Environmental Research, Policy and Regulation: The Chesapeake Bay Experience

T. C. MALONE and W. H. BELL
Center for Environmental and Estuarine Studies, University of Maryland System, P.O. Box 775, Cambridge, MD 21613, USA

Current efforts to manage the environmental impacts of human activities tend to focus on symptoms of environmental stress rather than on underlying causes. Given the need to "act now," a distinction must be made between short-term, tactical responses to indicators of stress and long-term, strategic solutions based on a theoretically sound understanding of ecosystems and the role of the human species in ecosystems. The formulation of environmental policy and management plans for coastal seas must be based on information generated by environmental research that is independent of government agencies responsible for policy and management and special interest groups that have environmental agendas. Using Chesapeake Bay as an example, we discuss (1) the relevance of independent research to coastal seas' governance and (2) the importance of clearly defined roles and relationships among research institutions and government agencies.

Introduction: The Problem

Among the more striking characteristics of the global environment is change. The uniqueness of modern environmental change lies in the predominant role of a single species and in the accelerated rate at which change is occurring. Ecosystems are being modified as a direct consequence of human activities ranging from local pollution to global increases in greenhouse gasses in the atmosphere. These and other environmental phenomena reflect patterns of resource exploitation and economic development that cannot be sustained. They are symptomatic of profound ecological changes that reduce the capacity of ecosystems to support the natural resources of our planet and, as a consequence, to support the economies of human civilization.

The ecological expression of unsustainable development practices are pronounced in the watersheds of inland seas and estuaries of industrialized countries where both population density and standard of living have increased rapidly in recent decades. Today, well over 50% of the world's human population inhabit the coastal zone, and it is projected that this will increase to over 75% by the turn of the century. Population growth, increased per capita consumption, and suburban development are altering the ecological mosaic of watersheds and their aquatic ecosystems. For example, urbanization in the Hudson River basin of New York appears to be related to an exponential decline in the reproductive success of anadromous fish spawning in tributaries of the Hudson River (Limburg and Schmidt 1990). Although such relationships do not prove causality, they do suggest a connection between population growth in watersheds and the capacity of aquatic ecosystems of watersheds to support natural resources.

Chesapeake Bay and its watershed have been subject to rapid population growth and economic development throughout most of the 20th century. The Bay, North America's largest and most productive estuary, is at the receiving end of a watershed

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that currently supports a population of 13 million or about 186,000 people per km^3 of Bay water. Population density has increased by 60% since 1950 and is expected to double soon after the turn of the century. Development of the watershed has been accompanied by declines in water quality and natural resources. Nutrients flowing into the Bay from both point and nonpoint sources have stimulated algal growth leading to problems such as bottom water oxygen depletion and declines in submerged aquatic vegetation (SAV). Inputs of toxic metals and organic compounds appear to be affecting the Bay's resources in some regions. With the notable exception of the blue crab, commercial landings of the Bay's major fisheries have also declined in recent decades (Magnien et al. 1989). Although the causes and consequences of such changes in the ecology of the Bay are poorly understood, it is likely that they are a manifestation of land-use patterns in the watershed that are undermining the capacity of the system to support natural resources and sustained economic development.

The public perception of these and other indicators of unsustainable economic growth are placing institutions and agencies responsible for environmental matters under great pressure to "protect," "restore," and manage for "sustained use" the ecosystems of the land-sea interface. Unfortunately, these pressures come at a time when our knowledge of how ecosystems work is rudimentary at best, and the respective roles of our environmental research and management institutions are inadequately defined. Given limited resources, the immediate demand to stem the tide of pollution, and the long-term need to develop environmental policies and management strategies that are environmentally, economically, and culturally sound, it is important that the roles of our environmental institutions be well delineated and coordinated.

Scaling The Process of Environmental Governance

The history of environmental governance has not been characterized by its attention to long-term, social, economic and ecological trends and goals. Efforts to "manage" natural resources and the impacts of human activities on the environment have tended to focus on the immediate symptoms of ecosystem stress rather than on the fundamentals of how ecosystems work. Environmental management has generally evolved in an *ad hoc* fashion in response to environmental catastrophes. "Management" must become more than a euphemism for ameliorative and corrective responses to events. It must become a proactive strategy based on a sound understanding of how ecosystems function.

Given the need to "act now" and the current status of our understanding of ecosystems, it is important to distinguish between short-term, tactical responses to symptoms and long-term, strategic plans to address fundamental problems. Both approaches are clearly needed. In the short-term, limits must be placed on the rate at which we are polluting the environment and exploiting natural resources. Of necessity, these limits will be somewhat arbitrary and controversial and should be viewed as temporary "steps in the right direction" rather than as permanent solutions. In the long-term, the development of a strategy for environmental management must be based on a sound understanding of ecosystems and of the role of the human species in ecosystems.

The Chesapeake Bay Program is the first major attempt to develop a comprehensive plan for environmental management that makes this distinction between tactical responses and strategic planning. Supported by the states of the Chesapeake region (Maryland, Virginia, Pennsylvania, and the District of Columbia) and the federal Environmental Protection Agency, the Program was initiated in 1983 with the formation of the Chesapeake Executive Council charged with developing a **basin-wide** approach to the restoration and protection of living resources, habitats and ecological

relationships. From the beginning, the administrative structure of the Bay Program included a Scientific and Technical Advisory Committee and a Technical Advisory Committee. Under the auspices of these standing committees, research planning and implementation address the need for both short-term responses and long-term planning. Short-term priorities focus on reductions in nutrient inputs, toxic loading and shoreline development. The long-term goal is to develop an integrated strategy of environmental management based on how land- and water-use patterns are related to the ability of the Bay and its watershed to support natural resources and economic development.

The Chesapeake Bay Monitoring Program is an important part of the long-term research strategy (Magnien et al. 1989). The purpose of this program is to develop a record of changes in water quality, the abundance of natural resources, and ecological relationships in order to document trends that can be used to help resolve natural variability and anthropogenic effects. The importance of this program not only lies in its potential to resolve sources of variability but also in evaluating the effectiveness of management decisions such as the implementation of nutrient reduction tactics. The provision in the Chesapeake Bay Agreement for a 40% reduction in nutrient input to the Bay by the turn of the century is a tactical response to an immediate problem, eutrophication. The response includes improved wastewater treatment to reduce point sources and "best management practices" in agriculture to reduce nonpoint sources. The target of 40% will undoubtedly be modified as our understanding of the Bay ecosystem improves.

The Critical Areas Program in Maryland is a tactical response to control erosion and the flow of pollutants from the watershed to the Bay by regulating shoreline development. As the ecological effectiveness and economic ramifications of this program become better understood, it too will be modified. In this context, a recent report to the Executive Council of the Chesapeake Bay Program recommended the appointment of a Commission on Growth in the Watershed of the Bay. Governor Schaefer of Maryland has responded by appointing a Commission charged with developing a strategy to control development and protect "environmentally sensitive areas."

The long-term success of such efforts will depend on cooperation among a variety of groups including the institutions of academia, government, and business. Effective coordination requires a clear understanding of and respect for the roles of each institution as well as an ongoing inter-institution dialogue. At present, the respective roles of government environmental agencies and academic research institutions are not well delineated. This impedes systematic progress toward a basin-wide, integrated plan of environmental governance. It promotes the traditional *ad hoc*, site-specific approach to environmental management. It also gives rise to a haphazard proliferation of committees, panels, and commissions that, despite good intentions, often do little more than waste time, confuse issues, and lead to a false sense of progress.

The Role of Science

An important aspect of this problem is confusion and a general lack of agreement on the role of academic research institutions in the environmental governance process. In this context, distinctions must be made between the development of an information

base needed for effective governance, the formulation of environmental policy, and the implementation of policy through management and regulation. The availability of information provided by objective scientific observation and theory is crucial to the framing of environmental policy and related management programs. Traditionally, academic institutions have been the primary source of such information, presumably because the faculty of these institutions are in a position to conduct research without the bias of advocating how the resulting information should be used by society.

Recent studies suggest that environmental research in estuaries and coastal seas has suffered from social and political pressures that restrict research to preconceived notions of what is "relevant" without concern for fundamental ecological processes (Schubel 1986). This conclusion is supported by a comparative study of environmental governance practices in place for the Chesapeake Bay, the Baltic Sea, the North Sea, and the Inland Sea of Japan (Morris and Bell 1988). Results of this comparison clearly demonstrate the desirability of having "a community of scientists having the independence to pursue their work unhindered by bureaucratic influence, yet occupying some position relevant and influential to the difficult decision-making process." The principal problem is not the "Ivory Tower" or the quality of the scientific information generated by its inhabitants. Rather, the problem involves the means by which independent research and information exchange are pursued.

An example of the role of independent research in coastal seas' governance is provided by the Center for Environmental and Estuarine Studies (CEES) of the University of Maryland System (Bell 1989). CEES' research is not governed by specific management plans including the current Chesapeake Bay Agreement. The faculty strive to conduct scientific studies that contribute to the advancement of knowledge concerning the ecology of organisms and ecosystem function. During 1987-88 CEES faculty conducted 252 research projects in aquatic and terrestrial ecosystems worldwide. About 75% of these projects involved the Chesapeake Bay and its watershed. A summary of CEES' research projects according to their contribution to the priority commitments of the 1987 Chesapeake Bay Agreement shows that CEES' scientists contributed to all but one of the priorities (Table 1). Significantly, these projects accounted for only 1% of the funding for the Chesapeake Bay Program as a whole in 1989 (ca. $500 million). Furthermore, nearly half of this funding was derived from sources outside of the Bay Program (e.g. the National Science Foundation) for research that was not designed to address the goals of the Bay Program *per se*. As a source of scientific information on the environment, univeristy-based research appears to be both relevant and cost-effective.

Table 1. Support (in thousands of dollars) for Bay-related research by CEES, 1987-1988.

Commitment Area	Federal	State	Other	Total
Living Resources	$ 912	$ 4,108	$228	$ 5,248
Water Quality	885	1,917	54	2,856
Population Growth	0	87	0	87
Education	3	213	106	322
Public Access	0	0	0	0
Governance	3,716	3,948	73	7,737
Total	$5,516	$10,273	$461	$16,250

The utility of information generated by such research programs depends on effective collaboration and communication among research institutions, government agencies and the public. However, confusion of responsibilities is and will lead to conflicts of interest and competition that impede the constructive flow of information among these groups. One manifestation of this is the tendency for government agencies to make decisions on the basis of information generated by the technical staff of those same agencies (Morris and Bell 1988). Although this is a natural tendency, it is dangerous. For example, a serious conflict of interest arises when an agency charged with the enforcement of environmental regulations also engages in research that may support increases in its regulatory authority. This can lead to results that are self serving and is generally not conducive to objective, scientific inquiry.

Conclusion

In concept, the Chesapeake Bay Program embodies two of the major ingredients required for a comprehensive coastal seas' governance initiative:

(1) the recognition that environmental management must reconcile the immediate need to respond to the symptoms of environmental stress with the ultimate requirement for a fundamental understanding of the effects of human activities in an ecosystems context and

(2) a holistic view of environmental management based on the principle that a healthy environment and economic development are interdependent.

This is an important and pioneering aspect of the Bay Program. Environmental management must be based on a fundamental understanding of the influences of human activities on ecosystems as a whole as well as on how ecosystems support the growth and survival of the human species.

Returning to the "Ivory Tower" metaphor, objective scientific inquiry requires a degree of insulation and, therefore, should be the primary responsibility of public and private institutions that do not advocate particular political, social, or economic agendas and are independent of agencies responsible for policy, regulation and management. Research can only lay the intellectual foundations for environmental governance. A comprehensive program of governance will only be achieved through a free exchange of information among institutions with clearly defined roles.

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