Refining the Process of Science Support for Communities Around Extreme Weather Events and Climate Impacts

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Abstract Native American communities along the Gulf of Mexico, separated in significant ways from contemporary tools and technology, experience and cope with weather extremes in unique and largely unknown ways. From one generation to the next there has been little communication between *science*, where advanced tools of warning and survival can be derived, and *community*, where lessons of "living off the land" can inform science of the most pressing needs and the most practical and useful technologies to fill them. This chapter describes a successful and ongoing science/community relationship to address immediate pressures of extreme weather and the resilience to confront potential threats from forces extant, including climate variability and human exploitation of natural resources. Lessons learned here, particularly those of communication and collaboration, apply around the world where both global science and self-supporting communities have become isolated from one another.

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1 Introduction

This chapter presents a case study of rural people in the context of a changing physical environment and the role that community engagement plays or does not play in that process. The story is interesting and compelling. It focuses on coastal Louisiana in the United States and on perceived environmental changes that are altering long-held principles of sustainable self-sufficiency. Of a May 2015 storm, one who harvests shellfish says,

> The storms are getting stormier, stronger. What used to be normal bad weather, now it is just severe weather, not just bad weather. When you see a little blue cloud in the west you think about running for cover because you don't know what is in it. And lately when you see the storm clouds it is tornado weather.

We also see where local, relatively isolated communities are compelled to engage, to act, in context of larger forces of change extant, from the impacts of oil spills to the consequences of climate. This is also a story of building trust and communication across communities of science and policy. The quote below from an American Indian elder who lives in one of the communities involved in this case study effectively reflects the interplay of science and community engagement.

> (Science/Community) Engagement should go both ways. There is lived science, my life science. And there is learned science. It is not to take away from anyone, but there is other knowledge other than learned science. It is very complex. *-American Indian Community Elder.*

Well-intentioned efforts of university and government science to assist vulnerable communities under environmental threat—threats generally not of their doing or choosing—often fall short of expectations. The observation above from a community elder, one who has experienced many environmental threats and welcomed the learned visitors wishing to help, points to an important, often overlooked, ingredient: science and community "Engagement," with a capital "E," is a two-way street, sharing both "learned" and "lived" science.

Before sharing aspects of our case study, we present a short discussion of where we are coming from theoretically, as authors—to shed a better light on our interpretation of events and the case study.

In this chapter we connect the concept of community to the notion of environmental change and focus particularly on how traditional communities—*communities-of-place*—understand and relate to climatic changes in their own lives.

We believe that how these more traditional, natural-resource based communities respond to climate change will inform how 21st century communities, both traditional and modern, can adapt to change. Additionally, we want to better understand how the dynamics of engagement benefit from meeting people where they actually live and work, in their own small, rural, natural-resource-based communities.

In order to achieve pro-active support for community resiliency and adaptation, we explore the climate change adaptation framings of the limited, but still existent small, rural American communities that rely directly upon the environment for their livelihoods and subsistence. Then we suggest ways to use that knowledge for successful engagement with communities.

The latest effort to support communities experiencing disastrous impacts of severe weather, associated with what we and the community believe is climate change, is adaptation through community engagement. While the phrase does not have a catchy new[1] term such as community resilience, community engagement to adapt to climate change is both very real and very relevant.

By focusing on the notion of "community," we have a better chance of adapting to and achieving resilience from extreme weather, whether related to climate change or not. We do not use the term community in the typical sense of a 'government entity' or a political boundary but rather as a sense of the social bonds that exist in a particular place. Our understanding of community is reflected in *Gemeinschaft* (Tönnies 1996) qualities, which can be defined as a society or group characterized chiefly by a strong sense of common identity, close personal relationships, and an attachment to traditional and reciprocal mutual aid. In other words, Gemeinschaft means strong social relationships and bonds.

Gemeinschaft communities commonly are communities-of-place with caring reciprocal "giving-caring" relationships with the natural "giving" environment. This is an holistic and balanced give-and-take between people who live in a particular place and their surrounding natural environment.

As a means to resilience and adaptation, valuing community is important, given that much of American society inhabits socially detached suburbs or urban environments. Suburban and urban environments could be characterized as a more modern society and, following Tönnies, labeled Gesellschaft, a society or group characterized chiefly by formal organization, impersonal, less connected social relations, the absence of generally held or binding norms. Thus, *Gemeinschaft* implies the existence of closer social relationships or a sense of (rural) community, while *Gesellschaft* denotes a more formally structured society with impersonal ties. It should be noted that urban and rural communities can include characteristics of both.

[1]"New" as used in the human community sense rather than in a purely ecosystem or engineering manner.

1.1 Community and Understanding a Place

It is important to think about how different communities respond to various environmental changes. Many rural communities have a more interactive and subsistence based focus on their surrounding environments. More urbanized environments may be less-subsistence oriented with their surrounding natural environments. In this chapter, we focus on such environmentally attached communities; we concur with those who focus on community as key for understanding and action when environmental changes start to occur. We focus on rural communities because we believe that success in dealing with extreme weather and climate change requires a return to a more sensitive consideration of the environment. However, knowing how to achieve such a goal is still unclear. To say that the goal is *community* resilience or that *community* engagement is the method is not to understand the implication of these ideas. It is dangerous to assume we know what issues rural communities face without rigorous scientific study and some level of experience within these places and communities.

As community researchers, we recognize that there are scientists who come from the Gesellschaft-type urban world who want to contribute to extreme weather and climate adaptation. This can be accomplished through appropriate community engagement. But, most scientists lack the clear community experience to achieve effective responses to such climate-based environmental changes. As researchers, we ask the central question, ***How can scientists collaborate and engage with society to achieve adaptation to changing natural environments'?***

We emphasize participatory collaboration because understanding future extreme weather events is useful in the context of adaptation only if it is shared with a deep understanding and respect of what community members already know and practice.

2 Challenges of Scientists' Community Engagement for Adaptation

2.1 Variety of Environmental Change Signals

The challenge of how science can help communities is as daunting as the challenge of detecting, making sense of and responding to changes in the environment. For example, it is often assumed that changes caused by global warming will be detectable with unique signatures immediately recognized by both scientists and lay citizens alike. Most climatologists expect these signals, or events, will be distinct from an historical climatic norm. In this chapter, we are concerned that over-interpretation of environmental change, or extreme weather changes, be attributed solely to global climate change. Adapting or responding to changes in weather extremes must be taken in context with other confounding processes such as land subsidence and sea level rise—and assaults on the environment such as the BP Gulf of Mexico oil spill of 2010.

2.2 Changing Louisiana Environments

We focus geographically herein on the dying off of the coastal Louisiana marshes. This is currently the result of at least five factors: land subsidence as levees block soil deposition from spring river floods, major storm surges from tropical events, the BP oil spill killing the grasses, salt inundation from oil production channels cut through marshes, and sea level rise. All but the oil spill cause soil to be inundated by salt water, which kills the plants. Two factors, major storm surges and sea level rise, may be caused by climate change.

Other visible environmental changes are happening in the local environments of Louisiana. These include clearly recognizable changes for which global warming may be the trigger. Community members have developed their own understanding of changing local environments from their own observations and from media reports. Obvious changes may be recognizable clearly as suspiciously out of the normal range by members of communities. But even such noticeable changes will likely require repeat occurrences for community members to be convinced that something different is happening and that it is related to large-scale climate change.

2.3 Community Responses

When a community observes new environmental dynamics (such as rising waters and increased flooding) an array of responses may occur once they are noticed. While responses are likely to be similar to responses already taken, some responses to environmental changes may have very new qualities.

The following framing of climate change, and responses to the change, by two Louisiana coastal communities that are extremely dependent upon their surrounding natural environments, will permit examination of the complexity of "responding to climate change" (Anderson et al. 2012).

Community members typically may use responses they have already developed in reaction to other, distinct changes within their environment. That is the efficient approach. Additionally, local people may develop new and innovative responses because they assess that the earlier ways of responding did not work. Much of a community's response to extreme weather depends first upon their past experience and then upon the nature and severity of the current extreme weather encounter. Community responses may be informed by understanding why the new environmental phenomena are occurring. And local people often frame their own decisions about how to respond. Such informed responses may be most successful if considered over a time frame of several events (Apel 1984), such as, how likely is it for hurricane and flooding to occur this year? Community members will likely ask multiple questions including: Is the disruption going to be rare? Is it going to be extremely threatening? If it happens, will it differ from what has been experienced before?

The following sections report how community members perceive and deal with their own environmental changes (Heidegger 1971) through their own words. After outlining findings from the study of the two communities, other stand-alone examples of the appreciation of environmental dynamics will be described. The penultimate section will discuss some of the qualities and conditions of science-community engagement that must exist for environmentally sophisticated communities to become leaders in climate change adaptation, i.e. to be models for other less-environmentally and interpersonally attached communities. From this model can grow the interactive dynamics between society and science that are critically important for even modestly successful adaptation to climate change. First, we begin with a description of our data collection methods.

3 Research Methods

The research for this chapter involved a series of multiple methods including ethnographic observation, unstructured interviews/conversations (Herda 1999; Denzin et al. 2008; Smith 1999, 2012) with a variety of community members in two coastal, traditional Native American communities (Grand Bayou and Pointe-au-Chien) who live on the littoral edge of the coastal Louisiana Mississippi River delta. The remaining observations we include in the chapter come from on-the-ground interactions with members of these two communities along with other coastal Louisiana communities and coastal scientists with whom we work.

3.1 Community Background

One tribe, Grand Bayou Atakapa-Ishak, in Plaquemines Parish close to the main channel of the current Mississippi River path, is indigenous to the area. This area is "home to a small population of indigenous shrimp fishermen and women who have survived 15,000 years in the marshlands" (Nienaber 2012, p. 1). We will refer to this community as **Grand Bayou** since their community is located in a bayou within the marsh and must be accessed by boat. Damage from Hurricanes Katrina (2005) and more recently Isaac (2012) was extensive as was the damage to the environment from the BP oil spill (2010). It is a place where the health and well-being of the community is greatly tied to the surrounding natural environment. While the community has dwindled in the number who live in the "village," significant numbers of members and their offspring of all ages identify with the community and share customary social events in the village such as baby showers, graduations, weddings, birthday parties and funerals.

The second community which we included for this chapter is the **Pointe-au-Chien** in Terrebonne and Lafourche Parishes, located in the most westerly part of the historic Mississippi River delta. Similar to Grand Bayou, the community is located at the water's edge and is home to the Pointe-au-Chien Indian tribe. The tribe is located where they are now as a result of being pushed into the bayou region during the eastern colonial expansion in the early 1700s (Pointe au Chien Tribe 2015). Larger in membership than Grand Bayou, Pointe-au-Chien also experienced severe damage from Hurricane Rita, less than one month after Hurricane Katrina, as well as Hurricanes Gustav, Ike and Isaac, along with suffering severe environmental damage from the BP oil spill. Both Pointe-au-Chien and Grand Bayou communities are surrounded by the petro-chemical extraction industry and oil and gas wells -making them at-risk for disasters due to oil spills in the region.

4 Adaptation Collaboration

This section presents a detailed examination of various collaborations and efforts in research to understand indigenous communities and their responses to changing climate and weather.

The traditional communities that form the focus of this chapter, after Hurricane Isidore and Lili (both 2002), became "teaching communities" on climate change and its impact on them (First Peoples Conservation Council 2012; Leonetti 2010). By "teaching community" we mean that members welcomed outsiders to visit, discuss and learn about the experiences and responses that were taking place in the community. These visitors included, and continue to include, scientists, private foundation leaders, reporters, government agency and non-profit representatives. International visitors have also come from China, Liberia, Australia, Brazil and France. Such conversations can be extremely productive for visitors and communities alike.

One activity initiated by the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center with Grand Bayou was to observe how the community mapped the changes occurring in the surrounding ecosystem (Laska 2006). This effort resulted in NOAA learning about vulnerability mapping, used to this day, as a model for other coastal communities. Because the collaboration did not result in a direct benefit to Grand Bayou, NOAA created a brochure, a tool that the community needed, in conjunction with Grand Bayou to help it represent itself at professional and academic meetings external to the community. These collaborations, which continue today, give a clear appreciation of the importance of collaboration for success. As one local resident who participated in the process noted, "We have to learn the language of the other if we are to survive. We are no longer just a bayou community, we are the world and if we are to survive, we need to learn from each other."

While such a model of engagement—visiting—is useful, it is time intensive and may not be so productive as more structured activities. Therefore, the University of New Orleans Center for Hazards Assessment, Response and Technology (UNO-CHART), and later the Lowlander Center, undertook to implement with the communities, problem-solving collaborations that were organized in different ways (Berkes 2009). The balance evolved from methods that were externally driven collaborations, to those that are internally managed by the communities today (Kindon et al. 2010). Following is a description of those programs and how they evolved toward greater self-management. This discussion will lead to our recommendations for a science-intensive collaborative model.

The two study communities have taken the lead on three climate change adaptation initiatives that are informed by applied social science and the practices of federal agency regional practitioners. In the next sections we describe the variety of collaborative research efforts that occurred in the two communities.

4.1 Participatory Action Research (PAR)

An NSF-funded project with Grand Bayou was undertaken before the Katrina (2005) catastrophe. It used a Participatory Action Research (PAR) method of community and specialist engagement (Laska et al. 2005). PAR assumes equal status between community members and scientists/practitioner partners. Its goal is to enhance community members' agency, i.e. their own control of their future. The usual Participatory Research has outside scientists performing a research service for the community rather than supporting the increased capacity of the community members to understand and implement their own actions (Blackburn 1998; Cooke and Kothari 2001). The PAR method for the Grand Bayou collaboration consisted of the core team of social scientists inviting an array of bio/physical and social scientists, environmental science specialists and other representatives of applied government agencies and non-profit organizations to become part of a team of advisors to Grand Bayou as they responded to the consequences of climate change, namely sea level rise (Laska et al. 2005).

While the intent was to form a cadre of experts to support the community, the secondary outcome was that experts learned how to become members of that cadre. The scientists and practitioners brought together for the project learned about environmentally-based communities, learned from the communities and learned how to support them in their resiliency efforts. That is, scientists and practitioners learned what is important to understand in order to partner with the communities (Peterson 2010).

Peterson (2010) applied the concept of *boundary lands* to a consideration of the conditions under which scientists learned best to collaborate with communities. The boat discussed in the next example, Sci-TEK, is an example of a "safe boundary land." The term refers to the social space in which the two groups—community residents and scientists/practitioners can experience successful, non-threatening encounters with one another (Peterson 2010; Berkes 2009). The boundary land can be geographically located in either the community, the academy/practitioners work place or at a neutral site such as a professional or regional meeting or in the field such as on a research boat. Peterson found in which of the sites the scientists learned best about how to collaborate with communities. Unfortunately, but likely expected in hindsight, the scientists were more comfortable when they were interacting with community members in *their* comfort zones—conferences, university settings, field trips—rather than when the scientists were in the communities. Thus, the PAR interactions between community members and scientists/practitioners were seen by the scientists/practitioners as more successful when they occurred at the universities or national professional meetings or on the research boat (Peterson 2010).

4.2 Science and Traditional Ecological Knowledge (Sci-TEK)

A team of geospatial mapping/coastal bio/physical processes experts and social scientists specializing in community engagement undertook a project to elicit the observations of the environment-based members of Grand Bayou and the other communities proximate to Barataria Bay on the west side of the reaches of the Mississippi River (Bethel et al. 2011). A doctoral student and an anthropology graduate student developed the prototype of this model. Then, the success of the initial project resulted in funding by the state of Louisiana Coastal Protection and Restoration Authority (LaCPRA) to develop the collaboration process further. The purpose of the larger project was to quantify the qualitative representations of ecosystems that traditional community members, including harvesters, believed should be considered when coastal restoration projects are developed and implemented. The restoration projects divert fresh water and sediment from the river to create new land and modify the salinity of the area to a more fresh-water regime.

4.3 Effective Engagement Strategies

To obtain the place-based community's opinion about how best to do the restorations, local harvesters were engaged with boats, for professional pay, to develop teaching lesson plans and implement field trips in the target areas for state agency scientists. One of the goals of the collaboration was to achieve balanced conversations on the boats between the two groups of environmental experts—the local seafood harvesters/experts and the scientists employed by the coastal restoration unit. The balance was in the equity of authority of knowledge that was exchanged between the fishers and agents. Harvesters and scientists described to one another what ecological processes they saw, what they understood about these processes and how they came to develop their own knowledge about their surrounding local environments.

Local community knowledge was blended in the conversations and each group benefitted from being shown how the other observed and what they learned. For example, the harvesters were very strong advocates for directing the sediment and fresh water to restore wetlands proximate to existing wetlands rather than in open water, and pressed the scientists to appreciate their thinking. The project was entitled Sci-TEK, short for combining Science and Traditional Ecological Knowledge.

Prior to the boat trips both groups expressed uncertainty as to whether the days spent together on the boats would be productive or only repeats of the tension experienced during public meetings where both groups often disagreed on restoration approaches and found these disagreements repeated in terse sound bites, over and over again. Members of these groups offered little reciprocal respect prior to these boat trips (Bethel et al. 2011; Laska 2006).

The fisher-expert (a person who fishes for a living and is knowledgeable about the community) took the lead when designing the day on the water for the group of research scientists. A lesson plan was informally developed by the fisher-expert who plotted the route and the points of interest in which the whole team would participate. By the end of the boat trips, the study team for the project would often see the harvesters (people who harvest from the sea) and the scientists lingering at the dock to continue their science and collaborative conversations as the research team drove away. One heard the "other" and learned from the other (Levintas 1996; Dussel 2013). The other became a collaborator not an object or an adversary. This was very important in terms of gathering observations. It is important to note that the fishers were not just interviewed as research subject sources for data that the outsider scientists turned into concepts and theories, but also as co-contributors to explanations and understanding (Sillitoe et al. 2002; Fischer 2000). It became evident early in the project that individual science projects such as multiple field sites containing instruments measuring water levels, temperatures and salinity content were important in order to understand ecosystem dynamics; so too were the constant observations of the ecosystem conditions and changes by harvesters using their multiple senses (Peterson 2015; Davis 2010; Leonetti 2010).

Listening, really listening, learning new things from one another about the shared subject matter of coastal ecosystem dynamics, gaining mutual respect for what one knew that the other did not, appreciating that both groups valued the ecosystem and its productivity and were trying their best to envision how to support the future health of the area all came out of the encounter. Such an approach is very costly both financially and especially in the time required to conduct such a collaboration format (Peterson 2015; Gaventa 1993; Park 1993). However, there is evidence that not taking the time, funds, and energy is even more costly. Kent and Taylor (1984) point out that the critics of community engagement who do cost benefit analysis of engagement verses traditional scientific methodologies do not include the very lengthy and costly litigation process that often results from both poor science and disregard of the community.

Boundary land dynamics (Laska and Peterson 2011) were also observed in the Sci-TEK project (Bethel et al. 2014). Following the boat trips, participants of those trips especially harvesters and the scientists from the state agencies, were asked to meet in small groups, but groups larger than on the boats, to review the map outputs from their boat conversations (all of which had been transcribed and coded in an ordinal data set). When they met at the land-based sites, the dynamics were more similar to the public meetings, more adversarial. So the location of the encounters, whether the collaborators feel comfortable in the setting, plays a key role in the success of the collaboration.[2]

4.4 First Peoples' Conservation Council (FPCC) 2012

With the guidance of external partnerships, the coastal tribes initiated development of a conservation council to control and self-direct scientific studies and restoration projects. The First Peoples' Conservation Council (FPCC) of Louisiana was formed in 2012 as an association to provide a forum for any tribal entity in the state of Louisiana. It is a collaborative forum to identify and solve natural resource issues on their Tribal lands, and like its sister organization in Wisconsin, intends to initiate scientific studies with university partners (First Peoples' Conservation Council, FPCC 2012). The importance of this tribal-initiated development is that it represents the community taking clear and purposive action related to the science and study of their changing natural environment.

The Natural Resource Conservation Council, NRCS, has a provision in its federal statutes that permits its support of tribal councils (Leonetti 2010; Cochran et al. 2013). With the mentoring and guiding of the oldest such council, the Wisconsin Tribal Conservation Advisory Council (WTCAC), the Louisiana tribes were able to develop a similar council. The WTCAC is the initiator of research that is pertinent to the health and well being of the environment. Such initiation allows communities to hire the scientists needed as well as grooming its own tribal members for leadership and research roles in physical sciences (Mears 2012; Leonetti 2010).

The First People's Conservation Council (the Council) is an opportunity to give a voice to Louisiana First Peoples on conservation issues at the State and National levels. The current purpose of the FPCC includes both internal and external capacity building to achieve meaningful restoration projects within and surrounding the tribal communities. This occurs through collaboration and training for the tribes

[2]A fisheries biologist presenting to the Society of Applied Anthropology a few years ago outlined a model of engagement for the harvesters and agency scientists who meet to determine fishing seasons and catch size: Always hold meetings that require an overnight so that the attendees can meet and visit at the bar in the hotel. These encounters are experienced as some of the safest locations for honest conversation about contentious issues.

and the development and co-management of conservation projects through education and demonstration (First Peoples' Conservation Council 2012).

Through a strong partnership with the USDA-NRCS, the Council reviews and recommends proposals for conservation projects for Louisiana Tribal Members. The current six member Tribes include: the Pointe-au-Chien Indian Tribe, Grand Bayou Atakapa-Ishak Tribe, Isle de Jean Charles Band of Biloxi-Chitimacha-Choctaw Indians, Avoyel-Taensa Tribe, Bayou Lafourche Band of Biloxi-Chitimacha Choctaw Indians and the Grand Caillou-Dulac Band of Biloxi-Chitimacha-Choctaw Indians.

5 Community Observations and Stories About Changing Environments

In this section we explore some of the observations and stories from local people about their changing environment. These changes often consist of extreme weather events that challenge local people's livelihood and sense of community. A change in extreme weather events also tests former strategies of adaptation and response to other changing physical environments.

The quote below is from a local elder of Grand Bayou who attributes the community's success in surviving hurricane Isaac in 2012, to their prior experience with other storms:

> Yes we did survive it [tsunami-like event during Isaac]. And one of the reasons that we did was because we did have to draw upon the past knowledge of how to deal with water and wind and an adverse situation…. We know how to deal with water in extreme situations.

Traditional interactive knowledge within the bayou community informs everyone that changes they experience now are out of the ordinary from what has been observed over many generations. For example, an early May 2015 storm that hit south Louisiana brought several hours of darkness as if in the middle of the night, but actually occurred mid-morning. One resident, a master gardener who monitors weather closely, stated that she had never experienced anything quite like it in her 80 plus years, nor had she heard stories of any such experience in their past. This same veil of darkness brought with it winds and rain, hail and tornado activity. Recall from the beginning of this chapter, an observation we repeat here, from a "harvester" or one who makes his living from harvesting shellfish, at sea, from a boat:

> The storms are getting stormier, stronger. What used to be normal bad weather, now it is just severe weather, not just bad weather. When you see a little blue cloud in the west you think about running for cover because you don't know what is in it. And lately when you see the storm clouds it is tornado weather.

For the harvesters on the water at the time of the May 2015 storm, their knowledge of past storms was inadequate for what they experienced this time.

They were unable to locate safe harbors suitable for their size boats. One harvester mentioned that this event has made their old way of reading clouds and wind conditions "not good," obsolete.

The combination of sea level rise and subsidence of the land can force the fisher to choose between personal safety and subsistence harvesting. This conundrum is evident in the following quote shared by a community member interviewed during the study:

> Big boats. We need to get big boats. … That open water is too much. If we get big boats and we don't get a catch we won't have any boat. You'll be pulling a pirogue.
>
> The catch ain't there, that's why all the open water, the land (estuaries) have all disappeared. So what's a big boat gonna do for you?

An experience by the Grand Bayou during Hurricane Isaac was similarly perplexing. The storm, which was a slow moving, Category 2 hurricane, produced a storm surge well beyond the one predicted. The following quote is from one of the local people who experienced something never seen before in this community:

> Isaac is part of a new reality. We had our history of all the past storms and their signatures and we were buying into a lot of the media categorizing of the storms. **But where we were, we saw something that we were not prepared for** at the time so that is a lesson learned. **We had not seen it in that significance in any other time before when the water pulled back out of the bayou, it just kept pulling back and pulling back and everything was calm.** I mean the sun came out and it's like - we thought we dodged the bullet more or less … the exit took all night … all through the night … all through the night, the water kept going out and going out … and going out until it got to the morning and so we had been up all night watching the event and the winds were blowing, and then in the morning when the sun came up, and things were kind of calm and balmy we went into the house, because we were in the boat … went into the house to get some rest, because we had been up all night. And within maybe 35 to 45 min- the water … (Interviewer: you had no sense it was going to come back?) Not at that rate. You know, that is a lot of water to put in one place. We expected it (tide) to come back but not so fast and not so much.
>
> And when it came back in after all the water was gone … when I say the bayou, that means all the ponds, all the little ravines, everything was kinda dry, so when the water came back in, I would say from the time we left the boat, 40 min later, we came out and the water was already chest high in the yard space, so we got … we got out of the house because it came in with such a rush. The pilings were breaking loose. The ropes were snapping. Bim had to run to go try get his boat to get on it because it was … it was being taken by the tide to the wind. He was up to his chest in water in that short period of time. On the land, the water came in that quick and that fast. It was something that we had never seen happen before. So that was a new reality. And we know that it is a new signature - and we know that we cannot rely … let's call it a lesson. When they say category one, category two, that may have something but don't just rely on that because the signature of Isaac was, it was 200 or so miles and it just moved at 4 miles per hour. That was more important than the speed of the wind, and the category or whatever. So that was more important to us. And seeing the way it behaved with the water, so that was another thing, so that's now part of our history our memory and our knowledge of how to deal with the storms, so we will know to see that. And, when we see that, we will know what to expect. So that was a learning experience.

5.1 A Scientists' Perspective

The extreme weather event just described was so interesting and unique that we sought out scientific information about it to be a companion representation with the tribe's experience. We found Dr. Bob Rabin, Research Meteorologist, NOAA/National Severe Storms Lab, Norman, OK and Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison, an attendee at the National Center for Atmospheric Research (NCAR)'s "Rising Voices of Indigenous People in Weather and Climate Science" annual workshop, June 29, 2015, who offered to assist. Dr. Rabin contacted Dr. Suzanne Van Cooten, Hydrologist In Charge at the National Weather Service (NWS) Lower Mississippi Forecast center (LMRFC) in Slidell, LA. She is a member of the Chickasaw Nation. The following quote shows the science perspectives (Suzanne Van Cooten and meteorologist Bob Rabin) of the same storms that many of the local people described earlier.

> The storm, which was a slow-moving Category 1 hurricane (peak wind of 80 mph), produced excessive rainfall and record storm tides at Grand Isle and Shell Beach, well beyond what might be expected for a storm of this category.
>
> Grand Isle and Shell Beach are the closest observing stations to the home of the Grand Bayou tribe, operated by the NOAA National Ocean Services (NOS). Shell Beach is located about 20 miles to the northeast, near Lake Borne. Grand Isle is located about 20 miles to the southwest on the same side of the river as Grand Bayou, near the open Gulf of Mexico. Neither station samples water levels near the Mississippi River and surrounding marshes. At Shell Beach, the record tide occurred near the time of hurricane landfall (red curve, Fig. 1) at 2 am CDT on August 29th. At Grand Isle the highest water level occurred a few hours later (red curve, Fig. 2) at 9 pm CDT. Both stations reported a rapid decrease in water level in the subsequent hours, followed by a leveling off and slight increase by 6am CDT on August 30th. It appears that the second increase in water level at these two locations may have been affected by the astronomical tide. However, the water levels remained up to 3 feet (1 meter) above the expected level of astronomical tide (tide not affected by local conditions) during this time.
>
> The conditions experienced by the Grand Bayou community have similarities to the water level plots described above. However, the more extreme drop and subsequent rapid increase in water level may have been influenced by additional factors such as:
>
> - Low water levels in the Mississippi River prior to hurricane landfall.
> - Slow movement of the hurricane.
> - Hurricane trajectory parallel to the Mississippi River after landfall and subsequent reversal of wind direction with hurricane passage.
>
> Further research is needed to understand the detailed response of water levels in vicinity of the Grand Bayou given the trajectory of this particular storm and antecedent river levels. Records indicate that only 10 major hurricanes have made landfall in Plaquemines Parish from 1900–2010 (ref: NOAA/National Hurricane Center 46). The particular combination of storm trajectory, speed of motion, wind intensity, time of high astronomical tide, and antecedent river level storms could make the observed double water surge a rare, "once in a lifetime," occurrence reflected Dr. Bob Rabin.

The Grand Bayou elder, in an exchange with Dr. Rabin added a very relevant climate change question to the discussion of the changing environmental conditions:

> We knew that we were witnessing "something new;" I use this term because we have the unfortunate history of having storms being part of our "norm." I wonder if the tsunami-like event can be traced back to or linked with land loss (loss of protection) in Louisiana and climate change in general? Was this convergence of conditions unique in its outcome, or are we witnessing climatic occurrences that will continue to be unpredictable, with 'new norms' being created?

This quote illustrates local understanding and observation of environmental change by local indigenous community members in the face of extreme weather. Traditional Ecological Knowledge in the context of this discussion is really TEA Traditional Ecological Anticipation, which helps the community adapt to the future (Berkes 2009; Duerden and Beasely 2006). It could also be understood as EEK, Experienced Ecological Knowledge. Tradition is a living relationship; a dynamic experience that posits change for the present (or future) and the present or future will alter the traditional experience. In other words, community members naturally develop certain skills and adaptive abilities to deal with changes in their surrounding environments. It is not nostalgia. The past is a body of knowledge to anticipate the changing present and future. A modification of Paul Riceour's (1991) description of the function of history would be to understand past, present and future to have neither linearity nor clear lines of demarcation. Science, like history is not about reporting what was or is, but about creating alternative futures. Learning to anticipate changes in severe weather patterns is a means, or path, to adaptation (Tschakert and Dietrich 2010). The following quote is shared by an indigenous community elder that characterizes these changes in extreme weather and how communities respond to them.

> The world is a living, breathing thing and there is perpetual change and there are seasons. We people, we make those seasons vary, we make them vary by the way we use resources on planet Earth. We are always in flux. We are always changing. And be mindful of what is happening to the world that we are inhabiting. Community Elder Grand Bayou.

5.2 Changing Environments/Changing Food Sources

The dialogue between community members revolves around the ways their environment has changed and is changing (Cochran et al. 2013; Tsosie 2010). Human-induced changes are affecting the land, water and air, fueled by the demands of natural resources to support an energy-dependent lifestyle. Changes are both subtle and substantial as one community member stated, "We notice the subtle nuances of change. We live with it daily." Another community member shares their thoughts when talking about perceived change of species:

> I see a downfall. First of all the seafood we eat. You can't catch crab any more. The fishes are scarce. Before you could catch a bunch of fish, red fish, trout and Brazilian shrimp. And now, the Brazilian shrimp are gone and the white shrimp are in. Change. They used to come in in August and now they are coming in June, hardly. And crabs and the oysters are scarce also. This is affecting how we eat; now we have to eat more chicken and things that are processed and not organic. And it's affecting our health. If we can't get as much seafood as we normally got, we have to buy all of these things that are processed.

Without seafood as the main staple, the communities that depend on the catch for their diets now depend on processed inexpensive foods (Lynn et al. 2013). This change in diet is taking a toll on people's physical and financial health. A nurse from one of the communities observed, "It is vital to our health for some of these things to be addressed because we are finding more sickness, more disease, more people here are dying of cancer".

When one of our researchers asked fellow community members what they were going to do to care for their future, she received this response:

> We are going to have to make some changes ourselves. Our food supply. We are going to not be dependent on food from the grocery store. We are going to have to raise some of our own without fertilizers. When it comes to our seafood we are going to have to try to go to the areas where the water is cleaner and fish there. We are going to have to sustain ourselves. We have to try.

Another community member focused on the loss of land and the impact on safety while harvesting. "The men have been discussing the need for larger boats to withstand the roughness of the water during the unpredictable weather that doesn't have familiar patterns and signatures experienced by the community." Comparing concerns with fishers from the Grand Bayou, the men agreed that larger boats are needed because the water is now open where there used to be land. The land *chieneres*—elevated oak lined ridges in the marshes—were places of safe refuge if a storm developed.

Both communities are cautious about purchasing larger boats in that the cause for the larger boats, the open water, also means disappearance of the estuaries that produce the harvest. "Prices are down and the catch is scarce. Not good for the family. We were depending on a good season. It's not showing itself." Fishers were being offered (in May 2015) 50 cents a pound for their 40–50 count/pound shrimp. "The men are not going out. They can't take what the dock is offering. The dock is stealing from the boats offering 50 cents when they worked all night and have to pay for fuel and ice. They want to get rid of us." The economic challenges of low market price for the catch co-occur with the environmental challenges (Laska et al. 2015).

In 2011, the year after the BP Deepwater Horizon oil disaster, the two communities of Grand Bayou and Pointe-au-Chien initiated an ethno-botany project. They brought together experts that would help their communities identify traditional plants that were part of both communities' earlier diet and medicinal use (Lynn et al. 2013; Kimmerer 2013a, b). While discussing the different names and uses of various bayou plants the discussion also included the change of timing in the flowering and fruiting of plants and its impact on the community and migratory birds. A local community member shared these thoughts on the matter:

> Well I think it is getting harder to be able to make gardens, to be able to know the time to plant things, to grow things. I don't know what we are going to do I mean. We need our gardens to depend on … I think the world can make the changes if they tried. They could stop using the things that are adverse to our body. They can grow, it may not be as fast but it would be healthier.

Another local person commented on the changes as well as the future:

> I'm very concerned. Things are happening so drastically to me that I think that should concern us. Because our way of life and the things we do. If we are going to have a future for our kids … Things are so different. We don't want it to be so drastically different. We want them to be able to catch crabs. The land used to be so high that my daddy planted a big garden. I want to be able to plant a garden myself today. I want to be able to have the kids to be able to do the same.

This quote clearly reflects a strong local concern for the current state of affairs with the local environment and a sense of loss about what was or what used to be the environmental norm for the local region.

5.3 Observations on Health and Changing Environments

The intersection of environmental health, the air, water and land, directly impacts the harvest that communities have depended on for generations (Laska et al. 2015). The consequences of water, air and soil pollution have a direct impact on humans and human health, but for residents of certain environments the impact seems of greater proportion. These observations by two community members: "So many changes in our lifetime. I noticed at the times years ago that they didn't suffer some of the things we are experiencing today." And, "A lot of sickness and diseases because at one time there wasn't anyone with asthma, no one had sinus problems, and we seldom ever had colds unless we mixed with people who had them. There was not this kind of thing on the bayou."

The rate of environmental change is unprecedented (Maldonado et al. 2013). The following quotes show how environmental change has been framed by community members in Pointe-au-Chien and Grand Bayou, who have an understanding of the local environment:

"There are expert scientists out there who say changes always happen. That perpetual change always happens and you just have to go along with it." In conversation, another community member replied, "I say that it is not true. For hundreds of years we have been here, there was no change. It is only now that change is happening. Since in the last decade or so that changes are taking place. It is because the things that are being put in the air and a lot of things being introduced into our environment." A third member shared, "There are some changes. The changes are happening at a greater rate, accelerated rate, you'll have to adjust to what is happening in the seasons." One of the community members replied:

> I would say that some of the negative parts have accelerated very quickly. I don't know what it will take to put some of those stuff behind us. We need clean air and clean water. I don't know how it is going to come about but these are a necessity of life. If you have clean air and clear water it will give life. It you don't have them then it cuts your life short.

Residents from both the Grand Bayou marsh community and Pointe-au-Chien community believe that the changes occurring in the atmosphere, the waters and the land around them are exacerbated by the pollution from oil and gas production that occur in their village and all along the Louisiana coast (Laska et al. 2015). They see patterns shifting in the growth of shrimp, the decline of insect and bird species, and the lack of pollinators. Other changes such as seasonal shifts in planting are also noted. As described in the introduction, environmental changes from different aspects of fossil fuel extraction and use, including damage to the ozone layer, all come together in their analysis. These communities are sensitive to change because, as one local person states, "Our life dependency is on the environment." The two communities whose quotes are included in this study mirror observations of other coastal communities within the coastal region. They further highlight what is experienced by coastal indigenous people. It translates to other communities and regions that are so tied to their surrounding natural environment.

6 A Proposal for Collaboration Going Forward: Climate Change, Regional Science and Community Task Forces

Collaborations have emerged from one community, with members of other small-town close-knit communities, and with university-based scientists. In essence, these collaborations have produced useful understanding of people, environmental changes and place. While university-based expert knowledge is useful in local communities' attempts to adapt to environmental change, traditional community understanding of the ecosystem in which they live, their relationship to it and their ability to collaborate is critical to effect successful, adaptive strategies for climate change (Ross et al. 2010).

Scientists and practitioners who come from a world outside of these small rural communities have much to learn in order to make a positive contribution. A person cannot just walk into such small, closely knit communities and say, "Hey let's all collaborate!" Relationships must be established and, most importantly, trust must be built.

Drawing from experience in addressing climate change and employing regional science and community task forces, scientists and practitioners can lay out the strategies and work plans for community collaborations to be most effective and beneficial (West et al. 2008). Following ideas of Participatory Action Research (see, e.g., Reason and Bradbury 2008), a PAR project in Louisiana selected experts with specific varieties of interests important to the community: A Scientific and Traditional Ecological Knowledge (Sci-TEK) project in Louisiana demonstrated best collaboration on one-to-one, face-to-face approaches (for insight on Sci-TEK practices see, e.g. Bethel et al. 2014); the First Peoples Conservation Council works toward managing scientific studies carried out by specialists they will hire. Government agencies look more and more to community members, but respect for the role of science remains constant (Pound 2003; Park et al. 1993). This chapter has examined how science and scientists should collaborate with communities, and what should scientists learn about collaboration to be most effective (Apel 1984). It is important to consider the structure of the science/community collaboration, the training for it, the science content, the format of the science communication and variations of the latter for all communities experiencing climate-based environmental change from extreme weather. Perhaps most important is the need for collaboration, respect and trust.

6.1 Structure of the Collaboration

The Coastal Wetlands, Planning, Protection and Restoration Act (CWPPRA) of 1990 (see Fig. 1) created a team of scientists, a taskforce from five federal agencies and a state agency co-located at the U.S. Army Corps of Engineers office in New Orleans to assist implementation of coastal restoration projects funded by CWPPRA (2015). The agencies are the Environmental Protection Agency (EPA), Commerce (National Marine and Fisheries Service), Interior (U.S. Fish and Wildlife Service), Agriculture (USDA) (Natural Resources Conservation Service),

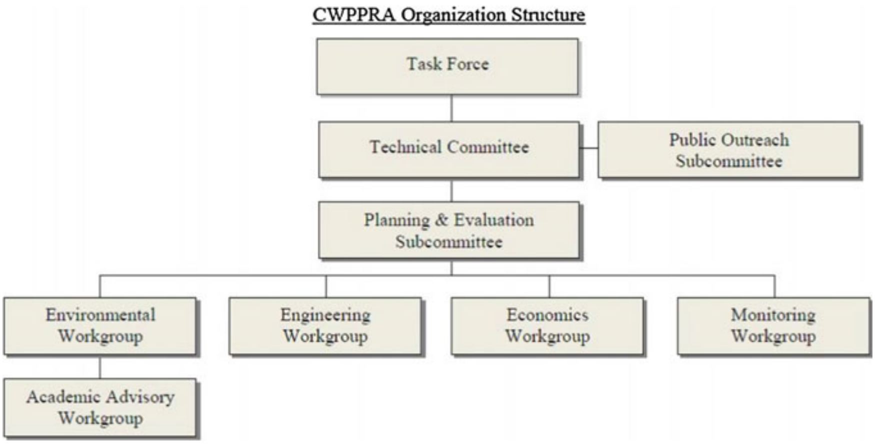

Fig. 1 CWPPRA task force organizational structure (reproduced from CWPPRA task force meeting document, 2015)

the U.S. Army Corps of Engineers and the state of Louisiana's Coastal Protection and Restoration Authority (CPRA) (CWPPRA 2015).

6.2 Value of Co-location

We propose that representatives of other relevant state agencies also be part of the collaboration and, if possible, be physically co-located with the federal agencies. An attempt to create a collaboration that included state agencies, non-profits, and universities working with communities was initiated by Laska and Peterson in (2011) and was titled, "The Oval Table," to note that both Louisiana and the U.S. Army Corps of Engineers sat at the heads of the table. While it functioned, recommendations were made to bring all participants to a common table where all were welcomed and had the same status and power in the dynamics of deliberation.

Louisiana parishes' (counties') governing bodies propose the projects to be implemented with CWPPRA funding. An agency review process determines which projects will be accepted (CWPPRA 2015). Our proposal in this chapter does not pose specific projects, only the collaboration mechanism to conduct them and, eventually, the resources for adaptation projects that would be open for competition just as they are in the CWPPRA program. We use an example of collaboration with local communities addressing climate variability and change. Scientists, by being located within the region, would gain knowledge about the local and regional ecosystem dynamics and interaction with the communities engaged would increase. Trust would grow as communities and co-located scientists collaborate (Park 1993).

A citizen advisory committee could be part of the collaboration. They could be paid for their time. They ideally would be selected on the basis of their individual community engagement history and would represent the communities and the counties. An applicable model of the citizen selection and participation process is that of the Prince William Sound Regional Citizens Advisory Committee. This Committee was formed after the Exxon-Valdez oil spill (1989) to provide an element of citizen/oil industry risk management to the safety program implemented after the oil spill (Prince William Sound Regional Citizens' Advisory Committee 2015; Cochran et al. 2013).

Continuing the proposal for a co-located science team, three existing outreach arms of the federal government (the Sea Grant fisheries agents, USDA Cooperative Extension agents and NRCS District resource conservationists) could help link science teams with the communities. An example of this is happening in Louisiana. One of the senior staff of the LSU Agriculture Center collaborates with a GIS expert from the Louisiana Sea Grant to create storm surge maps that are then shared with members of local communities in community meetings. While both are senior staff members for their respective outreach agencies, not agents themselves, they work closely with agents to ensure the interests of the community are addressed.

6.3 Preparation of Participants—Scientists and Community Residents

Participating scientists would be trained in the same skills as the scientists in the Sci-TEK and PAR projects. Participating communities and their members likewise would have to learn how to work comfortably with scientists—demonstrating their "lived" science and knowledge—and learning from the scientists (Berkes 2009; Mears 2012; Naquin et al. 2015). The key knowledge to be imparted during training has been described in Sci-TEK—"really listening, learning new things from one another about the shared subject matter, gaining mutual respect for what one another knows, appreciating that both groups value the ecosystem and its productivity and recognizing that all are trying their best to envision how to support adaptation to climate (and consequent extreme weather) change in the interest of the ecosystem including but not limited to humans contained herein."

As part of this model of working together, a careful pre and continuing collaboration education process would exist. A commitment to participate from each scientist assigned to the team would be required before being accepted into the team. Scientists would have to achieve high standards of collaboration in order to qualify for the taskforce (Kunde 2007).

Community residents serving on the advisory committee could participate in a training program. They would be asked to contribute to curriculum preparation for the scientists (Huntington 2000). The manner of training could be taken from the Neighbor-to-Neighbor model currently practiced, honoring the Project Impact (PI) methods and program created by FEMA during the 1990s to help make local communities more resistant to disasters. This proved to be quite successful through education and mitigation. In addition, local 'Impact' teams were created among educators, media, non-profits, universities, government agencies, and professional and recreational groups. One such program that grew from the Project Impact model is Tulsa Partners, which still serves as an exemplar model for public safety and awareness. PI showed that multiple entities could collaborate, investigate and make significant changes to make communities safer. A similar approach could be used by others to address coastal issues, disasters and changes due to crises brought about by changes in large scale climate. The Neighbor-to-Neighbor format of this approach assumes that communities learn best from one another. Sprigg and Hinkley (2000) point this out in an assessment of the potential consequences of climate variability in the Southwest United States. They also conclude that "confidences gained during these studies are difficult to achieve; they are lost when the (collaboration) is sporadic." The co-located science approach that we are offering could have the communities learn continually from one another how to collaborate with scientists.

6.4 Content of Science Shared and Scenario Planning

The challenge of how to share information, science and meaningful information across the environment is a valid concern. It is also a necessary part of being adequately prepared for instances of extreme weather that may impact a community. Let us now explore ideas of how to share science with communities that experience or anticipate the consequences of trends in extreme weather. These communities are mainly interested in adapting to these trends, understanding that reversing them is beyond the community's ability (Tschakert and Dietrich 2010; Walker and Salt 2006). So, how does one begin to adapt to these rapidly changing environments and climatic conditions?

Creating scenarios of prospective and desired future conditions is strongly advised as a means to get to the point where communities are aware of current environmental changes and those that are possible in the future. Walker and Salt (2006) in *Resiliency thinking: Sustaining ecosystems and people in a changing world* suggest that building scenarios for what a community wants for their future is essential. When facing extreme weather regime change, a condition that moves the current environmental conditions into a tipping point, people are willing to take the time to imagine their futures (Walker and Salt 2006). When developing scenarios in this manner, the people in collaboration are asked to see their desired future options and weigh them with values. Public elements of hazard mitigation (e.g. sea walls) and extreme weather risk reduction (e.g. forecasts) can be key. Values can include such things as safe water, community networks, safe environments for children, green energy, bike paths, and so on. Scenario building also helps the community evaluate the unintended consequences of development. Greensburg, Kansas is an excellent illustration where an entire community built a futuristic scenario and lived into that vision.

Conversely, scenarios that predict failure of risk reduction due to extreme weather systems are important but difficult to do in a public setting. Communities (especially public officials, utilities, etc.) want to believe they are safe and want that image communicated. More effort will have to be invested in how to build realistic scenarios that communities are willing to 'own' and work with. In other words, to create truthful scenarios.

People of all ages should help build these scenarios. Youth can create a positive vision for what they want the world to be, long after many of us are gone; scientists can test the vision for achievability. Youth are currently active in such climate activities as the Indigenous Climate Change Network (15 years in existence) and Rising Voices (3 years), both Native American initiatives. These are just two of the many indigenous climate change groups that have formed.

Doing such science-based scenario building to prepare for extreme weather events will support the creative, anticipatory, collaborative learning necessary to address anticipated and unanticipated climate events (Hooke 2010). Outreach specialists, citizens and other scientists can call upon regional science teams, respected by the communities, to assist directly in building these scenarios. The authors of this chapter, for example, have acted as a long-term mini-science team for several of the coastal communities. By doing so, both familiarity and trust has been built and sustained.

6.5 Using Stories for Science Communication

Increasingly, storytelling is being used by many parts of society, including business, to talk about adaptation to climate change and the extreme weather it may bring, returning a means of communication to an earlier era of values much like the renewed interest in the dynamics of community (Avraamidou and Osborne 2009; Conle 2003). Three qualities of storytelling make it important. First, it permits the content, in this case science observations and predictions, to be reported in culture-based content. Second, stories permit those who create them and those that hear them to appreciate the relationship among the different dimensions of the story, permitting the representation of different response alternatives in a realistic, i.e. culturally appropriate, manner (Laska et al. 2010; Smith 2012; Kent and Taylor 1984). Finally, story telling can include hopeful alternatives in a realistic, culture-bound story, a quality required by community members who are committed to adapting to climate change. There must be a belief in the possibilities of adaptation, as articulated by one of the Grand Bayou community members:

> It [climate change and weather extremes] is drastic. We need to do something about it … definitely. I don't know what or how *but there are things that can be done*.

7 Conclusions and Lessons Learned: How to Engage Effectively with Communities

In lieu of the usual suggestion for future studies, we make suggestions for future *action* and community engagement. This chapter demonstrates that collaboration is desired by communities to help develop life-sustaining scenarios for their future in the face of extreme weather events and climate change. These life-sustaining scenarios must account for the extreme weather events that redistribute energy for the climate system trying to find a new, stable state.

The coping mechanisms and projects we have shared from the Louisiana region have proven successful in building capacity, skills and trust. They have, as well, built the knowledge necessary to create alternatives for the future. There are stellar examples elsewhere, in this country and abroad, but our focus is on Louisiana which most of the author's call home.

- **Establish Different Types of Collaboration**
  Collaborations can be formal and informal, some coming together naturally, unforced to address a particular issue. The informality of collaboration can be done quickly and without many resources, and dissolved when an issue is resolved. Often the short-lived collaborations can address smaller problems that give community members and scientists alike a sense of achievement. Such celebrations can be witnessed in the development of a community garden or fixing a boat dock. People are more apt to feel vested, and skilled to take on increasingly difficult and complex problems when smaller more immediate issues are part of the solution (Cuomo 2011; Fischer 2000; Escobar 1999).
- **Build Capacity through Collaboration**
  In the absence of a positive collective action people are more prone to retain familiar behaviors even if adverse, when no viable options or resources are available. Building capacity through collaboration, scientist to scientist, between scientist and agencies and communities; inter and intra collaboration in each sector creates a border space for double and triple loop learning or transformative action and knowledge. It provides options and space for building scenarios and provides a doable vision and collective asset for achievement.
- **Create Collaborations Now**
  As climate and weather events create more severe impact on communities and regions, material resources and time will become more precious (Laska et al. 2015). The sooner we build adaptive capacity and science collaborations the more communities will be able to anticipate and address risks and severe impacts with holistic approaches.
- **Increase Capacity/Mitigate Vulnerability to Extreme Weather**
  Ben Wisner (2009) argues that *risk* is determined by the hazard multiplied by the vulnerability of the impact area, lessened by the capacity of the civil society and the measures of mitigation of the locale. Three of these factors, vulnerability, capacity and mitigation, are social dimensions that can be addressed by the types of collaboration presented in this chapter. Wisner's equation is usually understood in the context of lessening the impacts of natural disasters. But, in this case we believe it also applies to reducing the impacts of climate change. We propose that to engage in collaboration is to develop a true public sphere where knowledge can be shared and new knowledge created.
- **Build Collaboration on Trust and Time**
  Collaboration is a slow growth endeavor that builds on trust, trust of skills, trust of process, trust of capacity, trust of knowledge and most of all trust of the other people involved (Peterson 2015). As in learning any new method, there is a learning curve until there is comfort with the process. Given that collaboration takes a diverse public, many people with various skills, knowledge and capacity, there must be time for people to grow into the dialogue and work, a point raised by Sprigg and Hinkley (2000) in the context of assessing social, economic and environmental consequences of climate change. Pushing ahead when not everyone is ready is ultimately counterproductive, but given the shortness of

time to accomplish adaptation, achievement of collaborative capacity by all those involved is paramount. Work and process needs transparency as part of the trust building (Park 1993). Many federal agencies' calls for proposals now include citizen engagement. We suggest that social and environmental scientists and the affected communities be included from the beginning of the process. In so doing the probability of developing a healthy relationship and successful outcome is heightened. Collaboration is a social science specialty.

- **Share Collaboration Strategies with Scientists**
  Some science and professional science organizations such as the American Meteorological Society (AMS) have created workshops and space to introduce physical scientists to Participatory Action Research methods (Kunde 2007; Hooke 2010). The AMS held workshops at their 2007 annual meeting that included Peter Park, one of the leading scholars on PAR. The motivation is to help scientists increase their own capacity and skills to link with local communities for collaborating to solve environmental problems (Hooke 2010). Scientists who are engaged, such as the ones working with the Thriving Earth Exchange of the American Geophysical Union, are realizing that engagement of communities is essential for long-term and complex issues such as climate change.
- **Embrace Different Knowledge Types**
  Peter Park (1993) argues that there are three types of knowledge we use on a continual basis to understand and create new knowledge. He refers to these types as representational/instrumental, relational/interactive, and critical reflective/emancipatory/insightful. Chris Argyris (1994) refers to these stages of learning and creation of knowledge as double loop and triple loop learning, i.e. the continuing iterative process of action/reflection.[3] Most of what science creates in knowledge is through hypothesis-based research that yields representational or instrumental knowledge. Park posits that unless there is a relational and interactive aspect of the data, one cannot move to the critical reflective or emancipatory process of knowledge creation or embedding. Emancipatory knowledge can also be understood as transformative knowledge and anticipatory knowledge. In the situation of extreme weather events, all three types of knowledge become iterative into feedback loops so that anticipatory capacity can be nurtured. As communities and researchers become more adept at relational learning, exchange and building capacity of the other as well as trust, the more the collaboration's capacity is expanded to accommodate anticipatory events. In increasing capacity, lessening vulnerability and taking appropriate mitigation measures, participating communities will have reduced their current and future risk from extreme climate events (Wisner 2009).

[3]Single loop is the positivist approach, hypothesis testing. Double loop is the application but not taking the idea any farther. The triple loop is the process of continuing to refine, i.e. the action/reflection process "ad naseum" (Argyris 1994).

- **Embrace Action Research Models**
  Tscharkert (2010) has embraced action research models to develop what she calls anticipatory learning, and posits that it is essential for learning while experiencing various scales of climate adaptation. Such anticipatory learning builds anticipatory capacity. Daniel Wildcat (2009) proposes that the only research that is worth doing is life-sustaining research. To achieve a positive life sustaining future, Kyle Whyte[4] offers powerful insight into his work with traditional knowledge as a holistic method to envision an appropriate community model. Action research calls for highly creative and imaginative engagement that embraces non-liner systems thinking, and supports placed-based community knowledge. The communities are not blank slates. People are knowledgeable and want to share their knowledge in significant ways that will make a difference. The borderland is ripe for dialogue and problem solving. Community knowledge is essential to harness for co-management of environmental work leading toward a sustainable life-giving future (Wildcat 2009; Kimmerer 2013a, b; Berkes 2009). The communities we have described have opened themselves to being 'teaching' communities. They desire to be co-managers in developing their own future, and have active participants who are willing to get involved. The two case studies shared here illustrate a very powerful step towards attaining the health and overall well-being of people in a particular place or community.
  As our examples demonstrate, methods do exist to help foster successful collaboration between scientists and local residents that could serve as models for all communities. The types of learning to be incurred include good examples of double and triple loop learning that lend themselves to critical change. Some

[4]Whyte (2013)
"It is sometimes assumed that TEK (Traditional Ecological Knowledge) is only instrumentally valuable to climate science because it is observational knowledge collected over generations. However, TEK best refers to a persisting system of responsibilities. McGregor, for example, defines TEK as the relations among "knowledge, people, and all Creation (the 'natural' world as well as the spiritual)…[it is the] process of participating (a verb) fully and responsibly in such relationships, rather than specifically as the knowledge gained from such experiences. For Aboriginal people, TEK is not just about understanding relationships, it is the relationship with Creation. TEK is something one does" (McGregor 2008, p. 145). TEK actually refers to entire systems of responsibilities that are intrinsically valuable insofar as the systems are at the very heart of communities' worldviews and lifeways. The inclusion of TEK in adaptation, management and stewardship strategies is actually about respecting systems of responsibilities. It means creating inclusive research practices that are not only about sharing stories of knowledge, but about sharing understanding of a host of responsibilities that should play integral roles in adaptation, management and stewardship strategies. Institutions that govern or fund research can shelter TEK systems of responsibilities by doing what it takes to ensure their robust participation well beyond the provision of accumulated observations of some landscape. More importantly, TEK concerns tribal strategies for adaptation that are based on tribal systems of responsibilities and the worldviews/cosmologies such systems flow from. Collaboration across science and TEK systems must involve conversations about how different groups of people understand the nature of reality and responsibility (McGregor 2008)."

scientists have been successful in partnering with communities to achieve these more complex changes but there has to be a certain culture of trust established in these instances.

Finally, it is important for scientists to realize that local people's knowledge and experience with environmental change and extreme weather events are vital to effective policy and action. As scientists we often follow a top-down approach—but in this chapter we have explored more community-based participatory models, solutions for action and understanding in light of these global environmental changes. We, as residents of the United States, should be motivated by the challenge and by the example of those who have laid the groundwork for ensuring our future is life-sustaining (Pelling 2011; Wildcat 2009) and this comes through establishing a good, solid base of understanding and respect between researcher and community member. The solution rests with local people, their knowledge, experience and collaborations with others who can respect their local knowledge and ability to act.

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