

What's in a name? Unpacking "participatory" environmental monitoring

Nerea Turreira-García, Jens F Lund, Pablo Domínguez, Elena Carrillo-Anglés, Mathias C Brummer, Priya Duenn, Victoria Reyes-García

▶ **To cite this version:**

Nerea Turreira-García, Jens F Lund, Pablo Domínguez, Elena Carrillo-Anglés, Mathias C Brummer, et al.. What's in a name? Unpacking "participatory" environmental monitoring. Ecology and Society, 2018, 23 (2), 11 p. 10.5751/es-10144-230224 . hal-01997709

HAL Id: hal-01997709

https://univ-tlse2.hal.science/hal-01997709

Submitted on 29 Jan 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright © 2018 by the author(s). Published here under license by the Resilience Alliance.
Turreira-García, N., J. F. Lund, P. Domínguez, E. Carrillo-Anglés, M. C. Brummer, P. Duenn, and V. Reyes-García. 2018. What's in a name? Unpacking "participatory" environmental monitoring. *Ecology and Society* 23(2):24. https://doi.org/10.5751/ES-10144-230224

Synthesis

What's in a name? Unpacking "participatory" environmental monitoring

Nerea Turreira-García [1], Jens F. Lund [1], Pablo Domínguez [2,3,4], Elena Carrillo-Anglés [4], Mathias C. Brummer [5,6], Priya Duenn [3] and Victoria Reyes-García [3,7]

ABSTRACT. While the number of projects that claim to conduct participatory environmental monitoring (PEM) is growing, "participation" continues to be translated into very different practices. We performed a systematic review of PEM projects reported in peer-reviewed journals (n = 146) to explore the main ways in which participation is operationalized and whose interests it serves. We found that local people were mainly involved in PEM projects through data collection, while professionals dominated during the ideation and design of the projects, as well as during the evaluation and use of data. Data collected through PEM was mainly used by professionals and researchers (56% of the cases that provided information on this topic), and less often used by local communities (20%). Our findings indicate that in most PEM projects published in scientific journals, participation is mostly functional in the sense that local peoples' involvement is framed so that they contribute to the gathering of information in a cost-effective way, while their potential interests in shaping the purpose and format of the project and use of the data appear overlooked. Overall, the actual practice of most PEM projects analyzed appears to foster participation in a very limited sense of the word. Although some studies document strong empowerment effects of PEM programs, many studies are superficial in their documentation of this aspect or they do not involve local people beyond collecting data.

Key Words: *citizen science; community-based; empowerment; locally based; patrolling*

INTRODUCTION

Participatory environmental monitoring (PEM) refers to a plethora of approaches involving local people in the structured gathering of information about the environment where they live (Abbot and Guijt 1998). Recent years have seen a growing emphasis on such approaches that claim to be cost-effective in yielding valid environmental monitoring data while simultaneously empowering local people through participation (Danielsen et al. 2013*a*). Although a quick check of this literature suggests that there is variation in how PEM schemes take the concept of "participation" into practice, to date there has been little effort to systematically analyze this aspect across the growing number of PEM schemes (but see Danielsen et al. 2009). In this paper we aim to fill this gap through a systematic literature review assessing the different ways in which local people participate in PEM schemes.

PEM is a form of environmental monitoring. Generally speaking, environmental monitoring refers to the actions oriented to detect changes in natural processes or human activities affecting biophysical systems. Results from environmental monitoring are typically used to support decision making and planning in relation to natural resources management (Abbot and Guijt 1998). Environmental monitoring has traditionally been carried out by professional scientists generally incurring large financial costs (Danielsen et al. 2009). The growing emphasis on assessing larger scale environmental trends, especially after the 1992 Rio Conference, resulted in increased efforts to monitor the environment. In this context, researchers argued that participatory approaches would be a cost-effective solution to environmental monitoring with significant social cobenefits in the form of local empowerment (Danielsen et al. 2007, 2013*a*, Larrazábal et al. 2012).

For the purpose of this review, we consider as PEM the variety of approaches that involve any level of local and/or nonprofessional participation in monitoring. In the literature, such approaches are also referred to as "community-based" (e.g., Topp-Jørgensen et al. 2005, Bellfield et al. 2015, Johnson et al. 2015), "locally based" (e.g., Danielsen et al. 2005, 2010, Nielsen and Lund 2012), or "hunter/fisher self-reports" (e.g., Noss et al. 2005, Uychiaoco et al. 2005, Rist et al. 2010). To be as inclusive as possible, we adopt the definition of PEM *senso lato*, and include published efforts that have been referred to as participatory, community-based, locally based, or community-led monitoring or patrolling and that involve local, rural, and/or indigenous peoples or communities.

The concept of participation has a long history in research and development. To unravel its meaning in the context of PEM, we distinguish between spaces of participation created for people and those created by people (Cornwall 2008). The latter refers to self-organized networks and movements that are created and framed by those who participate in them. The protests against oil-carrying pipelines in North America, where citizens come together and, in many cases, organize their own information collection, analysis, and communication to further their protest (see e.g., https://www.oilandwaterdontmix.org/), are examples of such spaces. Although in such self-organized movements, local people have high degrees of ownership and control over the purpose and process of

[1]Department of Food and Resource Economics, University of Copenhagen, Denmark, [2]Laboratoire de Géographie de l'Environnement (GEODE), UMR 5602 CNRS - Université Toulouse 2, France, [3]Institut de Ciència i Tecnologia Ambientals (ICTA), Universitat Autònoma de Barcelona, Spain, [4]Departament d'Antropologia Social i Cultural, Universitat Autònoma de Barcelona, Spain, [5]Center for Agro-Food Economy and Development, Castelldefels, Barcelona, Spain, [6]University of Bayreuth, Germany, [7]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain

participation, PEM schemes are almost invariably created by someone else than the local people who are, in turn, invited to participate in a space created for them. For example, local community involvement in carbon monitoring for REDD+ (Reducing Emissions from Deforestation and forest Degradation in Developing Countries) is a created space for local people's participation (http://redd.unfccc.int/).

By definition, created spaces of participation come with predefined agendas and, therefore, limits to participation. Different approaches have been suggested to further understand the nature of participation in such spaces. White (1996) distinguished four types of participation drawing on the interests and functions that the different actors have. Using this analysis she distinguished between nominal, instrumental, representative, and transformative participation. For example, in instrumental participation, involving local people in data collection may mean cost-efficiency for the actors who created the scheme, while the local people may perceive it as a cost in terms of time spent doing the monitoring. Thus, an examination of different actors' perceptions of what participation implies, reveals the underlying motives for participatory efforts as well as of the implications for different actors of how the efforts unfold in practice.

Pretty (1995) provides a hierarchical typology of participation that allows us to differentiate among six different levels of participation depending on the level of empowerment and autonomy of those who are invited to participate, i.e., local people. Among the lowest levels of participation in this typology we find manipulative participation, where top-down processes and decisions are legitimized by being called participatory and, in fact, no or little participation exists. Passive and consultative participation occurs when those who are invited simply receive and provide information, respectively. Functional participation implies that people are invited to participate because organizers believe it may lower the costs of achieving objectives. At a higher level we find interactive participation, in which participants and organizers of the participatory space are on more equal footing in deciding the purposes and process of participation. Finally, self-mobilization refers to processes where participation is no longer by invitation, but rather a self-created space. The term self-mobilization parallels the notion of participatory spaces created by people (Cornwall 2008).

It is worth acknowledging, however, that while we could reasonably characterize the participatory element in PEM processes by analyzing how these processes facilitate local empowerment, participatory processes are rarely predictable and might have unintended outcomes. For example, Tanzanian villagers participating in a PEM scheme with the predefined purpose of providing information about forest quality and disturbances were found to carefully manage the information created by the monitoring to safeguard their autonomy (Nielsen and Lund 2012, Funder et al. 2013). Thus, a monitoring effort that had clear elements of control and oversight by higher-level authorities was reshaped by the invited, local-level actors.

Our starting point for developing a framework with which to characterize participation is the work of Danielsen et al. (2009). These authors identify categories of monitoring schemes based on the level of involvement in data gathering and use by local stakeholders and scientists. Specifically, they differentiate among five types of participatory monitoring setups: (1) externally driven and professionally executed; (2) externally driven with local data collectors; (3) collaborative monitoring with external data interpretation; (4) collaborative monitoring with local data interpretation and; (5) autonomous local monitoring. Further, we are inspired by Shirk et al. (2012) who emphasized the importance of the degree and quality of public participation in the input stages of the research process. Shirk et al. (2012) assessed the degree of participation through a quantifiable measure of duration of involvement, research effort, numbers and/or diversity of stakeholders, and the quality of participation by examining the extent to which a project's goals and activities align with local participants' needs and interests. We define the input stages of the projects as the ideation (whose initiative the monitoring is) and design (who takes the decisions at the planning stages). Hence, drawing on insights of Danielsen et al. (2009) and Shirk et al. (2012) our framework takes into account the five commonly defined project stages, which are ideation, design, data collection, evaluation, and use of the data. To unpack the practices involved in PEM we reviewed 119 articles reporting PEM case studies, structured on the following two questions: Who is involved in PEM efforts and how? And whose interests are pursued in participation?

METHODS

We used two standard web-based search engines, the Web of Science and Scopus, to identify published case studies reporting PEM projects. Keywords used in the search included related terms encompassing three main concepts: (i) "participatory" or "community-based" or "locally-based" or "community-led"; (ii) "monitoring" or "patrolling"; and (iii) "local communities" or "rural communities" or "local people" or "indigenous." The search included documents published in English and up to December 2015 (included). The search was limited to case studies, thus excluding reviews and theoretical papers.

The search resulted in 267 documents. An initial screening was done based on the title, abstract, and general content of these documents to select those providing information about PEM projects. A total of 119 documents (44.5% of those initially identified) referred to one or more projects involving local people in environmental monitoring. These works were selected for an in-depth examination. When a document reported data from more than one project, we classified each project as a different case study, so our final sample consisted of 146 case studies described in 119 documents.

To unpack participation, we gathered the following information from each case study: (1) different actors' participation in each PEM stage; (2) characteristics of those involved in data collection (number of individuals, livelihood), including whether they were remunerated or not; (3) local participants' motivations to participate and; (4) actors' perceived costs and benefits of the PEM project. To allow for quantitative analysis, all the information collected was coded (Table 1) and entered in a Microsoft Office Access 2007 database specifically designed for this work.

We noted the specific location where data were collected and the total duration of the monitoring project (in months). We recorded whether the main livelihood of the local population was based on the direct use of natural resources, i.e., gathering, agriculture,

Table 1. Definition of variables used in the analysis.

Variable	Definition	Format
Location	Place where data were collected (country)	Text
Duration	Duration of data collection (months)	Number
Livelihood	Is the main livelihood based on the direct use of natural resources?	0 = No 1 = Yes 2 = Not specified
Payment	Monitors receive payment	0 = No, never 1 = Sometimes 2 = Yes 3 = Not specified
Project stages	Ideation, design, data collection, evaluation, and use of data	5 stages codes
Participants	Who participates?	7 participant codes
How?	Description of how the actors participate	Text
Number of monitors	Amount of monitors participating	Number
Motivation	Reported motivation of local people to participate	17 motivation codes
Perception	The benefit/cost perceived because of the monitoring program	5 perception codes

fishing, and pastoralism, or not. Finally, we also noted whether monitors were paid for the monitoring activity or not (0 = no, never; 1 = sometimes; 2 = yes; 3 = not specified). Monitors that were described as volunteers were considered as not paid or to have received a small contribution.

The project stages were classified as ideation, design, data collection, i.e., monitoring, evaluation, and use of data. The participants were classified into seven categories, some of them combining two or more actors: (1) professionals/researchers, including rangers and foresters; (2) local communities, including lay citizens and community networks; (3) governmental and nongovernmental organizations (hereafter "external organizations"); (4) professionals/researchers and local communities; (5) local communities and external organizations; 6) professionals/researchers and external organizations; and (7) all actors involved. Multiple categories could be checked per case study. Information regarding actors' participation in the different stages was transcribed verbatim from the articles; final classifications were revised by the first author. We also noted down the number of monitors.

We extracted statements on the local people's motivations to participate and later classified them into 17 codes, e.g., landscape management or empowerment. Multiple motivations could be reported per case study. Finally, we recorded the perceived costs and benefits reportedly expressed by each of the actors regarding the implementation of the PEM projects, which were later categorized according to the types of participation of White (1996), i.e., nominal, instrumental, representative, and transformative. Perceptions that could not be categorized as such were categorized as "other."

We used descriptive and bivariate statistics to analyze data. To visualize the geographical clustering of the case studies, we performed a kernel density estimation analysis (see Reyes-García et al. 2015) using QGIS 2.6 Brighton. We then explored patterns of frequency of participants' involvement in the various PEM stages. We analyzed the percentage of case studies reporting number of monitors and populations involved. We also calculated the percentage of cases mentioning motivations of local participants and selected cases that represented the most common motivations to use as examples. We finally calculated the distribution of perceptions that belonged to each of the types of participation of White (1996), and commented on few remarkable cases.

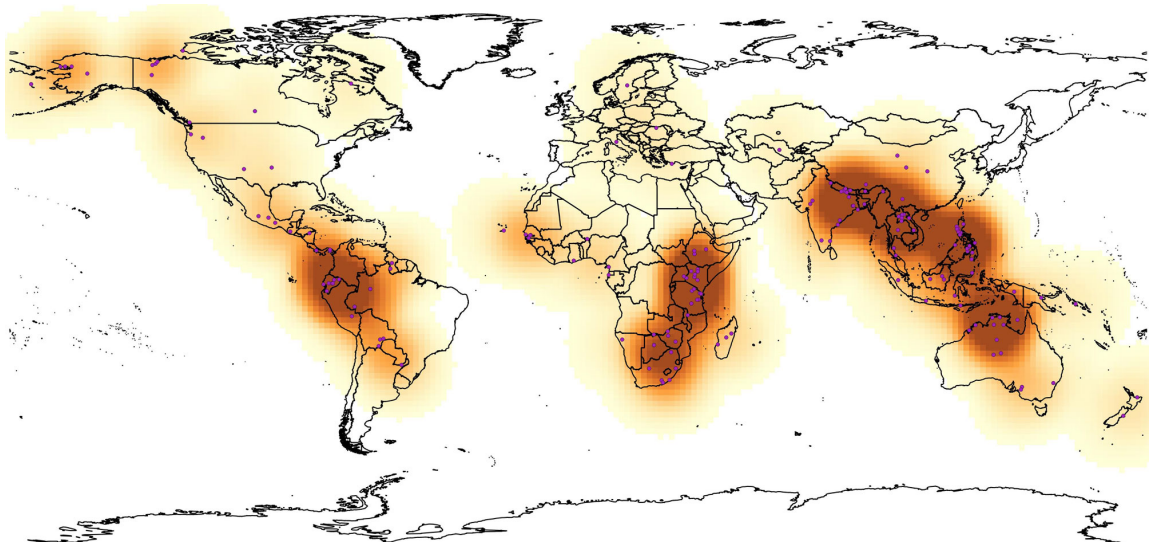
RESULTS AND DISCUSSION

Description of PEM projects

From the initial pool of 276 documents, 119 (44.5%) reported actual case studies of PEM projects. Some documents reported more than one case study, so our total sample consisted of 146 projects. Of the remaining documents, some were theoretical discussions and some used secondary data, such as a review of 15 locally based monitoring projects (Danielsen et al. 2005), a review of the role of community carbon monitoring for REDD+ in developing countries (Larrazábal et al. 2012), or a theoretical discussion on the potential for integrating community-based monitoring into REDD+ (Torres 2014).

The period 2010 to 2015 (representing 5 of the 25 years analyzed) featured 50% of all the articles on the topic. Of the 146 PEM projects examined 35% were conducted in Asia, especially Southeast Asia, 24% in Africa, 14% in South America, 13% in North America, and 12% in Oceania. Very little research (1%) on PEM involving lay people in Europe has been published (Fig. 1). This geographical bias could be explained by our choice of key words, e.g., local communities or indigenous, because most European initiatives involving lay people in the collection of data and information about their environments are generally done through citizen science projects. Citizen science refers to projects in which citizens are expected to gather observation data, e.g., counting birds or egg hatching events, a methodology that has gained momentum in recent years partly because of the possibility of collecting such data through a connected interface (Dickinson et al. 2010). Although we did not include this key word in our search, we did find four citizen science projects that could have potentially been part of our review (Leach and Fairhead 2002, Elbroch et al. 2011, Thornton and Leahy 2012, Stevens et al. 2014). However, we argue that given the methodological differences, the bias in PEM projects found in our search might reflect, not only the choice of words, but also fundamental differences in how participation in environmental monitoring is evolving with varying access to technology.

Fig. 1. Distribution and kernel density estimation of case studies. The dots indicate the location of the case studies and the yellow color gradient represents the density of case studies in a given area.



For many of the projects examined, we were unable to find information on all of our selected review variables. For example, only 90 of the 146 PEM projects examined mentioned the project's starting year, and the total duration of the projects was only mentioned in 57 cases (39% of the total). Interestingly, more than half of the projects for which we have information about duration (n = 35) reported less than 12 months of fieldwork, a third of those extended over two to six years, and were used to sample vegetation and/or animals. Without being able to draw a firm conclusion (given the paucity of data), this short duration suggests a tendency for PEM projects being seen as tools for rapid data collection, inhibiting the potential for empowerment of local communities.

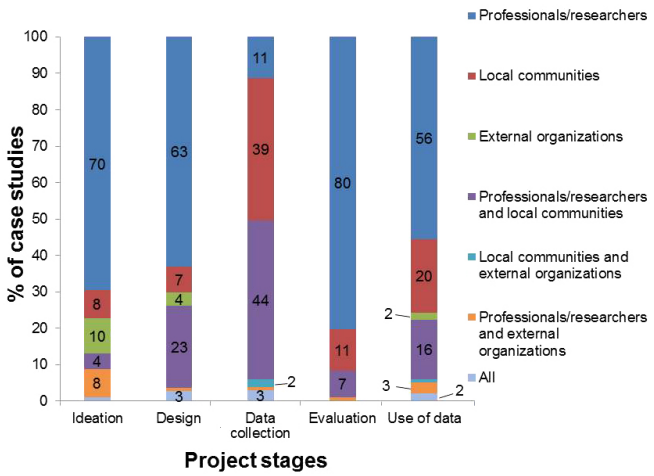
The majority of the local communities involved were rural (57%), very few were urban (4%), and 39% of the projects did not specify who was involved in data collection. A large number of the cases examined (40%) did not mention whether monitors were paid to conduct the environmental monitoring. Of the 60% that mentioned payments (n = 87), 31% reported that monitors were never paid, 11% that they were paid sometimes, and 17% that they were regularly paid for their work. Nevertheless, monitors might have received other kinds of benefits, such as access to decision makers (e.g., Vandergeest 2007).

Participation in environmental monitoring

The analysis of participants' involvement in the five stages of the PEM projects (ideation, design, monitoring, evaluation, and use of data) helps nuance the categories proposed by Danielsen et al. (2009), and consider whether PEM projects are "invited spaces for participation" or "spaces that people create themselves" (Cornwall 2008:275).

Within the case studies analyzed, there was some diversity in whether professionals/researchers, local communities, external organizations, and mixed teams participated in one or more stages of the project's life-span. Overall, professionals/researchers dominated the ideation, design, evaluation, and use of the data stages, while local communities, alone or in collaboration with professionals/researchers, were mainly involved in collecting data (Fig. 2). External organizations, i.e., governmental and nongovernmental organizations other than scientists and professionals, participated less than the other two groups in all the stages. However, we believe that these organizations have a very important role in the actual execution of the projects, as, given their long-term presence in the field, they usually act as bridges between researchers and local communities.

Fig. 2. Actors' participation in different project stages (n = 146 projects).



Most case studies (n = 133, 91%) reported who was involved in the data collection, but 32% of the studies did not report who participated in the other stages. This reduces transparency and hampers the assessment of empowerment and autonomy to those who participate.

Our results show that in most case studies, the PEM project idea did not originate from the local participants (only in 7 cases, 8% of the case studies that provided information on this topic). PEM efforts that involve scientific staff are thus almost invariably invited spaces of participation, where the monitoring effort is externally established and driven. According to Cornwall (2008), lack of participation in the ideation phase would imply that the potential to empower local communities is cut short. Nevertheless, it is possible that other PEM projects have originated from local participants, but that are not published.

Although the analysis shows that PEM projects are mainly designed by professionals/scientists (70 of the cases, 63%), there are 25 case studies (23%) in which professionals/researchers have codesigned, or at least considered the opinion of local participants in the design (e.g., Uychiaoco et al. 2005, Mutimukuru et al. 2006, Stacey et al. 2013). The earliest of these codesigned case studies is from 2005, which may indicate a growing emphasis on participation. Shirk et al. (2012) proposed a framework for practitioners to design participatory research that enhances its outcomes for scientific research, individual participants, and social-ecological systems.

As observed in Figure 2, local communities participate mainly in the data collection, while they are less involved in ideation, design, evaluation, and use of data. These results support the hypothesis that most PEM projects have a top-down nature. Professionals/researchers often train local communities on how to collect data and then data are collected either collaboratively (58 cases, 44%) or by local communities exclusively (52 cases, 39%).

Over a third of the projects (39%) involved less than 20 monitors, 21% involved between 20 and 350 monitors, and 39% did not mention the number of monitors involved in data collection. The general low number of monitors reflects that PEM projects are usually selective and targeted, mostly involving few people only. It is worth mentioning that the papers analyzed rarely mentioned how the monitors conducting the PEM were selected, so it is difficult to assess who is involved and, most importantly, who is left out (Cornwall 2008).

Similarly, the low level of local participation beyond data collection is also a consequence of the way PEM projects are framed. The procedures for data management and analysis are often developed by professionals or researchers (80% of the cases) who may not take into consideration whether those procedures suit the capacities and needs of local communities or not. Local people only participated in the evaluation of the data in 11% of the cases analyzed. For example, Ens (2012) reported a case study in which aboriginal peoples of Australia were trained to monitor environmental services using CyberTracker Technology. The author also indicates that local monitors were not capable of analyzing and interpreting the data in a meaningful way and needed external technical assistance for these tasks. A completely different outcome was achieved by Townsend et al. (2005), who used simpler monitoring methods, i.e., perceived abundance and direct and indirect counts of turtle populations, and taught the indigenous monitors to enter the data in the computer, analyze it, and make management decisions on the basis of their results. The acquaintance of these skills strengthened indigenous people's successful petition to the government for the rights to manage their territorial lands. These examples illustrate how the framing of the different stages of PEM efforts matter; in other words, local people's ability to participate in the different stages follows from the way in which the monitoring system is designed, including purpose and procedures for monitoring, analysis, and use.

According to our review, data collected through PEM are often used by professionals/researchers (55 cases, 56%), and only occasionally by local communities (20 cases, 20%), with some instances in which data benefit both actors (16 cases, 16%). That local communities rarely use the data might reflect a low degree of involvement in the overall process and, by extension, might relate to low empowerment potential. However, our assessment of the local involvement in the use of data should be taken with caution because there is a general lack of specificity in the reporting of the actual use of the data by local communities (only specifically mentioned in 21% of the cases). Several of the case studies featured statements about local communities' potential use of the data for their own benefit, for example for natural resource management and decision making (e.g., Grundy et al. 2004, Uychiaoco et al. 2005, Mutimukuru et al. 2006, Maheshwari et al. 2014, Boissière et al. 2014), for improving environmental regulations/laws (e.g., Şekercioğlu 2012, Spiegel et al. 2012), or for establishing payments for ecosystem services (Ens 2012). However, we lack empirical data analyzing the possibility that some data are used by the communities in the long term or at least after the research is concluded.

It is worth mentioning that, given the fact that our literature review is based on peer-reviewed literature, the results presented might be biased toward monitoring projects led by scientists. It is possible that academic and nonacademic organizations are involved in participatory monitoring projects in which local participation is considered at all levels, but that those experiences are not reflected in the academic literature. Keeping this caveat in mind, however, the observed uneven distribution of actor's participation in the different stages of PEM projects raises the question of whether PEM is actually about using local people as cheap labor to collect data. Although there is no simple answer to that question, two distinct approaches to PEM emerge from the literature. Some PEM projects are actually designed with research goals to test the PEM approach under particular conditions, and the role of local monitors is basically reduced to collect data at low costs (Danielsen et al. 2010*a*). Thus, participation in these projects is merely functional (Pretty 1995) and utilitarian. Conversely, other projects clearly aim to benefit the local monitors/community in one way or another, i.e., to improve management, provide socio-political benefits (e.g., Townsend et al. 2005). Taking into account that the main involvement of local participants is in the data collection and their input at the ideation and design of the projects is rather limited, it could be argued that, despite researchers' potential good intentions, PEM is currently a functional tool to gather information in a cost-effective way.

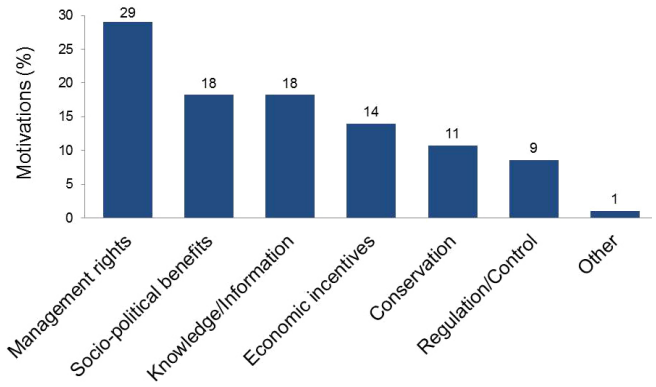
Interests in PEM

We also attempted to examine the nature of participation in PEM projects through understanding the motivations of local people to participate as well as their project perception. If people's motivations reflect ownership and empowerment, we would assume that projects allow local participation to a higher degree than if they reflect personal gains through remuneration.

Motivation to participate

In 30% of the papers reviewed we found explicit statements concerning the motivation of local participants to partake in the PEM project. From this reduced sample, we noted various aspects that motivate local people to engage in PEM (Fig. 3), which practitioners could take into account when designing PEM to ensure long-term partnership with local communities. In 29% of the cases in which local participants' motivations to participate were stated, people argued that they participated in monitoring their natural resources and landscape because the information gathered was useful to management or because gathering information was a prerequisite to obtain or retain rights to manage land and/or resources (e.g., Funder et al. 2013). The socio-political benefits associated with PEM, i.e., decision-making allowances, empowerment, social status increase, and improving relations with other stakeholders, were also a strong motivation to participate (18%). For example, in a case study among ethnic groups in the Solomon Islands, Aswani and Weiant (2004) reported that women were motivated to participate because the creation of their own long-term monitoring project empowered them to build their own enterprise and to generate cash income in a context in which women are usually undervalued.

Fig. 3. Motivations to participate in participatory environmental monitoring projects (n = 36 papers that stated motivations).



The motivation for the creation and dissemination of knowledge was equally relevant (18%). For example, Holck (2008) described that local people were motivated to monitor their forests because they felt that their knowledge was positively recognized and valuable to the project staff and foreigners, creating a sense of pride among community members. Some local participants also seemed to be driven by economic incentives (14%), a motivation which was also present in the two examples cited before. Other reasons to participate were conservation of natural resources (11%) and natural resources regulation and control (9%).

An important result, however, is that motivations of local actors are rarely recorded, which raises the issue of whether they are taken into account or not. And although some studies do report local motivations, even in these cases it is rarely done at a level of detail that allows us to exactly understand how the monitoring activities benefit people. Many studies mention cursorily that a motivation for monitoring is that local people gain useful information to manage their natural resources, about management rights, and/or about socio-political benefits. In reality, these may be difficult to separate because information and connections to powerful external actors, i.e., government agencies, project implementers, and scientists, may be useful for local management and have long-lasting empowerment potentials, but they could also reflect a dependency on external inputs, implying that local people are back at square one when projects end. This interpretation is further strengthened by the fact that payment is also often mentioned as a major motivation to participate.

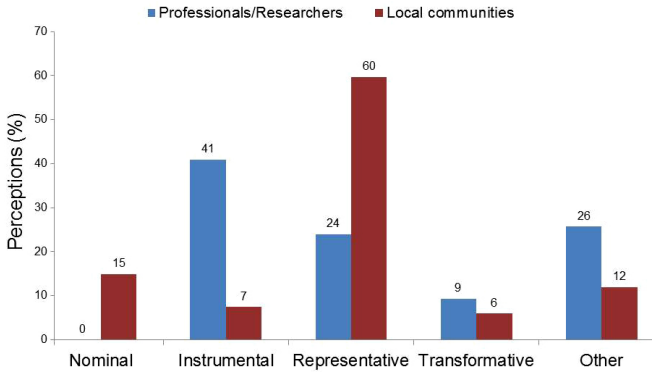
Taking into account that most of the reviewed PEM projects are designed with little or no local participation and therefore address problems that scientists or other external actors, e.g., governments or NGOs, believe important but are not necessarily perceived as such by local people, the continuation of an autonomous monitoring after the project funds end might be at risk. A paradigmatic example of this could be carbon monitoring for REDD+, which will most probably not be voluntarily continued by local communities after funding ends as long as the REDD+ finance mechanism is not in operation because people find no benefit in measuring carbon-stocks as such. The analysis of other participatory-conservation initiatives also suggests that payment-based initiatives tend to receive higher local participation with the pitfall that they rely on external finance mechanism putting their longer term sustainability under question (Méndez-López et al. 2014). More longitudinal studies of PEM efforts would be useful to enable analysis of their potential long-term empowerment effects.

Actors' perception of participatory projects

In our review we documented 268 statements that represented views or opinions regarding participation in environmental monitoring. Of those recorded, most belonged to professionals/researchers (64%), followed by the perceptions expressed by local communities and transcribed by the texts' authors (25%), and then by external organizations (11%).

When examining researchers' perceptions drawing on White's (1996) classification (Fig. 4), we found that none of the case studies seemed to belong to the nominal type of participation, i.e., that the interest of the implementation agency is to display that they are doing something. However, 41% (n = 70) of the perceptions reflected an instrumental type of participation, i.e., their interests focused on efficiency, limiting funders' input, drawing on community contributions, and making projects more cost-effective. For example, researchers considered that the inclusion of indigenous knowledge was useful and could enrich the monitoring (e.g., Townsend et al. 2005, Berkes et al. 2007) and perceived PEM projects as a cost-effective solution for monitoring (e.g., Dangles et al. 2010, Danielsen et al. 2010*b*, Rist et al. 2010, De Angelo et al. 2011). Some researchers also mentioned some limitations, such as the fact that PEM projects can be impractical for tasks that require specialization, or that they can be too time consuming (e.g., Kofinas et al. 2003, Townsend et al. 2005, Rennaud et al. 2012). According to most researchers, local people have the capacity to collect data (e.g., Gearheard et al. 2011, Grech et al. 2014, Venter et al. 2015), and accuracy and precision can be improved with training (Holck 2008, Danielsen et al. 2014). A few researchers raised concerns over the lack of local capacity to interpret and analyze data collected (e.g., Ens 2012, Hjalmarsdottir 2012), which hinders the possibility for empowerment and independence of local communities.

Fig. 4. Professionals/researchers' (n = 171) and local communities' (n = 67) perceptions of participatory environmental monitoring, by types of participation described by White (1996).



Twenty-four percent (n = 41) of researchers' perceptions denoted a representative type of participation, i.e., that they are interested in giving people a voice in determining their own development. For example, researchers argued that PEM can be seen as a means to achieve more qualified resource management (e.g., Uychiaoco et al. 2005, Chidammodzi and Muhandiki 2015) and conservation (e.g., Setty et al. 2008, Shen and Tan 2012). Almost 10% (n = 16) of researchers' perceptions indicated a transformative type of participation, i.e., that they were interested in truly empowering people to work independently (e.g., Danielsen et al. 2010*b*, Constantino et al. 2012, Peris et al. 2012). However, to achieve self-reliance and make their own decisions, people must be trained in data analysis and interpretation, as well as given authority over the purposes and format of the monitoring. Other opinions about the challenges and benefits of PEM projects of researchers (26%) were not classified according to White's (1996) types of participation. For example, the empowering ability of the PEM project was seen as hampered in circumstances when communities had a historical dependence on a paternalistic and central government and failed to assume responsibility to monitor and manage natural resources (Brooks and Tshering 2010) or when the technology used for monitoring surpassed local participants' capacities (Spiegel et al. 2012).

Overall, in most of the case studies for which we have information on these aspects, researchers reveal a functional or instrumental view of the role of local participation in environmental monitoring. In other words, the prevailing view of researchers seems to be that local involvement is relevant to ensure better monitoring data, as an input to local management or that it is a cost-effective approach to monitoring. Thus, it seems that for many researchers, the main goal of engaging in a PEM is to get information for predefined purposes, paying less attention to the empowerment potential. This overall impression of the interests of researchers aligns well with our results on the actual involvement of local people in the different stages of PEM efforts (cf. Fig. 2).

Local communities' main interest in participation reflected a representative type of participation (60%, n = 40), i.e., that they were interested in having leverage to shape the project. For example, local communities appreciated having an active role in natural resource management (e.g., Gaidet et al. 2003, Kofinas et al. 2003, Bell and Harwood 2012). In many cases, local communities were also reported as being interested in having their knowledge being appreciated by external actors and perceiving that such knowledge could serve for resource conservation (e.g., Tengberg et al. 1998, Noss and Cuéllar 2001, Oba et al. 2007) and regulation (e.g., Newman and LeDrew 2005, Mutimukuru et al. 2006). Few communities' interests denoted a nominal type of participation (15%, n = 10), i.e., they were interested in being included to retain some access to potential benefits. For example, some prevented opening new illegal shrimp farms (Vandergeest 2007) or perceived future economic benefits (Fabricius and Burger 1997, Rao et al. 1999). Perceptions reflecting instrumental participation, i.e., a cost of time spent on project-related activities, were rarely mentioned (7%, n = 5). Perceptions echoing transformative participation were found in few studies (6%, n = 4), expressed in the ability to decide and act for themselves. For example, local actors often felt empowered (e.g., Constantino et al. 2012) and capable of taking over responsibility for the PEM process (e.g., Rennaud et al. 2012); although this was not always the case (Brooks and Tshering 2010).

However, because only 40 studies (20% of the 119 documents) mentioned the perceptions of the local communities regarding PEM, it is possible that negative perspectives remain undocumented. It seems likely that there is a reporting bias because researchers reporting on PEM efforts they themselves have implemented are less likely to document negative sentiments of local communities who feel excluded or undercompensated.

The main views from the external organizations were that PEM projects were effective for environmental conservation (e.g., Robinson et al. 2005, Danielsen et al. 2007, Saunders and Bromwich 2012). They also perceived that PEM improved the relations between the different natural resources' users (e.g., Van Rijsoort and Jinfeng 2005, Giordano et al. 2010). This suggests that external organizations also use PEM projects as a functional-utilitarian tool to obtain information and the potential improvement in protection through improved relations.

CONCLUSION

Our review of studies on PEM projects published in peer-reviewed journals showed that most of them are, in practice, controlled by professionals and researchers. Local communities' involvement is reduced to data collection and they are rarely fully involved in the initial stages of the projects, when the purpose and format of the monitoring is decided. Their involvement in the analysis and use stages is also low, potentially inhibiting the empowerment potential of their participation.

Moreover, together with the low participation of local communities, the short-term character of most PEM projects, their technical framing, and the emphasis of researchers in highlighting the cost-effectiveness of such projects suggest that these sets of projects prioritize environmental monitoring over participation. It is important to emphasize that these conclusions are drawn on the basis of the information available in the studies reviewed. But, we do not know how well the image presented in these studies corresponds to the underlying reality of participation and collaboration in PEM projects that have not

been reported in the literature. Neither do we know the intentions and constraints met by the many hard-working scientists and local people engaging in PEM efforts.

Nevertheless, we believe that our results should be of concern for the research community engaged in PEM efforts, especially because our results echo previous works showing that many efforts labelled as participatory remain top-down or exclusive in practice (Cooke and Kothari 2001, Cornwall 2008). The discrepancy between rhetoric and practice should be of concern for the research community for several reasons, instrumental as well as idealistic. First, the differences in motivations and interests between researchers and communities are likely to lead to disappointment when local communities realize that their interests are unlikely to be met, rendering PEM efforts short lived (Shirk et al. 2012). Second, the discrepancy could contribute to delegitimize the research community that engages poor, resource-dependent communities in data collection efforts where there appears to be a distance between the discursive framing of the effort, as participatory, and the practice of who gets to decide what to monitor, how, and what the data can be used for.

For these reasons, we suggest that future PEM efforts should carefully balance the promises associated with participatory rhetoric with their intentions regarding participatory process in practice. Efforts that do signal participation should emphasize real engagement of local counterparts also in the ideation and design phases. For example, PEM projects could incorporate the idea of favoring the creation of self-reliant monitoring groups that have the tools to decide, in alliance with professional researchers, what is needed to be monitored, how, and in which way they can use the data for their own management decisions (see e.g., Topp-Jørgensen et al. 2005, Danielsen et al. 2013*b*, Boissière et al. 2014). This could contribute to improve communities' involvement in the decision-making process and potentially improve their socio-political outcomes. Finally, we encourage researchers documenting PEM to be more systematic about reporting their protocols, project's long-term outcomes for local communities (e.g., Funder et al. 2013), and to continue the analysis of field projects that might not be documented in the literature, for example autonomous local monitoring (e.g., Sheil et al. 2015). Such efforts will help researchers understand better the nature of each study, its implications, and possibly become a tool for increasing future good practices in PEM efforts.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/10144

Acknowledgments:

We started the analysis presented here in a course on Biocultural Diversity at the Master's program at ICTA-UAB. We are grateful to the students in the course, Jose Sancho, Oriol Andrés Conejero, Ignasi Galopa, Eduard Hernández Nualart, Yessenia Montero, Nuria Foguet, Nathaly Proaño Guevara, and Beatriz López-Fanjul, for their help with the review and insightful discussions. The title was inspired by the publications of Jacobsen et al. (2008) "What's in a name? The use of quantitative measures versus 'Iconised' species when valuing biodiversity"; and by Mutune and Lund (2016) "Unpacking the impacts of 'participatory' forestry policies: evidence from Kenya." This work contributes to the "María de Maeztu Unit of Excellence" (MdM-2015-0552)

LITERATURE CITED

Abbot, J., and I. Guijt. 1998. *Changing views on change: participatory approaches to monitoring the environment. SARL Discussion Paper No. 2*. IIED, London, UK.

Aswani, S., and P. Weiant. 2004. Scientific evaluation in women's participatory management: monitoring marine invertebrate refugia in the Solomon Islands. *Human Organization* 63 (3):301-319. http://dx.doi.org/10.17730/humo.63.3.r7kgd4thktmyf7k1

Bell, R. K., and L. A. Harwood. 2012. Harvest-based monitoring in the Inuvialuit Settlement Region: steps for success. *Arctic* 65 (4):421-432. http://dx.doi.org/10.14430/arctic4240

Bellfield, H., D. Sabogal, L. Goodman, and M. Leggett. 2015. Case study report: community-based monitoring systems for REDD+ in Guyana. *Forests* 6:133-156. http://dx.doi.org/10.3390/f6010133

Berkes, F., M. K. Berkes, and H. Fast. 2007. Collaborative integrated management in Canada's north: the role of local and traditional knowledge and community-based monitoring. *Coastal Management* 35(1):143-162. http://dx.doi.org/10.1080/08920750600970487

Boissière, M., G. Beaudoin, C. Hofstee, and S. Rafanoharana. 2014. Participating in REDD+ measurement, reporting, and verification (PMRV): opportunities for local people? *Forests* 5:1855-1878. http://dx.doi.org/10.3390/f5081855

Brooks, J. S., and D. Tshering. 2010. A respected central government and other obstacles to community-based management of the matsutake mushroom in Bhutan. *Environmental Conservation* 37(3):336-346. http://dx.doi.org/10.1017/S0376892910000573

Chidammodzi, C. L., and V. S. Muhandiki. 2015. Determination of the status of stakeholder participation in the management of the Lake Malawi basin through application of Integrated Lake Basin Management. *Lakes & Reservoirs: Research & Management* 20(3):166-181. http://dx.doi.org/10.1111/lre.12097

Constantino, P. A. L., H. S. A. Carlos, E. E. Ramalho, L. Rostant, C. Marinelli, D. Teles, S. F. Fonseca-Junior, R. B. Fernandes, and J. Valsecchi. 2012. Empowering local people through community-based resource monitoring: a comparison of Brazil and Namibia. *Ecology and Society* 17(4):22. http://dx.doi.org/10.5751/ES-05164-170422

Cooke, B., and U. Kothari. 2001. *Participation: the new tyranny?* Zed Books, London, UK.

Cornwall, A. 2008. Unpacking 'participation' models, meanings and practices. *Community Development Journal* 43(3):269-283. http://dx.doi.org/10.1093/cdj/bsn010

Dangles, O., F. C. Carpio, M. Villares, F. Yumisaca, B. Liger, F. Rebaudo, and J. F. Silvain. 2010. Community-based participatory research helps farmers and scientists to manage invasive pests in the Ecuadorian Andes. *Ambio* 39(4):325-335. http://dx.doi.org/10.1007/s13280-010-0041-4

Danielsen, F., T. Adrian, S. Brofeldt, M. van Noordwijk, M. K. Poulsen, S. Rahayu, E. Rutishauser, I. Theilade, A. Widayati, N. T. An, T. N. Bang, A. Budiman, M. Enghoff, A. E. Jensen, Y. Kurniawan, Q. Li, Z. Mingxu, D. Schmidt-Vogt, S. Prixa, V. Thoumtone, Z. Warta, and N. Burgess. 2013*a.* Community monitoring for REDD+: international promises and field realities. *Ecology and Society* 18(3):41. http://dx.doi.org/10.5751/ES-05464-180341

Danielsen, F., N. D. Burgess, and A. Balmford. 2005. Monitoring matters: examining the potential of locally-based approaches. *Biodiversity and Conservation* 14(11):2507-2542. http://dx.doi.org/10.1007/s10531-005-8375-0

Danielsen, F., N. D. Burgess, A. Balmford, P. F. Donald, M. Funder, J. P. G. Jones, P. Alviola, D. S. Balete, T. Blomley, J. Brashares, B. Child, M. Enghoff, J. Fjeldså, S. Holt, H. Hübertz, A. E. Jensen, P. M. Jensen, J. Massao, M. M. Mendoza, Y. Ngaga, M. K. Poulsen, R. Rueda, M. Sam, T. Skielboe, G. Stuart-Hill, E. Topp-Jørgensen, and D. Yonten. 2009. Local participation in natural resource monitoring: a characterization of approaches. *Conservation Biology* 23(1):31-42. http://dx.doi.org/10.1111/j.1523-1739.2008.01063.x

Danielsen, F., N. Burgess, M. Funder, T. Blomley, J. Brashares, A. Akida, A. Jensen, M. Mendoza, G. Stuart-Hill, M. K. Poulsen, H. Ramdhani, M. K. Sam, and E. Topp-Jorgensen. 2010*a.* Taking stock of nature in species-rich but economically poor areas: an emerging discipline of locally based monitoring. Pages 88-112 *in* A. Lawrence, editor. *Taking stock of nature: participatory biodiversity assessment for policy, planning and practice*. Cambridge University Press, Cambridge, UK. http://dx.doi.org/10.1017/CBO9780511676482.005

Danielsen, F., P. M. Jensen, N. D. Burgess, R. Altamirano, P. A. Alviola, H. Andrianandrasana, J. S. Brashares, A. C. Burton, I. Coronado, N. Corpuz, M. Enghoff, J. Fjeldså, M. Funder, S. Holt, H. Hübertz, A. E. Jensen, R. Lewis, J. Massao, M. M. Mendoza, Y. Ngaga, C. B. Pipper, M. K. Poulsen, R. M. Rueda, M. K. Sam, T. Skielboe, M. Sørensen, and R. Young. 2014. A multicountry assessment of tropical resource monitoring by local communities. *BioScience* 64(3):236-251. http://dx.doi.org/10.1093/biosci/biu001

Danielsen, F., M. M. Mendoza, A. Tagtag, P. A. Alviola, D. S. Balete, A. E. Jensen, M. Enghoff, and M. K. Poulsen. 2007. Increasing conservation management action by involving local people in natural resource monitoring. *Ambio* 36(7):566-570. http://dx.doi.org/10.1579/0044-7447(2007)36[566:ICMABI]2.0.CO;2

Danielsen, F., K. Pirhofer-Walzl, T. P. Adrian, D. R. Kapijimpanga, N. D. Burgess, P. M. Jensen, R. Bonney, M. Funder, A. Landa, N. Levermann, and J. Madsen. 2013*b.* Linking public participation in scientific research to the indicators and needs of international environmental agreements. *Conservation Letters* 7(1):12-24. http://dx.doi.org/10.1111/conl.12024

Danielsen, F., M. Skutsch, N. D. Burgess, P. M. Jensen, H. Andrianandrasana, B. Karky, R. Lewis, J. C. Lovett, J. Massao, Y. Ngaga, P. Phartiyal, M. K. Poulsen, S. P. Singh, S. Solis, M. Sørensen, A. Tewari, R. Young, and E. Zahabu. 2010*b.* At the heart of REDD+: a role for local people in monitoring forests? *Conservation Letters* 4(2):158-167. http://dx.doi.org/10.1111/j.1755-263X.2010.00159.x

De Angelo, C., A. Paviolo, D. Rode, L. Cullen, D. Sana, K. C. Abreu, M. Xavier da Silva, A.-S. Bertrand, T. Haag, F. Lima, A. R. Rinaldi, S. Fernández, F. Ramírez, M. Velázquez, C. Corio, E. Hasson, and M. S. Di Bitetti. 2011. Participatory networks for large-scale monitoring of large carnivores: pumas and jaguars of the Upper Paraná Atlantic Forest. *Oryx* 45(4):534-545. http://dx.doi.org/10.1017/S0030605310000840

Dickinson, J. L., B. Zuckerberg, and D. N. Bonter. 2010. Citizen science as an ecological research tool: challenges and benefits. *Annual Review of Ecology, Evolution and Systematics* 41:149-172. http://dx.doi.org/10.1146/annurev-ecolsys-102209-144636

Elbroch, M., T. H. Mwampamba, M. J. Santos, M. Zylberberg, L. Liebenberg, J. Minye, C. Mosser, and E. Reddy. 2011. The value, limitations, and challenges of employing local experts in conservation research. *Conservation Biology* 25(6):1195-1202. http://dx.doi.org/10.1111/j.1523-1739.2011.01740.x

Ens, E. J. 2012. Monitoring outcomes of environmental service provision in low socio-economic indigenous Australia using innovative CyberTracker Technology. *Conservation and Society* 10(1):42-52. http://dx.doi.org/10.4103/0972-4923.92194

Fabricius, C., and M. Burger. 1997. Comparison between a nature reserve and adjacent communal land in Xeric Succulent Thicket: an indigenous plant user's perspective. *South African Journal of Science* 93(6):259-262.

Funder, M., F. Danielsen, Y. Ngaga, M. R. Nielsen, and M. K. Poulsen. 2013. Reshaping conservation: the social dynamics of participatory monitoring in Tanzania's community-managed forests. *Conservation and Society* 11(3):218-232. http://dx.doi.org/10.4103/0972-4923.121011

Gaidet, N., H. Fritz, and C. Nyahuma. 2003. A participatory counting method to monitor populations of large mammals in non-protected areas: a case study of bicycle counts in the Zambezi Valley, Zimbabwe. *Biodiversity and Conservation* 12(8):1571-1585. http://dx.doi.org/10.1023/A:1023646012700

Gearheard, S., C. Aporta, G. Aipellee, and K. O'Keefe. 2011. The Igliniit project: Inuit hunters document life on the trail to map and monitor arctic change. *Canadian Geographer / Le Géographe canadien* 55(1):42-55. http://dx.doi.org/10.1111/j.1541-0064.2010.00344.x

Giordano, R., S. Liersch, M. Vurro, and D. Hirsch. 2010. Integrating local and technical knowledge to support soil salinity monitoring in the Amudarya river basin. *Journal of Environmental Management* 91(8):1718-1729. http://dx.doi.org/10.1016/j.jenvman.2010.03.010

Grech, A., G. J. Parra, I. Beasley, J. Bradley, S. Johnson, S. Whiting, li-Anthawirriyarra Sea Rangers, Yanyuwa Families, and H. Marsh. 2014. Local assessments of marine mammals in cross-cultural environments. *Biodiversity and Conservation* 23 (13):3319-3338. http://dx.doi.org/10.1007/s10531-014-0783-6

Grundy, I. M., B. M. Campbell, R. M. White, R. Prabhu, S. Jensen, and T. N. Ngamile. 2004. Participatory forest management in conservation areas: the case of Cwebe, South Africa. *Forests Trees and Livelihoods* 14(2-4):149-165. http://dx.doi.org/10.1080/14728028.2004.9752489

Hjalmarsdottir, E. H. 2012. Solar powered pumping technologies in rural water supply: case study from Kunene region, Namibia. *Waterlines* 31(3):197-214. http://dx.doi.org/10.3362/1756-3488.2012.021

Holck, M. H. 2008. Participatory forest monitoring: an assessment of the accuracy of simple cost-effective methods. *Biodiversity and Conservation* 17(8):2023-2036. http://dx.doi.org/10.1007/s10531-007-9273-4

Jacobsen, J. B., J. H. Boiesen, B. J. Thorsen, and N. Strange. 2008. What's in a name? The use of quantitative measures versus 'Iconised' species when valuing biodiversity. *Environmental and Resource Economics* 39(3):247-263. http://dx.doi.org/10.1007/s10640-007-9107-6

Johnson, N., L. Alessa, C. Behe, F. Danielsen, S. Gearheard, V. Gofman-Wallingford, A. Kliskey, E.-M. Krümmel, A. Lynch, T. Mustonen, P. Pulsifer, and M. Svoboda. 2015. The contributions of community-based monitoring and traditional knowledge to arctic observing networks: reflections on the state of the field. *Arctic* 68:1-13. http://dx.doi.org/10.14430/arctic4447

Kofinas, G., P. O. B. Lyver, D. Russell, R. White, A. Nelson, and N. Flanders. 2003. Towards a protocol for community monitoring of caribou body condition. *Rangifer* 23(14):43-52. http://dx.doi.org/10.7557/2.23.5.1678

Larrazábal, A., M. K. McCall, T. H. Mwampamba, and M. Skutsch. 2012. The role of community carbon monitoring for REDD+: a review of experiences. *Current Opinion in Environmental Sustainability* 4(6):707-716. http://dx.doi.org/10.1016/j.cosust.2012.10.008

Leach, M., and J. Fairhead. 2002. Manners of contestation: "citizen science" and "indigenous knowledge" in West Africa and the Caribbean. *International Social Science Journal* 54 (173):299-311. http://dx.doi.org/10.1111/1468-2451.00383

Maheshwari, B., M. Varua, J. Ward, R. Packham, P. Chinnasamy, Y. Dashora, S. Dave, P. Soni, P. Dillon, R. Purohit, Hakimuddin, T. Shah, S. Oza, P. Singh, S. Prathapar, A. Patel, Y. Jadeja, B. Thaker, R. Kookana, H. Grewal, K. Yadav, H. Mittal, M. Chew, and P. Rao. 2014. The role of transdisciplinary approach and community participation in village scale groundwater management: insights from Gujarat and Rajasthan, India. *Water* 6(11):3386-3408. http://dx.doi.org/10.3390/w6113386

Méndez-López, M. E., E. García-Frapolli, D. J. Pritchard, M. C. Sánchez González, I. Ruiz-Mallén, L. Porter-Bolland, and V. Reyes-Garcia. 2014. Local participation in biodiversity conservation initiatives: a comparative analysis of different models in South East Mexico. *Journal of Environmental Management* 145:321-329. http://dx.doi.org/10.1016/j.jenvman.2014.06.028

Mutimukuru, T., W. Kozanayi, and R. Nyirenda. 2006. Catalyzing collaborative monitoring processes in joint forest management situations: the Mafungautsi forest case, Zimbabwe. *Society & Natural Resources* 19(3):209-224. http://dx.doi.org/10.1080/08941920500460674

Mutune, J. M., and J. F. Lund. 2016. Unpacking the impacts of 'participatory' forestry policies: evidence from Kenya. *Forest Policy and Economics* 69:45-52. http://dx.doi.org/10.1016/j.forpol.2016.03.004

Newman, C. M., and E. LeDrew. 2005. Towards community- and scientific-based information integration in marine resource management in Indonesia: Bunaken National Park case study. *Environments* 33(1):5-24.

Nielsen, M. R., and J. F. Lund. 2012. Seeing white elephants? The production and communication of information in a locally-based monitoring system in Tanzania. *Conservation and Society* 10 (1):1-14. http://dx.doi.org/10.4103/0972-4923.92188

Noss, A. J., and R. L. Cuéllar. 2001. Community attitudes towards wildlife management in the Bolivian Chaco. *Oryx* 35(4):292-300. http://dx.doi.org/10.1017/S003060530003204X

Noss, A. J., I. Oetting, and R. L. Cuéllar. 2005. Hunter self-monitoring by the Isoseño-Guaraní in the Bolivian Chaco. *Biodiversity and Conservation* 14:2679-2693. http://dx.doi.org/10.1007/s10531-005-8401-2

Oba, G., E. Sjaastad, and H. G. Roba. 2007. Framework for participatory assessments and implementation of global environmental conventions at the community level. *Land Degradation & Development* 19(1):65-76. http://dx.doi.org/10.1002/ldr.811

Peris, J., S. Fariñas, E. López, and A. Boni. 2012. Expanding collective agency in rural indigenous communities in Guatemala: a case for *El Almanario* approach. *International Development Planning Review* 34(1):83-102. http://dx.doi.org/10.3828/idpr.2012.6

Pretty, J. N. 1995. Participatory learning for sustainable agriculture. *World Development* 23(8):1247-1263. http://dx.doi.org/10.1016/0305-750X(95)00046-F

Rao, K. S., R. K. Maikhuri, and K. G. Saxena. 1999. Participatory approach to rehabilitation of degraded forest lands: a case study in a high altitude village of Indian Himalaya. *International Tree Crops Journal* 10(1):1-17. http://dx.doi.org/10.1080/01435698.1-999.9752988

Rennaud, J.-P., J. Ruitenbeek, and T. Tennigkeit. 2012. Challenges of community-forestry based carbon projects: process, participation, performance. *Fact Actions Science Reports* (7):1-10.

Reyes-García, V., Á. Fernández-Llamazares, M. Guèze, A. Garcés, M. Mallo, M. Vila-Gómez, and M. Vilaseca. 2015. Local indicators of climate change: the potential contribution of local knowledge to climate research. *WIREs Climate Change* 7:109-124. http://dx.doi.org/10.1002/wcc.374

Rist, J., E. J. Milner-Gulland, G. Cowlishaw, and M. Rowcliffe. 2010. Hunter reporting of catch per unit effort as a monitoring tool in a bushmeat-harvesting system. *Conservation Biology* 24 (2):489-499. http://dx.doi.org/10.1111/j.1523-1739.2010.01470.x

Robinson, C. J., D. Smyth, and P. J. Whitehead. 2005. Bush tucker, bush pets, and bush threats: cooperative management of feral animals in Australia's Kakadu National Park. *Conservation Biology* 19(5):1385-1391. http://dx.doi.org/10.1111/j.1523-1739.2005.00196.x

Saunders, M., and D. Bromwich. 2012. New model rural cooperatives in Gansu: a case study. *Journal of Enterprising Communities: People and Places in the Global Economy* 6 (4):325-338. http://dx.doi.org/10.1108/17506201211272760

Şekercioğlu, Ç. H. 2012. Promoting community-based bird monitoring in the tropics: conservation, research, environmental education, capacity-building, and local incomes. *Biological Conservation* 151(1):69-73. http://dx.doi.org/10.1016/j.biocon.2011.10.024

Setty, R. S., K. Bawa, T. Ticktin, and C. M. Gowda. 2008. Evaluation of a participatory resource monitoring system for nontimber forest products: the case of *amla* (*Phyllanthus* spp.) fruit harvest by Soligas in South India. *Ecology and Society* 13 (2):19. http://dx.doi.org/10.5751/ES-02510-130219

Sheil, D., M. Boissière, and G. Beaudoin. 2015. Unseen sentinels: local monitoring and control in conservation's blind spots. *Ecology and Society* 20(2):39. http://dx.doi.org/10.5751/ES-07625-200239

Shen, X., and J. Tan. 2012. Ecological conservation, cultural preservation, and a bridge between: the journey of Shanshui Conservation Center in the Sanjiangyuan region, Qinghai-Tibetan Plateau, China. *Ecology and Society* 17(4):38. http://dx.doi.org/10.5751/ES-05345-170438

Shirk, J. L., H. L. Ballard, C. C. Wilderman, T. Phillips, A. Wiggins, R. Jordan, E. McCallie, M. Minarchek, B. V. Lewenstein, M. E. Krasny, and R. Bonney. 2012. Public participation in scientific research: a framework for intentional design. *Ecology and Society* 17(2):29. http://dx.doi.org/10.5751/ES-04705-170229

Spiegel, S. J., C. A. A. S. Ribeiro, R. Sousa, and M. M. Veiga. 2012. Mapping spaces of environmental dispute: GIS, mining, and surveillance in the Amazon. *Annals of the Association of American Geographers* 102(2):320-349. http://dx.doi.org/10.1080/00045608.2011.641861

Stacey, N., A. Izurieta, and S. T. Garnett. 2013. Collaborative measurement of performance of jointly managed protected areas in Northern Australia. *Ecology and Society* 18(1):19. http://dx.doi.org/10.5751/ES-05273-180119

Stevens, M., M. Vitos, J. Altenbuchner, G. Conquest, J. Lewis, and M. Haklay. 2014. Taking participatory citizen science to extremes. *IEEE Pervasive Computing* 13(2):20-29. http://dx.doi.org/10.1109/MPRV.2014.37

Tengberg, A., J. Ellis-Jones, R. Kiome, and M. Stocking. 1998. Applying the concept of agrodiversity to indigenous soil and water conservation practices in eastern Kenya. *Agriculture, Ecosystems & Environment* 70:259-272. http://dx.doi.org/10.1016/S0167-8809(98)00153-4

Thornton, T., and J. Leahy. 2012. Trust in citizen science research: a case study of the groundwater education through water evaluation & testing program. *Journal of the American Water Resources Association* 48(5):1032-1040. http://dx.doi.org/10.1111/j.1752-1688.2012.00670.x

Topp-Jørgensen, E., M. K. Poulsen, J. F. Lund, and J. F. Massao. 2005. Community-based monitoring of natural resource use and forest quality in montane forests and miombo woodlands of Tanzania. *Biodiversity and Conservation* 14(11):2653-2677. http://dx.doi.org/10.1007/s10531-005-8399-5

Torres, A. B. 2014. Potential for integrating community-based monitoring into REDD+. *Forests* 5:1815-1833. http://dx.doi.org/10.3390/f5081815

Townsend, W. R., A. R. Borman, E. Yiyoguaje, and L. Mendua. 2005. Cofán Indians' monitoring of freshwater turtles in Zábalo, Ecuador. *Biodiversity and Conservation* 14(11):2743-2755. http://dx.doi.org/10.1007/s10531-005-8410-1

Uychiaoco, A. J., H. O. Arceo, S. J. Green, M. T. De La Cruz, P. A. Gaite, and P. M. Aliño. 2005. Monitoring and evaluation of reef protected areas by local fishers in the Philippines: tightening the adaptive management cycle. *Biodiversity and Conservation* 14 (11):2775-2794. http://dx.doi.org/10.1007/s10531-005-8414-x

Van Rijsoort, J., and Z. Jinfeng. 2005. Participatory resource monitoring as a means for promoting social change in Yunnan, China. *Biodiversity & Conservation* 14(11):2543-2573. http://dx.doi.org/10.1007/s10531-005-8377-y

Vandergeest, P. 2007. Certification and communities: alternatives for regulating the environmental and social impacts of shrimp farming. *World Development* 35(7):1152-1171. http://dx.doi.org/10.1016/j.worlddev.2006.12.002

Venter, M., O. Venter, W. Edwards, and M. I. Bird. 2015. Validating community-led forest biomass assessments. *PLoS ONE* 10(6):e0130529. http://dx.doi.org/10.1371/journal.pone.0130529

White, S. C. 1996. Depoliticizing development: the uses and abuses of participation. *Development in Practice* 6(1):6-15. http://dx.doi.org/10.1080/0961452961000157564