

RESEARCH ARTICLE



Guiding carbon farming using interdisciplinary mixed methods mapping

Beth F. T. Brockett¹ | Alison L. Browne² | Andy Beanland³ | Mike G. Whitfield¹ | Nigel Watson¹ | George Alan Blackburn¹ | Richard D. Bardgett⁴

¹Lancaster Environment Centre, Lancaster University, Lancaster, UK

²Geography/Sustainable Consumption Institute, University of Manchester, Manchester, UK

³World Business Council for Sustainable Development, Geneva, Switzerland

⁴School of Earth and Environmental Sciences, The University of Manchester, Manchester, UK

Correspondence

Beth F. T. Brockett, Natural England, Mail Hub, County Hall, Spetchley Rd, Worcester, WR5 2NP, UK.
Email: bethftbrockett@gmail.com

Funding information

NERC/Living with Environmental Change PhD Studentship, Grant/Award Number: NE/J500161/1

Handling Editor: Yvonne Buckley

Abstract

1. In recognition of the need to address complex environmental problems, some ecological studies have adopted social research methods to better understand the complexity of social-ecological systems management. The overwhelming majority of these studies stop short of fully embracing qualitative methodologies.
2. The lack of integrative social and natural science data for a topic such as soil carbon farming is problematic as theoretical carbon sequestration opportunities identified through soil mapping and process-based models can fail to deliver the sequestration levels promised when introduced on-the-ground. Such mapping needs to account for the human factors involved in delivering increased soil carbon on-farm.
3. Here, we develop a mixed methods mapping approach to explore the potential for increasing soil carbon stocks on upland farms in the UK. Our approach considers ecological and social complexity through application of soil science, ecology, participant observation, interviews and a focus group.
4. Our maps revealed landscapes that are full of carbon farming opportunity, but contain previously hidden barriers to the delivery of increased soil carbon. For example, they revealed that carbon farming can be considered by farmers to work in opposition to perceived 'good farming' practices and be correlated with increased incidents of livestock disease. We also discovered that the use of maps in research can be problematic as they can close down discussion and exclude local representation of an area.
5. Trialling an interdisciplinary mixed methods approach produced new, deeper and more richly-textured understandings about how soil carbon management is produced socially as well as ecologically on upland livestock farms. Our findings have potential to improve the success of future carbon farming initiatives by incorporating farmer knowledge and social drivers of implementation.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2019 The Authors. *People and Nature* published by John Wiley & Sons Ltd on behalf of British Ecological Society

Interdisciplinary peer review workshop

For the attached abstract three reviews were received. Read the review assigned to you and consider the following (choose the questions most interesting to you):

- What do you think the disciplinary background of the reviewer is broadly? Or do you think they have an interdisciplinary perspective?
 - How does the style of the review differ from those of a standard ecology paper?
 - What are the key points you would pick out if you were the editor of this paper?
 - How would you rate the review in terms of constructiveness, thoroughness, conciseness and objectivity?
-

Reviewer 1

This is an interesting article that contributes valuable insights into interdisciplinary mixed methods approach. I cannot speak to the soil carbon science but I do have some comments listed below. Overall my suggestions relate to the structure and emphasis of the paper. There are bits I wanted to hear more about and parts that need to be more clearly written and explained.

The first thought that struck me reading the introduction (and reinforced by the bibliography) is that the authors are not particularly familiar with the fields of political ecology or science and technology studies (there are a handful of citations), both of which are key to the questions and concerns of the authors. Very broadly, both these fields (which have developed since the 1980s/90s) challenge familiar distinctions between nature/society that often extends to challenging the forms of knowledge, expertise and power that reproduce those distinctions. A consequence of this is that many scholars in these fields have been working across natural and social scientific spheres. At the end of the comments are some references that might be helpful to the authors – particularly the Lane *et al* and Landstrom *et al*.

The paper mentions the effect that past experience of agri-environmental schemes may have on farmer attitudes to 'carbon farming'. They also mention in passing the financial concerns that farmers may have. These policy and economic factors are the bread and butter of political ecology scholars who aim to situate local contexts (like the three case studies studied in this paper) within a broader political and economic one i.e. to better understand the complex conditions, legacies and dynamics that shape individual behavior. While this isn't the focus of this paper it would be good to hear a little more about it – like specific details of how agri-environmental schemes have failed farmers in the past, and why this is significant for projects in the future.

I would also like to hear more explanation of what the authors mean when they talk (in the methods section) of epistemology and 'different ways of knowing'. This is a huge topic (particularly for social scientists) and as it is currently presented here too vague. For example, the authors make a point of highlighting that the lead researcher of the project is both a natural and a social science researcher. Does this mean he has training in both? Does it mean that he examines things using tools and methods from both disciplines? Does it mean he self-identifies as this? In other words, what does it mean to be a natural and a social science researcher – is it a sensibility, a question of training, or the kinds of methods that are applied? I think the articles cited below by Lane *et al* and Landstrom *et al* will be helpful in this regard – both co-written by physical and human geographers.

Some of the distinctions between natural and social science come out in the discussion points at the end – around the tensions that arise (rather than compatibility – which is very important). There is an implicit suggestion that what makes natural science ‘scientific’ is the quest for universal findings/methods, whereas what this project demonstrates are the more complex, situated values, experiences and environments that exist. If this is what the authors think then perhaps they could foreground it in the beginning. Similarly, the authors write of the ‘hidden’ knowledge of the farmers that is elicited through walking (a very valuable and interesting insight). But how is this knowledge ‘non-scientific’? Is it not just that the farmers use different language, different references? It is still based on empirical findings and experimentation. I would like the authors to make clearer what they understand by ‘natural science’, ‘social science’ and ‘local knowledge’. What in the end distinguishes them, if anything?

I pose these questions because I feel there are assumptions still lingering in the uses of these terms that are not made explicit (which counters the ‘reflexive’ commitment that they set out to use), and it is these very assumptions that (in my experience) tend to block productive engagement between researchers from different backgrounds/disciplines. For example, the authors make a point of writing that farmers’ knowledge cannot be accessed by ‘quantitative’

methods. Is this true though? Surely farmers (the authors even say as much) use quantitative methods all the time. What the authors mean is that some of the ways they know their land and farm is through situated, responsive forms of knowing that cannot be aggregated or generalized. But do not all researchers rely on these kinds of ways of knowing to produce their findings? Isn’t there a lot of ad hoc, responsive skill involved in applying for funding, negotiating universities, carrying out research, writing up papers, and so on. Not to mention the values and emotions that are involved in any research. I don’t want to seem deliberately obtuse or provocative but simply push back against some of the lingering assumptions in this article about the assumed differences between different forms of knowing. In actual fact, it may be how these assumed differences are reproduced that is the problem to be interrogated (and there is much on this in the STS literature if the authors want to pursue it). This is touched on in the very interesting discussion of the role of maps in farm management projects – the way they operate to exclude some knowledge through claims to objectivity, whereas what is clear (from the authors findings) is that maps are always partial representations, reflecting a whole range of often hidden assumptions.

Finally, I don’t think the article is very clearly written or easily understandable. This appears to be because the project was so rich and the methods used so mixed and varied – which is great. It may also be because the article is written by a number of authors, and coming from different disciplinary backgrounds. At times it read like a list of things that were done over the course of the project which may have made sense in that context but when written down on paper lose some of that comprehension. Each of the methods stages needs to be more clearly explained. Currently, there is less effort to describe what actually happened/was done, and more effort spent explaining what, for example, a semi-structured interview is, or how interviews were recorded. This reads more like a PhD methods chapter (which might usually be fine but not for an article that focuses on methodology). I would have preferred to hear about how many people were interviewed, where, what questions they were asked, how forthcoming they were, what was interesting about the interviews, how long did they last etc. Similarly, stage two involved 7 months of being on-farm (a quasi-ethnography) but there is very little detail of what this involved, what was seen, learnt – this only comes out in small snippets in the discussion (e.g. around the sensory experience of one farmer

who values the improved biodiversity through the sounds it brings). I was particularly interested in stage 3 (maps) but again would have liked to have read more about what the spatial transcript map involved (the image is not helpful at all), and the 'mixed methods maps' – e.g. how did they decide what qualitative data to layer on to the quantitative data map? Or, line 264, what does: 'using the inbuilt software query tool and through 'playing around' with the structure of GIS as a tool and a concept' mean (a citation is not enough to explain)?

Reviewer 2

(Note that we have not included the annotated PDF that was submitted with this review)

This is a very interesting paper that described a study using mixed methodologies = social science methods (interviews, walk-throughs, observation) and natural science methods (modelling, soil surveys). I enjoyed reading the paper, which is worthy of publication.

I apologise to the authors for the delay in returning this review. I read your paper several weeks ago, but have not found the time to write my comments up electronically. Instead, I am attaching an annotated pdf that contains my comments. Most of these comments are suggestions for clarifications and some English errors.

My main comments on the paper are:

1) Your claims in this paper need to be toned down somewhat. I found your statement of contribution and uniqueness a bit overdone. For example, it is not that unusual for a researcher to be both a social and natural scientist—at least not in my circles (environmental economics). As another example, in your conclusions you state that "Our findings would not have been obtained by different disciplinary researchers working in parallel on this topic". But you don't know that. There is no way of telling whether different disciplinary researchers working in parallel on this topic could have achieve a similar result—provided that they work well in a team. I would avoid opinion statements like this in the paper.

2) It is not entirely clear from the introduction what type of research is going to be presented in the paper. When I read it, it seemed that you were going to present a review paper, rather than present a study you undertook on farms.

In the final conclusion, you refer to an 'identified research-implementation gap'. However, the introduction does not identify such a gap. There is no mention anywhere in the paper of a research-implementation gap. The only gap mentioned (in line 77) is about evidence that interdisciplinary methods are beneficial, but implementation of interdisciplinary approaches is lacking. Not the same as research-implementation gap; which is about research being used by decision makers on the ground.

3) There are some paragraphs that are poorly written and that are lacking clarity. I've noted these in the attachment. Of particular concern is the Methodology section. It is not entirely clear what you did at what points in time. The first part (stage one) is the least clear. It may work better to just write the methods as one section, without the three 'stages'. Can you describe more clearly what social

science methods you used, what natural science methods you used, and how they were integrated? Also poorly written is the last paragraph of the Results section (lines 393-400). It is not clear to me what you are trying to convey here.

4) You provide a lot of additional information that is not needed in this paper – mostly definitions of concepts that are ill-positioned in the text. For example a definition of focus groups or an aside about coding data. Please reconsider where such definitions should be located in the text. Ideally, such sentences are removed and replaced with a reference to relevant literature where the interested reader can find more information.

All in all, I found this a very interesting study to read. Although I integrate social science and natural science methods in my research myself, I still learned something new from your paper. Thank you for submitting to this new journal People and Nature.

Reviewer 3

Overview

The introduction provides background into the benefits of using an interdisciplinary approach by focusing on the use of qualitative data to inform quantitative sampling methods. The detail provided in this regard is good and provides a clear case for the need for mixed method approaches.

The subsequent sections give a good insight into the complexities of the project and the overall themes which immerse in the discussion are very interesting. Primarily the suggested use of location based interviewing methods to promote/stimulate discussion which can be captured, recorded and analysed in a systematic way.

The information provided on the soil carbon sampling techniques are well explained and clear, relying on the methods from previously published works for the detail required for replication. The approach of 'participating in informal and on-going conversations' to inform subsequent surveying and analysis is commended. There is an opportunity to repeat the semi-structured interview process to see if the knowledge imparted through this iterative process has influenced the themes which emerged from the qualitative assessment at the start of the process.

Overall the paper focuses on the need to incorporate social science data into quantitative methods to inform survey designs and improve model accuracy by harnessing existing knowledge.

Major Concerns

1. Concerns with the broader understanding of social science concepts.

The summary is concisely written, providing a clear overview of the rationale and scope of work. However, details of the approach taken are sparse and the final point in the summary identifies a non-specific link to the broader application of the work which is lacking in clarity.

There is no information provided on the presence/absence of mixed methods studies in relation to soil carbon farming previously undertaken within the literature.

The authors' interpretation of the Drury et. al. (2011) paper entitled 'less is more' states that 'utilising only data that fits a quantitative study design may result in the loss of a rich seam which has the potential to provide internal validity to the study'. This statement indicates that a quantitative study cannot have internal validity without a qualitative assessment; however, the Drury et. al. (2011) paper explicitly states that qualitative assessments can 'strengthen the internal validity'. This

paper also emphasises the importance of local, regional, national and even international data resources to inform the 'rich seam' detailed in introduction. This theme is also present in the Hicks et. al. (2016) paper which identifies the bias towards local knowledge and the need to understand broader policies and objectives which inform local processes. This concept is absent from the introduction text and is a key theme/feature of the literature within the reference list.

Lines 77 and 78 state that the:

'overarching goal was to address the evidence and implementation gap that exists, whereby the importance of qualitative and interdisciplinary mixed methods is increasingly recognised, but rarely integrated'

The text identified the importance of mixed methods approaches within ecology; however, there is no information provided which element of the study addresses the 'implementation gap'. The literature suggests that implementation gaps are often present due to higher level processes which result in the allocation of incentive schemes etc, and the broadening of knowledge bases and 'environmental literacy'. These concepts are not presented in the introduction which focuses on the evidence and need for mixed methods approaches. Information is provided within the methods in relation to the need for 'iterative flows of information as essential to bridging the knowing doing gap', this text is more suited to the introduction and contributes to explaining the 'overarching goal' of the study.

Overall, there is doubt as to the understanding and broader knowledge of the author in relation to the literature presented.

2. Structural issues with the content and ambiguity of method in relation to the Social Science elements of the project; not repeatable

The methods pre-ample details the complexities of data acquisition and states that 'social data vary with time'; however, this is a very broad statement which does not specifically link to any specific type of 'social data'. This text may also be more suited to the introduction narrative in relation to the requirement for a detailed understanding of the knowledge gaps and interdisciplinary expertise. The methods line 108 and 109 details the experience and expertise of one of the research team; however, this does not validate the methods. There is no information provided in the text to indicate that team structure and the division of expertise and skills within the interdisciplinary team have any influence on the overall effectiveness of the team or on the results/outcome of any study.

The methods are divided into three stages:

- Using Mixed Methods in Research Design
- Parallel, Integrated Data Collection
- Creation and Analysis of Mixed Methods Maps

The titles of these sections are misleading and do not provide insight into their content of scope of works undertaken.

The semi-structured interviews were only undertaken with the 3 farmers engaged with the project, thus showing a bias for local knowledge and processes. This does not account for local and regional processes relating to agri-environmental funding schemes or policy making which may influence the local experience. Despite the introduction introducing the importance of 'power relationships' in this regard. Semi-structured interviews and subsequent analysis is a method to unveil 'themes' within the data which is not explained fully within the text, and at no point are the emerging themes reported. There was no analysis undertaken, or information provided, relating to the qualitative data and if each of the three participant farmers were in agreement amongst themselves in relation to the emerging themes from the analysis. Was there a common understanding in relation to carbon

farming? Were there commonalities between the farmers in relation to the information gleaned from the semi-structured interviews? Are the data site specific? What constituted a 'theme', was it something which was repeated within an interview with an individual or between individuals? This detail needs to be addressed.

The data from these sources (interviews) were used to inform broader workshops which were collated and interpreted to broaden the data beyond the site. However, this is not detailed until half way through Stage 2 of the methods. There is no detail provided on the nature or scope of the workshops and the disjointed nature of the method descriptions makes this process difficult to follow or connect. The section relating to qualitative data in Stage 2, line 205 to 216, should be moved to stage one where it is more appropriate. In addition, the emergent themes that were used to structure the workshops need to be explicitly stated.

The use of automated analysis tools removes the ability to garner the 'rich seam' data which was expressed to be vital in the introduction. This is a controversial analysis technique and the settings of automated software packages are of vital importance when assessing their validity; no detail was provided in relation to methods used to calibrate the software used.

Minor Concerns

A. Model pruning and validation

Cross validation is a statistical method used for pruning data and refining models; however, it is well established that model validity should be undertaken using independent data. Cross validation processes are known to overfit data, overestimate model performance and have numerous confounding errors associated with them.

There was no analysis undertaken to compare the performance of models which used 'qualitative data with attention to place' and those without. Therefore, there is no evidence in the data that location specific qualitative data positively or negatively influences model accuracy.

Suggested Changes

Review the broader literature in relation to the concerns expressed and amend the text accordingly. Restructure the methods to follow a logical flow detailing processes which were followed. The methods should contain sufficient detail to ensure they are replicable.

Clarify the thematic analysis process used to analyse the semi-structured interviews. How were the emerging themes coded? Were the themes identified within the data of an individual subject or were only between subject themes used? How were these used to form the workshops? What was the structure of the workshops? What were the emerging themes from the workshops? How did these compare to the initial themes? All of these questions should be answered to provide clarity in the approach and results.

For the quantitative data, it is suggested that independent data be used to validate model accuracy.
