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Collating and validating indigenous and local knowledge to apply multiple knowledge systems to an environmental challenge: A case-study of pollinators in India

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ABSTRACT

There is an important role for indigenous and local knowledge in a Multiple Evidence Base to make decisions about the use of biodiversity and its management. This is important both to ensure that the knowledge base is complete (comprising both scientific and local knowledge) and to facilitate participation in the decision making process. We present a novel method to gather evidence in which we used a peer-to-peer validation process among farmers that we suggest is analogous to scientific peer review.

We used a case-study approach to trial the process focussing on pollinator decline in India. Pollinator decline is a critical challenge for which there is a growing evidence base, however, this is not the case world–wide. In the state of Orissa, India, there are no validated scientific studies that record historical pollinator abundance, therefore local knowledge can contribute substantially and may indeed be the principle component of the available knowledge base. Our aim was to collate and validate local knowledge in preparation for integration with scientific knowledge from other regions, for the purpose of producing a Multiple Evidence Base to develop conservation strategies for pollinators.

Farmers reported that vegetable crop yields were declining in many areas of Orissa and that the abundance of important insect crop pollinators has declined sharply across the study area in the last 10–25 years, particularly *Apis cerana*, *Amegilla* sp. and *Xylocopa* sp. Key pollinators for commonly grown crops were identified; both *Apis cerana* and *Xylocopa* sp. were ranked highly as pollinators by farmer participants. Crop yield declines were attributed to soil quality, water management, pests, climate change, overuse of chemical inputs and lack of agronomic expertise. Pollinator declines were attributed to the quantity and number of pesticides used. Farmers suggested that fewer pesticides, more natural habitat and the introduction of hives would support pollinator populations.

This process of knowledge creation was supported by participants, which led to this paper being co-authored by both scientists and farmers.

1. Introduction

1.1. The methodological challenge

There is an important role for indigenous and local knowledge in a Multiple Evidence Base to inform decisions about the use of biodiversity and its management (Sutherland et al., 2013; Tengö et al., 2013). The Convention of Biological Diversity (CBD) refers to the knowledge of indigenous and local communities (article 8[j]) and more recently the Nagoya Protocol (2014) notes 'the importance of traditional knowledge for the conservation of biological diversity and the sustainable use of its components, and for the sustainable livelihoods of these communities'. Policy makers increasingly seek to ensure that policy regulating environmental management is evidence based and also recognize that

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the evidence may arise from parallel knowledge systems (IPBES, 2016). While there are materials available for collating Indigenous and Local Knowledge (ILK) and practices for specific challenges (Lyver et al., 2015), methods for integrating indigenous or local knowledge with the scientific evidence remain debated (Gratani et al., 2011).

There are instances where local knowledge has been successfully gathered and incorporated into decision making with the agreement of the local community (Maclean and Cullen, 2009) but there is also concern about the validity and utility of local knowledge (Bohensky and Maru, 2011; Usher, 2000). As a counter argument it has been pointed out that the process of validating indigenous or local knowledge with western scientific knowledge might be superfluous or misunderstands the epistemology of indigenous knowledge systems (Gratani et al., 2011; Matsui, 2015), and that poor tools may serve to alienate people further from participation (United Nations, 2013 http://unfccc.int/resource/docs/2013/tp/11.pdf accessed 23/02/2017). Although epistemological approaches in parallel knowledge systems may differ there is a need for a transparent tool to verify and validate evidence, one that does not alienate participants but which allows those co-creating policy to be confident that, within its own cultural framework, the knowledge is both valid and agreed.

Sutherland et al. (2013) outline a 3-stage process for collating and integrating parallel knowledge systems to support integrated analysis for decision-making. The first of these stages is to recognize that there are fundamentally different types of knowledge, each associated with different needs for different stakeholder groups. The second stage is to collate and validate indigenous and local knowledge and the third stage is to partly combine it with available information from conventional scientific knowledge, using formal consensus methods such as the Delphi technique (Mukherjee et al., 2015). We developed stage two of this methodology and applied it to a case where indigenous and local knowledge could contribute substantially and may indeed be the principle component of the available knowledge base. Our aim was to collate and validate local knowledge in preparation for integration with scientific knowledge, for the purpose of producing a Multiple Evidence Base to develop conservation strategies for pollinators.

1.2. The environmental challenge

There is a growing acknowledgement (Diaz et al., 2015) that pollinator decline is a global phenomenon (IPBES, 2016; Potts et al., 2010; Tylianakis, 2013) and evidence that declining pollinator diversity and abundance can affect food security (Chaplin-Kramer et al., 2014; Delaplane et al., 2013; Garibaldi et al., 2011; Garibaldi et al., 2016; Klein et al., 2007; Potts et al., 2016) although uncertainty remains over the extent of the impact (Tylianakis, 2013). This concern extends to India (Basu et al., 2011) where little is known about pollinator population trends and there are no published empirical data explicitly linking a change in crop yields to pollinator abundance. This is worth underlining as it has been suggested that decisions, even at national policy level, have been made on the basis of scant evidence (Sutherland, 2013). In India there are no validated scientific studies to elucidate recent trends in pollinator diversity or abundance. This presents researchers with a conundrum – how to determine whether change has already taken place in order to determine the direction of trends in pollinator abundance/diversity and to establish whether they are linked to changes in crop yield.

Through a recently completed project (Defra Darwin initiative 19-024 http://www.darwininitiative.org.uk/project/19024/ accessed 23/02/2017) an important group of stakeholders were identified as smallholder subsistence farmers, including tribal people, who have personal and procedural knowledge of crop production. These subsistence farmers meet a large part of their nutritional needs through a variety of pollinator dependent vegetable crops (Chaplin-Kramer et al., 2014). The project included a participatory scheme, where local communities were engaged in pollinator monitoring efforts, thereby developing citizen science and incorporating valuable capacity building components, as exemplified by Community Based Monitoring and Information Systems (CBMIS) (Tengö et al., 2013). During the project the partners and stakeholders came to a consensual understanding of critical goals that addressed overlapping concerns. The farmers expressed a need to be aware of potential negative drivers of vegetable yields and a desire for a suite of practicable interventions to protect or increase those yields. Scientists (also stakeholders) hypothesised that pollinator populations are declining and that this may be an important driver of changes in vegetable yields. Pollinator-friendly management practices may help to increase yields but the base-line information to develop this is missing. The exercise was designed to address the shared aims of the stakeholders. At a larger-scale, this information will also contribute to a) our understanding of whether there could be a 'pollinator crisis' in India, as found in other countries; b) the global evidence-base on the status of pollinators.

Two clear knowledge gaps emerged from dialogue: 1) there was a lack of information on the diversity of crops that were grown and the trends in productivity (frequently not reflected in official databases, *Pers. Obs.*) in the study areas; 2) there was also a lack of information of pollinator identity and trends in abundance and diversity. To further understand whether there is a 'pollinator crisis' in India, it is important to know which pollinators are important for crop pollination and whether any changes in crop productivity are linked to changes in pollinator diversity or abundance.

This paper focuses on collating traditional and local knowledge that can be validated in a meaningful and respectful way (Gratani et al., 2014; Sutherland et al., 2013). Validity is interpreted as the extent to which observations reflect the phenomena or variables we are interested in (Kvale, 1995; Tengö et al., 2013). The process of validation involves verification (structural correctness of the knowledge) and evaluation (demonstration of the ability of the knowledge base to reach the right conclusion) (Vallejos and Morimoto, 2013). Here we present a novel method using consensual validation by peer groups of local knowledge holders, whereby knowledge is validated within its own cultural framework and carried out by individuals with the same mental model (Biggs et al., 2011). We suggest this is loosely analogous to the peer review process carried out by scientists to validate scientific data, thus standardising the quality of validation between farmers and scientists. It is in contrast to other methods where the traditional or local knowledge is presented as an environmental report and validated in technical reviews (Usher, 2000) or directly validated against scientific data (Gratani et al., 2011).

The aim of the knowledge gathering exercise was to establish whether farmer participants considered that the yields of pollinator dependent crops have changed in the last 10–20 years, whether pollinator abundance and diversity has changed over the same period via factual observations and then give their assessment of whether these phenomena (if they exist) are linked. A secondary aim was to identify possible mechanisms for any observed changes and potential interventions to conserve or restore crop yields and/or pollinator populations by asking farmers to make inferences based on their knowledge. We differentiate between factual observations and inferences; inferences are inferred mechanisms, causal links or theories, as distinct from factual observations. These can lead to hypotheses testable using experimental scientific approaches (Usher, 2000).

2. Method

The study sites were located in the East Indian state of Orissa and the study carried out in February 2014. The study sites were classified into three types representing different levels of farming intensity based on chemical inputs, vegetation cover, land cover and cropping intensity as described in (Chakrabarti et al., 2014): 1) an area of high intensification with large crop fields, low natural vegetation cover and relatively high chemical inputs; 2) an area of low intensification