3. Abstract in lay terminology (limit to 150 words)

Water is one of the resources most vulnerable to climate change in the western U.S., where in many cases water supplies are presently over-allocated, and any changes in the timing or quantity of streamflow would further stress those supplies. This project will link information being generated on the ecohydrological response to climate change in the McKenzie watershed in the Oregon Cascades to the human components of that system, including the actors and institutions that use and manage the water supply. This coupling of the human and natural components of the system is necessary in order to develop policy and program responses that adequately address and respond to the effects of climate change on water resources in this region. It will form a pilot project in which a framework for this type of research will be developed and refined and will become part of a larger grant proposal in which it will be applied to other watersheds in California and Oregon.

4. Project Description (limit to 3 pages):

Background

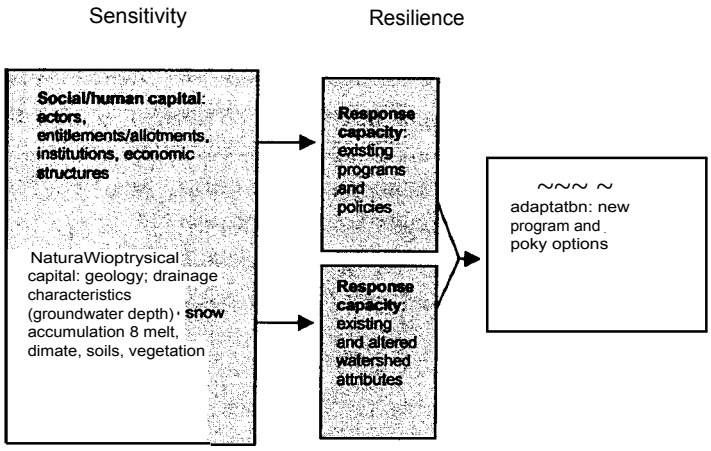
Increasingly, attention in the area of climate change research is focusing on understanding the effects it will have on ecosystems and societies. This includes attention to where changes are most likely to happen, where they will be most severe, and what kinds of conditions can either attenuate or amplify vulnerability to these changes. The need to understand how changes will affect both people and environments has heightened interest in finding ways to adequately address human-environmental systems jointly. Such analysis of *coupled* human-environmental systems is necessary to better understand vulnerabilities to environmental changes as well as to develop adequate responses and adaptations.

Water is one of the resources most vulnerable to climate change in the western U.S., where many of the water supplies are presently over-allocated and any changes in the timing or quantity of streamflow as a result of climate change would fizrther stress those supplies. In particular, summer water shortages are predicted to worsen in response to climate change in many parts of the western U.S., including the Oregon Cascades. Although less than 10% of annual streamflow occurs during July and August in this region, summer flows are particularly important for many of the water users there. At the same time, it is the flow most vulnerable to alteration with climate change, as snowmelt occurs earlier and a portion of the summer flow is shifted to winter and spring.

The McKenzie River originates in the Oregon Cascades and provides drinking water for more than 200,000 people in the City of Eugene and surrounding areas in Lane County, OR, in addition to contributing to hydroelectric generation. It provides habitat for fish, including two federally listed threatened species, bull trout and Chinook salmon, and it is an important source of income and employment through tourism, including fishing and rafting. Minimum flows must be maintained for some of these uses, including the provision of adequate aquatic habitat for the endangered fish species, and, even at current flow levels, water in some portions of the watershed is considered to be over-appropriated.

In the McKenzie River basin, empirical and modeling results have demonstrated that climate change will likely result in a change in timing and quantity of streamflow from this basin. However, it has also suggested that the degree to which these changes occur is mediated by some of the ecohydrological characteristics - or "natural capital" - of the sub-basins. These differences in natural capital result in some sub-basins being more sensitive to climate change than others. This work is improving our understanding of the ways in which "natural capital" can mediate - and in some cases ameliorate - the effects of climate change on water resources. However, there is a need for a parallel understanding of the ways in which "social and human capital" - that is the actors and institutions involved in managing and using the water supply - can attenuate or amplify vulnerability to these environmental changes. Combined, this information on natural and social and human capital will allow for a better understanding of the capacity of the coupled human-natural system to respond to climate change, ultimately leading to the development of appropriate policy responses to changing environmental conditions (Figure 1).

Figure 1. Framework for analyzing vulnerability to the effects of climate change on water resources



Adapted fmm Tumer et al. 2003

Work done to date

Empirical and modeling research on the ecohydrology of the McKenzie River basin has been ongoing, carried out by researchers at U.C. Santa Barbara (formerly an SDSU-Geography faculty member), Oregon State University, and an SDSU-Geography Ph.D. student, on whose committee I serve. The proposed research will add another component to this work, analyzing the human and policy dimensions of changes in water resources in this watershed. This component is critical to a more comprehensive understanding of the vulnerability of this system to climate change, and to developing policy recommendations that are implernentable in this region.

Project objectives

The overall objective of this project is to provide an improved understanding of the conditions that lead to vulnerability with respect to changes in water availability, how they affect the resilience of coupled human-natural systems in the McKenzie River watershed, and how this information can be used to develop mechanisms to respond and adapt to these changes.

The specific goals include: 1) Understanding vulnerability in relation to existing social and human capital in the McKenzie River basin, 2) Combining this information with that being generated on natural capital to create a more holistic view of the sensitivity and resilience of the coupled human-natural system in the McKenzie River watershed, and 3) Providing a framework for integrating the human and natural components of this system to develop policy options that are locally appropriate and are relevant to the primary water users in this watershed.

Methods and research plan

I will evaluate the social and human capital associated with the actors, institutions, and entitlements related to the allocation and use of water from the McKenzie River watershed. In this region, water demands come from a number of sectors, which can be grouped in three main categories: municipal/urban users, recreation and fishing sectors, and aquatic habitat (including endangered species).

I will conduct semi-structured interviews with water users and others representing the interests of water users in the McKenzie River watershed. These interviews will include: Eugene Water Electric Board, McKenzie River Guides Association, McKenzie Flyfishers, and Oregon Department of Fish and

Wildlife. Additional interviews will be conducted with representatives of the McKenzie River Watershed Council and other local groups that are involved in watershed management. These interviews will focus on understanding: 1) the annual and summer water needs of each of these groups, 2) the degree to which those needs are currently being met, 3) the ways in which changing water availability would impact their activities, and 4) the structures or institutions that exist within their organizations to respond to changes in water availability. Following fieldwork, I will integrate this information with the ecohydrological data to produce a set of potential policy options (Figure 1).

Timeline

Fieldwork will be conducted in June 2007. Following this period, results will be analyzed and I will begin development of a grant to be submitted in November 2007 which will apply the framework developed in this project to other watersheds in Oregon and California.

Project significance

There is an urgent need to understand the potential impacts of climate change on water resources, particularly in the western U.S., where water supplies are often already over-allocated. While scientists have made substantial advances in understanding the potential ecohydrological response to climate change in some regions, the translation of these results to policy is often lacking. In addition, the paucity of frameworks for integrating information on natural components of these systems with human-policy components make it difficult to develop policy recommendations that are socially relevant and locally appropriate. In the McKenzie River basin, there are a number of actors involved who may be affected differently by changing water availability, and it is important to understand who is most vulnerable and why. With this information, it is possible to seek ways to ameliorate the effects of changing water availability on the most vulnerable actors via policies that incorporate new inforration provided by research on natural systems with that on socio-political systems. This project also will contribute to the fields of sustainability science and vulnerability analysis. It will provide a case study in which to further develop the application of theory to practice in these fields.

Expected outcome and dissemination of results

This project is expected to clarify the ways in which the social, economic, and institutional characteristics of actors who depend on streamflow from the McKenzie River watershed affect their vulnerability to changes in that supply. It will combine this information with results on ecohydrologic characteristics that help define the vulnerability of the natural components of the system to produce a set of policy recommendations for adaptation and response to the effects of climate change on water resources in the McKenzie River basin.

Specifically, this work will result in: 1) one article to be submitted to the journal Global Environmental Change-Human and Policy Dimensions, co-authored with project collaborators, including a Geography Ph.D. student conducting ecohydrological research in the McKenzie River basin, 2) a presentation at the annual meeting of the Association of American Geographers, 3) one grant proposal to be submitted to the National Science Foundation, Dynamics of Coupled Natural and Human Systems program for a project that will use the framework developed and refined from this project and apply it to other watersheds in the Oregon Cascades and in the Sierra Nevadas in California, 4) presentation of results to water managers in Oregon (at venues to be determined in conjunction with water resource agencies in Oregon), 5) the incorporation of the project framework and research methods into a future graduate seminar on Water Resources.

5. Experience and Qualifications (limit - 1 Page): Provide a brief description of your relevant experiences that qualify you to complete the proposed research (do not attach your curriculum vitae). Include education, academic positions, relevant peer reviewed publications and honors/awards. Disclose all University grants you have received in the past three years and all external funding relevant to the project.

My academic and professional background makes me extremely well-suited to carry out this research. Although there is a great deal of interest in linking science to policy, particularly within the context of global climate change, there are relatively few researchers with substantial training in both of these areas. I have bachelors and masters degrees in social and policy sciences and a Ph.D. in geography, focused primarily on ecological research, but combining that work with socioeconomic and policy analyses. I have conducted field research in both the ecological and social sciences and have the ability to effectively combine these two areas. My research has included in depth analyses of the ways in which policy and landscape change are linked, and how the socioeconomic conditions of various actors mediate the way in which those policies play out at the local level (see Farley, in review, below).

I also have a substantive background in research on the effects of other aspects of global change, including land use change, on water resources. I have published on the effects of land use/land cover conversions on water quantity and water quality (in journals including Science and Global Change Biology; see below). I have consistently focused on translating results into policy terms (see Farley et al. 2005, below) and providing synthetic reviews that are accessible to those who are making land use decisions in the landscapes where I have worked (see Jobbagy et al., in press, below).

Funding for this project will act as seed money for the development of a project to be submitted to the National Science Foundation, from whom I have previously received funding (NSF Doctoral Dissertation Improvement grant).

The translation of science to policy requires researchers who are fluent in both of these arenas, who understand the strengths and limitations of the data and who can interpret the results in a way that makes them accessible to policy-makers. My experience and training make me well suited to carry out research with these objectives.

Farley KA (in review). Grasslands to tree plantations: the relationship between policy and landscape change in the Andes of Ecuador.

Jobbagy EG, Vasallo M, Farley KA, Pineiro G, Garbulsky MF, Nosetto MD, Jackson RB, Paruelo JM (in press). Forestacion en pastizales: hacia una vision integral de sus oportunidades y costos ecologicos [Grassland afforestation: towards an integrative perspective of its ecological opportunities and costs]. *Agrociencia.*

Jackson RB, Jobbagy EG, Avissar R, Roy SB, Barrett D, Cook CW, Farley KA, Le Maitre DC, McCarl BA, Murray BC. 2005. Trading water for carbon with biological carbon sequestration. *Science 310:* 1944-1947.

Farley KA, Jobbagy EG, Jackson RB. 2005. Effects of afforestation on water yield: a global synthesis with implications for policy. *Global Change Biology 11:* 1565-1576.

Farley KA, Kelly EF, Hofstede RGM. 2004. Soil organic carbon and water retention following conversion of grasslands to pine plantations in the Ecuadorian Andes. *Ecosystems 7(7):* 729-739.

Farley KA, Kelly EF. 2004. Effects of afforestation of a paramo grassland on soil nutrient status. *Forest Ecology and Management* 195: 281-290.