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Inventing Governance Systems That Respond to Coastal Ecosystem Change

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ABSTRACT

Coastal governance comprises the policies, laws, and institutions that together respond to the transformations of coastal ecosystems that are being brought about by anthropogenic forces. Coastal governance is adaptive and dynamic and must be rooted in sustained learning. This chaper examines the tensions between a governance process that integrates participatory democracy with the generation of knowledge on the processes of ecosystem change that it attempts to address. The term ecosystem, as used here, includes ecological, economic, and institutional components. Recommendations are offered for how the linkages between governance process and knowledge on ecosystems function and change might be strengthened. Particular attention is given to developing nations in the tropics, where the pace of coastal ecosystem change is most rapid and governance institutions are particularly fragile.

INTRODUCTION

The GESAMP report, "The Contributions of Science to Integrated Coastal Management" (GESAMP 1996), offers a simple conceptual framework for tracing the evolution of integrated coastal management (ICM) initiatives and analyzing the contributions of the natural and social sciences in each step of the process (see Figure 20.1). GESAMP reinforced that knowledge from both the natural and social sciences is required if coastal governance issues are to be analyzed and acted upon effectively.

There are many descriptions of the phases or steps by which coastal governance initiatives evolve (Chua and Scura 1992; GESAMP 1996; Cicin-Sain and Knecht 1998; UNEP 1995). GESAMP selected the most essential and stripped-down description, which emphasizes that

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Science and Integrated Coastal Management, ed. B. von Bodungen and R.K. Turner, pp. 327–339, Dahlem Workshop Report 85

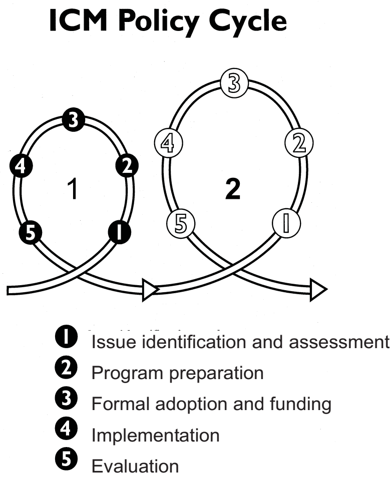

Figure 20.1 The steps in the ICM cycle. From GESAMP 1996, as adapted in Olsen et al. (1998).

the process is a cycle of learning that proceeds from awareness of a set of problems and opportunities (Step 1) to their analysis, to the formulation of a course of action (Step 2). Next comes the politically charged time (Step 3) when a society, be it a village or a nation, commits itself to new behavior and allocates the resources by which the necessary actions will be implemented. In most settings, Step 3 involves formalization of a policy and plan and the allocation of funds. Implementation of the actions is Step 4. Evaluation of successes, failures, learning, and the reexamination of how the issues themselves have changed rounds out an ICM cycle as Step 5. These five steps may be completed in other sequences, as for example, when an initiative begins with enactment of a law (Step 3) that provides the mandate for analyzing issues and developing a detailed plan of action (Steps 1 and 2). Altering the sequence, however, often comes at the cost of efficiency, as when it becomes apparent that the authorities provided by law are inadequate for implementing the actions that are required. Progress and learning are greatest when there are many feedbacks between the steps that make up a "generation" of coastal management (Olsen et al. 1996, 1999). This deceptively simple policy cycle is useful because it draws attention to the interdependencies between the steps within a generation and between successive generations of management. Diagramming coastal governance at different geographic scales helps diagnose issues and priority needs in a specific place. This is important because much of the planning and analysis (Steps 1 and 2) currently being conducted on coastal change and its implications fails to result in the meaningful implementation of new policies or plans of action. In many regions, particularly in the tropics where coastal change is most rapid and governance processes and structures are weak, what we see are the fragments of many unconnected cycles.

ICM is a form of adaptive management, a concept that first appeared in the natural resource management literature in the mid-1970s (see Holling 1979). ICM requires understanding the interplay between social processes and ecosystem change. To be successful in the face of complexity and uncertainty, ICM initiatives need to be flexible, adaptive, and have the capacity to learn. Adaptive management can overcome some of the obstacles from which traditional management suffers (Gunderson et al. 1995; Holling and Sanderson 1996; Imperial et al. 1993). It is designed to cope with the uncertainty and complexity of natural and social systems by creating spaces in which reflection and learning can occur, allowing management processes to take corrective action and modify behavior in light of new information. As Berman (1980) observes, "The ideal of adaptive management is the establishment of a process that allows policy to be modified, specified, and revised — in a word adapted — according to the unfolding interaction of the management process with its institutional setting."

The practice of adaptive management is based on the ideas that (a) projects and policies are inevitably experiments and should be designed and administered as such; (b) information has value not only as a basis for action but as a product of action; (c) actions can and should be taken in the face of uncertainty and complexity; and (d) management of ecosystems essential to humankind will continue for as long as humankind exists and there is no "final" solution to the management problem (Healey and Hennessey 1994). Some of the strategic changes in attitude that advocates of adaptive management promote are shown in Table 20.1.

THE TWO PILLARS OF INTEGRATED COASTAL MANAGEMENT

Lee (1993) has probed the interplay between knowledge of how ecosystems function and respond to anthropogenic forces and the processes of governance in democratic societies. In this paper, Lee's insights are adapted to conjure up the image of knowledge and a governance process as constituting the two pillars of ICM. The first pillar is a *governance process* that examines the interests of the many stakeholder groups, negotiates plans, policies, and decision making, and then applies enforcement mechanisms that are transparent and accountable to those affected by its actions. The second pillar is the generation and incorporation of the *reliable knowledge* that allows the manager to understand, and sometimes to forecast, the consequences of different courses of action. Lee emphasizes that such knowledge does not flow

Table 20.1 Conventional versus adaptive attitudes about management and policy analysis. Adapted from Walters (1986).

Conventional	Adaptive
1. Seek precise predictions and promote programmed management	1a. Embrace alternative approaches to resolving problems and addressing pertinent issues
2. Presume certainty in seeking best action	2a. Evaluate feedback and learn from failure as well as success and apply those lessons to future program decisions
3. Emphasize short-term objectives	3a. Promote long-term objectives
4. Minimize conflict among stakeholders	4a. Highlight difficult trade-offs and conflicts and build space for multiple viewpoints, consensus building, and negotiation
5. Seek equilibrium	5a. Expect and profit from change

only from "the sciences" but rather is the product of the scientific method. Thus, a learning-based approach requires the objective and careful analysis of management policies and management actions to specific issues addressed by an ICM initiative (e.g., specific measures to address a problem of overfishing or eutrophication) and to generations of the ICM cycle. From this perspective, management policies and actions need to be viewed as experiments based upon clearly stated hypotheses and evaluated by suitable indicators selected to probe the purposes and expected outcomes of the policies that are implemented. As stated by Lee (1993), "Without experimentation, reliable knowledge accumulates slowly, and without reliable knowledge, there can be neither social learning nor sustainable development."

Healey and Hennessey (1994) have examined the utilization of scientific information in the management of estuaries in the U.S. They concluded that while an adaptive approach that integrates "science" with all the steps in the management cycle is the best option, it is seldom practiced. Often, science and management proceed as "two solitudes" with little meaningful interaction. In some cases, there is episodic contact in which collaboration is typically restricted to the initial steps of issue analysis and planning. The sustained interaction and cross-fertilization recommended by GESAMP (1996) and detailed by Lee (1993) is unfortunately rare in current ICM practice.

An organizing framework for applying the adaptive, learning-based approach to the analysis of ICM initiatives that addresses an analysis of each step in the ICM process and the outcomes of ICM initiatives at different stages of maturity is described in Olsen et al. (1996). A "Manual for Assessing Progress in ICM" (Olsen et al. 1999) and an initial application of this framework to selected case studies is available (Olsen et al. 1998). These documents focus upon the first pillar — the governance process itself. This chapter is focused more on the second pillar — "reliable knowledge" — and particularly on the difficulties inherent in bridging the two pillars of ICM with a resilient lintel. To where does this gateway lead? The hope is that it signals the pathway to sustainable forms of human development. Herman Daly (1996) has suggested that the defining feature of sustainable development is "the replacement of quantitative growth expansion (growth) with qualitative improvement (development) as the path of future progress." Of the many definitions in circulation, this one appears to best capture the essence of the sustainable development concept.

THE DIMENSIONS OF COASTAL CHANGE

According to recent estimates (Cohen et al. 1997), almost half of the world's population lives within 150 km of a coastline on less than 20 percent of the planet's nonpolar land. Demographic trends suggest that the proportion of the world's human population that will live in coastal regions will increase within the next half century at a time when the numbers of people is likely to grow from the current 6 billion to nearly 10 billion. By the mid-1990s, twelve of the world's fifteen megacities were coastal. Coastal regions attract human populations because they are focal points for economic growth. They account for more than half of humanity's infrastructure for manufacturing, transportation, energy processing, tourism, communications, and other services and probably, therefore, a similarly disproportionate share of global consumption and waste production. High population growth, combined with endemic poverty in some regions and increasing consumption in others, is producing losses in important qualities of coastal ecosystems — often the very qualities that attract people to them. The symptoms include declining water quality, degradation or destruction of critical habitats, decline and collapse of fisheries, and losses in biodiversity. These losses combine to generate user conflicts and pose unprecedented challenges for institutions with coastal governance responsibilities (Olsen et al. 1998).

Within this context of sustained change, the challenge is not to define and achieve a static and optimal "mix of products and services." It is rather to engage in a dynamic, iterative process that works to modify societal behavior so that it can adapt more efficiently to rapidly changing circumstances. A definition of ICM that emphasizes these features (GESAMP 1996) is:

> "A continuous and dynamic process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystems and resources."

THE FIRST PILLAR OF ICM: THE GOVERNANCE PROCESS

Considering the enormity of the challenges that confront those attempting to promote responsible and effective responses to coastal change, it is useful to consider the differences between management and governance. Management is the process by which human and natural resources are harnessed to achieve a known goal within a given institutional structure. Governance, on the other hand, generates the fundamental goals and the institutional process and structures that are the basis for planning and decision making. Governance, therefore, sets the stage within which management occurs (Olsen and Christie 2000). For most coastal ecosystems, neither the goals nor the institutional structures for progressing towards sustainable forms of coastal development have yet been invented. Those engaged in negotiating the goals and inventing the institutions to achieve them are therefore engaged in governance, not mere management. However, since the term "management" is embedded in the terms *integrated coastal management* and *adaptive management*, it is difficult to consistently use the two appropriately. Yet the differences are important.

In this chapter, I use the term *ecosystem* to include both nature and its associated human society (see Ngoile et al., this volume). This inclusive definition is a feature of the models of ecosystems offered by Costanza et al. (1997) and the analyses of Lubchenco (1998). As defined by Slocombe (1993), the "ecosystem" implies an overt, systems approach in which human societies are viewed as one element of the planet's living systems. The focus is therefore upon coherent, self-defined, and self-organizing units comprising interdependent ecological, economic, and social components.

Both coastal governance and coastal ecosystems must be conceived as nested systems that range across spatial scales. This requires the successful application of the Subsidiarity Principle which, when applied to coastal ecosystems, calls for placing power and responsibility for planning and decision making at the lowest practical level in the governance hierarchy. Thus, coastal governance can and should be formulated, implemented, and adopted at the scale of individual communities or municipalities as well as at the state (provincial), national, and regional scales. Within individual nations there are major challenges at present that lie in effectively linking the goals, institutional structures, and decision-making processes at the community level with national policy, national plans, and national institutions. In developing nations, one approach to instigating coastal governance termed comanagement, or the two-track approach, adopts a strategy of formulating actions simultaneously at the community and national scales. This strategy typically begins a national coastal management initiative with pilot projects at selected sites that define and analyze the issues that must be addressed and formulate new approaches to resolving them at that small scale. The large amounts of money often invested in these initial pilots is justified on the assumption that success will be replicated and eventually produce a coherent and effective coastal management plan and decision-making procedures that encompasses the nation as a whole. National actions must in turn be integrated to address regional and global problems that require collective action at a multinational scale. This is where international conventions and the initiatives sponsored by the Global Environmental Facility (GEF) come into play. Yet the current reality is that ecosystem governance of all kinds, and coastal governance in particular, are not nested across scales and are full of contradictions and gaps. What does one do? There are arguments among those who advocate top-down approaches and those who argue for bottom-up. I suggest that a combination of the two is required.

The coastal ecosystems (containing both social and ecological components) that are the subject of coastal governance are also nested across spatial scales. Ideally, national and regional ICM should encompass areas that extend from the headwaters of catchments to the outer limits of Exclusive Economic Zones (GESAMP 1996). In practice, much of the best ICM is currently at far smaller scales and addresses only fragments of ecosystems (as in shorefront management that is the focus of many coastal zone management programs in the United States) or individual coral reef/lagoon/seagrass/mangrove systems or estuaries. Efforts to manage large systems are fraught with difficulties as illustrated by efforts in the Baltic and Black Sea (see Mee as well as Elmgren and Larsson, both this volume). Yet some successes are seen at larger scales, such as in the Chesapeake Bay Program and the binational program that has successfully addressed the drastic losses in the qualities of the North American Great Lakes that became apparent in the 1960s. From a global perspective, governance initiatives which attempt to define the changes in human activity needed to conserve the qualities of enclosed seas and gulfs, show much activity in problem analysis and negotiation but little in reversing downward trends. A multitude of small, but linked, local level actions will be needed to produce the desired results. Here again, the long-term goal is to recognize that ecosystems, like governance, are nested together and thrive when there are abundant positive feedback loops across spatial scales.

THE SECOND PILLAR OF ICM: RELIABLE KNOWLEDGE

As suggested by Lee (1993), the second pillar is knowledge on how coastal ecosystems function and change. It is essential to recognize that such “reliable knowledge” must be drawn from both natural and the social sciences and incorporate knowledge derived from the experience of the governance itself. Thus, the knowledge that informs ICM comes from a diversity of sources and may specifically include “traditional knowledge” when this is shown to be based on sound interpretations of observed phenomena and when it offers insights into the beliefs and values of a society.

Science contributes to the coastal management process by providing objective information that makes the debate over contentious issues an informed debate. Science can inform on the status and trends of coastal ecosystems and the causes and consequences of change. Science gives legitimacy to particular policy options or lines of argument. Science does not, however, provide all the answers. However intensively and extensively data are collected, however much we know of how the system functions, the domain of our knowledge of specific ecological and social systems is often small when compared to that of our ignorance. An important challenge of ICM is to cope with the unknown, the uncertain, and the unexpected and to design decision-making systems that can function in the presence of gaps in information and understanding. The reality is that managers must make decisions, whether or not unequivocal scientific information is available. The challenge is to identify, locate, and organize information in ways that will make it accessible and usable in the ICM decision-making process.

THE DIFFICULTIES OF LINKING THE TWO PILLARS OF ADAPTIVE MANAGEMENT

Sustained success in adaptive management requires linking the two pillars, and this involves many difficulties. First, there are major discontinuities in the scales of time and space within which governance cycles and ecosystem change occur. Second, there are the differences in the attitudes, the reward structures, and interests of those who identify with the policy process and those who pursue the rewards of a career as a scientist.

Linking Across Temporal Scales

Holling (1995) describes the process by which ecosystems evolve as a cycle comprising phases of exploitation, conservation, release, and reorganization. This sequence of phases plays out over many scales of time and of space. Thus, the cycle of change in an abandoned field or a pond may be observed over a few decades or less while the completion of a cycle in a watershed may span centuries or millennia.

Perhaps the greatest tension between the two pillars of adaptive management lies in the mismatches between cycles of learning in governance and the cycles by which the coastal ecosystems that are the subject of governance change. One mismatch lies in time. In coastal regions, the expressions of anthropogenic ecosystem change are similar or identical in both tropical and temperate regions, and the impacts on society have been repeatedly documented. The ubiquitous pattern includes reductions in the permanent vegetative cover in a watershed, changes in the volumes, quality, and timing of flows of fresh water to estuaries, reductions in the area of wetlands, destruction or degradation of estuarine habitats of crucial importance to fish and wildlife, overfishing, and severalfold increases in nutrient loading. In temperate regions, the sequence of anthropogenic change has often progressed over many human lifetimes, and "the way it was" (i.e., within the consciousness of the society and those engaged in resource management) spans only a small segment of a cycle of ecosystem change. In the tropics, the sequence is frequently being telescoped into a few decades, and the drama of what is occurring and its implications for society are more obvious. In both settings, the temporal mismatches between the cycles of coastal ecosystem change and cycles of coastal governance are usually large. Yet it is crucially important to locate coastal governance initiatives within the longer-term cycles of ecosystem change. The usual practice is to examine trends in the ecosystem for time periods only somewhat longer than the likely time span of the governance initiative. In politically stable settings, it is common for trends of ecosystem change to be examined over two to four decades, and the governance response is designed to modulate that fraction of the full cycle as if it was isolated from the larger process. In the tropics, where governmental systems tend to be less stable, management initiatives are typically conceived and executed as four- to ten-year "projects." Rather than contributing to a coherent and sustained program of governance, these projects are usually conducted in isolation from one another and are justified and evaluated on impacts discernible in a handful of years. Estimating trends over longer periods may be difficult but is not impossible. Where governance of ecosystems at an intermediate scale is vigorous and has assembled strong constituencies (the Great Lakes, Chesapeake Bay, The Netherlands), placing governance as a response to change over longer periods has been crucially important.

Linking Across Spatial Scales

Equally important are mismatches in spatial scale. Protecting an individual wetland and regulating the outflows of polluting industries along an estuary has a minor impact when nonpoint pollution flows and change to the hydraulics of a watershed by the construction of dams, logging operations, and the like neutralize the impacts of localized efforts. Thus, better integration of both reliable knowledge and governance across scales of space and time is essential. Modeling can fill this need especially when it helps integrate our understanding of the implications of coastal ecosystem change and governance options across scales of space and time.

Involving Scientists in the Governance Process

The second cluster of difficulties lies in the realm of differences in the values, knowledge, and skills of managers, planners, and politicians in the first pillar and scientists in the second. These differences and their consequences have recently been examined in several reports and articles (e.g., GESAMP 1996; NRC 1995, 1997). The consequences of the differences can be examined as they relate to the different actions associated with each step in the ICM policy cycle and how these, in turn, affect the success of completing a full cycle of coastal governance and linking it to a subsequent generation of effort. One of the many hurdles lies in understanding the importance of political salience. Herein lie the reasons why so many analyses of coastal issues and technically sound coastal management plans fail to gain the official endorsements and win the institutional commitments and funds required for implementing a plan of action. These crucial events play out in Step 3. Success lies first in gaining a place on the political agenda, defined by Kingdon (1995) as "the list of subjects or problems to which government officials, and people outside of government closely associated with those officials, are paying some serious attention at any given time." To win such attention, a coastal governance initiative must be perceived by a sufficiently large and powerful constituency as important. Furthermore, the proposed course of actions must be seen to be feasible and its likely consequences sufficiently attractive to reward those responsible for making it happen. Judgments are made as much on the basis of values and beliefs than "the facts of the matter." Furthermore, formal adoption of a new coastal governance program typically affects the distribution of authority and power among institutions, interest groups, and politicians. This triggers defensive behavior and bureaucratic maneuvering. This process is highly distasteful and mysterious to many natural scientists. It does not help that scientists are not professionally rewarded for becoming involved in these critical elements of the governance process (Lubchenco 1998).

CONDITIONS THAT FOSTER SUCCESSFUL LINKING

Boesch (1996, 1999) has identified factors that contribute most directly to a successful interpretation of science into a sustained coastal governance process. These, with minor modifications, can be stated as follows:

1. *Evidence of significant change*. Coastal management initiatives are triggered by change in a coastal ecosystem. Such change can be in the form of both threats and opportunities and must be perceived to be significant enough to warrant the attention of society.
2. *Reliable and valid indicators have been selected* and information on those indicators has been assembled to analyze and communicate the processes of change that the initiative will attempt to address.
3. *A measure of consensus exists within the scientific community.* Action will seldom be justified in the face of major, well-substantiated differences on the significance of the change, its likely causes, and its potential implications for society.
4. *Forecasting capabilities exist*, often in the form of models that serve to motivate and guide management actions.
5. *Effective and feasible responses* to change are known, operationally feasible, and the constituencies that will work to implement them are present.

It is instructive to place this set of preconditions for the success of the integration of science within the six preconditions critical to the successful implementation of a program identified by Mazmanian and Sabatier (1979, 1981). These preconditions suggest that only the first two of the six success factors concern the relationship between the first and second pillar:

1. Clear and consistent policy objectives
2. Convincing science in support of those objectives
3. Sufficient jurisdiction and authority
4. Good implementation structures
5. Competent and committed staff
6. A priority position on the policy agenda

A highly respected social scientist, Elenor Ostrom (1999), who analyzed the governance of common property resources, reaffirms the crucial importance of indicators that provide reliable and valid information to characterize the condition of a resource or ecosystem. She also emphasizes the importance of predictability — even if it is limited to predicting that the resources or ecosystem qualities of concern will be present long enough to warrant a management initiative.

These insights on preconditions to success in both science and governance help us understand why progress is so elusive in the vast majority of the world's coastal regions. Particularly in developing nations, reliable documentation of change early on in the transformation process is seldom available, even when such change is obvious to local residents. Reliable data that traces changes in, for example, vegetative cover, water quality, the abundance of estuarine fish and shellfish, frequently does not exist. Similarly, Mazmanian and Sabatier's success factors for implementation can rarely be met along tropical coastlines and are also difficult to achieve in many politically stable, wealthy nations. Worse yet, "reliable and valid indicators" have been identified in only a few instances. What are indicators for the condition of an estuary, a wetland, or watershed? To be useful, the protocols for collecting and analyzing the necessary data must be agreed upon and achievable at a reasonable cost. We are far from agreeing on what indicators should be tracked and what frequencies of sampling are necessary to estimate change across a sequence of scales. In the tropics, where agreement on such basics is most urgently needed, models of ecosystems, or of components of ecosystems that can be used to forecast "what if" scenarios, are rarely available to coastal managers. Little wonder that scientists tend to feel isolated from the ongoing governance process and decision making that determines the trajectory of coastal development.

FIRST STEPS IN CONSTRUCTING THE LINTEL THAT LINKS THE TWO PILLARS

The lintel that must join coastal science with coastal governance is absent, or weakest, in developing nations, where anthropogenic change to coastal systems is proceeding most rapidly. Reflecting on the enabling conditions that are conducive to progress towards effective ecosystem governance, three categories of actions emerge as potentially fruitful if we are to overcome the current difficulties:

1. *Selection of Indicators for the Documentation of Trends in Ecosystem Quality.* There are three interrelated needs:
   a. To broker a measure of consensus with the community of natural scientists concerned with coastal ecosystem change on a set of valid and reliable indicators that can be used responsibly and at a reasonable cost to document change in the qualities of coastal ecosystems.
   b. To develop standardized visual methods for conveying trends of coastal change to the public and to decision-makers that document and compare both the societal and natural components of coastal ecosystems.
   c. To promote the formulation and testing of indices of coastal ecosystem condition that combine sets of social and environmental variables into composite measures.

There are techniques for conveying change in natural components that display complex data in easy-to-grasp pictorial forms. These may be adaptable to developing country contexts. For example, in the U.S., the Environmental Protection Agency (EPA) has developed a simplified "report card" format that color-codes variables indicative of ecosystem conditions in estuaries and rivers. Red is used to highlight variables that are of greatest concern or are trending in an undesirable direction. Orange warns of variables that are in transition from one condition to another while green denotes acceptable and stable. The Dutch Ministry of Transport, Public Works, and Water Management (1989) has used the "AMOEBA concept" (Colijn and Reise, this volume) to portray graphically shifts in the abundance of categories of life forms since a baseline year in the 1930s.

In the social sciences, a consensus has emerged on reliable and valid indicators for assessing trends in the condition of a human population (child mortality, life expectancy, literacy). There is, however, no consensus among natural scientists on a comparable set of indicators for gauging for the condition of the "natural" components of coastal ecosystems. These indicators are urgently needed. Creating the conditions for sustained data gathering and data analysis on such indicators is another priority. This requires designing systems for tracking change in ecosystem qualities that allows for nesting analysis across spatial scales. In many developing nations, a combination of citizen monitoring and remote sensing technology could prove to be a powerful combination; however, to my knowledge, this has not yet been attempted as a strategy for documenting change in coastal ecosystems.

If such indicators had been selected, and trend data for them had been assembled, we could make the critically important comparisons between trends in the "natural" elements of ecosystems with trends in the associated human population. At present, convincing natural scientists that both data sets are important and such comparative analysis is useful is surprisingly difficult. For example, an effort has been underway for several years to negotiate a consensus among the community of coral reef scientists so that trends in reef condition worldwide can be documented in a similar enough manner to permit the aggregation of data on condition and trends at regional and global scales (McManus and Vergara 1998). It is proving difficult, however, to persuade the natural scientists involved in this effort to integrate social and governance variables into this system.

Another step is to integrate sets of variables for both "natural" and societal components into indices of ecosystem condition. Here again, social scientists and public health professionals have generated various indices, such as the United Nations' Human Development Index, that are useful when attempting to draw conclusions on progress or its absence. However, indices appropriate for tracking change in the condition of coastal environments, or that combine the natural and societal components of coastal ecosystems, are not being used in coastal governance practice.

2. *Developing Forecasting Capabilities.* In developing nations, where economic growth at almost any cost predominates, it is critically important to increase the scope of the messages that natural scientists are delivering to politicians and society. Too often these messages are a confirmation and documentation of past mistakes and "bad news" that comes from analyzing change that has already occurred. Greater efforts are needed in responsible forecasting — especially where such forecasting integrates across the natural and societal components of ecosystems. When natural scientists do get involved in governance decision making, they are often placed in the position of opposing development options because they see negative consequences for biodiversity, water quality, or habitats important to species other than our own. Often the linkages and interdependencies of their concerns with the societal variables that are usually of greatest concern to politicians and bureaucrats are weak or missing. Using simple trend projections and models to forecast the impacts of typical options in the development path could increase the salience of the messages being delivered by the scientific community into the governance process.

Experience in the governance of estuaries and their watersheds in the United States has demonstrated the power of such analysis. The EPA (1992) has developed ecological risk assessment frameworks and these are examples of simulation models for such variables as water quality and the impacts of hurricanes. In developing countries, where the magnitude and pace of change is greater, such tools are almost unknown. Where they do exist, they usually have been developed to assess the impacts of one-of-a-kind engineering proposals, e.g., a major dam project proposed by an international institution such as a development bank.

3. *A Typology of Contexts for Coastal Governance*. As the density of people in coastal regions and the intensity of human activities both increase, coastal ecosystems appear to progress through a predictable sequence of governance contexts along a natural to engineered ecosystem continuum. If this hypothesis is correct, a typology of coastal governance contexts could be developed to guide the science and the governance that are most likely to be appropriate and feasible for different contexts. An important task is to examine the winners and losers — in terms of both the natural ecosystem and the human society — that are associated with each step along the continuum.

In conclusion, the construction of a stronger connection, or lintel, that unites the governance process (ICM) with reliable knowledge (the sciences) will require agreement on the indicators by which the changing condition of ecosystems can be assessed. Such indicators will be most salient to all those involved in coastal governance when they integrate societal with environmental parameters, either as indices or by visual techniques that reinforce the interdependencies between the societal and the environmental realms. It is the acceptance and use of such objectively verifiable and reliable indicators that provides a shared language and sense of common purpose among professionals collaborating in more mature endeavors such as public health and economic development.

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