A Community Based Approach to Improving Resilience of Forests and Water Resources: A Local and Regional Climate Adaptation Methodology

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Abstract: *Forest-based ecosystem services are at risk from human-caused stressors, including climate change. Improving governance and management of forests to reduce impacts and increase community resilience to all stressors is the objective of forest-related climate change adaptation. The Model Forest Policy Program (MFPP) has applied one method designed to meet this objective since 2010. MFPP's program, "Climate Solutions University: Forest and Water Strategies," delivers a climate change adaptation process based on the 2007 publication by the Climate Impacts Group at the University of Washington, "Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments." MFPP enrolls up to six communities each year in Climate Solutions University, and guides them through a four step process: engagement of a community based climate planning team; assessment of resource and economic risks and adaptation opportunities; prioritization and development of an adaptation plan; and implementation with a range of governance, education, and land use management tools. This paper discusses some of the findings and lessons learned, that include: (1) People are the single most crucial success factor, both individual leaders with dedication to plan implementation and a supportive network of people in the community representing a range of interests. Outsiders cannot make it happen. (2) Using local values as the framework for communicating and avoiding fear of catastrophic change and scientific jargon is the best way to build public trust. (3) Even a modest adaptation plan can have a positive impact with targeted actions. (4) Plan stewards can be of any type (local government, resource agency, non-governmental organization (NGO)) if diverse and affected stakeholders are engaged, but local governments or agencies are more likely to have sufficient resources and established networks, as well as a background in policy. Ongoing commitment and allocation of positions (FTEs) are the most important "resources" needed for successful adaptation. Increased budget support for personnel dedicated to climate adaptation in local communities by federal and state governments would help.*

INTRODUCTION

Climate Solutions University—a program of the Model Forest Policy Program and the Cumberland River Compact—is a distance-learning program to increase forest, water, and economic resilience in rural underserved communities. We believe that addressing climate change impacts will require a sustained commitment to integrating climate information into the day-to-day governance and management of infrastructure, programs, and services that may be affected by climate change (Binder 2010). Through a lead entity such as county government, conservation district, or nongovernmental organization (NGO) working on science, education, and/or advocacy, communities enroll in a ten-month course of assessment and planning with the objective of producing a climate change adaptation plan to implement in following years.

This paper summarizes the purpose, content, outcomes, and lessons learned by the Climate Solutions University (CSU) experience after working with two dozen communities around the United States during a five-year period from 2008-2013. First, we briefly place the program in the context of the rapidly developing field of climate adaptation science and policy. We describe the program elements and what has been learned through practice, and synthesize a list of challenges and recommendations for communities. We conclude with specific suggestions offered to both improve effectiveness as well as scale up local adaptation actions promoting forest, water and economic resilience.

PURPOSE

Global Resource Crises

Climate changes are being driven by increased retention of solar irradiance ("global warming") caused by fossil fuel combustion and other emissions of atmospheric greenhouse gases (GHGs). Climate change is but one part of a series of resource management problems. These problems include continued growth of human population, economic activity based on energy resources that emit GHGs, impending "peak" of finite resources such as petroleum, natural gas, and phosphorus, and increasing human appropriation of net primary productivity of the biosphere to the detriment of long-term sustainability of ecosystem services required by human society (Haberl and others 2007; Heinberg 2010; Hall and Klitgaard 2012; Kates and others 2010). In sum, "Humans now dominate Earth, changing it in ways that threaten its ability to sustain us and other species. ... [A] global-scale state shift is highly plausible [in the near future] if it has not already been initiated" (Barnosky and others 2012). Forests are a significant resource affected by and affecting ecology and economy across multiple scales from the local to the global. The importance of forests for water supply, habitat, carbon sequestration and other ecosystem values is well documented, as are the potential impacts of climate change on those values (National Research Council 2008; National Climate Assessment and Development Advisory Committee 2013).

Governance, Resource Management, and Climate Resilience

Changes in fundamental social structures appear to be necessary to successfully adapt to climate change, including major changes in global governance systems (Biermann and others 2012). Governance means the process of decision-making and the process by which those decisions are implemented. In this respect, governance is much broader than government as it includes the

full range of political, social, economic and administrative actors that regulate development and management of decisions (Rogers and Hall 2003). In rural forested communities, these actors include land and resource owners (public, private, and tribal), regulatory and taxation governments and agencies, a broad range of NGOs, and recognized community leaders.

The latter—community leaders—are the most underappreciated factor in governance. As stresses become more acute and current governance less functional (multiplicity of overlapping crises, shortage of funding, political polarization and gridlock), authority at the local level is enriched. Our work supports the assertion from Lusiani (2013) that claims in an increasingly interdependent and multi-polar world, which has witnessed a fragmentation in responsibilities in recent years, it is more important than ever that the voices of ordinary people be heard and adhered to in the design, implementation and monitoring of sustainable development policies.

It is primarily at the local level of governance that specific adaptation actions and management choices are being made, or not (Moser 2010). Local governance actions continue apace whether or not they are planned with sustainability and resilience in mind. Thus empowerment at the local level is most important in natural resource dependent rural communities; local communities are the space where public policy and landowner decisions concerning land and resource use affecting climate change resilience come together. Fortunately, the opportunities to bring sustainability to local decision-making are ample if they can be catalyzed with good decision-making and implementation processes developed by the CSU program to drive "good governance."

CLIMATE SOLUTIONS UNIVERSITY IN ACTION

Basis for the Program

The Model Forest Policy Program (MFPP) based the Climate Solutions University (CSU) program on a 2007 publication by the Climate Impacts Group at the University of Washington[1], ICLEI[2], and King County, Washington:

The purpose of Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments is to help ... decision-maker[s] in a local, regional, or state government prepare for climate change by recommending a detailed, easy-to-understand process for climate change preparedness based on familiar resources and tools. The content of this guidebook was developed from reviews of scientific literature, the Climate Impacts Group's experience working with U.S. Pacific Northwest decision-makers on preparing for climate change, and King County, Washington's experience developing and implementing a climate change preparedness plan (Snover and others 2007).

Since the publication of Snover and others (2007), others have confirmed the importance of local level governance to achieve successful adaptive action (Perkins and others 2007; Binder and others 2010; Measham and others 2011).

The motivation for initiating the Climate Solutions University program in 2008 was a keen awareness that climate change was moving beyond mitigation (prevention) and that forest and

[1] http://cses.washington.edu/cig/
[2] http://www.icleiusa.org

water resources would be experiencing serious consequences with wide-ranging impacts to rural communities and downstream urban areas. At the same time, climate resilience efforts were heavily weighted to energy and transportation and the natural resources of rural areas were being underserved in science, program offerings, and funding (c.f. USDA Forest Service 2010, Forest Service 2000). Methods to bring climate resilience to rural communities was still a largely unknown art.

The Model Forest Policy Program's Climate Solutions University seeks to be a catalyst for sustainable forest and water governance choices. The program focuses on locally specific climate risk in rural areas, where most U.S. forest and water resources are located, providing close-to-the-source effective planning and implementation of adaptation strategies. In addition, as the need for payment for ecosystem services becomes clearer, CSU helps communities connect to downstream and other communities that benefit from the rural communities forests and water resources.

Before the formal launch of CSU in 2010, MFPP engaged with two communities as pilots to explore two possible approaches to climate adaptation at the local level: Bonner County, Idaho, in the Northwest and the City of Cookeville, Tennessee in the Southeast. In Bonner County, the effort focused on improving riparian resource conservation when property was developed. That effort did result in significant improvements to the county's lacustrine and riparian buffer requirements in the zoning code. In Cookeville, the need to adapt to climate change was included in the newest iteration of the city's comprehensive plan. The plan states that to adapt to predicted climate changes, measures such as committing to the reduction of green house gas emissions, promoting and implementing sustainable building practices, and protecting and enhancing our forests and green infrastructure should be implemented. These two processes demonstrated the ability to bring climate planning and policy to fruition, even in conservative states, the first of its kind in both Idaho and Tennessee at the time. Out of the experience with these two pilot communities, and building on Snover and others (2007), MFPP and the Cumberland River Compact developed the CSU curriculum.

Overview of the Program

Following the guidance of Snover and others (2007) and others, CSU addresses climate impacts together with other stressors, such as development pressures. The program has four basic steps in two programs. The first program, *Plan Development*, is a 10-month curriculum that guides rural communities in the first year to: 1) build and engage a strong, diverse stakeholder team; 2) assess climate risks and opportunities related to climate, forest, water, and economic conditions; and 3) formulate a climate adaptation plan that prioritizes water and forest restoration and protection measures. The second program, *Implementation*, in years two and beyond, guides communities toward concrete actions with measurable outcomes such as policy changes and restoration practices to improve land use, protect water quality and quantity, and support stable economies (more information can be found here: http://www.mfpp.org/csu/our programs/implementation_program/).

CSU provides training and technical expertise to enrolled communities through a variety of interactive methods. The *Plan Development* program includes eight learning modules supported by an online classroom, step-by-step worksheets and checklists for resource assessments and

planning process, extensive resources and references, webinars every other week, coaching calls weekly, and editorial review of adaptation plans as written and finalized.

The *Implementation* program focuses on providing customized programming to meet the specific needs of participating communities to implement their particular adaptation strategies. Webinars are offered monthly by noted experts on wide-ranging topics requested by community leaders or that analysis indicates would be beneficial. Webinar topics have included climate communications, ecosystem services, engaging in agency land use policy, and outreach to conservative audiences among others. In order to better achieve program objectives, we review the success of each community's planning effort at the end of each year, and conduct extensive interviews to determine how to improve the CSU program.

From 2010-2013, five or six communities were enrolled each year in the *Plan Development* program. Communities with resources and commitment continued in the *Implementation* program in following years. Community participation in Climate Solutions University since inception is indicated in Figure 1, and the governance categories of planning lead entities are shown in Table 1.

Table 1. Climate Solutions University, Curriculum Outline 2013

Module 1: Orientation
#1 Introductions
#2 Program Overview
Module 2: Climate
#1 Climate Overview & Framing the Issue
#2 Global / Regional / State Perspectives
Module 3: Team Engagement
Stakeholder Engagement & Team Facilitation
Module 4: Forest
#1 Assessing Risks and Vulnerabilities
#2 Assessing Opportunities and Solutions
#3 Assessment Status and Planning Narrative
Module 5: Water
#1 Assessing Risks and Vulnerabilities
#2 Assessing Opportunities and Solutions
#3 Assessment Status and Planning Narrative
Module 6: Economics
Assessing Conditions, Risks and Solutions
Integrating Economics into Forest and Water Assessments
Module 7: Analysis
#1 Risk Analysis
#2 Risk Prioritization
#3 Setting Adaptation Goals
Module 8: Adaptation Planning
#1 Setting Objectives
#2 Gap Analysis and Strategies
#3 Detailing an Action Plan for Implementation
Module 9: Adaptation Plan Review Sessions
#1-5 Five Individual Draft Plan Review Sessions and Editing
Climate Adaptation Plans Completed

Table 2. Governance Categories of Climate Solutions University Lead Entities

Class Year->	2009		2010						2011					
Category of Plan Development/ Implementation Leader	**Bonner County ID**	**City of Cookeville TN**	**Whatcom County/ Nooksack WA**	**Keene/ Ashuelot NH**	**Sumner County TN**	**Grand County UT**	**La Plata County CO**	**Town of Taos NM**	**Trinity County CA**	**Nez Perce Tribe ID**	**Alger County MI**	**Greene County TN**	**Chautauqua County NY**	**Bath ME**
Local government municipality		■			■			■						■
Local government special purpose													■	
Tribal government										■				
NGO youth education								■						
NGO science/research							■		■					
NGO conservation/restoration			■									■		
NGO advocacy	■			■		■					■			

Class Year->	2012				2013				
Category of Plan Development/ Implementation Leader	**Mattole CA**	**Shasta County CA**	**Delta County MI**	**Rockingham County NC**	**Upper Delaware NJ/NY/ PA**	**Marquette County MI**	**Santa Fe NM**	**Rogue OR**	**Norton Bay AK**
Local government municipality									
Local government special purpose		■	■						
Tribal government									■
NGO youth education									
NGO science/research									
NGO conservation/restoration				■	■		■	■	
NGO advocacy	■					■			

Plan Development

The first substantive step in the CSU curriculum is to orient the communities to the current state of climate science, including the location of resources needed to conduct assessments in each geographical area represented (e.g., NCADAC 2013; Vose and others 2012; National Research Council 2008). Next is the most important practical step, to develop a team within the community. This is done to ensure that sufficient resources are available to conduct the resource assessments and to prepare a plan that reflects the interests of as many constituencies as possible (cf. USDA Forest Service 2000).

In each of the two key resource assessments—forests and water—both past and ongoing stressors are evaluated, with the addition of the likely impacts of future climate change. Of great importance is for the communities to understand the limits of the existing data, and the implications of the uncertainties inherent in projections of future resource conditions and impacts, especially with respect to climate change (Peterson and others 2011). While downscaling (increasing the resolution) of resource data and climate change impacts has improved, it is still true that the smaller the geographic scope of the assessment, the more uncertainty there is (Sunyer and others 2012; Hawkins and Sutton 2009; Wilbanks and Kates 1999).

The curriculum increasingly works to incorporate economic impacts and solutions in the forests and water assessments. Economic solutions such as payments for ecosystem services (PES) are inextricably linked with the assessments of risks to and solutions promoting resilience of forest and water resources. Economic measures are often significant justifications for other plan elements, for example cost avoidance by taking specific actions to prevent or reduce fire-fighting costs by prohibiting subdivisions in Wildland Urban Interface (WUI) zones. Economic measures also include direct expenditures to increase resilience, such as planting trees in riparian areas to reduce erosion and flood damage, purchase of in-stream water rights to conserve riparian resource values, and transfer of value from benefitting urban areas by means of payment for ecosystem services.

Finally, the communities and their teams are guided through a synthesis and planning exercise. Strengths and weaknesses, opportunities and threats are evaluated ("SWOT" analysis), a prioritization of risks and opportunities is prepared, and specific plan elements are developed along with a first draft of an implementation plan (Kazmierczak and Carter 2010). Focused goals, objectives and strategies are carefully crafted using SMART criteria (specific, measurable, attainable, relevant, and time-bound) (c.f. Niemeijer and de Groot 2008; Bell 2012). A year-one implementation timeline is laid out that clearly outlines who will do what by when, using practical actions over short, medium and long-term timeframes.

Implementation

The *Implementation* program is designed to ensure plans are put into action to the fullest extent allowed by available time and resources. In some cases, plan element implementation occurs concurrently with plan development. For example, in Sumner County, TN, a comprehensive plan update was in process at the same time the County was preparing its climate change adaptation plan. The forest resource assessment prepared by the county planner for the CSU program became the basis for the natural resources section of the County's adopted, wholly revised comprehensive plan.

In most cases, plan implementation occurs in the years after the CSU's Plan Development program curriculum year ends. Communities that choose to participate in the *Implementation* program enjoy the benefits of an active network of climate adaptation practitioners. This provides communities with shared experiences and information through peer implementation learning opportunities.

As the long-term focus of the CSU program is to generate plan implementation, MFPP also works with communities to expand their capacity by means of geographic clusters; it is easier for an adjacent county to replicate a successful planning effort than to create a plan in a community in an entirely new area. Other support to expand capacity include direct policy assistance, collaborative outreach, and fundraising support. Special projects that have been provided through the CSU Implementation program have included webinars on dealing with conservative constituencies, using storytelling to convey the need to adapt, and how to develop tools to implement PES (payment for ecosystem services).

OUTCOMES—COMMUNITY PLANNING AND ACTION

Drawing on a few examples from the 24 communities in the program to date, we highlight a few outcomes of the CSU program.

Bonner County, ID – 2009

The first pilot community for testing the CSU adaptation process was Bonner County in northern Idaho, home base of the executive director of the Model Forest Policy Program (MFPP). Bonner County fits the rural, forested community profile the program was seeking to assist with climate resilience. The MFPP director led the project through an intense 18-month process of climate data collection, analysis and risk assessment, local leader education, and policy research and advocacy. The planning team organized itself into three subcommittees—education, policy, and politics—according to the passions and skills of its members.

Taking advantage of a window of opportunity, the climate planning overlapped with the county's land use codes revision process. The climate risk findings for the county included increasing forest tree mortality, extreme spring floods, warmer lake temperatures, severe milfoil invasion in the lake, and inadequate policies to protect the riparian zones of streams and shorelines. The climate team advocated for a "watershed overlay" in the county's land use codes, with a special focus on riparian zone protections, largely unregulated at the time.

The outcomes for the Bonner project included:

- Community leaders were well educated on climate change and acknowledged its importance to the natural resources of the county;
- A new county commissioner was elected who favored addressing climate risks; and
- New riparian zone protection requirements were adopted by the Bonner County Board of Commissioners.

As with many communities, the political winds shifted again with the next election two years later and little further progress has been made on the policy front. However, the new riparian zone protections are in place benefiting the water quality and health of the lake over time.

This community example illustrates the importance of outcomes related to: education of both leaders and key stakeholders, employing policy solutions, and engaging elected officials. It also illustrates that persistence and longevity is critical to maintaining progress. The climate education and leadership must continue indefinitely in order to keep resilience progress in place. While the code changes are having ongoing beneficial effects, further adaptation actions have yet to be taken in Bonner County due to the lack of local organizational capacity to persist with education and advocacy activities around climate resilience, as well as hostile to uninterested political leadership.

Sumner County, TN – 2010

In 2010, the first full year of the CSU program, the county planner for Sumner County, TN, led the adaptation planning process for this rural, but urbanizing, county in Middle Tennessee immediately northeast of Davidson County (Nashville). Sumner County was motivated to participate by two factors: 1) the nearby Cookeville community had completed the process as the Southeast pilot community; and 2) Sumner County was in the midst of a new 25-year comprehensive planning process and the climate assessment would benefit that plan by prioritizing future land actions in the most conservation and resilience promoting locations. The climate planning team also served as the natural resource subcommittee for the comprehensive plan.

During the planning year, middle Tennessee experienced a catastrophic 1000-year flood on the Cumberland River,[3] severely impacting Sumner County and highlighting the extreme weather patterns already occurring in the region. The flood reinforced the assessment risk findings, including precipitation extremes (floods and drought); population growth coupled with unsustainable growth patterns threatening critical habitats, and public health impacts.

Public polling as part of the comprehensive planning process showed broad support for natural resources conservation and preserving rural characteristics in the county. The goals of the climate plan were incorporated in the county's adopted 2035 Comprehensive Plan, calling for increasing the tree canopy county wide, protecting headwater streams and forests with new steep slope ordinances, and low impact development patterns.

While Sumner County has moved toward sustainable development by improving the stormwater regulations, other progress has been slow largely as a result of a change in planning staff, budget cuts, and changing priorities.

La Plata County, CO – 2010

In the San Juan Mountains of southwest Colorado, the Mountain Studies Institute (MSI), a science-based conservation organization, recognized the climate change impacts to the alpine ecosystems and communities. MSI led the climate adaptation planning process with a team including public land agencies, universities, and NGOs. The Colorado team conducted a rigorous assessment: southwest Colorado has warmed about 2° F since 1977. Climate zones will migrate to higher elevations and warmer temperatures will lead to drier soils and changes in precipitation patterns, including reduced snowpack, earlier timing of snow melt and shifting streamflow peaks leading to shortages for agricultural irrigation. Snowmelt has already shifted two weeks earlier from 1978 to 2004. The results for the forests of the region will

[3] http://www.state.tn.us/tsla/exhibits/disasters/floods2.htm

include increased risks for pests and disease, forest fires, and upslope shifts for forest species ranges. These changes are being exacerbated by increasingly intense wildland-urban interface pressures.

A plan was developed with a focus on mitigation of catastrophic wildfire risks on both private and public lands and management of scarce water resources. Initial outreach to private landowners at the wildland-urban interface received intense opposition from anti-Agenda 21 activists following a local election that put their sympathizers in office. A fire education grant to the local government for work by MSI was returned to the funder. To adapt to the changing political winds, MSI shifted focus to fire mitigation on public lands and the productive relationships they already had in place with the U.S. Forest Service and the Bureau of Land Management (BLM). Building upon existing public-private collaborations, MSI is actively engaged in public lands work along with hosting climate conferences, restoration projects, and field research. However, due to resource limitations and the political climate, no governance changes called for by the plan have been implemented.

Rockingham County, NC – 2010

The Dan River Basin Association (DRBA) is a nonprofit watershed organization in the mostly rural, forested hills of the southern Appalachian Mountains. DRBA's mission is to safeguard the watershed and promote the history, natural resources, and unique cultural features of the Dan River valley region.

The CSU planning project was led by Jenny Edwards and focused on the portion of the basin in Rockingham County, North Carolina. A major factor in a successful planning effort was the active involvement of the Piedmont Triad Regional Council, a regional planning organization with GIS expertise that recognized the value of adaptation goals and supported the assessment and plan development process. DRBA chose to focus on natural resources and a "no regrets" approach to conservation without focusing on "climate change" terminology, which helped avoid unnecessary conflicts in a conservative community.

Risks to the Piedmont forest include high rates of loss and fragmentation of prime forest and farm land to development; drought with hotter, drier summers; tree stress of invasive pests and species; and increasing rates of extreme storm events. The beautiful rivers and streams of the region are at risk from increasing flood events coupled with an infrastructure of high-risk coal ash ponds in the flood plains and hundreds of aging Depression Era small farm pond dams with degrading structural integrity. After this paper was drafted, one of the coal ash ponds discharged a large quantity of toxic waste to the Dan River (Sholchet 2014); the climate adaptation plan prepared the DRBA to respond rapidly to the crisis. DRBA has been able to maintain continuity of personnel working on plan implementation, leading to a growing network of collaborators working toward resilience in the county.

OUTCOMES—LESSONS LEARNED

Community Selection, Team Membership

Community selection has been based primarily on "readiness" factors including significant forest and water resources at risk, the perceived organizational capacity of the lead entity to complete

the project, demonstrated local government leadership or support, and project leader skills. The geographic distribution of the communities over time was coast to coast with a preference for areas where regional clusters of communities could develop over time. The rural nature of the selected communities tended to result in a predominance of politically conservative leadership in elected officials and agency leadership. The organizations serving in the project lead role varied considerably including watershed NGOs (10), local governments (3), conservation districts (3), forest NGOs (3), Tribal governments (2), science NGO (1), youth education (1), local elected official (1), and university extension service (1). The numbers are higher than the 24 communities due to co-leader positions with a number of communities. In fact, the co-leader situation proved to be a strong model for effective project management.

A major criterion for outreach and community selection is to build regional networks. Communities near each other tend to have similar resource issues and impacts as well as overlapping governance entities (e.g., same state government); building clusters of planning communities enables them to learn from each other in a synergistic way that is not possible solely with distance learning from MFPP staff. The four largest CSU community clusters to date are in Upper Michigan and around the Great Lakes, those in the Four Corners region of the Southwest, in Northern California and Southern Oregon, and in the Southeast in Tennessee and North Carolina.

Climate Risks Assessed

The assessment process completed by the communities identified risks to forest, water and economic resources related to existing non-climate stressors, current climate impacts, and projected future climate impacts for each community. While each community had different local conditions, they tended to be consistent with the corresponding regional climate risks reported in national climate assessments. In spite of the wide geographic distribution, the key climate risks identified shared many commonalities across nearly all the communities including changes in forest composition, invasive species, changes in the hydrologic cycle, degradation of water quality and quantity, and weather extremes.

The forest risk assessments had similar results within geographic regions. In the West, fire is a major concern almost everywhere (except for the wettest community, Whatcom County/ Nooksack Watershed in Washington). In the Great Lakes, Northeast, and Southeast, increasing severity of precipitation and related flooding and changing species composition are the major concerns. A few communities containing or close to urban areas also have significant conversion and land use change issues increasing wildland-urban interface lands. Some are isolated enough that they are not growing in population, although resource extraction is expanding (e.g., Upper Peninsula, Michigan).

Assessed water risks are closely related to forest risks, and include land-use changes and urbanization patterns that exacerbate climate impacts. Changing hydrology and the impacts of changes in the forest are the major concerns. Hydrological changes, together with increasing demand for water for municipal and agricultural uses stresses both water quality and quantity. Sea level rise and coastal erosion was a factor in coastal communities. In nearly every case, these impacts were already occurring in measurable ways with projections for increasing severity in coming years.

Economic Risks were correlated closely with the loss of natural-resource-dependent livelihoods and included degraded tourism and outdoor recreation opportunities, higher costs for at-risk ecosystem services of water supply from forested watersheds, and higher costs for insurance, risk management, and damages to infrastructure.

Adaptation Strategies and Solutions

The range of solutions fell into three major categories: education and outreach, policy and governance, and on-the-ground restoration or conservation. In addition, monitoring and adaptive management was an important element for the long-range effectiveness of the communities' adaptation plans (c.f. Hawkins 2009).

Education and outreach plays a key role in every stage of planning and implementation. Education focuses heavily on the planning teams themselves early during the CSU curriculum, then it extends out into stakeholder education and engagement as part of plan development and implementation. A third level of outreach is required to the broader community and specific stakeholders in order to successfully enact many plan elements, especially when considering policy changes to land use planning and zoning or local codes and ordinances. Education of private landowners to motivate voluntary conservation practices is also necessary, especially in areas where the majority of forestland is owned by private landowners (northeast, southeast, Great Lakes).

Policy solutions require the most political will and the longest time horizon to accomplish. The goal of policy changes is conservation of forest cover and source water areas to protect ecosystem services and avoid the harm caused by inappropriate development such as in floodplains and wildland-urban interface areas. It is also a frequent policy goal to integrate climate risk strategies into all community planning process, such as comprehensive plans, habitat conservation plans, drought and flood plans, watershed management plans, and public agency plans (Binder and others 2010; Cohen 2011; USDA Forest Service 2010).

On-the-ground conservation activities is an element in each adaptation plan. Recommendations include wildfire management practices for forests, riparian and shoreline restoration projects, wetlands restoration, and invasive species monitoring and control measures. There is also significant call for infrastructure projects to better withstand extremes of floods, drought, and storms with improved stormwater management and upgraded culverts, pipes, bridges and roads. Collaborative projects with land management agencies or community-based forestry is a goal in several plans (cf. Cheng 2011).

Organizational Capacity and Planning Process

There are two basic outcome categories: "process and organization" and "forest and water resilience." The main lesson MFPP has learned regarding process and organization is that it is difficult to predict whether any particular lead entity will be able to successfully put together a broad stakeholder team and follow through with plan development, let alone implementation. In some cases, local agencies have unexpectedly not been able to allocate sufficient staff time to the effort. On the other hand, two other community efforts were led by very small NGOs, but due to the good relationships between the organization and the local power centers, good work

was accomplished and continues in the larger community (cf. Danks 2009; Danks and Jungwirth 2008).

On the substantive side, the main predictor of what kind of adaptation elements will be in the plan and implemented is the type of organization in the lead. Local governments (including tribes) tend to be more focused on policy, so they are likely to work for incorporation of climate adaptation into various plans, with a higher chance of follow through into substantive policy changes. NGOs tend toward less regulatory measures, such as education, monitoring, and restoration. Over all, conservation districts have been the single best performers in both assessment and implementation, perhaps because they are a hybrid type with capabilities in both policy and on-the-ground conservation efforts. Watershed groups have the closest mission affinity for working at the landscape level and skills in effective education and outreach coupled with restoration activities.

Difficulties Obtaining Outcomes

Continuity of staffing dedicated to implementing and breathing life into an adaptation plan over time is the most certain predictor of completion of a plan with community buy-in and long-term implementation follow through. The single most common cause of poor plan implementation is lack of allocation of sufficient human and financial resources. This can often be traced to inadequate organizational capacity and lack of institutionalization of the adaptation goals into the lead entity's core mission and budget.

Monitoring and evaluation (M&E) is another key element of adaptation that is very difficult to achieve. There are both qualitative and quantitative measures of successful improvement in resilience: examples include more sustainable forest practices, miles of stream bank planted with trees, wetlands restored, acres of forest under conservation easement, stable instream flow, species biodiversity, etc. However, it takes significant resources to conduct appropriate monitoring, and it is rarely done outside of large public or private landowners. The CSU program continues to work to obtain long-term commitments by communities to monitor the impact of their adaptation activities and funding to support those activities.

Our conclusions concerning barriers to climate adaptation are consistent with those found throughout the governance and climate adaptation literature (Moser and Ekstrom 2010; Smit and Wandel 2000).

Factors for Success and Future Potential

As the community examples above illustrate, participating communities have achieved some significant successes in adaptation implementation but all also have great unfulfilled potential in their long-term commitment to climate resilience activities. Plan leads included entities across the governance spectrum, from county and city governments, to conservation districts, to NGOs. Some government leads have been successful in obtaining quick governance changes, but continuity of effort has been stronger in the conservation districts and some NGOs.

The community successes vary in type and distribution. Education, at the soft end of the solution spectrum (with land use and related regulations at the other end), has had a fairly consistent result. Numerous people in the lead entities and on the planning teams reported having learned

a great deal about climate change, the impacts likely to occur in their communities, the costs of those impacts, and the range of actions that can be taken to deal with the impacts and their costs. In communities with significant National Forest System land, collaborative participation by the Forest Service, and even joint management efforts such as community forestry, have been furthered by the CSU planning process. As new national forest planning regulations—including climate change as an explicit element—are implemented, the success of CSU communities to build upon relationships developed in the planning process will be put to the test.

Obtaining explicit recognition of the need to address climate change in local comprehensive and resource planning processes has occurred in most CSU communities that take up the question. Moving from that recognition into regulatory measures is far more difficult, with rural communities often being particularly resistant to change. In many rural communities, the path of education and working on collaborative relationships with public and private stakeholders holds greater promise than strong direct advocacy of policy changes that is difficult to obtain without first building good working relationships. Linkage with mandatory policy change, such as those associated with EPA's stormwater permitting regulations or California's climate planning requirements, offers more powerful methods for adaptation measures to be incorporated into policy change by simultaneously providing negative feedback for failure to comply with higher level governance dictates, and positive feedback such as planning grants, reduced infrastructure and disaster management costs, and potential for PES from nearby urban communities.

On-the-ground activities such as tree planting in riparian buffers are relatively easy to accomplish politically, but require long-term organizational continuity and dedication, as well as significant funding resources. In order to be most effective, these activities should be conducted on the basis of careful evaluation of where the greatest benefit can be obtained per unit of effort, i.e., assessment and prioritization. Furthermore, riparian restoration should be designed in association with a full assessment of the upstream watershed and its anticipated hydrologic shifts so that subsequent floods or droughts don't negate the riparian restoration benefits in future years. Assessing risks and prioritizing restoration activities has been easier than avoiding harm by changing flood plain land use policies.

A number of specific governance measures show great promise of providing significant resilience capacity through the CSU program. MFPP staff are particularly excited by the synergy of an expanding network of adaptation practitioners with experience and expertise in forested rural communities all around the country. Substantive governance measures we will be working on over the near term are implementing PES, inclusion of forest and water resilience in all applicable plans and decision-making processes, collaborative or community-based forestry on public lands, and use of fiscal and management tools available to rural communities to increase the knowledge and practice of sustainable forestry (Binder and others 2010; Danks and Jungwirth 2009).

Finally, the single most obvious factor determining whether or not a community will implement a climate adaptation plan is the continuity of dedicated staff time. Communities have little problem learning how to obtain scientific information to support resource risk assessments; the federal government has been funding research and top-level educational and coordination efforts at consistent and fairly high levels—$2.5 billion per annum (OMB 2013). Adaptation activities are funded at fairly low levels—$100 million per annum—and few of those dollars appear to be

supporting personnel in rural communities to prepare and implement climate adaptation plans. This weakness in the funding structure supporting climate adaptation in local communities is confirmed by the work of Fran Sussman and others (Sussman and others 2013, 2014).

CONCLUSIONS

Adapting to climate change is an essential public and private governance activity in order to increase community resilience to inevitable impacts, as well as promote sustainable use and conservation of natural resources. Uncertainty about future climate changes and impacts of those changes are great, but adaptation, and adaptive management, are specifically designed to increase resilience in the face of uncertainties. It is relatively easy to assess the range of likely impacts from climate change, and it is becoming easier with advances in our understanding of the climate system and monitoring data over time. It is also relatively easy to identify the needed policy changes to respond to the identified threats. The more difficult task is to overcome inertia in our governance systems to actually implement adaptive actions.

Climate Solutions University endeavors to achieve adaptation with risk assessment and community planning processes developed by numerous practitioners in the field over a period of years. Working with rural forested communities around the country, we guide them through an intense program of resource and risk assessment, prioritization and planning, leading toward on-the-ground actions to increase resilience. In the course of this work over more than four years, we have learned a number of lessons about what works and what doesn't work.

First, people and relationships are primary. Without people who are willing to do the hard work of assessing the status and trends of resources in their community *at the same time* as they develop a network of supporters, successful implementation over time is not likely. Building public trust is essential, and this is best done by using local values as the framework for communicating, and by avoiding alarmist fear of catastrophic change and by not using scientific jargon. The plan leaders that have been most successful in the CSU program are those that already have the necessary relationships and sense of trust within their community.

Second, the relevance and appropriateness of chosen adaptation objectives to the community is a key factor. The types of adaptation actions that are likely to emerge at the end of the planning process are in good part related to the type of entity in the lead role. Local governments, either general purpose like counties or special purpose like conservation districts, are much more comfortable with policy or regulatory actions than NGOs. The ideal scenario entails collaborative ownership of plan implementation with each organizational type being engaged in the adaptation effort and playing to their strength, whether it is policy, education, or restoration.

Third, incremental implementation is better than no implementation. Almost every plan includes significant provision for education and outreach. Even if no "hard" governance changes are likely in the short term, a message that is spread by members of the community—as opposed to by outsiders—lays the foundation for locally empowered adaptive actions. This foundational work is particularly important in communities with a significant presence by landowners from outside, such as the U.S. Forest Service and industrial forestland owners. The collaborative relationships developed in the process become a positive outcome in themselves. These relationships lead to

a strengthening of democratic governance at the local level that Americans should be proud of and promote as a key component of climate adaptation (Moser 2009; Oyono and others 2006).

Finally, there are no short-term or easy paths to resolve many of the natural resource stresses currently being experienced around the world. Governance institutions have a great deal of inertia, even in the face of overwhelming impacts. Adaptation practitioners must be dedicated to a long-term commitment in their community to develop the trust and build a base to enable governance shifts when opportunities arise, whether in the form of regular county or national forest planning cycles, or crises like a thousand-year flood or loss of an important tree species. The required dedication does not exist in a vacuum; both monetary and human resources must be allocated to local efforts over time, by the local communities themselves, and by state and national agencies and NGOs in the best position to provide it. One action that would help the effort is for the federal and state governments to provide more direct support to local communities with budget support for personnel over time dedicated to adaptation planning and action. The grace period has passed, the climate impacts are already happening, and the time to act is now.

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