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Enhancing climate change adaptation: strategies for community engagement and university-community partnerships

James S. Gruber · Jason L. Rhoades · Michael Simpson ·
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Abstract This paper discusses current opportunities for universities to partner with local governments and NGOs to support local level adaptation to climate change and a proposed ten-stage model which delineates the key stages of a collaborative climate change adaptation process. We offer findings and recommendations based upon two case studies of recently completed regional climate change adaptation projects in New Hampshire and Minnesota. These recommendations are also informed by previous research on effective community-based natural resource management programs and the role of building local community capital to support ongoing adaptation efforts. Key findings include the identification of relevant and significant roles for higher education that are supportive of local climate change adaptation efforts. These roles include, but are not limited to, conducting applied climate change research, assessment of current conditions and the risks from

severe weather events, translating science for lay audience and local decision makers, disseminating local-scaled climate information, providing technical support for multisector collaborative planning efforts, and evaluating the effectiveness of local adaptation actions. Both case study sites found that the involvement of higher education in local climate change adaptation efforts raises the legitimacy of the process.

Keywords Collaborative planning · Climate change adaptation · Local government · University roles · Stakeholder engagement · Engaged scholarship

Introduction

Local communities across the USA are experiencing adverse impacts from increases in severe weather events (IPCC 2013; Interagency 2010; National Resource Defense Council 2012). Community leaders are becoming aware of projected changes in our climate and are considering how these changes might impact the future sustainability of their community. These evolving needs of local communities present unique and important opportunities for universities to develop new partnerships that can provide needed support for undertaking climate change adaptation. Universities may be well positioned to provide requisite technical expertise and outreach and to offer a range of resources for local adaptation efforts (Lowe et al. 2009).

Focusing adaptation efforts at the local scale is logical and responsive to the site-specific nature of climate impacts and vulnerabilities (Few et al. 2007) and allows for local experimentation of innovative approaches (Castán Broto and Bulkeley 2013). Local level adaptation planning can also provide a tailored response in part by tapping into local

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knowledge, values, and attitudes to better understand the vulnerability of key human and environmental systems, the communities' primary concerns, and potentially effective and acceptable responses for addressing those concerns (Adger et al. 2009; Collins and Ison 2009; Winsvold et al. 2009). Integrating public participation into adaptation planning through a well-facilitated engagement process is a valuable tool to help incorporate locally held knowledge, beliefs, attitudes, and values into the decision-making process (Castán Broto and Bulkeley 2013; Nelson 2009; Rowe and Frewer 2000; Smit and Wandel 2006; Vedwan et al. 2008).

Substantial barriers exist, however, which make it difficult to undertake this type of adaptation at the local level. Primarily, in planning, there is a tendency to discount events that are far removed in space and time. This results in resistance to incorporating climate change adaptation into future plans (Broad and Agrawala 2000; Hillerbrand and Ghil 2008). This tendency to resist adaptation is reinforced in policy makers who question the legitimacy of the scientific information being used that is based upon confidence or probability levels rather than "certainty" (Walker et al. 2002). A participatory process focused at the local level can be an effective way to address this resistance and to build legitimacy of planning for climate change adaptation and raising awareness of the need to reduce GHG generation. As part of this process, it is important that scientific and technical data on climate change be documented, effectively downscaled for the local region, clearly communicated to the lay public and policy makers, and then reviewed and discussed by a broad cross section of stakeholders in an open and transparent manner (Agrawala et al. 2001; Lowe et al. 2009; Reid et al. 2009). Numerous studies have shown that participatory approaches and support for transparency in decision-making activities and stakeholder actions are critical for the legitimacy of an initiative (Barker 2005; Campbell and Vainio-Mattila 2003; Cloutier and Joerin 2012; Gruber 2010; Walker et al. 2002).

Even if there is some interest among specific local organizations or branches of government in undertaking a participatory climate change adaptation process, the lack of resources or capacity can also present a significant barrier to action. Organizations and institutions at the local level may not have the financial resources to research, plan, or undertake adaptation. Furthermore, they may not have the technical capacities needed to analyze and respond to such a complicated issue. Lastly, they may not have sufficient experience with conducting outreach and facilitating a participatory process. Local governments in the Northeast highlighted these types of issues in a recent needs assessment conducted by the climate change focused nonprofit, Clean Air Cool Planet (Clean 2011).

Despite the great potential for universities to support local level climate change adaptation, collaboration on a project as complex as climate change adaptation is a challenging task.

This paper proposed a working model for collaborative adaptation planning and explores opportunities for universities to partner with local organizations and governments using this model as a framework. Specifically, using this model, this research further seeks to better understand the support that local organizations seek and to delineate the roles that universities and local partners may be best suited to play throughout a climate change adaptation process.

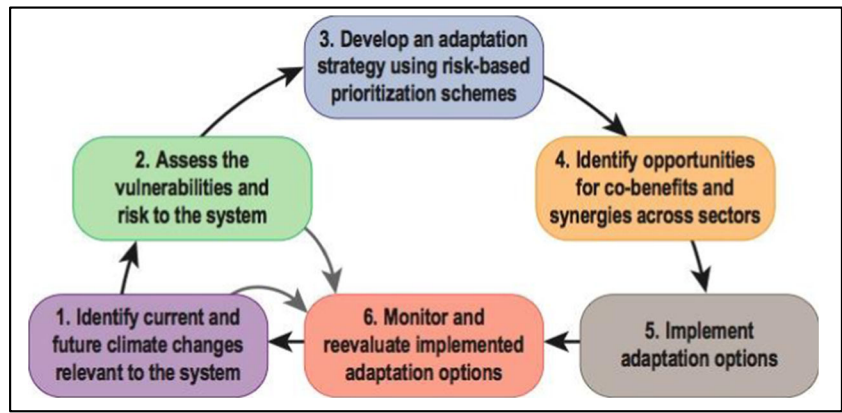
Climate change adaptation models

To better understand the opportunities for partnership and the important roles that universities can play in supporting local and regional level adaptation efforts, it is helpful to have a basic framework of the adaptive process within which these topics can be explored. A model of the climate change adaptation process can be helpful in this regard as it lays out the important steps that take place. The model must be both comprehensive enough to cover the entire adaptation process and detailed enough to allow for a nuanced examination of the partnership at each stage.

In their 2010 report *Adapting to the Impact of Climate Change*, the National Academy of Science's National Research Council (NRC) proposed a six-step climate change adaptation model (Fig. 1). This model is useful for our current purposes as it shares common characteristics with other significant change process models such as the "Public Policy Cycle" process by Rosenbaum (2013) and the adaptation process in the National Climate Assessment Report (2013) (Fig. 2), and offers more specifics relative to climate change adaptation. The NRC model lays out their recommendation for key benchmarks that need to be accomplished at each step. Additionally, the NRC report recommends important elements in developing a successful adaptation strategy. These elements include clear objectives, opportunities for incorporating adaptation plans into the existing organizational goals and procedures, identifiable co-benefits, and the presence of strong leadership (NRC 2010). Similarly, the National Climate Assessment Report (NCA) model lays out several iterative steps that are consistent with the NRC planning process. These steps include the identification of risks and vulnerabilities, assessment and selection of options, implementation, and the monitoring and evaluation of outcomes. The NRC and NCA models do not break these larger steps down into specific tasks or approaches that may be undertaken to accomplish each benchmark. As a result, these models offer a strong conceptual basis for an examination of roles in collaborative adaptation partnerships but do not have the needed specificity to allow for a nuanced examination of the process.

In order to further refine the climate change adaptation process and make it more suitable to our current research needs, we developed the collaborative planning approach

Fig. 1 NRC Framework six-step planning process for climate change adaptation. Source: National Research Council 2010



(CPA) model for climate change adaptation (Fig. 3). This model is consistent with the NRC (NRC 2010) and NCA (NCA 2013) frameworks but provides specific approaches on how to operationalize the steps. The specific approaches in the model were developed through an iterative learning process, based upon more than 40 previous research and consulting partnership projects completed by Antioch New England Institute (Gruber 2002; ANEI 2015). These projects included a wide range of multistakeholder collaborative planning efforts between local governments, NGOs, and the university. In the two case studies presented in this paper, we have found it to be a useful construct for designing, communicating, and assessing multistakeholder approaches. This model can also serve as a checklist that ensures that we do not neglect

important considerations as we work through the collaborative climate change adaptation process.

Our CPA model consists of ten stages covering a complete collaborative adaptation process. The ten stages are broken down into a total of 33 steps to provide the model with enough specificity to allow for a meaningful exploration of the different partners' roles during various aspects of the process. We chose to use this model as the foundation upon which to conduct our case study research. We will save a detailed description of the model for the discussion section when it will be considered in detail within the context of the two case studies.

Methods

Case study sites

The two case study sites used in this research are the Lake Sunapee Watershed in New Hampshire and the Minnehaha Creek Watershed in the Greater Minneapolis Region of Minnesota (Fig. 4). Each site approached the university seeking to form a local community-university partnership. Both 2-year climate change adaptation projects were conducted by Antioch University New England and other partners between 2009 and 2013 with grant support from the National Oceanic and Atmospheric Administration (NOAA).

The overarching goals for both case study sites were to increase local resilience, adaptive capacity, and social capital in order to protect the watershed and the community infrastructure. The approach for both sites included engaging the public with local data on severe weather trends and introducing to them the best available climate change science. This CPA was used to engage a wide range of stakeholders in assessing the current conditions, developing an overall set of objectives for addressing identified concerns and challenges, and reaching agreement on strategies to move forward on implementing the prioritized actions (Fig. 5). This process was also designed to foster understanding of the watershed,

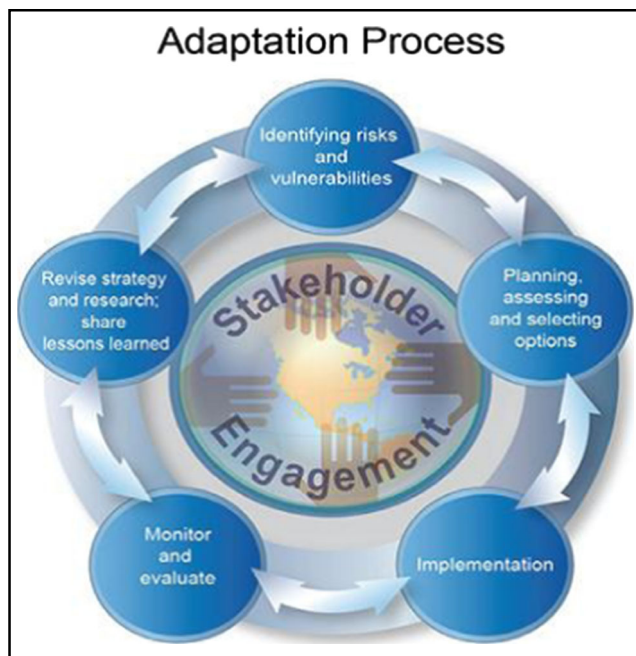
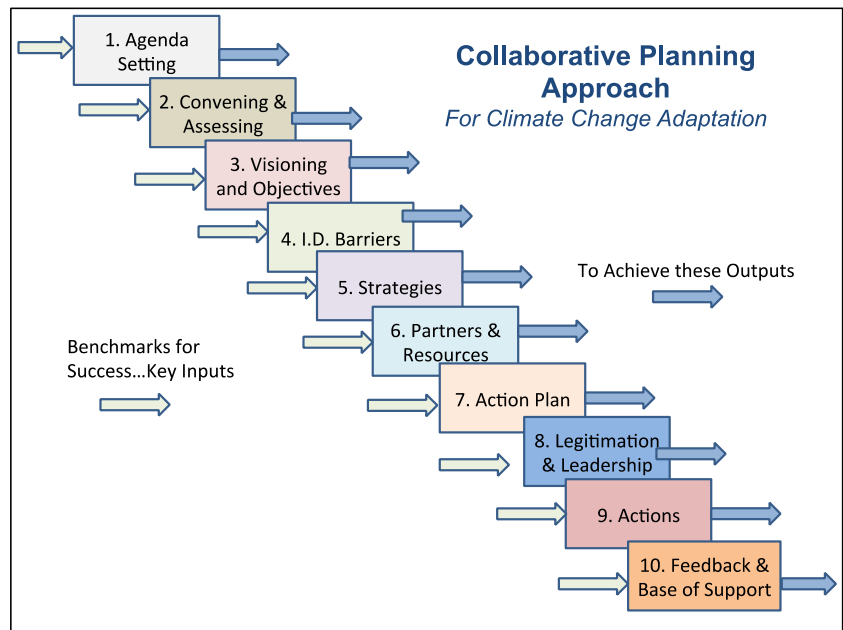


Fig. 2 Adaptation process from the National Climate Assessment Report. Source: National Climate Assessment 2013

Fig. 3 Ten-stage collaborative planning approach (CPA) model for climate change adaptation. Source: James Gruber, 2014



to build trust, and to encourage collaboration. Participation in both case study sites was open. A wide range of stakeholders was invited and strongly encouraged to participate that included key policy makers, local NGOs, and local community and business leaders (Fig. 5).

Both projects included three overlapping phases: (1) engaging the public, across town boundaries, on identifying current observed changes within the watershed including flooding, increase in erosion and siltation, and conditions of existing storm water infrastructure; (2) researching and presenting the scientific findings to the public; and (3) supporting formal and informal community leaders in assessing priorities and creating action plans in response to the findings and their priorities.

Description of sites and outcomes

Lake Sunapee watershed, NH

The Lake Sunapee site is a rural watershed within a region of four local governments. The local partner was the Lake Sunapee Protective Association (LSPA). The population of this region is 11,955. This region had been experiencing severe weather events that resulted in significant flooding and erosion events. The Lake Sunapee Watershed Infrastructure project was designed to assist local communities in mitigating their current and anticipated future adverse impacts from increased storm water runoff due to climate change. The focus of the public engagement and participation component of the

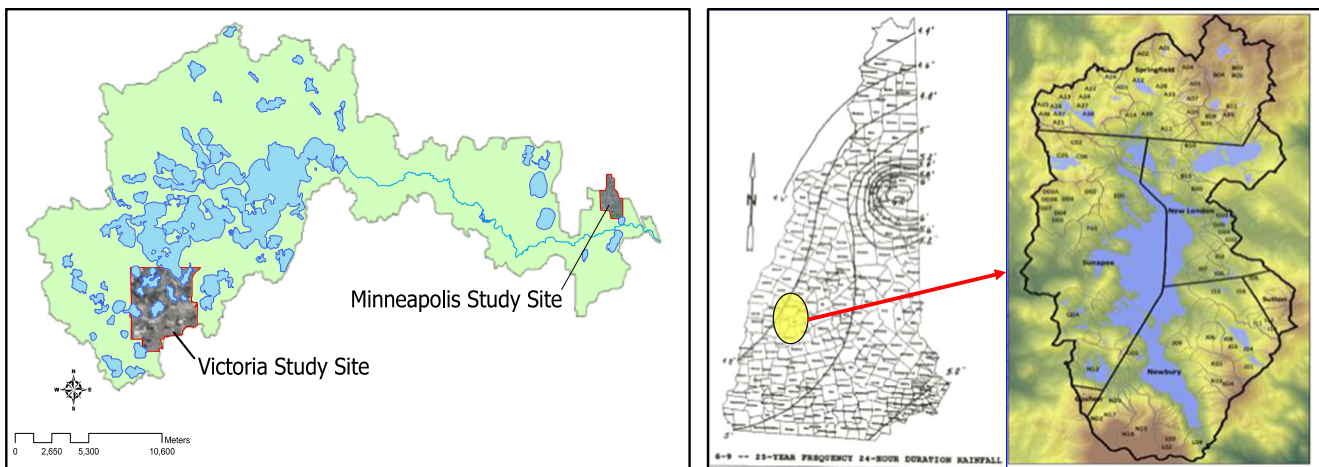


Fig. 4 Case study sites in Minnesota and New Hampshire. Source: M. Simpson

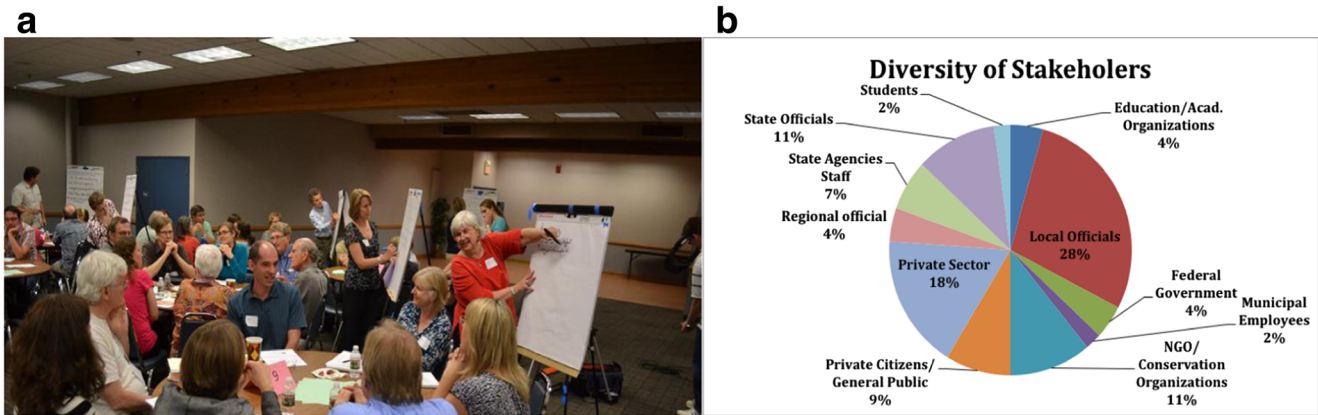


Fig. 5 **a** Community forum in Minnehaha Creek watershed case study site. **b** Chart illustrating diversity of stakeholders that was typical for participation in collaborative planning approach. Source: J. Gruber, 2014

project was to incorporate members of the public and local leadership in the planning, development, and implementation of adaptation actions in response to (a) increasing probability of severe storm events causing increased runoff, (b) increased runoff potential from changes in land use practices, and (c) potential road damage associated with increased runoff impacting road crossings with undersized culverts. Vulnerable road crossings were identified based on probability of peak flow from rain events overtopping the designed capacity of built infrastructure. Outcomes of the project include the following:

- Specific catchments were identified as sensitive to further increase in impervious surface that could cause water conveyance infrastructure to become inadequate to handle increase runoff.
- Proposed sizing of water conveyance infrastructure was recommended to embed resilience in the overall system to respond to potential increase in frequency of extreme runoff events.
- The road agents (highway superintendents) from the participating communities had come together as a working group for the first time (and continue to do so) to share best practices in response to potential vulnerabilities highlighted by the study.

Minnehaha Creek watershed, MN

The Minnehaha Creek site includes both an urban region and a suburban region of the watershed. The population of these two regions is approximately 300,000 people. The primary local partner at this site was the Minnehaha Creek Watershed District (MCWD). The MCWD project was a comparative analysis of stormwater system vulnerability from a projected change in frequency of large precipitation events in the built-out urban environment of the Hiawatha catchment in

Minneapolis and a suburban growing community of Victoria that has the potential for additional build-out. The project included three overlapping phases: (1) engaging the public on identifying current observed changes within the watershed including flooding, increase in erosion and siltation, and conditions of existing storm water infrastructure; (2) researching and presenting the scientific findings to the public; and (3) supporting formal and informal community leaders in assessing priorities and creating action plans in response to the findings and their priorities. Outcomes of the project include the following:

- Specific components of the stormwater system were identified as being under capacity for both current and future 24-h–10-year precipitation events.
- Street flooding zones and potential structure damage zones due to surcharged stormwater components were identified for these same projected storm events.
- Potential alternative approaches to storing excess storm water that exceeded the capacity of the current infrastructure were proposed, with comparative cost impacts for these strategies.
- Specific land use and subdivision development policies and regulations, as well as stormwater fee mechanism, were identified that enhanced the resiliency of communities to future impacts resulting from increased frequency of more extreme rain events.

Assessing the roles of project partners

After the close of both projects, a survey questionnaire was developed to allow key local project partners to reflect on their recent experience and rate the optimal roles of a university and local partners in a successful climate change adaptation process. This survey listed all 33 steps in the CPA model, and

next to each was a five-point Likert scale to delineate if that step was as follows:

- Primarily a university role
- A significant university role with some involvement of local/regional partners
- A mutually shared role between local/regional partners and the university
- A significant local/regional partners role with some university involvement
- Primarily a local/regional partners role

The questionnaire was sent to the LSPA in New Hampshire and the MCWD in Minnesota. Each organization was instructed to confer as a group and offer a collective ranking for each step based upon the role that each partner needed to play in the process to accomplish the objectives of that step.

Following the completion of the questionnaire, a follow-up interview was conducted with a representative from each organization to provide added context and meaning to the questionnaire responses. The interviews were semistructured, following a set list of questions, but allowing respondents to raise issues they felt were important and to answer questions in a way that they felt was most relevant and meaningful to their case. For each of the ten stages, participants were asked to reflect on the important challenges and successes of that stage as well as to further clarify what the most important roles were for the university during that stage. Respondents were also asked for their recommendations as to how universities could best provide support to local communities on climate change adaptation projects. To ensure that the perspectives of the partnering organizations and the interviewees were accurately represented in this paper, those interviewed reviewed and endorsed all comments incorporated in this paper.

Results

The results of this research are summarized in Table 1 and through a review and discussion of each of the ten stages of our CPA model that incorporates the responses from the two case study sites. Under each stage, we (1) briefly describe the stage, (2) clarify the roles of the university based upon the ranking survey and interviews with the two case study sites, and (3) share feedback from participants of both sites to further clarify the university's role and to offer insight into important challenges and potentially beneficial approaches for a collaborative climate change adaptation process.

Stage 1. *Agenda setting: researching and raising awareness about relevant climate change related issues and forming a local leadership team.* Unfortunately, natural disasters with loss of life and property are

frequently the first agenda setting events. However, we have found that there are also opportunities to raise awareness and engage the local community through research and dissemination of results to key members of the public and stakeholders.

Both project sites recognized either mutually shared roles or a significant role for the university in this stage with a key focus on researching and preparing information about the urgency of addressing climate change impacts. As the MCWD explained, "the most important role of the university in this stage was providing background information and framing it in a way that was understandable by local audiences, as well as guiding us through the process of raising awareness particular to stormwater and adaptation (MCWD)." In the LSPA case, engaging university students proved to be a helpful strategy for collecting the local level climatic data needed to inform the rest of the process.

Both sites recognized that forming and facilitating a leadership team of key community leaders and organizations was another critical action during this first stage. These leadership teams need to be willing and able to communicate the urgency of addressing climate change and then lead the future planning process. As part of this step, the MCWD suggested that it would be helpful to "make more intentional use of the local leadership team, to generate continued involvement in the public process as well as help disseminate the results and move community adaptation conversations forward (MCWD)." To help effectively raise awareness, the LSPA pointed out that a university working with a local NGO needs "to know your audience; what information they will want, (and) how they can best understand it (LSPA)." Previous research by an author of this paper has documented that the integrity of this type of leadership team is seminal to the future success of the evolving process (Gruber 2010).

Stage 2. *Convening and assessing: convene a broad cross section of the community to assess the evolving situation and affiliated problems to confirm the need for adaptation planning.* We have found that it is critical to bring together a broad and diverse group of stakeholders including community leaders, scientists, engineers, policy makers, business leaders, those who are typically marginalized in society, and those who doubt (or counter) the existence of climate change, as well as many others, in order to effectively assess the situation and

Table 1 Clarification of roles for universities in local climate change adaptation

Clarification of roles for collaborative planning for climate change local adaptation	1. Primarily university role	2. Significant university role with some involvement of local NGO and local/regional partners	3. Mutually shared role between NGO/regional partners and university	4. Significant local NGO and other local/regional partners role with some university involvement	5. Primarily local or regional partners role
1. Agenda setting: researching and raising awareness about relevant climate change related issues and forming a local leadership team.					
1.1 Researching and preparing information about the urgency of addressing climate change impacts.	MCWD	LSPA	LSPA MCWD		
1.2 Communicating information to the public and key stakeholders to raise awareness about the links between climate change and natural disasters.			LSPA	MCWD	
1.3 Organizing a steering committee of key community leaders and organizations to help plan and lead the adaptation planning process.					
2. Convening and assessing: convening a broad cross section of the community to assess the evolving situation and affiliated problems and confirm the need for adaptation planning.					
2.1 Identifying key stakeholders.			MCWD	LSPA	
2.2 Designing convening event(s) that will bring together community leaders and a diversity of stakeholders.				LSPA MCWD	
2.3 Inviting and achieving strong and diverse attendance at the convening event(s).			MCWD	LSPA	
2.4 Reviewing and presenting changes in weather patterns/ climate conditions including assessing current conditions such as frequency and intensity of recent storm events.	LSPA	MCWD			
2.5 Reviewing and presenting current impacts from weather patterns and land-use patterns/development on homes, businesses, local ecological systems (green infrastructure) and built infrastructure (grey infrastructure), water quality, agricultural practices, etc.		MCWD	LSPA		
2.6 Discussing and understanding the underlying causes of the current conditions.					
2.7 Endorsing the need to undertake planning and potential future action.			LSPA MCWD	LSPA	MCWD
3. Visioning and objectives: an overall vision and primary objectives are developed and agreed upon.					
3.1 Promoting and building interest among local stakeholders to participate in a planning effort to lay out a future vision and articulate objectives to achieve this vision.			LSPA	MCWD	
3.2 Facilitating a collaborative, multi-stakeholder process that results in an overall vision and objectives that is supported by a diverse group of stakeholders (local government, businesses, NGOs, citizens, etc.).			LSPA MCWD		
3.3 Providing a synthesis of the results of this process to current and potential key stakeholders and the broader community.		LSPA	MCWD		

Table 1 (continued)

Clarification of roles for collaborative planning for climate change local adaptation	1. Primarily university role	2. Significant university role with some involvement of local NGO and local/regional partners	3. Mutually shared role between NGO/regional partners and university	4. Significant local NGO and other local/regional partners role with some university involvement	5. Primarily local or regional partners role
4. Identify barriers: the social, financial, political, logistical, philosophical, and cultural difficulties that need to be addressed are identified in order to inform the approach for achieving the agreed-upon objectives.					
4.1 Analyzing financial issues that influence future climate adaptation policies including infrastructure improvement costs.	LSPA		MCWD		
4.2 Conducting surveys on key stakeholder and public perspectives and areas of social and cultural concerns.	LSPA		MCWD		
4.3 Facilitating a public process to identify all of the actual and perceived barriers to achieving agreed-upon objectives.			LSPA MCWD		
5. Strategies: the potential strategies are assessed and prioritized based upon technical and financial considerations as well as social and cultural values and public priorities.					
5.1 Conducting a process that identifies potential strategies that recognize barriers and overall objectives.	LSPA			MCWD	
5.2 Assessing each alternative based on the potential impact of each strategy and the feasibility of implementing that strategy.			LSPA	MCWD	
5.3 Identifying specific approaches and policy too LSPA for the implementation of the proposed strategies.			LSPA	MCWD	
5.4 Disseminating and communicating these results to key stakeholders and the broader public to raise awareness and seek additional review.			MCWD	LSPA	
6. Partners and resources: potential partners are identified and engaged and resources required are identified.					
6.1 Identifying and forming potential partnership that may include: Public-private partnerships, public-private-community partnership and other governmental partnerships			LSPA	MCWD	
6.2 Identifying currently available resources to support to local communities.			LSPA MCWD		
6.3 Providing additional technical planning and design resources such as GIS mapping, modeling, simulations, etc.	LSPA MCWD				
7. Action plan: an action plan is formulated based on previous analysis of data, financial, political, social, and other considerations.					
7.1 Framing a draft action plan through a collaborative, multi-stakeholder process that includes potential over-all action steps at local and/or regional level, including responsibilities, timelines, and resources required.			LSPA MCWD		
7.2 Seeking public feedback/comments on the draft plan.			LSPA	MCWD	
7.3 Revising the plan for adoption by the appropriate authorities.				LSPA MCWD	

Table 1 (continued)

Clarification of roles for collaborative planning for climate change local adaptation	1. Primarily university role	2. Significant university role with some involvement of local NGO and local/regional partners	3. Mutually shared role between NGO/regional partners and university	4. Significant local NGO and other local/regional partners role with some university involvement	5. Primarily local or regional partners role
8. Legitimation and leadership: there is a formalizing of decisions and the implementation process including establishing a leadership team.					
8.1 Formalizing the leadership team for the implementation of the adaptation plan that includes all the needed skill sets and represents the community.			LSPA		MCWD
8.2 Providing a clear charge to the leadership team including expectations.			LSPA		MCWD
9. Actions: Initiate actions based on priorities, balancing highest return with ease of achieving results.					
9.1 Implementing actions based upon the approved adaptation plan.				LSPA MCWD	
9.2 Evaluating the effectiveness of each of the implementation actions.		MCWD		LSPA	
10. Feedback and base of support: Embrace open and dynamic feedback on the process and actions taken and continue to build a broad base of support.					
10.1 Providing opportunities for public feedback throughout the implementation process that may include surveys, presentations, public forums, and other approaches.			LSPA		MCWD
10.2 Sharing progress and challenges with the broader community.			LSPA MCWD		
10.3 Celebrating successes.			LSPA MCWD		
10.4 Synthesizing feedback and reporting it to key stakeholders and the general public for the next planning and implementation cycle.			LSPA MCWD		

LSPA Lake Sunapee Protective Association, MCWD Minnehaha Creek Watershed District

confirm the need to initiate adaptation planning.

Both project sites stated that significant university support was needed during this stage. In particular, they highlighted documenting the weather patterns/climate conditions including frequency and intensity of recent storm events as an important university role. Representatives of both case study sites stated that the university needs to document and share this information in a form that can be understood by the layperson. Further, it is important to include both current and projected vulnerabilities and risks as a result of these climatic changes. In both sites, it proved essential to have a discussion both on the current observed climate impacts on local homes, businesses, ecological systems, water quality, and the built environment and also on the related causes including weather patterns, development patterns, and agricultural practices.

One important challenge noted by both sites was ensuring a diversity of participants and “bringing divergent views to the table (MCWD)”, particularly the business community. One participant noted on a feedback survey the importance of “including people from where the problem is coming from... agriculture, development, big-box stores.” Another participant noted the value of “comments from diverse stakeholders, not just technical professionals, are important.”

Stage 3. *Visioning and objectives: an overall vision and primary objectives are developed and agreed upon.* The development of a vision and specific objectives can be achieved through a number of collaborative multistakeholder processes. We have found that important characteristics of a successful process are that it is transparent, open to the public and the media, seeks consensus, and includes representatives of all of the key stakeholder groups. The process may include conducting surveys, convening numerous small discussions and work groups, holding large stakeholder forums, and convening a mix of other informal and formal public events.

Both case study sites expressed that the process of helping a local community develop an overall vision and primary objectives is an important and mutually shared role between the university and the local partner. Local leaders of both case study sites were wary of using “doom and gloom” as a primary motivator to take action on climate change adaptation. One individual expressed that this approach “sucks the air out of the room” and shared that a positive vision is critical for engaging citizens and local leaders to take action. LSPA reflected, “It is helpful to connect the project more

explicitly to developing a future vision of the town (LSPA).” As a neutral third party, the university has an opportunity to help frame and lead a process that will result in both a shared vision and specific, agreed upon objectives that incorporate the views of all stakeholders. LSPA confirmed this opportunity stating, “having (the) university as a partner on the project and as the facilitator of the meetings lent an increased air of legitimacy and importance to the project.”

The synthesis of the output of this process into accessible summary documents for the public and local policy makers was also recognized as a logical role for the university. In these case studies, this step proved a good opportunity for student involvement. Under faculty supervision and in collaboration with the project team, students collected and organized data and then developed various outreach materials such as newsletters and fliers to be shared with the community.

Stage 4. *Identify barriers: the social, financial, political, logistical, philosophical, and cultural challenges that need to be addressed are identified in order to inform the approach for achieving the agreed-upon objectives.* We have found that recognizing real and perceived barriers to potential local actions is essential in order to move forward on developing effective and socially accepted strategies for climate change adaptation. Developing content-focused working groups during this stage (e.g., one focusing on objectives related to stormwater infrastructure, another on land use planning, etc.) can support a more robust discussion and a greater depth of problem solving.

There was a wide range of ratings regarding the university role during this phase of climate change adaptation planning. The MCWD (urban/suburban) case study site indicated that they could take on a more significant role (including analyzing financial issues, additional surveys, and facilitating public processes) as compared to the smaller rural LSPA case study site. Due to more limited resources and staffing, rural universities may need to assume additional roles with their local communities during this stage than urban campuses. Both partnering organizations agreed that the collaborative work undertaken in this stage needs to be supported by clearly documented local information, data, and other reference information. Universities that provide this information “need to explain to stakeholders how the data was generated (LSPA)” in order to maintain the integrity of this process.

Stage 5. *Strategies: the potential strategies are assessed and prioritized based upon technical and financial considerations as well as social and cultural values and public priorities.* It is common knowledge that local communities frequently have a wide range of demands that exceed their limited financial and human resources. Actions to adapt to the current and anticipated future impacts of climate change must compete with these other demands, must be economical and efficient, and where possible should piggy-back on other programs such as asset management and regulatory compliance. We have found that it is essential for all proposed strategies to be vetted and prioritized by the stakeholders based upon their potential impacts and feasibility. This prioritization should take into consideration risks (quantified through downscaled data), along with financial, social, and cultural values of the public. Issues of environmental justice and the disempowered should also be recognized.

The participatory process during this stage was “used to focus stakeholder conversations and generate specific, actionable strategies that communities could use for adaptation planning (MCWD).” Both case study sites recognized the university role during this stage as either mutually shared with the local/regional partners or as providing only “some involvement.” The MCWD site noted “the major role of the university at this point (stage) was to provide up to date science relative to the study and interpret it for the audience, as well as provide insight on the participatory process structure itself.” LSPA noted that during this stage “(the university) helped ensure that the information was understandable for the diverse stakeholders involved in the project.”

Stage 6. *Partners and resources: potential partners are identified and engaged and resources required are identified.* Leveraging assistance (and potentially other resources) from other local, regional, or state partners has been recognized as essential for many types of adaptation efforts. The NRC (2010) “Six-Step Planning Process for Climate Change Adaptation” specifically noted the importance of “identifying opportunities for co-benefits and synergies across sectors” as a leveraging strategy.

Both case study sites indicated that developing additional local partnerships was essentially their role. One of the challenges pointed out was that “resources generated (or identified) by the work groups were limited by those (stakeholders) in the room (MCWD).”

This reinforces the importance of including a broad diversity of stakeholders early on and throughout the climate change adaptation planning process.

Providing technical assistance in planning and design, such as GIS mapping, modeling, and simulations, was recognized by both case study sites as a significant role for the university. One site noted that “the University had contacts with additional experts (including other universities with different types of expertise) and other municipalities and so could draw on those contacts to bring in outside resources to help inform (the) project (LSPA).” The rural case study site community (LSPA) had less technical resources and could use greater university support in this area than the urban/suburban (MCWD) communities.

Stage 7. *Action plan: an action plan is formulated based on previous analysis of data, financial, political, social, and other considerations.* It is our observation that if the previous six stages of this collaborative planning process were undertaken in a manner that built a broad understanding and recognition of the need and types of actions that may be needed, locally developed action plans are more likely to occur. Building broad-based engagement and ownership of the process and outcomes is an important component of ensuring that action plans are actually acted upon. This principle was reiterated by a local community leader in a previous environmental planning process when she summarized the importance of broad based stakeholder engagement for achieving actionable outcomes by commenting “a policy is nothing if it doesn’t rest on burning public opinion” (Stefka 1998).

The role of the university, although recognized by both case study sites as still significant during this stage, also diminishes from this stage forward. MCWD noted “the university role here was again to present relevant information and provide the participatory structure for use during the work group session.” The LSPA site stated that the “University played an important role in collecting and categorizing data and approaches into a cohesive product... maybe not quite an action plan but a collection of approaches.”

Stage 8. *Legitimation and leadership: there is a formalizing of decisions and the implementation process including establishing a leadership team.* Prior to undertaking substantive actions, there is a need for formal legitimation of the priorities and recommendations. Stages 1 through 7 can be considered an informal collaborative planning process. The formal codifying

and implementation of priorities requires the involvement of those formally charged by society to make binding policy decisions and appropriate funds, such as a city council or regional watershed authority. The legitimization process also requires establishing formal leadership to implement actions. The vital role of leadership in managing adaptation processes is noted in the NRC report on climate change adaptation (NRC 2010).

It is our experience that members of these local policy and implementation authorities are highly responsive to recommendations developed through broad collaborative and transparent processes that have gained support (or consensus) from a broad range of stakeholders. The role of the university is limited in this legitimization stage primarily to “providing relevant scientific data (MCWD).” In a more rural region, they may need to assist in developing recommendations for the roles or “formal charge” of a leadership team (LSPA).

Stage 9. *Actions: initiate actions based on priorities, balancing highest return with ease of achieving results.* We have found that if the individuals in formal leadership roles are supported by a broad cross section of the community members, they are more likely to implement actions. Due to the scale, evolving scientific data, changing understanding of vulnerabilities, and limitations of local resources, adaptation actions are typically implemented through a long-term phased and iterative process. Others have recognized that adaptation actions that contribute to other local government community goals such as improving public health or enhancing economic competitiveness are more likely to be given a higher priority (NRC 2010).

Throughout this process, a local university can keep the community engaged and raise their level of knowledge by taking on “a leadership role in basic education and awareness building about stormwater, climate change, and local adaptation planning (MCWD).” In prioritizing actions, LSPA reflected that it is important to get people thinking in specific terms, like “what is the problem, what will we be facing in the future, and how could we possibly address it.”

Stage 10. *Feedback and base of support: embrace open and dynamic feedback on the process and actions taken and continue to build a broad base of support.* As a final stage in this process, which then informs future planning and actions, it is important to monitor and assess the effects of adaptation actions. We posit that providing this information in a timely manner to policy makers and the public is

essential for effectively implementing this change process in a cost effective and politically acceptable manner.

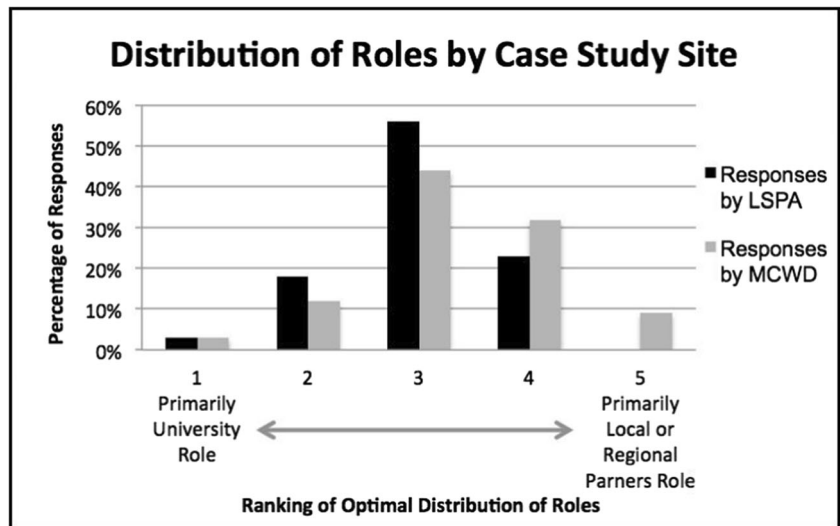
Many universities have capacity in applied research and assessment skills to meet the adaptation monitoring and assessment needs of local communities in a cost-effective manner. LSPA noted, “local level analysis really helps to increase the buy-in by municipalities and residents. As opposed to bringing in regional or global information, the backyard data really brings it home and that is important.” Universities can also play a local supporting role in building and maintaining a broad base of support for adaptation. The MCWD site noted the significance of this role. They stated that “the university role becomes critical in continuing climate change adaptation conversations that need to happen both locally and regionally, as well as to continue to disseminate current research and the state of the science.”

Discussion

There are many rewards as well as challenges inherent in universities working in partnership with local NGOs and governments in support of climate change adaptation efforts. Effective partnerships require a clarification of roles for each of the partners. This research has demonstrated that there are some roles most suitable for the university to fulfill and others that are more appropriate for the local partners. However, the findings demonstrate that the majority of tasks are best accomplished in a shared collaborative manner that draws upon the strengths of both partners (Fig. 6). In this partnership, the role of the university can perhaps be best understood as working to fill gaps in the capacity of the local partners. To help foster a smooth collaboration, it may benefit universities and local partners to have a preliminary meeting to discuss the capacities of each organization and the distribution of roles going forward.

It is also noted and illustrated in Fig. 6 that the rural case study site (LSPA) required a greater role for the university than the urban/suburban site (MCWD). It is likely that this reflects limitations in the capacity of the rural communities involved in the LSPA case. Compared to their more urban counterparts, the rural communities have generally fewer resources in terms of staff, expertise, technology, equipment, and funding to draw on in adapting to climate change. While the current research comprises only two case studies, it seems likely that, for similar reasons, rural communities more broadly may require greater support adapting to climate change than urban communities. As a result, this may indicate that there

Fig. 6 Percentage of survey responses grouped by case study partner (LSPA and MCWD), showing each organization's rankings of the optimal distribution of roles



could be an especially significant role for universities working with rural communities to support climate change adaptation.

Regardless of the initial capacity of the local partners, the university can help design the adaptation process to build capacity among the local partners and transfer ownership to them. Again, while the current research draws on just two cases, it demonstrates the possibility of achieving this dual aim. Looking at the distribution of roles divided between the first five stages focused broadly on convening and assessing, and the last five stages focused on strategizing and implementation, it is apparent that both local partners ranked a greater role for themselves in the latter stages of the project (Fig. 7).

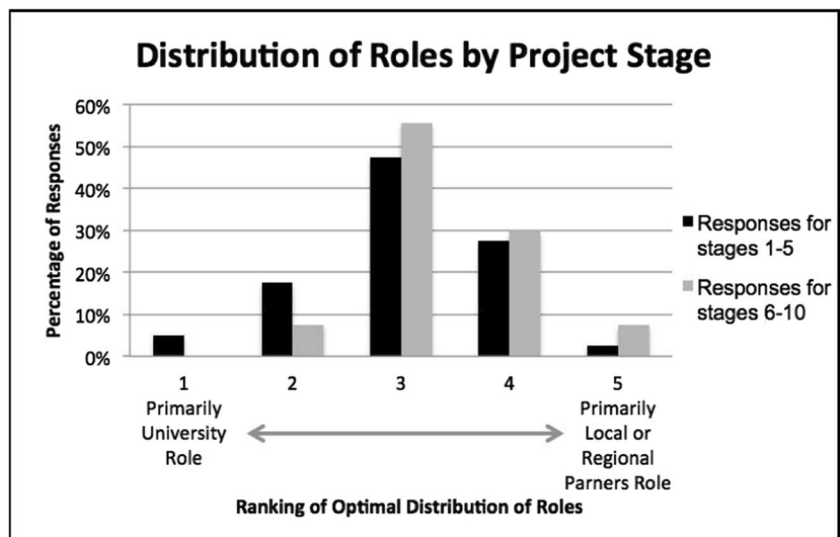
Partnering with local communities can also result in benefits for the university. Such partnerships can provide faculty with meaningful research and outreach opportunities.

It can also enhance the quality and relevance of the curriculum with locally relevant applied subject matter. It can

provide further opportunities for students in the form of internships and work-study appointments supporting the project. Additionally, engaging in meaningful projects to support community well-being and addressing complex scientific challenges could enhance a university's reputation both locally and on a broader scale. Antioch University New England's involvement in these two cases has realized many of these benefits. For example, over 20 students have gained valuable practical experience working on the cases, and these cases have played an important role in bringing about Antioch University New England's new "Center for Climate Preparedness and Community Resilience."

These types of partnerships are consistent with the current national effort that has received major support by the National Science Academy and National Council of Graduate Schools to establish the Professional Science Masters (PSM) program. Currently recognized at over 100 universities, the PSM

Fig. 7 Percentage of survey responses grouped by project stage, showing partner organizations rankings of the optimal distribution of roles



program embraces strong partnership between local communities and university in order to train both scholars and practitioners who are able to support the current needs of society.

Conclusion

As the impacts of climate change are increasingly experienced across the country, new and more effective means to promote adaptation at the local level are essential. These local adaptation efforts need to be framed within the context of global climate change and the importance of promoting mitigation actions. While the primary emphasis of these two case studies focused on adapting to severe weather impacts, the CPA collaborative approach may be applicable to other types of planning including climate change mitigation. This paper provides a useful model and an approach as to how universities, through engaged scholarship and partnerships, can meet the needs of local communities planning for the current and future impacts of climate change, while raising local awareness of climate change and enhancing the quality and relevance of education.

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