Alternative Futures for Changing Landscapes

THE UPPER SAN PEDRO RIVER BASIN IN ARIZONA AND SONORA

Carl Steinitz
Hector Arias
Scott Bassett
Michael Flaxman
Tomas Goode
Thomas Maddock III
David Mouat
Richard Peiser
Allan Shearer

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Foreword

> In the process of finding solutions to our transportation, settlement, agriculture, energy and other material needs, remaining natural environments have been placed under enormous stress, and continue to be fragmented, polluted or damaged in other ways. . . . This decline in habitat has led to a widespread crisis not confined to any one country or region.
>
> — Commission on Environmental Cooperation, *The North American Mosaic: A State of the Environment Report*

North America is facing a widespread crisis due to its shrinking biodiversity. Half of North America's most biodiverse ecoregions are now severely degraded, and the region now has at least 235 threatened species of mammals, birds, reptiles, and amphibians.

The pervasive and worldwide conflict between conservation and development is not new, and it is not newly recognized. The three NAFTA partners—Canada, Mexico, and the United States—formed the Commission on Environmental Cooperation (CEC) to respond to the threat posed by rapid decline in biodiversity.

The three countries have enacted a number of conservation strategies in the past few decades. Overall, the total protected area in North America has increased from less than 100 million hectares in 1980 to 300 million hectares now, or about 15 percent of the continent's land surface. Yet, despite these accomplishments, looming threats overshadow these positive achievements. Natural areas in all three countries are in danger of being overwhelmed by multiple factors. The North American situation can be seen all around the world, frequently in even more critical conditions.

The future of the Upper San Pedro River Basin in Arizona and Sonora is just one example of the tensions between conservation and development, and it is further complicated by the presence of a major military installation. In 1994, the Department of Defense directed military installations to begin managing their environmental programs from an ecosystem perspective.

In 1996, the Department of Defense sent representatives to the Biodiversity Research Consortium, a partnership of government agencies and universities. BRC's goal is to develop databases and analytical methods for assessing and managing risks to biodiversity. Winifred Rose and Robert Lozar of the U.S. Army Engineer Research and Development Center represented the Army. Consequently, the groundwork was in place when I expressed interest in applying the Alternative Futures process to the Upper San Pedro River region. In 1997, my proposal to the Department of Defense's Legacy Resources Management Program was approved. Legacy is a Congressional program to foster proactive natural and cultural resources projects outside routine environmental funding channels.

While the scientific community still debates the meaning of ecosystem management, the concern for the military is managing installations in the context of how they interact with and impact the environmental processes—biological and physical—of their surrounding landscapes. The Army Training and Doctrine Command's Fort Huachuca, enmeshed in the volatile and highly publicized environmental issues in the Upper San Pedro River Valley of Arizona, seemed to be the Army's best candidate installation for such a study.

Environmental issues from an army perspective within the Upper San Pedro River valley include:

- Fort Huachuca's location adjacent to the San Pedro Riparian National Conservation Area; the SPRNCA's originating legislation requires a base flow to be maintained in the river.

- The presence of a number of water-dependent endangered species on and near the installation.
- The widespread concern for balancing water use between conservation concerns and growth in this growing and attractive high-desert environment.
- Litigation involving the alleged impacts on the watershed.

In further support of a study of alternative futures for this changing landscape, the Environmental Protection Agency initiated the Federal Clean Water Action Plan in October 2000. The plan directs federal agencies to assume a watershed perspective for environmental management and improve natural resources stewardship through an increase in public involvement in watershed management on federal lands. It also calls on federal agencies to work together with states, tribes, local governments, private landowners, and other interested parties to take a watershed approach to federal land and resource management. Watershed planning includes assessment and monitoring of watershed conditions and identification of priority watersheds on which to focus budget and other resources. Carl Steinitz's alternative futures framework is a major component of this approach.

Although the alternative futures approach increases somewhat the complexity of the installation planning and management process, it compensates by making the planning evaluation process for the region more seamless, especially for those many aspects of the environment that do not respect property boundaries. It does require greater agency and community interaction: in this example requiring international cooperation because the watershed originates in Mexico. The rewards of such an analysis lie in the remarkable perspectives it provides. The case study in this book illustrates a potentially efficacious way of considering and assessing policy scenarios aimed at planning for future change while diminishing its harmful impacts.

This study is not an attempt to steer the community in a particular direction. It is, rather, a means to help local planners predict the consequences of the region's potential alternative futures, and therefore improve their foresight in choosing among them. It is our hope that it will be viewed as a framework to better enable the region's leaders to work together in planning the environmental future of this richly diverse and scenic high-desert environment. The study's extensive analysis is a tool that should aid this dynamic community in realizing "smart growth" in the future. The study has already influenced Fort Huachuca to be the first army installation to devote significant funding to purchase conservation easements.

I am very grateful to all of the planners, researchers, agency personnel and interested local citizens in the United States and Mexico who have worked together with us to make this project both possible and, I hope, successful. But I wish to especially thank the members of the research team for their efforts, talent, and camaraderie.

Robert L. Anderson III
U.S. Army Training and Doctrine Command
Conservation and Natural Resources Program
Fort Monroe, Virginia

Preface

The research described in this book was conducted by a team of investigators from the Harvard University Graduate School of Design, the Desert Research Institute, the University of Arizona, Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (IMADES), the United States Army Training and Doctrine Command, and the United States Army Engineer Research and Development Center.

This study makes use of the work of others, especially in its descriptions of the region and the issues that it faces. We are grateful for the cooperation and permissions that have been granted to us by the region's planning agencies, the Semi-Arid Land-Surface-Atmosphere Program, the Commission for Environmental Cooperation, the United States Bureau of Land Management, and Fort Huachuca. We also appreciate the many persons from the study area who participated in the scenario guide survey and those who provided comments at our public presentations.

The research was funded by a grant obtained by the U.S. Army Training and Doctrine Command's Environmental Division, Fort Monroe, Virginia, from the Department of Defense Legacy Resources Management Program, Project Number 981702. However, there is no contractual obligation or consultative relationship between the investigators and any sponsoring groups or governing jurisdictions. The information herein is believed to be reliable, but the investigators and their institutions do not warrant its completeness or accuracy. Opinions and estimates are the judgments of the research team. The sole purpose of this research publication is educational: to provide information to the many stakeholders and jurisdictions of the region regarding issues, strategic planning choices, and their possible consequences related to the built and natural environment.

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CHAPTER 1

Alternative Futures for a Changing Region

When regions face changing conditions and environmental crises, new policies and plans are required. Usually, there are several simultaneous causes of these crises, and each requires consideration in terms of policy and planning options. Decision makers, and stakeholders in general, have a difficult problem. They must try to foresee the potential consequences of their choices, and policies and plans must be seen together, as a set. Studies of alternative futures based on different assumptions provide a way to investigate the possible outcomes of current policy options and decisions.

If the future were easily knowable, planning for it would be a simple task. However, no one can know what the actual future of a region will be, and therefore planning for the future is a complicated and uncertain process. Since no single vision of the future is likely to be accurate, it is helpful to consider a set of alternative futures that encompasses a spectrum of possibilities. Therefore, this study, and others like it, examines several alternative possible futures for the region.

There are two main ways of thinking about alternative futures (figure 1.1). The most common approach postulates or designs a small number of alternative plans for future land use and/or land cover and comparatively assesses their potential consequences. These alternative futures are often based on geometrically defined development patterns (compact, diffuse, linear, etc.), on political interest group priorities (the conservationists' plan, the developers' plan, etc.), or on single dominant policies (sewer alternatives, transport alternatives, etc.). The advantage of this approach is its simplicity, although a danger is that a misleading simplification often results. Its principal disadvantage is that while a sense of what the future might be is created, it may be impossible to identify the full set of policies needed to achieve that future.

Many planning studies have used this approach. These include most of the spatially oriented land use modeling studies carried out beginning in the 1960s. See, for example, Steinitz and Rogers 1970.

The other approach, which forms the basis of this study of the Upper San Pedro River Basin, more closely resembles the typical decision-making processes of the many governmental, organizational, and individual choices that shape the future for a region. This approach aims to identify the several most important issues responsive to policy and planning decisions, along with the widest range of options pertaining to each issue. As is the case in any policy debate, these are not taken one at a time, but rather as a simultaneous set, with each seen in the context of others. A scenario is then created to reflect choices among the possible options for each policy in the set. The word *scenario* is usually understood to mean an outline of events, typically the plot of a story, play, or film. Similarly, for the purposes of this study, a scenario is an outline or plot that can generate a hypothetical future of the Upper San Pedro River Basin.

In a scenario-based study of alternative futures, each single policy option either alters a spatially varied characteristic that can attract or repel future development or alters a parameter in one of the several process models that assess the impacts of future change. Choices are made, and the resulting scenarios are used to direct the allocation of future land uses using a model of the process of development. The alternatives are then assessed for their consequences. This approach provides for the creation of a variety of alternative futures for a region and gives guidance on how to achieve them

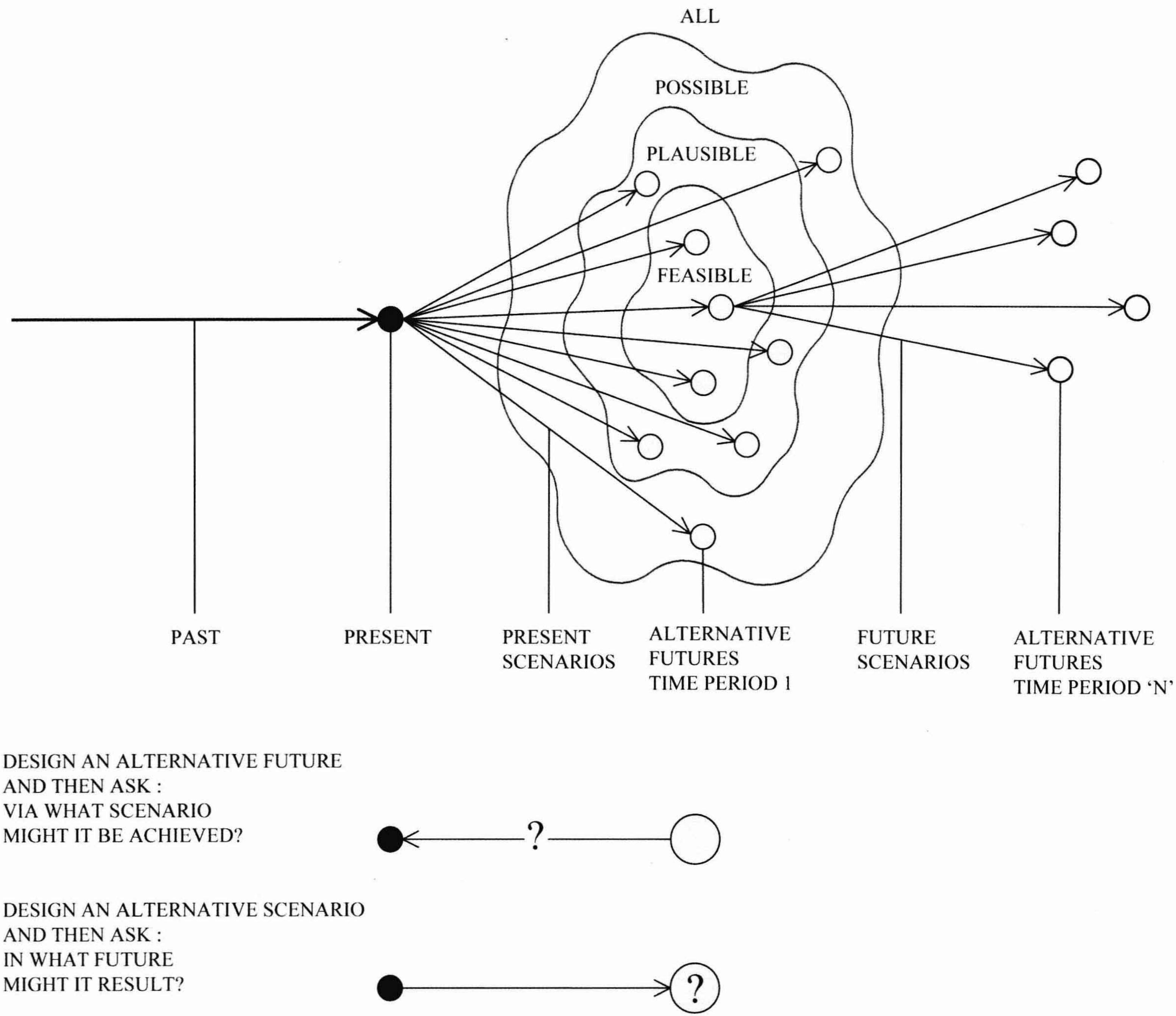

Figure 1.1 ■ Two strategies for considering the future

because the alternatives themselves are based on a set of assumed policy decisions. An additional benefit is the ability to test the effects of individual policy choices by using sensitivity analysis.

Both approaches to the study of alternative futures for changing regions allow consideration of the past and the present. Both recognize that there are an infinite number of future options. Both must reduce the number of alternatives for study from the infinite to a manageable number that includes the most important issues and an appropriate range of policy choices. Both approaches can be used in studies of alternative futures, and both approaches can provide important insights.

Several important and changing landscape regions have recently been studied using scenario-based alternative futures. These include Monroe County, Pennsylvania; the region of Camp Pendleton, California; the Willamette River Basin in western Oregon; the Southern Rocky Mountains in Alberta; the California Mojave Desert; and the Iowa Corn Belt.

Monroe County, Pennsylvania

Alternative Futures for Monroe County, Pennsylvania was a study conducted in 1993 by researchers from the Harvard University Graduate School of Design in collaboration with representatives of the U.S. Environmental Protection Agency (EPA) and the county government (Steinitz et al. 1994; Steinitz and McDowell 2001).

Monroe County in northeastern Pennsylvania lies in the heart of the Poconos. Its beautiful scenery and year-round recreational opportunities have made it an ideal destination for tourists for the past hundred years. Recently, these valuable landscape resources and improved transportation have attracted new residential development, making Monroe County the second-fastest-growing county in Pennsylvania. An estimated 90,000 additional people were expected to locate there by 2020, doubling the current population. As a result, Monroe County faced a crisis, the classic dilemma of conservation versus urban development. In addition, New York City and Philadelphia are only 90 mi (149 km) away, putting 60 million people within a four-hour drive of the recreational attractions of the area.

The study analyzed the trends of growth in Monroe County, determined the possible effects of that growth, and provided some insight into how that growth might best be managed. It identified six key processes (geologic, biologic, visual, demographic, economic, and political) as necessary points of evaluation, discussion, decision, and action. The research prepared six alternative futures for 2020. These were determined by modeling the results of (1) following the county's comprehensive plan, (2) allowing development to be market-driven, (3) pursuing the strategic development interests of each township, (4) adopting a policy of land conservation with an emphasis on outdoor recreational opportunities, (5) concentrating new development in a corridor served by public transportation, and (6) conserving all existing undeveloped land. Models of the six key processes produced maps of expected development impact outcomes, allowing people to visualize the consequences of the alternative futures. This process allowed decision makers to consider how change might affect the future of their county. Tangible results included the later preparation of a plan by Monroe County for its development and conservation, and the passing of a twenty-five million dollar bond issue for conservation.

The Region of Camp Pendleton, California

Biodiversity and Landscape Planning: Alternative Futures for the Region of Camp Pendleton, California explored how urban growth and change in the rapidly developing area located between San Diego and Los Angeles might influence the biodiversity of the area (Steinitz et al.1996; Adams and Steinitz 2000). The study was conducted in 1994–96 by a team of investigators from the Harvard University Graduate School of Design, Utah State

University, the National Biological Service, the U.S. Forest Service, the U.S. Environmental Protection Agency (EPA), the Nature Conservancy, and the Biodiversity Research Consortium, with the cooperation of the two relevant regional agencies, the San Diego Association of Governments (SANDAG) and the Southern California Association of Governments (SCAG), and Marine Corps Base (MCB) Camp Pendleton. The research was supported by the Strategic Environmental Research and Development Program (SERDP), a joint program of the U.S. Department of Defense, the U.S. Department of Energy, and the U.S. EPA, through a grant to the Western Ecology Division of the EPA's National Health and Environmental Effects Research Laboratory.

The study region was an 80 by 134 km (50 by 83 mi) rectangle that encompasses the five major river drainage basins directly influencing Camp Pendleton: San Juan, San Mateo, San Onofre, Santa Margarita, and San Luis Rey. The research strategy was based on the hypothesis that the major stressors causing biodiversity change are related to urbanization. The study area is one of the most biologically diverse environments in the continental United States. Within the region are more than 200 plants and animals listed by federal or state agencies as endangered, threatened, or rare. These include the least Bell's vireo, the coastal cactus wren, and the California gnatcatcher. In addition, a number of plants and animals are of local concern because of declining populations, such as the California cougar. The region is also one of the country's most desirable places to live and work, and it continues to grow and develop. Its population in 1990 was about 1.1 million. The regional planning agencies forecast that by 2010 the population will grow to 1.6 million, and it is expected to continue to grow beyond that date. The effects on biodiversity will depend on several factors, including where and how people build homes, where new industry will be located, where new infrastructure will be built to support urbanization, and whether and where land will be conserved.

Future change was studied at four scales: several restoration projects, a subdivision, a third-order watershed, and the region as a whole. Regional change was simulated via six alternative projections of development to 2010 and to subsequent "build-out." The first scenario was based upon the current local and regional plans as summarized by SCAG and SANDAG and those of Camp Pendleton. Five additional scenarios provided a method to explore and compare the impacts of different land use and development policies relating to biodiversity. Alternative 2 illustrated what may be considered the dominant spread pattern of low-density growth. Alternative 3 also followed the spread pattern, but introduced a conservation strategy in 2010. Alternative 4 proposed private conservation of biodiversity by encouraging large-lot ownership adjacent to and encompassing important habitat areas. Alternative 5 focused on concentrating centers of development and new communities. Alternative 6 concentrated growth in a single new city. All alternatives accommodated the population forecast for the region.

A set of process models was used to assess each alternative. The soils model evaluated the agricultural productivity of the area's soils. The hydrology models predicted the 25-year storm hydrographs for each of the rivers and their watersheds, flooding heights and water discharge, and resultant soil moisture. The fire models assessed both the need for fire in maintaining vegetation habitat and the risks of fire and fire suppression. The visual model assessed scenic preferences for the region's landscape. Biodiversity was assessed in three ways: a landscape ecological pattern model, ten selected single species potential habitat models, and a species richness model.

The evaluations of the alternative futures were used by stakeholders, including MCB Camp Pendleton, to assess the desirability of the policies that generated them and to devise and compare additional development scenarios and conservation strategies.

The Willamette River Basin, Oregon

The Pacific Northwest Ecosystem Research Consortium (PNW-ERC) is a regional research consortium involving researchers at the University of Oregon, Oregon State University, the University of Washington, and the U.S. EPA, and is supported under a 1996 cooperative agreement between the EPA and the universities. The research of the consortium is designed to create a regional landscape context for interpreting trajectories of regional ecosystem change in western Oregon's Willamette River Basin, to identify and understand critical ecological processes, and to develop approaches for evaluating outcomes of alternative future land use, management, and policy (Hulse et al. 2002).

The Willamette River Basin encompasses 12 percent of the state of Oregon, but it is the home of 68 percent of Oregon's population and accounts for 31 percent of the timber harvested and 45 percent of the market value of agricultural production in the state. By 2050, an additional 1.7 million people are expected to live in the Willamette River Basin, bringing the total to around 4 million. That is equivalent to adding three more cities the size of Portland. The high quality of life and quality of the environment are major factors in attracting people to the region. The key challenge will be to accommodate the expected population growth while sustaining and improving the highly valued features of the basin. Already at least 1400 mi (2253 km) of streams in the basin do not meet water quality standards, largely because of runoff associated with human use of the land. Seventeen plant and animal species in the basin are listed under the Federal Endangered Species Act.

Three alternative visions for the future of the region were prepared in 10-year increments through 2050. These were based on basin stakeholder input regarding policies for urban and rural residential, agricultural, forestry, and natural lands and their associated water uses. The Plan Trend scenario represents the expected future landscape if current policies are implemented as written, and, where no policies exist, recent trends continue. The Development alternative reflects a loosening of current policies, across all aspects of the landscape, to allow freer rein to market forces. The Conservation alternative places greater emphasis on ecosystem protection and restoration, although still reflecting a plausible balance between ecological, social, and economic considerations as defined by the stakeholders.

These alternative futures were compared for their impacts on ecological conditions of the Willamette River (including projected changes in river channel structure, streamside vegetation, and fish communities), water availability and use (including whether future demands can be satisfied by the finite water supply in the basin), ecological conditions of streams (including projected changes in stream habitat and the composition and diversity of native fish and benthic invertebrate communities), and terrestrial wildlife (including changes in habitat and abundance and distribution of selected wildlife species).

A central aim of the research has been to communicate to decision makers the system-level implications of positions and policies being modeled. A group appointed by the governor of Oregon and charged with creating a restoration plan for endangered salmon used the Conservation 2050 scenario as the centerpiece of its recommendations to the Oregon legislature (Jerrick et al. 2001).

The Southern Rocky Mountains, Alberta

The Southern Rockies Landscape Planning Project was initiated in 1996 by the Ecological Landscape Division of Alberta Environment, Its purpose is to develop and test computerized planning support tools that may be used to evaluate the ecological and socioeconomic impacts of alternative future regional landscapes by 2018 and 2048 (Alberta Environment and Olson and