SUSTAINING THE FLOWS OF NATURAL AND ECONOMIC RESOURCES FROM WATERSHED LANDS

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ABSTRACT

Watersheds are the source of natural and economic resources that are often subject to *joint production processes*, which is when the production or use of a resource is closely linked to the production or use of other resources. Consequently, tradeoffs among crucial resources are often necessary. The optimal amount of goods and services from the shared resources should be the flow of resources that maximize the present value of the net benefits to society. The best way to achieve the maximum net benefit is through integrated watershed resource planning. It is also necessary that natural and economic resources be environmentally sustainable, while they satisfy society's increasing demand for products and services. This paper focuses on how watershed management can address the increasing demand for high-quality water, while sustaining natural and economic resource flows.

INTRODUCTION

Watersheds are the source of many natural and economic resources that benefit society. The resources are often subject to *joint production processes*, which is when the production or use of a resource is closely linked to the production or use of other resources (Gregersen et al. 1987; Brooks et al. 1992, 1997). Due to joint production processes, tradeoffs among crucial resources are often necessary. The optimal amount of goods and services from the shared resources should be the flow of resources that maximize the present value of the net benefits to society. In this paper, we will show that the most effective way to achieve the maximum net benefit is through integrated watershed resource planning.

NATURAL RESOURCES

A variety of natural resources that sustain economic development and benefit people are found on watershed lands (Gregersen et al. 1987, Brooks et al. 1997, Eckman et al. 2000). Most of Arizona's clean water comes from upland watersheds and flows to downstream places-of-use, where it is used for irrigation and human consumption. Hydropower generation in the Phoenix area is another water-based activity that benefits society.

Many of Arizona's watersheds are the source of timber that is processed into a variety of wood products for sale or local use. Watershed managers, foresters, and other land managers have long debated the relationship of timber harvesting to streamflow regimes. Agricultural crop production and livestock grazing are also watershed activities that are economically important. Consumptive (hunting and fishing) and nonconsumptive (viewing and photography) wildlife values are found on watersheds, which also contain opportunities for a variety of other outdoor recreation activities. Locally important natural resources, such as pinyon nuts, mushrooms, and medicinals and botanicals, are collected on watershed lands.

ECONOMIC RESOURCES

While describing shared natural resources on watersheds in physical terms is useful, economists provide another perspective of watershed resources. Considering the economic value of natural resources is fundamental to developing managerial strategies to sustain natural resource flows. *Use values*, both *market* and *nonmarket*, and *nonuse values* are terms used by economists to describe the value of natural resources on watershed lands. The values must be quantified to assess the benefits and costs of watershed management to sustain natural resource flows.

The direct consumption or use of a resource, rather than passively contemplating or enjoying it, is a use value. Examples of use values include those for water, timber, and other natural resources available on a watershed. Market value is the value of a resource once it is traded in the marketplace. The seller's production costs and a consumer's willingness to pay establish the price of a good or service. Hydropower, timber, and some forms of recreation, such as paying a fee to use a camp site, are market commodities. The resources are produced and consumed by users who pay a price that should approximate their values. Nonmarket values are also obtained from the direct consumption or use of a resource; however, no payment is made to the pro-

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ducer for the resource. Lack of payment does not mean that the resource has no value, only that a marketplace transaction does not reflect its value. Although flood control is valuable, a cash market for the good does not exist. Although wildlife observation, clear-flowing water, and scenic vistas do not have a tangible market value, they remain economically valuable to society. The goods and services from nonmarket values are *public goods*; if a producer provides them, the good or service is integral and accessible to all.

Nonuse values are the other category of economic values. Resources whose values are derived from the possibility of their future use are nonuse values. Nonuse values include the following.

- Option values reflect the willingness to pay to preserve the choice to use an amenity in the future.
- Existence values reflect the willingness to pay to know that a resource will continue to exist, even if the person never uses it.
- Bequest values reflect the willingness to pay to maintain a resource for use by future generations.
- Stewardship values reflect the willingness to pay to maintain a healthy environment for use by all living organisms.

An array of economic resources must be considered when managing the sustainability of watershed resource flows. Many planners, managers, and decisionmakers recognize the relevance of nonmarket and nonuse values to natural resource decisions. Methods for inputting the economic value of nonmarket and nonuse resources have been recently developed to facilitate the decisionmaking process.

SUSTAINING RESOURCE FLOWS

In the past, a watershed was managed to sustain the flow of resources through equal, periodic resource flows year after year, decade after decade (Gregersen et al. 1987, Brooks et al. 1997, de Steiguer 2000). Currently, managing for even, natural resource flows from a watershed has been replaced with managing a watershed to achieve economic resource flows. The economic goal of this multiple-use problem is to select watershed management actions that will maximize the present value of the net social benefits from the combined flow of water, timber, and other natural resource values over time. Maximizing the economic benefits of the resources on a watershed has been legislatively mandated. The Forest and Rangelands Renewable Resources Planning Act of 1974 and the National Forest Management Act requires that watersheds are managed to maximize the net benefits using multiple-use, ecosystem-based, and sustained-yield management prescriptions. Watershed management practices that reach this goal are complex, detailed, and holistic in their implementation and, therefore, require large amounts of data and analyses. Fortunately, emerging tools and technologies are available to planners, managers, and decisionmakers to help achieve the goal (Guertin et al. 2000).

Integrated planning efforts structured around a watershed approach to land stewardship sustain economically efficient resource flows from watershed lands. Various analytical techniques, methods, and procedures help to realize the planning efforts. Watershed managers are developing comprehensive plans using integrated planning tools. Recently, watershed managers successfully implemented practices, projects, and programs that meet this objective and that sustain natural resource flows from watershed lands.

RESPONDING TO INCREASING WATER DEMANDS

Planners, managers, and decisionmakers know that it is critical to practice natural resource conservation and sustainability and economic resource flow sustainability, while meeting the increasing demand for land, water, and other natural resources. Much of the literature available on this important subject broadly addresses integrated watershed management practices, projects, and programs and the multiple outputs obtained from these efforts (Brooks et al. 1997, Gregersen et al. 2000, Ffolliott et al. 2002b). This paper focuses on watershed management as it relates to the increasing demand for high-quality water, which is a continuing issue in Arizona and other regions that experience persistent water shortfalls. This perspective is based on the following.

- Water is a key watershed management issue in the twenty-first century.
- Water is the only resource that unifies the various elements of integrated watershed management.
- Water is the best example of why planners, managers, and decisionmakers must address the demand for and supply of natural resources.

Although the increasing cost of water will reduce its use, the supply of high-quality water will continue to decline. Many related issues have been discussed elsewhere (Brooks et al. 1997; Ffolliott et al. 2000, 2002a; Gregersen at el. 2000). However, some commonalities suggest water and watershed management areas that must be addressed to meet the increasing demand for high-quality water. They include:

- Watershed management researchers have successfully developed the technical ability to secure the highest quantity and quality of available water. Continuing technical research on water resources, while focusing on obtaining the necessary management and institutional support to effectively use current technologies is necessary.
- People effectively reduce their consumption of water, and increase their investments in the infrastructures needed to sustain high-quality water supplies, during and after floods, drought, and other crises. However, the emphasis on crisis management should be replaced with a focus on developing long-term mitigation strategies to avoid unsustainable use, thereby, making future disasters less likely.
- Decentralization of environmental responsibilities and an increase in participatory management of watersheds and water resources is occurring. Many locally led watershed management initiatives exist in Arizona (Endebrock 2000), and this form of natural resource participatory management is growing worldwide.
- Globalization of environmental issues and responses is receiving increasing attention. International trade of commodities produced from natural resources and global agreement and programs about the environment and natural resources have increased significantly.

Society must develop effective combinations of institutional arrangements in response to increasing water and other natural resource scarcity. These responses should:

- Use the accumulated technical knowledge about how to manage water and other natural resources;
- Employ local watershed resource users who understand of the issues and options associated with a watershed management approach to land stewardship; and
- Help resolve conflicts that occur due to the actions of users at different locations on a watershed or within the large river basin.

Participants at the International Conference on Water and the Environment held in Dublin, Ireland, on January 26 through 31, 1992, developed the *Dublin Conference and the Conference Report* to help guide the development of effective international water policies (The World Bank 1993, World Meteorological Organization 1999). The basic underlying principles of the report are that water:

- Is a finite and vulnerable resource that is essential to sustaining life, economic development, and environmental integrity;
- Development and management should be based on a participatory approach that involves users, planners, and policymakers at all levels; and
- Has an economic value and, therefore, should be managed to achieve an economic goal.

To encourage effective international water policies, the participants of the Dublin Conference adopted several policy objectives. Those that concern Arizona include:

- Protecting against droughts, floods, and other natural disasters by increasing the investment in data collections to better predict disaster recurrence intervals and, in doing so, upgrade disaster preparedness;
- Providing for sustainable urban development, which unaffordable water can threaten, by developing future reliable water supplies;
- Contributing to rural water supplies by applying water-saving technologies and management methods that introduce institutions and incentives for the rural communities to adopt effective water-conservation approaches;
- Protecting aquatic ecosystems from water-flow disruption and pollution discharges that require expensive treatment, destroy aquatic biota, and limit water-based recreational opportunities;
- Enhance effective water management by accurately measuring water-cycle components and other environmental characteristics that affect the delivery of high-quality water; and
- Resolve water-use conflicts by reconciling the interests of all stakeholders, monitoring water quantity and quality, developing action plans, exchanging pertinent information, and enforcing agreements.

The *Dublin Conference and Conference Report* was the impetus for formation of a *Global Partnership on Water,* which formalized the recommendations of the United Nations Conference on the Environment and Development, held in Rio de Janeiro, Brazil, in June 1992. Participants gathered to consider effective water policies (Brooks et al. 1994, 1997; Easter et al. 1995; Quinn et al. 1995) and the sustainable development of natural resources (Gregersen et al. 2000). The main objectives of this partnership, which are relevant to Arizona, were to:

- Support integrated water resource management programs through existing and future government and other collaborative efforts;
- Encourage governments, land owners, and other stakeholders to adopt consistent and mutually complementary policies and programs;
- Build mechanisms to share information and experiences;

- Develop innovative and effective solutions to common problems to integrated water resource management;
- Suggest practical policies and appropriate management practices based on the above solutions; and
- Help match identified needs to available resources.

Implications of the International Conference on Water and the Environment, the United Nations Conference on the Environment and Development, and similar policy-oriented gatherings to the people of Arizona are clear. Significant increases in the quantity of water are needed to meet anticipated future water demands in Arizona and to avoid mounting water crises and shortages. These efforts will require that both reductions in the per capita consumption of water and development of new and improved supplies of water be considered. Greater efficiency in use and, consequently, reduced per capita consumption of water can be achieved by improving water-use technology and methods. Additionally, supplies of usable water might be increased by locating and developing new and improved water supplies. Planners, managers, and decisionmakers have several options to consider when responding to increased water demands. Options, such as the following, reflect a watershed management approach to land stewardship.

- The timing of natural water flows can be manipulated through watershed management practices to ensure usable water supplies.
- Usable quantities of water can be increased to some extent through water harvesting, accessing deep aquifers, increasing storage, and changing storage techniques to reduce evaporation.
- Usable water can be increased by changing the quality of water, although the cost is often high.

Improving management of available water supplies is also necessary despite any progress to reduce the demands or increase the supplies of water. Effective applications of known technologies must be encouraged. An increase in public awareness about the need to balance the economic and environmental values of available watershed resources is also required. Implementing effective watershed management policies will help guide societies' responses to increased demands for water and other resources, and will ensure sustainable supplies of high-quality water into the future.

SUMMARY

Watershed managers must recognize tangible commodities and intangible amenities when implementing strategies to sustain natural and economic resource flows from watershed lands. Intangible resources have become increasingly significant to the people of Arizona. Managers should strive to replace even-flow natural-resource production with maximization of the net social benefits from the combined flows of water, forage, timber, and other natural resource values over time. This practice will help to ensure that watershed management meets society's growing economic needs. Responding to increasing water demands will be a particularly pressing need.

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