Stakeholder Engagement in Environmental Evidence Synthesis

Edited by Neal R Haddaway and Sally Crowe

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EVIDENCE-BASED ENVIRONMENTAL MANAGEMENT

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Foreword

Since its foundation, in 2008, the main foci of the work of the Collaboration for Environmental Evidence (CEE) have been the development of rigorous methods of evidence synthesis and to make these openly available to those who wish to use them. This has, in the main, been an academic exercise of testing and adaptation of various elements of the systematic review process. The growing CEE community has learnt a great deal from this and many improvements have been made. CEE Guidelines and Standards continue to ensure we develop capacity to produce ever more rigorous and reliable products to inform environmental decisions. Alongside this work it has always been the intention that the products would be public goods contributing to the development of an evidence base to inform wider society. It follows from this that the questions addressed should be relevant to environmental management problems and evidence synthesis conducted in the public interest with stakeholders as key participants.

Stakeholder engagement has always been acknowledged in the evidence synthesis process but, until recently, has taken a back seat whilst other aspects of methodology have been the centre of attention. This Special Series of papers presenting experiences and lessons in stakeholder engagement raises awareness of the key importance of this aspect for relevance of evidence synthesis to wider society. For example, A common criticism of evidence synthesis methods such as systematic review is that they follow an 'information deficit model' in which scientists. working in isolation, produce and publish evidence and expect this to be sufficient for wider society to take notice of it. Although potentially valid for some examples of evidence

syntheses, this criticism is largely unfounded when one examines the efforts of stakeholder engagement in which a considerable level of co-production is inherent in the process, particularly in the question formulation and protocol production stages, but in some cases also in the conduct of the synthesis itself. This Special Series provides examples of this crucial development of evidence synthesis methodology and provides examples of ways of working with stakeholders that will increase the probability of uptake and use of evidence-informed decision making in the environmental sector.

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Editorial

Experiences and lessons in stakeholder engagement in environmental evidence synthesis: a truly special series

Neal R Haddaway • Sally Crowe

The importance of stakeholder engagement has been stressed from the beginning of the evidence synthesis movement in conservation biology [1]. Since then, as the number of experienced systematic reviewers grows year-on-year, so too does the collective experience of practical engagement activities. This special series represents where we are today: a collection of reflections and *best practices* honed as a result of challenging and rewarding experience. The conclusion from these papers is clear: do it, do it properly, report it. The series is a vital tome for all reviewers and, we hope, a catalyst for improving conduct and reporting of stakeholder engagement in evidence synthesis.

Engaging with stakeholders provides a suite of benefits to research and to stakeholders themselves. It can, for example: increase the quality of research and decision-making; broaden understandings of context and drivers of change; increase legitimacy and acceptance of research; increase research impact; empower stakeholders and facilitate the sharing of information. There is also, arguably, a moral obligation to publish findings freely and engage with the wider community in publicly funded research projects. Without adequate perspectives from stakeholders we run the risk of pursuing research goals that don't address issues that are important to the public and other end users. Furthermore, engagement with stakeholders offers the opportunity to raise public awareness of both environmental issues and

the research we conduct as scientists. This may also help create a culture of ownership of some of the solutions that may propel research outcomes into environmental change and impact. However, 'one does not simply walk into Mordor' [2]: balanced, unbiased and effective stakeholder engagement requires considerable resources and careful planning.

Many of the early systematic reviews in the field of conservation and environmental management were academic endeavours aimed at testing the framework of systematic reviews within a novel discipline. As such, stakeholder engagement was perhaps not a priority. Since these early days, reviews have devoted little space to explanations of stakeholder engagement activities: such efforts were implicit or referred to the origin of the question, setting of the scope and sources of funding. Until very recently, there was no requirement in systematic reviews published by the Collaboration for Environmental Evidence (CEE) to mention stakeholder engagement efforts, although this Special Series is helping to drive change.

Although engagement would differ substantially between reviews intended to be academic goods, private goods and public goods, each review has its own set of stakeholders. Transparency about how these stakeholders interact with the review would expand the principles of systematic review methodology across the synthesis process, from question inception to communication. Transparency and shared learning are at the heart of recently published international guidelines for improving the reporting of stakeholder involvement in health and social care research [3]. The editors take the view that these (especially the 'GRIPP 2 short form') could assist systematic reviewers in focusing their reporting of stakeholder engagement in ways that are specific to their experience as reviewers and help the research community at large.

This special series collates commentaries from a diverse range of authors with experience of evidence synthesis and various aspects of stakeholder engagement. It also represents the culmination of several years of work by the CEE Stakeholder Engagement Methods Group, formally established in 2015 following a series of workshops in South Africa in late 2014. This group aims to investigate and promote best practices in involving stakeholders in systematic reviews and maps.

The papers presented within this series are, in part, produced by the Methods Group and its members, but are supplemented by many contributions from other experts. Commentaries range from descriptions of groups' experiences engaging with stakeholders in evidence syntheses to guidance on methods for balanced and unbiased multi-directional interaction with stakeholders across the review process. Individually, these manuscripts provide sage advice for specific aspects of stakeholder engagement. Collectively, this series represents a huge step forwards in the field of evidence synthesis: a go-to guide and reference for those wishing to undertake effective, reliable and efficient stakeholder engagement within a systematic review or map.

Several key themes emerge across the papers in this series. First, considering the importance of stakeholder engagement should be an integral part of all reviews, but the degree and type of stakeholder engagement realised will depend on the exact nature of the review. Second, there is sometimes a need to adapt review methodology for the needs of specific stakeholders; identifying when reviews should be 'gold standard' reviews (public goods), and when reviews should be adapted for specific stakeholder needs (private goods), for example emphasising co-production. Third, that we may benefit from expanding our definition of who/what we count as stakeholders in our reviews; something particularly important for public goods reviews. Fourth, that engaging with stakeholders in an open way that avoids tokenism (the *tickbox* approach) is not only vital throughout the review process, from planning to communication, but also requires careful planning and integration into review processes and workflows.

We hope that the legacy of this series will grow and develop, providing useful guidance and insights into best practices (and indeed experiences of practices that haven't worked well for whatever reason). We hope this will continue to be overseen by the CEE Stakeholder Engagement Methods Group (visit http://www.environmentalevidence.org/method-groups for more information), and we encourage those with interest and experience to join us. We aim to raise the transparency, balance, openness and minimisation of bias in stakeholder engagement activities across evidence synthesis in the field of conservation and environmental management, among others. We hope you enjoy reading these articles as much as we have!

Acknowledgements

We thank the many authors of the wonderful manuscripts in the special series on stakeholder engagement in evidence synthesis in this journal. Their work has been most insightful and a delight to read. We also thank Andrew Pullin and the CEE board for support in producing the special series.

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1

A framework for stakeholder engagement during systematic reviews and maps in environmental management

Neal R. Haddaway • Christian Kohl • Natalie Rebelo da Silva • Joachim Schiemann • Armin Spök • Ruth Stewart • Jeremy B. Sweet • Ralf Wilhelm

People have a stake in conservation and environmental management both for their own interests and the sake of the environment itself. Environmental decision-making has changed somewhat in recent decades to account for unintentional impacts on human wellbeing. The involvement of stakeholders in environmental projects has been recognised as critical for ensuring their success and equally for the syntheses of evidence of what works, where, and for whom, providing key benefits and challenges. As a result of increased interest in systematic reviews of complex management issues, there is a need for guidance in best practices for stakeholder engagement. Here, we propose a framework for stakeholder engagement in systematic reviews/systematic maps, highlighting recommendations and advice that are critical for effective, efficient and meaningful engagement of stakeholders. The discussion herein aims to provide a toolbox of stakeholder engagement activities, whilst also recommending approaches from stakeholder engagement research that may prove to be particularly useful for systematic reviews and systematic maps.

Keywords: Stakeholders • Communication • Dissemination • Methodology • Best practice • Conflict resolution • Stakeholder analysis

Background

Environmental management is a multifaceted subject, influencing humans and the environment alike in a plethora of complex and intricate ways. Conservation and environmental management are of interest to people both because of their own interests and also for the sake of the environment itself. Today, environmental decision-making also accounts for impacts on human wellbeing, for example through the instigation of the *'at least do no harm'* mandate of the Convention on Biological Diversity [1]. In accordance with the dual recognition of the importance of the environment to human wellbeing, and of human wellbeing in environmental management, the involvement of stakeholders in management projects has been recognised as a critical step in ensuring their success (e.g. [2]). Here, we define stakeholders as being any person or organisation who can affect or may be affected by the planning, conduct, results and communication of a systematic review or map (collectively referred to in the following pages as 'reviews'), in line with common, broad definitions accepted in the literature (e.g. [3]) (see "Defining stakeholders", below).[1]

Stakeholder engagement may provide several key benefits to environmental management research projects (reviewed in [4, 5]), including: improving the evidence base [6]; greater public acceptance [7]; higher likelihood of intervention success [8]; wider communication of findings [9]; and increased likelihood of impact on decision-making [10]. However, engaging stakeholders in research can also be associated with dis-benefits, such as reinforcing power imbalance [11], causing or worsening misunderstandings, and delaying decision-making [12]. However, these negative impacts should not be taken as a reason to avoid stakeholder engagement, but highlight the need for carefully planned, unbiased and balanced engagement.

1 The literature cited in "Background" refering to the term 'stakeholders' uses a range of different definitions for who those stakeholders might be, sometimes meaning direct users of research outputs, such as policy decision makers and practitioners (e.g. land managers in the field of environmental management), and sometimes meaning those directly affected by decisions (e.g. patients in the field of medicine).

Stakeholder engagement is associated with a number of challenges that makes its implementation problematic (see Box 1), including: increased demand on time and resources, potential for marginalising or favouring certain groups of stakeholders, biased representation of true stakeholder groups, and tokenistic engagement. Nevertheless, stakeholder engagement has been shown to increase the efficacy of management interventions, particularly where success relates to uptake of activities by practitioners [13].

In the same way as with primary research, reviews can greatly benefit from engaging with stakeholders to ensure that inputs and outputs are of the greatest relevance and reliability to all interested parties. The Guidelines for Systematic Reviews in Environmental Management [14] states that stakeholders play an important role in formulating the review question and advising on the search strategy, and that involving stakeholders at an early stage is of particular importance. Early reviews in conservation and environmental management were, to a large extent, trial cases and focused perhaps more on academic topics (e.g. [15, 16]), or those with restricted groups of identified and engaged stakeholders (i.e. often just the review commissioner) [17, 18]. However recent developments in CEE systematic review and systematic map methodology [19] and an increase in the uptake of systematic review methods in evidence-based conservation and environmental management have resulted in increasing interest in stakeholder engagement throughout review processes.[2] As a result there is a need for guidance in best practices for stakeholder engagement.

Here, we formulate a framework for engaging with stakeholders when conducting reviews, highlighting recommendations and advice that may prove useful for effective, efficient and meaningful engagement of stakeholders. We use our experience and a summary of the literature to provide advice for reviewers when deciding which stakeholder engagement activities are priorities, considering which methods are likely to work best in their particular context and, where

2 A search of Web of Science Core Collections on 18th April 2017 using the term "stakeholder engagement" AND "systematic review" as a topic word search yielded an exponentially increasing number of publications.

resources are limited, which methods may be most effective [10]. The existing literature relating to the benefits of stakeholder engagement in reviews is limited, particularly in the field of environmental management where there is a complete knowledge gap. Hence, in addition to being based on an extensive (non-systematic) review of the existing literature on stakeholder engagement generally, this guidance is also based on extensive first-hand experience of reviews, and follows a series of key informant interviews with nine review experts from the fields of environmental management, conservation and social science, all with experience of stakeholder engagement (see Appendix 1 for further details of these interviews). The results of these interviews were used to construct and refine the conceptual models provided herein. This commentary thus goes further than purely reviewing the literature, by complementing the evidence base with experiences of the practicalities of reviews and the required central tenets of systematic review methods.

This document will introduce ideas in stakeholder engagement and provide advice to those designing stakeholder engagement plans for their review. It aims to provide a toolbox of possible stakeholder engagement activities, whilst also recommending approaches from stakeholder engagement research that may prove to be particularly useful for reviews.

Stakeholder engagement and systematic review methods

Stakeholder engagement should reflect systematic review methodology, by being a reliable, transparent process that aims to be as verifiable and objective as possible. Objectivity and repeatability may seem particularly challenging when dealing with groups of people and what may often be strong and variable opinions. However, by maintaining a high level of transparency and clarity, stakeholder engagement can remain a reliable and verifiable process: key tenets of the parallel process of systematic review.

Whilst there is undoubtedly a need for transparency in any stakeholder engagement activities, measures to reduce bias in stakeholder

engagement can only be recommended, since appropriate stakeholder engagement methods will be to a great extent context-specific, and available resources for stakeholder engagement may be limited to varying degrees.

Defining stakeholders

Various definitions of stakeholders exist in the literature, with perhaps the most widely cited one being "any group or individual who is affected by or can affect the achievement of an organisation's objectives" [3].

Reviewers may define the term stakeholder in much the same way (Table 1), although in practice many use the term synonymously with 'review commissioner' or 'end-user'. It may be appropriate, however, to take a broad definition of stakeholders that includes all parties that may affect or be affected by a review. To that extent, we have produced a conceptual model that categorises and separates stakeholders according to three dimensions: who they are, what their

Table 1. Key informant interviewees' definitions of the term 'stakeholder' with respect to systematic reviews

Definition	Interviewee
"The client. Also experts engaged to do the topic synthesis."	Novice reviewer
"People who are either affected by the issue or those who may be able to influence the issue: includes local people (e.g. producers), NGOs and governments."	Experienced reviewer
"Anyone with an interest in a particular issue or anyone likely to be affected by an issue or a decision: includes poor people and researchers, research experts (systematic review methodology experts)."	Experienced reviewer
"People that have an interest in the subject matter: includes researchers and experts. Those generating evidence and the end-users of evidence. Also includes subjects of conservation and development projects."	Experienced reviewer
"A person or representative of an organisation that is affected by an activity that is being reviewed in one way or another: includes scientists."	Expert reviewer
"Those who have a stake in the question, e.g. policy-makers, academics, educators, NGOs."	Expert reviewer
"Someone who has a stake in the findings—the issues have real meaning in their lives; someone affected by the review findings."	Expert reviewer
"Those in one way or another that use the information from a systematic review: mainly those in decision making (e.g. ministries, agencies—on all levels, local, national and international), includes scientists."	Expert reviewer

Source: unpublished data.

roles are, and what actions they may take in relation to the review (Fig. 1). This broad definition includes several key actors that are seldom recognised in definitions, but that we feel should be included to ensure that all affected parties can be given appropriate opportunity for involvement and discussion where suitable, or can be taken into consideration when formulating a stakeholder engagement plan (e.g. research funders). Stakeholders can perform multiple roles within this model. The reader should note that we do not restrict our definitions to 'end users', since this definition assumes the reviewers are well aware of (and potentially engaged with) all possible current end users. Our broader definition does not make this assumption.

Guidance 1. Using a broad, encompassing definition of stakeholders can help to ensure that all relevant stakeholders are engaged, particularly minority groups.

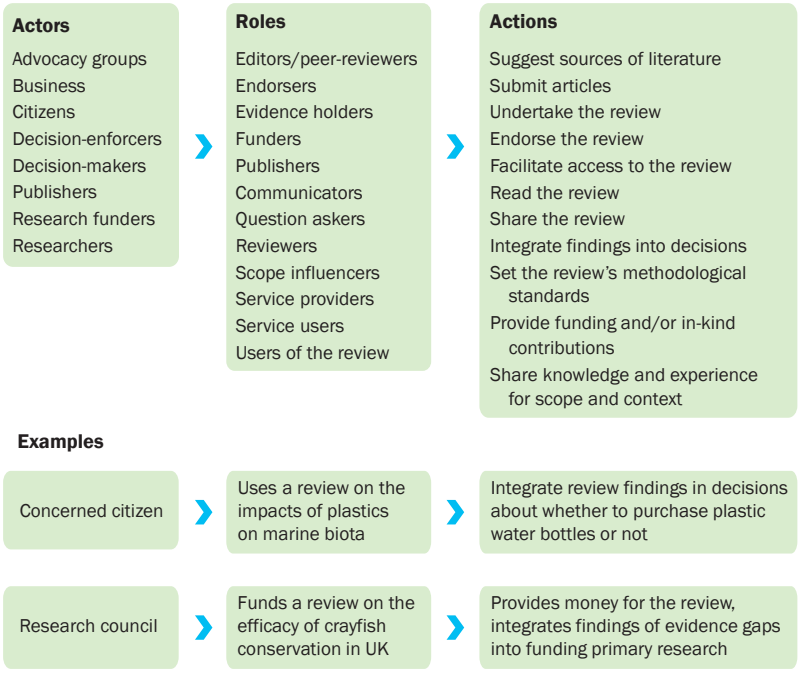

Fig. 1. Conceptual model of stakeholders, identified by the actors, their roles and their actions.

Why engage with stakeholders?

Stakeholder engagement in reviews is undertaken for several major reasons (see details in Figs. 1, 2): (i) to set the scope and definitions of the review, (ii) to ensure the relevance of the review from a broader society perspective; (iii) to prioritise review questions; (iv) to suggest and locate relevant evidence; (v) to interpret the review findings or set them in context; (vi) to improve the clarity and readability of the review report; (vii) to increase the communication and impact of the review results; and (viii) to endorse the review. Reviewers may have any number of reasons for undertaking stakeholder engagement, but a comprehensive stakeholder engagement strategy will help to ensure that all benefits are felt.

We described the major justifications for and benefits of stakeholder engagement briefly above, but some additional specific benefits are worth mentioning. Figure 2 summarises these benefits visually

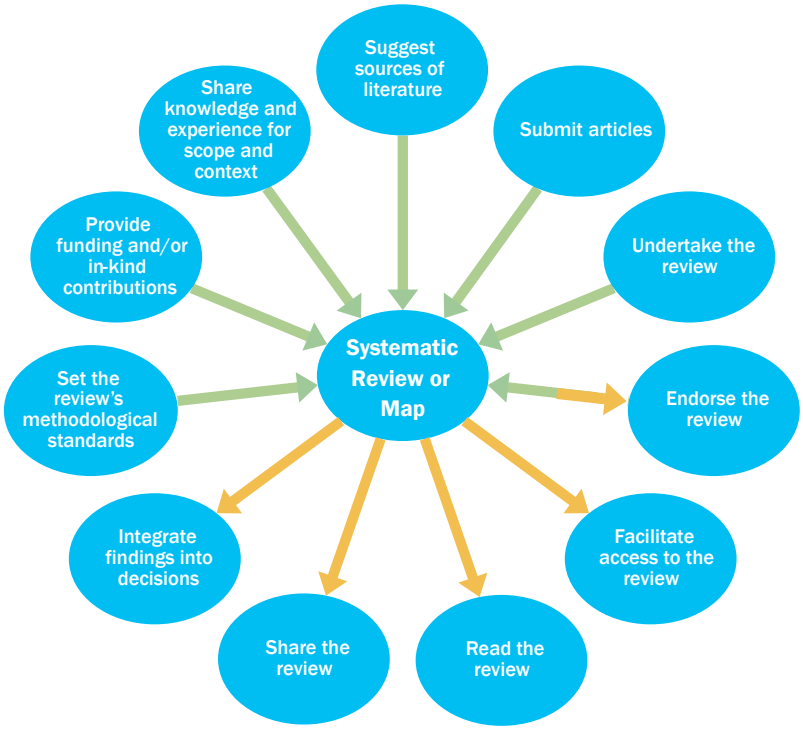

Fig. 2. Model of potential benefits of stakeholder engagement. Model shows direction of benefit with respect to stakeholders (green arrows benefit the review, orange arrows benefit the stakeholders).

and we give some examples in more detail here. Along with ensuring clarity and readability of the review report, engaging with stakeholders can ensure that processes remain transparent, since additional appraisal of the review process is inherently involved. Furthermore, by identifying, categorising and understanding the characteristics and nature of various stakeholder groups, potential controversies and conflicts during communication of the review results can be anticipated. Along with refining the scope of the review, stakeholders can provide a practical understanding of definitions that may be critical to the review's inclusion criteria: getting these wrong can significantly reduce the utility of the review's conclusions [16]. Stakeholders can improve the quality of a review by improving the search strategy, helping to set the balance between specificity and sensitivity, also potentially improving the review's efficiency. Stakeholders can also improve review quality by providing access to evidence critical to the review; studies or data that are inaccessible, un-indexed, or un-published in academic resources (i.e. grey literature). This may be particularly useful if the evidence base consists of useful data from practitioner-held information, such as consultancy reports, or if non-English language research may be likely. Reviews can be made more relevant through gaining a better understanding of the context in which the findings fit. Similarly, stakeholders can help to tailor communications for the right audience. This is crucial for ensuring that review findings are translated from long, technical review reports into digestible formats that have a high likelihood of being read and integrated into decision making. Stakeholders can help to formulate dissemination media for the review (such as policy briefs, press releases, fact sheets, etc.) that can greatly increase the coverage of dissemination activities and maximise impact. Furthermore, stakeholders may be a useful resource in documenting impact in decision-making, something that has as yet been notoriously difficult to do [20]. Finally, stakeholder engagement may be seen as a key means of promoting evidence-based approaches to decision-making, and may be a useful means of capacity-building. Since any stakeholder engagement related to a review would require an explanation of what systematic review methods involve, this engagement can prove to be highly useful in providing various degrees of training in review methods. Indeed, reviews that engaged with stake-

holders throughout the review process may also provide hands-on training that can be particularly effective in building capacity across various communities, including: commissioning high quality reviews using state of the art methods; being able to critique and integrate the results of reviews into decision-making; and, being able to undertake reviews themselves.

Challenges of stakeholder engagement

Stakeholder engagement is not without its challenges. An analysis using systematic review key informant interviews by Cotrell et al. [13] identified a number of key challenges (see Box 1).

One significant challenge with stakeholder engagement is that of explaining systematic reviews to those with no previous experience of the methodology (Box 1, point 10). We recognise here that our broad definition of stakeholders includes review experts, but focus here on the common groups of stakeholders (including researchers) who are not aware of systematic review methods. Systematic review methods in environmental management are relatively novel, with a small minority of the research community aware of precisely what is involved in a formal CEE review. The concepts and processes involved in a CEE review are the subject of extensive documentation and training ([14]; http://www.environmentalevidence.org), and an understanding of these processes requires a solid grasp of the way in which academia and science research publishing work. There is thus a significant challenge in explaining systematic reviews to stakeholders sufficiently that their involvement is meaningful without overloading them with jargon and complicated novel concepts. Organisations working closely with stakeholders and reviews have approached this challenge in slightly different ways, but minimising the amount of new information regarding methodology may be useful initially, whilst also allowing stakeholders to gain further awareness using online information and tutorials at their own speed. Workshops and meetings may be started with short presentations that provide a brief overview of systematic review methodology. There may be a need for a 'soft landing' when it comes to explanations of systematic review; perhaps through the use of infographics or explanatory booklets in lay terms.

Box 1. Key challenges in stakeholder engagement

1. Stakeholder engagement requires additional time and resources.
2. Where resources are limited stakeholder engagement must be carefully planned to ensure the results are sufficient.
3. Stakeholder engagement may divert resources away from the conduct of the review.
4. Reviewers should understand and be transparent about the desired objectives of stakeholder engagement from the outset.
5. Tokenism (i.e. activities undertaken for the sake of being seen to undertake them) in stakeholder engagement must be overcome to ensure activities are worthwhile.
6. The group of engaged stakeholders may not be balanced and representative.
7. Conflicts between stakeholders can arise that must be carefully resolved.
8. Reviewers may need training in how to coordinate stakeholder engagement and interact with stakeholders, particularly where conflict may arise, or an expert in conflict management may be needed.
9. Inputs from multiple different stakeholders can sometimes contradict and processes must be in place to develop and deal with the situation and any compromises that may be necessary.
10. Stakeholders must be briefed in systematic review methods carefully to ensure full understanding and appreciation of the possible inputs they can have, whilst avoiding confusion.
11. Specific criteria may be needed to aid stakeholders in prioritisation of review questions.
12. Difficulties in maintaining continued engagement throughout the review to maintain interest and involvement.
13. Reviewers must bear in mind stakeholders' concerns about confidentiality when writing up their findings and discussing stakeholder inputs with other parties.
14. Contributions to the review by all involved, including stakeholders, need to be taken into account when deciding on authorship, drafting acknowledgements and attributing credit.
15. Reviewers must ensure there is no undue influence on the review as a result of stakeholder engagement (and must define what constitutes undue influence; possibly defined as a significant change to the scope or content of the review as a result of the opinion of one or more stakeholders not broadly accepted by the stakeholder group).

Another challenge is the importance of clearly stating the objectives of stakeholder engagement from the outset (Box 1, point 4). Providing stakeholders with examples of the ways in which they can be involved and the types of information and inputs they can supply can be critical to ensuring that resources are used efficiently and inputs are meaningful. For example, it may be useful to give examples of the types of comments on a protocol that would be useful along with the types of comments that might not. Equally it is important to outline exactly what stakeholders can expect from stakeholder engagement; being clear about what they can influence and what they cannot. For example, they may be able to contribute to defining the inclusion criteria but they cannot influence decisions about which studies are included. Procedures for dealing with conflict and contradictions should also be specified from the outset. For example, experienced or trained mediators or facilitators may be used in physical meetings (Box 1, point 8), and where conflicts cannot be resolved, lead reviewers may be given the final say in the approach used in the review.

Whilst some people may fear that stakeholder engagement can derail a review, such an outcome should not be possible (unless the derailment is warranted, for example if the review question or outcomes under consideration are deemed inappropriate). Stakeholder engagement should help to direct a review by providing advice and experience to the review team: it should not be able to unduly influence it (i.e. their influence should not significantly alter review methodology unless agreed by all/the majority of stakeholders and the review team of subject and methodology experts (reviewed by Oliver et al. [21]).

The transparent, objective, and verifiable methods used for the review running parallel to stakeholder engagement should remain robust to any potential stakeholder bias or undue stakeholder influence. However, stakeholder engagement could potentially reduce the efficiency of review activities, where significant resources are diverted to this task, reducing those available for the conduct of the review.

Stakeholder engagement in practice

Stakeholder analysis and balance

Stakeholder analysis is the process by which key actors in a system are identified, categorised and understood [22]. It has been used extensively in dispute resolution and conflict management [22, 23], but is likely an implicit aspect of most stakeholder engagement activities, despite perhaps not being recognised as such. Stakeholder analysis is undertaken for a range of reasons, including: (i) ensuring balance in stakeholder groups; (ii) prioritising certain groups of stakeholders over others where resources are limited; (iii) identification and investigation of possible conflicts between stakeholders; (iv) tailoring contact to specific types of stakeholder; and (v) phasing contact with stakeholders through a project according to their relevant utility to and benefit from the research. Whilst always a useful exercise, stakeholder analysis may not always be necessary; for example, where the stakeholders for a given subject are already well known.

Stakeholder analysis is typically done using a range of methods that relate to the categorisation of stakeholders [24]. The majority of these methods are 'top-down': they involve categorisation of stakeholders by a third party, usually a reviewer [25]. There are also 'bottom-up' methods, however, that involve (amongst other things) categorisation of the various stakeholders by other stakeholders [25]. This latter method can be particularly resource intensive, however, but can identify intricacies that would otherwise be missed by reviewers less familiar with the existing relationships amongst stakeholders.

The most common means of stakeholder analysis is via interest-influence matrices [26]. These matrices classify stakeholders along two dimensions; interest in the subject in hand and influence in the processes involved. Such matrices allow the identification of key stakeholders that should be targeted (e.g. high interest, high influence), or modified (e.g. low interest, high influence) by attempting to increase their level of interest. Other dimensions can be plotted on such matrices, for example, amount of available evidence and necessary engagement effort. Other means of categorisation described in the stakeholder analysis literature include semi-structured inter-

views, snowballing, social network analysis, knowledge mapping, etc. (reviewed by Brugha and Varvasovszky [27]). Further details on these methods should be sought from the extensive methodological literature.

Generally speaking, 'balance' in stakeholder engagement may be understood as the representation of all main interests, views and opinions [28], but its application in practice is challenging. What stakeholder engagement balance should not be aiming for is the strict proportional, quantitative representation of stakeholder groups present in society. There are many reasons for avoiding quantitative balance in stakeholder engagement. Firstly, activities such as workshops are unlikely to be able to cater for and attract all relevant stakeholder groups, so ensuring that one representative from every group is present is likely to be an intangible aim. Furthermore, some individuals may represent larger stakeholder groups, whilst other individuals represent only themselves. Such group representatives, however, may have collated the views and speak on behalf of a large number of individual stakeholders. Accordingly, quantitative assessments may ignore the underlying numbers. The key aim with ensuring balance is to allow all major types of stakeholder to be given the opportunity to provide input. For example, where a review focuses on the environmental impacts of 'fracking', a balanced stakeholder pool might consist of citizens, policy-makers, conservation practitioners, representatives from the fossil fuel industry, land-owners, representatives from regional water boards, etc. Balance is most evident when it is absent: for example, through the notable absence of fossil fuel industry representatives. In this way, stakeholder analysis can help to identify where balance is lost by categorising stakeholders and predicting which groups should be present.

Often, resources for stakeholder engagement are limited (Box 1, points 1–3), and key stakeholders must be prioritised and contacted in preference to others. This pragmatic approach should be undertaken carefully to ensure that balance is still maintained wherever possible, and that the engaged stakeholders provide knowledge and opinions that are representative of or accepted by the stakeholder community at large. Basing a review on definitions that are not broadly accepted, for example, can drastically reduce the worth of a review [29]. Similarly,

using stakeholder analysis to phase contact with stakeholders may be a useful way of dealing with limited resources with maximum efficiency. Equally, the phased inclusion of stakeholders should be based on sound analysis of the risks of excluding certain groups from specific processes. It should also be noted that systematic reviews are lengthy processes, and long gaps between contact for those phased stakeholders that are involved more than once can lead to significant *stakeholder attrition* (drop out) if contact is not suitably maintained. Stakeholder analysis can also be useful in identifying groups of stakeholders that might benefit from different forms of contact. Certain groups may interact more if contacted in a specific way or at a specific time; such as teachers being more responsive by telephone after school hours. Other groups may require different wording in emails, for example, if their level of understanding of academic literature and systematic review methods is expected to be higher. Stakeholder analysis can also be a vital means of early identification of potential conflicts between different stakeholder groups. Such awareness can be crucial for ensuring that stakeholder engagement activities run smoothly, for example by interacting with conflicting groups at different meetings rather than assembling them in one room. Finally, stakeholder analysis can also help to identify potential bias that may reduce stakeholder engagement balance. Sources of bias in stakeholder engagement are discussed in further detail below.

Guidance 2. Stakeholder analysis can help to identify and sort stakeholders according to useful categories related to the type of benefits they might provide to the review or receive from it. Stakeholder analysis can help ensure balance, prioritise limited stakeholder engagement resources, help to identify or anticipate potential conflicts, and assist in tailoring and phasing contact with stakeholders, particularly if reviewers are less familiar with or uncertain of the stakeholder community linked to a certain review question.

Stakeholders and review stages

Prioritising and phasing stakeholder engagement should be based on a sound understanding of the major stages in a review, and a clear appreciation of the types of roles and actions that stakeholders can per-

form. These actions are summarised in Fig. 1. Tables 2 and 3 display the review stages of the major activities within a review, and the relationship between stakeholder actions, review stages and direction of information flow, from question formulation through to communication and integration of results into decision-making. Engagement activities can be focused towards different groups of stakeholders depending on the actions they are believed to be able to perform. Care must be taken to avoid surprises relating to actions performed by stakeholders that were not identified in advance, since this information may come too late and may risk full endorsement and acceptance of the review.

Table 2. Systematic review processes and stages

Process	Stage
Question formulation	Early
Protocol	Early
Searching	Mid
Article screening	Mid
Data extraction	Mid
Critical appraisal	Mid
Synthesis	Mid
Final review	Final
Communication	Final
Decision-making	Post

Table 3. Stakeholder actions, systematic review stages and directions of information flow

Action	Review stage(s)	Direction of action
Share own experiences	Early	Review ←
Share articles	Early, mid	Review ←
Endorse the review	Early, mid, final	Review ← → stakeholders
Undertake the review	Early, mid, final	Review ←
Share missing/supplementary information for specific studies	Mid	Review ←
Provide context	Early, final	Review ←
Provide funding and/or in-kind contributions	Early, final (communication)	Review ←
Represent an organisation/group	Early, final	Review ←
Set review standards	Early, final	→ Stakeholders
Share knowledge	Early, final	→ Stakeholders
Facilitate access to the review	Final	→ Stakeholders
Read the review	Final, post	→ Stakeholders
Share the review	Final, post	→ Stakeholders
Integrate review findings into decisions	Post	→ Stakeholders

Table produced during a workshop to analyse the results of key informant interviews.

The need for acknowledgement

As stated above, stakeholder engagement activities should be transparently documented throughout the process. In addition, the role of stakeholder engagement in a review should be clearly stated in some form of acknowledgement. Stakeholders may have contributed considerable time and resources to a review, and acknowledgement for their efforts is not only fair and important for transparency reasons but also a sensible courtesy. Such acknowledgement can take a variety of forms, including: (i) co-authorship of review protocols, reports and resulting publications (although caution must be taken to ensure the review maintains sufficient independence and acceptance by the broader stakeholder group); (ii) documentation in methods text within reports; and (iii) mentioning within acknowledgement sections of dissemination media, including formal publications. Care should be taken if stakeholders are to be mentioned specifically, and permission should always be sought before providing any names of individuals or organisations. Care should also be taken where conflicts may arise through publishing individual names of stakeholders, and referring to generic groups or categories of stakeholders may be preferable if anonymity is desired.

Guidance 3. Acknowledgement of stakeholder contributions should be carefully considered in order to ensure transparency and to thank significant contributors. Permission should be sought before naming specific stakeholders in order not to violate privacy and/or not to be harmful to them in their professional capacity.

Sources of bias in stakeholder engagement

A variety of biases can find their way into stakeholder engagement that can reduce the efficacy of the engagement process. Here, we refer to biases in the stakeholder engagement process itself, not bias held by any individual stakeholder. Reviewers should not attempt to mitigate individual's biases, but rather attempt to engage with stakeholders in an unbiased way. In the following section we discuss those biases in

Table 4. Potential biases that may arise in outputs of stakeholder engagement

Bias	Stage	Explanation	Mitigation
Identification bias	Ss	Purposeful selection of stakeholders using personal/organisational knowledge or unsystematic searches may result in a biased and unbalanced group of stakeholders	Use a combination of selection methods
Network bias	Ss	Asking others to suggest potential stakeholders may result in a biased and unbalanced group of stakeholders	Use multiple starting points (suggestees) from a range of backgrounds
Awareness bias	Ss, Sr	Announcing an open call for stakeholder engagement may target a biased and unbalanced group of stakeholders	Advertise the open call using a range of different channels, using stakeholder analysis to identify stakeholders that may require specific forms of contact
Self-promotion bias	Ss	Systematically searching for potential stakeholders may select only those with an online presence, producing a biased or unbalanced group of stakeholders	Use a combination of selection methods
Access/technology bias	Sr, Oe	Stakeholders may not have the ability to respond to invitations or on-going engagement, producing a biased, unbalanced group of stakeholders	Provide multiple modes of engagement that do not rely purely on one technology/format
Intimidation bias	Sr, Oe	Stakeholders may be less likely to respond if they feel their views are unlikely to be heard over the views of the majority	Provide support to minority stakeholders by tailoring contact and ensuring that views will be heard in initial invitations
Faith bias	Sr, Oe	Stakeholders may not engage if they believe that their views will not be heard due to failures on the part of the reviewers	Undertake stakeholder analysis to help identify and categorise potential conflicts. Ensure openness and contactability to support and facilitate response from less vocal and minority stakeholder groups
Apathy bias	Sr, Oe	Stakeholders may not respond if they feel others will perform their role for them	Encourage stakeholders to engage by explaining that all views are valid and important, and stress the need for a comprehensive, balanced group of stakeholders
Commitment bias	Oe	Stakeholders may not be able to commit to involvement along the full extent of the systematic review process, causing attrition over time and leaving a biased, unbalanced group of stakeholders	Phase contact with certain stakeholders according to their likely involvement
Timescale bias	Oe	Long timescales involved with systematic reviews may mean that attrition occurs over time as stakeholders change roles, in turn leaving a biased, unbalanced group of stakeholders	Attempt to engage with multiple stakeholders from each organisation to ensure some contacts remain
Resource bias	Oe	Stakeholders' resources may be too limited to allow full engagement throughout the systematic review process, leaving a biased, unbalanced group of stakeholders	Phase contact with certain stakeholders according to their likely involvement. Minimise necessary resources needed for engagement, for example by reducing unnecessary reading

Stages are:

Stakeholder selection (Ss);
Stakeholder response (Sr);
On-going engagement along with suggestions for mitigation (Oe).

turn, and provide details of how the bias can be avoided or mitigated. Since it is the reviewers who hold the power in this situation, it is they who must be responsible for identifying, understanding and (where possible) mitigating these biases. We discuss these biases across three key aspects of stakeholder engagement; stakeholder selection, stakeholder response and stakeholder attrition. Each bias is summarised along with suggested mitigation measures in Table 4.

Stakeholder selection

Bias in stakeholder selection arises through the methods used to identify and invite stakeholders. There are four ways in which stakeholders can be invited to engage; purposive selection, 'snowballing', open calls, or systematic selection (Fig. 3). Bias can arise with any mechanism used to identify stakeholders. Purposive selection involves the identification and invitation of selected, often well-known stakeholders. This process potentially results in a biased sample of stakeholders and risks excluding minorities (*identification bias* [30]). This method is often preferred, however, since reviewers are usually familiar with the targeted stakeholders, meaning that there may be higher chances of positive responses, and more manageable numbers of engaged stakeholder groups. 'Snowballing' describes the use of an initial list of stakeholders who are then asked to propose further stakeholders, continuing on in a rapidly expanding manner. Snowballing can also result in identification bias, and can further compound the risks of ignoring minorities by repeating the same bias across multiple stakeholders (*network bias* [31]). Multiple iterations of snowballing with several different starting points (perhaps using key stakeholder groups or known minority stakeholders) can reduce network bias. Open calls for stakeholder engagement can generate much greater numbers of interested stakeholders, with a potentially wider diversity by avoiding identification and network bias. However, open calls risk missing those with no access to the advertisement (we propose the term *awareness bias*). It may also produce an unmanageable number of interested stakeholders, and minority views may be swamped if all parties are engaged yet reviewers' resources are limited. Systematic identification of stakeholders mirrors the systematic approaches used

to identify evidence within a review, and involves a search for potential stakeholders, for example the Poverty and Conservation organisations database (http://povertyandconservation.info/en/organisations; an IIED project). Systematic approaches are inherently less likely to suffer from bias and they use a verifiable, justified methodology. However, large numbers of stakeholders may be identified, and use of the method online risks missing those without an online presence (*self-promotion bias* [32]). Systematic searches may be the least biased method for identifying stakeholders, but using several methods together is likely to result in the least overall bias and unbalance in the stakeholder pool.

Fig. 3. Methods of stakeholder invitation with explanations (italics) and their relative advantages (red text) and disadvantages (green text).

Stakeholder responses to invitations

Once stakeholders have been identified, invitations to engage should be sent out. Stakeholder response to invitations is another point at which bias can manifest itself. As described above, stakeholders can only respond to open calls if they are aware of them (awareness bias). In addition, the ability to respond to invitations requires that stakeholders have the ability to contribute (e.g. access to an email account), something that may prove challenging in certain situations (we propose the term *access/technology bias*). Stakeholders may not be able to attend physical meetings due to limited time or money (*resource bias* [33]). Minority stakeholder groups may not respond if they feel their views are unlikely to be heard over the views of the majority (*intimidation bias* [34]). Similarly, stakeholders may not engage if they believe that their views will not be heard due to failures on the part of the reviewers or the review methodology (we propose the term *faith bias*). Finally, some stakeholders may not respond if they feel others will perform their role for them (we propose the term *apathy bias*).

These biases can be mitigated in a range of ways, including: (i) using multiple advertisement channels for open calls to maximise the target audience; (ii) providing multiple modes of response for those who may not have access to the internet; (iii) providing support to minority stakeholders by tailoring contact and ensuring that views will be heard in initial invitations; (iv) undertaking stakeholder analysis to identify and avoid potential conflicts between stakeholders; (v) offering financial support for attending meetings to those with limited budgets; and (vi) ensuring openness and contactability to support and facilitate response from less vocal and minority stakeholder groups.

Stakeholder attrition in on-going engagement

Stakeholder attrition (drop out) can result in a change in the proportion and balance of stakeholders throughout the on-going engagement and review processes. Differing abilities to commit to the long-term nature of stakeholder engagement throughout a full review can result in loss of important stakeholders (we propose the term *commitment bias*). Another effect of the extensive nature of systematic review

timescales is the loss of stakeholders through changes in individual job roles over time (we propose the term *timescale bias*). As mentioned above, stakeholders may drop out of stakeholder engagement if resources are limited (resource bias). Similarly, access/technology, intimidation bias, apathy bias, and faith bias may continue to be a problem throughout continued engagement. It is important to note that attrition will clearly be more significant as time goes on, meaning that the type and degree of input from stakeholders engaged throughout the review process is likely to diminish in latter stages of the review.

These biases may be mitigated in several key ways. Limitations in the ability of stakeholders to commit resources to engagement can be combated by phased contact with resource-limited stakeholders to ensure that they are contacted at the most appropriate stages and not overtasked. This is particularly important where certain stakeholders are needed for structuring communication activities. Providing stakeholders with multiple modes of interaction (for example workshops, email, face-to-face interviews, etc.) can mitigate access/technology bias and resource bias. Alternatively, resources to aid travel to physical meetings can be provided to stakeholders. Engaging with multiple stakeholders from key organisations can ensure that organisations are not lost if staff changes occur. Finally, providing stakeholders with an encouraging, supportive environment and ensuring openness and contactability (as described above) can reduce intimidation, apathy and faith biases.

Guidance 4. Potential for bias to occur in stakeholder engagement can be mitigated by using a carefully planned, systematic approach to stakeholder engagement. Employing a combination of methods to identify stakeholders, using multiple start points for iterative identification techniques (such as snowballing), and systematically searching for stakeholders can mitigate biases during stakeholder identification. Contacting stakeholders and allowing them to respond via multiple channels (e.g. in person, by post and via email) can mitigate biases during stakeholder responses. Avoiding overtasking by phasing contact, providing multiple methods of interaction, including redundancy within stakeholder organisations through multiple contacts, and providing a supportive, encouraging environment can mitigate biases during on-going engagement. Finally, careful planning can identify potential bias, for example using stakeholder analysis, and allow for attempts to be made to mitigate bias.

Measuring the success and impact of stakeholder engagement

A further specific challenge relates to how we measure 'success' in stakeholder engagement. Reviewers should consider the original objectives of the stakeholder engagement process for their specific review, commonly to: assist in defining a scope that is broadly relevant to a wide range of stakeholders; provide additional evidence where available; endorse the methods used in the review; and, contribute to communication of the review findings.

Many reviewers would define success as improving the quality, communication and impact of a review, but success should also include meeting the objectives of the stakeholder engagement process itself. Issues that are related to success include: (i) a feeling of inclusion and opportunities to be heard by all relevant stakeholders; (ii) acceptance of systematic review methods as a reliable means of summarising scientific evidence on a topic; (iii) faith in the review findings as a robust synthesis of the evidence; (iv) trust in the review team, which can be a particular problem when tackling controversial issues. These latter definitions of success are likely to be affected by stakeholders' beliefs of 'what counts as evidence', and care should be taken to ensure they are aware that systematic review is only one tool for summarising evidence, albeit often seen as the 'gold standard' method [35]. Closely related to measuring success, impact should be documented in stakeholder engagement activities in order to show how stakeholders were able to input to the formulation and undertaking of the review. This is also closely related to acknowledgement and transparency. A further benefit from monitoring impact, however, is that future stakeholder engagement activities may benefit from critical assessment of procedures that resulted in optimum impact.

Guidance 5. Reviewers should document any impact that stakeholder engagement may have on the review. Reviewers may also wish to formally (internally or externally) attempt to critically assess success or impact to help improve future stakeholder engagement activities. Making results of this assessment open access would also benefit the wider systematic review and stakeholder engagement research community.

Framework for stakeholder engagement

As we have discussed, stakeholder engagement should be undertaken in a transparent manner, attempting to minimise bias where possible. The framework outlined in Box 2 may act as a checklist for those planning engagement activities. It does not form a rigid set of requirements: rather, it is comprised of a suite of potentially suitable methods for maximising balance and minimising bias throughout engagement. The framework provides a guide for processes that may be useful and beneficial in ongoing communications with stakeholders.

Summary

Stakeholder engagement can be a time-consuming and resource-demanding process, but it is widely felt by systematic review experts that it should form an integral part of all systematic reviews to some degree or other, particularly at early stages of the review. If planned carefully, stakeholder engagement can be a resource-efficient process that provides a variety of tangible benefits to the scope, processes, quality and acceptance of outputs of a review. But more than this, stakeholder engagement can be vital for ensuring that review outputs have the greatest relevance and impact to the stakeholders that will be the end-users of and/or affected by the review. Reviewers should be aware of potential pitfalls of stakeholder engagement, avoiding bias and striving for balance. By following the suggestions and recommendations in this guidance, we hope that reviewers can increase the effectiveness and efficiency of the planning, conduct and reporting of stakeholder engagement activities during systematic reviews and maps.

Box 2. Approaches and tools for stakeholder engagement in systematic review/map considering measures to ensure balance and mitigate bias

1. **Identification of stakeholders**
   - *a. Stakeholder analysis*
     - i. Check for balance
     - ii. Prioritise certain stakeholders
     - iii. Tailor engagement activities
     - iv. Phase engagement
     - v. Identify potential conflict/bias and plan for mitigation
   - *b. Selection process*
     - i. Purposive selection
     - ii. Snowballing
     - iii. Open call
     - iv. Systematic approach
2. **Initial invitation**
   - *a. Invitation type, i.e. open call/advertisement versus closed invitation (selected stakeholders only)*
   - *b. Invitation format (e.g. email/telephone/conference presentation) and wording*
   - *c. Tailor invitation to specific stakeholders/stakeholder groups*
   - *d. Clarify purpose and format of stakeholder engagement*
3. **Initial engagement**
   - *a. Format*
     - i. Group meeting/workshop
     - ii. 1-on-1
     - iii. Remote (email, online or post)
   - *b. Plan for dealing with conflict*
     - i. Involve experienced mediator/facilitator
     - ii. Modify engagement format to minimise conflict
     - iii. Plan for dealing with unresolvable conflict, i.e. where compromise would impact the review
4. **Explanation of subject-specific terminology**
   - *a. Level of explanation of systematic review methodology*
     - i. Brief explanation in contact
     - ii. Links to external sources of additional information
     - iii. Full explanation (tailored to specific stakeholders)
     - iv. Explanation through presentation in workshops/meetings
   - *b. Agreement on contentious definitions and terminology*
   - *c. Avoid jargon*
5. **Maintaining interest throughout the process**
   - *a. Level of on-going communication with stakeholders*
     - i. Regular contact to avoid lack-of-interest attrition
     - ii. Warn stakeholders of potential reduced contact during review activities

6. **Documenting stakeholder inputs to the review**
    a. *Include explanation of inputs from stakeholders (specified, where suitable) that affected the review scope/methodology in the protocol and final review*

7. **Dissemination and communication**
    a. *Dissemination media format*
        i. Review only
        ii. Review plus press release
        iii. Multiple media tailored to specific stakeholder groups
        iv. Advertising of published media (e.g. blogs, social media)
    b. *Active versus passive dissemination*
        i. Review outputs (dissemination media) published online
        ii. Dissemination media sent to stakeholders
            1. Subgroup of active stakeholders
            2. All identified stakeholders

8. **Acknowledging stakeholder contributions**
    a. *Acknowledge all engaged stakeholders*
    b. *Obtain informed consent before naming specific stakeholders*
    c. *Describe planned/completed stakeholder engagement activities in the protocol and final review*

9. **Eliciting feedback on stakeholder engagement activities**
    a. *Request feedback on perceived success of stakeholder engagement process from stakeholders (i.e. opinions and comments)*
    b. *Use feedback to assess success of engagement process*
        i. Define stakeholder engagement success as
            1. Stakeholder feeling of inclusion
            2. Stakeholder opinions taken into consideration
            3. Stakeholder endorsement of the review

10. **Critical self-assessment**
    a. *Evaluate stakeholder engagement processes internally*
    b. *Evaluate stakeholder engagement processes externally by independent body*
    c. *Publish findings of evaluation*
    d. *Alter processes in the future where necessary*

Authors' contributions

NRH undertook key informant interviews. NRH and NRdS undertook thematic analysis of survey results. NRH, NRdS and RS formed a working group to discuss thematic analysis results and prepare conceptual models. NRH drafted the manuscript and all authors contributed to the final manuscript. All authors read and approved the final manuscript.

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Appendix 1.

Description of interviews with key informants

The following method for interviewing and identifying themes from interviewees' responses is not intended to be a robust qualitative research method, but rather a means of applying context to the literature review and experience of the manuscript authors. The methods are not formal qualitative research methods, but were rather intended to record a range of experiences and views transparently.

Interviews were conducted between September and November 2014 with nine key informants from a range of research and policy organisations with varying degrees of experience of working with stakeholder engagement in systematic reviews. Informants were selected based on an exhaustive assessment of published systematic reviews and systematic maps in the journal of the Collaboration for Environmental Evidence, Environmental Evidence. Shortlisting of potential interviewees was undertaken by subjectively identifying reviews likely to have involved a high degree of stakeholder engagement. These reviews were identified through being public goods rather than private goods (i.e. undertaken for specific commissioners), and through focusing on topics believed to be particularly controversial or contentious. A final list of 9 potential interviewees was assembled based on lead authors or corresponding authors from relevant, published review reports. Potential interviewees were initially invited by email and subsequently interviewed over Skype (by NH). Informants were asked a range of discussion questions (see below for the questionnaire) and their responses were recorded as a voice file and detailed notes taken during conversations. These detailed notes were then cross checked against recordings to ensure that concepts were reported accurately and that quotations were correct (by NH).

Following the interviews these summary notes assessed against the themes identified from the literature review that informed the main body of the manuscript. Themes in the manuscript were separated by the timing and type of stakeholder engagement activity possible within a systematic review or map. Two authors (NH and NRDS) independently coded concepts and quotes relating to these themes

in each set of interview notes (codes were checked for consistency but no discrepancies were identified). Coded concepts and quotes were then grouped by theme. The identified themes from within interviewees' responses were discussed by three researchers (NH, RS, NRDS) during working meetings in Johannesburg in November 2014 before producing draft conceptual models. These models were in turn discussed and refined in a workshop including all other authors in November 2014 in Cape Town, integrating experiences gained during the stakeholder engagement activities of the EU-funded project, GRACE (www.grace-fp7.eu).

Interviewee's responses and comments were then used to highlight particular examples of activities that had been undertaken in stakeholder engagement activities within previous systematic reviews and maps and were integrated into the manuscript.

Stakeholder Engagement in Systematic Reviews

Key Actor Questionnaire

Pre-questionnaire survey

Some questions ask you to think more generally, but others will elicit specific examples of your experiences with a specific review.

About You

1. Name
2. Organisation
3. Which of the following best describes your experience with systematlc reviews?
    a. Experience of multiple systematic reviews (systematic review expert), if yes, how many?
    b. Prior experience of conducting one systematic review
    c. Understanding of systematic review processes but no experience of under taking a systematic review
    d. Some knowledge of systematic reviews as a method of synthesising evidence
    e. No prior knowledge of systematic reviews

4. If you have worked with systematic reviews before, which of the following types of review have you been involved with? (Please check all that apply)
    a. Qualitative reviews (qualitative synthesis)
    b. Quantitative reviews (primarily meta-analysis/quantitative synthesis)
    c. Mixed methods reviews (both qualitative and quantitative syntheses)
5. If you have worked with systematic reviews before, which coordinating body/bodies were they registered with? (Please check all that apply)
    a. Cochrane Collaboration
    b. Campbell Collaboration
    c. The Collaboration for Environmental Evidence
    d. EPPI-Centre
    e. None
    f. Other (please specify)

This questionnaire and the interview that follows will focus on stakeholder engagement in Evidence Reviews. We define stakeholders as those who are affected by or can affect a decision (after Freeman, 1984. Strategic Management: a Stakeholder Approach. Pitman, Boston)

6. Which of the following best describes your experience with stakeholders in a research capacity?
    a. Substantial experience of working with stakeholders (multiple research projects or more than 12 months)
    b. Some experience of working with stakeholders (one research project or under 12 months experience)
    c. No experience of working with stakeholders
    d. Other comments

General Experience with Stakeholders

7. In your experience of systematic reviews, in which processes have stakeholders been involved?
    a. Commissioning (raising funds)
    b. Question formulation
    c. Protocol development
    d. Protocol peer-review
    e. Searching / identifying studies
    f. Screening
    g. Data extraction
    h. Critical appraisal
    i. Synthesis
    j. Report writing
    k. Final report peer-review
    l. Dissemination
    m. Other, please specify

Your Opinions

8. In your experience overall, would you say that stakeholder engagement has been;
    a. A success
    b. Neither a success nor a failure
    c. A failure
    d. Unable to say
    e. Other

    Please explain your answer
9. Do you feel that stakeholder engagement has influenced the course of your systematic review(s)? (yes/no)
10. Do you feel that this influence was positive or negative?
    a. Positive
    b. Negative
    c. Unsure
    d. Prefer not to say
    e. Other, please specify

    Please explain your answer
11. Do you think that stakeholder engagement is a valuable and important process of evidence reviews?
    a. Yes, always
    b. Yes, sometimes
    c. No
    d. Unsure
    e. Other

    Please explain your answer

In-depth Questionnaire

About You

1. What is the nature of your involvement with systematic reviews?
2. How are you involved with stakeholders as part of your role in systematic reviews?

Your Understanding of Stakeholders

3. What is your understanding of the term ‘stakeholder’?
4. How would you define ‘stakeholder engagement’ with respect to systematic reviews?

General Experience with Stakeholders

5. In your experience of systematic reviews, when have stakeholders been involved in the review processes?
6. For those stages, how were stakeholders involved?
7. For your last review, which stakeholders were involved?

Identification of Stakeholders

8. How did you go about identifying stakeholders for your last review? (purposive selection / open call / snowballing / third party)
9. Did you perform any form of stakeholder analysis to assess the types and likely roles of identified stakeholders?

Inviting and Engaging with Stakeholders

10. How have stakeholders been invited to participate in your experience? (in person, open call / telephone / letter / addressee (contacts) / workshop / existing networks)
11. How did you approach wording of the contact, more specifically, did you consider definitions and explanations? How did you define contentious terms? Did you make efforts to avoid jargon? Did you tailor your contact for the type of stakeholder?
12. Did you experience any challenges when describing and defining systematic reviews and their processes to stakeholders?
13. Did you clearly establish the purpose of stakeholder engagement and what they should expect?
14. Did you face any particular challenges when attempting to invite stakeholders? If so, what were these challenges?
15. Do you feel that the pool of stakeholders was balanced? Did you feel a specific group or groups of stakeholders were missing?
16. Did you feel that stakeholders represented the views of their organisations, or do you feel there was a personal conflict of interests with some individuals?
17. Did you involve a trained mediator or facilitator in stakeholder engagement? If so, how did that go?
18. Have you experienced conflicts between stakeholder groups? If so, how did you resolve them?

On-going Engagement

19. Did you engage with stakeholders throughout the review process? If so, how: which stakeholders were involved in which stages (refer to answer to question 7 from pre-interview survey)? If not, why not?
20. Overall, how did you engage with stakeholders (one-way / two-way / regular contact / updates)
21. How easy was it to keep stakeholders engaged in the systematic review(s)?
22. Which groups of stakeholders were most easily engaged, in your experience? Were any groups particularly difficult to engage?
23. Did you chase up unresponsive stakeholders? If so, how? If not, why not?

Disseminating Results

24. Did you disseminate your review to your stakeholders? How did you select which stakeholders to send it to?
25. In what format did you disseminate the review? (in full / generic summary (length?) / non-technical summary / tailored to specific stakeholder groups / other)
26. How did you circulate the disseminated product? (in person / workshop / email / post)

Acknowledgement and Feedback

27. Did you acknowledge the role of stakeholders in your review in any way? If so, how?
28. Did you request feedback on the review/engagement process from stakeholders? If so, how?
29. Was the feedback positive?
30. Did you report the elicitation of feedback publically/privately (i.e. to commissioners)? Did you report the feedback publically/privately?
31. Was the feedback used in any way? If so, how?
32. Did you perform any sort of internal assessment of stakeholder engagement activities? If so, how? (external / internal / level of independence)

Your Opinions

33. How successful do you feel stakeholder engagement in systematic reviews has been in your experience? (We define success as stakeholders being involved as much as necessary and their views have been taken into consideration.) How would you define success? Was your review influenced by stakeholder input in any way?

Advice and Recommendations

34. In your opinion, at which stages of the systematic review process should stakeholders be engaged?
35. In your opinion, at which stages of the systematic review process should stakeholders NOT be engaged?
36. If you could change the way that your review engaged with stakeholders, what would you do differently?
37. In your opinion, what processes/actions should be an integral part of all stakeholder engagement in systematic reviews?
38. In your opinion, what processes/actions should NOT be undertaken as part of stakeholder engagement in systematic reviews?

2

Knowledge production and environmental conflict: managing systematic reviews and maps for constructive outcomes

Rasmus Kløcker Larsen • Annika E. Nilsson

Systematic reviews and maps in the environmental field are often carried out in contexts of contestation between different knowledge holders and users, placing demands on the review team to constructively relate to different interests and perspectives. The aim of this short commentary is to place systematic reviews and maps into a broader perspective of conflict management related to knowledge production, including the role of facilitated stakeholder involvement. We introduce a brief framework that identifies four dimensions that are relevant for choosing among different approaches to knowledge production in conflict situations: type of conflict, view of knowledge, model of stakeholder involvement, and measure of quality. We also provide some suggestions on how such a framework can be applied in connection with planning for systematic reviews and maps. Options include managing conflicts through facilitated stakeholder involvement *within* the review itself as well as a thorough assessment of what specifically the method can contribute *in relationship* to other approaches to knowledge production for environmental management.

Keywords: Systematic review • Conflict • Post-normal science • Wicked problems • Stakeholder involvement

Background

Systematic reviews [1] and maps [2] (hereafter referred to simply as reviews) in the environmental field are often carried out by research teams to inform policy makers in contexts of contestation between different knowledge holders and users [3]. In this short commentary, we argue that conflict situations place demands on the review team to think through stakeholder involvement up front in order to constructively relate to different interests and perspectives. The aim is to place reviews into a broader context of conflict management related to knowledge production and to present different approaches to stakeholder involvement.

Conflict, wicked problems and post-normal science

The term conflict is often associated with negative connotations. Our starting point is instead that conflicts in interests, perspectives and/or knowledges are a persistent characteristic of all societies in the sense that actors enter situations with different worldviews and interests. If mechanisms are in place to handle conflicts well, they can be constructive and contribute to mutual learning and creative problem solving. While research may not be able to resolve conflict of perspectives, worldviews, and/or interest, we argue that it has a role beyond providing new facts. Specifically, research processes conducted with care can play a role in improving the actors' understanding of the meaning of the conflict and the grounds on which differences in perspectives are based [4].

This way of viewing conflicts is especially relevant for so-called 'wicked' problems [5]. Wicked problems defy simple definitions and explanations and stakeholders may disagree not only on the effectiveness of suggested solutions but also on the nature of the problem itself. Typical of wicked problems are high degrees of uncertainty, complexity and contestation. If the assumption is that only one perspective is valid, then knowledge production related to wicked problems can easily create or exacerbate destructive conflict situations. We argue that if the analysis instead starts from an assumption of several valid perspectives, a more constructive outcome is more likely for everyone involved.

Recognition of wicked environmental governance problems has gone hand-in-hand with a shifting understanding of the role of science in society, including the relationship between science and politics. Whereas 'normal' science has been expected to produce objective truths that should inform politics ('science speaking truth to power'), the practice of 'post-normal science' [6] or 'Mode-II science' [7] focuses on problems that cannot be resolved via normal science practice, namely uncertainty and contestation arising from the plurality of legitimate perspectives. There is increasing understanding that knowledge generation is inherently social and political [8], requiring carefully designed strategies for actively involving stakeholders.

Much emphasis in recent years has also been placed on how knowledge production, through deliberation, can contribute to social learning whereby participants conjointly negotiate competing problem definitions and ways of problem solving. This may support the development of improved relational capabilities to deal with common problems that individual participants cannot resolve on their own (for reviews see also [9, 10]). Social learning has also been put forward as a complement to conventional environmental policy instruments [11, 12]. However, in situations shaped by great inequalities and power differentials more specific demands are placed on the facilitation of knowledge production [13]. Examples include cross-cultural encounters where emphasis must be on opportunities for mutual recognition and equal opportunities to participate in decision making [14].

The case of mining in the Arctic

Our argument regarding controversy and the role of knowledge in decision making can be illustrated by a brief reflection on the issues surrounding mining in the Arctic. Here, environmental reviews and assessments often focus on a limited subset of environmental impacts and mainly address a narrowly defined 'technical' problem. However, when such studies inform political decisions, for example when the assessment is the basis for a mining permit or a government position on land use planning, they cannot be disconnected from the issues related to land use conflicts and the legal and moral rights of different groups. While normal scientific methods might be relevant to answer

the problem posed by the assessment/review, it is not sufficient for addressing the broader conflict situation. If a knowledge production process is not seen as legitimate, it can even exacerbate existing conflicts. Recognizing the nature of wicked problems, post-normal science directs attention to these social dynamics of the knowledge production process (for further reading about knowledge controversy in the case of mining in the Arctic, see e.g. [15]).

Choice of process for knowledge production

An important task for the systematic review community is to define its own specific role in relation to the broader context of conflicts related to knowledge and the 'tool box' that is available for managing

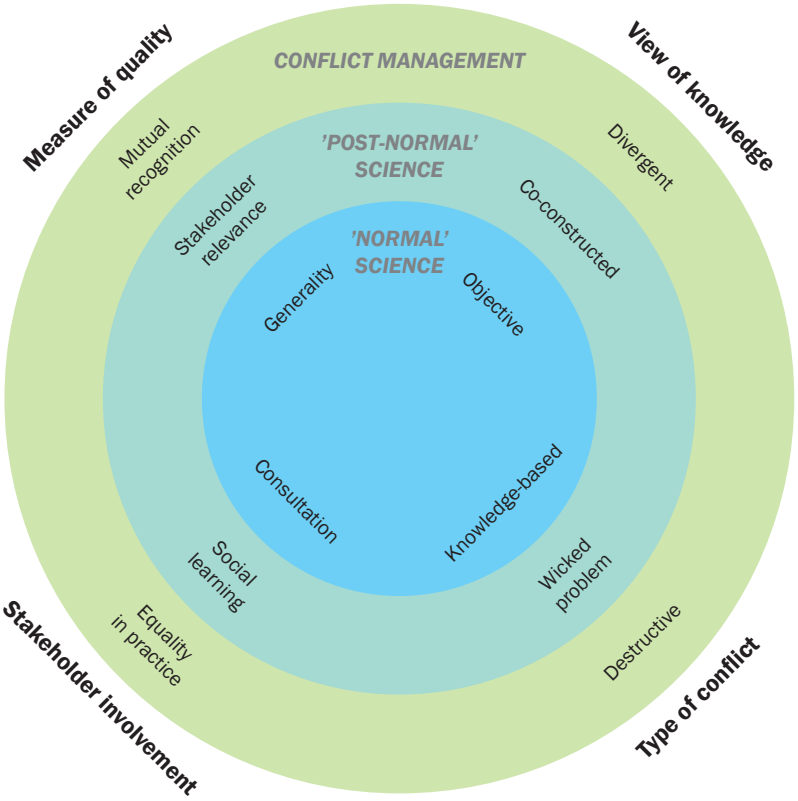

Fig. 1. Heuristic framework of modes of knowledge production in relation to conflict.

Table 1. Different approaches to process design in knowledge production

	Normal science	Post-normal science	Conflict management
Question	Well-defined problem	Wicked problem	Potentially irreconcilable problem definitions
	Closed-framed question	Stakeholder-negotiated question(s)	Co-existing diverging questions
Evidence	Published scientific and grey literature	Filling primary data gaps highlighted by stakeholders	Evidence generation integrated in process design, e.g. via joint fact-finding
	Quantitative and qualitative scientific analysis	Exploring interpretations through social learning	Facilitated exploration of the role of different types of knowledge
Review team	Experts	Involving stakeholders in framing the process, e.g. identifying research questions	Stakeholders are the experts and directly involved in answering the question
	Scientific independence	Consensus seeking	Building mutual understanding of disagreements
Stakeholder group	Consultation role only	Decision-making authority	Stakeholders may not agree to form a group—distinct meetings instead
	Identified based on pre-defined problem	Involvement prior to problem definition	Facilitation aiming at equality in practice among different stakeholders

Inspired by the outline of methodological steps in systematic reviews and maps [1], this table highlights issues that need to be considered in the planning of any assessment of knowledge.

them. We discuss the options available in relation to four different dimensions that have been variously discussed in past work on post-normal science and conflict management (e.g. [6, 16]). These options reflect four (interdependent) operational stages that may inform process design in planning for a systematic review: (i) assessing the type of conflict, (ii) creating awareness about different views of knowledge (epistemology), (iii) deciding the relevant model of stakeholder involvement, and (iv) deciding on how to measure quality of the knowledge production process (Fig. 1). Whereas the space limitations prohibit a detailed examination of the implications of each of these options for designing reviews, we include a brief summary with concrete examples that we hope will help stimulate further debate on this topic (Table 1).

The type of conflict

The choice of process for knowledge production depends both on the type of controversy and level of disagreement. In cases where stakeholders agree on the problem definition and what kinds of data are needed to answer the question(s), normal scientific methods and systematic reviews following standard protocols may be sufficient. Faced with wicked problems, where there is no agreement on the problem definition in the first place, normal scientific credibility and standard systematic review protocols will not suffice. Here, equal emphasis must be placed on the legitimacy of the knowledge production process [18]. Does the process include all relevant stakeholders? Is the process transparent? Do all knowledge holders have an equal voice in the process of gathering and evaluating information? Such approaches are common in scientific assessments that are conducted in a policy context. In destructive conflict situations, (at least some of) the parties reject the legitimacy of other perspectives and, potentially, even the right of others to articulate their views and interests. Here, stakeholder involvement must focus on how to more constructively mediate between the differences in interests and perspectives [4].

The view of knowledge

Decisions about the choice of knowledge production process in research tend to be shaped by the underlying philosophy of science (e.g. epistemology, the view on how we know what we know) [16]. The view of knowledge can influence the sensitivity to different worldviews in ways that can also affect how we handle conflict situations. For instance, it determines whether one is interested in the normal scientific facts, the different perceptions of the problems at hand, and/or the underlying reasons why different perspectives exist. The view of knowledge determines not only what problem definitions are recognized but also what types of data are considered valid [19], which in turn shapes the framing within which evidence-based decision-making takes place A vital step is therefore to negotiate the definition of what constitutes credible evidence and to transparently document not only scientific data but also indigenous and local knowledge and practitioners' experiences. Different views of knowledge can be especially pronounced in cross-cultural settings and can also have implications for what research methods are considered ethical [17].

Model of stakeholder involvement

A number of typologies have been constructed that help make sense of different modalities of stakeholder involvement (e.g. [20]). For a well-defined scientific problem without wicked dimensions, stakeholders may not need to be engaged very deeply in the knowledge production process. Of course, they can still have an advisory role for identifying salient questions and for making sure that the results become integrated in decision making. This is how stakeholder involvement in science is most often defined. When addressing wicked problems, it becomes important to choose research methods that contribute to shared learning and which allow stakeholders to become actively engaged in the knowledge production process and the 'structuring' of the problem situation [21]. For instance, in joint-fact finding, stakeholders 'work together to produce a common knowledge base that they consider valid and relevant for the decision-making situation under dispute' [22]. In situations of high controversy and destructive conflict, it is rarely possible to agree on a joint problem formulation and the purpose of the process may initially be to explore why such divergence exists in the first place. Addressing conflict constructively also requires ensuring 'equal participation in practice' (e.g. [17]), for example by being attentive to uneven distribution of influence and resources. Approaches that rely on active involvement of stakeholders also require strategies and resources for ensuring that the goals of the involvement can actually be achieved, for example investing in arranging workshops, professional facilitation, and economic compensation for stakeholders' time investments.

Measure of quality

The measure of quality that is adopted for assessing and steering a knowledge production process will shape the level of trust the users are likely to place in it. For well-defined problems, the level of trust relates to normal scientific method and the aim is typically to ensure a high level of generality. Wicked problems require more attention to the broader context of knowledge production, such as the quality of the process for engaging stakeholders. A common quality dimension is the level of transparency in the process, where the demands on transparency for a broader audience increase with the level of controversy. In destructive conflict situations with high levels

of controversy, the primary aim of the process is typically to provide support for stakeholders to rebuild mutual respect and recognition of others' perspectives and interests. While quality in reviews in the normal science tradition relate to reproducibility of results as an important value, quality in post-normal science and conflict management rather depend on the rigorous selection and application of methods for participation, co-construction and transparency (e.g. [16, 22]).

Conclusions

We have introduced a simple framework for thinking about how the systematic review community may respond to conflict between actors affected by the issue under review and/or the review itself. A central argument is that there are options available to maneuver through various models of stakeholder involvement *within* the review itself as well as through being cognizant of the potential and limitations of such reviews *in relationship* to other approaches to knowledge production for environmental management. Notably, in wicked problem situations, especially in situations of high or even destructive conflict, other knowledge production approaches are likely to be more relevant than systematic reviews and maps on their own.

How do these proposals relate to current practice (see e.g. [1]) in the conduct of systematic reviews? First and foremost, the four dimensions that we raise need to be addressed already in the early planning of a review, which should ideally include an assessment about the nature of issues at hand and the potential role that knowledge production may have in contributing to constructively managing a potential conflict situation. The planning phase should—in addition to standard ethics review and assessment of risk and opportunities associated with the work—involve a systematic stakeholder mapping [23] and judgements when systematic reviews and maps can play a constructive role. Already in making this judgement stakeholders need to be involved, since their perspectives and knowledges will determine what type of review is most relevant.

Second, based on this initial assessment during the planning phase, those responsible for the review may opt for a normal, post-normal or conflict management approach to the review—with corresponding responses regarding, e.g. stakeholder involvement. For instance, if a well-defined

question can be identified and the level of controversy is low then standard practice may be followed. That is, involving stakeholders in deciding on a protocol but doing the actual review independently to ensure normal scientific integrity. In contrast, if the problem is wicked in nature or stakeholders cannot agree on the problem definition(s) then post-normal or conflict management approaches will guide ways to engage stakeholders more comprehensively in the review, e.g. in the knowledge production and analysis steps.

Overall, we have in this paper made some arguments for the reasons why and ways how systematic reviews may move further towards providing what is also known as 'multiple evidence bases' for decision making [24]. Co-production of knowledge across multiple knowledges is warranted when reviews address controversial and wicked problems, combining systematic mapping of published scientific literature with direct participation of stakeholders to contribute with their diverse knowledges. Placing the specific process of systematic reviews into such a larger context is a first step towards acknowledging the different perspectives that need to be considered in addressing complex environmental problems. Openly acknowledging multiple perspectives also serves to avoid forced consensus that could otherwise undermine the legitimacy of scientific review.

Authors' contributions

RKL and AEN jointly produced this manuscript through complementary equal contributions. The author listing on the title page is alphabetic. Both authors read and approved the final manuscript.

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3

How stakeholder engagement has led us to reconsider definitions of rigour in systematic reviews

Laurenz Langer • Yvonne Erasmus • Natalie Tannous • Ruth Stewart

As a methodology designed to inform policy and practice decisions, it is particularly important to ensure that systematic reviews are shaped by those who will use them. There is a broad range of approaches for engagement of the potential users of reviews that aim to elicit their priorities and needs and incorporate these into the review design. This incorporation of their priorities and needs can create a tension between their calls for locally-specific, often rapidly-produced evidence syntheses for policy needs and the production of unbiased, generalisable, globally-relevant systematic reviews. This tension raises the question of what is a 'gold standard' review. This commentary aims to address head on this often undiscussed key challenge with regard to stakeholder involvement in systematic reviews: that responding to stakeholders can mean reconsidering what makes a review rigorous. The commentary proposes a new model to address these tensions that combines the production of public-good reviews, with stakeholder-driven syntheses. In this, it presents the approach taken by our team at the Africa Centre for Evidence at the University of Johannesburg to achieve two different but complementary outputs: (i) 'public goods', namely comprehensive and generalisable systematic reviews of the evidence available for and accessible to a global audience, and (ii) locally-focussed, stakeholder-driven, pragmatically-produced syntheses for decision-making at a policy level.

The designed approach incorporates balancing the formal requirements of full, published systematic reviews with engagement of national and international decision-makers. It also accommodates space to move from stakeholder engagement to co-production, where stakeholders are engaged to such an extent that they become partners in the production of the review. These approaches are integrated into the traditional steps for producing a systematic review with implications as to what constitutes a gold standard approach to synthesising evidence.

Keywords: Stakeholder engagement • Rigour • Rapid evidence assessment • Public good • Government

Background

As a methodology designed to inform policy and practice decisions, it is particularly important to ensure that systematic reviews are shaped by those who will make use of them, a process known as stakeholder engagement. Stakeholders might include service users such as patients, practitioners such as teachers, community leaders, those working to set or implement national or local policy, and many others. There is a range of approaches for engagement of stakeholders in research, from advisory groups to co-production. This range includes the opportunity for stakeholders to shape the scope of the review, the types of outcomes considered, and the dissemination of the research findings, amongst other things [1]. Where stakeholders get involved as co-producers, they may also learn and apply specific review skills such as searching, coding, and critical appraisal. The choice as to which approach to stakeholder engagement is adopted is shaped in many ways by whether the review is 'supply-led' (i.e. driven by the researchers/research community) or 'demand-led' (i.e. driven by the users of the review). The former is likely to already have scope and methodology in place, with stakeholder engagement used as a mechanism to im-

prove particular aspects of the scope, validate the question, or advise on dissemination. In the latter the review is being produced in direct response to stakeholders' demands, and their inputs are therefore much more likely to influence the scope and design of the review. As such not all stakeholder engagement leads to demand-led reviews, but all demand-led reviews are steered by stakeholder engagement.

Any engagement by stakeholders in systematic reviews can be particularly challenging due to the complexity of the methodology. A key hindrance here is that, in systematic reviews, the link between the user of the research and the data collected and analysis generated is thinner than in primary research. For example, systematic reviews do not interview research participants or collect household level data, a process with which review users might be more familiar than, say, extracting effect sizes or conducting thematic synthesis of data reported in primary research. There is a body of literature that aims to understand and advise how best to elicit contributions from stakeholders, including consideration of who initiates engagement [1]. There is however less guidance on what to do with the contributions stakeholders make, particularly if they contradict what methodologists recommend [2].

Discussions about how best to engage stakeholders, and meet their evidence needs, have given rise to a debate around how best to balance the sometimes-competing interests of the different contributors [3, 4]. For some, achieving rigour is a scientific and technical process to maximise the generalisability of the findings; it is seen as a process that obliges adherence to requirements laid down by one of the specialist systematic review collaborations (including the Collaboration for Environmental Evidence (CEE)) with an emphasis on the methodological aspects of the review. For others the legitimacy of methods is paramount [5, 6, 7]. Parkhurst defines this as ensuring that the review is perceived to have been produced in such a way that is respectful of stakeholders' divergent values, and fair in its treatment of views and interests [3, 7]. There are also issues of relevance of the review, which can include its focus, format, and timeliness [8].

Stakeholder engagement in systematic reviews therefore presents a major challenge to review teams that goes beyond the usual discussion of whom to involve and how. Responding to stakeholders'

priorities can often drive review teams towards a more relevant, actionable, and timely (rapid) process. Engagement in itself therefore creates a tension between the production of globally relevant systematic reviews—in which methodological steps to enable generalisability are prioritised—and locally-specific, often rapidly-produced evidence syntheses for policy needs. Stakeholder engagement therefore presents a dilemma for review teams about what is a 'gold standard' review.

This commentary aims to address head on this 'elephant in the room' with regard to stakeholder involvement in systematic reviews: that responding to stakeholders when producing a demand-led review can mean reconsidering what makes a review rigorous.

After 20 years of producing evidence synthesis in partnership with stakeholders, our team at the Africa Centre for Evidence at the University of Johannesburg has adopted an approach for producing evidence syntheses that prioritises methodological generalisable 'public goods' published in recognised systematic review libraries, and responsive evidence products that meet the needs of decision-makers, which can require a broader understanding of rigour. This paper presents this approach for discussion.

What has led us to develop this approach?

We understand the need for rigour. We have conducted reviews for 3ie, CEE, Cochrane, Campbell, and the EPPI-Centre and so bring a wealth of methodological expertise to the challenge of balancing stakeholder engagement with the need for rigour. Our work has at times been supply-led and at other times demand-led, and this has influenced the range of people involved and types of engagement we have undertaken as well as how we have viewed the concept of rigour. We have worked with a wide range of stakeholders using approaches all along the spectrum of involvement [9]; from one-off requests for advice from stakeholders to formal advisory groups, working groups, and even full co-production. We have also supported decision-makers in producing their own evidence syntheses. In employing this spectrum of engagement approaches, we have produced a wide range of

synthesis products: from full reviews through to responsive evidence assessments, reviews of reviews, and evidence maps.

The range of stakeholder engagement we have undertaken, with different drivers and different products, has led us to reflect that the definition of rigour commonly used by research producers does not always fit within particular stakeholder contexts, and therefore we have been reconsidering the question of what is a 'gold standard' systematic review.

An overview of the approach we now use

As a team committed to producing evidence syntheses which are demand-led, useful, and used we have to take seriously these issues about how and why to include stakeholders and how to address the tensions with regard to rigour that arise as a result. As methodologists we have a good understanding of the 'compromises' made when different priorities are balanced with respect to what makes a review rigorous.

Our approach includes the following eight steps:

i. Stakeholder mapping to ensure all relevant groups are considered;

ii. Engaging a wide range of stakeholders including methodologists, subject experts, and decision-makers;

iii. Producing a protocol that can be peer reviewed to ensure we garner feedback from methodological experts;

iv. Producing an evidence map as comprehensively and rigorously as possible within the time and funds available; [1]

1 We acknowledge that 'evidence mapping' is a relatively new field and different variations on the methodology exist. Some search more comprehensively than others, some include critical appraisal, some have a level of synthesis within each cell, and others do not. In our case the types of evidence included are broader than just academic research, the comprehensiveness of our searches is time-dependent (although that is often also true in systematic reviews), and there is unlikely to be time for either a critical appraisal step nor any synthesis within the cells of the map itself; only in later review stages is this possible.

v. Sharing that map through an interactive visualisation with a wide range of stakeholders, including both decision-makers and methodologists. This visualisation takes the form of a spreadsheet that can be viewed online. The two axes most commonly represent (a) interventions and (b) outcomes, and within each cell is a representation (for example as numbers, dots, or colours) to indicate the size and nature of the available evidence that corresponds with that specific intervention and outcome combination. Users can apply a number of filters to focus the evidence that is included in the display (for example selecting studies based in a particular country or applying a particular study design), and can click through into each cell to find reference information for included evidence;

vi. Selecting areas for synthesis based on stakeholder input. This might include one or more specific cells, or particular intervention or outcome areas. It may also involve applying one or more filters, for example selecting randomised controlled trials conducted within Africa;

vii. Conducting syntheses that are explicit about the elements that constitute rigour and how they are balanced; and

viii. Producing more than one output to meet the needs of both the immediate stakeholders with whom we have engaged (the tailored evidence syntheses), and the needs of potential future users (the global good systematic review).

What this means for the rigour of our evidence syntheses

In theory, having different outputs from the same project should mean that we are able to meet the requirements for rigour as laid out by systematic review collaborations. Having said that, we have found that we do not 'fit' in the usual publishing requirements of the systematic review collaborations. For example in 2012/2013 we produced a three-stage review on smallholder farming that included a systematic review of reviews, an evidence map, and a full synthesis. The Camp-

bell Collaboration's processes were not flexible enough to consider all three steps and only accepted the full synthesis stage, which had to be written up as a standard systematic review, almost as though the first two stages had not taken place [10, 11]. The very fact that our approach has not fit within the usual formats hints that the requirements for rigour within these formats may not be fit for real world decision-makers' evidence demands.

We are unlikely to be able to employ all the 'best practices' promoted by systematic review collaborations as the elements of rigour within our reviews are likely to be broad and responsive to stakeholders' priorities. Stakeholders' priorities sometimes take us outside what is considered 'best practice'. When trying to be responsive to decision-makers' needs we often have to be quick, which can mean that some steps required for technical/scientific rigour are adapted to the demands of the specific context. For example, having a percentage of papers double screened or double coded rather than all of them, or doing a shorter, less comprehensive critical appraisal stage. The stakeholders with whom we are working may also have priorities for synthesis that do not match those of other stakeholders. This may mean that the review may be of considerable value to some people but not others. This might be for a number of reasons including the fact that the subject that they choose is relevant only to specific environments, or that their outcome of preference does not apply to others' contexts.

Full publication of all our reviews' outputs is less likely to take place when we adopt stakeholders' priorities. Outputs are fed into decision-making cycles immediately without waiting for formal publication processes, which will not necessarily take place. If confidential documents have been included, as has been the case in some of the syntheses we have conducted for government colleagues, it may limit the scope for full publication of data.

Quality assurance processes of reviews, such as peer-review, can also look different. Rather than having formal methodological peer-review, decision-makers' quality assurance processes (and thus definitions of rigour) have to be followed. These can often be different (for example validation meetings of the usefulness of evidence mapping methodologies by a range of government departments) but are not

necessarily less stringent: for instance when evidence syntheses are tabled at Cabinet level, the level of scrutiny of the synthesis can be much higher than in traditional academic review as the stakes are higher.

What this means for the relevance and usefulness of our evidence syntheses

We propose that this approach to stakeholder engagement for demand-led reviews is much more likely to be relevant to the needs of those specific stakeholders involved. In our experience of working with the government in South Africa to co-produce an evidence map on Human Settlements under the leadership of the Department of Planning, Monitoring and Evaluation, the review team jointly developed a conceptual framework that fit closely with the country's National Development Plan and Mid-Term Strategic Framework. This enabled the evidence map to feed directly into policy debates in government.

Of course such close consultation does not necessarily mean that the synthesis will meet the priorities of other groups of potential users, but we believe that this approach creates more legitimacy as the syntheses are easily recognised as having responded to the priorities and values of the users [7]. Timeliness is such an important factor for decision-makers so by working with them and to their timelines, the review is much more likely to be used: if you miss the policy-window, then the review simply will not be read.

Demand-led reviews move the review design and conduct much closer to the user of the review. This approach changes the balance of power between the researcher and the review user, which can elicit worries about the independence of the review process and findings. Review stakeholders might for example influence the review in such a way as to arrive at the preferred findings and recommendations. In our experience, there are three points to consider in this regard.

First, while being more flexible and tailored to decision-making needs, demand-led reviews cannot compromise on the underlying systematic review principles of transparency and following a structured, systematic review approach. Any demand-led review has to comply with these principles as traditional, supply-led reviews do.

Second, where vested interests become a challenge to a demand-led review, the review project should be discontinued. However, it is not clear why an independent but unused review is any less a waste of research than a review that cannot be completed due to undue attempts of stakeholder influence. The risk of vested interest due to stakeholder engagement therefore does not seem to present an inherent reason not to conduct demand-led reviews. One could also argue that to challenge and change vested interests and beliefs, if possible at all, engaging with such actors and groups in the review process has a higher likelihood of success than assuming that review findings will reach such groups by themselves.

Third, we are not arguing that linking the concept of rigour closely to the review methodology followed is per se not valid. Rather, we are aiming to extend the concept of rigour to not only include methodological soundness, but also questions of the review's relevance to decision-making contexts, and the perceived legitimacy of the review by the user audience. In this extended definition of rigour then, different aspects can be balanced against each other. However, a review of high-relevance and legitimacy which has achieved these attributes through allowing stakeholders to influence and undermine the review research process certainly would not be considered a rigorous systematic review.

How this relates to approaches taken by others

Our attempts to tailor evidence synthesis methodology to better meet users' demands and needs have not been developed in isolation. Oliver and Dickinson, for example, highlight the challenges of producing policy-relevant reviews with issues of context and questions about transferability raised [8]. As highlighted in their paper, there are issues in relation to translating the global reviews to specific contexts and needs, suggesting that even when these public goods are produced there is considerable translation required to achieve policy-relevance in specific contexts. Some efforts start with this challenge, taking 'public good' reviews and aiming to make them more accessible and

more likely to be used by decision-makers [12]. This supply-driven approach is different from, but not necessarily contradictory to, our approach.

Others aim to provide evidence response services that are limited in their generalisability and future value, but maximise the potential for evidence use by decision-makers by meeting their urgent needs [13]. Whilst this meets requirements for rigour in terms of relevance, timeliness, and legitimacy it does not conform to the methodological requirements of full 'public good' reviews. The formal systematic review collaborations are shifting slightly in this regard: the Collaboration for Environmental Evidence is discussing where different review products fit, whilst recognising that its primary goal is to produce 'public good' systematic reviews; the Campbell Collaboration has started to register and conduct evidence maps.

The greater the number of funders commissioning reviews and the more people from different disciplines apply the method, the more these issues come to the fore and need to be discussed. A good example of this is the recent introduction of evidence synthesis in the humanitarian sector, which motivated a range of interesting debates on rigour and policy-relevance too [14]. We anticipate that there will therefore be more people asking what it means to produce demand-led reviews that respond to stakeholders' needs, and seeking new approaches such as the one we propose.

Conclusions

We have identified the following strengths to our approach with regard to increasing the usefulness and use of reviews through stakeholder engagement in demand-led reviews: our syntheses meet a decision-making need (or needs) and are therefore much more likely to be used. The general appeal of evidence synthesis as an input in decision-making processes increases as their value is demonstrated to stakeholders (e.g. awareness of reviews and more positive perceptions of them). And depending on the approach for stakeholder engagement that is taken, stakeholders' skills to produce, use, and commission syntheses also increase.

On the other hand, the generalisable 'public good' aspect of synthesis decreases the more you engage stakeholders' priorities. Furthermore, those working on the syntheses with stakeholders need to be very flexible in terms of labour: gathering, and then being responsive to, stakeholders' needs is very time consuming. There are also high opportunity costs for both academics and decision-makers in the production of demand-led syntheses. For example, researchers might derive few or no publications out of the synthesis and decision-makers might have few professional incentives and rewards for engaging in evidence synthesis. There is also a need for a range of expertise within the synthesis team—including technical methods expertise, public policy-making, and engagement skills—and careful project management.

What this means for definitions of rigour and what is a 'gold standard' review

We set out to discuss a tension that is inherent within the promotion of stakeholder involvement in systematic reviews but is rarely recognised—that to be responsive to stakeholders in producing demand-led reviews requires a re-thinking of what constitutes rigour. This issue is often presented as a tension between rapid evidence assessments and full reviews, but we believe it is a bigger question about what makes a 'gold standard' review. We propose that a shift in language is required. We prefer 'responsive reviews' to 'rapid reviews'. We also believe that responsive reviews are not 'quick and dirty' but rather 'quick and good enough' [15].

We are proposing that a shift in our whole approach is needed, whilst also recognising that this is not always feasible. We believe that responsive reviews remain an important way to increase the use of systematically reviewed evidence in decision-making. At the same time, the inherent value of 'public good' reviews for future decision-making remains. We also acknowledge that funding sometimes requires that responsive reviews are done without time for a linked 'public good' full review. Perhaps most importantly 'gold standard' reviews are not only those that are technically methodologically 'rigorous', but are also those that are responsive to decision-makers' needs and are recognised as being so.

Concluding statement

This commentary aims to address head on the often undiscussed key challenge with regard to stakeholder involvement in systematic reviews: that responding to stakeholders can mean reconsidering what makes a review rigorous. It proposes a new model to address these tensions that combines the production of 'public good' reviews with stakeholder-driven syntheses. During 2017 and 2018, we will be putting this model to the test on a synthesis project exploring ecosystems services' interventions for poverty alleviation in Africa and are looking forward to reporting back on our experience.

Abbreviations

CEE: Collaboration for Environmental Evidence
REA: rapid evidence assessment/responsive evidence assessment

Authors' contributions

LL,YE, NT and RS all contributed to the funding proposal, project design, and impact pathway which has inputted into this work. LL,YE and RS have developed many of the government relationships described in this paper. RS has prepared this manuscript. All authors read and approved the final manuscript.

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MARKETING

4

Much at stake: the importance of training and capacity building for stakeholder engagement in evidence synthesis

Jacqualyn Eales • Neal R. Haddaway • J. Angus Webb

Systematic reviews and maps are complex methods for synthesising evidence that involve specialist and resourceintensive activities. Systematic reviewers face challenges when attempting to clearly and precisely communicate their methods to end-users and other stakeholder groups. We propose that these challenges are likely to be a key causal factor in the generally low uptake of systematic reviews and maps by policy and practitioners in environmental science and management. We argue that training and capacity building are inherently important components of systematic reviews and maps for all stakeholders; the reviewers themselves, the end-users of specific reviews, and the broader research and decision-making community. Training can help to build capacity for undertaking reviews and maps, and can help to explain complex methods to stakeholders. Training is important for those wishing to undertake stakeholder engagement activities as part of a review. It allows researchers and decision-makers to critique systematic reviews and maps based on their methods. Finally, training may be necessary to allow reviewers to prepare visualisations and communication media for presenting the findings of systematic reviews and maps. We conclude that a broad approach, by viewing every opportunity of stakeholder engagement as a potential for training and capacity building is appropriate both within a specific review and across reviews as a community of practice in evidence synthesis.

We call for systematic reviewers to improve networks across disciplines in relation to training, sharing experiences and course content, and ensuring a consistent approach to capacity building in the conduct and use of evidence syntheses.

Keywords: Education • Communication • Knowledge exchange • Expertise • Evidence synthesis skills • Review

Background

Systematic review methods were developed within the field of medicine in the 1980s and 1990s [1] in an attempt to improve the evidence base for clinical decision-making. The Cochrane Collaboration was established in 1992 to oversee the production of guidance in systematic review methods and the peer-review and endorsement of systematic review protocols and reports [1]. The methods were subsequently adapted for the field of conservation and environmental management [2], and the Collaboration for Environmental Evidence (CEE) was established in 2008 to coordinate standards for environmental systematic reviews, and has endorsed a number of courses since its establishment (see recent examples in Table 1).

In order to fully understand or conduct a systematic review or systematic map, reviewer authors, researchers, end-users and decision-makers (hereafter included within the term stakeholders; [3]) require detailed and comprehensive knowledge across a suite of research and communication skills. As this skillset is rare, training is a necessary part of the effort to increase adoption of systematic synthesis methods in environmental science and management. We believe that this current training gap is likely a key factor in the generally low uptake of systematic reviews and maps by policy and practitioners. Indeed, ideas around the use of training have, until now, been rather traditional, considering training as useful purely in capacity building for those wishing to conduct a systematic review or map. Such a limited view of the role of training in increasing both the understanding and use of systematic review methods and results ignores the impor-

Table 1. Systematic review and map training endorsed by The Collaboration for Environmental Evidence undertaken in 2017 to date

Course title	Course type *	Location	Date	Provider
Systematic review & map methodology	Commissioned	Lund University, Lund, Sweden	16–17th February 2017	Mistra EviEM
Introduction to systematic reviews & maps	Commissioned	Pontifical Catholic Univ. of Chile, Santiago, Chile	3rd April 2017	Independent trainers
Systematic review & map methodology	Commissioned	Pontifical Catholic Univ. of Chile, Santiago, Chile	4–5th April 2017	Independent trainers
Systematic review & map methodology	Commissioned	Global Evidence Synthesis Initiative, American Univ. of Beirut, Beirut, Lebanon	1–2nd June	Mistra EviEM
Systematic review & map methodology	Closed	Stockholm Environment Institute, Nairobi, Kenya	12–13th June 2017	Mistra EviEM
Systematic review & map methodology	Closed	Stockholm Environment Institute, Bangkok, Thailand	12–13th June 2017	Mistra EviEM

* Open courses are those that are arranged by the providers with participation open to the public. Closed courses are those arranged by the providers with participation by invitation only. Commissioned courses are those that are arranged and funded by an external organisation.

tance of the need to continually raise awareness about these methods across all stakeholders. To date, the need for innovative and thoughtfully designed training has not been seen as a priority by the evidence synthesis community, and we propose that, although not traditionally thought of as part of stakeholder engagement, training and capacity building are an inherently important component of systematic evidence synthesis.

Currently, guidance from CEE [4] and from the Campbell [5] and Cochrane [6] collaborations does not focus on the importance of training for effective engagement among the different stakeholder groups. This is because such guidance relates to the conduct of single systematic reviews or maps. Whilst training activities may well be linked to a specific review project, a strategic approach to training and capacity building is key to raising awareness and interest, and increasing the uptake of systematic reviews and maps as methods and as a reliable form of evidence in decision-making.

Fundamentally, training and capacity building increase direct and indirect communication among different stakeholder groups engaged with evidence syntheses. The two-way information flow that comes from effective communication can ensure that: an evidence synthesis concentrates on the issues of greatest importance; outputs can be

understood by a wider audience; and benefits of evidence-based approaches are clear. These benefits include improved transparency, accountability, and accuracy, and reduced risk in decision-making. These points are all essential for helping to bridge the 'knowing-doing gap' that currently prevents the uptake of much applied research in environmental science and conservation [7].

Systematic review and map training challenges

Systematic review and map methods training inherently involves challenges, some of which are particularly apparent when the training is aimed at non-specialists or a non-research focused audience [3]. These challenges include:

1. Explaining complex concepts in lay terms.
2. Deciding between overview and methods training.
3. Explaining relatively abstract concepts without information overload (e.g. critical appraisal and meta-analysis).
4. Determining when systematic review/map methods are appropriate (resources, timelines, staffing, desired output).
5. Ensuring that participants appreciate that while robust evidence syntheses require greater resources than informal and ad-hoc reviews, the payoff is in the reliability of results.
6. The need for ongoing training as methods develop and improve.
7. Making training cost-efficient.
8. Tailoring training media to the situation (e.g. workshops or written media).
9. Providing continued support for people who are conducting reviews.
10. Ensuring an appreciation of the importance of course accreditation by a coordinating body (e.g. CEE).

In the following pages, we outline several types of training courses or efforts and how they can address these challenges.

Training providers

Courses accredited by the Collaboration for Environmental Evidence [8] have been written by trainers with experience in stakeholder engagement in evidence syntheses in the environmental sector. They are designed for a non-research focused audience, are updated with new methodological developments as they arise. The Campbell Collaboration provides and approves (primarily methods-focused) courses by affiliated trainers and maintains lists of both Campbell-approved and non-approved courses. These include training offered by the EPPI-Centre of the University College London, ranging from 1-day workshops to a MSc course in systematic reviews for public policy and practice [9]. Since systematic reviews are well-developed in the field of medicine, a wide range of training courses have long been advertised by the Cochrane Collaboration. These include specialised courses, for example, on software to support meta-analysis [10]. Most courses are aimed at a research audience, yet a stakeholder engagement component is not strongly evident. However, a 1-day course focusing on engaging stakeholders and audiences in research was offered by Cochrane Australia in June 2017 [11]. The Cochrane Collaboration offer training via Cochrane groups such as Cochrane South Asia [12], and also advertise training courses provided by affiliate or independent organisations, such as York Health Economics Consortium and academic institutions, such as Columbia University. Despite the wealth and breadth of experience in capacity building and training in all these fields, there has so far been no concerted effort to connect and learn from the expertise in systematic review training across disciplines.

Opportunities to improve stakeholder engagement through training

We identify five broad categories of training across evidence synthesis processes, from question formulation to communication of findings, where training is important for effective two-way communication among the full range of different stakeholder groups (Table 2). We discuss these below.

Training reviewers to maximise benefits of stakeholder engagement

End-user and public engagement (point 1 in Table 2)

Reviewers, particularly those new to the methods, often lack sufficient skills to engage effectively with stakeholders. Researchers new to systematic review methods may not appreciate the nuances involved with stakeholder engagement for evidence syntheses (Challenge 5). These include explaining review methods in sufficient but not unnecessary detail (Challenge 1), predicting and managing potential conflicts between different stakeholders, and maintaining interest and enthusiasm throughout the process (Challenge 3) [3].

In addition, engaging with stakeholders is a complex process [3, 13], requiring reful planning to ensure balance and mitigation of any possible bias or undue influence from stakeholders on the systematic review or map [3]. Reviewers may need to undertake training in methods that can help manage stakeholder engagement. In particular, where conflict between different stakeholder groups arises, those facilitating engagement activities may find their role very challenging. Here, training in conflict management may prove useful [3, 13]. However, such training along with carefully planned stakeholder engagement can add significantly to costs, and reviewers must take care to remain within budget (Challenge 7). Due to the 'hands-on' nature of stakeholder engagement activities, this type of training is most likely to be effective in person via workshops and training courses (Challenge 8).

Systematic review and map methods (point 2 in Table 2)

Undertaking a systematic review or map is a time-consuming and challenging task that requires a range of specialist skills [4, 5, 6], including searching for evidence [14] and meta-analysis [15]. A systematic review or map should not be undertaken without specialist methods training if review authors wish to produce a reliable synthesis devoid of major limitations or bias [16, 17]. While the major systematic review coordinating bodies have been slow to recognise the benefits of training aimed specifically at stakeholder engagement, as described above, training in the technical aspects of systematic methodology is

Table 2. Stakeholder training stages, beneficiaries and descriptions of the purposes of different training opportunities, along with suggestions of suitable training media

Training summary and purpose	Stakeholders engaged in training	Stage of evidence synthesis process	Suggested training media
1. End-user and public engagement			
Providing skills relating to stakeholder analysis, conflict management, and participatory methods	Reviewer	Scoping and question formulation, communicating outcomes	In person or online (training courses)
2. Systematic review and map methods			
In depth methodological training regarding each step of the systematic review and map process; question formulation, scoping, searching, screening, data extraction and coding, critical appraisal, synthesis, report writing	Reviewer	Planning (scoping, protocol development) and conduct	In person or online (training courses)
Anything from a basic overview of systematic review and map methods to advanced details on methodology, provided as a transferable skill	Students	Any (not linked to a specific review)	In person or on-line (presentations, training courses)
3. Preparation of communication media			
Production of readily digestible data visualisations	Reviewer	Report preparation	Written (technical summaries), in person or online (workshops, training courses)
Training in development of communication materials tailored for specific stakeholder groups, and in communication skills	Reviewers	Communication	Written (technical summaries), in person or online (workshops, training courses)
4. Value of systematic review/map methods			
Advocacy of systematic review and map methods as a funded activity, source of evidence in decision-making, or research endeavor. Explanation of limitations of traditional reviews relative to systematic review/map methods	All stakeholders (particularly review funders, prospective reviewers, policy stakeholders and practitioners)	Any (not linked to a specific review)	Written (flyers, fact-sheets, non-technical summaries), online (websites, videos), in person (presentations, workshops, short courses)
Giving an overview of the need for and methods involved in systematic reviews and maps	Subject experts, researchers, policy specialists, practitioners, rev. advisory groups	Question formulation	Written (flyers, fact-sheets, non-technical summaries), in person (workshops), online (websites, videos)
Giving an overview of the need for and detailed methods involved in systematic reviews and maps	Peer-reviewers	Peer-rev. (protocol, final report)	Written (technical summaries)
Giving an overview of the methods involved in systematic reviews and maps and how to interpret the review findings	End-users (policy stakeholders, practitioners)	Communicating outcomes	Written (flyers, fact-sheets, non-technical summaries), online (websites, videos), in person (presentations, workshops)
5. Technical critique of review methods			
Critical research commentaries in the academic literature can raise awareness in the research community regarding misunderstandings about systematic methods	Researcher community	Any (not linked to a specific review)	Written (research articles)

relatively common (see Box 1 for an example of a recent training course). These are often in the form of capacity-building workshops and training courses [9, 11, 12] that aim to provide a primer for those wishing to conduct an evidence synthesis. Whilst additional support for systematic reviewers is likely to be necessary (Challenge 9), these workshops aim to cover the methodological steps of a review or map in sufficient detail to allow participants to plan and conduct a review for themselves. An additional challenge that networks such as CEE aim to solve through active training working groups is the need for continued training as methods develop over time (Challenge 6). Methodology training is most likely to be effective in person via workshops and courses. Mentoring is also an option, which addresses the challenge of providing continued support throughout the review process.

Preparation of visualisations and communication media (point 3 in Table 2)

Systematic reviews and maps often identify large volumes of evidence and must attempt to summarise the collated evidence (in systematic maps [18]) or synthesise the findings of individual studies as a whole (in systematic reviews [4]). In order to make the results readily understandable, review authors often produce summaries that describe the evidence visually (e.g. forest plots, evidence atlases and heat maps [17, 19]).

Such visualisations can often be challenging to produce and may require knowledge of specialist software. There may thus be a need for training in techniques and softwares for preparing evidence visualisations. Such training may be effective in written media, but may also lend itself well to pre-recorded videos, online instruction, or in-person workshops.

For end-users who are unfamiliar with long technical documents and even the visualisations described above, additional approaches to presenting the outcomes of systematic reviews and maps are necessary. We recommend that reviewers summarise their work in a variety of media, including technical summaries [e.g. 20], factsheets or policy briefs [e.g. 21], video briefs [e.g. 22], and infographics [e.g. 23]. Producing these summaries requires skills in science communication and media design, and reviewers may therefore benefit from 'science

translation' (point 3 in Table 2). For example, The American Association for the Advancement of Science coordinates such workshops [24]. Stakeholders and other non-research focused end-users are likely to respond best to presentations in an easily understood format, thus this type of training will help to ensure outputs of evidence syntheses are disseminated widely, understood and used.

Box 1. Summary of a CEE-endorsed 2-day methodology workshop in systematic review and map methods at Lund University in February 2017

Length of event: 2 days (09:00–17:00).

Description: This workshop aimed to introduce systematic reviewing and systematic mapping as methods for evidence synthesis. Participants were provided with an in-depth understanding of the activities that are necessary to maximise comprehensiveness, transparency, objectivity and reliability throughout the review process. This step-by-step course took time to explain the theory behind each part of the review process, and provides guidance, tips and advice for those wanting to undertake a full systematic review or map.

Format: The course took the form of a series of interactive presentations (c. 7 h) and practical exercises (c. 7 h), including examples from recent relevant systematic review and map projects. Participants were encouraged to ask questions, and time was set aside for a question and answer session. Participants were also encouraged to use their own research in practical exercises. The course featured practical sessions run using review the management platform EPPI Reviewer [14].

Audience: PhD students and researchers in the Centre for Environmental and Climate Research, Lund University.

Participants/trainers: 14/2.

Type of course: Commissioned and funded (i.e. directly requested) by a senior researcher at Lund university.

Certification: The course was endorsed by CEE, involving submission of presentations, a detailed programme and learning objectives for peer-review by experts in systematic review training. Certificates of completion were provided to participants.

Trainers: The course was provided by two experienced systematic reviewers working at a CEE Centre in Stockholm (Mistra EviEM). One of the trainers has extensive experience of providing training in systematic review and map methods.

Training for stakeholders, education and outreach

Value of systematic reviews/map methods (point 4 in Table 2)

Many stakeholders wish to better understand the purpose and characteristics of systematic reviews and maps, but do not need to be able to conduct a review. In these cases, a basic understanding is likely to be sufficient (Challenge 2). Here, relevant training should provide an understanding of the benefits of systematic methods compared to informal narrative literature reviews, and the importance of the central tenets of comprehensiveness, transparency, repeatability and objectivity [4, 5, 6]. There is a general appreciation for the 'added value' associated with reviews that label themselves as 'systematic', but there is also a misunderstanding over what is required to make a review reliable [17, 25]. This kind of training would be suitable for potential commissioners of syntheses along with end-users (policy stakeholders and practitioners) wishing to integrate review findings into decision-making processes. Similarly, reviewers may wish to target end-users with specific training efforts in order to maximise the likelihood of use of a reviews findings. Box 2 summarises a recent training event provided to policy advisors forming part of the European Commission's Science Advisory Mechanism. Such training can help to increase awareness of the limitations of traditional reviews and the benefits of systematic review methods.

Technical critique of review methods (point 5 in Table 2)

Many syntheses call themselves systematic reviews, but fail to meet basic qualifying standards of what is considered to be a systematic review [17] as set out by systematic review coordinating bodies [4, 5, 6]. Training in how to critically appraise reviews can enable stakeholders to highlight common problems with non-systematic reviews. Tools for critical appraisal of reviews have been published for such purposes, for example CEESAT [26], which include assessments of limitations and susceptibility to bias, such as a lack of comprehensiveness and the presence of selection bias and vote-counting [16]. At present, stakeholders may not fully appreciate the potentially fatal characteristics of some non-systematic reviews. Having undertaken training in technical

Box 2. Details of a recent training event given by Mistra EviEM at the European Commission's Science Advisory Mechanism (SAM) in Brussels in May 2017

Length of event: 2.5 h (09:30–12:00).

Description: This event introduced the work of EviEM to policy stakeholders working within the European Commission. In particular it introduced systematic reviews and maps as rigorous methods for evidence synthesis, along with ways in which attendees to learn more about completed reviews and suggest topics of interest that EviEM can consider as future reviews.

Format: This event took the form of a seminar lasting approximately 1 h, followed by a question and answer session.

Audience: Policy-makers and science advisors from the SAM and related organisations.

Participants/trainers: 25/2.

Type of course: Invitation-only event funded by Mistra EviEM and coordinated by the SAM.

Certification: This event did not receive formal endorsement from CEE.

Trainers: This event was provided by representatives of EviEM, the CEE Centre based in Sweden. Both presenters have experience of evidence-based environmental management and conduct/training in systematic reviews and maps.

critique of review methods participants can recognise and appreciate reliable reviews, justify the resources needed to obtain a higher level of reliability in reviews that follow systematic principles (Challenge 5), and appreciate the value of endorsing reviews with a coordinating body such as CEE (Challenge 10).

Training students in systematic review methods (point 2 in Table 2)

Training university students (undergraduate and postgraduate) in systematic review or map methods is a vital means of raising awareness and educating future decision-makers and researchers about the benefits of systematic approaches to evidence synthesis (see Box 3). Since students may wish to incorporate systematic review methods in their

work it is important to be pragmatic and recognise that systematic reviews or maps may not be appropriate within the restricted timeframes of many students' secondary research theses (Challenge 4). Training in universities may make use of workshops, taught and self-led courses and online resources [27], and represents a mechanism by which training can be provided without the need for a direct funding source (Challenge 7).

Conclusion

Systematic review and map methods are complex and nuanced means of synthesising the available evidence to improve decision-making. Because of their complexity, training is often needed at various stages of the planning, conduct and communication of reviews. Effective stakeholder engagement is a critical component for the success of systematic reviews and maps [3, 13], but to date, stakeholder engagement and training activities have largely been undertaken independently by the evidence synthesis community, and we believe this constrained thinking has limited the uptake of systematic reviews. We propose that every occasion where reviewers engage with stakeholders should be viewed as a potential training opportunity. This would provide a range of benefits, including raising awareness, acceptance and understanding of systematic reviews. We identify five main areas where training of reviewers and other stakeholders can not only build capacity for systematic review conduct but also provide a range of other benefits from stakeholder engagement.

Finally, there are ongoing efforts to improve networking between systematic review methodologists across disciplines (e.g. the Evidence Synthesis Technology Methods Group [28]). We call for similar efforts to connect those involved with training and systematic reviews across disciplines to share knowledge and experiences, improving our collective understanding of best practices in capacity building and raising awareness in the methods and their integration into decision-making. An evidence synthesis methods group that spans disciplines, including actors from CEE, The Campbell Collaboration, The Cochrane Collaboration, is one such opportunity for networking and collaborative

exchange. The increasing level of interest in training in systematic review and map methods (see recent examples in Table 1) suggests that we are at a critical time to consolidate and optimise efforts.

Notes

Jacqualyn Eales and Neal R. Haddaway contributed equally to this work.

Authors' contributions

NRH and JE drafted the manuscript. All authors edited the draft. All authors read and approved the final manuscript.

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5

A five-step approach for stakeholder engagement in prioritisation and planning of environmental evidence syntheses

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Systematic reviews and systematic maps, regarded as a gold standard for syntheses of documented research evidence, are increasingly used to inform decisions in environmental management. To increase their relevance and uptake, systematic reviews and maps can be planned with the help and engagement of stakeholders, i.e. organisations and individuals involved in and affected by environmental policy-making and practice. We report on the empirically tested five-step approach that the Mistra Council for Evidence-based Environmental Management (EviEM) is using to engage stakeholders and incorporate their views and opinions in the prioritisation and planning of reviews, including (1) stakeholder identification; (2) identification of policy- and practice-relevant topics; (3) framing and prioritisation of review questions; (4) establishment of the specific scope of a review; and (5) a public review of a draft review protocol. We provide examples from EviEM's reviews and describe various challenges and valuable lessons learnt from the engagement process, hoping that this will be useful reading not only for reviewers, but also for stakeholders who plan to participate in the engagement process.

Keywords: Knowledge needs • Participation • Priority setting • Public review process • Question formulation • Scoping • Stakeholder identification • Review co-design • Systematic review • Systematic map

Background

Systematic reviews and systematic maps (here also referred to as 'reviews') are regarded as a gold standard for syntheses of documented research evidence, and they are increasingly used to inform decisions in environmental management [1, 2]. Following core principles of transparency, objectivity and repeatability, they aim to identify, collect and synthesise available evidence, attempting to minimise subjectivity and bias at each stage of the review [3]. To be valuable for environmental policy and practice, evidence syntheses must address relevant questions, and their findings need to be recognised as legitimate evidence. One way to increase their value is to engage with organisations and individuals involved in and affected by environmental policy-making and practice [4, 5, 6]. Whilst there is growing evidence that stakeholder engagement can help reviews become clear, relevant, broadly communicated, and used in policy and practice [5, 7], the roles of stakeholders in the engagement process have varied across review teams and topics [8]. We define stakeholders as those who use or may be affected by review findings [9], including researchers and subject experts, practitioners, commissioners, and representatives of governmental and non-governmental organisations [10]. Stakeholder engagement has been defined as a 'bi-directional relationship between the stakeholder and the researcher that results in informed decision-making about the selection, conduct, and use of research (findings)' [11], p. 986.

Systematic reviews and maps are conducted through a step-wise process including: (1) establishing a review team; (2) formulation of a question and scope, involving a scoping exercise; (3) peer review and publication of a review protocol; (4) searching for evidence; (5) screening of evidence for eligibility; (6) critical appraisal of study validity (not obligatory for maps); (7) meta-data extraction; (8) data extraction (in systematic reviews only); (9) synthesis (in systematic reviews only); (10) reporting and communication of the review findings [3, 12, 13]. Stakeholders can be engaged throughout the whole review process [14], but here we describe engagement with stakeholders in prioritisation of review topics and in the review planning stage, and as an example we use the Mistra Council for Evidence-based Environ-

mental Management (EviEM) approach. EviEM is the Swedish centre in the network of the Collaboration for Environmental Evidence (CEE), a coordinating body for promotion, conduct and registration of environmental systematic evidence syntheses. CEE hosts a library of reviews and protocols, produces review guidelines and ensures that registered reviews comply with the rigorous review standards [3, 15]. Since 2012, EviEM has conducted systematic reviews and maps relevant (but not restricted) to Swedish environmental policy and management [16]. During 2012–2017 EviEM has been funded by the Swedish Foundation for Strategic Environmental Research [17] and governed by an independent Executive Committee comprised of scientists, evidence synthesis experts, and stakeholder representatives. EviEM is financially and politically independent. It has a secretariat with methodology experts (project managers) who conduct systematic evidence syntheses with the help of international scientific experts. Unlike reviews entirely driven by commissioners and their particular interest in a certain topic, the findings of which may have limited generalisability [9, 18], EviEM reviews are intended to be 'public goods' [19]. They are placed in an open domain, available to a global audience and have relevance for a broader range of stakeholders.

EviEM uses a relatively formal but flexible approach to stakeholder engagement in the review prioritisation and planning stages. To incorporate stakeholder views and opinions, EviEM initiates a five-stage process: (1) identification of stakeholders; (2) identification of policy- and practice-relevant topics; (3) framing and prioritisation of review questions; (4) establishment of the specific scope of a review; (5) a public review of a draft review protocol. We describe details of these five stages in the following sections (see also Fig. 1).

Stakeholder identification

Stakeholder identification is critical to the entire stakeholder engagement process and review conduct [10]. However, it may be difficult to know who the stakeholders are and to identify a representative stakeholder group [20]. EviEM identifies stakeholders at two different levels and for two different purposes.

First, to understand knowledge needs (Fig. 1, stage 1), EviEM identifies a broad range of stakeholders across the whole environmental sector in Sweden. This is done through a detailed stakeholder analysis, partly based on methods by Schmeer et al. [21]. In short, EviEM conducts a search for stakeholders among representatives of the Swedish Parliament, various Ministries, county and municipality administrations, governmental agencies, research funding councils,

Fig. 1. A five-step approach for stakeholder engagement in prioritisation and planning of evidence syntheses.

Swedish and international non-governmental organisations, industry representatives, and relevant European policy makers. The next step is to get to know stakeholders' characteristics, their main interests and roles, level of influence, fears and expectations, and possible links to EviEM. Finally, based on all collected information, stakeholders are classified according to their priority (low, medium, high, or critical), as seen from EviEM's perspective.

Second, to refine review questions, a specific group of stakeholders is identified for each review, and this process is described in the "Framing and prioritisation of review questions" section.

Identification of policy- and practice-relevant topics

To identify policy- and practice-relevant topics, EviEM arranges meetings with stakeholders across the entire environmental sector, inviting them to state their needs for knowledge. Meetings typically start with a short introduction to systematic evidence synthesis methodology, after which participants discuss potential review topics. The main outcome of these 'general' stakeholder meetings is a list of topics and questions that usually includes broad global, national or regional environmental issues, perceived gaps in the evidence-base, and controversial environmental questions recently discussed in public debate (Fig. 1, stage 2).

Two examples of stakeholder-generated topics suggested to EviEM are *"How is biodiversity affected by anthropogenic interventions in shallow bays (such as removal of algae, dredging and embankments)?"* (later reformulated into a more focused question that is now being reviewed [22]) and *"What are the reasons for the decline of sea birds in the Baltic Sea region?"* Questions proposed by stakeholders are often more suitable for systematic mapping than for systematic reviewing. For example, they are often open-framed, i.e. not specific enough to be answerable in a single study and therefore not possible to answer in a synthesis of similar studies [3]. It could also be that a synthesis of the evidence is not needed because the question has already been addressed by recent reviews, or that it is not feasible, e.g. because there is a lack of primary research on the topic.

Framing and prioritisation of review questions

The next step is to rephrase the questions if needed and prioritise them in collaboration with stakeholders. Several priority setting initiatives in other research areas, especially medicine, have developed a number of approaches to accomplish this critical work (see e.g. [23, 24]). At this stage (Fig. 1, stage 3), EviEM review experts screen proposed topics to determine whether they are reviewable as such, or whether they should be split up or narrowed down into one or more specific questions.

As part of this question-framing process, EviEM undertakes scoping studies of proposed review topics (e.g. [25, 26, 27, 28, 29, 30]). Scoping studies are summaries of the volume of existing evidence on a specific topic. They introduce the review topic, investigate if any other (systematic or traditional) reviews on the same topic already exist, seek to clarify whether there is sufficient scientific literature and need for a systematic review or map on the topic, and identify review-specific stakeholders [31]. Review-specific stakeholders are mainly identified through 'snowball sampling' [32, 33], usually starting with relevant stakeholders identified in a broader context (see "Stakeholder identification") who may be able to refer to other, less visible stakeholders. Snowball sampling may entail community bias through overrepresentation of certain stakeholders and their interests [32]. However, EviEM strives to minimise that risk by active searches for stakeholders with different or opposing interests.

When conducting scoping studies, EviEM may also engage scientists working with the topic to ensure that the review question is scientifically meaningful, i.e. answerable, conceptually clear, and methodologically feasible. One or more of these scientists may later be recruited to the team that will conduct the review. Even where a stakeholder-generated question seems to be specific enough for systematic reviewing or mapping and there is no need for additional question-framing, it may still be difficult to conduct a review due to methodological constraints. For example, in 2012 EviEM received a suggestion to review adverse effects of perfluorinated alkylated substances (PFASs) on marine biota. At that time, systematic review

methodology in toxicology and chemical risk assessment was less developed than it has become more recently (see e.g. [34, 35, 36]), and the EviEM Executive Committee concluded that validation of the review methods would require significant efforts. One of the difficulties with the suggested review question was to define the outcome. However, questions related to PFASs were considered important to address, and EviEM therefore invited both stakeholders and scientists (topic experts) to a focus group to identify a reviewable and scientifically meaningful question that could also have relevance for the stakeholders. The question finally selected was how PFAS phase-outs have affected PFAS concentrations in the environment. In this case, the outcome was fairly easy to define, and the question is currently being reviewed [37].

If multiple reviewable questions are identified during the scoping process, key stakeholders (mainly those who originally suggested the topic) may be asked to prioritise the most relevant ones. Based on the conclusions of scoping studies and stakeholder prioritisation, the review experts propose specific questions for systematic reviews or maps to the EviEM Executive Committee, which takes the final decision regarding the selection of questions to be reviewed.

To guide the Committee in their decision, mandatory and optional criteria for EviEM review questions have been established. The mandatory criteria stipulate that a question should (1) deal with conditions in the natural environment, (2) be relevant to the situation in Sweden, (3) be well-defined, conceptually clear and reasonably limited in scope, (4) deal with problem descriptions or countermeasures whose scientific support is insufficient, disputed or incompletely known, and (5) be covered in the scientific literature (or by other investigations) to such an extent that a systematic review or map could be undertaken [31].

Establishing the specific scope of a review

Once a review question has been approved by the EviEM Executive Committee, stakeholder engagement resumes through a 'review-specific meeting' (Fig. 1, stage 4) led by one of EviEM's review ex-

perts and a scientist (topic expert) appointed to chair the review team. At this meeting, representatives of all stakeholders identified by the scoping study are invited to discuss the review question in detail. Through an open dialogue, the participants are encouraged to share their views and help refining the scope and focus of the review by specifying preferred PICO/PECO elements of the review question (i.e. population, intervention or exposure, comparator, and outcome) [3, 38] and criteria for inclusion of studies. The stakeholders are also involved in the development of a search strategy by suggesting search terms and sources of relevant literature (the latter is especially important for locating grey literature). Stakeholders not able to attend the meeting are invited to send their comments by email. Useful stakeholder suggestions are incorporated in a draft review protocol subsequently written by the review team.

In this process of knowledge exchange the stakeholders can improve the relevance of EviEM's reviews as they fine-tune the review scope according to their priorities. The general topic of a review cannot be changed at this stage, but discussions during stakeholder meetings often lead to either a broadening or a narrowing of the scope of the review. For example, during preparation of the protocol for a systematic review on the ability of wetlands to remove nutrients from water [39], at least two important study inclusion criteria were changed following advice from the stakeholders. The scope of the review was extended to cover removal of phosphorus as well as nitrogen, whereas it was narrowed down to cover created and restored wetlands only (excluding natural wetlands).

Different stakeholders may have different priorities, and all their suggestions may not be equally feasible or scientifically sound. The final decision regarding the scope of a review is always made by the review team when writing the protocol. However, to avoid situations where some stakeholders may feel that their suggestions were not considered, justifications for the final decisions are always communicated back to the stakeholders or provided in the review protocol (see "Public review of a draft review protocol").

Public review of a draft review protocol

When a review protocol has been drafted by the review team, it is published on the EviEM website and opened for a public review (Fig. 1, stage 5). A review protocol is a detailed methodological plan for the conduct of a review, explaining rationale, review question and methods for all stages of the review process [3]. Anyone interested is welcome to comment on the draft, but all previously identified stakeholders receive a special invitation to continue their engagement. After a period of 2 to 3 weeks, the public review is closed, and the protocol is revised based on comments received.

Stakeholder comments received during the public review process can modify the scope of a review as well its applicability and relevance. For example, EviEM's ongoing review of roadside management [40] was initially intended to cover management effects on vascular plants and all kinds of animals, but when the protocol was open for public review, one stakeholder pointed out that studies of mammals and birds along roadsides may often be difficult to use as evidence of management effects. After careful consideration, the review team decided not to include effects on vertebrates in the review, but to focus on vascular plants and invertebrates instead.

The development of the protocol, including the engagement of stakeholders, is reviewed by the EviEM Executive Committee. After their approval of the process, the protocol is submitted for peer review, and this marks the closing of the early stakeholder engagement in prioritisation and planning of evidence synthesis.

The Knowledge project

Although stakeholder engagement is depicted in Fig. 1 as a step-wise process, working with a range of stakeholders on developing the scope or focus of a review is frequently an iterative and non-linear undertaking. For example, in one of its more ambitious efforts to identify policy- and practice-relevant topics or knowledge needs, EviEM initiated the so called Knowledge project [41]. It was inspired by the effort to identify 100 highly policy-relevant ecological questions undertaken

by Sutherland et al. [42]. The Knowledge project encompassed (1) identification of stakeholders across the environmental sector in Sweden (as described in stage 1); (2) interviews with identified stakeholders regarding their knowledge needs over the next 5 years; (3) collating and clustering of identified knowledge needs (248 in total); (4) identification of experts on subjects within the topic clusters; and (5) a 2-day workshop where subject experts and other stakeholders prioritised their knowledge needs and developed potential review questions. This procedure differed slightly from the previously described 5-stage engagement process as stakeholders, including subject experts, were actively involved in framing and prioritisation of questions before any scoping studies had been conducted. This was done to involve more stakeholders early in the process and to identify a larger number of highly prioritised questions. The project resulted in a list of twelve prioritised topics and four more focused but still not 'reviewable' questions, indicating areas where more knowledge is needed for decision-making within Swedish environmental policy and practice. EviEM now uses that list to identify questions suitable for systematic reviews and maps, starting from stage 3 of the engagement process.

Concluding thoughts and lessons learned

The existing CEE guidelines for systematic evidence synthesis in environmental management state that stakeholder engagement is important and should be encouraged [3]. However, there is little guidance on how to identify and engage stakeholders. We have provided an overview of an empirically tested approach to the engagement of stakeholders in early stages of the review process, hoping that this will be useful reading not only for reviewers, but also for stakeholders who plan to participate in the engagement process. In this last section we conclude by providing reflexions and lessons learned from our engagement approach.

To avoid bias stemming from the vested interests of specific groups of stakeholders, it is important to engage with a representative, diverse and well balanced group of stakeholders [43]. EviEM invites participants that represent typical stakeholder groups (e.g. gov-

ernment agencies, industry, NGOs) but also a range of different views within those typical groups (e.g. government agencies with different priorities and targets).

However, there can be several obstacles to engage with a representative range of stakeholders. First, it could be difficult to identify all relevant stakeholders. Second, once stakeholders are identified it may be challenging to reach them. Third, it could also be difficult to find a suitable time and place where a representative range of stakeholders can meet. Fourth, regardless of where a meeting is arranged, there is a risk of geographical bias. To minimise that risk, EviEM strives to arrange stakeholder meetings in different parts of Sweden. Another way could be to develop web-based solutions such as e-participation tools and online platforms for knowledge exchange [44]. EviEM has not yet explored such solutions, but on several occasions during the review process, EviEM provides opportunities for stakeholders to engage and send their comments via email.

When prioritising review questions and establishing the scope of reviews, EviEM seeks to conceive systematic reviews and maps that are relevant to a broad range of stakeholders. Such an approach can require significantly more time and resources than synthesis methods used to address narrow review questions with only local applicability [19]. Since parts of the early stakeholder engagement take place before a review is initiated (stages 1–2), it is difficult to calculate the full cost of such efforts per review, but the engagement attributable to a specific review (stages 3–5) requires typically around 2–4 weeks of work by the EviEM review expert managing the review. This effort is fairly small in relation to the entire review process, but if the scope of the review is broadened as a result of the stakeholder engagement, the conduct of the review may become substantially more time-consuming and thus expensive. If a review is commissioned for a specific use by a single user, e.g. a governmental agency, the commissioner may not afford or be interested in expanding the scope of the review beyond their own interest. Therefore, without its current funding model, which offers independent financing of reviews through a research council (see [16]), EviEM would probably not have been able to engage with stakeholders and conduct the reviews using the approach described here. Long-term independent financing clearly improves

the conditions for producing syntheses that are relevant to a broad range of stakeholders and provide generalisable results.

Like several other reviewers (e.g. [5]), we have experienced that it can sometimes be challenging to reconcile stakeholders' desires and expectations with established methods for evidence synthesis (as discussed in "Identification of policy- and practice-relevant topics" and exemplified by the review on PFASs in "Framing and prioritisation of review questions"). Other authors have argued that a more pragmatic approach, where urgent needs of local stakeholders potentially compromise the comprehensiveness of the review, may be justified [45]. However, the iterative process of prioritisation and scoping employed by EviEM, which involves a continuous dialogue between reviewers, scientists and other stakeholders, usually contributes to scientific rigour while retaining the relevance of reviews to stakeholders.

Early stakeholder engagement can facilitate endorsement of the review, especially when stakeholders feel that they participate actively in review planning and have opportunity to influence the scope and focus of the review [10]. Early engagement also raises awareness among stakeholders of the rigour, transparency and objectivity of systematic reviews and maps. It is therefore reasonable to assume that early engagement of stakeholders may facilitate legitimisation and a wider uptake of review findings in environmental policy and practice [4]. Nevertheless, it is very difficult to measure whether the uptake of reviews would be different if there was no early engagement.

Finally, reviewers can also gain from the stakeholders they are interacting with. Based on our experience as reviewers, early stakeholder engagement helps us to grasp the stakeholders' sometimes opposing views and potential consequences of the review findings for those concerned. Also, it is very valuable for reviewers to establish a network of stakeholders that will be used in the final stages of the review process, when the results are to be communicated.

Notes

Magnus Land and Biljana Macura contributed equally to this work.

Authors' contributions

This paper is based on a draft written by ML and BM. All authors assisted in editing and revising the draft. All authors read and approved the final manuscript.

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ML and BM are project managers, CB is deputy director and project manager and SJ is director at Mistra Council for Evidence-based Environmental Management (EviEM).

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6

Lessons for introducing stakeholders to environmental evidence synthesis

Jessica J. Taylor • Trina Rytwinski •
Joseph R. Bennett • Steven J. Cooke

Involving stakeholders in systematic reviews is common practice and is advised in the Collaboration for Environmental Evidence (CEE) Guidelines (v.4.2). Frameworks for engaging stakeholders exist and should be used; however, there are additional lessons to be learned in a country, or region where evidence-based environmental management is an emerging paradigm. Based on our experience working with Canadian governmental institutions, we provide five lessons that we have learned while introducing stakeholders to the CEE systematic review (hereafter SR) process. These lessons are: (1) Advocate for a systematic review with broad geographical scope and target audience; (2) Control stakeholder mission-creep; (3) Establish a mutually beneficial timeline; (4) Reduce the potential of biased targeted searches; and (5) Manage stakeholder expectations. By incorporating these lessons into existing frameworks, we hope to make the introduction of SRs to stakeholders more efficient to conserve resources and maintain long-lasting, productive relationships between the review team and stakeholders.

Keywords: Stakeholder engagement • Systematic reviews • Commissioner • Funder • Environmental management

Background

An important component of conducting systematic reviews (SRs) is the engagement of stakeholders, which can include subject matter experts in academia, non-government organizations, and government, or anyone with a stake in the findings of the review [1, 2]. Stakeholder involvement in environmental management has been reviewed [3] and frameworks for involving stakeholders in SRs have been developed [4, 5], most recently in environmental management [6]. These frameworks should be the basis for stakeholder involvement; however, certain challenges can still arise when stakeholders are participating in the process for the first time. Typically, we adopt a common definition of stakeholder as defined in Haddaway et al. [6] in that it includes *"all parties that may affect or be affected by a review*"; however, for the purpose of this commentary, our advice applies mainly to those involved in the review process from question definition to review synthesis (i.e., commissioners, funders, advisors).

As is the case in many countries, in Canada the concept of formal evidence synthesis in environmental management is an emerging one [7]. Canadian government institutions, such as Parks Canada and Fisheries and Oceans Canada, have a history of using evidence-based advice, although they have only recently begun commissioning formal Collaboration for Environmental Evidence (CEE) SRs to integrate into their decision-making processes. This new relationship does not come without its challenges and provides an opportunity to develop a process that benefits both the stakeholders and the review team. Our authorship team has experience conducting five environmental SRs and writes this from the Canadian context where currently, most SRs are commissioned by government institutions seeking to address predefined management topic(s). With this in mind, we provide five lessons to consider when undertaking a SR with stakeholders that are new to the process to help ensure a successful relationship between the review team and the stakeholders involved.

Advocate for a systematic review with relevant geographical scope and target audience

Those that commission (and fund) systematic reviews in the environmental sector often are interested in questions that have an inherent regional or national focus. However, the literature relevant to a given SR may be much broader such that it is worthwhile and indeed necessary to include data from other jurisdictions. It is important to engage with relevant stakeholders when developing/refining the 'question(s)' and in determining trade-offs with a particular scale—local specificity or broader applicability. When a SR is done without a particular jurisdiction as the focal area, the SR inherently has broader value and relevance to the international community. For example, it would make little sense to conduct a SR on the effectiveness of habitat restoration activities at the level of the province or state in North America. Instead, it may make sense to approach things on an ecoregional scale (traversing multiple jurisdictions or even countries) or even a taxonomic perspective (e.g., salmonids).

Details regarding the scope of the SR and associated search should be discussed during the commissioning phase but needs to be decided such that the funder feels the work will be relevant to their needs. It is important to be sensitive to the fact that a funder (e.g., a government agency) may not want to 'spend money' on examining literature from the other side of the world. Yet, some species and ecosystem types (or ones quite similar—e.g., the congeneric yellow perch in North America and European perch in Europe) occur in other jurisdictions such that it is sensible to consider diverse literature. In some cases, even if the species or ecosystems are quite different, the issue/topic is germane (e.g., fish removal from lakes), which again points for the need to not impose jurisdictional limitations on SRs unless there is good reason for doing so. This also applies when the question represents a local knowledge gap and necessitates a broader geographical scope to uncover relevant evidence. Issues regarding the external validity of studies tends to increase concomitantly with the breadth of literature considered. Through discussions and use of examples it is important to consider the potential value of including the relevant global literature even when engaging in an SR that was

triggered by a local issue. By doing so the proponent will benefit but so will the broader scientific and management community as the global relevance (or at least beyond a single jurisdiction) of the work is realized. However, the ultimate decision on scale should be up to the commissioner of a SR.

Control stakeholder mission-creep

Constructing a clear, carefully articulated question for a SR is a crucial step, and often necessitates a compromise between comprehensiveness and detail [1]. This is especially true in environmental science, where interacting processes can quickly make a problem very complex. For example, a systematic review that examines the impact of an environmental stressor may need to consider interactions with other stressors (which frequently co-occur), as well as the mitigating influence of varying baseline conditions. In addition, given the ever-growing body of literature, there is a clear risk that an overly comprehensive question can make a SR intractable, especially in the timeframes often required by government agencies (e.g., a hard deadline at the end of fiscal year; see lesson 3 below).

In contrast with a tendency for some individual stakeholders to adhere to a strong local focus (see lesson 1 above), there is a tendency among broader stakeholder groups toward 'mission creep'. In our experience, government agencies tend to be more hierarchical than research institutions that may be actually conducting the SR. Involving several stakeholders in question design means involving their managers, and their managers' managers as well. Governments are also subject to (sometimes rapidly) changing priorities. These issues can lead to a proliferation of opinions and an understandable tendency toward including as many requests as possible into the question framework. If all stakeholders up the chain of command do not have a basic understanding of the strict protocols and rigour of SRs, there can be pressure to design a review with an overly-broad or vague question that attempts to string together many disparate elements. Open lines of communication can help to alleviate this problem, and balance the needs of stakeholders with the require-

ments for conducting a rigorous SR within the allotted timeframe. Involving both coordinators and implementers during the development of the review protocol can be a strength of government-supported SR, and it is always appreciated when busy managers and practitioners take an interest in the review process. This is worth the hazard of mission-creep, but makes it crucial to provide an initial, clear description of the SR process, and what distinguishes it from traditional literature reviews.

Establish a mutually beneficial timeline

During the early stages of SR planning, it is important to discuss and agree on a realistic timeline with those commissioning the review. Depending on the experience of the review funders, it may be beneficial to provide some form of training or at the very least discuss the process thoroughly to communicate a reasonable timeline for the review. Stakeholders that have previously commissioned a SR may have a better appreciation for the time required to ensure a comprehensive review.

In certain cases, some flexibility in the process may be necessary. This is particularly the case with government funders that have fiscal or other internal deadlines as the length of time SRs take will often cross one or more fiscal years. In this case, it may be useful for the funders to introduce deliverables that are independent of the CEE process and satisfy their accounting needs. An example of this is the need to provide a narrative report of the literature base in the form of review descriptive statistics once screening is complete to report on the size of the review, or alternatively an interim systematic map report. Deliverables may also include giving presentations, webinars, or holding update meetings. Deadlines and deliverables like this are best discussed and agreed upon early in the process so those leading the SR can adjust timelines accordingly. It may also be helpful to re-confirm these deliverables throughout out the process whether at the beginning of meetings or through a more formal project update, to ensure everyone involved has clear expectations.

Reduce the potential of biased targeted searches

Often the search strategy of a SR includes conducting targeted searches for the more difficult to find, grey literature. These sources of information can be identified through consultation with: (1) stakeholders, (2) the network of experts leading the SR, and (3) the broader community via social media and email solicitations. If not executed well, individually-driven searches can lead to bias in the derived literature set, if for example, researchers leading the review put more effort in targeting particular geographical regions (e.g., jurisdictions or even countries) or researchers.

From our experience, ways to reduce the potential of biased targeted searches can occur at different stages of the SR process. For example, at the early stages of the SR, to reduce the potential for biased advice on where to uncover new sources of information, we recommend forming an advisory team made up of stakeholders and experts that is both geographically balanced to the extent possible, and diverse in regards to their backgrounds, views, and skill sets (e.g., academics, practitioners, topic experts, SR experts, etc.). Additionally, at the stage when these targeted searches are being undertaken, it has been our experience, that stakeholders and/or the broader community can apply pressure or encouragement to pursue information in one or a few narrowly focused direction(s)—especially if the advisory team is geographically unbalanced and/or with similar backgrounds etc. as per our previous comment. Furthermore, this potential issue can be magnified if these narrowly focused directions are suggested late in the review process, not leaving sufficient time to adequately follow up on all potential sources of information. These situations require a discussion to ensure that the suggested sources of information will be considered, but only if effort is equally weighted across all identified sources of information.

Manage stakeholder expectations

Two common expectations we have encountered when introducing stakeholders to evidence synthesis are that: (1) all research retrieved will be included in all stages of the review, including narrative and/or quantitative synthesis, and (2) a quantitative synthesis will be conducted. We have learned that frequent communication between the project leaders and those commissioning the SR is essential at all stages of the review process to set and manage expectations for the final review product.

Of particular importance for those leading the review is the need to explain to the SR commissioners that even if it is determined that there is sufficient research on the given topic, this does not mean all of the existing relevant research is of the same quality or in fact 'usable'. For example, studies may contain particular deficiencies in the design, conduct, or analysis, such that the study has high susceptibility to bias, and therefore may need to be excluded from narrative/quantitative synthesis. Also, how the data are reported can limit quantitative analysis if insufficient methodological details were provided (e.g., means, variability, sample size) [8], or if the study had insufficient replication to allow for effect size calculations [9].

In reality, many of the identified sources of information are excluded at the later stages of a review and this is not always evident from the outset. Therefore, those leading the review may need to explain from the beginning, and continually remind stakeholders, as to the objectives and benefits of SRs over other forms of literature reviews. Indeed, it is the quantity and quality of the existing literature that dictates the final review product, and as such, expectations need to be managed early on, and throughout the review process to ensure the proponent is satisfied with the final product. One further approach we are using to help set and manage expectations is to provide training in the form of workshops for the commissioners to introduce the role of SRs in evidence-based management and to familiarize them with the steps in the SR process by explaining what each step involves and why it is important. Ideally this would be provided prior to the start of any commissioned SR.

Conclusion

Being engaged in environmental evidence synthesis in Canada where this activity is relatively new has taught us valuable lessons through engaging stakeholders that are unfamiliar with the CEE process. We share these lessons to provide others who are planning on conducting CEE SRs in a similar situation with advice on overcoming some of the inherent challenges. Ultimately, a common thread among these lessons is the importance of clear bi-directional communication between the review leaders and the stakeholders throughout the SR process. We have found that beginning each stakeholder meeting with a refresher on the process, as well as updates (including volumes of literature encountered, and the time taken at each step), have helped government agencies appreciate the value of SRs and what distinguishes them from a traditional literature review.

By incorporating these lessons into existing frameworks, we hope to make the introduction of SRs to stakeholders more efficient in order to conserve resources (i.e., time, money), manage expectations, and maintain long-lasting, productive relationships.

Abbreviations

CEE: Collaboration for Environmental Evidence
SR: systematic review

Authors' contributions

The manuscript was drafted by JJT, TR, JRB, and SJC. All authors read and approved the final manuscript.

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7

Transdisciplinary working to shape systematic reviews and interpret the findings

Sandy Oliver • Paul Garner • Pete Heywood • Janet Jull • Kelly Dickson • Mukdarut Bangpan • Lynn Ang • Morel Fourman • Ruth Garside

Important policy questions tend to span a range of academic disciplines, and the relevant research is often carried out in a variety of social, economic and geographic contexts. In efforts to synthesise research to help inform decisions arising from the policy questions, systematic reviews need conceptual frameworks and ways of thinking that combine knowledge drawn from different academic traditions and contexts; in other words, transdisciplinary research. This paper considers how transdisciplinary working can be achieved with: conceptual frameworks that span traditional academic boundaries; methods for shaping review questions and conceptual frameworks; and methods for interpreting the relevance of findings to different contexts. It also discusses the practical challenges and ultimate benefits of transdisciplinary working for systematic reviews.

Keywords: Systematic review • Research synthesis • Policy relevance • Transdisciplinary • Stakeholder • Evidence synthesis • Contextual analysis • Stakeholder involvement

Background

Policy dilemmas cross conventional academic boundaries. The academic response to the challenge of informing decision-making in such a context has been twofold: providing ready access to relevant scientific evidence with systematic reviews, or research syntheses, that include studies from different social, economic and geographic contexts, and draw on multiple academic disciplines; and building teams of academics and other stakeholders to address policy dilemmas by working in unconventional ways (see Box 1 for definitions). Indeed, most policy dilemmas raise many scientific questions across a range of disciplines [1]. Early systematic reviews in environmental science were largely academic endeavours and in these circumstances the validity of the work can be undermined by lack of consensus about review questions, specifically the choice of outcomes and analysis of contextual variables [2]. Since then, involving stakeholders in the production of systematic reviews has been seen as critical [3]. In addition a few systematic reviewers have broadened their analysis to address both impact

Box 1. Definitions of key terms that describe the process and products of systematically reviewing policy-relevant research

Systematic reviews of research inspect research reports using explicit, accountable and rigorous research methods [7].

Research synthesis aims to integrate the findings of different studies to answer the review question leading to knowledge that is greater than the sum of the individual studies [7].

Policy relevant Systematic reviews can be considered relevant to policy (and policy makers) when they present findings clearly for policy audiences to: illuminate policy problems; challenge or develop policy assumptions; or offer evidence about the impact or implementation of policy options; and take into account diversity of people and contexts [18].

Transdisciplinary research integrates the natural, social and health sciences in a humanities context, and in so doing transcends each of their traditional boundaries. It does so by scientists and other stakeholders working together beyond their traditional roles to transcend traditional boundaries to investigate systems in a holistic way [8].

Stakeholders in systematic reviews include any person, organisation or social group that may influence or be influenced by the process of preparing or using systematic reviews or by the decisions informed by their findings.

Box 2. The mismatch between the worlds of research and implementation: an example from health

The proposed solution of 'directly observed therapy' (DOT), a practice that involves healthcare practitioners observing patients taking their treatment, is not well supported by systematic review evidence regarding distinct approaches to implementation of directly observed therapy [9], including incentives and enablers [10], or reminders [11]. Whilst these reviews, drawing on randomised controlled trials, provided some useful inputs to specific technical recommendations being made by the World Health Organization at the time, in broader policy terms they offer disappointing findings to national policy makers frustrated by the "real world" where: conflicts disrupting health systems; practitioners favouring patients they considered most deprived and therefore most deserving; and patients finding the timing of the treatment and incentive (a midday meal) inconvenient [10]. Moreover, many of these reviews considered DOT without a comparator, and reviewed individual interventions alone, rather than typical packages of interventions, which is insufficient [11]. This example highlights the importance and need to consider the 'financial and logistical barriers to care; approaches that motivate patients and staff; and defaulter follow-up' [9]; in programmes of care and the systematic reviews that inform them.

and explanations and meaning of impact [4], both change and reasons for change [5], and to develop a theory of change [6]. These much needed methodological advances have important implications for delivery of services. In the health sector these implications are well illustrated by systematic reviews addressing the problems of patients offered an effective, but long and demanding, treatment for tuberculosis (TB). These reviews expose differences between the world of research, and the wider world that research is meant to serve (see Box 2).

Currently, the content of systematic reviews is largely evaluations of programmes, sometimes adapted by researchers in the field specifically to enable rigorous evaluation, with studies stripped of their organisational and socio-political context during the review process. Consequently the synthesised findings of these primary studies, with high internal validity, offer persuasive evidence of impact for policy decision-making. Yet, the partial picture this evidence presents largely ignores the policy context which risks evidence-informed policy decisions subsequently stalling with programmes failing to deliver better policy outcomes. This situation is illustrated in Fig. 1.

If systematic reviews are to address real world problems that are situated in complex systems, there is a need for systematic review

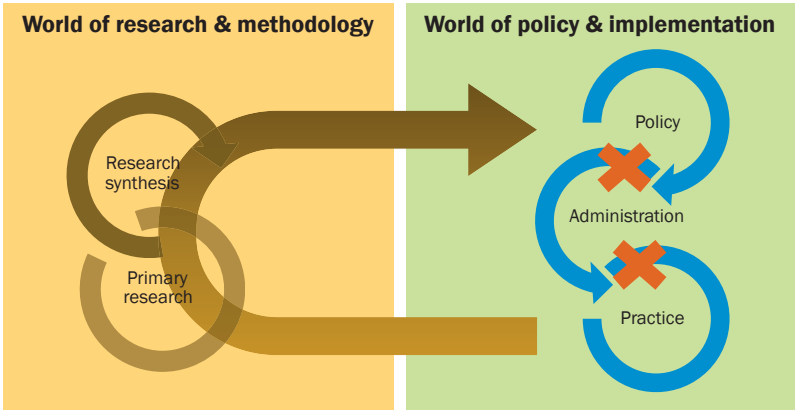

Fig. 1. Typical limitations of knowledge transfer between worlds of policy and research: Research-based information about the effects of services flows from where it is collected (bottom right), typically from practice arenas where data are framed by research tools and analysed to maximise the internal validity of primary studies (bottom left), and then synthesised to emphasise average effects with an assessment of the degree of heterogeneity of studies and judgements about generalisability of findings. Subsequently summaries of syntheses are presented to panels, such as guideline groups, making policy decisions (top right). Information flow from policies to guide research base practice are interrupted during implementation efforts where evidence maximising external validity is required for systems issues, to complement evidence addressing practice issues (middle right).

designs that span academic disciplines; new ways of working to construct those designs; and methods to interpret the findings. This need is for transdisciplinary research methods—ways of working that cut across and beyond academic disciplines.

This paper offers some solutions to the challenge facing systematic reviews in environmental science, namely the need for a 'balance… between a reductionist approach that simplifies the question but may limit both the quantity of information available and the applicability of its conclusions, and a holistic approach in which the question contains so much complexity that no studies have attempted to address it' [2]. In doing so it also draws on other sectors where systematic reviews were introduced to policy decision making earlier.

Transdisciplinary methods

Here we offer three different transdisciplinary methods for producing systematic reviews: combining concepts from across and beyond academic disciplines in conceptual frameworks for systematic reviews;

communication methods for working with people from across and beyond academic disciplines; and models for structuring findings to take into account contextual influences.

Conceptual frameworks to span boundaries

As systematic reviews are increasingly commissioned by policy organisations, rather than initiated by curious and reflective practitioners, the scope of individual questions addressed has broadened. For instance, a review investigating the impact of agricultural interventions on the nutritional status of children included studies from social science, agriculture, psychology, nutrition, economics and physiology [12]. The review was structured by a theory of change conceptual framework with components that included participation in educational programmes and adoption of technology, leading to changes in diet from home produce or to enhanced household income and food purchases; and from this on to improved nutritional uptake and health status. The theory of change was used instead of a traditional systematic review (SR) 'PI/ECO' (population, intervention/exposure, comparison, outcomes) structure to define components of and drive the review. The approach made a large and complex review manageable and coherent, while accommodating the individual packets of evidence which were quite different in terms of question, research evidence, discipline and context.

In contrast, when policy questions seek to develop understanding rather than assess the measures of effects of an intervention, conceptual frameworks may be the output of a review, rather than used as the driver. For a review analysing qualitative studies about protected terrestrial areas, such as national parks and forests, and human well-being [4], the resulting conceptual framework combined dimensions of well-being (health, social capital, economic capital and environmental capital) and governance (regulation, enforcement, participatory management and empowerment) against a backdrop of human rights. The result was a conceptual framework to present a set of coherent findings from very disparate studies spanning economics, education, epidemiology, environmental science, anthropology, law, history, and public health.

Although use of conceptual models is hardly new, they may be underused. A recent mapping review of over 1000 studies examining the links between conservation activities and human health and well-being found very few well-articulated, detailed theories of change, despite the sometimes long and complex chains of possible interactions that were being researched [13].

Communication methods for shaping review questions and conceptual frameworks

The construction of review questions and use of conceptual frameworks in systematic reviews requires collaborative teams that span academic and social systems and that think critically and creatively together by managing conflict well [3, 14]. Although there is widespread support for involving stakeholders when conducting systematic reviews [15], current guidance is directed more towards who to engage than how to work with them creatively to shape the review. Insights about such social interactions emerged from insider research [16, 17] and reflective practice addressing the early stages of the systematic review process when refining questions and framing reviews addressing broad issues [18]. From this insider research and reflective practice, we now recognise the parallels between shaping reviews and two other forms of creative thinking processes: qualitative analysis and non-directive counselling [18]. While the former examines observations for patterns and meaning to make sense of data, the latter refrains from interpretation or explanation but encourages others to talk freely and discover patterns and meaning themselves to make sense of their own experience. Originally developed to help individuals address personal problems [19], its core element of active (or reflective) listening has been subsequently developed and applied to support creative problem solving by groups [23].

The non-directive counselling approach has been helpful in supporting interdisciplinary review teams (inclusive of stakeholders) to solve the problem of shaping a conceptual framework for their review that will accommodate the interests of the review funder and the framings of existing relevant studies [18]. As a stepwise process for qualitative analysis and non-directive counselling has been clarified,

Box 3. Thinking and communication processes analogous to developing a question or conceptual framework for systematic reviewing [18]

Qualitative analysis

Analysing primary data or reports of qualitative research involves asking questions [20] or synthesising qualitative studies [21] with questions:

- that sensitise the researchers to the landscape of interest—what is going on here, who is involved, how do they define the situation, what does it mean to them, are their definitions and meanings the same or different, what are they all doing (the same or differently) and why?
- that explore recurring themes as stakeholders talk;
- about processes, variation, connections (or assumptions) about key concepts, changes over time and pertinent structural influence;
- about exceptions or contradictions; and
- about where to look for evidence and how to recognise it in different contexts.

Non-directive counselling

Questions focused on learning and implications for action [22, 24] involve:

- asking open-ended questions to encourage talk and reflection on specific examples;
- adopting the stakeholders' own language;
- asking future oriented questions about how stakeholders would use the evidence;
- provoking thinking, demanding clarification and challenging assumptions;
- summarising responses to confirm understanding, invite correction and introduce language that links with wider understandings;
- interrupting repetition or vague assertions;
- moving the conversation on; and
- getting to the crux of the matter and articulating the main focus.

shared and incorporated into text books and training programmes (Box 3), we see an opportunity to clarify and practice their application for shaping systematic reviews.

However, the active listening that is at the heart of non-directive counselling brings risks. Systematic reviewers working closely with stakeholders who are bringing direct experience and strong interests risk losing their critical distance. Moreover, examining, comparing and reconciling the ideas, opinions and perspectives of different stakeholders through mutual challenge and constructive conflict [25] may be particularly difficult to attain when there is an imbalance in power or money, as in commissioned systematic reviews.

Models for structuring findings to take into account contextual influences

Considering the needs of multiple stakeholders is not only for the beginning of a review: there are also opportunities towards the end when interpreting emerging findings. Typically users of systematic reviews want to know how relevant the findings are to their own situation, or the populations for which they make decisions. The principle of globalising the evidence, but localising the decision [26] can be helped by careful description of the characteristics of the included studies, or carefully delineating the factors that might be important in contextualising the evidence, and then making sure this is systematically extracted and summarised. For example, subgroups may be distinguished by their place of residence, religion, occupation, gender, Race/ethnicity, education, socioeconomic status, and social networks and capital [27]. This approach, with its mnemonic PROGRESS, for capturing social determinants of health, has been integrated into guidance for pre-specifying subgroup analyses in systematic reviews [28, 29]. The method is well suited to public health because it provides a framework for epidemiological analyses.

However, the PROGRESS determinants of health ignore the inner layers of individual risk factors (such as genetics, physical impairment or lifestyle factors) that feature in biology and behavioural science. They also ignore the outer layers of ecological or geological factors central to environmental science. No mention is made of intersectional theory of sociology about social identities overlapping or intersecting [30], perhaps because multiplying subgroup analyses reduces statistical power in epidemiology [31]. Lastly, PROGRESS ignores any dynamics arising from: interactions between the multiple layers; the life course (age); life transitions (moving home, employment, school or leaving prison, hospital or a significant relationship); historical changes (conflicts, mass migrations (post)colonialism); or geological or climate changes (natural disasters).

A more flexible approach to investigating contextual influences or inequalities may be found in the work of Bronfenbrenner [32, 33] who conceptualised children's lives as being shaped by environmental factors acting and interacting in a set of nested structures, from within

families (at the micro level) to within their historical context (at the macro level). This has been applied to systematic reviews of research [34] and policy [35] addressing children's rights in post-conflict areas. The potential for applying frameworks such as Bronfenbrenner's to different systematic reviews is suggested by the various adaptations of similar ecological frameworks that can be found for primary research elsewhere, such as: environmental science [36]; migration studies [37]; and violence [38]. We illustrate that potential in Fig. 2 by visually summarising the findings of a systematic review of qualitative studies of microfinance [39].

Ecological models not only offer a framework to make sense of review findings but, as they provide a way to navigate the complexity of people's life circumstances, they also provide a framework for identifying stakeholders who can help with shaping the review or interpreting the findings. An ecological framework can be immensely beneficial when researching context-sensitive topic areas such as children, gender and the broader social, cultural and natural environments.

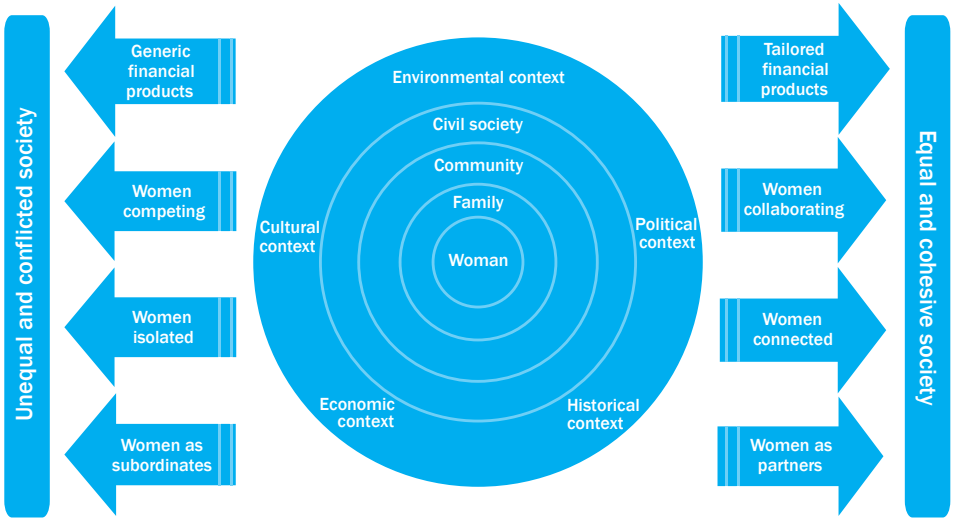

Fig. 2. An ecological model of women's engagement with microfinance programmes.
To complement evidence presented along a causal pathway or programme theory of change, which focuses primarily on the programme design and internal validity of evidence at each causal link, evidence can be presented within an ecological framework representing participants' social context to facilitate analysis of external validity for implementation decisions. (Adapted from a 'pathways to peace' framework [35] by the EPPI-Centre to present the key contextual issues influencing the outcomes of microfinance programmes [39]).

Practical challenges and ultimate benefits

Transdisciplinary working when conducting systematic reviews is not easy. The challenges manifest when working with contrasting paradigms, and epistemological, ontological and methodological differences. Our own experience tells us it requires time and effort to adapt to unfamiliar information resources, terminology, communication styles and research methods. Guidance is available from a systematic review which found that transdisciplinary research is enhanced by team leaders with good ideas and vision, contacts, good interpersonal skills, humility, familiarity with the disciplines and the opportunity to choose their team members and keep them all on board, and by team members with maturity, flexibility and personal commitment [40]. Grounding the unfamiliar in social and cultural contexts recognisable to the particular review team can encourage respect for different ideologies and paradigms, and a better understanding and appreciation of disciplinary diversity. Transdisciplinary research is also helped by the physical proximity of team members, the internet and email as a supporting platform, and an institutionally conducive environment. Constructive working practices include: developing a common goal and shared vision; having clarity about, and rotation of, roles; good communication and constructive comments among team members, and importantly, a collaborative ethos of openness and sharing in learning with and from distinct disciplines.

Ideally such teams synthesise more complete evidence, more coherently, and align reviews more closely with stakeholder interests, leading to more compelling evidence. For these reasons, commissioned systematic reviews, which tend to be both complex and time-pressured, require that care be taken not only in drafting substantive content of terms of reference for the conduct of the systematic review, but also in selecting a team of reviewers well motivated to take on transdisciplinary reviews. A track record in project management, a typical requirement in requests for proposals, does little to reveal the capacity of the leader for the critical tasks of forming a team, holding it together, and resolving different points of view. Further, transdisciplinary reviews attract different stakeholders who may be driven by disparate motivations. Generally, academics tend to be

comfortable 'producing knowledge', partly because they are rewarded by the academic structures in which they are situated for doing so. Non-academics, on the other hand, are rewarded for 'getting things done' and seeking practical results and impacts, which may lead to different approaches and motivations in larger and more diverse teams. Once again, the ability of a team leader to manage any resulting tension in teams with academic and non-academic members, is critical to the successful outcome of the review. Indeed, producing knowledge combined with getting things done underpin good transdisciplinary research, which is commonly assessed in terms of relevance, credibility, legitimacy and effectiveness in problem solving or social change [41].

Despite these challenges, transdisciplinary working, with academics and other stakeholders, has led to growing numbers of systematic reviews that address policy questions. Transdisciplinary working has also made possible the adaptation of review methods for new fields and the sharing of knowledge between experienced reviewers and novice teams who bring subject expertise to build reviewing capacity and produce learning which is empowering and reflects both the local and global.

Conclusions

Systematic methods for answering important questions from existing literature are well developed. These methods need to be complemented by clearer methods that emphasise the thinking and debate for developing the questions, shaping reviews and interpreting emerging findings. Such work requires crossing academic and policy boundaries, and exploring how concepts, definitions and language differ. Communication methods analogous to collective qualitative analysis or non-directive counselling look promising for refining questions and constructing conceptual frameworks collectively. Ecological models look promising for understanding the context of research findings and addressing the big questions about social change.

Authors' contributions

This paper combines six strands of thinking. PG, PH and SO analysed the limitations of practitioner focused systematic reviews within multilevel, adaptive systems. JJ and SO analysed current frameworks for equity analysis. KD, MB and SO conducted the research addressing how systematic reviewers and their stakeholder partners navigate the policy–research interface. MF and SO analysed the intellectual steps in shaping evidence gaps. LA and SO developed the multi-level ecological model that informed the early childhood development and policy-related systematic review. SO and RG applied these arguments about transdisciplinary research to environmental science. All authors read and approved the final manuscript.

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8

Inclusive development and prioritization of review questions in a highly controversial field of regulatory sciences

Armin Spök • Monica Racovita • Sandra Karner • Gloria Adduci • Greet Smets • Patrick Rüdelsheim • Christian Kohl • Ralf Wilhelm • Joachim Schiemann

How to best assess potential health, environmental and other impacts of genetically modified organisms (GMOs) and how to interpret the resulting evidence base have been long-standing controversial issues in the EU. As a response, transparency and inclusiveness became a major focus of regulatory science activities in the GMO impact area. Nevertheless, nearly three decades of controversies resulted in a heavily polarized policy environment, calling for further efforts. Against this backdrop the EU funded project GRACE explored the value of evidence synthesis approaches for GMO impact assessment and developed an evidence synthesis framework with a strong emphasis on openness, stakeholder engagement, transparency, and responsiveness to tackle regulatory science challenges. This framework was tested and implemented in the course of 14 systematic reviews or maps conducted on selected review questions spanning potential health, environmental, and socio-economic impacts of GMOs. An inclusive development and prioritisation of review questions is of key importance in evidence synthesis as it helps to provide a better link between stakeholder demands and concerns and policy relevant outcomes. This paper, therefore, places a particular focus on the stakeholder involvement strategy developed and experiences gathered during this particular step in the course of the GRACE project. Based on this experience, possible lessons for future engagement exercises in highly controversial fields of regulatory science are discussed.

Keywords: Evidence synthesis • Systematic reviews • Transparency • Inclusiveness • Stakeholder involvement • GMO impact assessment • GMO risk assessment • Prioritization of review questions

Background

Evaluating potential health, environmental and socio-economic impacts of genetically modified (GM) crops has been a dynamic field of research since the early 1990s. Interpreting the resulting primary data has frequently been a subject of controversial debates augmented by the complexity and the diversity of test designs and the multitude of endpoints under investigation [1] as well as by contradicting results. Reviewing secondary data by academia and regulatory committees has frequently led to discussions about, among other, studies not (appropriately) considered, relative weight attached to data generated by different methods, bias, lack of transparency and to divergent conclusions [2, 3, 4, 5, 6, 7, 8].

Against this backdrop the EU funded research project GRACE (GMO Risk Assessment and Communication of Evidence) set out to explore the use of evidence synthesis approaches to assess and synthesize exiting evidence on potential health, environmental and socio-economic impacts of GM crops [9]. At the time of the planning and start of this project (2011–2012) systematic reviews and maps had sparingly been applied to GMO impact research.

GRACE had a twofold aim: (i) to explore the suitability of systematic reviews and maps in GMO impact research and assessment, and (ii) to assess the available evidence on selected research questions. The results were expected to support evidence-based policy making in GMO impact assessment.

By adapting existing guidance documents [10, 11, 12] GRACE developed a general framework appropriate for the synthesis of GM crop impact data [13]. Based on this general framework 14 systematic reviews and maps were planned and started in parallel.

A particular emphasis was placed on an active stakeholder involvement going beyond what is generally done in the course of systematic reviews and maps. A multi-step stakeholder engagement approach was

developed inspired by two main considerations: (i) the long-standing polarization of the GMO impact debate which is accompanied by a lack of trust among stakeholders and (ii) the concept of Responsible Research and Innovation (RRI) underlying the recent research programmes funded by the European Commission and many national agencies [14, 15, 16]. The resulting engagement approach, aiming to strengthen the openness, inclusiveness, responsiveness, and transparency of systematic reviews, was implemented for all GRACE reviews and maps in a harmonised way by a team specifically set for the purpose, involving researchers with expertise in natural and social sciences.

According to participant surveys and authors' experiences, stakeholder participation was perceived to be most productive and important in the development and selection of the review questions. As shown in this paper, stakeholders had a considerable impact on the definition and selection of research questions and, thereby, on the scope of synthesis results. These steps are, therefore, the focus of this paper.

The GRACE stakeholder engagement approach for planning reviews and maps

An overview of the stakeholder engagement approach is provided in Fig. 1.

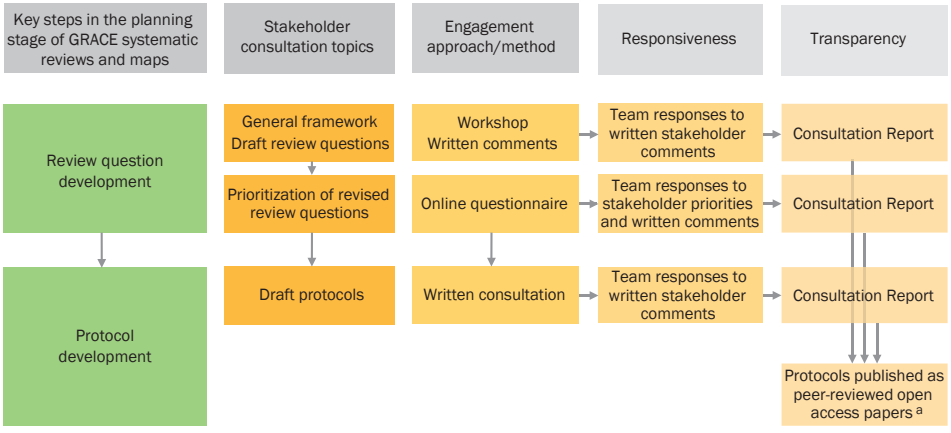

Fig. 1. The GRACE approach to stakeholder engagement in the planning stage of evidence synthesis.
a: Two review protocols on macro level socio-economic impacts were not published as available journals specialised on publishing such protocols considered them to be out of scope.

Openness

Participation in stakeholder workshops was open for all interested stakeholder representatives following a broad invitation circulated to some 500 stakeholder contacts encompassing a broad range of, among others, competent authorities, industry, civil society organisations, professional organisations and researchers. Subsequent steps mainly involved workshop participants.

Despite limited resources, considerable attempts were made to have the key stakeholder groups represented across all steps.

Inclusiveness

As a first step, the overall framework and preliminary review questions were discussed in a 2-day workshop. Stakeholders could provide written comments and questions on the workshop discussions but also on issues not discussed there. Written comments were open to a wide audience including, but not limited to, workshop participants.

The resulting lists of the candidate review questions were prioritized in a second step by stakeholders using an online questionnaire, helping thus the project team identify a final set of review questions.

In the third step review protocols were developed and subjected, as drafts, to stakeholder comments in the course of a written consultation. Following a revision of the protocols prompted by stakeholder comments, they were published or prepared for publication as peer-reviewed journal papers.

In the fourth step preliminary results of the individual reviews as well as draft general conclusions and recommendations were presented and discussed in the course of another 2-day stakeholder workshop and again subjected to written comments.

Responsiveness

Stakeholders participating in the workshops as well as those provided with consultation materials could provide comments to the review team, which were then collected, categorised and subjected to the individual teams overview through the project's internal clearing house

mechanism. Review teams discussed all comments, revised the review questions and developed written point-by-point responses to all comments and questions.

Transparency

Workshop participants were provided with draft documents and presentations before the workshop meetings. Each step was documented in a detailed stakeholder consultation report which covered workshop inputs and discussions, survey results, written stakeholder questions and comments as well as review team responses. Workshop reports documenting discussions were circulated as drafts to all participants in order to ensure that discussions and viewpoints were accurately depicted. The workshops, the written stakeholder comments, and the review teams' responses are documented in detail in a series of consultations reports available [17, 18, 19, 20, 21] on the project website [9].

Reflexivity

To better understand how the GRACE approach was perceived by participants, their views were gathered via phone interviews as well as via online and paper questionnaires.

Status of GRACE systematic reviews and maps

The characteristics described above also accompanied the stakeholder consultations on the preliminary results of the individual reviews and maps (not shown as they are beyond the scope of this paper). Furthermore, GRACE developed general conclusions and recommendations on the use and value of evidence synthesis approaches in GMO impact assessment [22, 23, 24] which were also included in the scope of the consultations. By the time of the submission of this paper, 7 of the 14 review/map protocols [25, 26, 27, 28, 29, 30, 31] and the results of one systematic review [32] have been published as peer reviewed open-access papers and 10 review/map protocols and the published systematic review are available on the Open Access database CADIMA [33].

Development and prioritization of review questions

The main steps in the development and prioritization of review questions are depicted in Fig. 1—indicating also the methodology used. The manner in which this process influenced the evolution of review questions is indicated in Table 1 and illustrated in Fig. 2.

Table 1. Development and selection of review questions

GMO impact area	Development and selection of review questions					
	Preliminary review questions	Changes made to review questions			Candidate review questions	Selected review questions
		Revised	Dropped	Added		
Health impacts	11	4	6	4	9	4 [a]
Environmental impacts	23	4	3	0	20	6 [b]
Socio-economic impacts	33	15	2 [d]	9	40	4 [c]
Total	67	23	11	13	69	14

Numbers indicate how many review questions entered into the process, were modified and selected. The review questions selected for conducting systematic reviews and maps are detailed in Table 2.

a All four review questions were revisited based on stakeholder comments.

b The prioritization exercise initially produced 11 questions, of which 3 were kept unchanged, 2 were further modified, 6 were dropped and another one added.

c 27 review questions on micro level socio-economic impacts were combined into one broad systematic map; 4 review questions on macro level socio-economic impacts were selected based on 14 candidate questions—two of the four questions were combined into one review question.

d 2 questions were dropped as separate questions but included in the scope of other review questions.

Proposing and discussing review questions

In the first step a total of 68 preliminary review questions covering the three fields of GMO impact research were subjected to a consultation with 41 stakeholders. During this step the focus was on understanding and discussing the general characteristics of systematic reviews and maps, the potential relevance of this method for GMO impact research and assessment, the conceptual frameworks for the review questions, and the preliminary review questions.

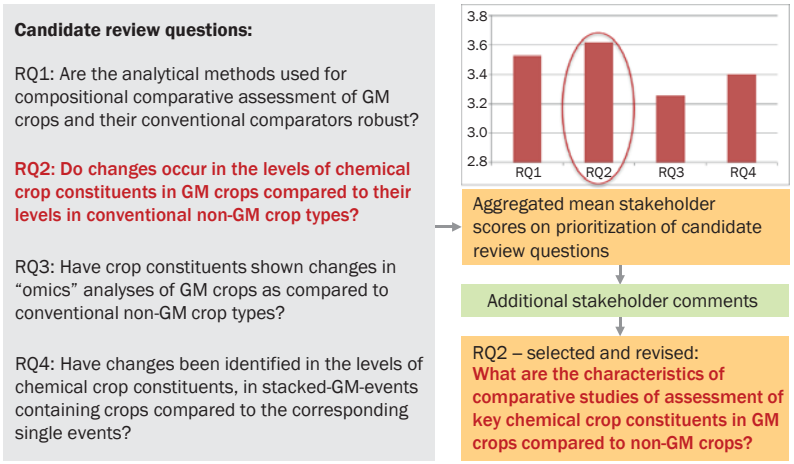

Fig. 2. Example how stakeholder priorities and comments influenced type, scope and wording of review questions (described in detail for all review questions in [17, 18, 19, 20]).
(The bar chart was reproduced with permission from [19].)

Based on the workshop discussions and more than 170 written stakeholder comments received after the workshop, the project team modified the review questions considerably in terms of subject, scope, wording and numbers (summarised in Table 1). Of a total of 68 review questions, 23 were revised, 11 dropped and 13 new questions added. For the health and environmental impacts work streams this resulted in a reduction of the number of review questions. For the socio-economic impacts work stream it led to a broadening of the scope and to adding more review questions.

The resulting 69 candidate review questions were then prioritized by stakeholders in the next step.

Developing criteria and a process for prioritizing review questions

The method and criteria used were tailored to accommodate (i) the specific challenges of dealing with a large number of review questions in three very different scientific and policy contexts in parallel, (ii) the fact that this prioritization was done by stakeholders in a very polarized policy environment, (iii) the constraints of a relatively inflexible research project with tight timelines and resource limitations, and (iv)

the exploratory nature of the project in applying evidence synthesis to GMO impact research.

The criteria used were (i) importance for impact assessment, (ii) the existence of expert controversy, and (iii) degree of public awareness (inspired by O'Connner et al. [34] and Clavesi et al. [35]). These three criteria refer to three important dimensions, which also act as three different contexts in the GMO debate: scientific, regulatory, and public dimension. A scoring system (1–5) was used with the option for adding comments allowing for a more nuanced feed-back.

Prioritization of the candidate review questions

The stakeholders participating in the previous consultation step plus those who expressed a particular interest (n = 55) were asked to score each of the 69 candidate review questions in each of the three criteria by using an electronic questionnaire (LimeSurvey).

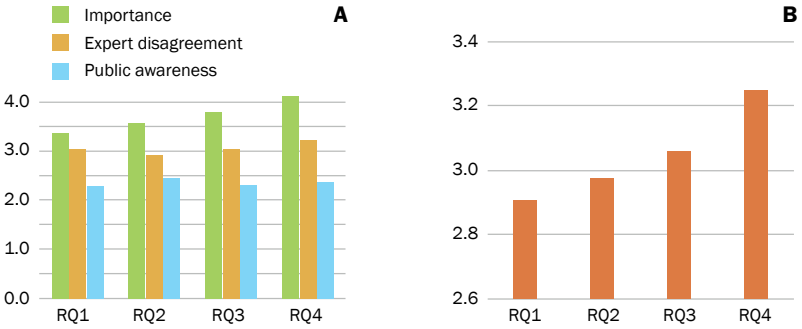

Fig. 3. Example of scores resulting from stakeholder prioritization. Review questions (RQ) 1–4 on Bt crops and Cry toxin.

A *Means of scores for each criterion (importance, expert disagreement, and public awareness) on a scale of 1 (lowest) to 5 (highest).*
Criteria: Importance: the review question is of high importance for the impact assessment of GMOs. Expert disagreement: there is expert disagreement on the review question. Public awareness: the review question is the subject of high public awareness.

B *Aggregated mean scores (mean scores across all three criteria).*
RQ1: Does the knowledge about the biology of *B. thuringiensis* and its action towards organisms (target and non-target) raise any new questions in relation to the risk assessment of CRY toxins produced by GM plants? RQ2: Does the knowledge about the mode of action of CRY toxins at the molecular level pose any issues for the risk assessment of CRY toxins produced by GMPs? RQ3: How is the phylogenetic relationship, related to mode of action and specificity, between CRY toxins? RQ4: What is the current evidence base to conclude on whether the effects of combined, stacked or pyramided CRY toxins, as produced by stacked GMPs, will be additive, synergistic or antagonistic? (Reproduced with permission from [19].)

The respondent rate of the questionnaire was 34.5% (health and environmental impacts) and 29.1% (socio-economic impacts) respectively. Aside from scores, stakeholders provided 74 additional comments. The resulting data set was analysed using SPSS and Excel. Mean scores for each criterion as well as aggregated scores (sum of mean scores of each criterion—assuming an equal relative weight of each criterion) were calculate for each candidate review question and where discussed and considered along with additional stakeholder comments by the three project teams (health, environmental and socio-economic). An example of how stakeholder scores were reported to the review teams is provided in Fig. 3.

No relative weighting of the different criteria was imposed a-priori, so each review team was essentially free to weight the scores for the individual criteria which allowed considering specifics of their thematic. Moreover, on top of stakeholder priorities and comments, the review teams also needed to consider time, resource, and contractual obligations. All review teams were, however, asked to provide short responses outlining their rationale and how they arrived at the final set of review questions.

As a result, 14 of the 69 proposed candidate review questions were selected and decisions pondered whether they would be pursued as systematic reviews or maps. In the process, and based on the additional stakeholder comments, four review questions on health impacts were revised again, and 27 review questions on micro-level socio-economic impacts were merged into one review question for a broad systematic map (final review questions shown in Table 2).

The systematic approach for processing stakeholder comments described above was particularly important across these steps. It enabled stakeholders and all interested parties to track how their comments and questions were received and processed by the review teams, if comments suggesting modifications were adopted or not, and if not, the reason for which they were not (fully) adopted. Thereby any interested party could track how stakeholders shaped the choice of topics, scope and wording of the review questions.

Table 2. Systematic reviews and maps conducted in the context of the GRACE project

GMO impact area	Research question	SR/SM	Ref. [a]
Health	What are the characteristics of comparative studies of assessment of key chemical crop constituents in GM crops compared to non-GM crops?	SM	b
	What evidence has been collected on the potential toxicity of newly proteins in experimental animals, and what were the characteristics of these studies?	SM	b
	What is the evidence for a changed risk of allergic reactions to an allergenic crop after it has been genetically modified?	SM	b
	What are the characteristics of repeated-dose feeding studies with experimental animals receiving whole food or feed products derived from genetically modified (GM) crops and non-GM counterpart as a control focusing on potential health impacts other than performance?	SM	b
Environmental	Does the growing of Bt maize change abundance or ecological function of non-target animals compared to the growing of non-GM maize?	SR	[25]
	What are the effects of the cultivation of GM herbicide tolerant crops on botanical diversity?	SR	[26]
	Are population abundances and biomasses of soil invertebrates changed by Bt crops compared with conventional crops?	SR	[27]
	Are soil microbial endpoints changed by Bt crops compared with conventional crops?	SR	[28]
	How susceptible are different lepidopteran/coleopteran maize pests to Bt-proteins?	SR	[29, 32]
	What is the evidence on the inheritance of resistance alleles in populations of lepidopteran/coleopteran maize pest species?	SM	[30]
Socio-economic	What are the socio-economic impacts of genetically modified crops worldwide?	SM	[31]
	What is the impact of trade restrictions of GM products in different countries on the competitiveness of different partner countries and corresponding sectors in comparison to a situation where there are no restrictions on GM trade?	SR	c
	What is the impact of the introduction of GM crops on the welfare effects in different countries in comparison to a situation where there are restrictions on GM cultivation?	SR	c
	What is the impact on GM regulation of different political actors and other drivers in the EU in comparison to the situation in the US?	SM	c

Ref: references, *SM:* systematic map, *SR:* systematic review

a Protocols for seven systematic reviews or maps resp. and results of one systematic review were published at the time of writing this article. Preliminary results of the systematic reviews and maps are also available from GRACE Stakeholder Consultation Reports and from the final conference [21, 24].

b Publication of protocols is in preparation.

c Protocols will not be published as journal papers as they are considered to be out of scope for the main journals publishing evidence synthesis protocols.

Experiences and lessons

The previous sections describe the main characteristics of an evidence synthesis engagement approach developed in response to highly polarized views, lack of trust, and the novelty of evidence synthesis for the respective stakeholder community. This section briefly reflects on some of the experiences and lessons learned (also summarised in Table 3). From the viewpoint of the systematic review community, these considerations are limited due to the lack of completed reviews and maps. At this point, therefore, no conclusions can be derived on how the approach described here ultimately affects the relevance and acceptance of the review findings. From the viewpoint of GMO risk regulation, however, it can already at this stage be concluded that the approach describe here appears to be a very interesting and promising alternative option to render GMO risk research more transparent, inclusive and accountable and, that it is definitely worth to be further explored.

Openness and inclusiveness

The evidence synthesis community frequently highlights the importance of stakeholder involvement in the planning stage of systematic reviews and maps. Review questions should be jointly developed with stakeholders [12] but little reflection is available on what approaches have been used and what have been the experiences. For the GMO impact community, stakeholder involvement in the planning stages of research and assessment is a rare endeavour. Not surprisingly, the GRACE opportunity for upstream involvement was positively perceived by participants with the development and prioritization process of the review questions considered as most relevant step.

Broadly circulated invitations at the beginning of the process (step 1) and the absence of participant selection encouraged a total of 95 stakeholder representatives to participate in one or more steps of the process. It also helped to establish and maintain an atmosphere of openness which is helpful for trust building. The only exception applied to journalists who were excluded from workshops to allow participants to speak freely.

Table 3. Overview of experiences and recommendations for evidence synthesis in controversial contexts

Measures	Experiences—assessment by the authors	Recommendations
Openness and inclusiveness		
Broad stakeholder invitation—any interested stakeholder can participate	The absence of participant selection prevented conflicts about the composition of the stakeholder group and contributed to trust building	This approach needs supporting measures to ensure that interested stakeholder representatives can participate in all subsequent steps (e.g. travel support, smaller stakeholder groups)
Multiple ways of engagement (workshops, written consultations)	Online written consultations were mainly used to introduce issues not mentioned in or to clarify or emphasize discussion topics of the face-to-face consultations	This set-up is useful for clarifying issues and views and for bringing up issues not addressed during face-to-face meetings, e.g. due to lack of time. It does, however, not help in engaging individuals unable to participate in the face-to-face consultations
Familiarizing participants with the evidence synthesis process	This measure is very important for a meaningful engagement. This works better if the same representatives of a stakeholder organisation participate in the entire consultation process	The engagement process must be tailored to the level of knowledge of and experience with evidence synthesis Measures need to be in place to ensure that the same individuals can contribute over the entire engagement process (e.g. providing travel support and opting for smaller stakeholder groups)
Responsiveness		
Procedure for written responses to stakeholder comments	The measure was extensively used by stakeholders The procedure resulted in a systematic and transparent consideration of stakeholder comments by review teams and allowed for transparency of how stakeholder inputs shaped the process	Time and resource needs are significant and therefore preclude routine application. The procedure appears suitable for sensitive or controversial topics and smaller scale evidence synthesis endeavours
Stakeholder can influence topic selection and scope	It was challenging to balance stakeholder needs with other project requirements. Many such requirements were contractual (timeline and funding) and therefore given priority	Ultimately decisions about modifications of review questions and process need to stay with and be clearly accountable to the review team(s). In turn the review team(s) should make transparent the reasons for their choices
Transparency		
Providing draft plans and preliminary results for stakeholder review	This measure was appreciated by stakeholders whereas review team members were sometimes reluctant to disclose preliminary plans or results. Participants considered it important for open discussions and trust building	Measures described above are more meaningful and credible if linked to extensive transparency requirements. Ensuring transparency is time consuming so adequate time needs to be planned in advance
Providing detailed documentation of consultations, stakeholder comments, team responses and how stakeholder comments shaped the process	This measure was appreciated by stakeholders and considered important for open discussions and trust building	

Stakeholder balance was well achieved in all steps with the exception of the written consultation on the review protocols: CSO representatives were provided with the protocol but did not comment. Stakeholder balance across the process is shown in Fig. 4.

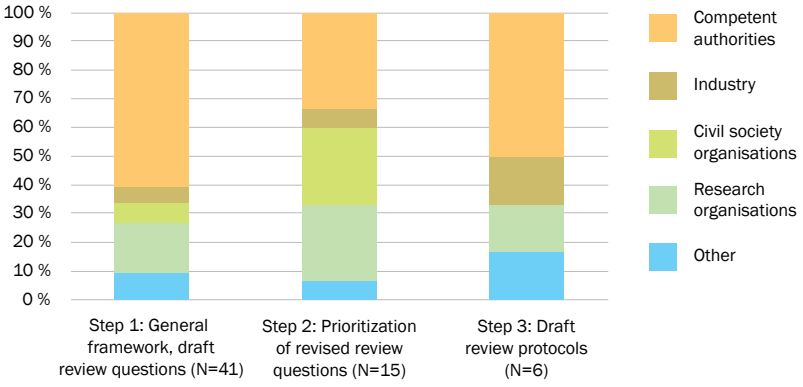

Fig. 4. Stakeholder balance for each engagement step.
N: number of stakeholder participants in each step.

Openness measures, however, brought in additional challenges: the consecutive consultation steps in the planning process were conceptualized as a step-by-step learning process, hence, the consultation processes in step 2 (prioritizing review questions) and 3 (on draft review protocols) were limited to those participating in step 1. Still, the number of participants was progressively declining and, more importantly, there was considerable fluctuation among individual participations. Only nine of the 41 stakeholder individuals participating in step 1 continued to step 2.

Possible reasons for this participation pattern, as suggested by the authors, are: the high and still increasing number of stakeholder events on GMO issues; the relevance of evidence synthesis for many stakeholders is still not fully clear; the absence of resources to support participation of stakeholders; the lack of familiarity with evidence synthesis (procedure, strengths and weaknesses); the combination of health, environmental and socio-economic topics into the same consultation workshops made it difficult for some people to follow as some topics were outside of their area of expertise (in organisations like competent authorities, industry and research, health, environ-

mental and socio-economic topics are typically covered by different persons); stakeholders felt overloaded with the number of tasks and documents presented to them.

To mitigate such risks, additional measures have to be considered to enable the same individuals to follow the entire process, e.g. smaller groups, more intensive training in evidence synthesis methods and tools, and travel support for stakeholder participants.

Responsiveness

Overall, the GRACE stakeholder consultations led to intense interactions in the course of 2-day workshops and more than 520 written stakeholder comments and team responses. The established procedure to systematically discuss and respond in writing to all stakeholder inputs inspired internal discussions of the review teams. As described in previous sections, stakeholder comments effectively shaped the prioritization, scope and phrasing of the review questions and thereby improved the quality and relevance of the review plans.

On the other hand, stakeholder suggestions sometimes conflicted with resource, time and other requirements of the GRACE project. Occasionally, stakeholder suggestions were contradicting each other, thus it was very important that ultimate decisions remained with the review team.

Review teams, however, needed to be transparent with which inputs they have considered or not, and why. Suggestions not taken sometimes led to disappointment or frustration from stakeholder participants, this being indicative of the need to carefully balance stakeholder expectations and the flexibility to accommodate inputs.

Transparency

Transparency measures were generally appreciated by stakeholders but sometimes resulted in a reluctance of scientists to share preliminary and draft plans with a broader stakeholder group. The reason was the hesitation of some scientists to expose their output to a thorough scrutiny by a polarized stakeholder community at a point in time when such results were considered preliminary or even estimative.

Moreover, some scientists pursuing a typical academic career had difficulties to see what they could gain from an 'extended peer review' at this stage.

The procedure for tracing and making transparent how stakeholder inputs were perceived and processed by review teams was—to the best knowledge of the authors—used for the first time in evidence synthesis and was positively received by stakeholder participants and observers [36]. The detailed documentation of all engagement steps also provides a unique evidence base for any ex-post analysis of stakeholder views and their impacts on the project.

The extensive transparency requirements allowed better identification and understanding of divergent views and assessments and were important to establish and maintain the atmosphere of openness despite long standing lack of trust among some stakeholders.

Setting an example for other controversial regulatory science topics?

The consultative approach described here offers interesting advantages if operating in the context of long-standing controversies which often goes together with polarised views and lack of trust. In such contexts the substantial time and resource requirements from stakeholder participants and review teams would also be well justified.

The approach allows to systematically capture and make transparent stakeholder and review team views and priorities. It also provides elements for openly and transparently engaging with stakeholders in planning stages of the review without the ultimate obligation to arrive at a consensus—something which is very difficult to achieve in case of long standing controversies. Still, as shown in this paper, the procedure can help to improve the quality and relevance of review topics and plans.

Another challenge highlighted in this paper is how to operate in contexts with little or no prior experience with evidence synthesis. Although introductions and a training into evidence synthesis were provided this was by no way sufficient. Many stakeholder representatives participating in consultation workshops did not participate in the training and had superficial understandings of the methodology.

Moreover, the measures in place to provide openness resulted in participation patterns making step-by-step knowledge generation difficult.

Drawing on this experience the approach could work better in the course of smaller scale endeavours, focussing on a smaller number of review questions in a more homogenous field of research, providing more intense training in systematic review methodology as well as providing resources to stakeholders to encourage continuing participation and tackle attrition.

Abbreviations

CADIMA:	Central Access Database for Impact Assessment of Crop Genetic Improvement Technologies
CEE:	Collaboration for Environmental Evidence
Bt-crops:	genetically modified crops producing an insecticide following genetic transfer of a gene from a bacterial species *Bacillus thuringiensis*
GM:	genetic modification
GMO:	genetically modified organisms
GRACE:	GMO risk assessment and communication of evidence
RQ:	review question
SM:	systematic maps
SR:	systematic reviews

Authors' contributions

AS let the work package on stakeholder engagement and was the principle researcher for the stakeholder engagement concept. He also drafted this manuscript with the help of MR. All authors contributed to the manuscript. AS, GA, GS, SK, MR and PR jointly planned, organised and documented the activities described in the paper. Online prioritization was conducted by GA and AS. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets of the systematic reviews and systematic maps referred to in the article are available or will be made available at https://www.cadima.info/. Detailed documentations of the stakeholder engagement steps including the development and selection of review questions are provided at http://www.grace-fp7.eu/.

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9

Rethinking communication —integrating storytelling for increased stakeholder engagement in environmental evidence synthesis

Anneli Sundin • Karolin Andersson • Robert Watt

Storytelling is a two-way interaction, written or oral, between someone telling a story and one or more listeners. It is a well-known and powerful means of communicating messages and engaging audiences. In this commentary paper, we present a framework for the integration of storytelling in systematic reviews and systematic maps at the stages where stakeholders are actively involved. Using storytelling to explain complex research has, in the past, not been considered a rigorous method of communicating science. But an increasing number of studies are showing how narratives can be useful for developing trust with an audience and increasing knowledge retention as well as the ability and willingness by audiences to learn and take action. Being easily digested by the human brain, stories help bridging between our logos and pathos; when an audience becomes emotionally receptive of facts, chances increase that they will respond and act on the knowledge.

Here, we argue that storytelling holds potential as a tool in systematic reviews and systematic maps, serving mainly two purposes. First, collecting contextual narratives from stakeholders at the stages of question formulation and protocol writing can help to inform and generate relevant research questions and review designs. Here, we refer to contextual narratives as stories gathered from stakeholders to gain an understanding of their perspective. Second, creating a final story that faithfully

presents the review results, while also relating to the contextual narratives, can contribute to effective communication of the results to stakeholders as well as to a broader audience. This approach can increase their engagement with the science and the implementation of evidence-based decisions.

The paper concludes that storytelling holds untapped potential for communicating evidence from systematic reviews and maps for increased stakeholder engagement. It is time for researchers and research networks such as the Collaboration for Environmental Evidence to support and emphasize the importance of exploring new tools for effective science communication, such as storytelling.

Keywords: Environmental management • Narratives • Science communication • Stakeholder engagement • Storytelling

Background

The issues at stake in environmental management and conservation are often complex, while communication of systematic reviews and systematic maps needs to be clear and comprehensible (for definitions of and differences between systematic review and mapping methodologies, see e.g. [1, 2]). Traditionally, scientific knowledge has been communicated as isolated logical ideas with limited context given to the target audience. This poses the risk that the audience, particularly the non-expert one, might make inaccurate assumptions when they try to make sense of new information [3]. Therefore, effective science communication is considered to be an important foundation for evidence-based decision-making [4]. The results from systematic reviews and systematic maps are commonly communicated to stakeholders through formats such as final reports, policy briefs and summaries [1]. In the case of evidence-based environmental management, stakeholders are defined as "all individuals and organisations that might have a stake in the findings of the review" ([1], p. 16). The findings are, in similarity with primary research, most often written with a traditional logical-scientific structure (see examples in [5]).

Communicating evidence in an understandable and practically relevant way for stakeholders, for instance by embedding knowledge in a narrative storyline, has shown to increase an audience's engagement, willingness to act upon the knowledge and use the evidence as a basis for their decisions [3, 6, 7]. By placing knowledge into context, stories are easier to process and generate more attention and engagement than traditional logical-scientific communication [8]. Storytelling, the ancient tool of using stories to communicate knowledge [7, 9], has the potential to give evidence meaning, motivate and engage audiences and give relevance to their realities.

Although storytelling has grown as a tool for science communication in several research fields such as health care and science education [3, 8, 10], integrating it into systematic reviews and systematic maps in environmental management and conservation to communicate evidence to stakeholders and other target audiences is yet to be explored and used to its full potential.

This commentary paper argues for an increased and integrated use of storytelling in science communication for increased stakeholder engagement and evidence-based environmental management. The argument is valid for research in general but particularly so for systematic reviews and systematic maps, in environmental conservation as well as in other sectors. These reviews and maps are intended to provide stakeholders with an overview of existing, often complex, evidence on a particular topic and may thus have a greater influence over decisions made on an aggregate level than individual primary research studies [4]. Primary research, on the other hand, might be of higher significance for decision-making in certain contexts.

Telling stories and the introduction of storytelling in science communication

Telling stories has been a method for humanity to make sense of their environment, organise experience and ideas and communicate with their community to create shared understanding since ancient times [9]. It has been and still is an art form with a purpose to educate, inspire and communicate values and cultural traditions. Storytelling

typically follows a structure that describes the cause-and-effect relationships between events that take place over a particular period of time and that impact a range of individuals [8]. It is often interactive and can help the listeners to cultivate their imagination. Storytelling has the potential to generate a shared understanding among people about a situation, a topic or a problem, and through its engaging nature it has the potential to attract and sustain interest and enable audiences to make meaningful connections [11]. Another advantage of storytelling is that it is often easily accessible and does not require the audience to have expert knowledge to understand and associate with the knowledge that is being communicated. It is also in the narrative form in which most people receive their news and information [8].

Storytelling exists in many different forms and there are many different techniques. It can be applied to visually describe a narrative using different mediums such as video, photography or graphics/illustrations, in what is usually called visual storytelling. Something relatively new is to go digital in storytelling, i.e. using our modern digital means that makes it possible for essentially anyone to share their stories [12]. Of course, storytelling often exists in traditional forms as well, such as in theatrical performances.

Storytelling has been explored as one of many tools for communication in different scientific contexts and it has, as a debated concept within science, grown rapidly over the recent decades. Sectors such as health care are increasingly confident in using narratives as a communication tool for diagnostics, therapeutics, and the education of patients, students, and practitioners [10]. In a study by Greenhalgh [13] on health-related behaviour change in the UK, it was found that storytelling led to positive results.

"Although health professionals were frequently cited (and greatly valued) as sources of information, there was not a single instance in our interviews [of British Bangladeshi diabetes patients] when information from health professionals was associated with a reported change in behavior. In contrast, reports of changes in behavior were very frequently linked to a story told by another Bangladeshi" [13], p. 595.

Storytelling is now being explored as a tool for communicating research in other fields, such as in science education [3, 8], see table 1

for examples of how storytelling has been used in different fields). Introducing storytelling in the research community has, however, not been unproblematic. Some scientists have met it with scepticism, alluding to its inherently manipulative risks and that narratives are not as valid as scientific data due to its lack of systemisation, its inability to be reproduced and controlled, and to capture the complexity of science [8].

Table 1. Uses of storytelling in different fields

Example	Fields	How storytelling is applied	Target group/ stakeholders
Using evidence for better practice: a success story [14]	International development/ public health	Tool to highlight the benefits of using systematic reviews in the sector	Development and health workers
The story behind the science [15]	Science education	A website creating stories that can be used by science educators to help illustrate specific concepts	University students
Influence of evidence type and narrative type on HPV risk perception and intention to obtain the HPV vaccine [16]	Healthcare	Method to increase risk perception about a virus and behavioral intention to get a virus vaccination	General public
How people with motor neurone disease talk about living with their illness: a narrative study [17]	Medicine	Data collection method (narrative case studies)	General public
Drought risk and you [18]	Climate change	Storytelling is used as one of several methods for gathering narratives to build local, historical knowledge about drought impacts, experiences and adaptation	Decision-makers for water management in the UK

Nevertheless, storytelling can indeed fill a function as a communication tool for scientists and science communicators. Introducing new knowledge through a narrative that an audience can relate to provides a context in which complex information can be easier to understand and analyse. The human brain seems to better absorb and retain scientific knowledge and messages when it is introduced through a coherent narrative [19, 20]. In fact, as Dahlstrom [8] describes it, "…narratives seem to offer intrinsic benefits in each of the four main steps of processing information; motivation and interest, allocating cognitive resources, elaboration and transfer into long-term memory" (p. 13615). Some studies even claim that using narratives is

the one most powerful way of planting new ideas in the human brain [11, 21]. Narratives are likely to bring about more engagement with an audience than traditional scientific communication since it aids the bridging between logos and pathos, terms deriving from "Aristotle's Rhetoric", the ancient Greek text about the art of persuasion. Logos refers to the logic behind the argument itself and pathos refers to the inherent emotions of the listener [6]. Bridging these two can result in an increased willingness by the audience to respond and act upon the information given [19].

Untapped potential for the use of storytelling in evidence synthesis

In spite of its increased popularity in science communication in general, the particular use of storytelling to communicate results from systematic reviews and systematic maps in environmental management and conservation has been rare, if used at all. Indeed, we have not been able to find any documented examples. Given the complexity of the issues and interests at stake in environmental management, we argue that exploring innovative tools to transfer evidence and communicate it to multiple audiences (decision-makers, environmental managers, the public etc.) is highly relevant.

The guidelines for conducting systematic reviews in environmental management, developed by the research network Collaboration for Environmental Evidence (CEE), do not include communication of results as a separate step in the review process ([1], p.10). Nevertheless, in the brief section on further dissemination of findings ([1], p.11), the guidelines do mention the need to communicate results not only in a full report, but also through other more easily digestible formats such as policy briefs, executive summaries and guidance notes. These summarised and condensed documents are, however, likely to be structured in the same way as the full report, i.e. a traditional logical-scientific structure, but in a condensed way and with less technical detail (Sif Johansson, personal communication). Thus, these products may still need to be further processed to build shared understanding and drive the engagement of stakeholders to take evidence-based action.

Embedding knowledge from reports, briefs and notes in a coherent story that connects with the interests and concerns of stakeholders is one tool to build shared understanding. A final story can provide relevant context to review results and helps stakeholders identify when and where they can engage and take action. To situate review results in a coherent and relevant final story, we propose gathering contextual narratives at the initial stages of a systematic review and map. These contextual narratives describe stakeholders' understanding of the issues under investigation in the systematic review or map, based on their experiences and previous knowledge. We believe the process of gathering contextual narratives can also increase stakeholder engagement. In the following section, we describe how these two ways of using storytelling can be integrated into systematic reviews and systematic maps. It should, however, be clear that storytelling for communication of evidence should not be understood as the sole way to reach and engage a target audience, but rather as a complementary tool to the battery of traditional communication products.

1. Assemble contextual narratives from stakeholders at the early stages of the review process, facilitating question formulation, protocol writing and review design.
2. Formulate a final story at the end of the systematic review, based on the results from the systematic review or map and aligned with the contextual narratives earlier assembled. The final story can be used for communicating the results and make it digestible for stakeholders.

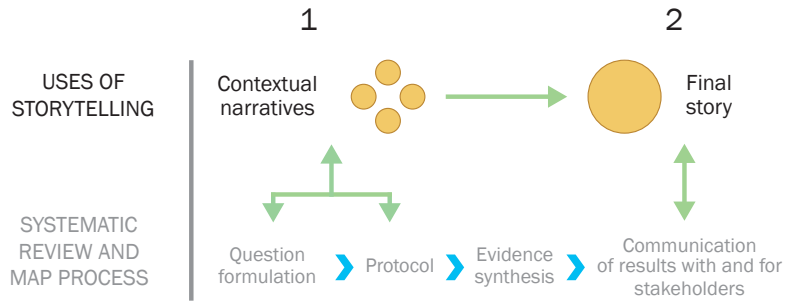

Fig. 1. Conceptual framework for the integration of storytelling in systematic reviews and systematic maps.

According to Gough et al. [4] there are mainly two different options for stakeholder involvement: stakeholders become either consultants or collaborators to the review team. As collaborators, the stakeholders are engaged to a larger extent than as consultants. During the initial stage, the reviewers formulate research questions together with stakeholders, who also contribute to the scope of the review or map as well as key concepts and definitions. In this paper, we explore the integration of narratives in systematic reviews and maps where stakeholders play a collaborative role. While this is one way to incorporate storytelling in evidence synthesis processes, there may be other means for its operationalisation.

At the initial stage of the review process, i.e. question formulation, stakeholders bring their various experiences, knowledge, priorities and values to the table. In the area of healthcare research, narrative inquiry is being commonly used as a technique to comprehend individual experiences [20]. If narratives were explored and used at an early stage in systematic reviews and maps in environmental management and conservation, they could contribute not only to increased stakeholder engagement, but also to a more informed process where diverse perspectives and needs of stakeholders effectively can be gathered. These 'contextual narratives' (see Fig. 1) can be assembled using different types of storytelling techniques, for example, the "Message Box" exercise pioneered by COMPASS, and can be collaborative between stakeholders. The Message Box can help stakeholders to identify and formulate their relevant problem in need of investigation [22]. Gathering the contextual narratives will (i) help to identify the most pertinent review questions and take into account the needs of stakeholders for review design and protocol writing and (ii) provide context to the research issue that can be used when communicating the final results.

By requesting the stakeholders to prepare their narratives in advance of the first workshop or stakeholder meeting, the reviewers can ensure to capture experiences and concerns from all stakeholders, including marginalised or vulnerable ones. At the same time, misperceptions are better avoided and diverging opinions easier to handle. The individual narratives will be rather 'raw' in nature, and stakeholders can be encouraged to step forward and reflect freely without

necessarily being constrained by facts and data. Gathering contextual narratives at this stage of a systematic review or map is likely to increase the engagement and curiosity among stakeholders concerned, as well as creating a sense of ownership. Moreover, by giving this space to stakeholders, the review team can identify the agency of marginalised groups and individuals. The team also gets the possibility to identify variables important to stakeholders that can be integrated into stages of data extraction and synthesis. Recording and clustering the narratives are important as well, in order to facilitate accurate and traceable use when they are to be aligned with the final results for communication and outreach. It may be beneficial to consult a professional storyteller prior to the meeting and assembly of narratives.

While the stakeholders have limited to no active participation during the intermediate stages of the systematic review (i.e. search, article screening, critical appraisal and data extraction, data synthesis and report writing) (Neal Haddaway, personal communication), they are again critical when the results are to be communicated, now as end-users. Here, storytelling can be used as an effective tool to communicate the logical-scientifically structured findings by formulating a final story that aligns and connects with the contextual narratives initially assembled (see Fig. 1). In contrast to the format of the final reports of systematic reviews and maps, where information is plainly presented, an experience is generated among stakeholders by embedding and grounding the findings into a contextually relevant story [11]. When the review team is preparing the communication and outreach material and activities, the narratives of perspectives and needs of stakeholders can be included to provide a context and to feed into the final story. This is important in making the final story resonate with the target audiences; the story will, in part, be based on the contextual narratives, thus the reviewers can adapt the material in terms of language, tone, place, and the use of jargon. The final stakeholder meetings are also an opportunity to test the story, and collaboratively adjust it. It could be equally beneficial, if not even more so at this stage, to consult a professional storyteller when developing the final story, for an increased outreach and stakeholder engagement potential.

As a final point, a major advantage with both assembling contextual narratives and developing a final story is that they can be used and

adapted for a large range of communication formats. This includes not only those suggested by CEE (policy briefs, executive summaries and guidance notes) ([1], p.11), but they can also serve as a basis to develop and inform other communication products, e.g. by providing the synopsis for a video or underpinning the basic structure for an op-ed or an oral presentation.

Conclusion

The guidelines for conducting systematic reviews within environmental management recognise that review results should be communicated in a range of formats beyond the final report itself [1]. In addition, this paper suggests that new innovative communication tools should be encouraged by researchers and research networks, such as CEE. One such tool to complement the traditional battery of communications products is narrative storytelling. We encourage the guidelines for systematic reviews to be more informative and detailed regarding communication and stakeholder engagement. This could contribute to systematic reviews and maps being better designed for evidence-based decision-making in environmental management and conservation.

Storytelling can be an essential tool to effectively reach a target audience with scientific results. Through a story or a narrative, context is provided to the audience and complex scientific data can be easier to understand and analyse. In this commentary paper, the authors have argued for a more systematic and integrated use of the innovative communications tool storytelling to increase stakeholder engagement from early stages of systematic reviews and maps in environmental management and to communicate results to a wider audience. Assembling contextual narratives early in the review process can enhance stakeholder engagement and facilitate the development of research questions. In addition, the contextual narratives can feed into a final story collaboratively created with the stakeholders to be used for an array of different communication purposes.

We acknowledge that the effectiveness of using storytelling as a tool to engage and communicate with stakeholders, as well as the

type of storytelling methods to be used, are determined by the type of review undertaken, the stakeholders involved and is context-specific. We also recognize that further research is needed to understand storytelling as an effective means of science communication and how to best integrate and carry out storytelling activities into systematic reviews and systematic maps in environmental management and conservation. To conclude, it is crucial that space and possibilities are available to researchers, reviewers and review teams who are motivated to explore novel methods for translating knowledge and communicate it to multiple audiences.

Abbreviation

CEE: Collaboration for Environmental Evidence

Authors' contributions

RW conceived the idea for the manuscript and assembled the team of co-authors. AS and KA drafted and revised the manuscript. RW, KA and AS commented on and improved the draft manuscript. All authors read and approved the final manuscript.

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About the Special Series Editors

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About the Stakeholder Engagement Methods Group

The Stakeholder Engagement Methods Group is an open group of experts and interested individuals who provide a platform for discussions of best practice in stakeholder engagement through the conduct of evidence syntheses. The group also acts as a forum for sharing experiences and knowledge on key topics, such as conflict resolution and communication. The Methods Group was founded by Neal Haddaway and a group of co-authors of a methods manuscript outlining a framework for stakeholder engagement published in Environmental Evidence in 2017 (now Chapter 1 of this book). To learn more about the Group, visit its page on the CEE website (www.environmentalevidence.org).

About the Collaboration for Environmental Evidence (CEE)

CEE is an open community of stakeholders working towards a sustainable global environment and the conservation of biodiversity. CEE seeks to promote and deliver evidence syntheses on issues of greatest concern to environmental policy and practice as a public service. CEE is a not-for-profit and relies on the dedication and enthusiasm of scientists, policy formers, environmental managers and other stakeholders to provide a reliable source of evidence to continuously improve the effectiveness of our actions.

About the Mistra Council for Evidence-Based Environmental Management (EviEM)

Mistra EviEM's goal is for environmental management to be placed on a scientific foundation. Through systematic reviews of various environmental issues, EviEM aims to improve the basis for decisions in Swedish environmental policy. EviEM has conducted a total of 17 systematic reviews and maps on a range of topics, from the impacts of reindeer grazing on mountain vegetation to the impact of roadside management on biodiversity.

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MISTRA EviEM
EVIDENCE-BASED ENVIRONMENTAL MANAGEMENT

Stakeholder engagement is an integral part of all systematic reviews to some degree. However, there has been little discussion of this important process in systematic review guidance to date, particularly in the field of environmental management and conservation. This series of commentary articles discusses various aspects of engaging with stakeholders: describing the ranges of methods available, outlining experiences from various systematic review experts, and discussing issues relating to conflict, the benefits of training, engaging directly with decision-makers, and communicating review results.

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