ClimateWise®: Facilitating Locally Driven Adaptation to Climate Change

Marni Koopman[1] and Alan Journet[2]
Geos Institute, 84 Fourth St., Ashland, Oregon 97520
[1]marni@geosinstitute.org; [2]alan@geosinstitute.org

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Introduction

Over the last few decades, as leaders and decision makers have increasingly realized that climate change could have catastrophic consequences across the globe, much attention has rightfully focused on attempting to reduce the magnitude of climate change by reducing greenhouse gas emissions and increasing carbon sequestration. Yet as greenhouse gas emissions continue to rise and the effects of climate change are increasingly being felt by individuals and communities, adaptation to climate change also needs to be implemented. Often, adaptation is seen as a competitor to mitigation, yet in our experience the increased awareness of climate change impacts that comes with adaptation planning can actually increase enthusiasm and support for mitigation measures. Because the impacts of climate change are felt at the local level, adaptation strategies that are developed and implemented at the local level are expected to be most effective at increasing the resilience of local people and the natural environment they depend on.

Climate change will be felt by communities across the globe. As climate change affects such variables as the intensity and frequency of flooding, wildfire, severe heat days, and coastal erosion, the natural environment plays an important role in buffering those impacts to local communities. Functioning natural systems can abate floods, stabilize soils, reduce wildfire severity, and provide shade and cooling. Because of the important role of natural systems in buffering climate change impacts to human communities, an integrated approach to planning for climate change adaptation across both natural and human communities is needed.

As climate change progresses and human communities increasingly experience its impacts, people are expected to respond in a variety of ways. Yet we know that often people do not respond in the most effective manner when they are experiencing sudden and unexpected events such as floods or fire. We are concerned that climate change will lead communities to undertake actions that are not well reasoned and that conflict across the different sectors of the community. By planning in a collaborative and cohesive way across sectors, based on a sound understanding of climate change and its likely impacts, as well as the current vulnerabilities of local communities and the resources they rely on, we strive to reduce future conflict and to preserve the quality of life desired by residents.

Supported by private foundation grants, ClimateWise® was developed by the Geos Institute, in collaboration with the Climate Leadership Initiative, as a procedure to facilitate the development of climate change adaptation strategies and tactics at the local level. To date ClimateWise® has been completed in 5 regions in the western states of California and Oregon (Doppelt et al 2008, Barr et al 2010, Doppelt et al 2009, Koopman et al 2010, Koopman et al 2011) while a further 3 are underway in Oregon and Montana. This paper describes the steps in the integrated process and provides examples from pilot studies.

How Did We Get Here?

The first hint that atmospheric gases influence climate came as long ago as the mid 19th century when Tyndall (1861) explained how the ability of earth's atmospheric gases to retain heat contributed to the global temperature. The Swedish chemist Arrhenius (1896) furthered understanding by suggesting that increasing the atmospheric concentration of carbon dioxide could increase the global temperature. It was not until many years later that Revelle (1957) again raised concerns about the potential role of carbon dioxide released from fossil fuel burning as a contributor to global warming – calling it 'the greenhouse effect' and arguing that the gas would be absorbed in oceans far more slowly than others suggested.

In recent times, Hansen *et al.* (1988) developed the argument by underlining the future trajectory that continued emissions of greenhouse gases would generate. His Congressional testimony sparked the current wave of concern for mitigation efforts. It was followed by the establishment of the Inter-Governmental Panel on Climate Change by the World Meteorological Union and the United Nations Environment Programme.

To the end of the last century, the prevailing concern was to mitigate global warming by reducing carbon dioxide release or sequestering that already released thereby averting the worst effects still thought to be many decades if not centuries away. However, by the middle of the first decade of this century, the evidence that climate change was occurring more rapidly than previously predicted and, indeed, consequences were already happening was becoming so clear that King (2005) argued that it was time to focus political attention not only on mitigation but also on adaptation to the climate change that was and is now inevitable. This view has been reflected in such general accounts as that of Hertsgaard (2011) and a discussion of adaptation in conservation and natural resource management by Hansen and Hoffman (2011).

Project Initiation and Key Roles

ClimateWise® was developed to address the need to begin to plan for the inevitable impacts of climate change across natural and human systems. Due to the experimental nature of early pilot studies, the locations for these studies were chosen internally, by Geos Institute staff and partnering organizations, with input from local contacts and decision makers. Locations were chosen

to provide a collective diversity of expected climate change impacts as well as local features such as land use patterns, cultural traditions, economic drivers, biological diversity, rural vs. urban percentages, and political climate. The pilot study areas also varied in scale, with one conducted at the scale of an individual small county (San Luis Obispo County), another at the scale of an entire large watershed (Klamath Basin), and many in between.

One feature that became apparent as the pilot studies were carried out was the importance of a local "face" for the project. In recent efforts, a convening organization (CO) was identified at the local level, to act as a local face, and the location was chosen based on the strength of potential convening organizations. Because the CO becomes the primary contact organization, establishes the Steering Committee, and organizes many of the events, it is important that this entity is credible and respected in the region with staff having time, energy and enthusiasm for the project. The CO could be a governmental entity such as a Council of Governments or a group of county staff, a federal or state agency, a NGO, a business development group, or a variety of other organizations with strong local ties and interdisciplinary interests.

One role of the CO is to establish a Steering Committee (SC) that provides necessary ties to community members to ensure their participation. The SC is composed of 10 – 15 leaders representing the critical socioeconomic and natural sectors of the region. The SC also helps guide the process to work within the values and culture of the local community. And the SC identifies options for implementation of adaptation strategies developed and identifies funding mechanisms to support implementation.

The key to the success of ClimateWise® is the integration across natural and human communities. The Geos Institute staff includes aquatic, terrestrial, and climate change scientists. We work closely with a Socioeconomic Associate (SA) to provide expertise in human, built, economic, and cultural systems. We also bring in local climate scientists, social scientists, and others who have expertise relevant to the

effort. The Geos Institute staff and SA collaborate to provide background information on important sectors (described below) as well as relevant model projections for climate change and its related impacts to natural systems.

Process

One barrier that communities face when trying to plan ahead for climate change impacts is in translating scientific materials pertaining to climate change and its potential impacts into simple language. Most planners are not familiar with climate change models, are not experienced with interpreting projections, and get caught up in the many layers of uncertainty associated with model output. We overcome this inertia by bringing climate scientists into the process and providing climate projections in graphical form specific to the target region. We partnered with modelers at the USDA Pacific Northwest Research Station to obtain a suite of climate projections at locally-relevant scales (8km). Scientists at the Geos Institute analyze and display this information so it is easy to understand. We write a report that explains the models, their output, their utility for local planning, and summarizes supporting scientific literature that further elucidates how the region and its resources are expected to change in the future. This report (called the "Projections Report") is peer reviewed by leading climate change scientists. While this report is part of the ClimateWise® process, we are willing to prepare it for others as well.

Our Socioeconomic Associate prepares a companion report summarizing the potential regional human consequences of climate change. Together the two reports serve as background material used to inform leaders and experts of the region who are brought together in a series of meetings and workshops. The "Socioeconomic Report" provides information on economic drivers, water and energy supply, health and emergency response issues, cultural issues, local infrastructure, and many other locally relevant details. In addition, this report uses the projections from the Projections Report to provide some basic understanding of how the communities of the region might be affected by climate change and which populations or areas would be most vulnerable. More in-depth understanding of likely impacts is developed at the workshops.

The Steering Committee takes the lead in inviting local leaders and experts from important sectors to a workshop. The purpose of the workshop is to bring together community leaders and experts to develop a common understanding of the risk of climate change to their region, and to develop collaborative strategies to reduce their vulnerability. The workshop, organized by the Convening Organization, is attended by 60-80 participants and is facilitated by staff from the Geos Institute, the Socioeconomic Associate, and the Convening Organization. Local leaders such as County Commissioners, city council members, and others are invited to make introductions. Leading climate scientists, especially from local universities if possible, are invited to present climate change projections and supporting information.

An important part of the workshop is to bring the group together on their understanding of the risk of climate change to the local community. This involves presentation of climate change science, either by Geos Institute scientists or by leading climate change scientists, followed by a question and answer period. Our approach does not require that participants agree with the science; indeed, we encourage them to ask questions and voice their concerns. We work within a risk assessment framework that allows participants to weigh the likelihood that climate change is occurring against the cost of climate change should it occur. By doing so, we are able to facilitate a constructive session and enthusiastic participation by participants, regardless of their personal views on climate change. Many participants may be skeptical of the science, yet they generally understand that the costs, both locally and globally, are high enough to warrant some level of action, especially if that action is beneficial to the community in other ways. One important feature of the process is that all individuals feel welcome and are able to contribute to strategy development, across a diverse range of personal views on climate change trends and causation.

Workshop participants then break into Focus Groups (FGs), each representing one or more locally relevant topics from the natural and socioeconomic arenas (e.g. forestry, agriculture, business, human health, Native American tribal issues, emergency response, infrastructure, environmental justice issues, terrestrial ecosystems, aquatic ecosystems, etc.). Participants are assigned to groups on the basis of expertise. The collection of topics is highly variable depending on the region. Each FG's task is to identify potential risk factors in terms of exposure, sensitivity, and adaptive capacity (e.g., Hansen and Hoffman 2011). The discussion of each FG is facilitated by a member of one of the collaborating groups. After lengthy discussion, participants are asked to rank the risks to their sector, based on which risks are most important to each participant within the FG.

Most resource scientists are usually well-versed on the likely impacts of climate change to their sector. But many individuals representing the socioeconomic sectors have had little exposure, prior to this effort, to the science of climate change and the likely local impacts. Many participants seem to need time to digest the serious nature of the new information. We incorporated a lunch break into early efforts, but have moved to an overnight break in more recent efforts, in order to provide some time for participants come to terms with the information that is presented.

After the break, participants are rearranged into new focus groups that work across sectors rather than within sectors. All of the different sectors should be represented within each FG. We take the prioritized lists of likely risks that were created during the first session and rearrange them into common themes, such as water supply, forest fire, species changes, snow pack declines, etc.

Each FG is charged with examining the higher priority risks (identified in the last session) and developing strategies that address these risks in ways that are compatible across the sectors. For instance, participants in the agricultural FG (during the first round) might have identified that declining water availability due to declining snowpack and stream flow during the growing season is a risk to agricultural production for certain crops. During the second round, a diverse group of leaders and experts might recommend a variety of approaches to maintaining stream flows, including the reintroduction of beavers, restoration of river beds and wetlands that connect to local streams, and water conservation in both residential and agricultural sectors.

Participants are asked to consider the uncertainty associated with specific projections in order to ensure that the strategies developed are generally robust to changes in climate change trajectories. For all strategies recommended by the group, we ask them to provide specific details, such as who should implement the strategy, where it should be implemented, what might be the negative side effects to other sectors or resources, and what the time frame is for implementation and results. FG members are asked to prioritize those strategies and tactics that they think are the most feasible based on time, funding, and political restraints, and most likely to have a positive impact on community resiliency.

Compilation of information collected during the workshop is undertaken by Geos Institute staff and the Socioeconomic Associate, with extensive input from the Steering Committee and the Convening Organization. To the extent possible, recommended strategies are integrated across sectors and specific details (who, what, where, how much?) are provided. Some strategies may not have been ranked as high priority during the workshop, yet the steering committee might single them out due to high political feasibility, valuable partnerships, creativity, or likely efficacy.

Project Completion

From the information collected, a draft report is developed by Geos Institute staff and the Socioeconomic Associate. The report is composed of the initial projections, the identified impacts and risks and the recommended strategies and actions suggested for addressing these. After a period for review by the participants and other partners, the report is edited and provided to a group of local elected leaders and other decision makers. They are invited to attend a dinner event. At this event, leading scientists discuss the local impacts of climate change. Workshop results are presented by many of the workshop participants and steering committee members, who are their constituents. The elected leaders are then provided with an opportunity to offer input and help with prioritization, and they have further discussion of the issue. Their input is incorporated into the draft report. Once their input is incorporated, a final version is released to all participants and the general public.

Toward the end of the process, the Steering Committee holds a meeting to develop strategies that will facilitate the implementation of the recommended strategies for climate change adaptation. This might involve, for example, identifying some strategies that could be incorporated into ongoing projects and updated plans at the city, county, state, and federal level. Other strategies might need to be forwarded to policy makers to encourage changes to local laws and regulations. And some other strategies might be incorporated into a Climate Action Plan for cities or counties. Finally, many recommended strategies involve education and outreach and can be incorporated into existing educational programs or could be implemented as new programs. Funding mechanisms should also be identified during this meeting. The SC might also develop plans for disseminating the report and educating the public regarding its contents. Opportunities for implementation vary by region.

Table 1. Future temperature in the Klamath Basin, based on projections from three different global climate models.

TEMP.	2035-2045	2075-2085
Annual	+2.1 to +3.6° F	+4.6 to +7.2° F
Summer	+2.2 to +4.8° F	+5.8 to +11.8° F
Winter	+1.7 to +3.6° F	+3.8 to +6.5° F

Example Outcomes

Klamath Basin

Residents of the Klamath Basin completed the ClimateWise® process in 2010. Because of the size and travel difficulties in the basin, 4 workshops were held to provide more opportunities for participation. Climate change in the Klamath Basin is expected to result in reduced snowpack and earlier snow melt, both of which lead to decreased streamflows in late summer. These lower streamflows will lead to higher water temperature. With salmon populations at extremely low levels, and competition for scarce water resources already a contentious issue in the basin, there is potential for severe water restrictions and further adverse impacts to salmon populations that could lead to further declines and perhaps extinction. Climate change could also increase the frequency of severe storms, causing increased sedimentation of streams and lower water quality.

The Yurok tribe was concerned that climate change could lead to a loss of important natural resources that provide them with food, medicine, and cultural traditions. Many species of the region are expected to disappear from the area. Should these species dwindle in abundance in traditional Yurok gathering areas, the tribe may lose access to them. And the loss of these resources could have far reaching impacts on their cultural traditions, potentially

Cutthroat Trout

leading to a loss of ancestral ties and tribal involvement by young people.

Workshop participants developed strategies for increasing local resilience in the face of climate change. For instance, they recommended changes to land use (decommissioning of roads, reseeding after disturbance) to reduce the risk of erosion and sediment input to streams during severe storms. They recommended exploring management techniques that might retain late summer flows, such as meadow restoration. And they recommended identifying and protecting springs and other cold water sources in order to maintain water quality and protect cold water fish like salmon and trout. Participants supported the restoration of fisheries to boost the local economy.

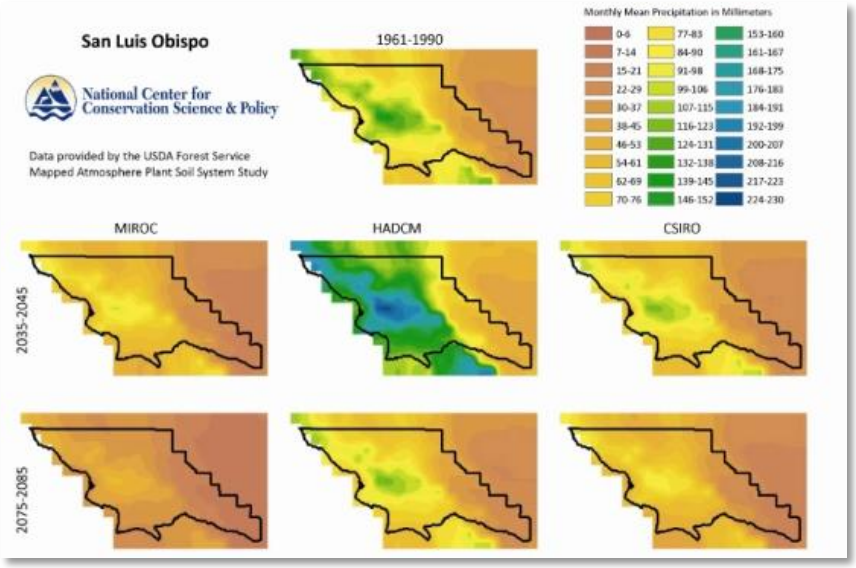
Other strategies that were proposed and recommended included: (1) providing private landowners with incentives to propagate important tribal resources and allow collection, (2) promoting new forms of tourism in spring and fall, (3) reducing the building of homes and other structures in areas at risk of floods or wildfire, and (4) conducting research into dry land (non-irrigated) agriculture.

In retrospect, the basin may have been too large and diverse of an area to undertake in a single project because climate projections and local issues vary widely between the Upper Klamath Basin and the Lower Klamath Basin. However, maintaining some link between the diverse but interdependent resources, management issues, and cultures is important to developing effective climate adaptation strategies.

San Luis Obispo County

San Luis Obispo County completed the ClimateWise® process in 2010. Participants identified sea level rise impacts to coastal infrastructure, agriculture, and intertidal ecosystems as a primary concern. They also identified declining groundwater, heat-related impacts to agricultural workers, loss of tourism from ecosystem change, loss of fisheries, increased flood risk to local communities, and the vulnerability of wine grapes to climate change as primary concerns for the area.

ClimateWise® participants developed strategies to address many of the identified risks to the county. These included increased



Projected change in precipitation across San Luis Obispo County, based on 3 different climate models, for mid-century (middle) and late-century (lower) time periods, as compared to the historic period (upper).

education and incentives for the agricultural sector on water conservation, worker safety, and crop diversification. Other strategies included rolling easements along coastlines to reduce infrastructure loss; restoration of floodplains, wetlands, high meadows, and riparian areas to reduce flood risk while enhancing habitat for aquatic species; monitoring of ground water use to better identify conservation opportunities; and collaborative planning for the location of solar energy development to best retain habitat connectivity and intact habitats for wildlife.

The city of San Luis Obispo, Cal Poly University, and the County of San Luis Obispo were all developing Climate Action Plans at the time of the ClimateWise® process. Many were concerned that this effort would compete with other efforts. Instead, ClimateWise® led to increased understanding of the potential impacts of climate change to the local area. The process helped establish new relationships, understanding, and lines of communication among previously independent sectors. And through the process many people became interested in the issue and more likely to participate in efforts to mitigate climate change.

San Luis Obispo County Supervisor Jim Patterson listens to experts from agriculture and other sectors.

At the end of the ClimateWise® process, the County Supervisors in San Luis Obispo voted to incorporate the strategies developed through the process into the Climate Action Plan for the County. They won an award from the state to help fund implementation and serve as an example for other counties to follow suit.

Fresno County

Fresno County completed the ClimateWise® process in 2011. Participants in the process identified numerous risks to the region, many of which are already severe issues and are expected to be greatly exacerbated by climate change. For instance, Fresno County experiences some of the worst air quality in the nation. Ozone formation is directly correlated with air temperature and is expected to rise sharply with climate change. Increased ozone and pollution are expected to add to the already high rates of asthma, allergies, and heart disease. Such pollution is also detrimental to forest health in the Sierras. Expected increases in forest fires could also exacerbate air quality issues. Increased temperatures are expected to lead to a 5-fold increase in severe heat days in some areas, with the potential for impacts to vulnerable populations such as the elderly, infants, and outdoor workers.

One of the greatest concerns among Fresno County leaders and experts was the risk to agricultural production from declining snowpack because this could lead to reduced

water supplies, and higher nighttime temperatures reducing "chill hours" needed for crops like almonds, peaches, and nectarines. Declines in agricultural production would have economic repercussions that reverberate throughout the county's many sectors (processing, packaging, transportation, etc). Finally, loss of the iconic species, the giant Sequoia, could lead to a loss in revenue from tourism in the County and the surrounding area.

Participants in the Fresno County workshops developed a suite of recommended actions for reducing their vulnerability to climate change impacts. These included water metering to encourage conservation, new approaches to community structure to reduce car travel and associated air pollution, new energy and water conservation incentives, restoring natural systems to increase natural cooling of air and water around livestock and people, new irrigation efficiency measures, and restoring natural areas of groundwater recharge, like floodplains and wetlands. Participants also recommended restoring large lakebeds that have been dry for 100+ years due to water diversion for agriculture. These lakebeds could hold water during early spring runoff, which could be used throughout the late summer dry period. Wildlife communities and agriculture would both benefit from such an approach.

Fresno County was unique among the areas where we have worked in that they already have numerous planning documents that address the issues that are expected to be exacerbated by climate change (air quality, water scarcity, agriculture, etc.). Yet most of the existing planning documents, which have not been implemented due to funding limitations, do not take climate change into consideration. Thus, these plans may be insufficient to deal with the expected future severity of each issue. Because existing plans lack funding for implementation, many participants were concerned that ClimateWise® would result in yet another plan without funding, and this is certainly a risk. Many lessons that were learned during the ClimateWise® process in Fresno County could be incorporated into the existing plans as they move toward implementation, in order to ensure that they are robust to climate change impacts. In fact, existing plans may have higher chances of getting funded if they demonstrate their potential efficacy at reducing the community's vulnerability to climate change.

Conclusion

Climate change is a global phenomenon that will continue to affect local communities the world over. ClimateWise® is a locally-driven process that helps representatives of the many natural and human socioeconomic system sectors of each community prepare for climate change. While the process is focused on minimizing and preparing for inevitable impacts (i.e. "adaptation"), one of the results of the process is often an increased interest in reducing the overall magnitude of climate change by reducing greenhouse gas emissions (i.e. mitigation). After completing the workshops, most participants in the ClimateWise® process acknowledge, even if they did not before, that their community, and the natural resources on which it depends, can only

adapt to a limited extent. If greenhouse gas concentrations in the atmosphere continue to rise unchecked, even the most proactive community will experience severe impacts to the economy, human health, natural resources, food supply, safety, and other components. ClimateWise® guides communities to the development of strategies and tactics that will help them retain their quality of life to the extent possible even as climate change affects them.

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