (Source: Danielsen et al., 'Testing Focus Groups', 2014)

Lessons for citizen science

The case study suggests that over a range of birds, mammals and plants, ILK documented and validated with focus groups provides similar abundance indices of wild species to trained scientists undertaking transects. The strongest agreement between focus groups and transects was for birds and plants, with lower agreement for mammals. This might be because mammals were mainly recorded by footprints and dung along transects, while birds and plants were directly observed, hence the number of mammals recorded on transects is subject to substantial individual interpretation.

Interestingly, focus group participants' understanding of individual abundance indices appears to vary between taxa. For instance, mammals recorded in the scientists' transects at 0.7–0.8 individuals per hour are considered 'many individuals' by the focus groups, whereas birds recorded on transects with the same density are considered to be 'few individuals' in the same focus groups. Focus groups are, thus, integrating community expectations, in other words, recording something as less abundant when fewer than expected are recorded given its identity, size (perhaps) or interest as food.

In the scientific knowledge system, reliability has two components: conformity to fact (lack of bias) and precision (exactness). The case study suggests that villagers' focus group assessments of abundance are similarly accurate (unbiased) to scientists' transects. The precision of the focus groups' assessments was not measured because abundance values from the focus groups are categorical, which hampers assessment of precision.

Focus groups involve interaction between group members (Gibbs 1997). Although the views of the most powerful members of the group might bias the results, observation in this case suggested that when potentially inaccurate information was provided by one or a few participants, after discussion, this information was generally corrected. Hence, the conclusion represented the group consensus.

The 'process' aspect of the focus groups was important to the community members. Focus group discussions were undertaken in an open learning environment, where participants had the right to vote and express opinions. They were the gatekeepers, detecting and deciding which data were complete and which were false or out of context, and should be discarded. The findings suggest that community members' ownership of the data and information and their control over the knowledge, validation process and application of knowledge were critical to their sense of empowerment (Stephenson & Moller 2009; Huntington 2011).

Central to approaches that facilitate exchange between knowledge systems is the concept that knowledge itself is power, which means that those who share knowledge should not lose power in the process (Nadasdy 1999; Gamborg et al. 2012; Tengö et al. 2017). The case study findings suggest that using focus groups to validate ILK about natural resources could increase the information available for measuring the status and trends of natural resources, while at the same time empowering indigenous and local communities. Guidelines already describe how to promote the use of indigenous knowledge (e.g., Tkarihwaié:ri Code; the Convention on Biological Diversity 2011) but to aid this process and

Box 8.1. Recommendations for how to increase the ability of community focus groups to provide natural resource abundance data which scientists would consider reliable (Danielsen et al., 'Testing Focus Groups', 2014; Danielsen 2016). Further recommendations for the participatory monitoring of biodiversity are available in the Manaus Letter (PMMP 2015).

1. Establish independent focus groups in multiple communities that know about resource abundance in the same geographical area (triangulation across communities).
2. Convene regular (e.g., annual) village meetings to present, discuss and interpret data, and obtain feedback from the entire community (triangulation across community members).
3. Facilitate the collection of auxiliary data, for example, through community members' direct counts of resources in the same area when possible (triangulation across methods).
4. Include focus group participants who are directly involved in using and observing natural resources (thereby increasing the number of primary data providers).
5. Use unequivocal categories for resource abundance.
6. Ensure that the moderator of focus group discussions has relevant skills and experience in facilitating dialogue.

increase the ability of community focus groups to provide natural resource abundance data which scientists would consider reliable, this chapter proposes a series of recommendations (box 8.1).

This approach should not, however, be rolled out uncritically – representatives of indigenous and local communities should decide whether focus groups on resource abundance can help them be heard. The UN Declaration on the Rights of Indigenous Peoples states that development must take place in accordance with their 'Free, Prior and Informed Consent' (United Nations 2008). Focus groups may also be a useful starting point from which broader regional and national monitoring and assessment programmes could be designed and implemented according to local conditions.

Conclusion: Implications for achieving management goals

The case study in this chapter has shown how ILK can inform land management policies and processes. Further, the authors have previously found that, for the same recurrent government investment in protected areas in the Philippines, far more conservation management interventions result from participatory natural resource monitoring approaches than conventional scientific ones (Danielsen et al. 2007). A large proportion of the interventions emanating from participatory monitoring addressed the most serious threats to biodiversity and led to changes in local policies with potentially long-term impacts.

In a meta-analysis of published monitoring results, the degree of involvement of local stakeholders in natural resource monitoring influences the spatial scale and speed of decision-making based on the monitoring data (Danielsen et al. 2010). The greater the involvement of local people in monitoring activities, the shorter the time it takes from data collection to decision-making. The most participatory approaches lead to management decisions typically taken three to nine times more quickly than decisions based on scientist-executed monitoring, although they operate at much smaller spatial scales. In contrast, scientist-executed monitoring typically informs decisions in regions, nations and international conventions.

Participatory monitoring of natural resources with the involvement of ILK depends on local people making a significant investment in monitoring. These approaches are therefore most appropriate: (1) where local people have significant interests in natural resource use; (2) when the information generated can impact management of the resources and the monitoring can be integrated within existing management regimes; and (3) when there are policies in place that enable decentralised decision-making (Danielsen 2016).

Promoting approaches such as those outlined in this chapter could provide an important set of results that, when published, could be used in the assessment work of IPBES as it seeks to fulfil its mandate to recognise and respect the contribution of ILK and bring it alongside scientific knowledge. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services has an important catalytic role in promoting the use of new approaches to improve the capture of data and information, and bringing together material from different knowledge systems. This chapter has shown how social and natural science approaches can also validate the credibility of either approach (social and natural science), and allow more confidence in results used to make important decisions for the management of the natural world.

Acknowledgement

This chapter is a shortened version of a detailed report available in Danielsen et al., 'Testing Focus Groups', 2014.