SUSTAINABILITY CRITERIA FOR WATER RESOURCE SYSTEMS

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REFERENCE: Proceedings of the 1999 Georgia Water Resources Conference, held March 30 and 31, 1999, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia 30602-2202.

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Abstract. The presentation reviews a monograph produced by the ASCE Task Committee on Sustainability Criteria. The monograph examines many of the major issues and challenges raised by the concept of sustainability applied to water resource system design and management. It reviews various guidelines that have been suggested for achieving a greater degree of sustainability and the extent to which they have been applied in the development and management of water resource systems. It outlines some approaches for measuring and modeling sustainability and illustrates ways in which these measures and models might be used when evaluating alternative designs and operating policies.

This monograph is written for those interested and involved in the planning and management of water resource systems. This includes students as well as practitioners. It was written by individuals sharing a background in environmental and water resources systems planning and management, but having differing experiences and opinions. Hence different points of view are presented with the hope that they will stimulate thinking about just how water resource systems should be developed and managed, not only for those living today but also for those who will be dependent on these systems in the future.

This document is the product of two groups of professionals: a working group of the International Hydrological Programme of the United Nations Scientific, Educational and Cultural Organization (UNESCO) and members of the Task Committee of the Division of Water Resources Planning and Management of the American Society of Civil Engineers (ASCE). Both groups were formed to explore ways in which the concept of sustainability might be used as a measure of system performance when evaluating alternative water resource plans and management policies.

BACKGROUND ON SUSTAINABILITY

Water resource professionals have an obligation to design and manage water resource systems so that they can fully contribute to an improved quality of life for all humans. Water resource systems that are able to satisfy the changing

demands placed on them, now and on into the future, without system degradation, can be called "sustainable."

Sustainability is a unifying concept that emphasizes the need to consider the long term future as well as the present. This includes the future economic, environmental, ecological, physical and social impacts that will result from decisions and actions taken today. While we cannot know with certainty what all these impacts will be, or what future generations of individuals or societies will want or value, we can attempt to predict what we think might happen and what future generations may want or value as we develop our current plans, designs and management policies. Admittedly we can only guess at what future generations would like us to do now in our generation for them in their generations. We must take these guesses into account as we make our decisions or take actions to satisfy our immediate demands and desires.

Because sustainability is a function of various economic, environmental, ecological, social and physical goals and objectives, analyses must inevitably involve multi-objective tradeoffs in a multi-disciplinary and multi-participatory decision-making process. No single discipline, and certainly no single profession or interest group, has the wisdom to make these tradeoffs. They can only be determined through a political process involving all interested and impacted stakeholders. The participants must at least attempt to take into account the likely preferences of those not able to be present in this decision-making process, namely those who will be living in the future and who will be impacted by current resource management decisions.

Sustainability is intimately related to various measures of risk and uncertainly about a future we cannot know but which we can surely influence. Clearly our guesses about the future will, with certainty, be wrong. Hence they will need to be revised periodically. Recognizing that some management objectives will change over time, we must consider the adaptability or robustness of the systems we design and operate today to this management uncertainty and to the inevitable changes in the quantity and quality of the resource being managed.

SUMMARY

We begin Chapter 1 with a discussion of the definition of sustainability that is commonly used, but which we think is not very helpful for water resources planning and management. Nevertheless, this common definition is often cited, used and discussed in the considerable literature that exists today on the subject of sustainability and sustainable development.

In Chapter 2 we review some of the major issues and challenges posed by this commonly accepted definition of sustainability and try to identify why sustainability has been so difficult to quantify and to define very precisely. The discussion of the challenges and issues associated with this broad concept of sustainability (as applied to various water resources purposes) leads us to the particular definition we propose for water resource systems planning and management.

In Chapter 3 we define sustainability in a way that seems appropriate to those of us involved in water resources planning and management. This definition allows us, in Chapter 4, to identify and examine in more detail some ways of measuring sustainability for selected water resources functions or purposes. These measures rely on the inputs and judgments of those having an interest in such systems. The interests of different stakeholders may differ. While we recognize computer analyses lie behind most decisions involving facility design, construction and operation, it is their development and use toward achieving a common (shared) vision among all stakeholders that is important with respect to system sustainability.

This growing concern over the need to achieve increased levels of system sustainability (however defined) has lead to the creation of a number of guidelines for its achievement. Various professional engineering organizations in various countries created the guidelines, summarized in Chapter 5. The primary purpose of these guidelines is to help those in the engineering profession, and especially the practicing engineer, design and manage systems that are sustainable. Systems can be designed and managed so as to be sustainable even though particular projects and even institutions making up those systems may not be. There are many aspects of sustainable systems, including change, but all should lead toward the development and use of more sustainable technologies, to more sustainable environments and ecosystems, to more sustainable economic and financial policies, to more sustainable institutions and societies, and to improved long-term human health and welfare.

Chapter 5 also includes a series of brief descriptions - case studies - of some water resource development and management projects. They serve to illustrate the extent to which sustainability criteria have or have not been achieved in particular situations. These real-world examples also illustrate the difficult tradeoffs that must be made among various goals and interest groups when designing water resource systems and implementing policies for managing them.

Chapter 6 explores some economic criteria and associated models that consider economic objectives. The discussion examines the issue of appropriate discount rates - the weight we put on our current assets compared to the weights we assign to assets of future generations. One of the major needs still unmet is our ability to value non-monetary goods (such as those derived from our environment and our ecosystems) in monetary terms. Since we have not yet learned how this can be done, we are forced to make comparisons and tradeoffs between economic and environmental or ecological criteria expressed in different metrics (units of measure).

Chapter 7 identifies some of these environmental and ecological criteria and associated modeling and implementation approaches aimed at achieving a greater degree of sustainability. Through a series of examples emphasis is placed on the importance of communication and public participation, hopefully leading to a shared vision in what the outcome should be. The adaptive approach to planning is shown to be extremely useful, with guidelines given for its implementation.

Individuals and societies manage themselves through their institutions. While this monograph is not focused on that aspect of sustainability in any great detail, Chapter 8 briefly reviews some of the social and institutional aspects of sustainability. Institutional capabilities as well as conflicts and constraints are of major importance for water resources planners and managers. It is, after all, through our institutions that decisions are made regarding our water resources development and use. They are the clients for all of our technical planning and design models and decision support systems. Institutions can foster and encourage increasing sustainability, or they can do just the opposite. Three examples are given in support of that observation.

Chapter 9 examines how a variety of modeling technologies can and should contribute toward higher levels of sustainability. Emphasis is given to ways of improving the planning and management process and the information upon which recommendations are made and decisions are based. The potential role of Decision Support Systems (DSS) is presented and illustrated.

Chapter 10 examines how economic, environmental and hydrologic risk and uncertainty impacts on our attempts to define and work with sustainability criteria. Anyone involved in water resources planning and management must contend with risk and uncertainty and this is especially so when required to look into a distant future. No one can look into even the near future with precision. Future supplies of water and future demands for the services provided by water resource systems are unknown at the time system design and operating decisions are made. Professionals are asked to provide for this uncertain future. As a result, system robustness and other risk-based measures of system performance become important considerations, and are intimately tied into any measure of sustainability.

Chapter 11 addresses some equity, education and technology transfer issues related to sustainability. While the discussion is brief, the subject is as important as any discussed in this monograph. Different individuals will have different views as to what is equitable or ethical. The correct view is not always obvious.

Particularly for those working in educational institutions, it is important to consider capacity building and the technology transfer issues with respect to sustainability. In Chapter 11 some of the education, training and technology transfer aspects of sustainability are examined. Also discussed are the important roles professional societies as well as educational institutions play in producing and providing the expertise needed to continue into the future the efforts being made today toward achieving more sustainable systems.

The monograph concludes with Chapter 12 highlighting some key points concerning the planning and management of sustainable water resource systems. It emphasizes that in our search for sustainable development, the effectiveness of any mechanism derived to reach that goal depends, in the end, on the quality of the individuals interested in pursuing it.