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FORUM

Environmental monitoring: the scale and speed of implementation varies according to the degree of peoples involvement

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Summary

1. Solutions to the global environmental crisis require scientific knowledge and responses spanning different spatial scales and levels of societal organization; yet understanding how to translate environmental knowledge into decision-making and action remains limited.
2. We examined 104 published environmental monitoring schemes to assess whether participation in data collection and analysis influences the speed and scale of decision-making and action.
3. Our results show that scientist-executed monitoring informs decisions within regions, nations and international conventions. However, decisions typically take 3–9 years to be implemented.
4. We also show that scientist-executed monitoring has little impact at the village scale, where many natural resource management decisions are made.
5. At the village scale, monitoring schemes that involve local people, and relate to resource utilization at the village level, are much more effective at influencing decisions; these decisions typically take 0–1 year to be implemented.
6. *Synthesis and applications:* Involving local stakeholders in monitoring enhances management responses at local spatial scales, and increases the speed of decision-making to tackle environmental challenges at operational levels of resource management.

Key-words: 2020 target, biodiversity monitoring, citizen science, climate change, decision-making, locally based monitoring, natural resource management, participatory monitoring, REDD, stakeholder participation

It is now clear that the world has failed to achieve the United Nations' 2010 target to stem biodiversity loss (Butchart *et al.* 2010; European Union 2010). Additionally, anthropogenic global changes continue to undermine the ecosystem services upon which society depends (United Nations 2005; CAFF 2010). Future attempts to reverse this multifaceted crisis need scientific information (Hobbs 2003) and responses spanning different spatial scales and levels of societal organization (United Nations 2005; Sandbrook *et al.* 2010), yet understanding how to translate environmental knowledge into decision-making and action is limited (Mooney & Mace 2009; Milner-Gulland *et al.* 2010).

Case studies suggest that collaboration between scientists and local stakeholders in producing knowledge on the status of the natural resources can lead to favourable outcomes for the environment (Sheil & Lawrence 2004; Lawrence 2010), but quantitative analysis is lacking. Here we use meta-analysis techniques to explore if public participation in environmental monitoring influences the speed and spatial scale of decision-making and resulting action to address environmental challenges.

We first established a database of 104 publications on environmental monitoring schemes where the role of scientists and local stakeholders in the monitoring was described (see Appendix S1 and Table S1, Supporting information). We then identified who made decisions based on the results of the monitoring, and assessed the minimum time from the start of

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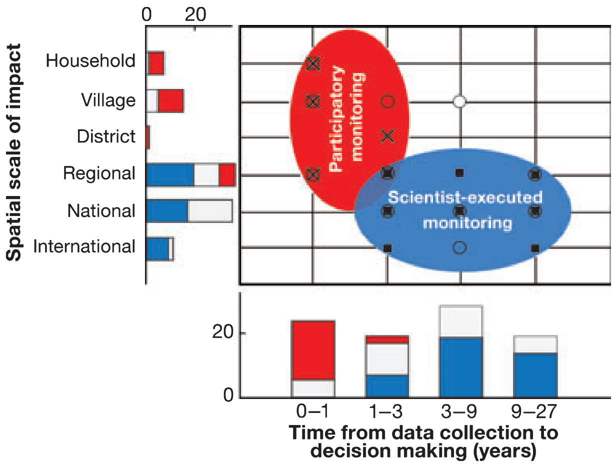

Fig. 1. Decision-making from environmental monitoring, based on data from published monitoring schemes 1989–2009 (n = 104). ■, scientist-executed monitoring schemes (n = 45); ○, monitoring schemes with local data collectors (n = 37); and ×, participatory monitoring schemes (n = 22). The circles comprise all the scientist-executed (blue) and all the participatory monitoring schemes (red). The bar chart indicates the number of scientist-executed monitoring schemes (blue bars), monitoring schemes with local data collectors (white bars) and participatory monitoring schemes (red bars) at each level of spatial scale and implementation time.

the data collection to the findings being used for decision-making.

The degree of involvement by local stakeholders in environmental monitoring profoundly influences the spatial scale and speed of decision-making based on the monitoring data (Fig. 1; Table S2). Scientist-executed monitoring informs decisions in regions (44%), nations (38%) and international conventions (18%) (n = 45 scientist-executed schemes). However, in many areas, particularly in the developing world, the government's role in influencing land-use is minimal and village decision makers are in practice the day-to-day managers of natural resources and make most of the management decisions (Getz *et al.* 1999). Scientist-executed monitoring has little impact at this scale (Fig. 1). Instead, the monitoring schemes that inform decision-making and resource utilization at the village level are those that engage people in the participatory collection, analysis and interpretation of the environmental data (Fig. 1). The greater the involvement by local people in monitoring activities the shorter time it takes from data collection to decision-making following monitoring (P < 0·001; see Appendix S1, Fig. 1 and Table S2b). Two types of participatory monitoring are recognized; one where local people collect data but the analysis is done by someone else, and another where local people collect and analyse the data themselves. The most locally based and participatory of these two options leads to management decisions, which are typically taken at least three to nine times more quickly than scientist-executed monitoring, although they operate at much smaller spatial scales (P < 0·001; see Appendix S1, Fig. 1 and Table S2a).

A limitation in our approach is that many environmental monitoring schemes are not published in the peer-reviewed literature. By using electronic databases for locating examples of monitoring schemes, we probably have disproportionally included schemes from large, well-funded programmes where academic publication has been a primary, or main, goal. We do not know if the spatial and temporal scale of decision-making in the published schemes is representative of the environment monitoring schemes that are being used in practice, but we believe that they represent the range of variation. Further studies aimed at providing more accurate assessments of environmental monitoring schemes could use questionnaires to natural resource managers and investigate those schemes they use. Another limitation is that management decisions might have gone unreported or might only have taken place beyond the period reported in the papers. Also, we don't know if the natural resource management decisions emanating from the monitoring are implemented successfully or not. We could have overcome uncertainties in data interpretation by validating and cross-checking our records with the authors of the papers on the 104 monitoring schemes in our sample. However, this could have introduced methodological differences between studies for which confirmation was available and studies which could not be validated. As the frequency of validation would be likely to vary across the type of monitoring, possible added accuracy would be associated with increased across-scheme bias. Overall, we consider the magnitude of our estimates and their relative proportions acceptable for the purposes of this paper, although figures from individual schemes are subject to uncertainty.

Our findings suggest that the type of monitoring undertaken in an area can have dramatic impacts on the solution chosen for different environmental challenges. By using scientists to undertake monitoring, there is a strong chance that decisions will only be taken at the large scale and will take years to implement. As such, this kind of monitoring is useful to influence national and international policy and to track the implementation of global conventions. At more operational scales of management, at the local level and involving people who face the daily consequences of environmental changes, scientist implemented monitoring generally has little impact. At these scales it is often more beneficial to involve local resource managers directly in the monitoring work; this allows them to assess trends in resources of value to them, and facilitates a rapid response in terms of decisions that directly impact environmental trends at the local scale.

Participation of community members in environmental monitoring may also have other benefits than aiding decision-making and management action (Danielsen, Burgess & Balmford 2005). For instance, even in scientist-led monitoring schemes (Janzen 2004), involvement of community members as paid staff in field-based inventories can help develop a change in attitude towards environmentally sustainable natural resource management among the local participants (Gardner 2010).

A consequence of our findings is that unless governments and non-governmental organizations involve local stakeholders, in many areas, environmental monitoring will tend to remain an isolated academic exercise that is primarily undertaken for the benefit of national and international stakeholders. Involving the locally based stakeholders in monitoring will both enhance management responses across spatial scales, and improve the speed of decision-making to tackle current negative environmental trends at operational levels of resource management.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. The materials and methods, and the results of the statistical tests.

Table S1. Summary of the dataset of published environmental monitoring schemes.

Table S2. Decision-making from published environmental monitoring schemes.

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