ENVIRONMENTAL DECISION MAKING IN CROSS-CULTURAL CONTEXTS

By

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ABSTRACT

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Worldwide sustainability challenges such as food insecurity and climate change require an understanding of both the natural world and environmental decision making made by individuals and communities. Building on theoretical understandings of environmental decision making such as the Theory of Planned Behavior and Value-Belief-Norm Theory of Environmentalism, this research seeks to better understand environmental decision making at the community and individual level. It does so in three cultural contexts: 1) undergraduate students' individual environmental decision making, 2) research relationships between Native American Tribes and climate science organizations, and 3) urban agriculture and sustainability practices in South America and the United States. To research the training that climate science organizations provide employees for engaging with Native American Tribes in climate research, we conducted interviews with CSO employees (n=9) and Native American Tribal citizens (n=7). Thematic content analysis revealed that 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 organizations, and they are typically not evaluated. To reduce climate change impacts, educators often work to foster environmental behaviors. Socioscientific issues education provides a framework for students to learn about climate change and related environmental behaviors, but rarely measures specific personal factors in student decision-making. Undergraduate students (n=132) were surveyed to investigate for which types of behavior the Theory of Planned Behavior, Value-Belief-Norm Theory of Environmentalism, or both theories are most effective. The combined theories of behavior best predicted behavioral intentions in regression models over either theory individually. Recycling, a direct environmental behavior, was predicted by different determinants than three indirect environmental behaviors. These results support the use of different behavior models for different behaviors and exploration of subjective and personal norms around environmental behavior in the socioscientific issues classroom. Benefits, motivations, and barriers related to urban agriculture are often presented differently across developed and developing nations. We developed semi-structured interviews based on the Theory of Planned Behavior to examine individual farmers' urban agriculture behaviors in the United States and South America. We also examined support that individuals receive for urban agriculture from organizations, governments, and policies. While farmers in the United States reported a wider range of community sustainability themes, farmers in South America centered community sustainability motivations around intergenerational familial and cultural groups. Social barriers were particularly relevant for South American farmers, where low subjective norms discouraged engagement in urban agriculture. Policies and organizations more often supported urban agriculture in the United States, which allowed South American farmers to experience fewer institutional barriers. The similarities and differences in motivations, benefits, barriers, and support for urban agriculture across these spaces can inform researchers and policy makers in further developing sustainable and impactful urban agriculture. Results from all three studies can inform how to communicate with individuals, organizations, and communities about environmental decision making in order to contribute to societal sustainability.

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KEY TO ABBREVIATIONS

TPB	Theory of Planned Behavior
VBN	Value-Belief-Norm Theory of Environmentalism
UA	Urban agriculture
SSI	Socioscientific issues
PBC	Perceived behavioral control
CSO	Climate science organization
STEM	Science, technology, engineering, and mathematics
TEK	Traditional ecological knowledge
US	United States
SA	South America

INTRODUCTION

Humans have long studied geology, chemistry, physics, and biology as a way to understand the laws of nature and alter the relationships between humans and natural resources. Human actions have consequences on environmental processes, and in turn impact future generations of humans. This complicated interplay results in sustainability challenges such as food insecurity and climate change. It is therefore important to understand both sides of the relationship between humans and the environment—the laws of nature and the theories governing human behavior. Environmental decision making is important to understand at the individual level and across different communities in order to develop a more complete picture on how to respond to sustainability challenges.

Many theoretical frameworks have been utilized and developed in the context of environmental decision making. Two that are widely recognized are the Theory of Planned Behavior (TPB) and Value-Belief-Norm Theory of Environmentalism (VBN) (Ajzen, 1991; P. C. Stern et al., 1999). There remain gaps in our theoretical understanding as to how those theories may fit together, may explain different types of environmental behaviors, and how these individual decision-making processes may scale up to relate to community-level actions. Individuals are nested in larger communities that impact sustainability through policy or relationships with other communities. Individuals may also have relationships with larger societal structures, such as a voice in policy making. This has the potential to impact climate change through citizen involvement encouraging policy makers to engage in top-down responses to sustainability challenges. Individuals also have their own motivations and experience barriers in engaging in sustainable practices. In urban agriculture (UA) specifically as a response to sustainability challenges such as food insecurity and water scarcity, individual motivations and benefits are suggested to differ across developed and developing nations. One goal of this dissertation is to explore environmental decision making on an individual and community scale to examine these gaps in theoretical understanding.

Climate change and food insecurity are two interrelated worldwide sustainability challenges that individuals and governments must work to solve through behavior and policy changes (Godfray et al., 2010; IPCC, 2018). Anticipated climate change impacts vary in different regions. In the region of Michigan State University, more erratic precipitation patterns is expected to lead to more severe droughts and increased flood events (Andresen et al., 2012). Nationally, Native American Tribes are some of the most impacted and interested in planning for climate change impacts and adaptations (Bennett et al., 2014; Papiez, 2009; Whyte, 2017). Food insecurity is another potential impact of climate change, with poor urban communities facing additional challenges in food access (Tacoli et al., 2013). These examples show that environmental impacts are related to larger societal and cultural factors. In addition, environmental impacts do not abide by political boundaries, and actions of one group or nation will impact others, often at the expense of more vulnerable groups. Therefore, it is important to examine environmental decision making with a cross-cultural lens. My dissertation seeks to do so in three contexts: 1) among undergraduate students due to the presence of education for environmental decision making in these spaces, 2) the research relationships between Native American Tribes and climate science organizations, and 3) in urban agriculture settings across South America and the United States.

When it comes to climate change, scientists and educators have often relied on facts and data to convince individuals and legislators of the urgency to act (Gifford, 2011). However, this model of combatting unsustainable behavior with facts does not align with TPB and VBN theories. Socioscientific issues (SSI) education provides a framework for allowing students the opportunity to explore broader social, moral, and political considerations when discussing controversial scientific subjects (Zeidler et al., 2005). These educational models do not currently link to environmental decision making theories, which could provide educators with a tool for assessing the impact of their courses. It should be noted that the role of educators in fostering student behaviors is a continuing debate, and educators should take care to ensure they are fostering students' exploration of their own values and opinions (e.g. Heimlich & Ardoin, 2008). However, scientists are also called to utilize their knowledge to foster environmental decision making for both individuals and communities (Beddington et al., 2012).

In addition to the need for linking science education theories with environmental behavior theories, the "value-neutral" approach of educating for behavior change does not incorporate the cultural understanding needed to work on scientific research with communities of varied backgrounds, such as Native American Tribes (Israel et al., 1998). Assessing the impact of environmental decision making is also needed in the context of urban agriculture, which is often suggested as an avenue to promote food security and address other sustainability issues (Hamilton et al., 2014; Mok et al., 2014). However, these impacts vary based on the context and form of urban agriculture, which means that individuals' decision making may also differ across these contexts.

In order to explore the interplay of individual decision making and science education frameworks, I completed a quantitative exploration of the relationships between the TPB and VBN in the context of indirect and direct environmental behaviors. This survey was designed based on prior literature that indicated the importance of personal norms and values from the

VBN in environmental decision making. This survey showed that personal norms may be particularly important for indirect environmental behaviors, those that link individuals to larger societal structures such as signing petitions and voting. This research has been impactful in guiding the development of curriculum that was implemented in a non-major's online climate change course. Future studies should continue to explore the differences between different types of environmental behaviors and when those behaviors are related to each other or lead to "spill over" behaviors.

In order to better understand cross-cultural dynamics in community-level environmental decision making, I utilized a qualitative interview study. Interviews of climate change organization employees and Tribal employees and citizens were conducted to examine the ethical practices and training needed for researchers engaging in climate change studies with Tribes. Results indicated that, despite often having mandates to work together or a history of working with Tribes, climate science organizations are not appropriately training their staff to work with Tribes. Interviews also revealed potential avenues for training, such as Tribal conferences and organizational protocols. These results were shared in workshops at the College of Menominee Nation for a network of Tribal citizens, scientists, and non-Indigenous climate scientists. These workshops generated a working group at the 2019 National Adaptation Forum, with the goal of developing and disseminating training guidelines.

The third chapter of this dissertation is a qualitative exploration of the motives, barriers, outside support, and sustainability practices in urban agriculture across the broad locations of the Andean region of South America and the Midwestern United States. This chapter takes into account both individual and community decision making through an exploration of individuals' behaviors and community policies and support in urban agriculture. The TPB guided this semi-structured interview protocol for a total of 17 interviews. Some interesting parallels and differences emerged amongst UA participants in South America and the United States that can guide future development of UA in these spaces. For example, subjective norms around UA are less prevalent in South America, which suggests that further visibility of UA projects may help develop support for UA. This work informed the development of a survey of UA resilience characteristics in Lansing, Michigan, which is subsequently being used to develop resilience workshops for actors in the UA system in Lansing. The interviews were also impactful in guiding the successful development of a Fulbright research grant in Germany with the Research Institute for Urban and Regional Development, which will further examine the motivations and environmental impact of urban farmers.

These qualitative and quantitative explorations of environmental decision making in cross-cultural spaces are one component of addressing sustainability challenges such as climate change and food insecurity. Each chapter of this dissertation addresses further background information, theoretical frameworks, methodology, and detailed results in each of the described contexts.

CHAPTER 1:

DETERMINANTS OF UNDERGRADUATES' ENVIRONMENTAL BEHAVIORAL INTENTIONS AND THEIR LINKS TO SOCIOSCIENTIFIC ISSUES EDUCATION

Introduction

Complex scientific issues are common sources of contention in public opinion and policy debates, requiring science students to be able to incorporate both scientific understanding and broader cultural, political, and social factors. Environmental issues, such as climate change or the use of genetically modified crops, often fall into this category. Students will need to navigate behaviors around these environmental issues (for example, by deciding whether to commute to work in a personal vehicle or via public transport) and therefore require a functional scientific literacy that allows them to integrate scientific understanding with these extraneous factors (Zeidler et al., 2005). Socioscientific issues (SSI) education provides a framework for developing functional scientific literacy in students and includes a focus on student decision making (Armitage et al., 2008; Herman, 2015, 2018). SSI education frameworks utilize broad themes of moral and cognitive development in advancing this goal (Zeidler et al., 2005). This broad focus would benefit from an understanding of specific, measurable components of student decision making. Environmental psychology theories that may provide insight into students' behaviors are rarely featured in SSI education (Fang et al., 2019; Heimlich & Ardoin, 2008; Herman, 2018; Zeidler, 2014).

To understand students' environmental behavioral intentions and provide a platform for incorporating behavior theories in SSI education, this study surveys undergraduates' behavioral intentions using two environmental psychology theories. In surveying student behavioral intentions with a theoretical basis, this study provides guidance for developing SSI instruction based on specific, measurable outcomes. The research questions framing this work are:

1. Is a combined and modified TPB and VBN Theory more effective than the individual models for predicting environmental behavioral intentions of an undergraduate student population?
2. Do individuals' knowledge and gender improve the effectiveness of this model?
3. Based on the most predictive behavioral model, what predicts undergraduate student behavioral intentions for indirect environmental behaviors? Predictors for the group of indirect behaviors are also compared to a direct behavior and a climate change-specific indirect behavior.

This combined model of behavior theories is linked to the SSI education framework in order to provide SSI educators with resources in developing classroom activities, interventions, or assessments that measure determinants of students' behavioral intentions.

Theoretical Frameworks

SSI are controversial social dilemmas based on scientific concepts that involve complicated social and ethical implications (Sadler & Zeidler, 2005; Zeidler et al., 2005). Environmental topics such as climate change have been utilized as an example SSI in prior studies (Herman, 2015; Klosterman & Sadler, 2010; Peel et al., 2017; Stenseth et al., 2016). A focus on SSI in science classrooms contributes to students' functional scientific literacy, wherein students' understanding of scientific content and its links to greater society allow them to engage in robust decision making (Fang et al., 2019; Tal & Kedmi, 2006; Zeidler et al., 2005). SSI education requires that students examine the nature of science, participate in classroom discourse, consider cultural issues, and utilize case studies (Zeidler et al., 2005). Students consider the nature of science by evaluating the strength of scientific evidence and robustness of claims based on that evidence. Educators promote classroom discourse by facilitating discussion among students about SSI. Cultural issues include the wider political, social, and technological context in which SSI and students are embedded. Case studies are the SSI topics used for classroom activities (Zeidler et al., 2005).

In examining SSI decision making, researchers recognize the importance of students' personal beliefs, but have not identified or measured components of those personal beliefs (Gutierez, 2015; Herman, 2015, 2018; Sadler & Zeidler, 2005; Zeidler, 2014). Most SSI research also focuses on decision making processes and not the result of those processes in students' own lives—that is, their behaviors (Herman, 2018). The integration of environmental psychology theories into SSI education can fill a gap in this understanding and provide guidance for SSI classroom activity development.

The Theory of Planned Behavior (TPB) is one model that has widely been used in science education and environmental psychology, for behaviors such as recycling, environmental organization membership, and car use (Bamberg & Schmidt, 2003; Fielding et al., 2008; Kaiser et al., 2005; Summers & Abd-El-Khalick, 2018). The TPB states that an individual's attitudes, subjective norms, and perceived behavioral control related to a specific behavior determine their intention to engage in that behavior (Ajzen, 1991). Intentions are hypothesized to lead to behaviors. Attitudes are defined as a favorable or unfavorable evaluation of a behavior. Subjective norms describe an individual's perceptions of social pressure to engage in a behavior. Perceived behavioral control (PBC) is an individual's evaluation of whether or not they are able to engage in a behavior.

The Value-Belief-Norm Theory of Environmentalism (VBN) is a model in which an individual's values, environmental worldviews, awareness of consequences, ascription of responsibility, and personal norms impact each other in turn to result in an individual's behavior. The VBN has been used to explain a range of environmental behaviors, including recycling, voting, and willingness-to-pay for environmental services (Aguilar-Luzón et al., 2012; López-Mosquera & Sánchez, 2012; Whitley et al., 2018). Biospheric, egoistic, and altruistic values are predictors for environmental worldviews and behavioral intentions (de Groot & Steg, 2008) and have been used in the context of SSI education (Sutter et al., 2018). Biospheric values assign an intrinsic value to nature, egoistic values involve an individual maximizing the benefits of an action and minimizing costs, and altruistic values orientations focus on the costs and benefits for other people (de Groot & Steg, 2008). Environmental worldviews are often measured with the New Environmental Paradigm, a widely used multiple-topic scale that determines whether individuals believe that humans impact the environment (Dunlap & Van Liere, 1978). An awareness of consequences shows the extent to which individuals link their own behavior to environmental impacts. This awareness is predicted to precede an ascription of responsibility where individuals feel personally responsible for negative environmental consequences (Steg et al., 2012; P.C. Stern et al., 1999). Pro-environmental personal norms, a sense of personal obligation to act on environmental issues, is the next component of the VBN. The causal model path of the VBN is not always supported (Aguilar-Luzón et al., 2012); there may be an interaction between personal norms and egoistic or biospheric values as indicated by their relationships to each other in other models (de Groot & Steg, 2008).

Comparisons of TPB and VBN suggest that VBN is superior at modeling simple environmental behaviors such as signing a petition, while TPB is better suited to explaining behaviors that require more effort or have high external constraints, such as reducing car use (Steg et al., 2012). Where variables from VBN and TPB have been integrated, the predictive power of these theories often improves over either theory individually (Abrahamse & Steg, 2011; Fielding et al., 2008; Han, 2015). Examining the variables in each theory reveals how these theories complement each other. Attitude as conceptualized in the TPB, as and benefits of engaging in a behavior, is arguably present in VBN through the awareness of consequences and the broad NEP. While awareness of consequences, ascription of responsibility, and personal norms within VBN describe whether an individual has the personal drive to act, PBC provides a measure of whether or not that individual feels able to act. Behavior requires both desire and ability, so a combination of these variables seems necessary in a behavior model. Indeed, personal norms have been found to be a particularly strong predictor within the VBN (Aguilar-Luzón et al., 2012; Kaiser et al., 2005; López-Mosquera & Sánchez, 2012). Finally, subjective norms were left out of VBN because the authors suggested that environmental behaviors went against social norms (P.C. Stern et al., 1999). Since the majority of individuals in the United States now support many environmental behaviors (Kennedy, 2017), subjective norms may encourage environmental behaviors and should be included.

In addition to complementing each other, variables from the TPB and VBN relate to the SSI framework. Classroom discourse, where peers discuss the scientific processes and their own reasoning related to SSI, should impact students' subjective norms, forming students' perceptions of their peers' expectations around environmental behaviors. Examining the cultural context of SSI is related to students' values and personal norms as they explore their own identities and values in relation to broader societal impacts of SSI.

Knowledge of environmental processes and gender are additional determinants that may impact student behaviors. Educators often measure content knowledge as an outcome of educational interventions (Gifford, 2011; Klosterman & Sadler, 2010; Peel et al., 2017; Sellmann & Bogner, 2013). In the SSI framework, students must evaluate the strength of scientific evidence and incorporate it into their reasoning (Zeidler et al., 2005), thus requiring an understanding of the scientific processes involved. However, whether scientific knowledge affects behavior is unclear. Some studies found strong impacts of knowledge on behavior (Bord et al., 2000; Kaiser et al., 1999) and others found knowledge to have a limited role or none at all (Baptiste, 2018; Kollmuss & Agyeman, 2002). Because of these inconsistencies, it is important to include scientific knowledge in investigations attempting to predict behavioral intentions, especially with student populations.

The impact of gender on environmental attitudes, concerns, and behavior has also been inconsistent across studies. Females have been shown to be more concerned about the environment, have more favorable environmental attitudes, and/or be more likely to engage in environmental behaviors than are males (de Leeuw et al., 2015; Diamantopoulos et al., 2003; Meinhold & Malkus, 2005; Zelezny et al., 2000). Some recent studies have shown no impact of gender on environmental attitudes or behavior (Burn et al., 2012; Herman, 2015; Miao & Wei, 2013; Scannell & Gifford, 2010). These inconsistencies and shifting environmental attitudes in the United States call for updated inquiry into the link between gender and environmental behavior.

Environmental Behavior Typologies and Undergraduate Engagement

This study synthesizes the range of environmental behaviors into two action types: direct and indirect. Direct behaviors, such as using public transportation and increasing home energy efficiency, reduce individuals' greenhouse gas emissions (P.C. Stern, 2000). Similar terms include individual, private sphere, household, and consumer behaviors (Chawla & Cushing, 2007; Kenis & Mathijs, 2012). Direct behaviors are only impactful if many individuals engage in them. Indirect behaviors, such as contacting a government official and joining an environmental organization, aim to impact the institutions through which individuals engage in environmental action (P.C. Stern, 2000). Indirect behaviors include those related to social activist movements and are also referred to as collective, public sphere, or environmental citizenship behaviors (Chawla & Cushing, 2007; Kenis & Mathijs, 2012). Indirect behaviors may be particularly important in creating societal-level changes in greenhouse gas emissions rates (Chawla & Cushing, 2007; Short, 2009) and are relevant to SSI because of the emphasis in SSI on societal-level moral and ethical decision making (Lee et al., 2013; Tal & Kedmi, 2006; Zeidler, 2014). Differences in direct and indirect behaviors may necessitate different behavior theories (P.C. Stern, 2000), and researchers have called for more studies examining different types of environmental behaviors (Abrahamse & Steg, 2011).

Undergraduate students are viable audiences for SSI educational interventions because they are enrolled in institutions of higher education. Undergraduates and other young people generally report more positive environmental attitudes than older populations (Markowitz et al., 2012) and may thus be interested in improving their ability to act environmentally. Indirect behaviors may be even more important for undergraduates than direct behaviors, considering that many undergraduate students have less control of household responsibilities when living in university, shared, or family housing. Additionally, higher levels of education are associated with more political involvement, indicating that college students are more likely to engage in indirect behaviors than their less educated peers (Beaumont et al., 2006). However, most measures of environmental behaviors focus on direct behaviors (Chawla & Cushing, 2007).

This study integrates components of the TPB and VBN to examine predictors for undergraduate student intentions regarding indirect environmental behaviors with a comparison to a direct environmental behavior. These predictors are discussed in the context of SSI education.

Methods

Survey Participants

Surveys were distributed to 984 students in Fall 2016 and Spring 2017 in general education science courses at a large midwestern university via an anonymous online link emailed by their instructors. A total of 132 students complete the survey sufficiently for analysis. Participation in the survey was voluntary and had no impact on students' grades, with the exception of one course in which students received an extra credit point. The response rate was higher in that course, with 30 out of 84 students (35%) completing the survey. The courses integrated introductory physical, biological, and chemical sciences with a focus on the environment. One of the main SSI learning goals in these courses was for students to "use scientific approaches to solving problems in the natural world". Courses emphasized links between how science is connected to other kinds of knowledge and the role of science in students' own lives. Students were encouraged to consider morals and values related to multiple stakeholders' viewpoints on environmental issues such as climate change and road salt application. Through this integrated understanding, focus on problem solving, and contextualization of scientific phenomena in students' lives, these courses utilized components of SSI. Gender, age, and ethnicity were collected to characterize the population (Table 1.1).

Table 1.1 Demographic descriptors of respondents. Students self-reported their gender, ethnicity, and age.

Demographic	Percentage of Respondents
Gender	
Female	53.0%
Male	41.7%
Genderqueer	3.0%
Ethnicity	
White/Caucasian	75.0%
Asian/Asian-American	9.1%
Black/African/African-American	5.3%
Latino(a)/Hispanic	5.3%
Other[1]	4.5%
Age	**Years**
Average (± std. dev)	19.9 ± 1.6
Range	18-29

[1]Includes American Indian/Native American, Native Hawaiian/Pacific Islander, and self-reported Other

Survey Development

Studies integrating the TPB and VBN informed a model for this study to test indirect environmental behavioral intentions with a direct environmental behavior as a comparison. The survey items included TPB determinants of subjective norms, attitudes, and perceived behavioral control, VBN items related to values and personal norms, and students' understanding of climate change processes (Figure 1.1). The New Environmental Paradigm was not used because it contains measures of general environmental attitudes, beliefs, intentions, and behaviors (Dunlap & Van Liere, 1978; Hawcroft & Milfont, 2010). Attitudes, intentions, and behaviors should be specific rather than general when using them in a TPB framework (Ajzen, 1991). Awareness of consequences and ascription of responsibility from the VBN were not included in our model because they indirectly impact behavioral intentions through personal norms (Han, 2015; Kaiser et al., 2005; Klöckner, 2013) and have been shown to be non-significant in other models (Jansson et al., 2011). In order to maintain a reasonable length for the survey to be able to include multiple behaviors, these indirect variables were not included in the model. For use in this study, personal norms referred to a feeling of moral obligation to engage in a behavior. Subjective norms referred to perceptions of others' expectations that individuals engage in a behavior. Survey items were developed based on prior literature as described below and adapted to fit four environmental behaviors.

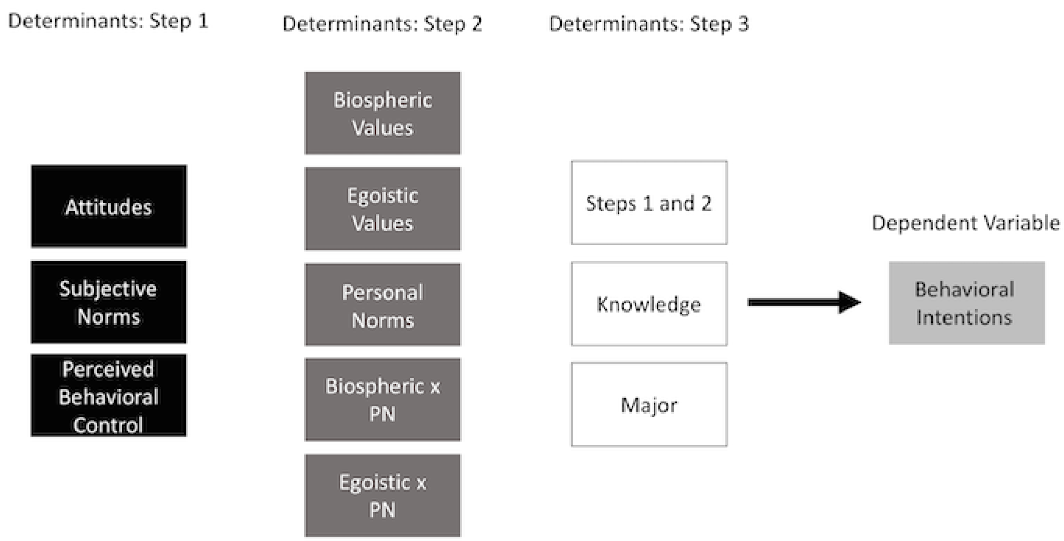

Figure 1.1 Hypothesized determinants of environmental behavior in hierarchical regression. Items in black boxes are from TPB (Step 1), items in gray boxes are from VBN (Step 2), and demographic items are in white boxes (Step 3, with Steps 1 and 2).

The four environmental behavioral intentions of writing a letter to a government official (indirect), voting for a candidate who will fight climate change (indirect), donating to an environmental organization (indirect), and recycling (direct) were chosen to capture a range of indirect environmental behaviors with a direct environmental behavior as a comparison. Recycling was chosen as the direct behavior for comparison because it has been widely studied, including in the context of the TPB and VBN (Barr et al., 2005; Carmi et al., 2015; Guagnano et al., 1995; Wynveen et al., 2012), and therefore should fit the proposed integrated TPB and VBN model well. Each of the indirect behaviors was taken or developed from prior studies on environmental behaviors (Beaumont et al., 2006; Gärling et al., 2003; Oreg & Katz-Gerro, 2006). The structure of questions examining the attitudes, subjective norms, personal norms, perceived behavioral control, and behavioral intentions for these specific environmental behaviors were taken from Harland, Staats, and Wilke (1999) because they were measuring the same variables from the TPB and VBN. A four-point Likert scale was used on items developed for this survey. Other items were taken in the same format they were developed to maintain validity and reliability of previously tested scales.

Questions about students' scientific conceptual understanding were taken from a validated climate change concept inventory (Libarkin et al., 2018). A climate change inventory was used because it represents a significant environmental SSI. A team of experts developed this inventory based on existing measures of climate change understanding and common climate change misconceptions. Questions on this measure were subject to several validity and reliability measures, including Rasch analysis (Libarkin et al., 2018). Five questions measuring a range of climate change content knowledge were chosen (Appendix A).

Environmental values items, measuring biospheric and egoistic values, were used in the same format as de Groot and Steg (2008) on a scale of -1 (the value is *opposed* to the principles that guide you) to 7 (the value is of *supreme importance* as a guiding principle) (Appendix A). The short forms of biospheric and egoistic values were chosen based on their anticipated positive and negative correlations with environmental behavior, respectively (Steg et al., 2012).

Scale Development

Simple confirmatory factor analyses indicated that attitudes, perceived behavioral control, subjective norms, behavioral intentions, and personal norms items each corresponded to a single measurement scale across the four behaviors (Table 1.2). The Cronbach's alpha for each scale was >0.6 (Table 1.2) and all Eigenvalues were greater than 1, indicating that the items for each variable provide an acceptable scale. Knowledge questions and values items were validated in prior studies (de Groot & Steg, 2008; Libarkin et al., 2018).

Table 1.2 Factor loadings for environmental behavior determinants. Each item for the determinants of TPB and VBN were factored together to ensure the measures formed a valid scale. Factor loadings below 0.290 are suppressed.

Theory and Construct	Item	Factor Loadings		
TPB: Attitude	I think recycling is important	0.709		
	I think writing to a government official about an environmental issue is important	0.765		
	I think giving money to an environmental organization is important	0.690		
	I think voting for a candidate who will fight climate change is important	0.752		
TPB: Perceived Behavioral Control	If I wanted, I could recycle during the next 6 months		0.679	
	If I wanted, I could write to a government official about an environmental issue in the next 6 months		0.681	
	If I wanted, I could give money to an environmental organization in the next 6 months		0.726	
	If I wanted, I could vote for a candidate who will fight climate change in the next election		0.761	
TPB: Subjective Norm	People who are important to me expect me to recycle			0.291
	People who are important to me expect me to write to a government official about an environmental issue			0.562
	People who are important to me expect me to give money to an environmental organization			0.480
	People who are important to me expect me to vote for a candidate who will fight climate change			0.773

Table 1.2 (cont'd)

Theory and Construct	**Item**	**Factor Loadings**				
VBN: Personal Norm	I feel a personal obligation to recycle				0.477	
	I feel a personal obligation to write to a government official about an environmental issue				0.688	
	I feel a personal obligation to give money to an environmental organization				0.706	
	I feel a personal obligation to vote for a candidate who will fight climate change				0.491	
TPB and VBN: Behavioral Intention	I intend to, always or in most instances, recycle in the next 6 months					0.603
	I intend to write to a government official about an environmental issue in the next 6 months					0.754
	I intend to give money, even a small amount, to an environmental organization in the next 6 months					0.771
	I intend to vote for a candidate who will fight climate change in the next election					0.537
Cronbach's Alpha		0.812	0.610	0.803	0.685	0.763

Scale scores were created for attitudes, perceived behavioral control, subjective norms, behavioral intentions, personal norms, climate change knowledge, biospheric values, and egoistic values using the alpha command in STATA Version 15 (StataCorp, 2017). Resulting scales were an average of student responses to the items, with higher numbers indicating higher agreement, knowledge, or importance of values.

In addition to an aggregate scale across all four behaviors, three subscales were generated. Because recycling is the only direct behavior, each recycling item was separated out to create a model of direct environmental behavior. A model of climate-specific behavior was also developed using the items related to “voting for a candidate who will fight climate change”. This climate-specific indirect behavior subscale was generated because the knowledge items were specifically climate related, so results from this scale can provide valuable insight into the role of knowledge as it relates to general vs. specific related behaviors. Determinants for the three indirect behaviors, including the climate-specific behavior, were then scaled together to create a model of indirect environmental behaviors, with resulting Cronbach’s Alpha values displayed in Table 1.3.

Table 1.3 Cronbach’s alpha for scales of indirect environmental behavior items. Individual factor loadings for items were all >0.32 and Eigenvalues of scales were >1.

Indirect Environmental Behavior Scale	Cronbach’s Alpha
Attitudes	0.779
Personal Norms	0.668
Subjective Norms	0.769
Perceived Behavioral Control	0.622
Behavioral Intentions	0.635

Regression

Hierarchical multiple ordinary least squares regression of environmental behavioral intentions was performed in STATA Version 15 (StataCorp, 2017). The first step in the hierarchical regressions included only TPB items and the second step only the VBN items. The third step included TPB and VBN items with gender and knowledge (Figure 1.1). Regressions were performed of the behavioral intentions scaled together (Model 1), on the three indirect environmental behaviors as a scale (Model 2), on recycling as a model for direct environmental behavior (Model 3), and on voting for a candidate who will fight climate change as a climate-specific behavior (Model 4).

Results

Overall, students reported favorable attitudes towards the environmental behaviors (Figure 1.2). Attitudes and determinants towards indirect environmental behaviors were lower across all scales than they were for recycling. Students reported slightly stronger average biospheric values of 4.6 than egoistic values with an average of 4.1 on the scale from -1 to 7. On average, students answered 2 of the 5 climate change questions correctly.

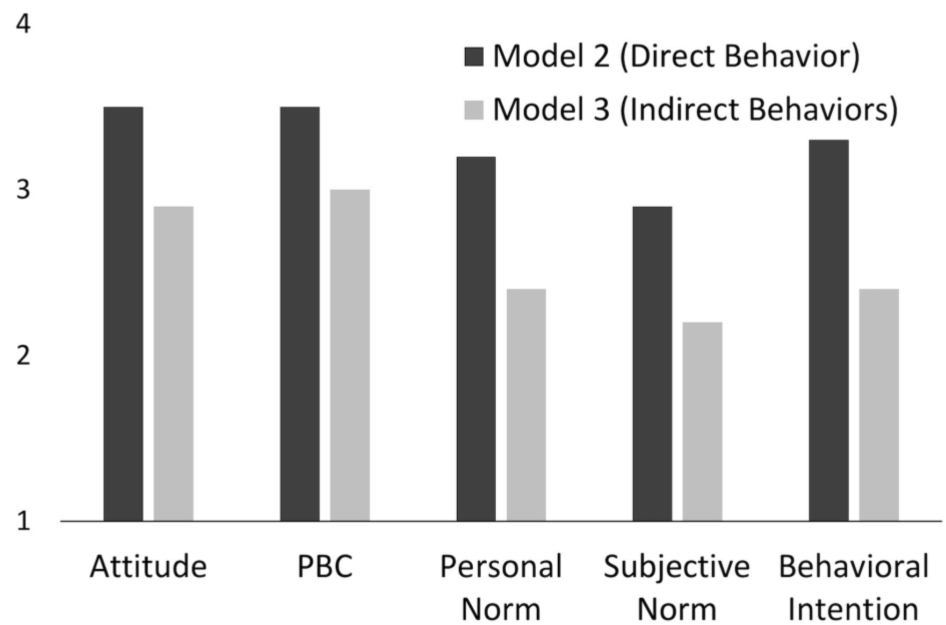

Figure 1.2 Mean responses for scale items. Items are on a 4-point Likert scale with 4 indicating strong agreement. Model 2 displays the average of results for the three indirect behaviors and Model 3 is recycling items only. Model 1 consists of Models 2 and 3 averaged.

The results of the multiple ordinary least squares regression of behavioral intentions on these scaled variables, climate change understanding, and gender is shown in Table 1.4. Three steps of regression models were utilized to investigate the effectiveness of the combination of TPB, VBN, and demographics over each theory alone. To investigate the differences in determinants for indirect and direct behaviors, four different models were used (Table 1.5). Model 1 included all four environmental behaviors, Model 2 included three indirect environmental behaviors of voting for a candidate who will fight climate change, donating money to an environmental organization, and contacting a government official about an environmental issue, Model 3 consisted of recycling only as a direct environmental behavior, and Model 4 contained only the voting item as a climate change-specific behavior. The sample sizes of the regression models satisfy the ratio rules of thumb to have at least 10 participants per independent variable (Van Voorhis & Morgan, 2007).

Table 1.4 Regression coefficients and t-test statistics for all behavioral intentions. The b coefficient and t-stat (in parentheses) from hierarchical multiple least squares regression are shown. Bootstrapping of the R^2 values (1000 reps) followed by a t-test was used to determine significance in difference of R^2 between Steps 1 and 2 and Steps 2 and 3.

Independent Variable	**Step 1: TPB**	**Step 2: VBN**	**Step 3: Full Model**
Attitude	0.254*** (3.71)		0.054 (0.73)
Subjective norms	0.439*** (8.27)		0.272*** (4.47)
Perceived behavioral control	0.195** (2.77)		0.143* (2.08)
Egoistic values		-0.226* (-2.50)	-0.243** (-2.83)
Biospheric values		0.041 (0.77)	0.074 (1.40)
Personal norms		0.456** (2.75)	0.154 (0.910)
Egoistic x PN		0.071* (2.21)	0.081* (2.62)
Biospheric x PN		-0.008 (0.022)	-0.024 (-1.10)
Knowledge			0.069 (0.59)
Gender: Female			0.025 (0.48)
R^2	0.68	0.71	0.76
ΔR^2		0.03***	0.05***
n	132	132	132

In all four models, the R^2 value improved significantly with the combined model over the VBN or TPB. Gender, biospheric values, and climate change knowledge were not significant in any of the models. Subjective norms were a significant predictor of behavioral intentions in all models except for the indirect climate behavior (Model 4). Personal norms were a significant predictor of behavioral intentions for Models 2 and 4 with the indirect behaviors. PBC was a significant predictor of behavioral intentions for Model 1 with all behaviors and Model 3 with recycling. Attitudes were only significant in the combined model with the indirect climate behavior. Finally, egoistic values showed significance in some of the models, and the interaction of egoistic values and personal norms was a significant predictor of behavioral intentions in Model 1 with all behaviors and Model 4 with the indirect climate behavior. In Model 1, subjective norms, PBC, and the interaction of egoistic values and personal norms were positively related to students' behavioral intentions; egoistic values significantly decreased students' behavioral intentions. Indirect environmental behavioral intentions in Model 2 were predicted only by subjective norms and personal norms. Recycling intentions in Model 3 were predicted only by subjective norms and PBC. Climate change voting behavior was predicted by attitudes, personal norms, and the interaction of egoistic values and personal norms.

Discussion

The TPB and VBN appear to be useful theories for conceptualizing undergraduate students' environmental behaviors, with items in the combined TPB and VBN model explaining 49-77% of variation in students' environmental behavioral intentions. The full combined model was more successful at predicting students' behavioral intentions than either model individually, satisfying research question one. Overall, students reported stronger intentions to engage in

Table 1.5 Models 2-4 regression coefficients and t-test statistics. The b coefficient and t-stat (in parentheses) from hierarchical multiple least squares regression are shown. Model 2 tested all three indirect behaviors, Model 3 included only recycling as a direct behavior, and Model 4 examined voting behavioral intentions as a climate change-specific behavior. Bootstrapping of the R^2 values (1000 reps) followed by a t-test was used to determine significance in difference of R^2 between steps.

	Model 2: Indirect BIs			**Model 3: Direct BI (Recycling)**			**Model 4: Indirect Climate BI (Voting)**		
Independent Variable	**Step 1: TPB**	**Step 2: VBN**	**Step 3: Full Model**	**Step 1: TPB**	**Step 2: VBN**	**Step 3: Full Model**	**Step 1: TPB**	**Step 2: VBN**	**Step 3: Full Model**
Attitude	0.310*** (4.61)		0.064 (0.97)	0.278** (2.96)		0.212 (1.97)	0.648*** (9.71)		0.471*** (5.86)
Subjective norms	0.457*** (7.98)		0.183*** (3.03)	0.290*** (5.00)		0.278*** (4.05)	0.185*** (3.40)		0.111 (1.96)
Perceived behavioral control	0.127 (1.86)		0.055 (0.89)	0.208** (2.75)		0.219** (2.78)	0.166** (2.70)		0.107 1.68
Egoistic values		-0.073 (-0.85)	-0.066 (-0.76)		-0.230* (-2.01)	-0.162 (-1.54)		-0.273* (-0.256)	-0.179 (-1.85)
Biospheric values		0.093 (1.71)	0.114 (2.05)		0.092 (1.07)	0.144 (1.83)		0.150 (1.93)	0.120 (1.68)
Personal norms		0.848*** (6.13)	0.685*** (4.71)		0.298** (3.05)	0.022 (0.22)		0.585*** (8.05)	0.247** (2.98)
Egoistic x PN		0.016 (0.52)	0.019 (0.60)		0.077 (1.84)	0.049 (1.26)		0.089* (2.29)	0.075* (2.13)
Biospheric x PN		-0.029 (-1.32)	-0.042 (-1.87)		-0.026 (-0.74)	-0.046 (-1.44)		-0.41 (-1.32)	-0.043 (-1.51)
Knowledge			0.073 (0.58)			0.174 (0.85)			-0.202 (0.183)
Gender: Female			0.018 (0.33)			0.096 (1.07)			0.029 (0.36)
R^2	0.65	0.76	0.77	0.44	0.30	0.48	0.69	0.65	0.75
ΔR^2		0.11***	0.01***		-0.14***	0.19***		-0.04***	0.10***
n	132	132	129	131	131	128	132	132	130

***p<0.001 **p<0.01 *p<0.05

recycling behavior than the indirect environmental behaviors. This indicates the importance of exploring indirect environmental behaviors in the classroom to equip students to address the broader implications of SSI.

Environmental Behavior Determinants

In Model 1 with all four behaviors, subjective norms, PBC, egoistic values, and the interaction of egoistic values with personal norms were significant predictors of behavioral intentions. Egoistic values alone had a negative correlation with environmental behavioral intentions as predicted (de Groot & Steg, 2008). However, individuals who value their own status and also feel obligated to engage in environmental behaviors have amplified intentions to do so over those with strong personal norms and low egoistic values. Based on the current study, egoistic values could support environmental behaviors when individuals' environmental personal norms are activated.

Students' knowledge of climate change processes, biospheric values, and gender were not significant in influencing undergraduate students' behavioral intentions. This answers research question two and supports the use of environmental behavior models without the inclusion of gender and climate change knowledge. SSI education research contextualizes the finding that knowledge was not a significant predictor of behavioral intentions. Students often incorporate their personal beliefs when evaluating scientific information (Zeidler et al., 2005), but the threshold model of content knowledge transfer suggests that once students receive a threshold level of scientific knowledge content, their scientific reasoning in SSI argumentation improves (Sadler & Fowler, 2006). However, there may not be a direct link between argumentation and decision making or behavior (Acar et al., 2010). So while content knowledge is helpful, SSI instruction requires content beyond scientific knowledge to improve students' functional scientific literacy, such as a consideration of their own personal and subjective norms. Attitudes were only significant in the TPB only models, with the exception of the indirect climate behavior of voting. This demonstrates that perhaps items from the VBN are more important than attitudes, which have been found not significant in other models as well (López-Mosquera & Sánchez, 2012). Finally, biospheric values may have an indirect, rather than direct, impact on behavioral intentions as hypothesized by VBN and therefore are not significant in the regression model.

Determinants for Indirect Environmental Behaviors

Regression results across Models 2, 3 and 4 address research question three and show differences in indirect environmental behaviors with the comparison of a direct environmental behavior, recycling, and a climate-specific behavior, voting for a candidate who will fight climate change. For the three indirect behaviors in Model 2, the VBN alone was a stronger predictor of intentions than the TPB. However, this was not the case with the indirect climate behavior of voting in Model 4. This could be explained because VBN was designed with a range of indirect behaviors in mind as a measure of ecological citizenship (P.C. Stern et al., 1999), while TPB is designed to be predictive with very specific matching between determinants and behaviors (Ajzen, 1991). In the climate-specific indirect behavior, attitudes were a significant predictor while subjective norms were not. Similar prior results on voting behavior were suggested to be related to the strength of individualist values (Hansen & Jensen, 2007), which are also an influential component of climate change beliefs, risk perceptions, and support for climate change education according to Cultural Cognition Theory (Kahan et al., 2011; Kunkle & Monroe, 2019). An integration of this framework with TPB and VBN determinants may prove useful in future studies.

The combined items from VBN and TPB were the strongest predictor for the indirect behaviors scaled together, with personal norms and subjective norms as the only two significant determinants of indirect environmental behavioral intentions. Thus, the integration of personal norms into the TPB may be particularly relevant when examining indirect behaviors. PBC appears not to impact indirect environmental behaviors in the same way as recycling, which is supported by a prior study on students' environmental activism (Fielding et al., 2008).

In Model 3, TPB better explains recycling behavioral intentions than VBN. This is in line with theoretical predictions and prior studies; recycling requires the availability of recycling facilities, causing PBC to have a large impact on behavioral intentions (Barr et al., 2005; Carmi et al., 2015; Guagnano et al., 1995). Recycling here serves as a single direct behavior comparison, but similar results were found where PBC was impactful for several direct environmental behaviors in high school students (de Leeuw et al., 2015). These differences between Models 2, 3, and 4 indicate that personal norms may be more important in developing indirect environmental behaviors, and PBC may be more important in developing direct environmental behaviors.

Limitations

The survey methodology used here has several limitations that are worth noting when interpreting these results. The survey measured behavioral intentions rather than actual behaviors. The relationship between behavioral intentions and behaviors is inconsistent, with some studies showing strong relationships (Kaiser et al., 2005; Levine & Strube, 2012) and others showing weak relationships (Gifford & Nilsson, 2014; Hassan et al., 2016; Herman, 2018; Kormos & Gifford, 2014). When possible, future studies should consider ways to measure actual indirect behaviors. Due to survey length concerns, only one direct behavior was used as a comparison to the indirect behaviors. Recycling is not a representative direct behavior, and recycling facilities are widely available in the United States, including on the college campus where this survey took place; therefore, it is a more common direct behavior than others (Barr et al., 2005). However, because of its prevalence in prior studies and use in TPB and VBN models, it provides a useful point of comparison for the purposes of this study. The United States context also influences the indirect behaviors, such as voting for a political candidate, because the structure of its political system allows public engagement.

Implications in the Classroom

The significant determinants of environmental behavioral intentions in this study can guide educators in engaging students around environmental behaviors. First, subjective norms (perceived social approval of behaviors) appear to have an impact on many types of environmental behaviors for student populations. Subjective norms may be activated by discussing environmental behaviors with peers, particularly when some students already engage in environmental behaviors, or by educators demonstrating that they engage in environmental actions (de Leeuw et al., 2015). In a meta-analysis, this social modeling has been shown to be among the intervention types with the largest effect sizes on individual environmental behavior (Osbaldiston & Schott, 2012). SSI classrooms provide opportunities for students to explore subjective norms through classroom discourse, which includes small group discussions and encouraging students to take perspectives of SSI decision makers (Tal & Kedmi, 2006; Zeidler, 2014). Interventions targeting students' subjective norms should measure pre- and post-perceptions of subjective norms and efficacy in changing behavior.

Second, personal norms (feelings of obligation to engage in a behavior) appear to play a strong role in indirect environmental behavioral intentions. To strengthen personal norms, students might be offered the opportunity to engage in contemplative and reflective learning practices where they consider their own thoughts, feelings, and desired actions within environmental systems (Blackmore, 2007; M. J. Stern et al., 2014). Examples of such activities in SSI classrooms include students journaling about or discussing their personal feelings and reactions to SSI (Klosterman & Sadler, 2010; Lee et al., 2013). SSI education researchers should evaluate personal norms as a component of students' understanding of their roles in environmental, cultural, and political systems.

A strategy from SSI that may incorporate both subjective and personal norms is the use of personal narratives. Personal narratives present scientific content within the context of a series of events and incorporates the viewpoints of human characters (Levinson, 2008). Narratives may activate subjective norms through students being exposed to multiple perspectives of characters within narratives, and personal norms via students observing and reflecting on their own reactions to the narrative.

A striking result of this study and others is the lack of students' engagement in indirect environmental behaviors (Kenis & Mathijs, 2012; Markowitz et al., 2012). Teaching students about their role in civic processes can improve students' intentions to engage in citizenship behaviors such as voting or contacting an official (Beaumont et al., 2006). However, even when courses focus on social aspects of environmental issues, students may not feel personally accountable or able to act on those issues (Lee et al., 2013). This again highlights the importance of examining students' own perspectives and roles with personal norms in discussing indirect environmental behaviors. SSI classroom interventions often focus on high-level processes such as national policy development and modeling global carbon cycling (Klosterman & Sadler, 2010; Zangori et al., 2017). Integrating these high-level discussions and models with individuals' roles in socio-political systems may link the broad with the personal and provide students a pathway for identifying indirect actions.

An understanding of behavior theories such as TPB and VBN and their relationship to students' environmental behaviors can provide guidance for SSI educators in designing SSI modules. While there is an understanding of some decision making processes within SSI, the analyses of environmental behaviors here provide specific, quantitative determinants that can be used to develop educational interventions and to measure the impact of those interventions. This study builds on research examining the TPB and VBN with a range of environmental behaviors and suggests that different models are needed in predicting direct and indirect environmental behaviors. Future research that incorporates additional direct and indirect environmental behaviors, larger samples across additional institutions, or develops interventions based on this work would further strengthen the connection between SSI, TPB, and VBN. In offering activities that allow students to explore their own norms towards environmental behavior and the norms of their peers, SSI educators may contribute to an environmentally active populace that can implement climate solutions in years to come.

CHAPTER 2:

TRAINING IS NEEDED TO COLLABORATE ETHICALLY: PARTNERSHIPS BETWEEN NATIVE AMERICAN TRIBES AND CLIMATE SCIENCE ORGANIZATIONS

By

Caitlin K. Kirby, Citralina Haruo, Kyle P. Whyte, Julie C. Libarkin, Chris Caldwell, Rebecca Edler

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 experienced challenges 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 organizations (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 organizations 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 organizations (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 minimize harms and maximize 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 utilized 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 organizations (CSOs). This article outlines the context of climate change adaptation, Indigenous peoples, and their relationships with scientific research organizations in the following literature review section. Our focus is on Indigenous peoples in the United States, but we utilize global examples to illustrate the need to engage in these practices throughout the world. We then further characterize 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 summarizing 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 specialized 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 maximization 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 recognizing 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 recognized and utilized (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 recognized 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 contextualize 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 organizations 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?
    a. 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 organizations, 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 recognized 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 recognizes 567 Tribes as sovereigns, individual states recognize over 50 additional Tribes (Salazar 2016) and there are many unrecognized Indigenous peoples; all of these are encapsulated in our use of the term Tribe. CSOs refer to both federally and privately funded organizations 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 organizations.

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 (Appendix B), with another designed for scientists within a CSO (Appendix C).

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 2.1). 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 2.1 Predetermined overarching themes with example subthemes and exemplary quotes from both perspectives.

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 Organizational protocol
Ethical STEM Training Activities: *Conferences*	Attend Tribal workshops and conferences Organize 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 2.1). The lack of specificity about the need for ethical STEM training within federal and organizational 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 2.1). In addition, little oversight on the part of Tribes or CSOs was evident.

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 2.1). 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.

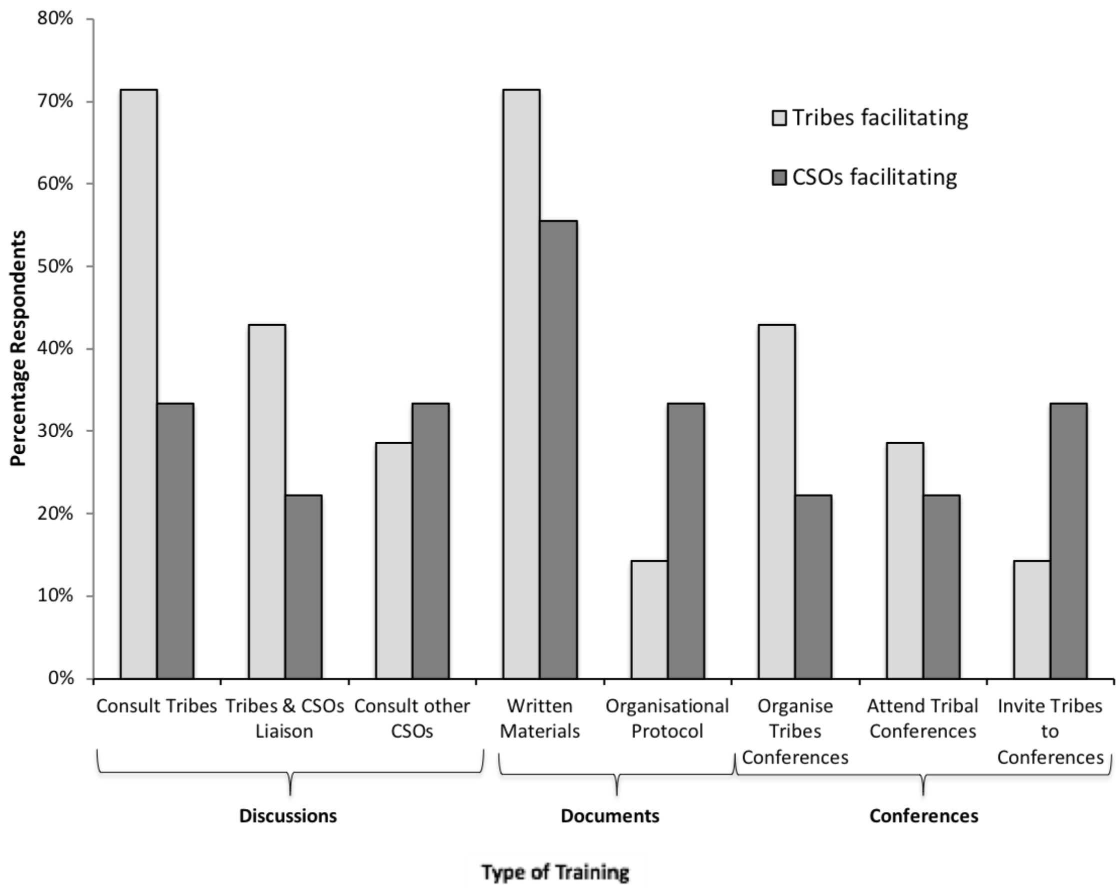

Figure 2.1: Ethical STEM training activities that are facilitated by Tribes (n=7) and CSOs (n=9). Each activity is shown, along with the percentage of respondents who suggested that their organization or Tribe facilitated such activities, either directly or by coordinating them for other parties.

Some respondents' organizations 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 organization, 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 behavior in CSO collaborations with Tribes (Figure 2.1). These included written guides from a variety of sources as well as organizational 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 emphasized 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 2.1). 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 organized 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 organize 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 utilized 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 2.2). 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.

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:

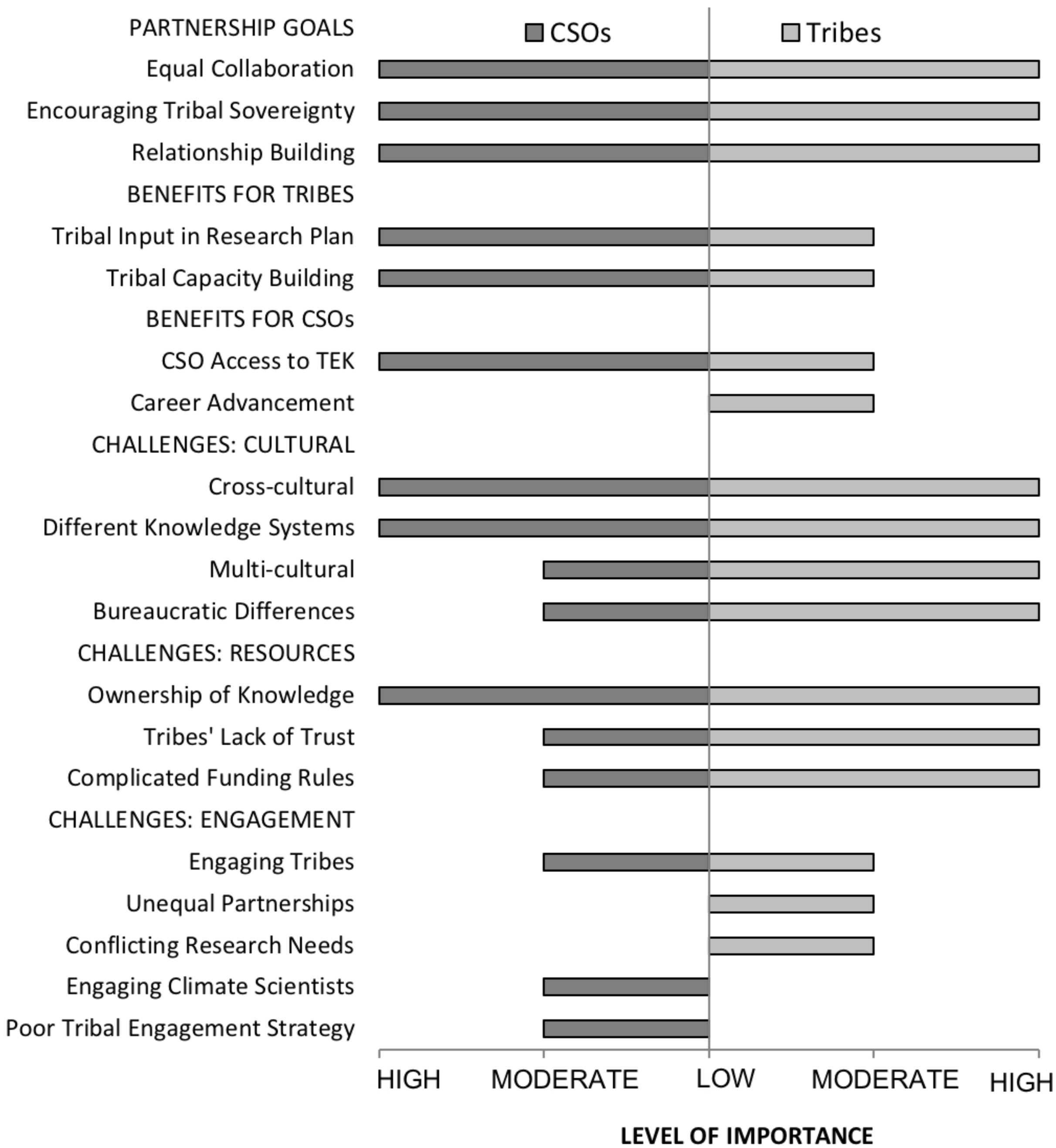

Figure 2.2: Emergent themes and their relative importance for Tribes and CSOs. Partnership goals, benefits for Tribes, benefits for CSOs, and challenges were four main themes identified via thematic content analysis. Levels of importance indicate the percentage of interviewees who discussed a subtheme. Items of low importance were <15% of interviewees, moderate between 15–60%, and high importance subthemes were discussed by >60% of interviewees.

“[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 2.2). 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 2.2). 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 emphasized 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 organization'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 2.2). 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 2.2). 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 2.2). 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 2.2).

Two challenges were mentioned only by CSOs (Figure 2.2), and they were related to the structure of their organizations. 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 analyzed 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 organizations 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 organizations. First, any organization 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 emphasize 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 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 emphasized 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 recognize 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 recognize 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 organizations, 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. Formalizing and publicizing 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 behavior 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 organizations should systematically utilize this training for their employees who will be working with Indigenous peoples. Distinct power differentials exist in the relationships between research organizations and Indigenous peoples, with organizations 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 organizations 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 organizational protocols in order to provide this training consistently. Dedicated commitment by these organizations 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.

CHAPTER 3:

CULTIVATION ACROSS CULTURES: URBAN AGRICULTURE BENEFITS AND BARRIERS IN NORTH AND SOUTH AMERICA

By

Caitlin K. Kirby and Patricia Jaimes

Introduction

Urban agriculture (UA) has the potential to address global sustainability challenges because of its proximity to population centers, relatively low operations costs, and often environmentally-conscious participants (Benis & Ferrão, 2018; Korth et al., 2014; Kulak et al., 2013). To improve sustainability outcomes, many cities are developing UA policies (Campbell, 2016; Vaage, 2015), although UA policies are more widely implemented in developed rather than developing nations (Campbell, 2016; Simatele & Binns, 2008). The anticipated benefits of individual urban growers drive the development of UA policies and adoption of sustainable practices (Prové et al., 2016; Vaage, 2015). Understanding the policy landscape and benefits of UA is important in optimizing UA practices and policies.

Two pictures emerge in examining UA engagement in developed and developing nations. In developed nations, researchers report a wide range of benefits and motivations, such as community building, food justice, and personal enjoyment (Egli et al., 2016; McClintock & Simpson, 2018). In developing nations, researchers focus on food security and income generation as primary impacts, as demonstrated in systematic literature reviews (Audate et al., 2019; Korth et al., 2014; Poulsen et al., 2015). Fewer researchers discuss broader social and environmental aspects of UA in developing nations (e.g. Spiaggi 2005; Othman et al. 2019). In addition, while urban growers express a desire to create environmental benefits, growers' sustainability practices are rarely demonstrated (Guitart et al., 2012). It is important to catalogue growers' behaviors along with their stated benefits or intentions in UA. This study aims to compare attitudes and sustainability behaviors related to UA engagement among a sample in a developed nation (United States) and developing nations (South America) to explore these differences in UA within a single study.

In addition to understanding growers' practices and benefits from UA, an understanding of current barriers for engaging in UA and UA support mechanisms may further guide policy makers. While the context of individual cities' UA movements and policies impacts UA locally (Benis & Ferrão, 2018; Frayne et al., 2014), prior UA research has shown shared themes across developed and developing nations (Hamilton et al., 2014; Mok et al., 2014). However, the majority of UA studies occur within a single city, often with differing terminology and research questions across studies (Pearson et al., 2010; Weidner et al., 2019). There is a need for multi-city research that spans countries with different income levels to best compare and validate prior research findings (Audate et al., 2019). In exploring examples of developed and developing nations' urban growers, we compare these samples to highlight potential avenues for future research and interventions fostering sustainable UA in both locations. This study examines UA projects in the midwestern United States (US) and across three countries in South America (SA). The guiding research questions for this work are:

1. What similarities and differences are there in urban growers' benefits, barriers, and sources of support in samples in the Midwestern United States and South America?
2. What sustainable practices are utilized by these samples of urban growers?

Literature Review

Urban Agriculture Benefits

UA promotes community resilience nutritionally, culturally, and physically. Researchers suggest that food security is a strong benefit of UA in developing nations, where low-income urban households are especially vulnerable to food insecurity due to high and fluctuating food prices (Zezza & Tasciotti, 2010). However, the direct impacts of UA on food security in developing spaces are poorly studied with inconclusive and inconsistent results (Korth et al., 2014; Poulsen et al., 2015; Warren et al., 2015; Zezza & Tasciotti, 2010). UA participants empower themselves through decision-making, beautification of their communities, improved social connections, and growing culturally relevant foods; this is particularly important for women, immigrants, low-income households, and minorities (Buckingham, 2005; Egli et al., 2016; Graham & Connell, 2006). UA may contribute to community health through physical activity, increased fruit and vegetable intake, and improved food security (Egli et al., 2016; Litt et al., 2011). These benefits beyond food security and income generation are often left out of discussions of UA in developing nations (De Zeeuw et al., 2011). This implies that UA is providing food security and income to developing nations, and provides additional benefits in developed nations. A comparative study across developed and developing nations could clarify whether this difference is due to different research questions and framing or due to a difference in benefits.

Urban Agriculture and Sustainability

Climate change, farmland scarcity, and other environmental challenges necessitate a trend towards sustainable agricultural production (Godfray et al., 2010). UA may reduce greenhouse gas emissions over conventional farming due to reduced inputs and lower emissions from food storage and transport (Kulak et al., 2013). Food transport and processing account for most food waste in developing countries (Godfray et al., 2010). UA also contributes to biodiversity and ecosystem services such as pollination and temperature regulation (Lin et al., 2015). A robust local UA movement can encourage sustainable behavior from consumers. Individuals with greater contact with local food systems shift to more plant-based diets and eat more seasonal foods (Weidner et al., 2019). Similar to food security, the extent of these benefits and whether they outweigh potential environmental harms of UA are unclear (Goldstein et al., 2016; Weidner et al., 2019). The extent to which urban growers purposefully and knowledgably engage in sustainable practices is unknown.

Urban Agriculture Barriers and Support

Given the potential benefits of UA, why has it not become universally integrated into the fabric of urban life? Both individuals and institutions experience barriers to UA. Households might lack income to purchase farming materials, access to sufficient space with uncontaminated soil, and access to water (Lovell, 2010; Specht et al., 2015; Weidner et al., 2019). UA also requires knowledge about growing crops, raising animals, or technology management of UA in unconventional locations, such as rooftop gardens or climate-controlled greenhouses (Specht et al., 2015).

Institutions can deter and support local UA movements. Local governments must consider issues associated with UA such as pests, unpleasant odors, contaminated foods, property values and aesthetics (Specht et al., 2015; Vaage, 2015). A lack of land access may encourage urban growers to utilize unowned vacant lots or rented spaces. This creates inherently unsustainable UA sites, which are more often operated by lower-income, marginalized communities (Lovell, 2010; Oyuela & Van Der Valk, 2017). Restrictive city ordinances in developed nations and a lack of policies in developing nations each tend to discourage UA (Oyuela & Van Der Valk, 2017; Alec Thornton et al., 2010; Vaage, 2015). Specific cities in both developing and developed nations have invested in UA success by offering municipal space for UA, creating UA networks, and developing permissive UA policies (Campbell, 2016; Hou & Grohmann, 2018; Prové et al., 2016; Spiaggi, 2005). However, local food system advocates and organizations, rather than local governments, often initiate these policies (Campbell, 2016; Oyuela & Van Der Valk, 2017; Prové et al., 2016). Examining barriers and support across developed and developing nations may reveal the most appropriate intervention points or greatest needs in these different spaces.

Urban Agriculture in the US and SA

The US and SA are experiencing the highest rates of urbanization worldwide (United Nations 2018), making them an appropriate space to study UA. Agriculture has played an important role in the development of the Andean region of SA with recent movements promoting sustainable agriculture in urban and rural communities (Altieri & Toledo, 2011; Carmin et al., 2012; Nadal et al., 2019). Extensive livestock grazing and cropland in SA has deforested and degraded local ecosystems. Improved yields from intensive agriculture has fostered some recovery for these lands (Grau & Aide, 2008), but has also created a surplus of crops that drives down prices and creates instability for farmers, who constitute up to 30% of the workforce in Andean countries (Soper, 2016; The World Bank, 2019; Villavicencio, 2012). UA is an additional mechanism for reducing deforestation by shifting agriculture to urban spaces. Similar to SA, the Midwestern United States has historically been a site of intensive, large-scale agriculture with crops and livestock (Hatfield, 2012). Many midwestern cities have declining industrialization and increasing blight that have bolstered the UA movement (Colasanti et al., 2012; Treece, 2015). Small-scale agriculture became a significant component of US culture from WWII Victory Gardens, and more recently with the rise of environmental movements (Grebitus et al., 2017; Mok et al., 2014). An exploration of individuals' UA engagement with policies can reveal methods for implementing, improving, and sustaining UA given increasing urbanization and food system pressures.

Methods

Theoretical Framework

In exploring why individuals engage in UA in different settings, we utilized the Theory of Planned Behavior (TPB). The TPB was developed by Ajzen (1991) and states that an individual's attitudes, subjective norms, and perceived behavioral control related to a specific behavior will guide their behavioral intentions and behaviors. Attitudes refer to an evaluation of a behavior based on its costs and benefits. Subjective norms are what the individual thinks others expect them to do. Perceived behavioral control is whether someone feels that they are able to engage in a behavior (Ajzen, 1991). The TPB has guided similar studies in examining farmers' sustainability and conservation behaviors (Menozzi et al., 2015; Yazdanpanah et al., 2014) and engagement in UA (Tiraieyari et al., 2019). The aforementioned studies were each conducted in different countries, indicating that the TPB is an appropriate framework for cross-cultural studies.

Respondent Selection

Individuals involved in UA in the US, Peru, Colombia, and Ecuador were contacted via professional networks and snowball sampling to participate in an interview. Cities that demonstrated active online social networks of urban growers were selected. Recruitment posts were made on active, city-specific urban farming, gardening, and permaculture Facebook groups in all locations. Through known individuals, researchers made contact with a community organization leader in Bogotá, Colombia and the Slow Food Peru organization in Lima. The use of online social networks to find initial respondents excludes individuals who are not active on social media or those without internet access. However, professional networks or snowball sampling produced at least one interview in each SA country and US state, thus accessing about equal numbers of respondents through social media as through other organizations and snowball sampling. All urban agriculture projects inclusive of personal gardens, educational farms, non-profit organizations, community gardens, and for-profit farms were included. SA interviews were conducted in the cities of Lima, Peru (n=3), Quito and San Vicente, Ecuador (n=2), and Bogotá, Colombia (n=3). US interviews were conducted with farms in the cities of Chicago, Illinois (n=2), Detroit, Michigan (n=4), and Toledo, Ohio (n=3). Because of the low number of interviewees in each city, analysis is conducted only at the level of US and SA. Participants were interviewed across multiple cities for each region to be able to compare across more than one city context within the US and SA. Initially, interviewees were not offered an incentive; after an interviewee requested an incentive, remaining interviewees received the equivalent of $25 US Dollars.

Cities with a range of populations were chosen to capture diversity in attitudes and policies (Table 3.1). The three SA countries are upper-middle-income economies, while the US is a high-income economy (The World Bank, 2019). The Human Development Indices of the three SA countries range from 0.747-0.752. The Human Development Index of the United States is 0.924 (United Nations Development Programme, 2017).

Table 3.1 Demographic information of cities. Based on 2017 data from the United Nations Department of Economic and Social Affairs (2018).

City	Country % urban	City Pop. (millions)	City Pop. Change 2015-2020
Lima, Peru	77.7	10.2	1.77%
Quito, Ecuador	63.7	1.8	1.55%
San Vicente and Bahía de Caráquez, Ecuador[a]		0.03[a]	1.30%[a]
Bogotá, Colombia	80.4	10.3	2.46%
Chicago, Illinois	81.5	8.8	0.22%
Detroit, Michigan		3.6	-0.56%
Toledo, Ohio		0.5	-0.04%

[a]Data for this urban area is from the 2010 Census (Brinkhoff, 2014). City population change is from 2001-2010.

Semi-structured Interviews

We developed a semi-structured interview protocol based on the TPB and research questions. The protocol asked about 1) farm structure and outputs, 2) sustainability practices, and 3) TPB determinants. Attitudes were elucidated by asking about individuals' reasons for engaging in UA and benefits provided by UA, with probes asking about its ability to provide income, protect the environment, and provide food security. Subjective norms questions focused on perceptions of others' interest and engagement in UA. Perceived behavioral control was explored via questions about barriers to starting an UA project and sources of support for engaging in UA. The interview protocol was written in English, translated into Spanish, and reviewed by two native bilingual Spanish and English speakers. SA interviews were conducted in person in Spanish. US interviews were conducted in English via video messaging or, when technology accessibility was limited, over the phone. Interviews with SA respondents lasted an average of 29 ± 20 minutes and interviews with US respondents lasted an average of 39 ±12 minutes. One SA interview (SA_7) was conducted with a group of five individuals; all remaining interviews were one-on-one. Interviews were conducted until saturation was reached on themes relating to the TPB. Because interviews were conducted in multiple cities, saturation was not intended to be reached on policy questions. The resulting sample size of 8 SA interviews and 9 US interviews are similar numbers per stakeholder group in other UA studies (Colasanti et al., 2012; Specht et al., 2015).

Two researchers with proficiency in English and Spanish developed the codebook based on two SA interviews. Researchers implemented thematic content analysis via constant comparison (Glaser, 1965), assigning themes based on the TPB framework. Broad categories of attitudes, perceived behavioral control, and subjective norms were imposed on the data. As additional sub-themes emerged, they were compared to prior sub-themes and merged or added to the codebook. Coders independently coded the same interview to establish interrater reliability with agreement on 91.8% of themes.

Results

Respondents described their farm structures, sustainability practices, attitudes, subjective norms, and perceived behavioral control around engaging in UA. We discuss these results and highlight similarities or differences across SA and US.

Types of Farms and Sustainability Practices

The purposes of UA projects varied between the US and SA, with a greater diversity of project types in the US. Three US projects were educational, three were for-profit farms, one was a community garden, and one was a network of community and school gardens. US growers frequently sold produce to individuals, restaurants, and through farmers' markets. They also commonly donated produce to family, friends, and community members. Most UA projects in SA had a smaller scope as self- or family-owned projects primarily for personal use. Two projects were community-oriented, with one municipal-owned community and educational garden and one family-owned community garden. Most SA growers sold some produce to friends and family, with a few selling to markets or restaurants. Half of the SA farms also donated produce to community spaces or friends and family. SA farms exhibited additional uses for products beyond those in the US. Half of the SA farms created value-added products, such as medicines or cosmetics, and half of the farms traded produce for other goods.

Several sustainability practices were nearly universally reported across the US and SA. Urban growers most commonly used organic or natural fertilizers (such as garden and kitchen compost) and pest control through natural or organic insecticides or physical barriers. All projects were polycultures, where multiple crops were grown. A few farms reported using one or multiple additional sustainable techniques including rainwater collection, lower water-use irrigation systems, organic and non-GMO seeds, and recycled or eco-friendly materials. Vertical cultivation, the use of built structures to grow plants vertically in order to save space, was more common in SA. A few growers in the US used low or no-till methods and cover crops. One US grower used renewable energy and sustainable transportation for farm business.

Attitudes: Benefits

Attitudes questions targeted the benefits of UA to growers themselves and to society. Respondents often reported positive childhood or educational experiences as their introduction to agriculture. Four overall themes of community sustainability, environmental impacts, personal, and economic emerged (Table 3.2). Community sustainability sub-themes situated UA and its benefits within a broad social network, including those who have access to the farm products, activities, or landscape. Environmental impacts described ways in which UA contributed to an improved environment that was healthier for its inhabitants. Personal benefits were improvements in individuals' physical or emotional health. Economic benefits eased households' financial burdens or provided income.

Community sustainability themes were most discussed and most varied across SA and US. Interviewees from SA and US most evenly discussed the personal and economic themes. The most commonly discussed reason for engagement in UA, though not necessarily the primary motivation, was enjoyment of farming activities.

Table 3.2 UA benefits sub-themes. The prevalence of each sub-theme for SA (n=8) and US (n=9) is displayed. Sub-themes are arranged from highest to lowest overall prevalence and highlighted in gray when there is low agreement (<50%) across the two locations.

Theme	Sub-Theme	SA	US
Community Sustainability	Food security	5	8
	Build community relationships	3	8
	Community empowerment	2	6
	Local food cycle	1	6
	Intergenerational learning	4	2
	Social activism	1	5
	Community connection with environment	2	3
	Improved aesthetics	0	4
	Increase community value	0	4
	Food sovereignty	2	2
	Create safe community spaces	1	2
Environmental	Environmental health and protection	7	8
	Climate change	1	2
	Maintain plant diversity	2	0
Personal	Healthy food	7	6
	Personal enjoyment	5	7
	Learn about agriculture	5	4
	Relationship with food	2	2
	Healthy/active lifestyle	2	2
	Relationship with environment	1	3
Economic	Provides income	5	7
	Cost-effective food production	4	4
	Self-sufficiency	4	2

Community Sustainability. Community sustainability featured the most sub-themes, with US respondents discussing it more often than SA respondents. Respondents felt that UA makes their neighborhoods more valuable, attractive, and safer. UA provides opportunities for community ownership of neighborhood spaces, relationships with nature and neighbors, and resilience through supporting local food systems. Social activism was primarily discussed by US growers, with local urban food production seen as a method to alter socioeconomic and environmental impacts.

Interviewees felt UA contributes to food security through culturally relevant and nutritious food. When asked about food security as a benefit of UA, most interviewees agreed that UA contributes. However, they rarely specified examples of their projects' contributions. Some interviewees doubted that UA improves food security on a large scale: "[UA] can give some people opportunities to… secure their own nutrition. However, I don't know how often that actually happens" [US_17]. These results do not support food security as a primary benefit among the majority of our sample.

Intergenerational learning was more commonly discussed in SA than the US. One SA interviewee described their work with regards to intergenerational learning:

> Estamos conservando el suelo, conservando todas las plantas nativas, conservando toda la parte alimentaria, haciendo una demostración para que la humanidad, sobre todo los niños y aún las personas mayores, se den cuenta que sí se puede. – *We are conserving the soil, conserving all the native plants, conserving all of the nutrition, demonstrating so that humanity, above all the children and even the elders, realize that yes they can* [SA_8].

SA growers often valued having multiple generations involved in UA projects.

Environmental. SA and US interviewees both indicated that UA provides environmental protection, within the city or on the farm site. Interviewees were often vague about how UA protected the environment. A few mentioned specific benefits, including reducing the urban heat island effect, improving air quality through increased oxygenation, remediating poor or polluted soil, using fewer harmful chemicals than conventional agriculture, and contributing to local ecology and biodiversity. Two other sub-themes for environmental impacts emerged. First, UA was suggested to combat climate change, with the potential to "repair the climate and the Earth by changing how we relate to it through our food system" [US_16]. Second, SA interviewees said UA maintained plant diversity, which promotes the environmental sustainability of UA.

Personal. Personal benefits were reported frequently and similarly across SA and US. Personal enjoyment and access to healthy foods were the most common personal benefits. Conventionally farmed foods were considered less healthy than UA products. One respondent from SA included in a list of UA benefits, "para comernos una comida limpia, sin químicos – *to eat clean food, without chemicals*" [SA_7]. SA interviewees emphasized healthy foods by discussing the theme several times throughout an interview.

Many UA growers also felt connected to their work because it provided them with a relationship to their food or an opportunity to get "acquainted with nature" [US_11] and feel "connected to the earth" [US_13]. This was seen as particularly valuable in an urban landscape that otherwise offers few connections with natural elements. Interviewees also felt they benefitted from learning about agriculture and leading a healthy, active lifestyle through farming.

Economic. Economic benefits were discussed fairly evenly across US and SA respondents. Interviewees agreed that income was a potential UA benefit, but it was often regarded as insignificant. Economic benefits were also achieved through spending less on food from other sources, with one SA interviewee deeming it necessary because “las cosas empiezan a subir el precio aquí –*things are starting to go up in price here*” [SA_5]. Similarly, some interviewees felt that UA allowed them to maintain self-sufficiency, such that one could “mantenerse ellos mismos, sin necesidad de un trabajo fijo – *keep up themselves, without the need for a fixed job*” [SA_7]. As in this quote, economic benefits were often discussed hypothetically without specific reference to the tangible benefits for each interviewee.

Subjective Norms

Subjective norms questions asked interviewees what city residents, friends and family, and local policy makers think about UA. Interviewees identified different types of people involved and detailed their levels of involvement and reasons for interest in UA. US interviewees described broad support for UA while SA interviewees described a general lack of interest (Table 3.3). Interviewees from both locations also discussed negative perceptions of UA and variations in interest due to income.

Table 3.3 Subjective norms sub-themes. The prevalence of each sub-theme for SA (n=8) and US (n=9) is displayed. Sub-themes are arranged from highest to lowest overall prevalence and highlighted in gray when there is low agreement (<50%) across the two locations.

Theme	Sub-theme	SA	US
Types and Involvement of People Interested	Most others appreciate UA	3	8
	General lack of interest	7	0
	Diverse and broad interest	0	6
	Others are interested but unengaged	2	3
	Mid/upper-income households most interested	1	1
	Mid/upper-income households most able to engage	0	2
	All income levels able to engage	1	1
Reasons for Interest	Related social movements (e.g. local food)	2	6
Reasons for Lack of Interest	Clashes with corporate, government interests	2	4
	Perceived as dirty/messy	0	5
	Signifies lack of progress	3	0

Three SA interviewees suggested that the lack of UA interest stemmed from agriculture representing a lack of socio-economic progress and thus not attractive to urban residents:

> [Un] gran porcentaje de [la ciudad] es gente … que ha crecido en el campo y ha crecido de padres agricultores, pero ellos prefieren venir acá y sienten que la agricultura y todo eso no es progreso. – *[A] large percentage of [the city] is people … that were born in the country and have been born to agricultural parents, but they prefer to come here and feel that agriculture and all of that is not progress* [SA_3].

In the US, six of the nine interviewees indicated that interest in and support for UA was broad and diverse. There was also discussion of a social movement forming around local, sustainable, and organic agriculture: "It's really supported by the whole 'buy local' movement… Ten years ago, it was a different story, but now it really is supported by, I think, people from all walks of life" [US_14]. This social movement was thought to spark interest in UA.

Five US interviewees suggested that UA could be perceived as messy, with pests and unpleasant odors. Corporations, conventional farmers, and government officials were perceived as uninterested in UA because it goes against economic interests: "If there was retail and housing on the space where my one-acre farm is, they'd be collecting a lot more taxes off that" [US_12]. These negative perceptions of UA were less salient than UA support.

Respondents reported conflicting ideas around income and interest in UA. Two SA and one US interviewee suggested that low-income households receive the highest benefits from UA. Other interviewees (one SA and one US) believed that middle- and high-income households are most interested, with UA "creciendo muchísimo más en los distritos de mayores ingresos económicos – *growing much more in the higher income districts"* [SA_3]. Two US interviewees also said that higher income households can easily engage in UA because they have fewer barriers. One interviewee addressed this alongside the idea food security:

> If you're going to produce all of the food that you would need, it becomes a full-time job. That requires an incredible amount of time and resources… So, the people who would engage in that are less likely to be food insecure themselves [US_15].

Conflicting ideas about income and UA indicate that UA has complex relationships to socioeconomic status.

Perceived Behavioral Control: Barriers and Support

Perceived behavioral control was measured by asking participants about barriers one might experience in starting an UA project and sources of support that enhance their UA work. Resulting barriers were categorized as resource, social, institutional, and environmental barriers (Table 3.4). Resource barriers related to physical, informational, and economic inputs. Social barriers were perceptions of UA and its societal impacts. Institutional barriers described regulations surrounding UA projects' locations and practices. Environmental barriers included factors like climate, pollution, and pests. Institutional and social barriers differed the most across locations.

Resource Barriers. Resource barriers included the most sub-themes and were most common. The space, effort, and knowledge required for engaging in UA were the three most common sub-themes. Inadequate time and insufficient farm laborers were occasionally mentioned. High fees and regulations for water use were more frequent barriers in the US. A few interviewees—one in SA and four in US—felt that the cost of starting a UA project was relatively low, while others considered it a barrier. These conflicting perceptions mirror the subjective norms around income and UA participation.

Table 3.4 UA barriers sub-themes. The prevalence of each sub-theme for SA (n=8) and US (n=9) is displayed. Sub-themes are arranged from highest to lowest overall prevalence and highlighted in gray when there is low agreement (<50%) across the two locations.

Theme	Sub-Theme	SA	US
Environmental	Weather and environmental challenges	1	4
	Not sufficient to overcome environmental issues	1	2
Social	Prefer conventionally farmed food	3	5
	Lack of interest	3	0
	Gentrification	0	2
Institutional	Lack of policy support	6	3
	Zoning and land access	0	7
	Policies restrict UA activities	1	6
	Difficult distribution channels	3	1
	Government regulating established farms	0	2
Resource	Lack of space	5	5
	Hard work	3	6
	Lack of knowledge	3	5
	Access to water	2	6
	Cost of materials	3	4
	Income insignificant	2	5
	Lack of dedicated labor	1	2
	Lack of time	2	1

The income generated from UA was often considered insufficient for supporting a family or even sustaining a UA project. This was often contrasted to the cheap price of conventional produce:

> If you're talking about urban agriculture being growing food inside of a city, there's probably some business model that could actually generate income. But it's really, really, really difficult, because the current system is optimized and extra cost taken out… When I buy a strawberry at Aldi's, I don't pay for all the costs to the planet of that strawberry [US_10].

These results align with the economic benefits, where individuals usually discussed income as a hypothetical UA benefit.

Social Barriers. Social barriers, like subjective norms, largely differed across locations. In both locations, there was a sense that consumers preferred conventionally farmed food because of its availability or affordability, and that this preference reduced the viability of UA. SA interviewees expressed that "a la gente no le interesa mucho cultivar – *people are not very interested in farming*" [SA_4], and in SA this lack of interest was a barrier to UA engagement.

A problematic social consequence of UA in the US was gentrification. One grower discusses how this has influenced perceptions of UA in their neighborhood:

> All the biggest landowning farms in the city [are white] in a majority black city…I think it still sometimes rubs them the wrong way when it's like a middle-class, college-educated Asian-American person coming into their neighborhood and taking an acre of land and building a farm on it [US_12].

This idea that UA projects change the landscape of low-income neighborhoods to suit the preferences of middle- and high-income individuals is echoed in the subjective norms perceptions that higher-income individuals are more interested and able to engage in UA.

Institutional Barriers. Institutional barriers differed across SA and US. SA respondents described a lack of policy support from governments, both local and federal, with five SA respondents being unaware of any UA-related policies. US growers described many UA-related policies, which were often restrictive. Examples include zoning policies that restricted land use, UA businesses, or regulations regarding the keeping of animals and bees. Policies related to food distribution and handling were helpful in some cases and restrictive in others. Unclear and restrictive policies discouraged UA "because people don't know exactly what they can do and can't do" [US_16]. Policies were also a barrier when governments were enacting regulations after a farm had been established, requiring UA managers to adapt their practices: "Two months ago, the city … rushed through an urban ag bill that was very restrictive, very not well thought-out, and addressed issues that… never came up, basically" [US_16]. These regulations seemed to arise from a lack of communication between policy makers and growers. While US growers experienced more institutional barriers overall, SA growers more often discussed poor distribution channels for farm products, where regulations or a lack of UA sales venues prevented sales (Table 3.4). One suggestion for distribution was for local governments in SA to create market spaces for UA and organic produce. In SA this was related to the social barrier of a preference for conventionally farmed food.

Environmental Barriers. Environmental barriers were the least common barriers, with broad environmental and weather barriers discussed more often in the US. Growers worked to address inadequate growing conditions due to sun, soil, or water, and extreme weather events: "I've got to be prepared for drought. You've got to be prepared for a flood, you've got to be prepared for a drop of 40 degrees in one day" [US_11]. Interviewees also expressed that UA alone is not sufficient to respond to broader environmental challenges:

> Pienso que contribuye, pero sin embargo, es como que la ciudad al medio ambiente le hace así de daño, y la agricultura urbana resarce un poquitito – *I think that it contributes, but nevertheless, it's like the city harms the environment, and urban agriculture compensates a little bit"* [SA_3].

This was seen as a barrier to achieving growers' environmental impact goals.

Support. Project support increases perceived behavioral control over UA engagement by reducing barriers. All US farms and only half of the SA farms received support for their project. Support was most often received by UA-focused organizations, and less commonly by governments or policies. The most commonly discussed types of support for UA projects were educational, economic, material, and policy support (Figure 3.1). Education programs taught UA best practices and increased awareness of UA among non-participants. Economic support consisted of grant money or incentive programs that provided tax breaks or refunds. Material support provided UA supplies, such as seeds, tools, or compost. Policy support involved local regulations that allowed or encouraged UA development.

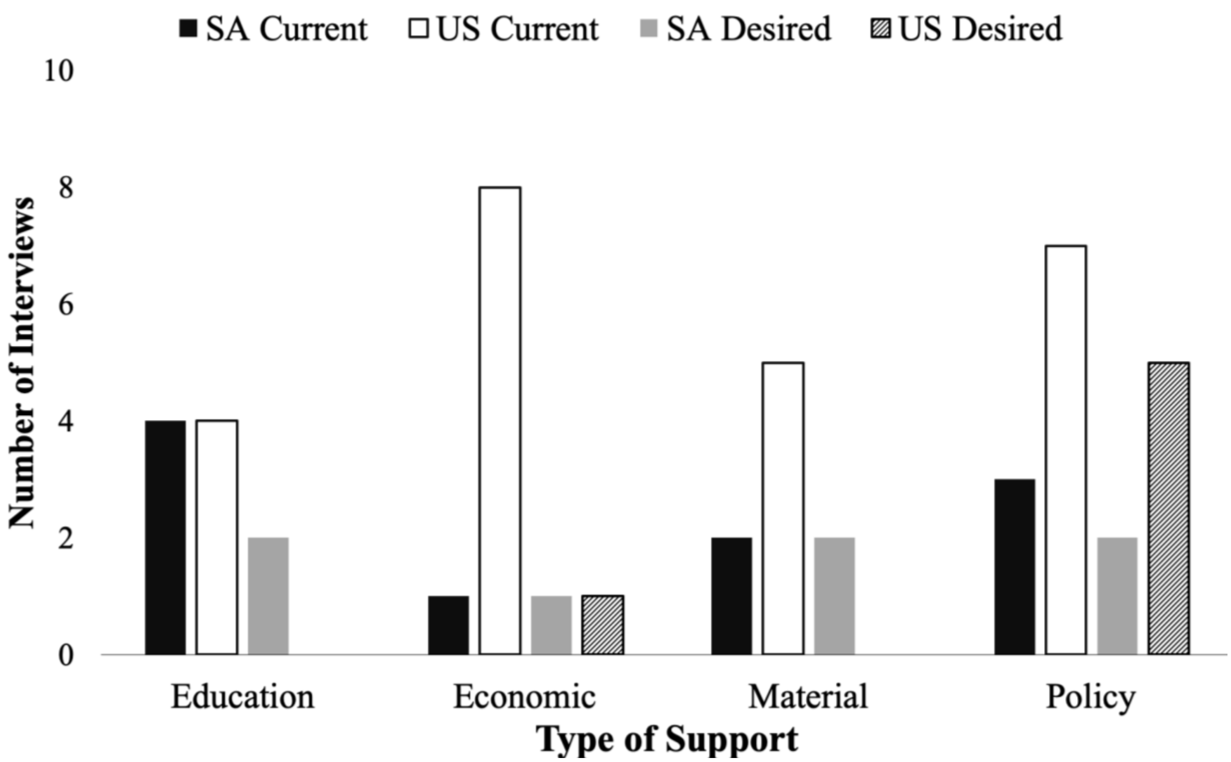

Figure 3.1 Type of support received or desired by UA projects in SA and US. The legend indicates interviewees' locations and differentiates between support that interviewees were receiving (current) and support that interviewees suggested would be useful (desired).

Education support was the most common support received in SA, often by other organizations with a UA focus. Some respondents wanted the government to encourage UA education, particularly through schools. One SA respondent wished the government would "dé talleres, que apoye con semillas, o enseñarles a los chicos, más que todo – *give workshops, support [UA] with seeds, or above all teach the children*" [SA_5]. This quote also demonstrated a desire for material support. Similar to education, materials were most often provided from UA-related organizations. Economic support was the most common type of support in the US, and often came in the form of grants received from cities, local and national non-profit organizations, the United States Department of Agriculture, universities, and corporations. Additional desired economic supports were expansion or creation of grants, reduced price or free water, expanded government loan programs to include UA projects, and tax breaks or credits to landowners who practice or rent out to UA projects. Only one SA grower had received grant money, and the city program that allotted those funds had since been discontinued. Policy support ranged from more passive support, such as allowing organic or local food markets, to more active support through city-owned land being used for UA. At least one US interviewee from each city mentioned a way in which zoning or land use policies were supportive of UA in allowing it to exist. While some interviewees desired more government support through policies, three US interviewees desired less government intervention, and one each from SA and the US mentioned specific ineffective or discontinued government interventions. A suggested mechanism for improving UA policies was to involve the community, including UA managers and other city residents, in policy creation.

Discussion

Differences and similarities in attitudes, subjective norms, and perceived behavioral control in this sample highlight potential avenues for supporting UA across SA and US. We integrate the components of the Theory of Planned Behavior to first discuss similarities in UA across SA and the US, and then address how differences in the determinants of TPB may impact the effectiveness of interventions or support in each location (Table 3.5).

Table 3.5 Overview of Theory of Planned Behavior themes and policy support. Summarized similarities and differences across the US and SA respondents.

Construct	Unique to SA sample	Unique to US sample	Both SA and US sample
Attitudes	Strong intergenerational learning, healthy food benefits	Strong community sustainability benefits	Strong personal, environmental, economic benefits
Subjective Norms	Lack of interest	Broad interest	Concerns over income and UA
PBC: Barriers	Strong social barriers	Strong institutional barriers	Strong resource barriers
PBC: Support	Support primarily from organizations rather than policies	Strong economic support	Educational support fairly accessible

Urban Agriculture Similarities

Similarities in attitudes indicate that individual benefits contrast somewhat with portrayals of UA in prior literature (Hamilton et al., 2014; Korth et al., 2014; Mok et al., 2014). The sample size and data collection methods of this study do not allow for generalization, but the in-depth nature of the interviews reveals some nuanced differences and similarities that provide a novel contribution to the literature and avenues for future study. UA participants reported contributing to their communities, households, and health through UA. The overall similarities across benefits in US and SA indicates potential for collaboration between urban growers, support organizations, or policy makers in each location. It is important to note that food security, while widely discussed, was rarely implicated as a concrete benefit for respondents or their communities. This was particularly true among for-profit UA farms and aligns with inconsistent findings about the significance of food security (McClintock & Simpson, 2018; Warren et al., 2015).

Interviewees shared the drive to produce environmental benefits from UA and engaged in many sustainability practices. However, few interviewees cited specific ways in which UA improved environmental outcomes. Interviewees also did not discuss potential negative impacts of UA on the environment, such as mosquito breeding, competition for water, and intensive energy inputs (Lin et al., 2015; Weidner et al., 2019). Sustainability practices that limit the use of insecticides may be particularly important in tropical areas where UA practices have shown to propagate insecticide-resistant mosquitos (Hamilton et al., 2014). In the Midwestern US, climate-controlled UA projects require high energy inputs that may make UA less sustainable than its conventional counterpart (Weidner et al., 2019). The results from this sample indicate that sustainability technologies would be readily adapted in UA but may require education of urban growers.

Lack of space is a common challenge in UA, particularly in SA. One study estimates that in Colombia around 7.5% of urban land would be required to provide food security to the country's poorest households, compared to 1.3% of US cities for the same scenario (Badami & Ramankutty, 2015). A few interviewees utilized rooftop gardens and vertical cultivation. Such methods of farming without land are known as Zero-acreage farming or Zfarming. The use of Zfarming methods in SA could ameliorate space constraints, however they may require expensive technologies to implement sustainably (Nadal et al., 2019; Specht et al., 2015). Researchers should further examine the environmental impact of these potentially resource-intensive farming methods, particularly because UA growers, in this sample and others (Guitart et al., 2012; Kirkpatrick & Davison, 2018; McClintock & Simpson, 2018) often engage in UA due to its perceived environmental benefits.

Across both samples, respondents were concerned about the ability for low-income households to engage meaningfully in UA. Respondents reported conflicting perceptions about the relationship between income and ability or interest to engage in UA. Prior studies mirror this

lack of clarity, where UA is suggested to be impactful for low-income households, but those with the lowest income are less able to acquire land or invest money and labor into their farms (Frayne et al., 2014; Specht et al., 2015; Zezza & Tasciotti, 2010). This also echoes critiques that UA reinforces societal inequalities rather than addressing issues for the lowest socioeconomic demographics and that mostly white, middle-class individuals are becoming involved in the UA movement (Campbell, 2016; Prov
é et al., 2016). Cities that adopt UA ordinances often do so in the hopes of generating economic activity (Vaage, 2015), which may further exclude low-income households. This underscores the need for UA policies to include funding mechanisms and involve low-income communities in policy development.

Urban Agriculture in South America

SA growers in our sample were more often engaged in smaller UA projects for personal use, a common trend across Latin America (Madaleno, 2000; Shillington, 2013). However, some SA growers hoped to develop their farms into businesses or otherwise expand their operations. UA support interventions in SA might thus focus on scaling UA projects. Other attitudes expressed by our interviewees point to potential community sustainability benefits for interventions to highlight, such as familial units and cultural preservation. For example, SA growers' focus on intergenerational learning and maintaining plant diversity honors the role of traditional knowledge that often originates in rural communities and may be preserved through UA (Young & Lipton, 2006). Overall attitudes in SA refute that food security and income generation are significant benefits in our sample, with personal health, environmental health and self-sufficiency being discussed more often as growers' reasons for engaging in UA. Education programs or workshops on UA may consider what benefits are most realistic for the population they are working with, and whether a focus on food security or income is relevant.

Perceived behavioral control and subjective norms responses revealed connections between UA barriers and perceptions, which elucidate ways to address the growing UA movement. Primary challenges experienced by the SA sample were encouraging interest in the local food movement and generating support for UA projects. Interviewees perceived that most SA residents are uninterested in UA, which has stifled UA support. For example, one interviewee in Ecuador described an NGO that discontinued UA workshops due to poor attendance. Garden education for schoolchildren, recruiting for agriculture programs in universities, and campaigns that encourage individuals to learn to grow food represent opportunities for engaging people in UA. These opportunities require institutional involvement. Any UA campaigns should emphasize benefits that are culturally important to local citizens (Prové et al., 2016), such as personal health. They should counteract the sentiment described by interviewees and in prior literature that agriculture is a rural activity that represents backwards progress (Prové et al., 2016; Alexander Thornton, 2008). Individuals can also support descriptive subjective norms around UA by allowing their projects to be visible and sharing their experiences. Subjective norms are an individuals' perceptions of what behaviors their peers are engaging in or support, and are likely to impact individuals' behaviors around environmental actions such as UA (Schultz et al. 2014; Tiraieyari et al. 2019; Author, *in review*).

SA growers in our sample conduct UA without significant institutional or resource support. SA growers were unlikely to suggest economic support mechanisms, focusing instead on a need for education and infrastructure for UA projects and businesses, such as local/organic markets. Local governments, NGOs, and community organizations might consider how local food production can be supported through local food markets and educational programs. Creating a more visible presence of UA might also work to increase subjective norms. Quito, Ecuador has enacted a climate plan and a few local UA initiatives that indicate potential for further policy development (Carmin et al., 2012; Nadal et al., 2019). To best support UA policy development, organizations should convene UA networks, including groups such as universities, nonprofit, and community gardeners (Campbell, 2016).

Urban Agriculture in the United States

US growers more often discussed community-level benefits of UA, such as community building and social activism. This difference in individual benefits may reflect structural factors in the US and SA. The integration of UA into community structures in the US allows urban growers to act as agents of change in their communities, with growers across the US and Canada reporting similar community-level motivations (Campbell, 2016; McClintock & Simpson, 2018).

In the US sample, UA challenges were maintaining strong resource support and navigating complicated policies. UA policies were fairly well-known among our sample of US urban growers, and more UA projects studied were educational or entrepreneurial endeavors. This integration into community structures led to a wider range of institutional barriers. Institutional barriers described by US respondents, such as zoning, land access, and preferring other development are UA challenges in many developed spaces (Campbell, 2016; Neilson & Rickards, 2017; Vaage, 2015). In addition, US interviewees indicated that economic support was available to them through various policies and believe that funding should be included in policy development (Campbell, 2016). Urban planners should be made aware of these challenges and the variety of functions and benefits of UA to a city landscape, such as food supply, income generation, and water management (Aubry et al., 2012). Similarly to SA farms, a strong network of active UA participants is an important component of further integrating UA within the urban landscape in the US (Campbell, 2016).

Conclusions

UA is a complex activity, involving multiple types of farm management, business practices, policy support mechanisms across developing and developed nations. Despite this complicated picture, many benefits of UA are seen among its participants, with an emphasis on food security and income generation in developing nations and community building and environmental impacts in developed nations. While this study partially supports these different narratives, it also indicates that growers' benefits from UA may be more similar across these spaces than previously documented. Future research should quantify the benefits and barriers of urban growers across many cultural spaces. Future studies should also consider the socioeconomic status of participants to further explore the complex perceptions of relationships to income and UA. A deeper understanding of growers' practices can influence the actions of non-profits, city policy-makers, and urban growers to provide maximum desired benefits to individuals and communities.

APPENDICES

APPENDIX A

PREVIOUSLY VALIDATED CLIMATE CHANGE KNOWLEDGE AND VALUES SURVEY ITEMS

The question stem for the values survey items is as follows, with the items in Table A.1: Below you will find 3 values. Behind each value there is a short explanation concerning the meaning of the value. Could you please rate how important each value is for you AS A GUIDING PRINCIPLE IN YOUR LIFE?

The rating scale is as follows:
0 means the value is *not important at all*; it is not relevant as a guiding principle in your life
3 means the value is *important*
6 means the value is *very important*

-1 means the value is *opposed* to the principles that guide you
7 means the value is of *supreme importance* as a guiding principle in your life

Your scores can vary from -1 up to 7. The higher the number (-1, 0, 1, 2, 3, 4, 5, 6, 7), the more important the value is as a guiding principle in YOUR life.

Table A.1 Biospheric and egoistic value items. Questions were taken from de Groot and Steg (2008) on their scale of -1 to 7. The question stem describing the rating system is also included in the table.

Value Type	Items
Biospheric	UNITY WITH NATURE: fitting into nature RESPECTING THE EARTH: harmony with other species PROTECTING THE ENVIRONMENT: preserving nature
Egoistic	INFLUENTIAL: having an impact on people and events WEALTH: material possessions, money AUTHORITY: the right to lead or command

Table A.2 Climate change knowledge questions. Questions were taken from Libarkin et al. (2018) with correct answers in bold. The percent correct displayed is from the question validation data in Libarkin et al (2018) and was used as a measure of question difficulty.

Question	Percent Correct
1. How has the amount of carbon dioxide in the atmosphere changed since the start of the Industrial Revolution 150 years ago? A. The amount of carbon dioxide has remained the same. B. The amount of carbon dioxide has decreased. **C. The amount of carbon dioxide has increased.** D. I do not know.	87%

Table A.2 (cont'd)

Question	Percent Correct
2. Which of the following best describes how plants take in carbon dioxide? A. Plants take in carbon dioxide from rain. B. Plants take in carbon dioxide from sunlight. **C. Plants take in carbon dioxide from air.** D. Plants take in carbon dioxide from soil. E. I do not know.	75%
3. Which is the most common form of radiation given off by Earth's surface? A. The Earth's surface mostly gives off visible radiation. **B. The Earth's surface mostly gives off infrared radiation.** C. The Earth's surface mostly gives off ultraviolet radiation. D. Earth's surface does not give off radiation. E. I do not know.	36%
4. Which is the best definition of a positive feedback loop in the climate system? A. A change in the climate system leads to a response that benefits climate change. B. A change in the climate system leads to a response that slows down climate change. **C. A change in the climate system leads to a response that speeds up climate change.** D. A change in the climate system leads to a response that harms climate change. E. I do not know.	22%
5. Averaged over long time periods, how does the amount of energy arriving from space compare to the amount of energy leaving Earth? A. The amount of energy arriving from space is greater than the amount of energy leaving Earth. B. The amount of energy arriving from space is less than the amount of energy leaving Earth. **C. The amount of energy arriving from space is roughly equal to the amount of energy leaving Earth.** D. I do not know.	16%

APPENDIX B

SEMI-STRUCTURED INTERVIEW PROTOCOL FOR TRIBAL CITIZENS AND EMPLOYEES

At Start of Interview - Virtual via Go To Meeting/Skype/Google Hangout

Hi, my name is [Name]. May I call you Dr/Mr/Ms____________?

[WAIT FOR REPLY]

Thank you for agreeing to participate in this interview. Have you read the consent form? Do you have any questions about the consent form? I wanted to remind you that I will be audio recording for transcription purposes only.

[WAIT FOR REPLY]

In this interview, we are interested in getting a better understanding of how climate science organizations and Tribes interact. We are specifically interested in your personal experiences and ideas. We have an interview protocol with about 20 questions that we have developed to ask you about your experiences.

Now, we would like to define two terms for you. In the interview we use the term **Tribes** broadly to designate diverse Indigenous populations, including federally-recognized, state-recognized, and unrecognized Tribes or other Indigenous peoples.

When we ask questions about **your tribe** or **Tribal organization**, we are referring to the Tribe for whom you work or in which you are a member.

Do you have any questions before we begin?

Great. We are starting the recording.

This is CE_____

Interview Protocol

1. Please describe how your Tribal organization works with climate science organizations.
PROBE: Describe your own personal experience working with climate science organizations.

2. Do you think it is important for Tribes to work with climate science organizations?
PROBE: Please explain why (or why not).
PROBE: What is the benefit for tribes?

3. Do you feel that your Tribe, including its agencies and departments, prepares its staff to work with climate science organizations?
PROBE (if YES only): Can you explain how?
PROBE: How does your Tribe foster relationships between climate scientists and Tribal members or affiliates?
PROBE: What is your role, if any, in this preparation?
PROBE: Can you think of any other activities your Tribe engages in that might prepare staff to work with climate science organizations?

4. What could your Tribe do differently to prepare climate scientists to work with Tribes?

5. Could you describe any additional activities that you personally engage in to prepare scientists to work with Tribes?

6. What do you know about how climate science organizations or climate scientists prepare to work with Tribal members or affiliates?

Now I will describe some specific scenarios.

7. Imagine that a climate scientist has collected data from Tribal lands. Do you feel that climate scientists are properly trained on how to work with Tribes in the data collection and publication process?

8. Imagine that a climate scientist receives a grant that allows collaboration with a Tribe, and allows funds to be allocated to the Tribe. Do you feel that climate scientists are properly trained on how to work with Tribes in the allocation of grant funds?

9. Do you feel that climate scientists are properly trained on possible conflicts that may occur between scientific deadlines and Tribal protocols?
PROBE if YES: What approaches are being used?
PROBE if NO: What approaches do you think could be used to assist scientists?

10. Are there other issues related to working with Tribes that climate science organizations should prepare for?

11. How do scientists become aware of treaty rights or Tribal cultural norms?

12. Does training prepare scientists to develop solutions that are culturally relevant to the Tribal context?

13. Is there anything else scientists need to know about the Tribal context?

14. In general, how effective is the overall training that scientists working with Tribes receive?
PROBE: How would you measure the effectiveness of this training?

15. Is there any type of additional training you feel would further benefit the relationship between Tribes and climate scientists?

16. Does your Tribe's official stance on climate change impact how the Tribe engages with climate scientists?

17. Does your personal perspective on climate change impact how you engage with climate scientists?

18. Is there anything else you would like to add?

APPENDIX C

SEMI-STRUCTURED INTERVIEW PROTOCOL FOR SCIENTISTS AT CSOS

At Start of Interview - Virtual via Go To Meeting/Skype/Google Hangout

Hi, my name is [Name]. May I call you Dr/Mr/Ms____________?

[WAIT FOR REPLY]

Thank you for agreeing to participate in this interview. Have you read the consent form? Do you have any questions about the consent form? I wanted to remind you that I will be audio recording for transcription purposes only.

[WAIT FOR REPLY]

In this interview, we are interested in getting a better understanding of how climate science organizations and Tribes interact. We are specifically interested in your personal experiences and ideas. We have an interview protocol with about 15 questions that we have developed to ask you about your experiences.

Finally, we would like to define one term for you. In the interview we use the term **Tribes** broadly to designate diverse Indigenous populations, including federally-recognized, state-recognized, and unrecognized Tribes or other Indigenous peoples.

Do you have any questions before we begin?

Great. We are starting the recording.
This is CE_______

Interview Protocol

1. Please describe how your organization works with Tribes.
PROBE: Describe your own personal experience working with Tribes.

2. Do you think it is important for climate science organizations to work with Tribes?
PROBE: Please explain why (or why not).
PROBE: Are there specific policies or legislation that require you to work with tribes?

3. Do you feel that the climate science organizations you work with prepare their staff to work with Tribes?
PROBE (if YES only): Can you explain how?
PROBE: How does your organization foster relationships between climate scientists and Tribal members?
PROBE: What is your role, if any, in this preparation?

PROBE: Can you think of any other activities your organization engages in that might prepare staff to work with Tribes?

4. What could your climate science organization or climate science organizations do differently to prepare their staff to work with Tribes?

5. Could you describe any additional activities that you personally engage in to prepare scientists to work with Tribes?

6. What do you know about how Tribes prepare to work with climate scientists?

Now I will describe some specific scenarios.

7. Imagine that a climate scientist in organizations you are familiar with has collected data from Tribal lands. How does the training your staff receives guide them in the data collection and publication process?

8. Imagine that a climate scientist from your organization receives a grant that allows collaboration with a Tribe, and allows funds to be allocated to the Tribe. How does the training your staff receives provide them with guidance on distributing grant funds?

9. Do you feel climate scientists are trained on possible conflicts that may occur between scientific deadlines and Tribal protocols?
PROBE if YES: What approaches are being used?
PROBE if NO: What approaches do you think could be used to assist scientists?

10. Are there other issues related to working with Tribes that climate scientists should prepare for?

11. How do climate scientists become aware of treaty rights or Tribal cultural norms?

12. Do climate scientists receive training to help them prepare culturally relevant climate solutions for Tribes?
PROBE: What does/would this training look like?

13. Is there anything else that scientists need to know about the Tribal context?

14. In general, how effective is the overall training that scientists working with Tribes receive?
PROBE: How would you measure the effectiveness of this training?
PROBE: Does your organization collect data on the effectiveness of training?

15. Is there any type of additional training you feel would further benefit the relationship between Tribes and climate scientists?

16. Is there anything else you would like to add?

APPENDIX D

REPRINT PERMISSION FOR CHAPTER 2

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