

CNH: Long-term vulnerability and resilience of coupled human-natural ecosystems to fire regime and climate changes at an ancient Wildland Urban Interface (Proposal #1114898)

As global climates change, large wildfires have become regular features of national and international news. These fires are newsworthy because they affect the lives and livelihoods of thousands of people and because the *types of fire* are so different than in the recent history of these places. Certain types of fire are necessary to sustain key structures and functions of many environments around the world. Both people and climate can alter the types of fire that these environments experience through their effects on fire ignitions and on vegetation (fuels). In various circumstances these alterations may either increase or decrease the risk for types of fires that *will not* sustain those environments or the human societies dependent upon them. Although the physical and ecological responses of fire and vegetation to weather/climate are relatively well known, the interplay between human activities and fire are poorly understood, especially over time scales of centuries. Improved understanding of these interactions is needed for managing these forests today, and for anticipating future social and environmental vulnerabilities where high-density human settlements have developed -- also known as the Wildland-Urban Interface.

In the past half-century many thousands of homes have been built within North American forests dominated by ponderosa pine (*Pinus ponderosa*) trees. These forests and communities are now extremely vulnerable to large, severe fires during droughts as a consequence of fire exclusion and other land use practices. Through a historical case study, this project tests alternative hypotheses of how human activities at the Wildland Urban Interface affect the response of fire-adapted pine forests to climate change and conversely, how humans respond to these changes over multiple centuries. The study area is an ancient Wildland Urban Interface in northern New Mexico where large communities of Native American farmers lived within ponderosa pine forests through varying climate episodes over the last 1,000 years. Archaeology and paleoecology will be combined to build multi-century fire and forest histories across gradients of human population sizes, ranging from large towns to relatively unoccupied areas. Dynamic computer models will be developed, and using paleoclimatic data as input they will simulate fire and forest histories across the landscape and through time. Tested against the local fire histories, these simulations will be varied in the magnitude and location of human impacts to identify tipping points in the sustainability of these forests and human communities.

The understanding of long-term, landscape-scale dynamics of human societies, forests, and climate generated by this project will be necessary for sustainable management of similar forests at the Wildland Urban Interface across the American West and elsewhere. Information from the project will be provided directly to manager-partners who are engaged in landscape-scale fire and forest management initiatives on federal and tribal lands. Participatory research with American Indian tribes whose ancestors lived in these ponderosa pine forests will contextualize the fire and forest histories and human responses to environmental changes. Participation in both research and education will strengthen the relationships between scientists, managers, and community members, facilitating the use of scientific information in management decisions aimed at establishing resilient, sustainable forests. An educational program will establish a legacy of learning by developing and implementing K-12 lesson plans that integrate fire-society issues in science and history classrooms in the region. The involvement of undergraduate and graduate students, participation of American Indian research partners and underrepresented K-12 students, and the linkages to contemporary managers provide a broad capacity to disseminate project results in meaningful, applicable, and lasting ways.