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RESEARCH ARTICLE (PEER-REVIEWED)

Ethical collaboration and the need for training: Partnerships between Native American Tribes and climate science organizations

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Abstract

Indigenous peoples develop and utilise climate science resources to address climate change impacts, and climate scientists often collaborate on such projects. Little is known about whether climate science organisations (CSOs) adequately train their staff to work ethically with Indigenous peoples, promoting benefits for Tribes while reducing harms. To research this training, we conducted interviews with CSO employees (n=9) and Native American Tribal citizens (n=7). Thematic content analysis revealed that many challenges, benefits and common goals exist for both groups. Tribes were more likely to discuss challenges, focusing on trust and capacity building. CSOs were more likely to discuss benefits, focusing on information exchange. Both CSOs and Tribes provide training activities for CSO employees, but training programs are not mandated or consistent across employees and organisations, and they are typically not evaluated. Our research indicates a need for co-created and evaluated training programs which take into account the challenges faced in cross-cultural partnerships.

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Keywords

climate change, Indigenous peoples, community engagement, tribally driven participatory research, ethics, STEM education

Introduction

Indigenous peoples in North America and beyond are among the populations most active in planning for climate change (Bennett et al. 2014; Whyte 2017). For example, the Quileute Tribe in northern Washington has relocated some village homes in the face of increased flooding and winter storms, and challenges experienced in obtaining sufficient food due to shifting fish populations in the Pacific Northwest (Papiez 2009). Policies at national and international levels require or recommend that climate science organisations (CSOs) work with Indigenous peoples with the goal of providing scientific climate change expertise and/or advice to support Indigenous planning (Exec. Order 2013; UNFCCC 2015). These calls for collaboration are consistent with broader movements to enshrine free, prior and informed consent of Indigenous peoples (UNGA 2008), where all affected parties in a collaborative project are able to influence the design of the work and be made aware of any risks and opportunities. Yet, recent events such as the struggle with the Dakota Access Pipeline, where the Standing Rock Sioux Tribe was insufficiently consulted about the installation of a crude oil pipeline that posed risks to their cultural and natural resources, call to question whether those who seek to collaborate with Indigenous peoples are doing so ethically (Grijalva 2017; Whyte 2017).

Research methodologies that incorporate community-based, Indigenous-centric, and Tribal participatory research approaches offer extensive guidelines for ethical research collaborations between scientists and communities. At the outset of a collaboration, scientist and Indigenous partners must consider who will benefit from research projects and in what ways (Israel et al. 1998; Thomas et al. 2011). Research collaborations between Indigenous peoples and science organisations also require navigation of the complex social, historical and legal networks in which scientific and Indigenous institutions are embedded. Historic subjugation and coercion of Indigenous peoples has led to a legacy of power imbalance between Indigenous peoples and scientific research organisations (Bohensky & Maru 2011; Fisher & Ball 2003) and mistrust towards researchers (Harding et al. 2012). Thus, it is incumbent upon researchers who wish to engage with Indigenous peoples to take responsibility for ensuring that their research will minimise harms and maximise benefits for all partners involved.

The mere existence of ethical research guidelines does not ensure their implementation, and there is a need to understand if and how these guidelines are utilised by researchers on the ground. This need is not exclusive to climate scientists; it applies to researchers from all fields of science, technology, engineering and mathematics (STEM). We propose the use of 'ethical STEM' as a description of scientific training and research that provides scientists and engineers with tools to critically evaluate their relationships with the communities in which they conduct research, and to do so in a way that maintains respect for and provides valid scientific research for those communities. Scientific career preparation should include discourse about ethical STEM, and must be expanded to acknowledge the cultural, social and political contexts in which science operates (Kimmerer 1998; Sadler, Barab & Scott 2007; Tanner & Allen 2007).

We present an exploration of what content is needed in ethical STEM training and how it might be effectively disseminated to researchers who wish to work with Indigenous peoples, based on interviews with experts working at the nexus of United States Indigenous peoples (Tribes) and climate science organisations (CSOs). This article outlines the context of climate change adaptation, Indigenous peoples, and their relationships with scientific research organisations in the following literature review section. Our focus is on Indigenous peoples in the United States, but we utilise global examples to illustrate the need to engage in these practices throughout the world. We then further characterise and define our sample of research participants. Our results section focuses on the current state of ethical STEM training that climate science researchers receive to work with Indigenous peoples, and highlights emergent themes from our interviews that demonstrate the need for further training and potential training content. We provide summarising and concluding thoughts on how this work can be applied in fostering scientists and Indigenous peoples to engage in climate adaptation partnerships.

Literature Review

Indigenous peoples' conceptions of climate change and their efforts in adaptation have been well studied. Indigenous peoples in East Africa and the Arctic track weather and climate events through specialised and contextual understandings based on how they interact with their environments, integrating such information into cultural and social aspects of life (Callison 2014; Herman-Mercer et al. 2016; Leclerc et al. 2013). Documented Indigenous responses to climate change include Indigenous Saami reindeer herders' pastoral practices in Nordic countries (Reinert et al. 2008) and the use of different varieties of crops, water maximisation techniques and shortened growing seasons among Indigenous farmers in Nigeria (Ishaya & Abaje 2008). Records of Indigenous peoples' response to climate change are also documented in multiple contexts outside of scholarly spaces (e.g. CSKT 2013; Kettle, Martin & Sloan 2017; SRMT 2013; Tebtebba 2011). Even with this considerable body of work, more research on Indigenous climate adaptation is called for, such as with Māori populations in New Zealand who are grappling with challenges of adapting to changes in the natural resources they rely on (Fitzharris 2007). In addition, much of the literature examining Indigenous adaptation to climate change focuses on aspects of Indigenous life that are considered to be 'traditional', ignoring the many other contemporary resources that are also impacted by climate change, such as the use of diesel fuel by Indigenous peoples in the Arctic (Cameron 2012).

Indigenous peoples who engage in efforts to increase their resiliency amidst a changing climate do so within larger socio-political structures that create barriers to this engagement. In our discussion of these efforts, we use the term natural resources while recognising that it may not adequately express Indigenous cultural, spiritual and moral relationships with the environment. Prior governmental interventions into Indigenous spaces via colonialism have caused many of the social, economic and cultural issues that Indigenous peoples face today (Cameron 2012). Despite this, many Indigenous peoples continue to engage with colonial governments, asserting their interest in and right to be involved in all levels of policy and decision making related to natural resources (Davis 2010; Leclerc et al. 2013). For example, Inuit hunter–trapper communities in Canada work to communicate across multiple scales of governance to integrate local knowledge and national monitoring in government-mandated management of natural resources (O'Brien, Hayward & Berkes 2009). However, Indigenous peoples can also be ignored or mistreated in discussions about climate change and natural

resource management. During the UN Conference on Climate Change in Indonesia in 2007, Indigenous peoples were excluded from important discussions about climate change, and their particular needs were excluded from documents resulting from that conference (Davis 2010). Indigenous Saami reindeer herders in the tundra face differing regulations across the nations of Norway, Sweden, Finland and Russia, with Norwegian regulations from the Ministry of Agriculture limiting how the reindeer herders are able to adapt to long-term climate change. These regulations stem from a misunderstanding on the Ministry's part of the cyclical nature of the Arctic ecosystem, which Saami herders have long recognised and utilised (Reinert et al. 2008). A willing collaboration between the Indigenous Saami and the Ministry of Agriculture prior to the implementation of new policies might have avoided this restriction on the Saami people. Collaborations between government agencies and Indigenous peoples are increasingly recognised on the part of governments, particularly with the adoption of the United Nation's Declaration on the Rights of Indigenous Peoples (Davis 2010; UNGA 2008).

Historical relationships between Indigenous peoples and researchers parallel those between Indigenous peoples and governments in their lack of ethical treatment. One topic that illustrates these relationships is the concept of traditional ecological knowledge (TEK). TEK refers to the body of knowledge held by an Indigenous community based on their history, values and beliefs, and can also encompass 'systems of responsibilities that arise from particular cosmological beliefs about the relationships between living beings and non-living things or humans and the natural world' (Whyte 2013, p. 5). TEK has historically been considered auxiliary or inferior to Western scientific knowledge in many scenarios. Although some scientists now place more value upon TEK, this generally occurs in a context in which TEK is used to supplement Western scientific understanding for the benefit of Western science (Latulippe 2015). TEK has also been improperly shared with the public, leading to harm of sacred sites and tribal resources (Harding et al. 2012; Williams & Hardison 2013).

When properly carried out, partnerships between Indigenous peoples and researchers can benefit both groups. For example, prior partnerships have increased Tribal social capital (Arnold & Fernandez-Gimenez 2007; Kellert et al. 2000), improved management of natural resources (Cronin & Ostergren 2007; Kellert et al. 2000) and integrated TEK with scientific understandings to bolster and contextualise each way of knowing (Kellert et al. 2000; Leclerc et al. 2013). These benefits are often reported by researchers without documented agreement from Indigenous partners. An explicit understanding of the benefits that Indigenous peoples receive or expect to receive from research partnerships is needed so that researchers are equipped to ensure those benefits are available.

While the nature of ethical practice within the context of scientific collaborations is well documented (Minkler 2004), little is known about ethical STEM training and implementation programs. Ethical STEM is a mechanism for developing cultural competence, which is the ability for individuals and organisations to work effectively in cross-cultural situations (Cross et al. 1989). Whereas cultural competence is most often discussed in healthcare contexts (Beach et al. 2005), the term 'ethical STEM' intentionally situates both concepts within the broader scientific community. All research scientists who work with community members should be prepared to engage in ethical STEM. In regard to climate change specifically, ethical guidelines need to be included in collaborative agreements between multiple levels of governments, natural resource management agencies and Indigenous peoples. These ethical guidelines need to explicitly consider past transgressions against Indigenous peoples and the threats they are facing due to climate change (O'Brien, Hayward & Berkes 2009). Our

research is situated here in an effort to integrate what we know about partnerships between Indigenous peoples and scientists, and to invite equal voice from all partners.

Research Questions

The current work is framed by research questions that seek to unpack how ethical STEM is communicated within the context of CSO–Tribe collaborations in the United States:

1. What is the current state of ethical STEM training that CSOs provide their staff?
   a. How effective is this training?
2. What is the current state of partnerships between Tribes and CSOs?
   b. What are the benefits and challenges in these relationships for Tribes and CSOs? This research question was developed based on themes that emerged from our interview analysis and can guide the development of training content and format.

Methods

PARTNERSHIP CONTEXTS

The research sample consisted of both Indigenous peoples and scientists employed by climate science organisations, with each interviewee having experience working in partnerships across these groups. Indigenous peoples in this context refer to groups who exercised political and cultural self-determination prior to a period of invasion and colonialism and who continue to exercise self-determination as non-dominant populations in territories in which nation states are recognised as the primary sovereigns (Anaya 2004). For the purposes of this article, Indigenous peoples and Tribes will be used interchangeably given that in the US context Indigenous peoples often refer to themselves as Tribes. In the US, the federal government recognises 567 Tribes as sovereigns, individual states recognise over 50 additional Tribes (Salazar 2016) and there are many unrecognised Indigenous peoples; all of these are encapsulated in our use of the term Tribe. CSOs refer to both federally and privately funded organisations whose goal is to provide communities with scientifically valid research, expertise and advice related to climate change impacts. To protect the anonymity of participants, the specific structure of these partnerships will not be shared; however, these partnerships occur across many contexts. Both Tribe and CSO respondents might be based at federal agencies, higher education institutions, or other organisations.

DATA COLLECTION AND ANALYSIS

The research team pre-identified individuals from across the US with Tribal or CSO affiliations and well-documented experience collaborating on Tribe–CSO climate projects. Tribe and CSO interviewees were from the Arctic, Mountain, California, Southwest, Oklahoma, Great Lakes, and East/Southeast regions of the United States. CSO interviews also included individuals from the Pacific and Pacific Northwest regions. One semi-structured interview protocol was designed for Tribal citizens and employees (Supplement A), with another designed for scientists within a CSO (Supplement B).

Sixteen interviews were completed (CSOs=9 and Tribes=7) via online video calls. The audio for each interview was recorded and transcribed. The driving questions for this work specified predetermined themes to examine in the resulting transcripts, focusing on three

broad categories of reasons for establishing partnerships, ethical STEM training activities, and evaluation of ethical STEM training (Research Question 1).

In order to acknowledge the emergence of additional themes not foreseen in the interview protocol (Research Question 2), we conducted thematic content analysis (Burnard 1991). Interviews were coded using a technique based on grounded theory (Corbin & Strauss 1990) where additional themes were created based on the language used by interviewees. Two authors, one with a Tribal perspective from the College of Menominee Nation (CH) and the other with a science perspective from Michigan State University (CK) developed a coding scheme through analysis of one Tribe and one CSO interview. Codes were added and discussed during subsequent interview analysis, with interviews being re-coded as new themes emerged. The entire team reviewed the resulting codebook for clarity and completeness, ensuring that it would accurately represent emergent themes at the Tribe–CSO nexus.

Following codebook development, an additional interview from each perspective was coded separately by CK and CH to establish inter-rater reliability. The average measure of intraclass correlation across the two raters was 0.89 (min=0.85 and max=0.92). Intraclass correlations close to 1 indicate near perfect agreement, with values above 0.75 suggesting strong agreement across coders (Cicchetti 1994). CH coded five of the remaining CSO interviews and CK coded two CSO interviews and the five remaining Tribe interviews.

Results

INTERVIEW ANALYSIS

The 16 completed interviews (CSOs=9 and Tribes=7) had an average duration of 43 minutes, with a standard deviation of 17 minutes. Interview lengths did not differ for Tribe and CSO participants. Upon reviewing our analysis, we found that our interviews reached saturation according to criteria in Francis et al. (2010). We set a minimum sample size of 12 interviews based on guidelines in Guest, Bunce & Johnson (2006) and four interviews beyond those 12 were coded with no additional themes added (Francis et al. 2010).

PREDETERMINED THEMES

Predetermined themes from the interview protocol were reasons for establishing partnerships, ethical STEM training activities and ethical STEM training evaluation (Research Question 1). Each predetermined theme contained at least one subtheme that was discussed by both Tribe and CSO participants (Table 1). Overall, analysis of the predetermined themes demonstrated multiple types of training activities that CSOs can engage in to learn how to work ethically with Tribes. However, engagement in these training activities varied and none of the trainings were evaluated. Each predetermined theme is discussed below to explore the current state of ethical STEM training for CSOs who work with Tribes.

Table 1 Predetermined overarching themes with example subthemes from both perspsectives

Predetermined Theme	Subthemes
Reasons for Establishing Partnerships	Federal Government Mandate
	Trust Responsibilities and Treaty Rights
Ethical STEM Training Activities: *Discussions*	Consult Tribes
	Tribes & CSOs liaison
	Consult other CSOs
Ethical STEM Training Activities: *Documents*	Written Materials
	Organisational Protocol
Ethical STEM Training Activities: *Conferences*	Attend Tribal Workshops and Conferences
	Organise Tribes Conferences
	Invite Tribes to Conferences
Ethical STEM Training Evaluation	Relationship Quality
	Tribal Authorship
	Lack of Complaints

REASONS FOR ESTABLISHING PARTNERSHIPS

The most commonly discussed motivations for collaboration were mandates from the United States federal government. Federal CSO interviewees often initiated partnerships because of Secretarial Order Number 3289, which requires federal climate science agencies to work with Tribes (DOI 2009). Trust responsibilities and treaty rights, which refer to the legal duties and moral obligations of federal agencies to uphold treaty contracts with Tribes to ensure consultation in natural resource management, were also mentioned as important motivators for building collaboration.

ETHICAL STEM TRAINING ACTIVITIES

The CSOs and Tribes suggested a variety of avenues for CSOs to receive ethical STEM training. The main types of activities suggested were discussions, documents and conferences (Figure 1). The lack of specificity about the need for ethical STEM training within federal and organisational policies has resulted in inconsistencies in training across CSOs. Training generally occurs in an ad hoc and experiential manner, with employees learning how to work with Tribes as they begin research partnerships.

Because the CSOs did not typically have established training programs, both Tribes and CSOs were responsible for providing ethical STEM training independently. Many interviews revealed that individual researchers were responsible for training themselves:

> *When I first get a new researcher, I'm going to send them some links, websites, some different things…They do their homework, then I might want to work with them. [T]*

In this case, although the researcher was responsible for completing the training, the materials were being provided by the Tribe, which was often the case (Figure 1). In addition, little oversight on the part of Tribes or CSOs was evident.

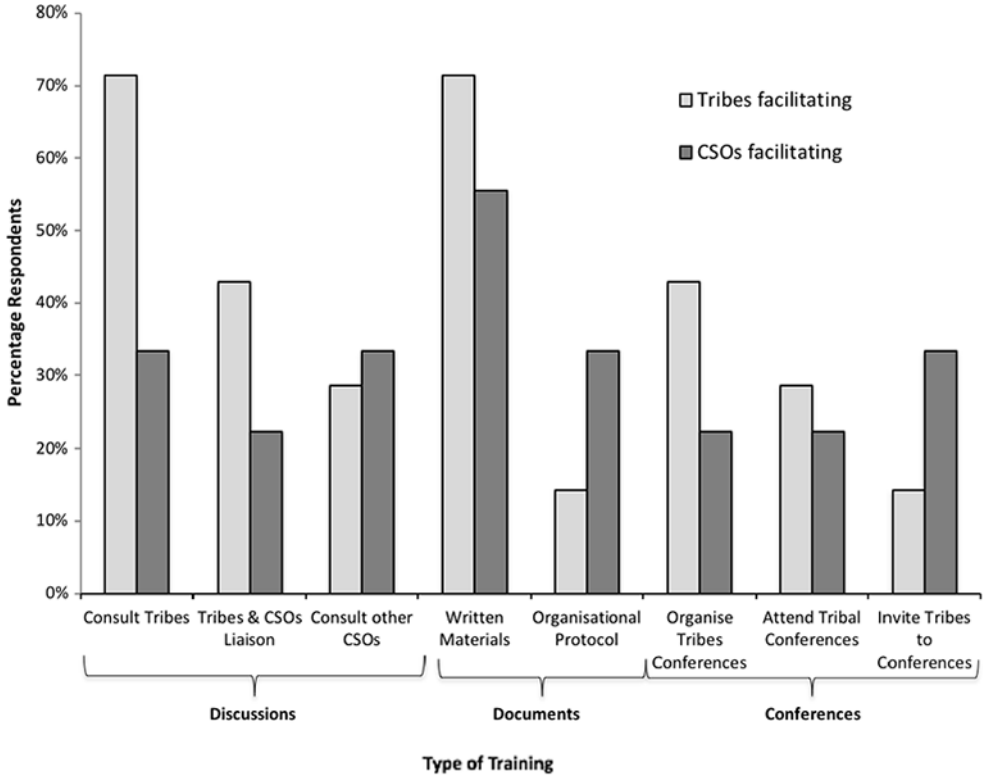

Figure 1 Ethical STEM training activities that are facilitated by Tribes (n=7) and CSOs (n=9). Each activity is shown, along with the percentage of respondents who suggested that their organisation or Tribe facilitated such activities, either directly or by coordinating them for other parties.

Discussions

Some CSOs encouraged their employees to engage in discussions or informal consultations with Tribes, a Tribe–CSO liaison, or other CSOs, to gain an ethical understanding of these complex partnerships (Figure 1). Many Tribe interviewees frequently engaged in these discussions themselves or connected CSOs with other consultants. Interviewees suggested that CSOs should engage in discussions with Tribes to learn about the Tribe's culture, research needs and project goals. Typically, interviewees considered CSOs responsible for initiating these discussions.

Some respondents' organisations featured a Tribe–CSO liaison position for coordinating research projects between CSOs and Tribes. Other respondents expressed the need for establishing this specific position within their own organisation, where the liaison would provide training for CSOs. Some CSOs consulted other researchers at CSOs who had prior experience working with Tribes. Occasionally, multiple CSOs and Tribes would participate in discussions, as one Tribe interviewee described:

> *One aspect of the work that we do is … promoting a coordination and communication among the scientists and Tribal representatives. So part of what we're doing is trying to create the forum for that kind of meeting to happen and then to help be the facilitator for the exchange of information. [T]*

Documents

Publicly or privately available documents that described best practices were a particularly popular training aid for establishing ethical STEM behaviour in CSO collaborations with Tribes (Figure 1). These included written guides from a variety of sources as well as organisational protocols and documents that were used specifically within a particular CSO or Tribe. One CSO participant described their development of written materials for ethical STEM training:

> *We are in the process of developing a…guidebook for our researchers…to help them understand what sovereignty is, what traditional knowledge is, things to be aware of with respect to cultural practice…Not all Native Americans are the same. [CSO]*

This quote emphasised the content of the guidebook and the multi-cultural nature of these partnerships.

Many CSOs were also interested in using their experience gained in prior work with Tribes to develop a comprehensive training curriculum. One Tribe and one CSO were each working independently to create ethical STEM training curricula, and additional CSOs suggested it as a future step.

Conferences

Conferences, workshops and group meetings were suggested as other platforms for ethical STEM training (Figure 1). These events were perceived as accessible and common, with one respondent commenting that there was '*always some type of training that is highlighting [Tribal] issues*' [T]. About half of the Tribes' interviewees and a few CSOs organised and attended Tribally focused conferences. The explicit focus of conferences and meetings was not ethical STEM itself, but rather the gathering provided a venue where CSOs could '*learn about Tribes and learn about their issues and how to interact with them*' [CSO]. CSOs were more likely to invite Tribes to CSO-hosted conferences than organise Tribally focused conferences, which sometimes resulted in a larger burden on Tribes to acquire funding to send Tribal employees to these meetings.

ETHICAL STEM TRAINING EVALUATION

None of the training programs for CSOs were intentional, and thus no evaluation of ethical STEM training was conducted by any interviewees. A variety of evaluation methods were suggested, although most evaluated the research relationship rather than the training itself. Each perspective stressed the importance of Tribal involvement in the evaluation process:

> *To me it would be feedback from the Tribes, Tribal council, or the environmental professionals you're working with. If they could provide some commentary of the experience…would be the key way of evaluating it. [CSO]*

This quote features the overall relationship quality between CSO and Tribal partners as a suggested evaluation metric. Tribal authorship of research publications and a lack of

complaints about the partnership were two additional suggested metrics. Typical quantifiable evaluative tools, such as the number of Tribal citizens involved in a project, were not regarded as particularly effective in these relationships.

EMERGENT THEMES

When coding interviews, thematic content analysis was utilised to reveal themes that were not anticipated in the interview protocol about the relationships between CSOs and Tribes. This resulted in four emergent themes: partnership goals, benefits for Tribes, benefits for CSOs, and challenges. The emergent themes describe the need, potential content and goals for ethical STEM training in facilitating Tribe–CSO partnerships (Research Question 2). As with the predetermined themes, each emergent theme contained multiple subthemes (Figure 2). Overall, emergent themes revealed that Tribe interviewees were more likely to discuss many challenges, while CSO interviewees were more likely to discuss a variety of benefits. Subthemes that described challenges were the most plentiful overall, indicating that the relationships between CSOs and Tribes are complex and challenging to navigate. We explore each of the four emergent themes below. Partnership goals, benefits for Tribes and benefits for CSOs demonstrate what a successful relationship between CSOs and Tribes might look like and may help guide ethical STEM training evaluation. Challenges demonstrate potential focus areas for ethical STEM training content.

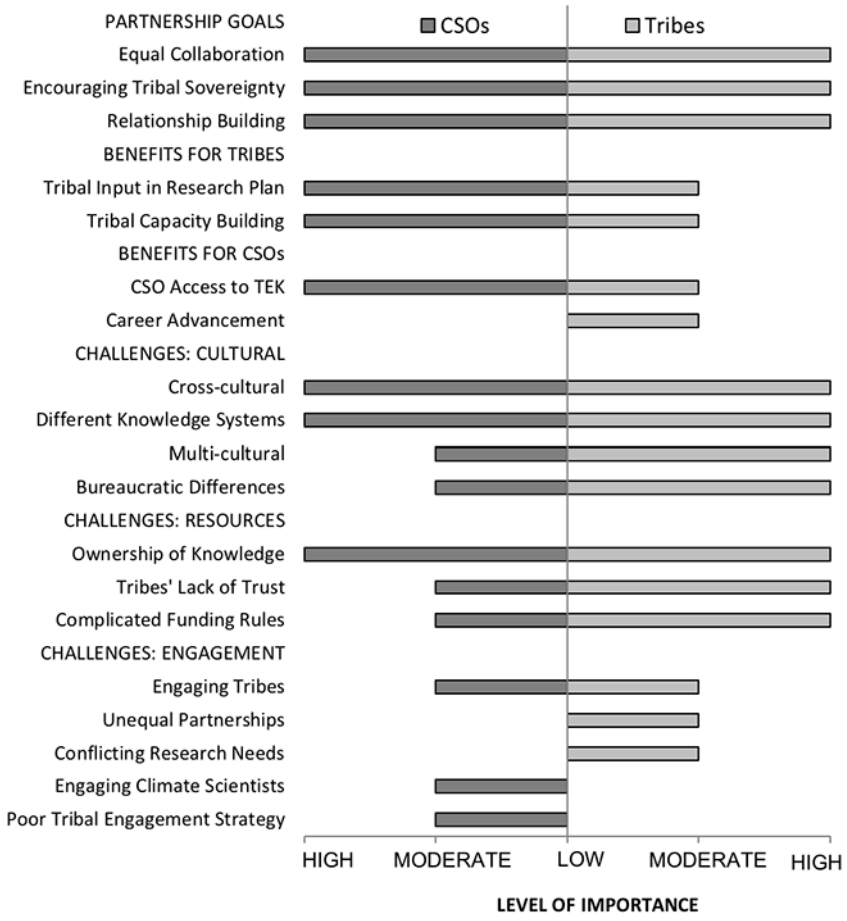

Figure 2 Emergent themes and their relative importance for Tribes and CSOs. Partnership goals, benefits for Tribes, benefits for CSOs, and challenges

were four main themes identified via thematic content analysis. Levels of importance indicate the percentage of interviewees who discussed a subtheme. Items of low importance were ←15% of interviewees, moderate between 15–60%, and high importance subthemes were discussed by →60% of interviewees.

Partnership goals

The presence of certain relational characteristics between Tribes and CSOs was critical to successful partnerships. Each interviewee suggested at least one of the following partnership goals: relationship building, encouraging Tribal sovereignty and empowerment, and equal collaboration.

A focus on relationship building between researchers and Tribal citizens was considered a necessary partnership component, with emphasis on the need for individual researchers to focus on personal relationships in order to earn trust. For example, one Tribe interviewee articulated their experience:

> *The scientist wants to come in and do their research and leave and don't see it as a relationship…A Tribe…wants this relationship with the researchers long-term. [T]*

This quote described the motive of the CSOs as research-based and short term, which misaligns with the Tribe's goals of a longer research relationship. A focus on building and sustaining personal relationships was often considered the responsibility of the CSO:

> ***I think scientists…that are looking to work with Indigenous communities really need to take it upon themselves to build those strong relationships within the communities. [T]***

The promotion of Tribal sovereignty and empowerment through working relationships was another desired characteristic of collaborations. One CSO stressed the importance of Tribal sovereignty:

> *[Tribally-led science] moves this idea of Tribes being a ward of the federal government… and it empowers Tribes as sovereign nations to understand and react to their own impacts and understanding of climate change. [CSO]*

Here, empowerment included scientific capacity and a broader understanding of Tribes as sovereign nations. Finally, a sense of equal collaboration, often via Tribal input throughout all stages of a research project, was a key characteristic of successful partnerships.

Benefits for Tribes

Benefits for Tribes generally highlighted the desire for Tribes to maintain control over their resources and the focus of climate change research. The ability for Tribes to 1) build capacity and 2) have input in the formation of research projects was most frequently mentioned (Figure 2). CSOs were more likely to discuss these potential benefits than were Tribes. A Tribe interviewee commented on building capacity:

> *One of the things I promote in my Tribal engagement strategy is that the ultimate goal is that the Tribe can do their own climate science, their own planning, their own projects… Having the groups collaborating is building the Tribe's capacity [T]*

Capacity building was discussed in a scientific sense: through interaction with CSOs, Tribes could expand or begin their own climate science research. Being absent from collaborations with CSOs, Tribes might not have access to resources to build this scientific capacity.

Tribal input into research formation was related to the power difference between Tribes and CSOs in regard to their scientific backgrounds. Both Tribes and CSOs were interested in proceeding with research projects that have Tribally relevant outcomes. While highlighting this benefit, Tribe respondents discussed the challenge of conflicting research interests between CSOs and Tribes. When these conflicts occurred, Tribes would also highlight their lack of capacity to carry out their own research. Other benefits specific to Tribes included networking with scientists, development of climate adaptation plans, promoting intergenerational learning, receiving funding, and access to scientific data.

Benefits for CSOs

The primary benefit to CSOs was access to Traditional Ecological Knowledge (TEK) and adaptation methods. TEK is not a typical component of formal education for scientists and is generally only available to CSOs through the cultural exchange of working closely with Tribes. Lack of trust and knowledge ownership concerns were often highlighted regarding TEK, suggesting that CSO access to TEK should not be considered a given in partnerships. One CSO described their views on TEK:

> *[Tribes] have a long history and they've seen a lot of change and they know how to adapt to change…and so we can learn a lot from what they know and from their adaptation tools. [CSO]*

Other benefits for CSOs included access to Tribal data and the ability to receive funding because of their engagement in projects with Tribal partners. Tribe participants suggested that CSO researchers benefit from career advancement by completing research projects. A desire for career enhancement on the part of a researcher was sometimes considered motivation to engage in unethical partnerships:

> *My experience is that researchers, you know, often are seeking a knowledge and a credential. And those are…their highest priorities and they often assume that they can enter Tribal lands and do work without getting the approval by Tribal leaders. [T]*

Challenges: Cultural

The most commonly identified challenges dealt with the cultural aspects of Tribe–CSO partnerships (Figure 2). Cross-cultural difficulties were described in general, such as:

> *We don't come with the same set of values, teachings, and understandings. [T]*

Interviewees also discussed specific cultural differences, such as perceptions of TEK:

> *The hardest thing to teach is kind of the reverence for other people, for other cultures. People talk about TEK like a thing and you need to gather it and we need to put it in a GIS database or something. And it's not. It's…a way of life. It's not a thing. [CSO]*

The cross-cultural nature of these partnerships was most apparent when dealing with the different knowledge and bureaucratic systems of the scientific and Tribal communities. Two narratives emerged surrounding different knowledge systems. One narrative considered Western science as complicated and technical, requiring communication to Tribes in a

different way from how scientists generally communicate their findings. The second was a concern over the cultural understanding of TEK. The two quotes below exemplify this contrast:

> *We come as agency scientists with a bunch of jargon, and ecosystems, goods and services, and scenarios, and pathways of stressors and thresholds. You're going to have to simplify that, or at least retranslate that into understanding, having done your background on…the Tribe and their community. [CSO]*

> *In a collaboration with people who have other ways of knowing, it's not about verifying the other ways of knowing with the scientific knowledge…Each puzzle piece is verified against its own metrics, its own criteria, experiences. It's considered accurate by the knowledge holders. [CSO]*

The first quote signified the need for CSOs to be prepared to translate their scientific understanding into accessible information. The second quote emphasised the importance of understanding and respecting the Tribes' process for creating knowledge, which may include their own language, methods and evaluation criteria.

Tribe interviewees often pointed out the bureaucratic differences between the structure of a Tribe and a CSO, describing CSOs as unaware of how to work with a Tribe's decision makers. Tribe and CSO interviewees also discussed the multicultural landscape of Tribes as a barrier to successful collaboration. When working with multiple Tribes, CSOs should take note that:

> *All Tribes…don't have the same cultural beliefs. They're different. They're unique. [T]*

Challenges: Resources

The primary resources that presented challenges were knowledge, trust, funding and time. A concern for all interviewees was ownership of knowledge, where knowledge was a broad concept encompassing scientific data and TEK. CSOs often discussed ownership of knowledge as a concern related to their organisation's protocol. Interviewees stressed the need to inform Tribes of what information they planned or were required to publish.

Proper handling of Tribal knowledge and data was linked to a lack of trust based on past transgressions by researchers. Trust here refers to the moral concept that different peoples should create conditions where each is certain that the other takes their best interests to heart (Wolfensberger 2016), and not to government trust responsibilities. Lack of trust was mentioned by most Tribe interviewees, but only some CSO interviewees (Figure 2). Issues caused by this lack of trust varied and included a reluctance to start partnerships, a lack of information sharing, and slowing down the research process.

Attaining funding for research expenses was of great importance to Tribes and of moderate importance to CSOs (Figure 2). Tribes faced barriers in dealing with scientific research protocols, including navigating federal funding agencies. Concerns were also expressed over the fairness of funding allocations to Tribes, and regulations that limited an open exchange of funds. Interviewees also encountered a lack of time and resources to dedicate to projects and ethical STEM training.

Challenges: Engagement

The challenges related to engagement in partnerships were least commonly discussed, but highlighted disparities in concern over certain partnership characteristics. Tribes and CSOs

mentioned difficulty engaging Tribal citizens and Tribes, as groups, in research. One Tribe participant described Tribes' lack of engagement as related to feeling uninvolved in the project and having other priorities:

> *I think a lot of times the Indians themselves don't feel like they're part of the project so their interest is very low. You know, they have other issues to worry about, mostly social issues. [T]*

This quote also demonstrates an example of an unequal partnership where Tribes are not given project control and voice in the project. Many Tribe participants were concerned about unequal partnerships, while only one CSO participant identified a similar theme (Figure 2). In addition to a lack of sufficient involvement in the project, Tribes were somewhat concerned about conflicting research needs where the goals of CSO and Tribal partners were misaligned. CSOs did not mention this as a challenge (Figure 2).

Two challenges were mentioned only by CSOs (Figure 2), and they were related to the structure of their organisations. Many CSOs are under a federal mandate to work with Tribes, and as such CSOs develop Tribal engagement strategies. However, documentation detailing these strategies is insufficient to provide adequate guidance for real-world engagement. Another challenge unique to CSOs was engaging their climate scientists in Tribal issues and ethical STEM training. Even though ethical STEM training opportunities exist, few CSO employees seek them out independently of a specific project.

Discussion

This study analysed the current state of relationships between climate science organizations (CSOs) and Tribes in order to understand the need for, prevalence of, and potential avenues for ethical STEM training in these partnerships. The abundance of emergent themes from the interviews indicates that interactions between Tribes and CSOs are complex. While guidelines for engaging in these types of relationships exist (e.g. CTKW 2014; NIH 2011), our research has shown that even among scientific organisations and Tribes that commonly work across these cultural boundaries, there are no consistent efforts to connect researchers or Tribes with ethical STEM training.

Tribes and CSOs shared many perceptions about their partnerships, with some key differences that indicate there is a need for CSOs to engage in ethical STEM training. First, there appears to be an unequal burden on Tribes in providing ethical STEM training for researchers who begin partnerships unprepared. While most respondents suggested that CSOs should be responsible for training their researchers to work with Tribes, Tribes often provided this training through documents or discussions. Second, CSOs tended to focus on the potential benefits that they hoped Tribes received from their interactions, while Tribe interviewees named a wider variety of challenges in these relationships. However, while CSO and Tribe respondents framed issues differently, they identified similar themes across partnership goals, benefits and challenges. For example, 'unequal partnerships' was a challenge that Tribes identified, while CSOs and Tribes also spoke to a partnership goal of 'equal partnerships'.

In order to produce more ethical relationships given our findings, we make three recommendations for researchers and organisations. First, any organisation or Indigenous community seeking research partners must be prepared to engage in partnership-building conversations during project development. Engaging in this process in an explicit manner, for example through written data-sharing agreements that emphasise relationship building, equal

collaboration and Tribal sovereignty, can help facilitate a smooth partnership (Harding et al. 2012). Tribes and CSOs should each be prepared to discuss their own norms and expectations at the outset of a partnership. Rather than approaching an Indigenous community with a predefined project and goal, researchers must seek out Indigenous partners early on in project development to engage Tribal members and to begin building personal relationships. This process should be undertaken before attaining grant funding for a project because of the concerns over funding that inadequately compensates Indigenous partners.

Partnership-building conversations must consider how to produce accessible results and foster other desired benefits (Emanuel et al. 2004; Ngā Pae o te Māramatanga 2015; NIH 2011). For Indigenous peoples, potential benefits include having input in the research process and building scientific capacity (Arnold & Fernandez-Gimenez 2007; Holmes, Lickers & Barkley 2002; Huntington et al. 2011). Researchers should evaluate the usefulness, relevance and accessibility of project results according to Indigenous partners as a measure of how well they are facilitating these benefits (Lemos & Morehouse 2005). Because Tribe respondents also emphasised a lack of trust towards researchers, we propose trust as an important partnership outcome. The benefit that CSO participants most often discussed was the integration of TEK into their research, which has the potential to produce novel ecological insights (Huntington et al. 2011; Kimmerer 1998; Porter 2007). Partners should recognise that some Indigenous cultural norms involve respect for privacy, and that partnerships do not guarantee access to TEK. Researchers must also understand the cultural context surrounding TEK and recognise inherent differences in the production of each type of knowledge (Latulippe 2015; Reo et al. 2017; Smith & Sharp 2012).

Second, further research is needed at the Tribe–CSO nexus to develop ethical STEM training and evaluation. Literature on training scientists to engage with diverse communities is sparse and often related to medical research (Beach et al. 2005; Minkler 2005; Wong et al. 2017), thus not addressing the specific challenges that climate change researchers might encounter when working with Indigenous peoples. Several training activities were identified by our interviewees, with most CSOs engaging in some training activities. However, the currently ad hoc nature of such training is unlikely to: 1) engage all applicable researchers; and 2) capture the diverse set of challenges surrounding Tribe–CSO collaborations. While interviewees most often placed the context of this training within their current organisations, there have also been calls to incorporate this knowledge into training for scientists via their more formal university education (Kimmerer 2002). Regardless of the venue of training, intentional programs are necessary to ensure that CSOs and other scientific researchers can ethically partner with Indigenous peoples.

In order to develop stronger ethical STEM training opportunities for scientists, further research should develop a wider and more representative sample of potential goals, benefits and challenges of such partnerships. Upon reviewing the results of this study, some interviewees expressed that individuals' roles in engagements might change their perspective and thus the study results. While gathering more perspectives from scientists and Indigenous peoples, researchers should also seek out developed trainings at this nexus to build an understanding of current best practices. Formalising and publicising best practices in preparing and facilitating these partnerships is especially important (Lazrus & Gough 2013). Educational programs and training interventions are most likely to be effective when they are based on clearly articulated theories of behaviour change (Townsend et al. 2003), and when they provide knowledge and skills that fill a perceived need by their audience (Suarez-Balcazar et al. 2008). Using a theoretically grounded program may allow for creation of a basic ethical

STEM training program that can be implemented – with appropriate cultural revision – in many research contexts. Basing that program on the needs identified in this research, related contexts and any further research that occurs at this nexus will ensure that it is most relevant to the scientific community that it is targeting.

Third, CSOs and similar organisations should systematically utilise this training for their employees who will be working with Indigenous peoples. Distinct power differentials exist in the relationships between research organisations and Indigenous peoples, with organisations often having more access to the resources needed to carry out scientific research (Bohensky & Maru 2011; Fisher & Ball 2003; Kimmerer 1998; Smith & Sharp 2012) and challenges burdening Tribes more than CSOs. This is true even within relationships featuring CSOs experienced in working with Indigenous peoples, as shown by Tribe interviewees discussing challenges relatively more than CSOs. It is incumbent upon scientific organisations to engage in ethical STEM training and proactively address these power imbalances. For example, researchers should understand project funding sources and how funding can be shared with the Indigenous partners before seeking out a partnership with an Indigenous community.

The training and evaluation process itself is likely to encounter many of the same challenges as any research partnership, but may be exacerbated by the cultural differences and contrasting worldviews of Indigenous peoples and Western scientists. Both training and evaluation need to take into account Indigenous and researcher perspectives, and the development of a training program should be approached in a similar manner as the start of a partnership. Tribes and CSOs should include ethical STEM training for researchers in organisational protocols in order to provide this training consistently. Dedicated commitment by these organisations is necessary, not only in achieving the goals of, in this case, promoting ethical STEM, but also in ensuring that these training programs are sustained over time (Suarez-Balcazar et al. 2008).

Conclusion

The consideration of ethical relationships between US Tribes and scientists has broad implications for similar collaborations internationally. The co-creation of ethical STEM training programs has the potential to ease the burden of challenges experienced by Indigenous peoples in future research partnerships and to rebuild trust that has been lost between Indigenous peoples and research scientists; this is particularly true when ethical STEM training is conducted in line with the guidelines suggested here and elsewhere in community-based research literature. More ethical and equitable partnerships that respond to the need of Indigenous peoples to build scientific capacity can only serve to improve society's understanding of climate change's impacts and potential for adaptation. These ethical STEM training efforts can be applied not only within the US, but also more broadly, as nations work to develop climate change adaptation plans in accordance with the Paris Agreement (UNFCCC 2015). Such efforts would respond to the literature that documents Indigenous peoples' interest in responding to climate change threats (e.g. O'Brien, Hayward & Berkes 2009) and the need to consider contextual and historic factors in relationships between Indigenous peoples and researchers (Cameron 2012). Maintaining ethical STEM principles of research will enhance the ability of climate adaptation researchers and programs, such as the Green Climate Fund (Schalatek, Nakhooda & Watson 2015), to adequately address the needs of Indigenous peoples participating in partnerships that reduce the harms they experience and promote maximum benefits for Indigenous peoples worldwide.

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