"2100? IT DOESN'T KEEP ME UP AT NIGHT!"

Lessons for the Next Generation of Climate Assessments

BY LEE TRYHORN AND ART DEGAETANO

Climate change is underway and the impacts are being felt. Assessments of climate change impacts, adaptation, and vulnerability (collectively termed "climate assessments") are being undertaken to inform decision making in this environment of uncertainty (Carter et al. 2007). The urgent need for climate information for management and adaptation decisions has led to an increase in the number of climate assessments being performed across the United States (National Assessment Synthesis Team 2001; New England Regional Assessment Group 2001; Frumhoff et al. 2007; Titus et al. 2009; Jacobson et al. 2009; Moser et al. 2009; Karl et al. 2009; NYSERDA ClimAID Team 2010). Assessment methodologies have gradually evolved and increased in number (Carter et al. 2007), and this trend is likely to continue. In recent years, climate assessments have been progressively propelled from exclusively research-oriented summaries or activities toward analytical frameworks that are designed for practical decision making (Carter et al. 2007). The latest climate assessments (the "new generation") are often required to formulate comprehensive adaptation alternatives or, at the very least, recommendations that will guide the choice of alternatives. This transition is occurring with mixed success, as the aims of research and decision analysis differ somewhat in their treatment of uncertainty (Dessai and Hulme 2004; Rayner et al. 2005). Research seeks to understand and minimize uncertainty, whereas decision analysis aims to manage uncertainty in order to prioritize and carry out actions (Carter et al. 2007).

Despite the increase in assessments that deal with adaptation alternatives, and the increasing recognition that climate impacts and adaptation are unique issues in each community (Miles et al. 2006; Lynch and Brunner 2007; Christoplos et al. 2009; Brunner and Lynch 2010a,b), there has continued to be a lack of practical advice for adaptation decision making at the local level (Arnell 2010). This is particularly true when considering smaller, less urbanized communities. There are a number of examples of larger well-resourced communities taking adaptation action (Lowe et al. 2009; NYC Climate Change Adaptation Task Force), but at smaller scales communities that are proactive with adaptation are a rarity. The attitude is captured by the quote used for the title of this essay from a water supply plant manager when asked about future planning efforts.

The focus of this essay is therefore ways in which assessments can make themselves more socially relevant (i.e., better link climate science to real-world problems being faced by communities) and successfully meet the new demands that are being asked of them. This essay draws on experiences from the 2010 Integrated Assessment for Effective Climate Change

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DOI:10.1175/2010BAMS3104.1

In final form 18 November 2010

Adaptation Strategies in New York State (known as NYS ClimAID 2010) to present recommendations for the next generation of climate assessments. The intended audience for this article is the "climate assessment community"—that is, the broad range of scientists and experts who contribute in some way to climate assessments. How science (and scientists) can evolve to meet these new demands on assessments is an important and challenging task for this group.

Our main arguments are supported by examples taken from the ClimAID report. These illustrate the type of climate-related decisions that communities in New York State (NYS) are making now and the types of information (both climatic and nonclimatic) they need to adapt. In the context of this essay, a community is defined as a group that shares a common place or interest. They may be a political entity (e.g., a local government), a subsector (e.g., a group of grape growers), or a group of scientists or other experts who are supplying information (Haas 1992). A group consensus on goals and values is not always assured and sometimes the process of reconciling diverse interests within a community to advance the common interest will fail.

CLIMAID: SUPPORTING ADAPTATION DECISIONS IN NEW YORK STATE. ClimAID ran from 2008 to 2010 and drew together a team of researchers primarily from Cornell University, The National Aeronautics and Space Administration's (NASA) Goddard Institute for Space Studies, Columbia University, and Hunter College of the City University of New York. The assessment was funded by the New York State Energy Research and Development Authority (NYSERDA) as part of their Environmental Monitoring, Evaluation, and Protection Program. The assessment was structured around eight sectors: water resources, ocean coastal zones, ecosystems, agriculture, energy, transportation infrastructure, communications infrastructure, and public health. A key aim of ClimAID was to engage with stakeholders across New York on their adaptation issues, and the sector leaders worked with NYSERDA and the Project Advisory Committee to identify relevant stakeholders from government agencies, private industry, nonprofit organizations, and academic institutions.[1] Each sector developed its own stakeholder process to meet its individual needs (e.g., the energy group primarily interacted with its stakeholders through one-on-one interviews, whereas the ecosystems group preferred large group workshops).

The goals of ClimAID were to provide New York State decision makers with cutting-edge information on the state's vulnerabilities to and opportunities from climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge. For example, the ecosystems team examined ways in which the viability of the maple syrup industry in New York could be maintained despite rising temperatures that often cause decreases in production (Skinner et al. 2010; Wolfe et al. 2010a). The adaptation strategies formulated with the industry included changes to management practices (tapping the trees earlier and bringing more maple trees into production) and the use of new technologies (increasing sap yield through the use of new types of spouts and using reverse osmosis to remove water from red maple sap) (Farrell and Stedman 2009; Skinner et al. 2010; Wolfe et al. 2010a).

The energy team also combined scientific and stakeholder knowledge when it examined the ability for hydropower generation to help meet the goal of ensuring a reliable green energy supply for New York State in a changing climate. The potential exists to deploy another 2,500 megawatts of hydropower around the state by 2022, but hydropower was found unlikely to be a viable adaptation strategy because of financial, regulatory, environmental, and siting barriers (State Energy Planning Board 2009), as well as likely climate changes (Horton et al. 2010). For instance, obligations to ensure adequate flows in times of drought at Niagara Falls take priority over power generation by the New York Power Authority (Parshall and Hammer 2010). To the extent that climate change increases the incidence of drought in the Great Lakes Basin, hydropower production levels across the state will likely decline. This suggests that other sources of renewable energy, such as solar and wind, should be explored (Parshall and Hammer 2010).

Despite efforts of federal and state agencies, the "home rule"[2] nature of governance in New York State (there are 1,605 local governments) means that having an impact on adaptation preparation and planning requires engaging communities. We did recognize,

[1] A complete list of these groups can be found in the final report (NYSERDA ClimAID Team 2010).

[2] Home rule is the principle or practice of self-government by localities. Within New York State, the powers of municipalities have increased greatly over the last century (NYS DOS 2010). Legislation in NYS provides power to local governments to govern over their own property and affairs, and restricts the power of the state legislature from acting in relation to a local government's area (NYS DOS 2010).

however, that actions at a number of levels will influence which adaptations can take place locally (Adger et al. 2005a; Keskitalo and Kulyasova 2009) and we worked to examine barriers from different scales that would impact adaptation action. Depending on the level at which the decision maker is operating, these barriers could sometimes be viewed as opportunities. An example of this type of disconnect can be seen in New York State's drought response. Although the New York State Department of Environmental Conservation may issue drought declarations across parts of the state, they do not have any authority to enforce water restrictions at the local level (Shaw et al. 2010). It is instead up to individual water utilities to decide how stressed their actual systems are and whether to implement management responses to these conditions. This could be problematic for water utilities with limited technical resources or insufficient risk aversion and could potentially result in water shortages. However, from a local perspective, this situation can also be seen as an opportunity for communities to take charge of their local water supply systems and implement restrictions that take into account their local context. During the most severe drought on record, many communities within the same county had vastly different water supplies available to them, ranging from no available water, requiring the hauling of water from elsewhere, to no shortage of water (*Ithaca Journal* 1963; Seckman 1963).

REFRAMING ASSESSMENTS: WHAT DO YOU WANT TO AVOID? Leichenko and O'Brien (2008) identified a need for research that increases our understanding of the interconnections between processes, outcomes, and responses within the broader context of change, and better integrates different streams of knowledge with decision making and policy formulation (Adger et al. 2005b; Moser 2010). For example, in relation to climate change, measures to prevent losses need to address the social and environmental precursors that serve as conditions for turning extreme weather events into disasters (Stehr and von Storch 2005). To successfully meet these new demands that are being placed on assessments, it is critical to have a clear understanding of the decision making context of communities, as they often face diverse managing goals, changing environmental conditions, conflicting interests, and a lack of predictability (Brugnach et al. 2008). To begin to unlock the complexity at the local level, we suggest reframing future assessments to focus on community values and goals (what they would like to preserve or avoid) rather than on potential climate hazards. Goals and values are basically a desired object or situation and typically include the protection of people, property, and the natural environment—however, they vary greatly among communities and are also subject to change (Clark 2002; Lynch and Brunner 2007; Tryhorn and Lynch 2010). Examples of climate-related community goals in New York State include the protecting of the alpine recreation and maple syrup industries (Scott et al. 2008; Skinner et al. 2010), ensuring that energy systems can meet peak demands (Parshall and Hammer 2010), expanding of wine and grape production (Wolfe et al. 2010b), securing a reliable water supply for residents, limiting the number of combined sewer overflows (CSOs), and protecting properties from flooding (Shaw et al. 2010). In this paradigm, defining these goals is a research outcome in itself and reflects an ongoing collaborative process between scientists and stakeholders.

In the past, assessments have often focused on climate hazards even though it has been well established that more information about projected climate changes and impacts rarely alters on-the-ground decision-making processes (Rayner et al. 2005; Mastrandrea et al. 2010; Brunner and Lynch 2010a). This was also a weakness of ClimAID and as the project progressed, our understanding of what information would actually be required to make adaptation decisions changed. Initially, we focused on characterizing changes to extreme rainfall (an example of a potential climate hazard). However, as we engaged more with stakeholders, they directed us to focus on the real problem: flooding. Flood damage already costs the state an average of $50 million a year and consequently any potential changes to the flooding regime are of great interest to decision makers at both the local and state levels (Shaw et al. 2010).

Many assessments have reported that more extreme rainfall will lead to more flooding (e.g. Frumhoff et al. 2007) and in urban regions or areas of steep topography this direct link between precipitation and flooding is obvious. However, the ClimAID flood analysis revealed that for most of the state, less than 20% of the largest streamflows recorded are actually caused by the largest rain events (Shaw et al. 2010). Most (approximately 60%) of the highest streamflow events in New York result from moderate rainfall events (25–75-mm two-day events) on very wet soils (limited rainfall storage capacity). In the future, even though the rainfall amounts of the largest storms are likely to increase (Tryhorn and DeGaetano 2011), higher temperatures may create a buffering effect by drying the soils through increased evaporation (Shaw et al. 2010). Ultimately, despite the projected increases in extreme rainfall events, it remains uncertain whether flooding will actually increase in New York State and communities will need to make decisions that account for this uncertainty. Similarly, other assessments have focused on warming temperatures to suggest that New York's maple sugar industry will face a decline in production in the coming century (Rock and Spencer 2001). While this may be true, instead of further examining potential changes to temperatures, the ClimAID analysis examined what could be done to meet the goal of maintaining the viability of the maple syrup industry in New York. It found that with adaptation to climate change, the industry can remain productive for at least the next 100 years (Wolfe et al. 2010a). In this case, if we had focused on finding out more about the climate hazards (extreme rainfall or temperature changes) instead of the actual problem, we would have missed the bigger picture.

Examples of goal-oriented (or problem-oriented) approaches can already be found in the literature (Lynch et al. 2008; Prins et al. 2010). A suggested framework for engaging with communities on adaptation problems is presented in Fig. 1. Aspects of the framework are drawn from the policy sciences (Lasswell 1971). This framework is well established in the literature and has been rigorously tested in many other decision making contexts (Clark et al. 2000; Brunner et al. 2002; Lynch et al. 2009; Tryhorn and Lynch 2010). More recently it has been used in studies of climate change adaptation (Lynch et al. 2008; Brunner and Lynch 2010a) and has been found to be a powerful and flexible tool for dealing with the *wicked problems*[3] that climate change presents. This type of approach is useful as sound policy in response to environmental concerns often emerges from a focus on the problem at hand and the values at stake, rather than a focus on one (climate change) of the often many causal factors (Lynch et al. 2008; Moser 2010). Responding to climate change is a contingent benefit, not an encompassing one (Prins et al. 2010). This approach may help

[3] Many of the problems associated with adapting to climate change can be described as "wicked." The term *wicked problems* was first used by Rittel and Webber (1973) in relation to public policy. These problems are characterized by the presence of stakeholders with competing interests and changing ideas about how to define the problem, what might be causing it, and how to resolve it.

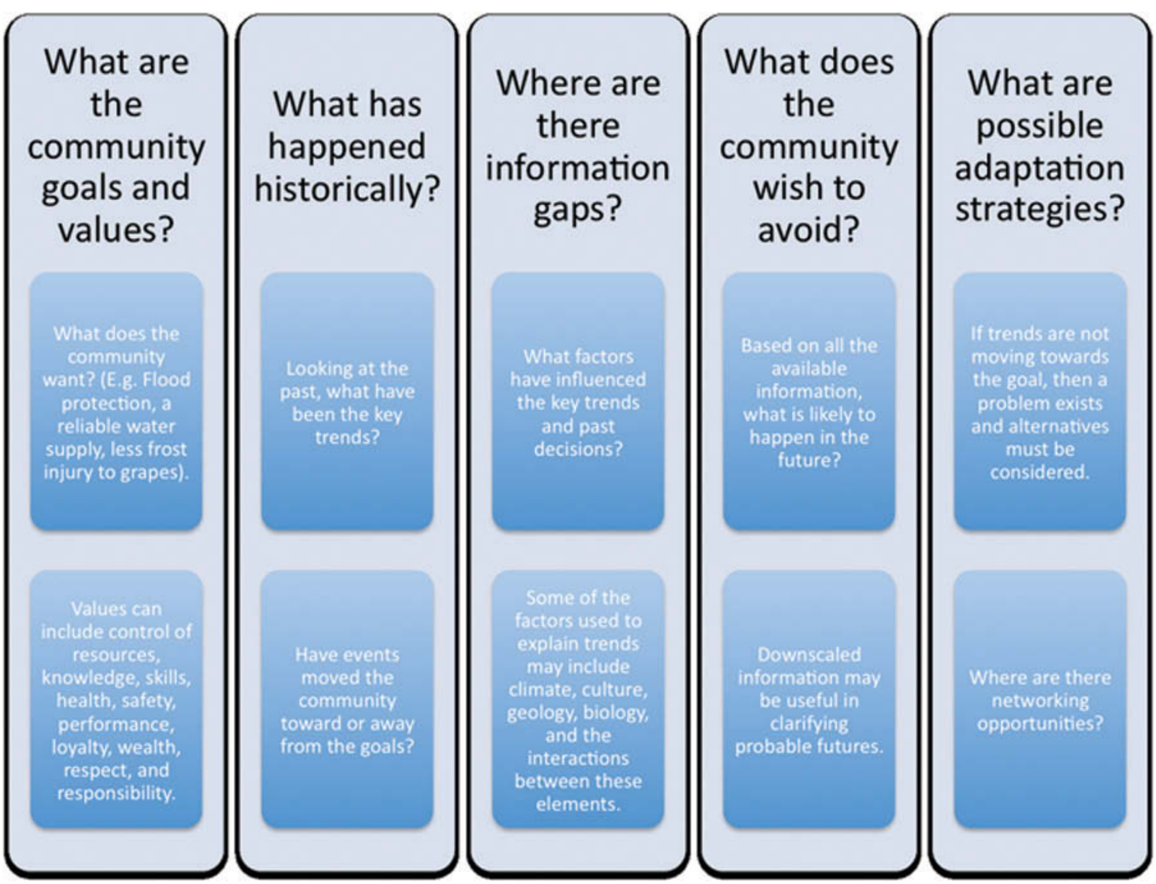

Fig. 1. A framework for integrating climate information into adaptation decisions at the local level.

to cross sector boundaries and capitalize on synergies that are often missing in purely sector-based climate assessments (O'Brien et al. 2006).

INFORMATION NEEDS: HOW MUCH AND WHAT TYPES? After the priority goals of the community are established, it is important to examine the historical trends relating to the goals, information gaps, and the factors that condition the nature and magnitude of the trends. For example, if the goal is to ensure a reliable water supply for a community, important information could include details on past streamflow and rainfall, population projections, the number of residents who rely on wells, how much supply the local reservoir holds, inventories of water infrastructure, and locations of leaks (Table 1; Shaw et al. 2010). Future projections of climate-related drivers may also provide pieces of the puzzle. Identifying these information gaps is crucial as recommendations for adaptation actions based on incomplete research will rarely be directly useful in on-the-ground decision making. Heller and Zavaleta (2009) found hundreds of adaptation recommendations in the literature on biodiversity conservation; however, few were specific enough to actually operationalize them. The amount of information required will depend on (among other things) the problem being addressed, the stakeholder groups involved, the scientific understanding of the problem, and resource constraints. In some cases more information may

Table 1. Examples of climate-related issues that communities are grappling with now in New York State.

What are the community goals and values?	Goal: A reliable water supply for the future	Goal: Expand the wine and grape industry	Goal: Protection of the alpine recreation industry	Goal: Protection of roads along the coast from flooding
What has happened historically?	• Population growth and low summer flows have put pressure on what was historically a reliable source	• Cold-injury events have damaged crops, causing large economic losses	• Warmer winters have seen reductions in the winter snowpack	• Increases in sea-level rise have seen increases in flooding in some areas
Where are there information gaps?	• Future streamflow • Leakages • Number of wells • Population projections	• Timing to expand into new crops	• Timing of snowpack loss	• Amount of future sea-level rise • Desired level of protection
What does the community wish to avoid?	• Water shortages • Water pollution	• Cold-injury events • Unnecessary use of costly frost protection measures	• Job losses • Loss of wealth	• Roads being washed out • Lack of emergency service access and escape routes
What are possible adaptation strategies?	• Water conservation • Interconnections with other municipalities • Rainwater harvesting	• Frost forecasts • Frost protection measures	• Promote summer recreation (e.g., water recreation parks) • Diversify revenue stream	• Beach nourishment • Phased withdrawal • Seawalls • Buyouts
Where are there networking opportunities?	• Intermunicipal drought planning	• Finger Lakes Grape Program • Lake Erie Regional Grape Program • Long Island Grape Extension Program	• New York State Hospitality and Tourism Association	• Cornell Local Roads Program

even serve to increase the ambiguity between adaptation alternatives and the desired outcomes (Pielke 2007). During the ClimAID project, we found that many municipalities across New York State do not have a good idea of how much their reservoir holds or how many of their residents rely on private wells (Shaw et al. 2010). It is difficult to formulate adaptation strategies for communities without this basic information.

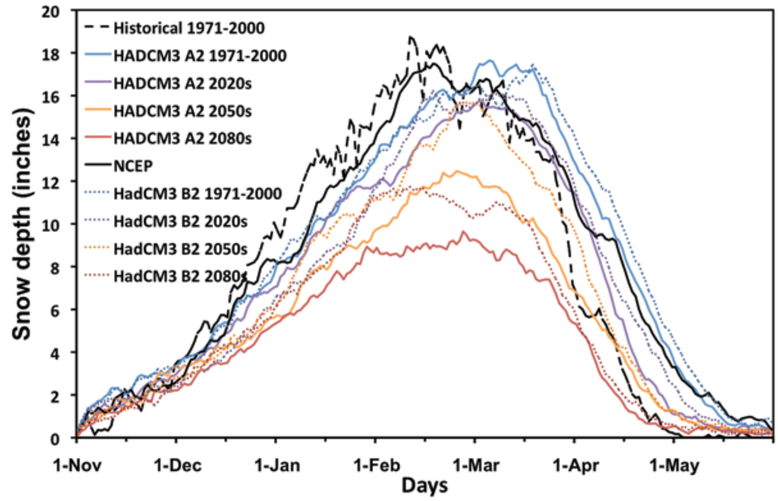

Fig. 2. Snow cover projections at the Wanakena ranger station in the Adirondacks (Wolfe et al. 2010a; Tryhorn and DeGaetano 2011, manuscript submitted to *J. Appl. Meteor. Climatol.*).

A good starting point is the realization that many communities within the same region will be making decisions around the same management area or problem (e.g., water supply) but the goals will be specific for each community (Table 1). Identifying the types of decisions that could benefit from climate information can also help to guide scientific enquiry. Every community in New York State is making decisions that already utilize climate information to some degree, such as those involving water supply and infrastructure, flood mitigation, crop selection, dairy cow heating/cooling, hazard mitigation, and transportation. Currently, these decisions primarily rely on the historical climate record (e.g., from 1931 to 1960)[4] and often do not take recent observations, let alone climate change, into consideration. Mosquito control and landscape care are currently often calendar based rather than weather based (Denly et al. 2010; Gussack and Rossi 2010). These types of applications could benefit from climate or weather data. Such attention to current climate conditions not only provides a means of accounting for nonstationarity in mean climate conditions, but also addresses inherent year-to-year variations in climate conditions.

Long-term infrastructure projections could also benefit from the use of climate information. Record flooding in Broome County in 2006 stimulated the preparation of a Multi-Jurisdictional Multi-Hazard Mitigation Plan that was used to inform the selection of mitigation activities (Broome County 2006). This plan did not incorporate climate change projections into its risk assessment. Similarly, the city of Ithaca did not include climate change information in its decision to rebuild its aging water supply treatment plant on a small local creek (B. Grey 2009, personal communication). Both of these decisions reflect the quote in the title of this essay and the fact that for most communities, climate change is not something they think about. Climate change could have been factored into both these decisions; if it had, it might have altered the ultimate decisions of these communities or at the very least allowed them to make a more informed, robust decision.

Less obvious are decisions where climate information is not currently being utilized, but where it could add value. An example is a school that is building a new sports field. Currently in this region, artificial turf is preferable to real turf as during high use times in the early spring and late fall the ground is saturated and artificial turf resists heavy use better, and requires no irrigation or trimming. However, it has been well established that artificial turf is hotter than natural grass when exposed to the sun (Galassi and Bortolin 2010; Yaghoobian et al. 2010). This already compromises athlete health and performance during the summer months (Denly et al. 2008) and may become more of an issue in this region with the projected rise in heat waves (Horton et al. 2010).

WHAT STAKEHOLDERS WANT . . . OR THINK THEY WANT . . . A large part of new assessments will involve the creation of downscaled climate projections. Decision makers are asking for downscaling, but how useful is it really? For many of the key variables in which decision makers have

[4] Return periods used for management and design estimates are currently calculated using data from 1931 to 1960 (Technical Paper 40, Rainfall Frequency Atlas of the United States, known as TP-40; see www.erh.noaa.gov/Tp40s.htm).

an interest, such as extreme rainfall, the results vary widely depending upon the climate model and the downscaling technique used (Tryhorn and DeGaetano 2011). It also remains unclear when uncertainties in regional climate change projections might be reduced (Mearns 2010). Despite these uncertainties, there are some areas and variables where it is possible to have confidence in the direction of trends. That information, while not quantifiable, may be enough for some adaptation decisions. For example, across a range of emissions scenarios, it is very likely that winter temperatures in New York State are going to increase and winter snow cover is going to decrease in the Adirondacks in the long term (Fig. 2; Tryhorn and DeGaetano 2011, manuscript submitted to *J. Appl. Meteor. Climatol.*). Despite large variations in greenhouse gas emissions trajectories, there is agreement between climate scenarios on the direction of change. These projections indicate that by the end of the century, the average maximum snow cover in the Adirondacks may decrease by 150–200 mm. That does not mean that the snow will disappear completely, but it does give an indication that the snow is likely to be more variable and that in the long term a different approach to tourism will be needed. In some areas, a transition is already occurring as water theme parks have become popular attractions in New York's alpine areas. This approach shifts the focus from needing more information for action to *what can we do to achieve our goals based on the information we have?*

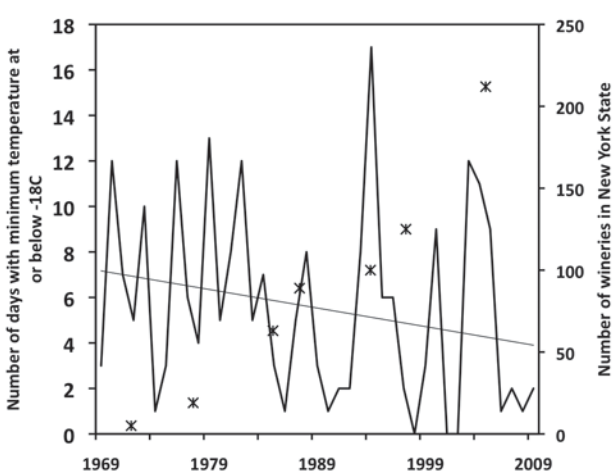

Fig. 3. The number of days per year with minimum temperatures at or below −18°C in Geneva, NY (solid black line) and the number of wineries in New York State (black stars). (The Geneva observational data were obtained from the Northeast Regional Climate Center and the number of wineries was compiled from the following references: Goldburg 1988; Pool 1996; McCandless 1999; USDA NASS New York Field Office 2010; Vino Vixenz 2010).

MAKING LEMONS FROM LEMONADE: DERIVING OPPORTUNITIES FROM THE CLIMATE PROBLEM. Some regions (like New York State) are going to have the opportunity to derive benefits from climate change. It was a great challenge for ClimAID to communicate that climate change will bring many opportunities for economic development. The past brings many lessons in this regard (Pfister 2010). In order to even exist, the viticulture industry in New York had to adapt considerably from its European origins. It was long thought that the extreme winter climatic conditions in this region, in combination with American pests and diseases, would never successfully support European grapes (*Vitis vinifera*) (ABJ 2010). Yet, the industry managed to overcome the three major obstacles largely thanks to Dr. Konstantin Frank. Grafting the European varieties to American rootstock (*Vitis labrusca*) increased resistance to pests, use of fungicides combated disease, and precision site selection along the Finger Lakes helped to identify microclimates with less extreme winter temperatures (ABJ 2010). New York is now the second largest wine-producing state in the country, after California (Hodgen 2008).

The industry expansion in New York State has coincided with a period of large temperature increases and lengthening of the growing season (Fig. 3). The growing season is expected to further lengthen in New York in association with climate change and will lead to great opportunities to expand viticulture (Wolfe et al. 2010b). By the end of the century, some projections indicate that it will be one of the few regions in the United States ideal for viticulture (White et al. 2006). Of course alternatives to achieve any one goal impact other community goals—for example, ice wine production in the region is likely to be negatively impacted by warming temperatures—which is why *net* losses or gains are important. This example highlights the competing values/goals within one particular community (the local viticulture industry) and the fact that within this community subgroups may require different adaptations depending on whether their goal is to start growing warmer climate grapes or to protect their ice wine crop.

FINAL THOUGHTS.

If you keep your eyes open enough,
Oh, the stuff you will learn!

—Dr. Seuss
I Can Read with my Eyes Shut

Fig. 4. Key characteristics for the next generation of climate assessments.

> *To some extent we are all blind and no doubt will remain so. But there are degrees of impairment, and so far as decision outcomes are concerned, it is the responsibility of the (policy) scientist to assist in the reduction of the impairment*
>
> —Harold Lasswell
>
> *A Pre-View of the Policy Sciences*

This essay has considered the information needs to help communities "open their eyes" to adaptation. We have provided empirical examples from the ClimAID report to argue that in order to make better inroads into adaptation actions, climate assessments need to further embrace a community-based, goal-oriented approach. In summary, our recommendations are that assessments (Fig. 4) should have the following characteristics:

- They should be problem focused (oriented toward the likelihood of achieving community values/goals), not climate hazard focused.
- They should emphasize the role of decision makers (this includes learning about the decision context and having stakeholders involved in the assessment process).
- They should be oriented toward a single community but also be cognizant of factors at other scales that can impact the feasibility of some adaptations.
- They should integrate scientific information with local values to provide adaptation alternatives that are consistent with scientific results and will reduce losses or vulnerabilities and capitalize on opportunities.

This type of community-based approach presents different challenges than the current broad assessment model that is widely used, but it is an important approach because we need case studies to test conventional wisdom on how to reduce net losses and vulnerabilities; to gauge the significance of scientific assessments in conjunction with other factors; and to provide models for other communities to adapt and state and federal governments to support. The first part is essential for scientists—we must put ourselves in a position to be shown that we are right or wrong on empirical grounds.

So how should we select which communities to work with? Every community's climate adaptation problem and capacity is different—communities are not interchangeable, as random sampling and standardized methods assume. Reducing net losses or vulnerability to climate variability and change is the primary policy goal in this context—not equity. However, equity can be integrated into this multivalued conception of the common interest. One approach is to use experience on how to minimize climate-related losses from successful communities and use that experience to help those that are more vulnerable (Brunner and Lynch 2010a). However, to have an impact it is crucial that they are predisposed to act. Capacity may not exist in a particular locale or there may not be decision makers who are interested in climate information (Pulwarty et al. 2009).

Past damages and vulnerability are both relevant indicators of need; and judgments are unavoidable, even if random sampling is the choice. Moreover, we recognize that because of resource constraints, if nothing else, we cannot help every community at once. The quote used in the title of this article is ambiguous. As understood in the context of technical rationality,[5] it refers to the problem of shortsightedness. Understood in the context of procedural rationality,[6] it implies an opportunity—that

[6] Refers to the actual processes of reasoning and describes a system's ability to discover appropriate adaptive behavior (Simon 1978; Bartlett 1986). Procedural rationality refers, for example, to the processes by which an individual or organization thinks through a policy or administrative problem, situation, or course of action.

[5] Assumes that reason is bound by, and defined in terms of, scientific technology (Schön 1983).

Table 2. Examples of techniques to support adaptation efforts at the local level.		
Program	**Description**	**Reference**
Networking strategy	Transfers information "horizontally" from one community to the next, as well as "vertically" to state and federal levels.	Lynch and Brunner (2007)
Urban Leaders Adaptation Initiative	Works with several large counties and cities to incorporating climate into daily urban management and planning. A key component is information sharing between participants.	Lowe et al. (2009)
Climate Smart Communities	Partnership between state and local governments aimed at both mitigation and adaptation actions.	DEC (2010)
Nested matrix	Recommends that assessments use a broad conceptual framework or matrix linked to smaller-scale illustrative examples. For example, a national assessment would be accompanied by localized case studies of impacts on specific sectors or implications for specific local decision making.	NRC (2007)
ICLEI Climate Resilient Communities	Peer network of cities, towns, and counties that provides technical and policy assistance, software training, and information services to help members build capacity, share knowledge, and implement sustainable development and climate protection at the local level.	Snover et al. (2007)

is, a series of near-term problems to be addressed quickly, incrementally, and in small steps, with continuous evaluations and adjustments along the way. Staged implementation of adaptation starting with extreme positive and negative outliers—or even any community willing to cooperate—will help us learn as we go and hopefully we will do better in each subsequent stage. These case studies can then be used as examples across the region for other communities facing similar issues. There are many examples of this approach in the literature (see Table 2): networking strategy (Lynch and Brunner 2007), the Center for Clean Air Policy's (CCAP's) Urban Leaders Adaptation Initiative (Lowe et al. 2009), New York State's Climate Smart Communities Initiative (DEC 2010), the nested matrix approach (NRC 2007), and ICLEI's[7] Climate Resilient Communities Program (Snover et al. 2007).

Often climate information is only one of many types of information that is needed to make a decision. Adaptation decision making will utilize information from different assessment approaches (Carter et al. 2007), as well as local experience and knowledge (Brunner and Lynch 2010a,b). Downscaling will be useful in illustrating how future conditions may differ from the past, but will not provide all the "answers." It will be challenging to integrate these different streams of information, and smoothing the transition from a research-driven to a practical decision-making agenda will require that assessments refocus to become goal and decision oriented. This approach joins scientists with communities to focus on key issues of concern, namely, community-identified values and goals that could well be in jeopardy in the future.

Adaptation decisions will have to be made at varying scales, by federal agencies, states, counties, towns, the private sector, nongovernmental organizations, and individuals. Progress will require the collaboration of physical and social scientists, and research institutions will need to create opportunities to enhance and reward this type of user-oriented science. Many research organizations have existing connections to communities of decision makers and expansion of these programs would enhance their potential to make meaningful contributions to climate adaptation.

Climate change research is a topic of which the boundary between policy relevant and policy prescriptive is blurred (Pittock 2010). As members of the climate assessment community, we believe scientists have a valuable role in facilitating adaptation action because of our special vantage point of having an understanding of the scientific underpinning of climate

[7] ICLEI = Local Governments for Sustainability (formally known as the International Council for Local Environmental Initiatives).

change. It remains to be seen how the broader climate science community will reorganize to best serve the decision needs of communities on the ground. Regardless, having an impact on adaptation and empowering communities by expanding the range of adaptation alternatives available to them will require scientists to further engage with the public and decision makers.

ACKNOWLEDGMENTS. This work was supported by the Northeast Regional Climate Center (NRCC), the Cornell College of Agriculture and Life Sciences, and the New York State Energy Research and Development Agency (NYSERDA). The authors would also like to acknowledge the hard work of the many ClimAID authors who contributed to the final report, as well as the enthusiasm of the participants from a variety of groups across New York State. We also thank Ron Brunner, and two anonymous reviewers for their constructive comments and suggestions, which helped to greatly improve the manuscript.

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