A Model Project for Exploring the Role of Sustainability Science in a Citizen-Centered, Collaborative Decision-Making Process

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The Context

The role of science in society is evolving as we enter the 21st century. The report, *Science — The Endless Frontier* (Bush 1990[1945]), outlined a model of national scientific research that served the country for 50 years. The contract between science and society established in that report stipulated that science is essential and that basic research meets national needs (Pielke and Byerly 1998). This stipulation and the abundant — seemingly unlimited and unquestioned — funding for research during the Cold War caused many scientists to come to believe that funding for science was an entitlement independent of societal needs. Implicit in this belief is that science alone can solve society's problems. We now are learning that many policy issues that involve science involve diverse economic, political, social, and aesthetic values as well, and rarely, if ever, is scientific information alone the basis of public policy (e.g., see Sarewitz 1996a, 1996b; Frodeman 1997). Moreover, resources are increasingly more limited and many in society are questioning the value of public-supported science.

This reality challenges the scientific community to define a new social contract that is in accord with the social and political conditions that characterize the dawn of the 21st century (e.g., Lubchenco 1998). Under the terms of the new contract, science is still essential. However, national needs now dictate that much of the research undertaken, and funding for science, will not be an entitlement independent of societal issues and concerns. As populations continue to expand, tensions between environmental preservation and economic development will exacerbate land-use conflicts. Quality of life for the 8-10 billion people who will inhabit the planet by the end of the 21st century will depend on how well we as a society resolve these conflicts. This paper addresses one way that a Federal government science agency can engage citizens in a partnership to develop a community-based decision making process grounded in sound science.

The Need for Community-based Projects Grounded in Sound Science

There is a growing sense of stewardship nationally in that local citizens want to be empowered to make the decisions about ecosystems, watersheds, and land use in their communities (see for example, Turner and Karl 2001). The President wants to empower states, cities, and citizens to make decisions, and his first priority to reform Government is to make Government "citizen-centered" (A Blueprint for New Beginnings-Government Reform 2001). The Department of the Interior recognizes that citizen involvement is a key to the successful achievement of its strategic goals and encourages development of a process of community-based decision making grounded in sound science (U.S. Department of the Interior 1997). Customer involvement and development of robust decision support systems are principal goals of the U.S. Geological Survey Strategic Plan as well.

The real world is complicated and there are no simple solutions. Natural ecosystems and human social systems are complex and interdependent. Tensions between environmental preservation and economic development are exacerbated at the interface between the natural areas and urbanizing areas where these systems adjoin one another. Choices and tradeoffs need to be made in that space where these systems come together. To gain a better understanding of these complex systems, it is necessary to take an interdisciplinary approach and consider a full range of values and interests that include scientific, economic, political, social, cultural, ethical, and aesthetic. Citizens and decision makers are finding themselves having to weigh both sound science and community values in making choices about land use and environmental resource management. To assist citizens and decision makers in understanding the consequences of these choices, we aim to develop an approach that incorporates the full range of natural and social science data within a collaborative problem solving framework to provide a basis for efforts to develop consensus on solutions to land-use planning and environmental policy concerns.

In light of the above, science is not a panacea, but it can help people illuminate the potential consequences of different choices and thus can inform decisions. Scientists and scientific institutions such as the U.S. Geological Survey (USGS) in isolation cannot determine the science needed to address the complex environmental, resource, and land use decisions that confront society; it must be determined in partnership with our constituents the people who use the science.

However, scientists and decision-makers have increasingly faced a range of problems in using scientific knowledge within decision-making processes that are often driven by a variety of non-scientific, adversarial, and stakeholder dynamics. For example, scientific information can be poorly understood by decision-makers and ignored. Or uncertainty in the data and conflicting interpretations among scientists can lead to confusion. Or scientists might construe the issue at hand as a solution for the purpose of promoting their own research interest (see Adler et al. 2000, for many more examples.) Increasingly both scientists and decision-makers have been realizing that the current ways of dealing with these problems, particularly in complex public projects, do not work well.

The Program of Action: INCLUDE — An Approach to Use Collaborative Problem Solving Techniques for Science-Intensive Environmental Resource Management Issues

The USGS, most notably within the Water Resources Discipline district offices, has made efforts to work with constituent groups to identify issues of concern and to design projects to help address those issues. In an endeavor to increase integration of diverse disciplines and build upon traditional and ongoing USGS efforts to work with constituent groups, the USGS launched an experimental activity, INCLUDE — Integrated-science and Community-based Values in Land Use Decision-making, in late 1998. Since January 1999, INCLUDE has been headquartered at the Western Geographic Science Center as a core element of an interdivisional research agenda. INCLUDE engages citizens as partners with discipline experts in a collaborative problem-solving process. The cornerstones of the INCLUDE effort are to: 1) identify the regional scientific issues of concern through a dialogue with the communities of place and publics of interest, 2) design the scientific investigations to address these concerns, and 3) effectively communicate the scientific concepts and findings to stakeholders. These cornerstones are laid upon a foundation of taking a problem-focused, rather than a discipline-focused, approach to contributing scientific information toward the resolution of environmental and land use issues.

The INCLUDE approach, conceptualized three years ago, is at the vanguard of sustainability science, an emerging field that explores the interactions between nature and society (Kates et al. 2001). This approach offers a way to implement an idea embraced by the proponents of sustainability science, that is that "participatory procedures involving scientists, stakeholders, advocates, active citizens, and users of knowledge are critically needed" (Kates et al. 2001, 641) to achieve wise and durable solutions to vexing environmental problems.

An Example of a Citizen-centered Project: The Creek Project

The Creek Project is an effort to engage citizens as active partners in the design and implementation of a project to address environmental issues of concern within the San Francisquito Creek watershed in Menlo Park, California. The project is transdisciplinary in nature in that it is situating scientific research in its social and political context (Rofougaran 2001, written communication). It aims to develop approaches and tools to assist local decision makers and citizens in incorporating both sound science and community values in land use and environmental resource management decisions. The communities in the San Francisquito Creek watershed hold different values and cannot agree on land use planning and environmental policy within the watershed. Messages on a community list server established after the creek flooded in 1998 reveal an angry public that is in disagreement as to solutions to flooding and habitat restoration. We propose to use collaborative problem solving techniques that incorporate the full range of natural and social science data to involve the public in the design of research about the issues and to provide a basis for efforts to seek consensus on solutions to land-use planning and environmental policy concerns. Methods developed in the San Francisquito watershed will form a guide for developing other USGS citizen-centered partnership projects for managing other watersheds across the country.

As stated by the Executive Director of the San Francisquito Creek Joint Powers Authority, "The [Creek] project is a consummate model of the complexities facing urban watersheds across the nation, involving issues that often overwhelm decision-makers and the public. Too often this leads to decisions that are driven by a single interest or overriding concern. We are interested in devising a true comprehensive watershed solution that involves voices from all constituents of the community for the San Francisquito Creek and its environs. [I]t is easy to envision empowering this community in such a way as to spark a new method of doing business. This community in particular is poised to receive presentations of the science in such a way as to allow them to make informed decisions, and rightfully become part of the process. We are delighted to have the opportunity to work with USGS on these issues" (Cynthia DíAgosta 2001, written communication).

The active participation of the community in the San Francisquito Creek watershed is coming from both the formal (government) and informal (citizen) structures. The San Francisquito Creek Joint Powers Authority (JPA) was formed in May 1999 to make decisions that pertain to management of the San Francisquito Creek and environs. Its Board of Directors is comprised of elected officials from the City of Menlo Park, City of Palo Alto, City of East Palo Alto, the Santa Clara Valley Water District, and the San Mateo County Flood Control District. The JPA represents the formal community structure. The San Francisquito Watershed Council (formerly known as San Francisquito Creek Watershed Coordinated Resource and Management Planning) represents the informal community (citizen) structure, although representatives of regulatory agencies, land management agencies, and local governments are members of the Watershed Council as well. The essential function of the Watershed Council process is to provide a forum where all stakeholders of the watershed can share information. Representatives of 30 stakeholder groups work together on the Watershed Council Steering Committee and Task Forces to address six areas of interest: natural resources, pollution prevention, flooding/erosion, land use/development, social issues, and education.

Statement of Problem and Objective

Thousands of communities in small watersheds across the nation are or will be facing issues of flooding, water supply, habitat restoration, aging dams, and stream impairment by sediment and pollutants from non-point sources. There is an immediate need to develop a decision support system based on sound science that incorporates community values that will help to provide for informed decisions on these issues. These issues are vexing decision makers in the San Francisquito Watershed, California.

Background

This watershed encompasses 45 square miles and includes a wide diversity of natural habitats and land use types. San Francisquito Creek is the last riparian unchannelized urban creek on the southern Peninsula of San Francisco Bay. It begins as overflow from the Searsville Lake dam built in 1892 in Stanford University's Jasper Ridge Biological Preserve. The creek flows for 14 miles from its source to its terminus in San Francisco Bay. Rural areas and open space characterize the upper watershed. In its lower reaches the creek courses through densely populated cities. San Francisquito Creek is the boundary between two counties (Santa Clara and San Mateo) and flows through parts of five municipalities (Menlo Park, Palo Alto, East Palo Alto, Portola Valley, and Woodside). It empties into San Francisco Bay at the city of East Palo Alto. The towns and cities in the watershed vary greatly in wealth from tremendous affluence to significant poverty.

The reservoir behind the dam, Searsville Lake, is projected to fill completely with sediment in 15 to 40 years depending upon future weather patterns. The consequence of the reservoir filling on riparian habitat and flooding is unknown. In 1998, San Francisquito Creek flooded along its downstream reaches, causing $28 million in damage. The creek is the last remaining run of steelhead trout (a federally listed threatened species) in the southern part of the San Francisco Bay. It has been listed under section 303(d) of the Clean Water Act as impaired with regard to Total Maximum Daily Load (TMDL). These four issues, flooding, aquatic habitat restoration, dam removal, and TMDL impairment, are of concern to the communities in the San Francisquito Creek watershed. A committee, composed of a subgroup of citizens from the Watershed Council and USGS scientists, decided that a sediment budget needed to be established for the watershed to aid in decisions concerning the four issues.

The following questions must be answered to evaluate the impact of sediment and to make informed choices about the management of the creek. What has been the effect of land use change in contributing sediment to the reservoir and on landscape change? Is the watershed impaired with regard to sediment? What impact will this sediment have on the carrying capacity of the creek and aquatic habitat? How can the multiple uses of an urbanized watershed be managed to minimize impact to the ecological habitat? Overarching questions to these are: How do we connect people and science so that science becomes an integral part of decisions? How can the scientific findings be effectively communicated to decision-makers? How can the competing interests be examined and reconciled to achieve balanced solutions to land use and environmental policy?

The Experiences: Approach and Plan

The Creek Project was designed by a group of citizens in dialogue with scientists. Four citizens and one scientist comprise the project steering committee. To address the questions above and the full range of issues defined by the community, the project takes a problem-focused in contrast to discipline-focused approach. The project began in fall of 2000 and has a planned duration of 4 years to coordinate with the decision timing and framework of the JPA. The Creek

Table 1. The three major components of the Creek Project.

Biophysical and Geographic Scientific Studies
- Overland sediment transport flow/upper watershed
- Tidal-influenced lower watershed
- Land cover model
- Native/invasive species (steelhead trout/Chinese mitten crab)

Social Dynamics Studies
- Information Technology and decision-making
- Role of science in environmental resource management/consensus building
- Role of community values vs. science and economics
- Role of informal and formal community structures
- Economic policy/risk assessment

Communication and Learning
- GIS/web site development
- Teacher training and school curriculum
- Community education
- Game and simulation development to assist in stakeholder decision-making
- Communication about risk and uncertainty

Project consists of three major components derived from deliberations of the steering committee (Table 1). Owing to funding realities the amount of research allocated to each component will vary, and consequently, the project plan will be adaptive for the duration of the project.

A multidisciplinary team of scientists, educators, practitioners and theorists of consensus building and environmental negotiation, urban and land use planners, and local community leaders and decision-makers has been assembled to accomplish the project objectives. Each of the components above is linked through a series of feedback loops. The purpose of the project is more than just to help solve specific issues in the San Francisquito Creek watershed. An overarching goal of the entire team is to explore the role of science, scientists, and scientific analysis in negotiations regarding the management of environmental resources. As part of this goal, an educational component will focus on working with school groups to test, evaluate, and learn from communities' experiences with using science in collaborative processes to resolve environmental issues

A goal of the of the Biophysical and Geographic Science Studies component is development of a computer-based decision support system (DSS) that will be of use for long-term land use planning to communities in the San Francisquito Creek watershed. At the heart of an effective DSS are models that can show the probable range of outcomes of different policy options. The particular focus of the current effort is investigation of erosion and sediment transport processes within the headwater areas of the watershed, and development of a model linking changes in land use to changes in sediment supply. This is being done to help with decisions with respect to Total Maximum Daily Load compliance.

The Social Dynamics Studies focus on the character of human system/natural system interactions, and ways to educate the public about the interdependence of these systems, so that they will gain an appreciation for a holistic and sustainable approach to watershed management. The natural sciences, the social sciences, economics, and the humanities each play a role in INCLUDE. All these provide useful tools, including computer simulations and cost-benefit analysis. Maps are another effective way to communicate information, and so INCLUDE exercises will also use geographic information systems (GIS). Quantitative techniques like these can allow stakeholders to examine and evaluate resource allocation more effectively. Quality-of-life choices, however, also depend on non-quantifiable, even intangible, cultural and political values. Environmental philosophers and political scientists will therefore contribute as well.

The Communication and Learning component is designed to: 1) raise community awareness of environmental problems within the watershed and 2) actively engage the community in the decision-making process. Two different strategies are being pursued: bringing information to the community through eye-catching and information-rich interactive displays in public places, and involving school students in data collection, data analysis, and decision-making activities. The use of games and simulations is yet another educational tool (see e.g., Barrett 2000; Karl 2000). One of the most useful hypotheses INCLUDE has developed, although we have yet to test this, is that games and simulations can help to build public understanding of the multiple dimensions of complex public issues and thus public support for whatever choice is eventually made. They can also preview possible options for resolution that individuals may be reluctant to advocate in a charged political atmosphere.

Next Steps

The collaborative problem solving approach requires a new class of professional problem solvers who have a breadth of skills and who want to work with citizen groups to solve society's problems. These professionals will have to listen to citizens and incorporate local knowledge and wisdom into the project design and implementation. A discipline approach will continue to be necessary to make fundamental advances in a specific field and to answer specific questions (e.g. water quality). The new professional will have to be able to synthesize diverse and complex information to help identify the problem and then assemble the proper team of discipline experts and citizens to address the problem. The complicated scientific and technical data collected by discipline experts will have to be translated into forms that are amenable to policy analysis and understandable to non-discipline experts. These data need to be communicated effectively and in a timely manner to contribute toward a decision. Synthesis, translation, and communication will be done at various levels, and will need to take into account complexity, risk, and uncertainty in a manner that lay stakeholders can understand and use. The problem solvers will not make decisions; they play an important role as scientific advisors in the negotiating process that helps resolve land use and environmental policy conflicts (see for example, Susskind 1994). This negotiation process should take place in a collaborative problem-solving framework to help achieve a mutual-gains solution to vexing issues (see for example, Susskind and Field 1996; Susskind et al. 1999).

The interdisciplinary approach and the new professional problem solver require institutional changes in government agencies and colleges and universities to be effective. Government agencies must be willing to empower citizens to work as partners to decide together land use and environmental policy. The Bureau of Land Management Partnership Series that teaches shared land stewardship between citizens and government is an existing example of this concept; it captures the essence of the citizen-centered approach toward sustainability. Institutions, such as USGS, must build the capacity to train and support the new class of professional. Colleges and universities must develop curricula to educate the future professionals in interdisciplinary approaches, and develop environmental research programs that integrate the natural and social sciences.

An ultimate goal of the Creek Project is to apply the models and approaches developed here to other watersheds across the nation that can serve as test cases to expand and refine the community-based interdisciplinary and collaborative-problem solving approach developed in the San Francisquito Creek watershed. It is by undertaking case studies in watersheds regionally and nationally that we can find ways to link people and science in a process of community-based decision making, and to foster decision making that is grounded in sound science.

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