Title: Enhancing sustainability science through qualitative data sharing

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Title: Enhancing sustainability science through qualitative data sharing

Abstract

Synthesizing diverse data sources and types of evidence can help to better conceptualize, investigate, and address increasingly complex socio-environmental problems. However, qualitative data sharing for reuse remains uncommon in sustainability science when compared to quantitative data. We make the case that qualitative data is more important to sustainability science than is often thought, and argue that there are practical pathways toward facilitating and realizing the benefits from sharing and reusing qualitative data. Qualitative data present untapped opportunities for socio-environmental and sustainability research. Such opportunities are hindered by practical, ethical, and epistemological challenges. To address these challenges and accelerate qualitative data sharing, we outline enabling conditions and suggest actions for researchers, institutions, funders, data repository managers, and publishers.

Keywords

data archiving; data sharing; data reuse; secondary analysis; sustainability science; synthesis; qualitative data

Introduction

Contemporary socio-environmental challenges, including biological conservation, climate change adaptation, and natural resource management, require solutions that simultaneously account for diverse actors, institutions, and environmental processes. The task for decision makers and researchers to study these challenges and offer sustainable solutions is further complicated by uncertain drivers of change, complex feedback loops (both social and environmental), and interactions across broad geographies and timespans.

Socio-environmental synthesis is emerging as a specific research approach that contributes to broader sustainability policy and practice goals by combining disparate disciplines to reuse data in innovative ways (see Table 1: Glossary; Figure 1). Socio-environmental synthesis is characterized by transdisciplinary inquiry that helps identify patterns across time or geographical scales (Palmer *et al.* 2005) (Pullin *et al*. 2013), identify emerging socio-environmental relationships (Hampton *et al*. 2013), and provide the necessary evidence to develop and implement policy (Palmer 2012, Romulo *et al.* 2018, Siegel *et al*. 2019).

[INSERT TABLE 1 HERE]

Socio-environmental synthesis has accomplished much in terms of both fundamental scientific discoveries and actionable, policy-oriented results through relying primarily on existing quantitative data (Rodrigo *et al*. 2013; Palmer *et al*. 2016). These data are readily accessed, downloaded, and re-interpreted, and are often made available for reuse by the same entities that fund their collection (national government science agencies, international organizations, or grant-funded researchers). However, the growing body of socio-environmental synthesis research can contribute even more by expanding to include qualitative data (see Box 1 for definitions of types of data).

Qualitative data present significant opportunities for enhancing socio-environmental synthesis research (Hicks et al. 2016; Ratajczyk *et al*. 2016; Bennett *et al*., 2017; Moon *et al.* 2019). For example, the exhaustive study *Voices of the Poor* (World Bank 2003) drew on qualitative data sources to redefine the idea of "ill-being" as multidimensional and recognize

that income poverty is only one aspect of deprivation. Similarly, qualitative data can advance synthetic approaches to understanding the multidimensionality of socio-environmental systems, specifically when it comes to accounting for the lived experiences, needs, values, and perspectives of individuals, groups, and even nations often left out of scientific and policy discourses. Data synthesis and therefore reuse of all data types is especially important in regions with fewer resources to produce primary data.

[INSERT TEXT BOX 1]

Despite its great potential, there are barriers to incorporating qualitative data into socio-environmental synthesis, including ethical commitments (e.g., privacy, anonymity, data sovereignty; Kukutai & Taylor 2016), epistemological differences surrounding data collection, sharing, and reuse (Moon *et al*. 2016; Cox 2015; Moon and Blackman 2014), and collective action issues associated with building knowledge commons (i.e., intellectual and cultural resources such as data repositories; Frischmann et al. 2014; Hess et al. 2011). Such obstacles can considerably slow or derail synthesis research, or deter researchers from sharing and re-using qualitative data. Despite efforts to overcome these barriers, (e.g., Karcher *et al*. 2016; Bishop & Kuula-Lummi 2017) this rich and diverse source of data (see Box 1) remains largely absent from socio-environmental synthesis research (Rodrigo *et al*. 2013; Palmer *et al*. 2016).

Here, we provide an agenda for progress that: (1) highlights the benefits to sustainability science, policy, and practice from adding qualitative data to the socio-environmental synthesis evidence base; (2) addresses the challenges associated with qualitative data sharing for reuse; and (3) outlines actionable steps for researchers, institutions, funders, data repository managers, and publishers to overcome obstacles and maximize corresponding benefits for sustainability.

Benefits of qualitative data sharing for re-use

Qualitative data reuse facilitates the inclusion of important, but less quantifiable, concepts (e.g., governance, aspirations), relationships (e.g., power structures, place attachment), and indicators (e.g., well-being, trust) into socio-environmental research that would otherwise struggle to account for human perceptions, values, or motivations (Hicks *et al*., 2016; Moon *et al*. 2016; Ratajczyk et al. 2016; Bennett *et al*., 2017). Including qualitative data in complex system analyses has the potential to lead to more relevant and actionable outcomes to address sustainability challenges by including a diversity of necessary information about a given setting or system, and by adding social, cultural, and historical context to help develop or monitor the outcomes of a proposed solution (Moon *et al.* 2019, Bennett, 2019). Below, we highlight and demonstrate benefits to including qualitative data for science, policy, and practice oriented toward addressing sustainability challenges. While articulating and organizing the benefits around these three domains, we note that they are by no means mutually exclusive.

Informing Science

In socio-environmental synthesis research, qualitative data characterizing both natural and social systems, as well as their interactions, can expand understanding of variability over time and space (Osmond *et al*. 2004; Nightingale 2003). While quantitative analyses can identify statistical patterns and relationships between drivers and outcomes, qualitative data can examine the underlying reasons for those relationships, using rich descriptions and analysis

of patterns in context (Riedlinger & Berkes 2001; Nightingale 2003; Brubaker *et al*. 2013). In addition, qualitative data is often better suited to measuring multidimensional concepts like equity and efficacy, which are increasingly important in both sustainability policy and practice. Increased sharing of data that describes these concepts can also facilitate new types of triangulation, internal validity, and estimations of accuracy within and across contexts (Cook & Hockings 2011; Fielding 2012; Dawson *et al*. 2017).

In the case of extreme environmental events, for example, interviews conducted repeatedly with the same affected population can illuminate shifting attitudes or perceptions of vulnerability and adaptation associated with displacement (Peek *et al*. 2014). Digitized historical photographs are also a valuable qualitative data source for tracking environmental change through time in non-numerical ways, as shown by McClenachan's (2009) work documenting the loss of large recreationally caught trophy fish over a 50-year period. When researchers have access to qualitative data derived from many different cases they can: (i) conduct novel cross-case and multi-level comparisons of patterns and contexts; (ii) analyze possible reasons why variance is observed in socio-environmental systems when quantitative measures indicate no causation between drivers and outcomes; and (iii) increase the likelihood of generalizability beyond what is often feasible for any single researcher or research team (Poteete & Ostrom 2005). Comparing cases allows identification of consistent patterns in relationships between human decision-making and observed environmental change (Magliocca et al. 2018) and can both confirm and challenge supposedly universal theories (Poteete & Ostrom 2005). This analytical approach can help build theory (Janssen & Ostrom 2006; Rudel 2008), as well as highlight the role of context (e.g., social, historical, political) and how variation in context affects socio-environmental outcomes (Cox 2014, Moon *et al.* 2019).

Informing Policy

There have been repeated calls for increasing the evidence base of effective management and intervention strategies to address complex socio-environmental problems (e.g., Cook & Hockings 2011; Pullin *et al*. 2013; Charnley *et al*. 2017; Game et al. 2018). However, Bennett (2016) suggests that calls for evidence-based conservation currently default to quantitative methods and data, and would benefit from greater engagement with a plurality of methods to "provide a more complete picture on which to base management decisions" (p. 8). Incorporating qualitative data into socio-environmental synthesis research both broadens the evidence base and creates the possibility of translating results for sustainability policy as well as contextualizing results for application in different contexts.. Expanding analyses and recommendations for impact using qualitative data can also increase the reliability of patterns and relationships to inform sustainability policies and governance (Poteete & Ostrom 2005; Sutherland *et al*. 2013; Game *et al.* 2018). Similarly, contextualizing drivers of change within socio-environmental systems at scales appropriate to both governance and ecosystem function is an important step for translating science into actionable sustainability policy (Wyborn & Bixler 2013).

As sustainability policy is increasingly entering the purview of governments and international bodies at all levels, from local to global, learning from on-the-ground cases of success and failure is indispensable (Cash e*t al*. 2006; Janssen & Ostrom 2006). In a recent study of large marine protected areas, for example, qualitative data on management processes proved to be more relevant than quantitative metrics when investigating how or why certain ecological, social, and economic outcomes were realized in some locations but not others (Ban *et al*. 2017). Qualitative data can also be used to refine generalized analyses and contextualize

assumptions and patterns observed at broader ecosystem processes and governance levels (Riedlinger & Berkes 2001). For example, qualitative data can inform the development of surveys and models that seek to understand human behavior and decision-making within specific contexts or under different policy scenarios as a way to predict the impacts of future changes (Janssen & Ostrom 2006; Lindkvist et al. 2017). Qualitative data analysis can also provide localized insights on why particular drivers affect outcomes differently between cases, ultimately to inform sustainability policies that are better adapted to socio-environmental contexts. For example, Gill *et al*. (2017) drew on qualitative data to understand the political and management context of marine-protected areas, to identify characteristics of the social context that conditioned the success of protection policies, and to highlight the linkages between policy context and implementation actions and outcomes.

Informing Practice

Sustainability practitioners and applied researchers are beginning to incorporate qualitative data gathering into their approaches to increase both the legitimacy and efficacy of sustainability activities. Because it can contribute diverse worldviews to an evidence base, qualitative data plays a particularly important role in data-poor nations, communities, and environments, and in documenting and translating traditional and local ecological knowledge (Fernández-Llamazares & Cabeza 2017; Biedenweg *et al*. 2018). Many sustainability practitioners recognize the value that qualitative data provides to improving equity and inclusion in sustainability practices because it brings local voices and experiences into the conversation. Sharing and reusing all types of data, when appropriate, can ward against research participant fatigue and reduce the burden placed on communities that are underrepresented in science and policy decision-making by repeatedly asking for their perceptions and experiences, and ensure that sustainability assessments build on the existing diverse knowledge base in a given place (Hartter *et al*. 2013; Clark 2008). Making qualitative data available for future reuse also increases returns on investment for funders and researchers by generating new information without large expenditures of time and money.

Among sustainability practitioners, there has been a move toward nuanced assessments of interactions between future environmental change and distinct localized responses to these changes. Planning processes and assessments that draw on qualitative data, such as focus group discussions about local environmental history or the minutes from public meetings (e.g., Biedenweg et al. 2018), can better represent the experiences and perspectives of local stakeholders than standardized methods that utilize only discrete quantitative measures of actions and outcomes (Drury *et al*. 2011; Bennett 2016). As a result, sustainability planning processes that draw on qualitative methods often lead to actionable and successful outcomes on the ground (Seppelt *et al*. 2011; Bennett 2016). Hicks *et al*. (2016) draw attention to the value of blending qualitative and quantitative data in socio-environmental assessments of multidimensional human wellbeing. Tengö *et al*. (2014) go further, calling not just for increasing the evidence base to include qualitative methods, but widening it to incorporate diverse knowledge systems (systems of agents, practices, and institutions that organize the production, transfer, and use of knowledge), including both those systems rooted in Western science and those based on indigenous or intersectional identities.

Challenges of qualitative data sharing for reuse

Although open science and data accessibility (via data repositories and metadata standards) are increasingly expected in many scientific fields, there are many challenges that must be addressed, regardless of data type. In this section, we highlight three challenge areas —

241 epistemological, ethical, and practical – associated with data sharing and associated sub-
242 processes (e.g., archiving, accessing). Table 2 summarizes these challenges, and in the
243 following subsections we highlight and elaborate upon the specific needs associated with
244 qualitative data within each challenge area.
245
246 [INSERT TABLE 2 HERE]
247
248 *Epistemological*
249 Epistemology (how we know what we know) focuses on the process through which
250 knowledge is generated, and the "relationship between the knower and the known" (Maxwell
251 2011: 10). Nuances within epistemological traditions influence whether and how qualitative
252 data might be shared and reused (e.g., Denzin & Lincoln 2008; Bryman 1984) (see Box 2).
253 The epistemology a researcher brings to a project influences everything from research design
254 to the collection, analysis, and interpretation of data (for further discussion, see Hammersley
255 1997; Moon *et al.* 2019). Epistemology also affects what one counts as "data", and influences
256 a researcher's view regarding data sharing for reuse. For example, taking the point of view of
257 'researcher as instrument,' efforts to analyze and re-interpret shared qualitative data for
258 synthesis purposes would be either as involved as the initial research process itself, or would
259 be otherwise unreproducible and invalid (Denzin & Lincoln 2008). Accordingly, we
260 acknowledge the potential incommensurability of data derived through and from different
261 epistemological frames. However, acknowledging the different origins of diverse data
262 sources does not preclude the possibility to use such data in tandem during analysis - what
263 Nightingale (2016) refers to as "productive tensions." For example, data sharing for reuse
264 could lead to qualitative data being integrated with quantitative data or even other qualitative
265 data into some synthetic or comprehensive picture of a social-ecological system (Mahajan et
266 al, 2019). Or, qualitative data could be used in synthesis research to parameterize, interpret,
267 or validate findings from analysis of other data sources.
268
269 [INSERT TEXT BOX 2]
270
271 As described in Box 2, not all epistemological orientations preclude data sharing for reuse.
272 Researchers with a generally positivist epistemological orientation who largely use
273 quantitative methods might gather and analyze qualitative data for the purposes of
274 triangulation or to increase explanatory power, and could feel comfortable sharing that
275 qualitative data for others to do the same. And researchers who largely work from a
276 constructivist epistemological starting point might feel comfortable sharing parts of their
277 qualitative data that describe empirical phenomena (for example, field notes describing what
278 happened or who was at an event might be shared, but not explanations from individuals
279 about the meaning of the event; Reyes 2018). There are still important questions to address,
280 however, before attempting to reuse data outside of its original epistemological frame (Asher
281 and Jahnke 2013). To a researcher with a constructivist epistemology, for example, the
282 interpretation of data and meaning is contingent on context, and yet reflective of patterns that
283 can be documented and categorized independent of the original researcher (for empirical
284 examples, see Broom et al. 2009). Provided there is sufficient background and metadata
285 (descriptive information about how data was generated and what is meant by measurement
286 categories) made available, from this perspective it is possible to share and reuse qualitative
287 data without compromising the complex empirical realities documented from human subjects
288 (c.f. Becker 1996; Barnett-Page & Thomas 2009).
289

The richness and descriptive complexity that makes qualitative data an important part of the evidence base for sustainability science also poses potential challenges to including qualitative data in synthesis research with an eye toward generalizable or transferable research findings (Goodwin & Horowitz 2002; Cook & Hockings 2011). Similar limitations have been noted about field observations in ecology (Osmond *et al*. 2004), and efforts at data sharing and synthesis in the ecological sciences have worked to address the limitations of small *n* studies by integrating less processed data from many individual studies (Hampton *et al*. 2013). However, with qualitative data reuse there is an added epistemological complexity, since many researchers who gather primary qualitative data do not see generalizability as a goal or a possibility. Critical epistemologies like those that underpin the concept of situated knowledge, for example, start from an understanding of knowledge and evidence that is partial and unique to a given individual, context, and interpretation, and are thus unlikely to be comfortable sharing qualitative data with an eye toward synthesis and generalized analysis (Hartsock 2002). Other researchers who gather qualitative data, like those with a constructivist epistemological stance, might be comfortable sharing raw or less processed qualitative data that includes adequate metadata to ensure that the particularities of the data gathering context are included in synthesis analysis.

Ethical

Ethical concerns, while potentially addressed through careful data gathering processes and management approaches, must receive special consideration as challenges to and important limitations on qualitative data sharing for reuse (Haraway 2001; Bishop 2009; Biddle and Schafft 2015). Ethical challenges are not limited to the sharing and reuse of qualitative data, and are common across social science and human subjects research and practice approaches. However, the extent of ethical decision-making and complexity of constraints, which range from protecting participants' rights to one's responsibilities to the scholarly community and the public good (Bishop 2009; Lupia and Elman 2014; DuBois et al. 2017), set qualitative data apart in this regard. Qualitative data sharing for reuse thus poses particular ethical challenges to researchers.

Ethical concerns associated with informed consent, confidentiality, and anonymity are well documented and are largely overseen by Institutional Review Boards (IRBs) and scientific integrity bodies (Bishop 2009). In some instances (associated with consent and/or risk of harm), researchers need to remove all identifying information from any data or analysis shared beyond approved research teams. In practice, this redactive work takes time and judgement calls must be made about what is considered identifying, personal, or otherwise sensitive information. Furthermore, it can have a disproportionately limiting impact for socio-environmental synthesis projects exploring interactions between people and their environments, and for studies conducted at fine spatial scales (Hartter *et al*. 2013). By potentially diluting socio-environmental dynamics within a given space, unnuanced privacy requirements may limit the contributions that such rich sources of information can make to the public good.

Informed consent processes, in which researchers make clear to research subjects how the information being gathered will be used, stored, and shared, can also prevent researchers from sharing qualitative data after a project is complete. Although many IRBs now offer language and guidance about how to include information about data sharing in informed consent statements, researchers are often not aware of this possibility at the study outset. Perhaps even more common, data from past projects is of renewed interest for sharing, but was gathered before such an option was common in informed consent statements. These are

often called legacy projects and an increasing number of IRBs have policies to guide data sharing in these cases. Even when consent is granted and the sharing and reuse of human subjects data is possible, the thorniest ethical concerns arise in the reuse process, including a lack of representation of and engagement with original research participants in synthesis work (Bishop 2009). It is overly simplistic to assume that research subjects would not want their data to be reused by others, especially if they care about the research topic at hand and avoiding research fatigue (Turner 2016). At the same time, research participants, the public, and the research community as a whole must trust that individuals engaged in secondary data use and analysis will be as transparent and respectful as those who gathered the data initially.

Such trust-building could and should include upholding promises of 'ethical openness' as described by the International Arctic Science Committee (IASC 2013). The Arctic research and practice community is leading the way in building ethically open data systems to enable knowledge sharing and data reuse when appropriate, including ELOKA[1] (Exchange for Local Observations and Knowledge of the Arctic), as a means for climate change stakeholders, practitioners, Indigenous Arctic residents, and researchers to learn from and build upon previous work and observations in the region. However, ethics of openness can be made vulnerable to desires to leverage an existing evidence base and discover something new, regardless of whether such a discovery is transparent, complete, or appropriate (c.f. Kapiszewski and Kirilova 2014; Lupia and Elman 2014).

Practical

The practical challenges associated with depositing and sharing any type of data are especially complicated for qualitative data, since there is a lack of both infrastructure and guidelines for appropriate content to facilitate reuse. Qualitative researchers, as well as non-researcher practitioners interested in sharing information generated through on-the-ground projects, have fewer options than quantitative researchers for repositories that can support the diversity of data types, access restrictions, and metadata needs of qualitative and multi-modal data (Corti 2012; Bishop and Kuula-Lummi 2017). Currently, data sharing continues to take many forms, from depositing in well-known managed repositories to authors' notes suggesting data is available "on request," to supplemental materials in a journal article. This wide range of approaches has some potential to deliver the benefits outlined above. However, sharing qualitative data in opaque, disjointed, or overly burdensome ways (or not at all), undermines the goals of data sharing and ultimately may dissuade researchers from using synthesis approaches.

Though repositories, open data communities, and support for research data archiving are growing across many types of institutions, the long-term financial resources necessary to maintain the infrastructure remain difficult to secure. In addition, many data repositories and data management infrastructures that do support open data access do not have adequate metadata standards to ensure the appropriate and accurate reuse of qualitative data in future synthesis research (Hoyle et al. 2013). New guidelines and processes have begun to address idiosyncratic data sharing in an effort to improve the sharing–to–reuse pipeline. For example, the FAIR principles (Wilkinson et al. 2016) – that data must be Findable, Accessible, Interoperable, and Re-usable – are often taken as a starting point to address the challenges associated with any type of data access and reuse.

[1] https://eloka-arctic.org/about

Even if all of the above-mentioned challenges can be adequately addressed (and many are currently receiving a great deal of investment and attention), increasing qualitative data sharing is in the end a collective action problem. The commons (e.g., communal grazing pastures) and public goods are vulnerable to social dilemmas that produce surmountable barriers to collective action. However, in the case of the *knowledge* commons (e.g., sharing and archiving qualitative data and data sets,), the collective action challenges are different, as actors must work together not only to manage the resource effectively, but also to create it (Frischmann et al. 2014; Hess et al. 2011). The lack of defined boundaries makes it difficult to exclude users, which produces incentives to free-ride and decreases incentives to those who might otherwise contribute their data to the commons. As a result, the main goal of governance for the knowledge commons is not to prevent overuse and therefore depletion, but rather to encourage use of the resources (e.g. new analyses), additions of refinements to existing data and metadata (e.g. adding thematic codes to existing datasets), and contributions of new data, (e.g. uploading original datasets), which ultimately enhances the overall value of the commons (Schofield et al 2009). While knowledge commons include a broad array of resource types, many studies have focused on those developed to support research that contributes to the public good (Reichman & Uhlir 2003).

Enabling qualitative data sharing

Realizing the benefits of qualitative data sharing for reuse requires commitment, support, and coordination from an array of actors and institutions. Below, we offer a framework for qualitative data sharing that addresses some of the challenges outlined in Table 2 above by considering both data access and data processing levels. We then present an agenda for progress, drawing attention to clear and tangible actions for: i) *researchers*; ii) *research institutions*; iii) *funders*; iv) *data repositories*; and v) *journals and publishers* to accelerate qualitative data sharing for reuse. Intentionally broad, the agenda is designed with relevance for all disciplines, fields, and topics that already focus on the human-nature interface, or that wish to do so better with help from socio-environmental synthesis and qualitative insights. While the five actors and institutions are discussed below as discrete entities, it is important to note that they are part of a system, and that reforms in any one institution type will have implications for others (e.g., funder mandates may be in tension with IRB insistence on the protection of human subjects).

Framework for qualitative data access and processing levels

Open data, which is "made available without restriction, on a non-discriminatory basis, for no more than the cost of reproduction and distribution" (National Research Council 1995), represents a major component of contemporary data sharing. Data on human subjects research, however, often involves confidentiality agreements with participants, and many qualitative researchers take an epistemological approach that precludes non-contextual re-analysis or interpretation of data. Table 3 presents a framework (elaborated in Jones et al. 2018) for addressing some of the practical, ethical, and epistemological challenges associated with qualitative data sharing for reuse and as listed in Table 2.

[INSERT TABLE 3]

The framework in Table 3 combines data access and processing levels (inspired by earth systems science (e.g. Savtchenko et al. 2004)). Many data repositories offer access level controls to facilitate the sharing of sensitive data. For example, researchers who share sensitive or personal data might require that anyone who wishes to access and reuse that data

must have IRB clearance from their own institutions, as a way to ensure ethical reuse of the data. In addition to placing limits on how qualitative data can be accessed, the framework presented in Table 3 here (and elaborated in Jones et al. 2018) builds on the tradition from remote sensing of data processing levels. For qualitative data, these levels move from totally raw data to partially redacted to completely summarized research findings. In many cases, both secondary and primary qualitative data can be processed (redacted or summarized to eliminate sensitive or personal information) and shared with fewer restrictions, while still maintaining most of the content that could be of interest for future research questions. For some researchers with a constructive epistemological orientation, providing data at a 'higher' level of processing might mean including extensive metadata and thematic coding of a subset of data, rather than the raw interview transcripts, which could alleviate concerns about mis-interpretation based on a different positionality. Combining the two dimensions of access and processing expands the potential ways in which all actors within the qualitative data lifecycle have to address many of the specific challenges associated with sharing qualitative data for reuse.

Actions for researchers

For researchers generating and sharing qualitative data, there are clear steps that will increase the potential access and reuse by others. Before research begins, researchers must consider the potential ethical implications of reuse and include such considerations into the design and informed consent process, as well as in the development of a data management plan.[2] Early on, consideration should be given to the level of processing of data that will be shared and archived (e.g., raw vs aggregated or transformed data). A critical component of any data-sharing plan is metadata and documentation (Elman & Kapiszewski 2014). Researchers will also need to allocate the necessary resources (e.g., time, financial) and build this into their funding proposals and operating budgets to support data management and long-term archiving. Furthermore, they will need to identify options for data storage repositories (e.g., university, offsite repository) that are appropriate for qualitative data. Developing and articulating expectations for what constitutes appropriate behavior will encourage participation in the research commons. In turn it becomes easier to identify and hold people accountable for negative behaviors.

Sustainability science and qualitative researchers can learn from the many disciplines and communities of practice that have successfully established governance structures for research commons that adhere to agreed-upon ethical standards (Dedeurwaerdere 2010, Mishra et al. 2016, Contreras et al. 2016). For example, those creating and using genetic data have established formal rules for participation: for example, researchers wishing to publish papers outlining their results are required to deposit their data into open-access databases like GenBank (Benson et al. 2013; Collins et al. 2003).

Actions for research institutions

There are three domains in which research institutions can facilitate sharing and reuse of qualitative data: 1) adapting research ethics policies (e.g., those governed by IRBs or science integrity bodies); 2) increasing resources for libraries and data librarians; and 3) establishing appropriate incentives for researchers to share data. IRBs can adopt and establish clear guidelines and policies for informed consent, qualitative data processing and retention in perpetuity, and access options associated with data sharing. Such adjustments will be critical moving forward, and consideration will also need to be given to data sharing associated with

[2] For one example of guidance, see https://dmptool.org

legacy projects, which in some cases may not be feasible due to conditions of prior consent. In this data intensive research ecosystem, libraries and librarians are quickly becoming the *de facto* clearinghouse for data management on university campuses. Despite this new role and responsibility, they often lack the necessary resources to support the sharing and reuse of qualitative data (Soehner *et al*. 2010). Dedicated positions focused on data management and archiving are helping to address this gap, as is additional training on information handling and storage for other library personnel (Mannheimer *et al*. 2019). Finally, research institutions can offer appropriate incentives so that researchers receive the necessary recognition for the creation and sharing of data products. These should include considering a data product as equivalent to a research publication for tenure purposes and supporting graduate research assistants to produce and disseminate data products derived from their research (Miguel *et al*. 2014).

Actions for funders

Funders, including government agencies, industry, and philanthropic foundations, can encourage data sharing for reuse by allowing budget lines for data preparation, and recognizing the increased cost that comes with generating adequate metadata for some types of qualitative data. In addition, funders could require a data review (review of existing accessible evidence base) to justify research requiring new data collection. This would increase all data reuse and ward against research participant fatigue, which is common for qualitative methodologies that demand significant time from participants (Hartter *et al*. 2013). Finally, funders will be critical for securing long-term financial stability for data repositories. In setting these policies, funders need to be aware of the particular challenges and costs for sharing qualitative data. For example, preparing qualitative data for sharing can be more costly because de-identifying large amounts of interview transcripts requires significant manual labor. Similarly, it will be important to consider whether there may be differential impacts, such as on researchers from low and middle-income countries, and ensuring there are solutions or necessary modifications so all can participate in both sharing and reusing qualitative data.

Actions for data repositories

Data repositories will be essential to accelerating the sharing and reuse of qualitative data. Repositories serve as data brokers, providing a catalog of their available data, as well as discovery and indexing services to facilitate reuse (e.g., Dataverse, Qualitative Data Repository, UK Data Archive). Repositories should at a minimum follow FAIR data principles (Wilkinson *et al*. 2016), and they can help establish the necessary standards associated with key aspects of qualitative data sharing such as metadata and access levels. Data repositories should continue to provide and expand their training and capacity building within the research community, especially among disciplines where qualitative data sharing is new. In addition, data repositories where there are costs, could have waivers for researchers from low and middle-income countries to ensure this is not a barrier to participation in data sharing and reuse. Infrastructure managed by data repositories can also help address some of the challenges outlined above, including options for embargo on data until the release of publications, options for different access levels depending on level of data processing, and the assigning of digital object identifiers (DOIs) to deposited data sets to allow primary researchers to receive credit for those deposits.

Actions for journals and publishers

While data sharing guidelines and policies are becoming commonplace in journals, there are few policies that specifically address the unique aspects of qualitative data. To this end, sharing of qualitative data is more likely to be seen as a possibility by authors where journals have explicit policies allowing multiple access levels (e.g., ranging from open access to strict embargoes) and types of data processing (e.g., raw data or complete interview transcripts, redacted interview transcripts, or data summaries) that are appropriate for qualitative data. In addition, journals should require a data accessibility statement prior to publication, and allow researchers to explain the rationales for access restrictions, processing, and storage location for qualitative data.[3] Journals that publish qualitative or multi-method research should assure that their policies cover qualitative data by both including clear guidance on the information expected to be shared and robust exceptions where ethical concerns or cultural considerations preclude data sharing. Finally, journals can help incentivize and document authors' commitment to open data through the use of 'badges' or other forms of certification based on author actions (like making data available, useable, etc.) (Kidwell 2016).

Conclusion

Quantitative data and analysis alone will struggle to convey the intangible benefits of biodiversity to climate adaptation and human well-being (Diaz et al. 2018). Although the primary focus of this paper is on socio-environmental synthesis research and the contributions it can make to sustainability policy and practice by broadening the evidence base from which it draws, reasons to share and reuse qualitative data are similar in many fields. When appropriate measures of participant confidentiality and protection of rights are taken into account, qualitative data sharing can be beneficial to the socio-environmental synthesis process and its outcomes. Still, sharing and reuse are currently under-emphasized and under-incentivized. This perspective has outlined many of the reasons why and provides suggestions to guide and encourage future efforts. Sharing qualitative data will not only contribute to synthesis efforts for conservation and sustainability, but also improve the quality of qualitative evidence (Moon *et al*. 2016) and contribute to the use of the best available social science in evidence-based decision- and policy-making (Charnley *et al*. 2017). Accelerating synthesis through qualitative data sharing will require accounting for ethical considerations and data sovereignty, the allocation of resources for data management and long-term archiving, tailored policies and guidelines that take into consideration the unique attributes of qualitative data, and appropriate incentives. Moreover, it demands commitment, support, and coordination from the entire research data community. Creating better enabling conditions and incentives for data sharing will ultimately improve the ability of socio-environmental synthesis to contribute to sustainability science, policy, and practice.

[3] See for example http://journals.plos.org/plosone/s/data-availability

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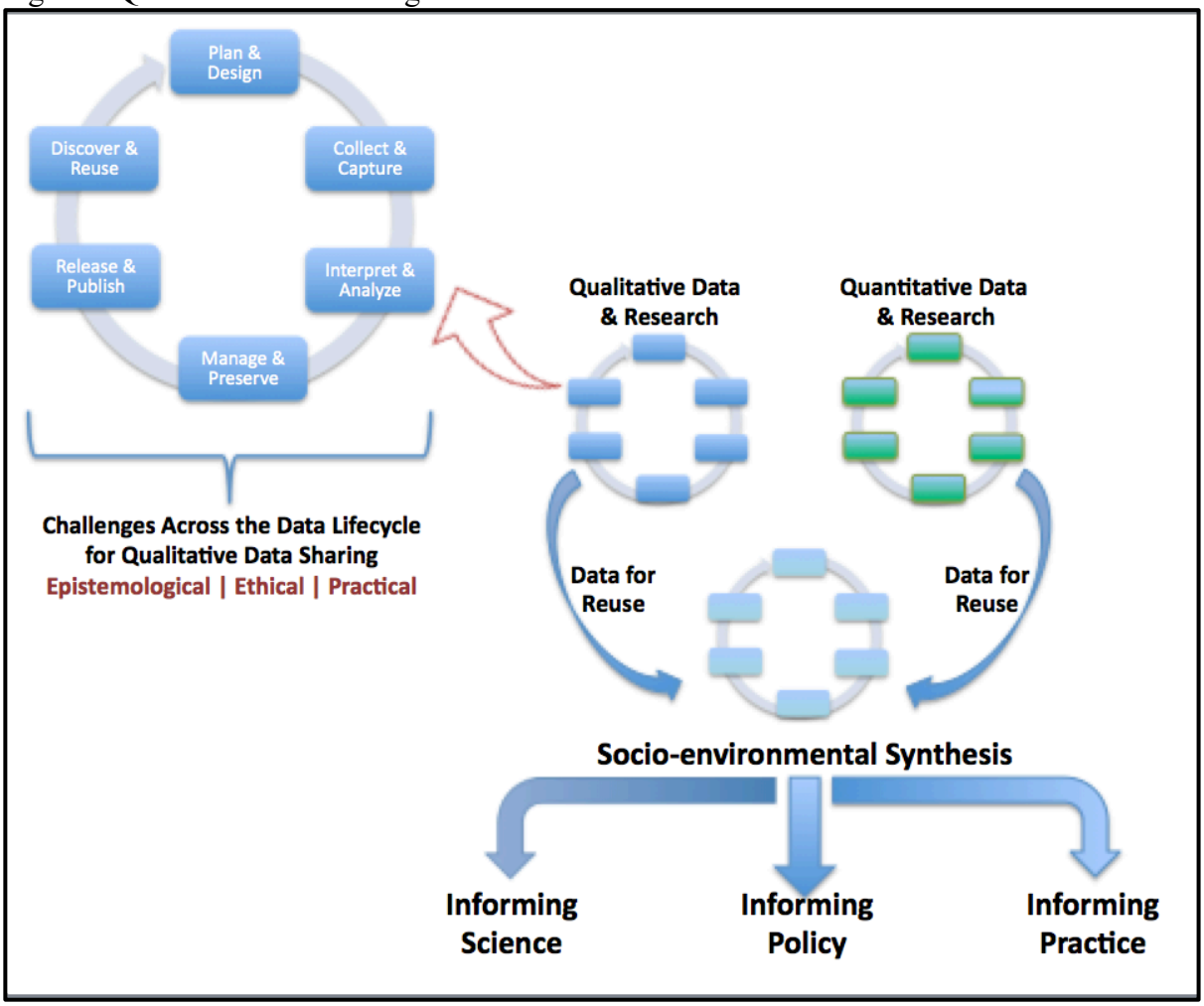
Figure 1 Qualitative data sharing for reuse



The data and research lifecycle is connected to socio-environmental synthesis via the last stage (data reuse), also illustrated here by the blue arrows. Data driven synthesis can take many forms including: (i) qualitative data only; (ii) quantitative data only; or (iii) a combination of qualitative and quantitative data. Socio-environmental synthesis as a research approach enhances and informs science, policy, and practice that is oriented toward addressing sustainability challenges.

Table 1: Glossary

Glossary	
Socio-environmental Synthesis	an emerging process of research and scholarship that draws upon disparate disciplines and backgrounds in order to share, integrate, and reuse different types of data in innovative ways and for more transdisciplinary and actionable results
Data Sharing	a process - done directly (i.e., researcher to researcher) or indirectly (i.e., via a data repository) - by which data is managed and made available to other researchers
Data Lifecycle	a broad overview of the stages and sub processes necessary for the successful management and preservation of data for use and reuse (see Fig. 1)
Data Reuse	the secondary use of data that has been directly collected (e.g., interview transcripts) or aggregated (e.g., a collection of management plans or policy documents).
Qualitative Data	Information that is not, in its initial form, depicted as discrete numerical values. Qualitative data can include text (written transcripts of interviews or focus groups, policy documents, journalistic articles, social media content), images (maps, photographs, artwork), video and audio artefacts (oral histories, news reports, music), and other types of unstructured information (Goodwin and Horowitz 2002). (see also Text Box 1)

Text Box 1: What is qualitative data?

Qualitative data is increasingly being defined within the context of how the data is organized, formatted, and managed (Boulton and Hammersley 2006). This contemporary understanding of data as either structured or unstructured helps to highlight the diversity of qualitative data types. Structured data is organized based on an *a priori* schema or framework. It is formatted to be machine readable (often in tabular form with discrete variables and observations of those variables). In contrast, unstructured data includes any type of information that is not organized into singular and discrete categories. In this sense, all qualitative data is unstructured, because a single piece of information - a word, a photograph, a statement - can be interpreted and assigned meaning in many different ways depending on the theoretical and analytical approaches used to interpret the information.

In other words, qualitative data is information that is not, in in its initial form, depicted as discrete numerical values. With this definition, qualitative data can include text (written transcripts of interviews or focus groups, policy documents, journalistic articles, social media content), images (maps, photographs, artwork), video and audio artefacts (oral histories, news reports, music), and other types of unstructured information (Goodwin and Horowitz 2002). While the unstructured format is consistent across types of qualitative data, there remain a wide diversity of qualitative data gathering approaches that influence data management approaches at the downstream end of the research process. Qualitative data may be collected directly by the person who will interpret it (primary data gathering) or it might exist prior to the research process, like data collected from historical archives of news stories, personal

communications, or visual materials. Qualitative data is often collected and used by social scientists and humanities researchers, but is not limited to only these disciplines. Field studies in ecology, biology and botany also often gather qualitative data in the form of written observations, sketches, and images. While these examples are not exhaustive of all types of qualitative data, they give the reader a starting point for understanding what counts as qualitative data.

Text Box 2: Epistemological Approaches in Qualitative Research

We summarize below three broad epistemological approaches to qualitative research that are most common within modern scientific inquiry: positivism/objectivism, constructivism, and subjectivism. In addition, there is an increasing body of literature that articulates an indigenous or traditional knowledge epistemological frame that falls outside of the scientific paradigm. The following definitions are derived from Maxwell (2011) and Moon and Blackman (2014).

Positivism: Data arises from systematic inquiry (classical scientific process) into underlying and immutable true (objective) nature of reality. Largely embraces notions of any data sharing, focuses on reliability and accuracy of discrete measurements, and uses qualitative data alongside other data to identify generalizable patterns and principles.

Constructivism: Data arises from human interpretation (constructing meaning and understanding) of the empirical (material) world. Largely sees data sharing as requiring extensive documentation of the context within which data was gathered in order to systematically characterize how and why knowledge was constructed in a certain way.

Subjectivism: Data arises from unique, relational processes that emerge only when an individual researcher engages with research subjects and interpretation of information. Largely rejects notions of qualitative data sharing for reuse by anyone other than the original researcher (or anyone at all, including the same researcher at a future point in time).

911 Table 2: Challenges for Qualitative Data Sharing

Challenge	References
Epistemological	
Epistemological traditions influence whether and how qualitative data might be shared and reused	Denzin & Lincoln 2008; Bryman 1984
Potentially incommensurate "nature" of data derived through and from different epistemological frames	Nightingale 2016
Critical epistemologies, which start from an understanding of knowledge and evidence that is partial and unique to a given individual, context, and interpretation, may not be comfortable sharing qualitative data for reuse that seeks generalizability	Hartsock 2002
Ethical	
Informed consent, confidentiality, and anonymity associated with data to be shared is difficult to guarantee without losing value of data	Bishop 2009
Sometimes data from past projects is of renewed interest for sharing, but was gathered before such an option was common in informed consent statements	Mannheimer et al. 2019
Lack of representation of and engagement with original research participants in synthesis work	Bishop 2009
Ethics of openness can be made vulnerable to desires to leverage an existing evidence base and discover something new, regardless of whether such a discovery is transparent, complete, or appropriate	Kapiszewski and Kirilova 2014; Lupia and Elman 2014
Practical	
Fewer options than quantitative researchers for repositories that can support the diversity of data types, access restrictions, and metadata needs of qualitative and multi-modal data	Corti 2012; Bishop and Kuula-Lummi 2017
Long-term financial resources necessary to maintain the infrastructure remain difficult to secure	Lynch 2008
Lack of adequate metadata standards to ensure the appropriate and accurate reuse of qualitative data in future synthesis research	Hoyle et al. 2013
Lack of incentives to encourage use of the resources, additions of refinements to existing data and metadata, and contributions of new data, and contribution of value-added data that ultimately enhances the overall value of the commons	Schofield et al 2009

912

Table 3 *Framework for qualitative data access and processing levels*

	ACCESS LEVEL			
PROCESSING LEVEL	A [open]	B [restricted]	C [controlled]	D [closed]
0 [Raw Data]	Federal legislative documents		Raw interview transcripts	Raw interview recordings (audio) Photographs of sacred sites or ceremonies
1	Federal legislative documents with search terms as metadata		Interview transcripts with names and locations redacted	Ethnographic field notes of sacred sites or ceremonies
2	Federal legislative documents with search terms and code for web scraping as metadata	Interview transcripts with names and locations redacted and metadata about settings of interviews	Excerpts of ethnographic field notes and metadata about sacred sites or ceremonies	*Empty boxes depict processing levels less commonly associated with closed access (Level 4)*
3	Federal legislative documents organized by theme and with code for thematic analysis	Interview transcripts with names and locations redacted and metadata about settings of interviews	Excerpts of photographs and field notes that represent the site or ceremony characteristics and metadata including thematic codes	
4 [Research findings/ output]	Descriptive summary of themes within federal legislature with methodology explained Summary of thematic analysis of interview transcripts with methodology explained	Summary of thematic analysis of interview transcripts with methodology explained Written Summary of sacred sites or ceremony with reference to specific photographs and notes	Written Summary of sacred sites or ceremony with reference to specific photographs and notes	

These three (color-coded) examples are only a small sample of possible qualitative content. However, this matrix and set of examples highlights the diversity of data types, research settings, and ethical and epistemological commitments that must be accounted for when making decisions about the level of access and level of processing at which to share qualitative data. As shown above, increased processing does not necessarily mean that more open access will be immediately appropriate, if the research context is sensitive or if the researcher has not provided adequate metadata for interpretation of the data.