Chapter 43
Preparing Communities for the Impacts of Climate Change in Oregon, USA

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Abstract No matter how fast society reduces greenhouse gases, rising temperatures will produce significant ecological, social, health, and economic consequences. Few public or private organizations in the US, however, have the capacity to effectively prepare for or adapt to these inevitable changes. Unless the public and private sectors begin now to prepare for these impacts, great harm and high costs will result. The Climate Leadership Initiative at the University of Oregon, with partners, instituted a multi-year programme to develop a model that can be replicated nationwide for (a) analysing potential climate impacts at the basin scale; (b) engaging government agencies and stakeholders involved with natural (e.g. landscapes, streams, and biodiversity), human (e.g. emergency response, health care, education), built (e.g. transport, irrigation, communications infrastructure and buildings), and economic (e.g. forestry, agriculture, manufacturing, tourism) systems in assessing what those likely impacts mean for their sectors; (c) helping the agencies and stakeholders develop strategies and policies to prepare their systems to withstand and adapt to climate change through methods that enhance, and not undermine, climate preparation efforts in the other sectors.

We began with pilot programmes in the Rogue and Upper Willamette river basins of Oregon. We are now working in the Klamath Basin of Oregon and California and will soon move to the national level with model programmes in three to four locations across the country. Our goal is to dramatically increase climate preparation and adaptation literacy and to build and deliver the tools and resources needed to assist all levels of governments, institutions and non-profits across the nation to proactively prepare for climate change.

Keywords Adaptation · Climate change · Community empowerment · Planning · Preparation · Stakeholder engagement

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Introduction

Even if global carbon emissions are rapidly cut, Oregon and the Northwest will likely experience up to a 3.6°F temperature increase in the coming years. Aquatic and terrestrial ecosystems and species, along with human health, the built environment, and the economy will be severely stressed. Our recent economic analysis found that climate change will cost Oregon at least $3.3 billion annually by 2020, $5.1 billion annually by 2040, and $9.8 billion annually by 2080 (CLI & EcoNorthwest 2009). In addition to temperature increase, Oregon is already beginning to experience the impacts of climate change, such as extreme weather events, increased plant disease outbreaks, reduced stream flow, and impacts on biodiversity. Even if greenhouse gas emissions are reduced today, these impacts will become more severe over time because of the build-up of emissions in the atmosphere. In addition, these impacts will disproportionately affect our most vulnerable species (e.g. organisms already at risk), as well as human populations (e.g. low income, elderly, minorities, infirm, and children).

The severe consequences of climate change underscore the urgent need to reduce locally and globally generated carbon emissions to control the problem. Equally urgent, however, is the need for a concentrated effort to help all levels of government, private companies, community groups, and others develop the methods and tools needed to prepare for the consequences of climate change that now cannot be prevented. Lack of preparation will lead to crisis management, which will be extremely costly for ecosystems and people.

Climate change is a symptom of maladaptive individual and organizational behaviours, practices, and public policies. Solutions require fundamental changes in our way of thinking and doing business. New governance structures and new analysis, planning, and decision-making tools will be needed to help government, the private sector, and communities prepare for and withstand climate change. Most of these entities, however, do not have the information or tools needed to prepare for these challenges. Nor do they have the training or tools to communicate the urgency of climate change mitigation and preparation in a way that leads to changes in behaviour within their organization or with the public. Given the current economic crisis and pressures they are under, few will develop these tools or pursue training on their own.

Systems Thinking Model

Our approach to climate change preparation uses a systems dynamics or systems thinking model. Climate change is a multidimensional dynamic issue. Multiple factors affecting each other in sometimes random ways produce cascading changes in the structure and composition of the climate and hence ecological, social, economic and human systems. Quantitative change in climatic systems beyond a certain point (e.g. more carbon emissions) results in qualitative change leading to a new set of relationships within the whole system. Yet most organizations, whether government, industry or nonprofit, use "linear" (and numbers-based) approaches in planning, management and policy development. In the systems thinking approach, the learning and adaptation model used is called "single loop" learning: people see an event (e.g. flood, fire) and respond with a quick fix that – usually temporarily – solves the problem (e.g. put out the fire, build a dam to prevent future floods). Linear, single loop learning almost always fails as soon as a slight change in the current system occurs and will not enable society to effectively respond to climate change.

The climate change preparation programme supports organizations and institutions in becoming "climate learning systems". This begins with learning how to "see" and comprehend the multidimensionality of climate change (recognizing how one factor affects another, which feeds back and effects still more non-linear change, as opposed to managing by numbers) and then to help them learn how to employ "double and triple loop learning". This type of learning involves (a) seeing an event (e.g. potential or actual flood, fires, a disease, etc.) and developing a proposed response; (b) analysing a proposed response to determine likely short and long term consequences; and (c) analysing the consequences of those consequences. The ultimate goal is to enable organizations and institutions to alter their means (practices, programmes, policies) and their ends (goals) under conditions of constant change.

A passive and reactive response to a deteriorating environment (in any business, government, or society at large) is a road to disaster. By the time people or organizations realize the severity of the problem, their capacity to respond has often been undermined to the point that they have lost the capacity to cope with the change. In contrast, developing the capacity to purposefully understand and prepare for climate change provides the potential for all levels of society to withstand the impacts and capture the opportunities presented by change.

Localizing Data to Identify Risks and Develop Recommendations

In 2007, the Climate Leadership Initiative (CLI), with partners such as National Center for Conservation Science & Policy (National Center) and the United States Forest Service Pacific Northwest Lab Mapped-Atmosphere-Plant-Soil-System (MAPSS) Team, launched a climate change preparation programme in Oregon. The purpose of the programme was to develop model, replicable projects (called Climate Future Forums) in river basins across Oregon to understand the likely local consequences of climate change and design appropriate preparation strategies for natural, built, human, cultural, and economic systems.

Three Intergovernmental Panel on Climate Change (IPCC) models, Hadley, MIROC, and CSIRO, (Randall et al. 2007) as well as a global vegetation model, MC1, (Bachelet et al. 2001) were downscaled to the basin or sub-basin level for the

Klamath, Upper Willamette and Rogue basins and projections were made using the A2 "business as usual" scenario.

[1](Projections are currently underway for the Lower Willamette and Umatilla river basins.) We looked at ten-year periods of 2035–2045 and 2075–2085. Local watershed data was also incorporated into the scenarios and time series maps, other visuals, and narrative descriptions were generated. A series of Climate Future Forums (CFFs) were then held in each of the chosen sub-regions of the Klamath, Rogue, and Willamette basins. In each region, the first forum was conducted with natural systems scientists to analyse the ecological implications of the downscaled climate models. The next forum included people responsible for cultural, built, human and economic systems (also referred to as "community systems") in the selected basins/sub-basins, who analysed the risks to their resources and proposed strategies and policies to prepare them to withstand and adapt to climate change.

Findings

The Rogue river basin, located in southwest Oregon, consists of a diverse array of communities, economic sectors, and ecological systems. The Basin's rich history, beautiful setting, and recreational and employment opportunities, attract visitors and residents to the region year-round. Climate change projections for the Basin include (CLI & National Center for Conservation Science & Policy 2008):

- Summer temperatures may increase dramatically reaching 7–15°F (3.8–8.3°C) above baseline by 2080, while winter temperatures may increase 3–8°F (1.6–3.3°C)
- Rising temperatures will cause snow to turn to rain in lower elevations and decrease average January snowpack significantly, with a corresponding decline in runoff and streamflows. Snowpack may be reduced 75% from the baseline by 2040, and by up to 95% from baseline by the end of the century
- The basin is likely to experience more severe storm events, variable weather, higher and flashier winter and spring runoff events, and increased flooding

[1]Climate models are systems of differential equations based on the basic laws of physics, fluid motion, and chemistry. The IPCC uses a minimum of 19 different models from around the world to make global climate projections. The models are developed by different institutions and countries and have slightly different inputs or assumptions. CLI and the National Center selected models that seemed to perform best in the Pacific Northwest.

The Hadley model comes out of the United Kingdom's Met Office Hadley Centre. The Met plays a key role on the international stage, representing the UK in many global organizations.

Japan's MIROC model, is the Model for Interdisciplinary Research on Climate (MIROC). The CSIRO model comes from The Commonwealth Scientific and Industrial Research Organisation, Australia's national science agency. MC1, developed by the United States Forest Service, is a dynamic global vegetation model created to assess potential impacts of global climate change on ecosystem structure and function at a wide range of spatial scales from landscape to global.

Risks that were identified by the participants include:

- Young native fish will be threatened by increased storm events and sediment load
- Changes in timing of stream flow could result in disconnect between food availability and fish life stages
- High elevation wildlife and plant species may not be able to make the shift to new areas due to a lack of available habitat and rapidity of changes
- Expansion of invasive species may occur as conditions become more favourable for exotics and less favourable for some natives
- Power lines are likely to face increased stress due to rising fires and temperatures
- Rising summer temperatures will likely increase the incidence and intensity of heat-related illnesses and vector- and water-borne diseases such as Lyme disease and West Nile virus
- Agriculture will face increased competition with in-stream and municipal users for available water supplies while rising temperatures are likely to require the use of more water and/or a shift in crop types and farming practices

Recommendations from participants for preparation planning include:

- Reduce existing stressors for aquatic and terrestrial species
- Move permanent structures out of high-risk floodplains, riparian areas and steep forested canyons when damaged by floods or fires and new development constrained in these critical landscape areas
- Expand the use of on-site renewable energy systems to provide protection against blackouts and provide stability to energy prices

The Upper Willamette River Basin, in west-central Oregon, is home to 6% of Oregon's population and is 90% forested. Projections for the Basin include (CLI & National Center for Conservation Science & Policy 2009):

- Annual average temperatures are likely to increase from 2 to 4°F (1–2°C) by around 2040, and 6–8°F (3–4°C) by around 2080
- Snowpack across the Pacific Northwest is likely to decline by 60% by 2040 and 90% by the end of the century
- Storm events could increase in intensity, resulting in more flooding in all rivers in the Basin
- Vegetation will shift from softwoods such as coastal spruce and fir, to mixed pine, hardwoods, and oaks

Risks identified by the participants include:

- Increasing temperature is likely to benefit warm water native and nonnative species, while harming cold-dependent native species, resulting in the decline of Chinook salmon, steelhead, and Oregon chub
- Non-native invasive plants such as blackberry and black locust as well as native "weeds" will become more common across the landscape as CO_2 levels rise
- Reduced snowpack and summer water storage in reservoirs behind generation facilities are likely to diminish hydroelectric generation

- Higher temperatures likely will lead to increased heat stroke and cardiovascular disease, particularly for those without air conditioning
- Crops sensitive to higher day and night-time temperatures, such as certain wine grape varieties, will lose viability, while other crops may benefit from a longer growing season
- Disturbances to transport systems due to increased storm activity could threaten local food security

Recommendations from participants for preparation planning include:

- Early detection and rapid response efforts to identify, manage, and control invasive species should be increased
- A shift should be made to protecting and restoring key parts of the landscape that can allow ecological systems and species to withstand and adapt to increased stress
- Planning agencies should limit expansion of residential development into forested areas or floodplains
- Agricultural agencies should research and develop new crop varieties suitable for a warmer climate that may be wetter in the winter and drier in the summer
- Local governments should encourage local food production to build resistance to transportation disruptions

Developing Tools to Build Capacity for Implementing Preparation Plans

Proceedings from the Climate Future Forums were incorporated into a report, which was widely distributed and presented to local decision-makers. One year post Climate Future Forums, we are returning to the communities to identify strategies for incorporating climate change preparation planning into existing planning efforts. We have also identified the need to develop an online decision support tool that would empower local communities and governments to conduct their own climate change projections, risk and vulnerability assessments, and understand the costs and benefits of different preparation strategies. This tool, the Climate Preparation Analyst (CPA^{TM}), which is currently under development and testing, is being designed for multiple uses, enabling people within any public or non-profit organization to: (a) educate themselves or others about climate change and the need for preparation/adaptation; (b) identify and access key sources of information, financial resources, and state and federal policies to support preparation, including links to key databases and resources; (d) identify gaps in governance including information needs (e.g. climate impact projections, monitoring), resource allocations (e.g. funding, staffing, technologies), and decision-making mechanisms (e.g. who needs to be involved, how fast do decisions need to be made); (e) design an anticipatory climate preparation plan; (f) make a decision about implementing a particular preparation project, plan, or policy, including a cost – benefit analysis; and (g) monitor and evaluate plans. The tool will provide an integrated approach to preparing natural, built, human, cultural, and economic systems to ensure that a strategy for one system does not detract from preparation strategies for another system.

CLI is also developing in-person and online trainings on mitigation, preparation and climate change communication. These trainings will be piloted in Oregon and eventually available to everyone.

Recommendations

Few communities or local governments in Oregon, the United States, or across the globe, have the information, tools, human or financial resources needed to prepare for the challenges posed by climate change. In addition, few recognize that climate change impacts are already being felt and that they will affect every place, community and individual on earth. By localizing climate change projections and convening local experts from a variety of sectors, we are building awareness of the impacts of climate change that are specific to a particular community, supporting the development of preparation plans that best meet the risks the face and the resources they have on hand, and empowering communities to be proactive in their planning efforts. We envision that the Climate Future Forum pilot programme in Oregon will eventually be replicable across the country and globe.

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