Pacific Northwest Climate Decision Support Consortium

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Pacific Northwest Climate Decision Support Consortium (CDSC)

NOAA has recently designated an OSU-led Climate Decision Support Consortium (CDSC) as the new RISA project for the Pacific Northwest starting September 2010. RISA, for Regional Integrated Science and Assessment, is a NOAA program that seeks to connect climate science with decisionmakers on a regional scale. The CDSC has a focus on landscape and watershed management in a changing climate and uses the definition of decision support systems provided in a recent NRC report (2009:37): "decision support systems … include the people and organizations that develop … products and services, as well as the knowledge, information, products, and services [themselves]." The CDSC is a consortium of three multi-university organizations: The Oregon Climate Change Research Institute (OCCRI), including Oregon State University (OSU) and the University of Oregon (UO); Idaho's project on Water Resources in a Changing Climate (WRCC), funded by NSF's Office of Experimental Program to Stimulate Competitive Research (EPSCoR), including University of Idaho (UI) and Boise State University (BSU); and the University Extension Services from Idaho, Oregon, and Washington including Oregon and Washington Sea Grant programs.

Stakeholders include 11 federal agencies that have formed a regional partnership around climate change called the Climate Change Consortium (C3), the water resources agencies of the three states, other state agencies that deal with climate-sensitive issues, and three major urban water utilities. The CDSC will continue such stakeholder involvement through the following activities:

- forming a research agenda around the needs of stakeholders;
- assembling needed expertise to address key questions;
- designing decision support tools to translate the research answers into practical applications;
- generalizing the results of those tools for other applications

Thanks to the "knowledge-to-action networks" that the CDSC will create, the work proposed herein would easily and naturally reach a wide audience and achieve applicability in these critical climate-sensitive decisions, in a region where stakeholders are paying close attention to climate change and incorporating it into decisions. Examples of decisions for which stakeholders have expressed a need for scenarios of future climate, hydrology, and land cover include

- protecting critical habitat for endangered and threatened species
- evaluating the future risk of wildfire especially in wildland-urban interfaces, and how ecosystems would recover after a fire or a drought in a future climate
- diagnosing landscape-related hazards including flooding and landslides
- developing and evaluating climate adaptation strategies
- coastal hazards including changing storm intensity, sea level rise, and effects on wetlands

1.2 Why a PNW Climate Decision Support Consortium (CDSC)?

OSU and its collaborating institutions, UO, UI, and BSU, along with the Extension programs in three states are together uniquely qualified and well-positioned to undertake this research and engagement owing to the opportunity presented by the confluence of Idaho WRCC, OCCRI, Extension, Sea Grant, and the C3 agencies. We have brought together natural, physical, and social scientists, education and outreach specialists, modelers, resource managers, planners, and practitioners across the region through existing networks and by knitting together new capabilities and partners. For example, at OSU alone, more than 50 faculty are working on issues related to climate science; this is matched by expertise in the consortium universities as well as co-located federal laboratories at OSU (e.g., NOAA, USFS, USGS, EPA). The strengths of a collaborative approach include access to this depth and diversity of intellectual, financial, and institutional resources; increased ability to address complex issues introduced by stakeholders; strengthened capacity to deliver new knowledge products in a timely fashion; and significant buy-in by stakeholders across the region. In addition, we have University commitments to support CDSC through (a) $100K/year contribution from College of Oceanic and Atmospheric Sciences to OCCRI; (b) Idaho WRCC in-kind contribution to outreach efforts and toward Prof. Von Walden's involvement; (c) Institute for Natural Resources, for Dr. Lisa Gaines's involvement years 1-4.

1.2.1 Relevance to NOAA's Climate Program

By focusing on the needs of stakeholders, CDSC will strengthen NOAA's climate mission to "understand climate variability and change to enhance society's ability to plan and respond." CDSC efforts will enhance the value of NOAA's climate enterprise by providing regional decision makers and other stakeholders with tools that help them understand and integrate informa-

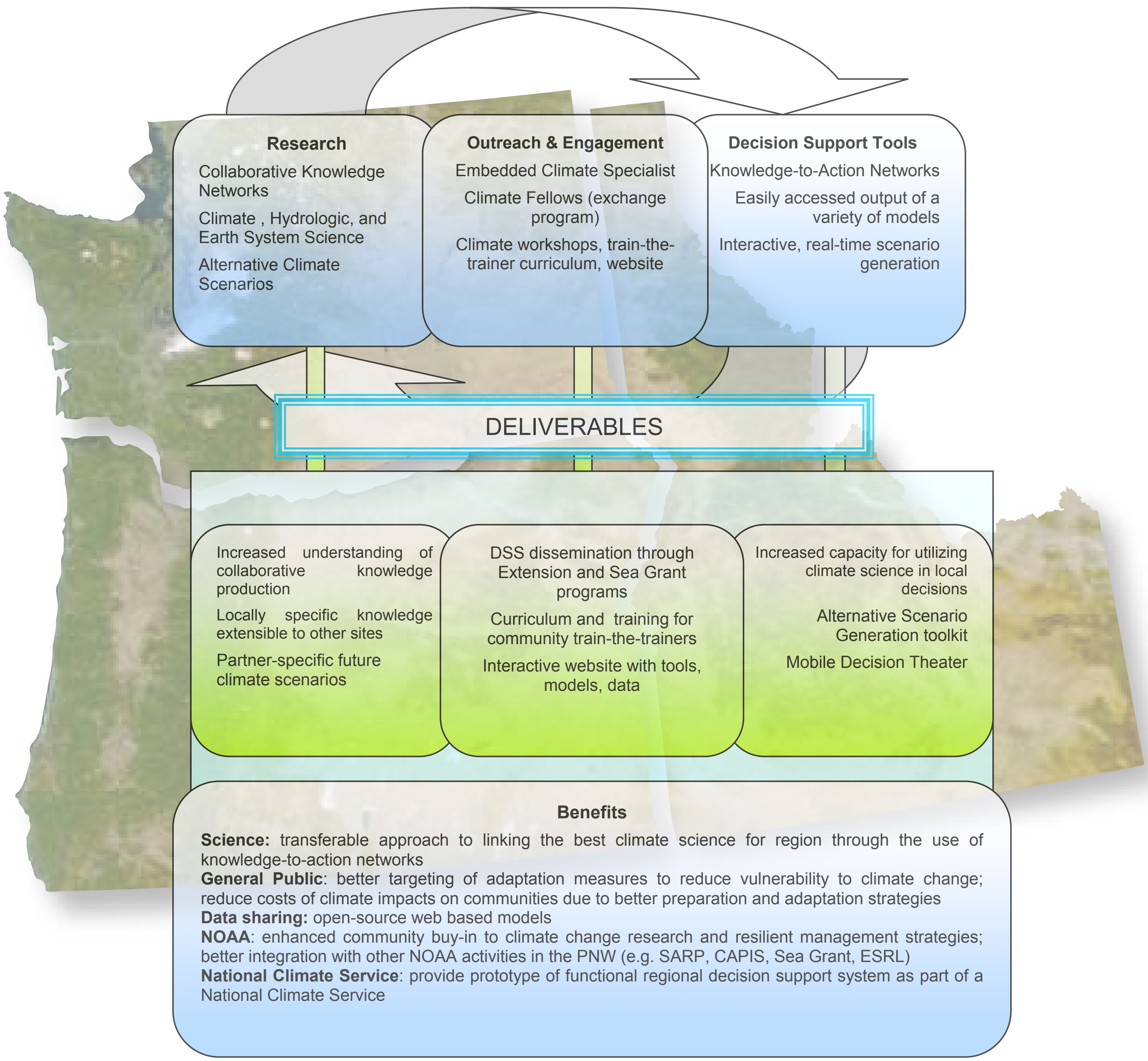

Figure 1: CDSC Decision Support System

tion about the impacts of a changing climate. Furthermore, CDSC builds on existing contacts with NOAA programs and investments relevant to developing decision support:

- Dr. Steven Brandt, Director of Oregon Sea Grant, directs the implementation of the western Sea Grant College Program's regional research priorities. Dr. Brandt and his appointed faculty and staff will be instrumental in coordinating the involvement of Oregon and Washington Sea Grant College Programs, facilitating involvement with other NOAA "West" agencies and in the NOAA National Sea Grant College Program's emerging strategic collaboration with NOAA Climate Services efforts with Sea Grant and Land-grant extension activities.
- Oregon State University hosts three projects funded by NOAA's Sectoral Applications Research Program (SARP), all focused on improving resilience in coastal areas. We will work with Sea Grant and the PIs of all three projects (Cone and Ruggiero at OSU, and Nyerges at UW) to leverage their work throughout the region. Coastal climate change in the PNW has received little attention from the current PNW RISA.
- NOAA's IDEA center is engaged in a stakeholder-driven project in the Northwest called CAPIS (Climate Adaptation Planning Information System), in which PIs and stakeholders affiliated with this RISA are involved, like the OR Dept. of Land Conservation and Development).
- Other NOAA projects and line offices including the Climate Prediction Center, National Climatic Data Center, Earth System Research Lab; for example, the ESRL Climate Attribution project seeks to provide timely responses to climate and weather events, evaluating the roles that, for example, La Niña or rising greenhouse gases may have had. CDSC will work to connect these NOAA ESRL and stakeholders.
- Faculty of the College of Oceanic and Atmospheric Sciences are engaged in NOAA-funded research related to climate, which will be strengthened by the reassignment of NOAA's Marine Operations Center - Pacific from Seattle to Newport, OR.

1. Build collaborative teams of researchers and stakeholders as partners in co-producing knowledge that can be used to develop integrated climate-resilient strategies for landscape and watershed management in the PNW.
2. Synthesize and integrate state-of-the-art climate, hydrologic, and other earth system science into a decision support system.
3. Develop a framework for interactively envisioning future scenarios that are usable in many decision settings.

2.1 Build Collaborative Knowledge Networks

As described above, the RISAs should work closely with stakeholder groups to expand the capacity for communities to integrate information about climate change into their decisions. McNie et al. (2007) frame the RISA challenge as part of the broader climate science enterprise in which supply of climate information and demand for climate information are mismatched; they note, based on the RISA experience that, "first and foremost, effective production of useful information for decision makers is about process." They cite several lessons learned including, "Early, iterative, sustained and two-way communication is essential for reconciling supply and demand of scientific information.... producing good and useful information is about understanding the full scope of the problem and thus context.... effective process must also be dynamic, resilient, and adaptive to challenges, events and opportunities."

This approach is supported by a recent NRC (2009) report, whose first recommendation is that decision support efforts be organized around six principles: "(1) begin with users' needs; (2)

give priority to process over products; (3) link information producers and users; (4) build connections across disciplines and organizations; (5) seek institutional stability; and (6) design processes for learning." They describe the collaborative partnerships between researchers and stakeholders resulting from these systems as ***knowledge-to-action networks***, defined as dynamically evolving networks in which questions are posed and answered collaboratively and iteratively, with answers applied to real-world decisions (Cash et al. 2003; Moser and Dilling 2007).

2.1.1 Stakeholder Questions

We began developing this proposal by contacting more than 20 stakeholders across the PNW and at various organizations, describing the proposed CDSC and soliciting their involvement. A list of stakeholders involved in developing this proposal is provided in Appendix A. This contact served two main purposes: (1) to assess the interest of potential partners in creating a PNW CDSC and (2) to identify the most pressing questions their organizations have about climate. A subset of their questions is compiled below and reflects a starting point for the proposal and the CDSC in designing responsive tools and research activities. Overwhelmingly, the concerns are related to climate change rather than climate variability, despite the lack of emphasis on either in our invitation. This may be an artifact of the way we framed the questions, or an indication that respondents have already integrated climate variability and seasonal forecasts into decision systems, or a reflection that issues related to climate variability are poorly understood or not salient to our respondents' organizations. We intend to examine this issue further in the CDSC. In particular, there may be scope to provide education about the emerging science of climate prediction on timescales of one to five years, which will be featured in the next IPCC modeling simulations.

After discussion with the stakeholders, we grouped their questions and interests into three categories: drivers of change, impacts of change, and response strategies.

Drivers of change

- Provide scenarios of future climate change and climate-related hazards from present and future generations of global and regional climate models [BPA, EPA, NMFS, USFS, DLCD]
- Provide guidance on use and development of future scenarios, including confidence limits, and the appropriate spatial and temporal scales at which anthropogenic change can be distinguished from natural variability; and on the characterization of annual variability [USFS, IDWR, NMFS, DLCD]
- Provide scenarios of future stream flow and stream temperature at basin scale, with estimates of confidence limits [EPA, BPA, IDWR, NMFS, PWB]

Impacts of change

- How will climate change affect regional water quality and quantity? [FWS, USFS]
- How will hazards - wildfire, storm surge, sea level rise, flooding - change across the landscape? [DLCD, USFS, NMFS]
- How will climate change and sea level rise affect coastal areas and other wetlands? [NOCA, FWS, PWB]
- How will climate change affect bull trout? [NOCA, FWS]
- Link climate variability to salmon and steelhead survival [FWS]

Response strategies

- Develop an integrated water resources strategy for a changing climate that can assist managers working with water users to mitigate the effects of climate change in the context of the prior appropriations doctrine [OWRD]
- Where does it make most sense to focus restoration efforts? [USFS, NMFS]
- Adaptation strategies most likely to maintain ecosystem processes and function [USFS]

- Develop a suite of adaptation strategies for listed species in freshwater, which will reduce their exposure to warmer temperatures and lower flows [NMFS]
- How can reservoir management be incorporated into future hydrologic changes and into adaptation strategies? [PWB, NOCA]

2.2 Synthesize and Integrate State-of-the-art Climate, Hydrologic, and Earth System Science

A key underpinning of the CDSC's decision-support capability is climate science and future climate scenarios (e.g., Mote and Salathé 2009). Both OCCRI and Idaho WRCC are developing the capability to provide a suite of climate variables from a range of sources; these parameters will be utilized in the development of the futures scenarios described below. Data sources include, but are not limited to:

- State-of-the-art climate modeling, including the global modeling results already available for the IPCC Fourth Assessment Report, and implications for the PNW (Mote and Salathé 2009);
- Global modeling results to be completed next year for the Fifth Assessment Report;
- Regionally specific results soon to be available through the North American Regional Climate Change Assessment Program (NARCCAP);
- New regional climate scenarios that OCCRI is developing, using thousands of regional model simulations run on volunteers' personal computers (www.climateprediction.net/content/regional-model/);
- Parameter Regression on Independent Slopes Model (PRISM) provides additional data on observed climate, accounting for elevation, terrain-induced climate transitions, coastal effects, temperature inversions, topographic position, and more (Daly et al., 2008). PRISM has also been used to create a monthly time series of climate grids for the lower 48 states at 4-km resolution 1895-present, augmenting station-based analyses of change (Mote 2003)
- Hydrologic model output for key locations throughout the PNW from at least two hydrology models: VIC (e.g., Wood et al. 2004) and SWAT (e.g., Stratton et al. in press).
- Richly detailed climate, hydrologic, and landscape observations from the HJ Andrews Long-Term Ecological Research site
- Vegetation and land cover simulations using Biome-BGC and other ecosystem models

In addition, we expect that for some projects, our partners may provide climate data or models they are currently using to be integrated into analysis and/or calibrated against other climate data.

The primary emphasis in hydrologic modeling is developing a new generation of hydrologic scenarios of future streamflows, soil moisture, and snowpack, using not one but multiple hydrologic models and an analysis of contributors to uncertainty. To that end, the PNW CDSC proposes to improve and customize the current generation macroscale hydrology models (e.g. VIC) to represent the PNW region. For instance, coupling a groundwater model (e.g., SIMGM from UW, MODFLOW from BSU) to provide realistic simulations for the basins where strong surface water-ground water exchanges do occur (e.g. Spokane Valley-Rathdrum Prairie basin, Snake River Basin) and considering processes such as snowmelt, evapotranspiration, irrigation, return flow that have varying degree of sensitivity within the PNW sub-watersheds.

2.3 Develop a Framework for Envisioning Future Scenarios

Because of increased awareness of the importance of complex interactions among human and natural systems, both the public and private sectors have increasingly turned to scientific, quantitative methods to inform policy and decision-making, particularly in situations where uncertainty is inherent and inescapable. The predominant approach in such assessments has been characterized as a "predict-then-act" paradigm, which pairs models of rational decision-making with methods for treating uncertainty derived largely from the sciences and engineering (Raiffa 1968; Lempert et al. 2003). The preferred course of action in predict-then-act assessments is the one that performs "best" given some (typically small) set of assumptions about the likelihood of various futures and the landscape processes that will be sustained if these assumptions prove true. Such assessments are strongly tied to the validity of their assumptions. These approaches are fraught with challenges, especially when applied over the spatial and temporal extents at which important long-term environmental processes operate, and in relation to the accompanying ecosystem goods and services that people rely on these processes to produce (Chan et al. 2006; Holling 2001).

In contrast, we employ an "explore-then-test" approach, which seeks actions that are shown to be robust across a large number of plausible future alternatives. This aligns well with an extension-based stakeholder engagement and two-way learning process where core drivers, boundary drivers and tradeoffs are considered in decision support. We define robust decisions as those that result in resilient system behaviors likely to achieve outcome goals under a variety of possible future trajectories, where aspects of these trajectories are more or less certain. Because they encompass a broad range of future possibilities and uncertainties (e.g., local manifestations of global climate change), this approach offers great potential to be responsive to opportunities and adaptive to problems. By virtue of its exploration of broad sets of contingencies, it also has the potential to serve as a constructive means for forging consensus among diverse groups of citizens and policy makers (Hulse et al. 2008; van Notten et al. 2005; Lempert et al. 2003). The CDSC will utilize and develop several explore-then-test tools to help our partners and the research team understand the implications of climate information, and the uncertainties accompanying it. These CDSC tools will include expansion of an alternative scenario generator called *Envision*, a mobile Decision Theater, and partner-specific future scenarios utilizing state-of-the-art climate science, all described in Section 3.3.

Fundamental to our approach is the concept that social agents make decisions in response to information as well as their internal value systems, societal pressures resulting from the emergence of scarcities, and perceptions of the responsiveness of various policies to their goals. *Envision* provides a framework for examining and simulating the coupled interactions and cyclical feedbacks among human actions, policy effects and landscape productions.