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Resource Development Planning for U.S.-Affiliated Islands

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INTRODUCTION

The small size of islands, and consequent scarcity of land and resources makes it undesirable and probably infeasible to concentrate human populations and activities on ever smaller areas of land, Similarly, although some resource recovery efforts are needed, small populations and economies disallow expense of large amounts of scarce capital and labor on artificial provision of environmental services or continuous reclamation of degraded areas. Clearly, the preferred alternative is to prevent degradation of the island ecosystem, Through application of rational management activities, ecosystem benefits may be sustained over the long term.

Resource management refers to decisions of policy or practices regarding how resources are allocated and under what conditions (or arrangements) resources may be developed (30). Resource management includes both **planning** activities in which resource management objectives and techniques for achieving those objectives are systematically identified and **implementation** activities in which specific management techniques are used to allocate resources among uses (and users) (25)

Planning processes typically involve several steps:

1. identification of some goal to be achieved (or problem to be mitigated),
2. identification of alternative ways in which the goal can be achieved,
3. evaluation of these alternatives,
4. choice of a strategy, and
5. specification of how that strategy is to be implemented (25).

In the development of resource management programs, there are three levels of planning: policy, program, and project. **Policy** planning refers to the broad choices that must be made among multiple and frequently competing resource management objectives. At this level the questions to be answered are explicitly value choices. In practice, such policy choices commonly are expressed in terms of 5-year development plans, State policy plans, or similar documents. Such policy statements provide some indication of a general awareness of resource management problems as well as the emphasis that such problems should receive. There are, however, no guarantees that resource management problems will receive systematic management attention (25)

Program planning refers to the identification and evaluation of alternative ways to achieve some resource management objective. A partial list of such techniques includes zoning, tax incentives, or direct subsidies to resource owners to maintain certain resource uses (e. g., agriculture, protected habitat), outright purchase of development rights to lands, and performance standards for certain uses. All of these management techniques have been or are currently being employed in a number of U.S. continental States (25).

Project planning is sometimes used to describe the detailed administrative guidelines and procedures for implementing a particular management strategy, or the detailed specification of a particular resource use consistent with resource management program objectives (25).

Policy, program, and project planning require different kinds of information and analysis. Policy planning must address a mix of value and empirical questions. As planning becomes more specific there are fewer explicitly value issues and more empirical questions (25).

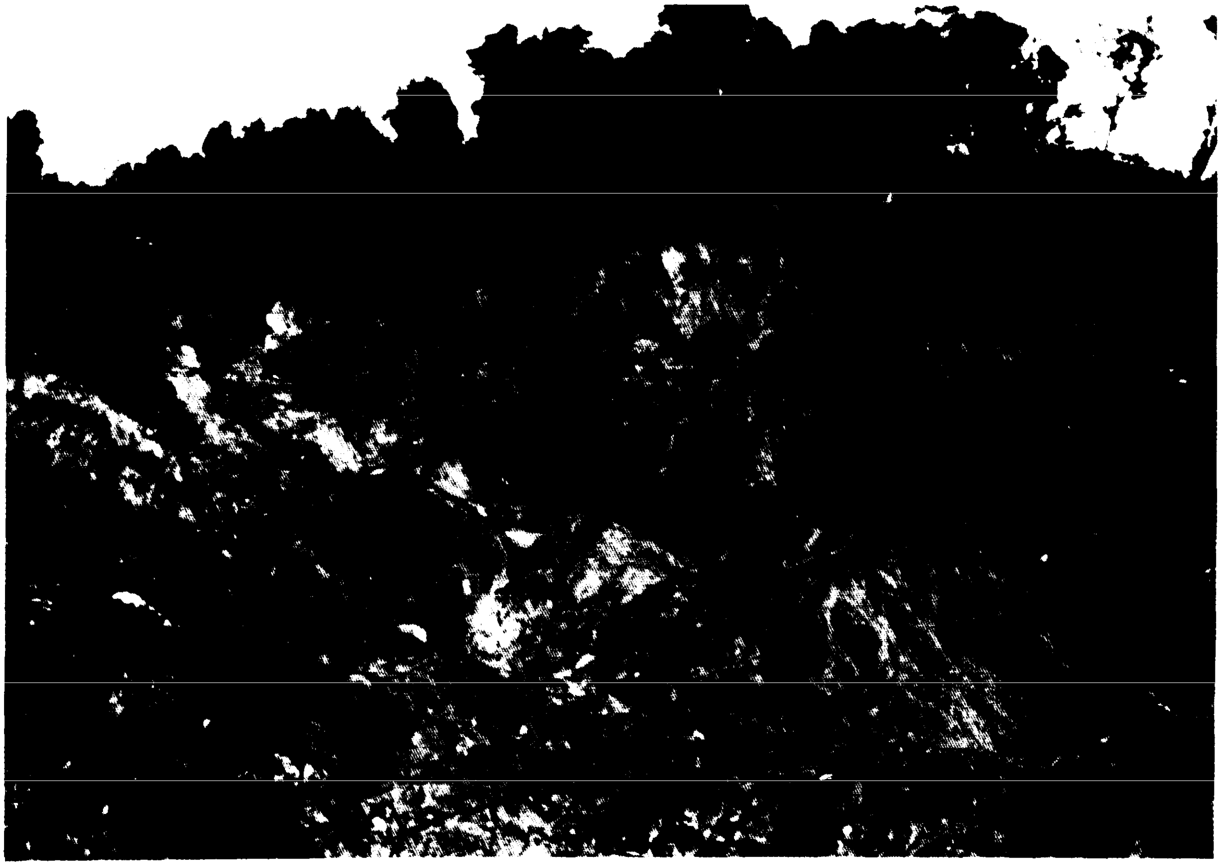


Photo credit: J. Bauer

Landslides, a common hazard on tropical high islands, may be promoted by inappropriate land use such as hillside construction or agricultural cultivation in erosion-prone areas.

Basic information and the appropriate technologies for analyzing that information are widely agreed to be a fundamental requirement for successful resource management (3). However, the types of information collected and stored, the types of analysis performed and how these activities should be integrated into resource management programs depend on the nature of the resource management problems confronted by an island, the degree of geographic specificity in planning and management efforts to deal with these issues, and the particular management techniques that are being employed for problem mitigation.

Resource Planning Goals for U.S.-Affiliated Islands

Island resource systems exist in close proximity and are strongly interrelated. Decisions that affect one resource are likely to affect other "downstream" resources. For example, conversion of island forests to agriculture, or removal of mangrove habitat for the purposes of coastal development can lead to degradation of reef areas through increased siltation. Conversely, mining of reefs, which act as natural wave energy and storm surge buffers, may lead to increased erosion or other damage to coastal areas, Integrated management of natural systems requires thorough knowledge of the interrelationships between resource systems. These interrelationships are often critical to the functioning of the whole island system (11).

Natural systems management problems are usually perceived in two ways: 1) as the **consequences** of particular resource uses, or 2) as **conflicts** over alternative resource uses. Accordingly, two general approaches exist to resource planning:

1. A use in mind; where to do it or put it?
2. A particular resource or an area of land; what to do with it?

The first approach is a frequently used, single-purpose planning methodology, After having established need and other socioeconomic considerations, the process involves translating use requirements into biological and physical (biophysical) site-selection criteria. As perceived resource values change, this has increasingly become a question of "where not to put it?" Overlay maps showing areas of high economic, social, or cultural value plus physical impediments commonly are used in a technique advocated by McHarg (29) to show where development would adversely affect the least number of community-determined values (18).

The second approach is relevant where a landowner, administrator, or manager wants to assess the resources under his jurisdiction and determine if an area is allocated to the most productive sustainable uses. To a limited extent, this planning approach may be taken by a private landowner who has flexibility in his operation, surplus resources, and usually substantial areas of land. It is not characteristic of tradition-bound agriculturists or pastoralists living at or near subsistence levels, nor of corporate landowners with a narrow mandate and large plant investment to protect through using products from the land (e.g., pulp and paper company). It does, however, often characterize the planning and management of public lands (excluding military lands or nature reserves). Countries undergoing rapid increases in population are adopting the approach of looking at the limited land estate and asking what to do with it to promote national economic and human well-being (18).

Both approaches are predicated on concerns about the long-term ability of the resources to provide goods and services **efficiently** and **safely. Efficient** resource uses are keyed to the natural constraints of a site. Such uses generally are efficient in maintaining a flow of goods (e.g., crops) and services (e.g., watershed protection), although there are exceptions where a higher flow may be provided efficiently by overcoming minor physical limitations (e.g., by improving drainage in soils). **Safe** uses build in an avoidance of ecological backlash (e.g., avoid unstable slopes, flood-prone areas—unless one wants to take a risk or alter the site by making corrective investments) (18).

Planning Needs and Constraints[1]

Each U.S.-affiliated island government has designated a planning office. In general, these offices are responsible for compiling information on factors affecting the economic development of these islands, presenting a framework for decisionmaking by island leaders, planners, and the public and advising their governments on rational development planning.

Some of these planning offices also are responsible for maintaining libraries and bibliographies of information for use by government personnel and the public. For example, the Guam Bureau of Planning has established a cataloged Planning Library to assist people conducting research on Guam. A Coastal Planning Bibliography was produced in 1978 in association with the development of the Guam Coastal Zone Management Plan, and a "Guam Inventory of Planning Information" was prepared in 1976 and updated in 1981 (17).

[1]The Office of Technology Assessment conducted a survey of resource development planning and management offices in U. S.-affiliated islands in April 1986. Respondents were asked to comment on how important they perceive the planning constraints identified by Lowry (25), whether their office uses any of the analytic techniques described, and the actions they think would do the most to improve resource development planning on their island. Of the 80 surveys sent out, only 8 were returned.

A number of plans analyzing resource management and impacts of development activities have been prepared in each island area either by internal planning offices, in cooperation with the Department of Commerce through development of Coastal Zone Management plans, or by the United Nations. Unfortunately, different plans are rarely centralized or aggregated. The Freely Associated States (FAS) were required to prepare 5-year comprehensive development plans under the terms of the Compact of Free Association. These plans commonly describe goals and problems, but tend to remain so general that they provide little guidance for island decisionmakers to evaluate potential projects.

Although ample evidence exists that improved resource management is unlikely in the absence of planning, it cannot ensure sustainable resource management. Planning processes may go awry for a number of reasons, including:

- lack of resources for planning,
- inadequate planning expertise "in-house" and heavy demand on existing island planners,
- lack of data for planning,
- lack of understanding of natural processes,
- lack of understanding of the social and political contexts in which plans are to be implemented.
- inadequate problem specification,
- inadequate specification of management alternatives, and
- use of planning as a substitute for management.

Lack of Resources for Planning

Lack of resources for planning is a common constraint on U.S.-affiliated islands. Planning requires a substantial amount of skilled personnel, information, and time. Those resources frequently are not available for resource system planning or, when they are available, they may be diverted to other planning enterprises that show more promise of immediate payoffs.

Inadequate Planning Expertise

The number of people involved in planning on the islands and their total years of experience are limited. Resource planning and management offices in the FAS, for example, are understaffed; they lack resource data and exercise little regulatory authority (app. F). Environmental protection boards in the FAS have not effectively compelled developers to evaluate alternate sites and procedures. Outside expertise is needed, at least initially, to help train planners and to plan and evaluate specific development proposals.

Lack of Data for Planning

A further constraint is posed by the lack of reliable data on almost all aspects of the economic and population structures of the islands. Census data commonly are suspect and many other data have not been collected. The unavailability of such data presents considerable problems for development planning (8).

While some insular polities have gathered extensive data and developed data management systems, others are still in need of basic information. Regardless of the island's level of data management development, an overall need still exists for further information gathering and research on basic biological systems, as well as improved data management and communication systems (app. F).

Detailed economic development planning, including identification of manpower and manpower training needs, is required to instigate any significant movement towards self-reliance (8). However, collection and analysis of many data are largely beyond the current capabilities of many insular government planning offices, especially since each government agency commonly collects information specific to its own functions. These data may not be collected for each island or island region within a territory, may not be standardized to allow aggregation, and may not be integrated into one system (5,6, 7,8,9,10).

Lack of Understanding of Natural Processes

Designing a resource management program requires a basic understanding of cause and effect relationships of biological and physical processes. Ignorance of such relationships can give rise to unexpected and sometimes severe unintended impacts. In addition to inadequate baseline biological data for organisms or resources to be managed, this appears to be an important constraint confronting island planners and resource managers.

Lack of Understanding of the Social and Political Contexts in Which Plans Are To Be Impemented

A central problem in the evaluation of management alternatives is the question of which values (or whose values) will be used to assess the worth of proposed management strategies. If the management alternatives do not reflect the values of those who are most affected by the plan, the effectiveness of management efforts are likely to be undermined. The evaluation of alternatives is particularly critical in island environments in which the values of the planners may be different from those of would-be "clients."

One way of ensuring that the choice of management strategies reflects the values of clientele is to involve them more intimately in planning processes. However, such involvement need not take the form of public hearings at which clientele may respond to a completed plan—a conventional strategy of "citizen participation" used in U.S. community planning processes of the 1960s and 1970s. To the extent that resource management programs do not reflect island values regarding man/environment relationships or cannot, through a process of community education, be shown to be consistent with those values, they are not likely to be successful (25).

Inadequate Problem Specification

In developing a resource systems management program, the possibility of inadequate problem specification always exists—of focusing on the wrong problem. For example, rather than identifying a problem as its underlying cause (e.g., overpopulation), it maybe more useful to define the problem by its adverse effects related to the underlying cause (e. g., resource overexploitation). In specifying resource management issues to be addressed, the central question should be: what adverse conditions need to be avoided or reversed?

inadequate Specification of Management Alternatives

Many contemporary resource management programs are "technique-driven" rather than "issue-driven." Often some particular management technique is touted as the management technique to be employed with particular resource management problems. Too little attention is paid to other alternatives or to the particular political and social context within which a resource management technique will be employed.

Use of Planning as a Substitute for Management

Planning sometimes becomes a substitute for management because it was hoped that the activity would be a catalyst for generating public support for resource management activities that would be socially or politically divisive. When that support fails to materialize, the "plans" are left unimplemented. Planning activities also may be encouraged as symbolic activities to reassure people that "something is being done" about some problem or condition,

RESOURCE DATA COLLECTION AND INFORMATION MANAGEMENT

Most resource planning techniques require a number of "sub-assessments" each requiring different types of information necessary to the formation of effective management plans, including:

1. *Biophysical* assessment—requiring information on factors affecting the physical and biological suitability of a site for various uses, including climate, geomorphology and geology, soils, flora, and fauna. This information can be used directly for site selection; after identification of the desired resource activity, the planner identifies constraints that could inhibit that resource use and looks for sites where the constraints do not exist or are manageable (36).

2. *Land classification-the* objectives of land classification are to identify the resources of a given area, determine appropriate management practices for existing resource uses, and predict the consequences of proposed changes in land use and policies (36). Overlay mapping techniques commonly are used to select sites for particular land uses. One such technique is to produce maps using white, black, or shades of gray to show the suitability of locations for specific types of development. The suitability ratings are combined by superimposing the maps, either manually or by computer, and examining the distributions of shading intensities.

Land classification techniques assume natural system relationships are determined by land physiography. Such techniques can be helpful in resource development planning, but they have limitations. Some systems are oriented toward a particular land use such as agriculture and, therefore, tend to assess suitability for that use rather than overall resource suitability. No single land classification system measures resource productivity directly; this would be too costly and time-consuming. Some techniques are more appropriate for use in ecological studies than for helping decisionmakers with land management questions. None of the techniques identifies the direct or indirect biophysical impacts of land use conversions. Moreover, the techniques neglect gradual changes in biophysical factors that can eventually limit various resource uses. Unless combined with simulation modeling, these techniques do not reflect changes in the magnitude of types of impacts over time (36).

Data on tropical ecosystems, both terrestrial and marine, are insufficient for many planning needs. Resource management and development for sustained yields requires up-to-date baseline data on current resource use patterns and the distribution and status of natural ecosystems. without such information, it is impossible to determine the capabilities of each resource for supporting various types of uses, or to predict the consequences of various resource use decisions on island ecosystems and populations.

Ecological Baseline Surveys

Many jurisdictions rely heavily on environmental impact statements to provide basic information about the condition of natural systems at a given time. However, when subsequent developments are planned in the same area, a new environmental impact assessment is made and much of the same information is gathered again, with resultant duplication of effort (and waste of scarce resources) (2). One alternative would be to design and manage environmental assessments so as to contribute to a central database which could then be used to prepare future EISs, thus minimizing duplication. However, care must be taken to ensure that the information in the central database is updated to reflect changes in land use or resource systems.

A second alternative would be to put increased emphasis on development of ecological baseline surveys which incorporate a "comprehensive appraisal of important natural systems parameters at a given time" (2). Resource inventories which identify natural resources in specific geographic areas and indicate their quality and variety commonly are part of an ecological baseline study. The principal uses of such information are in the preparation of land and water use plans and other program plans, project assessments, environmental impact assessments, area plans, and permit decisions.

The primary obstacle to development of ecological baseline surveys is cost of data collection, storage, and retrieval. The greater the number of variables and the greater the geographic scope, the more expensive it is to measure comprehensive resource data. One way to analyze cost-effectiveness of collection procedures and data parameters is to proceed with a "test case" by: 1) seeking interagency agreement about what parameters to collect, and 2) collecting information for a well-defined geographic area where resource use is high. This makes it possible to examine the utility of the information collected as well as the costs and skill requirements for collection.

Data storage and retrieval systems also may be costly. To avoid costly duplication, a scale must be chosen for mapped data that is appropriate for different users. Detailed mapping of the sort that is useful for permit decisions may result in maps that are too cumbersome for other uses. Some information may be stored and exchanged electronically, but a great deal of advance preparation may be needed to develop formats for storage (25).

Monitoring

Environmental monitoring refers to periodic measurements of natural resources and environmental quality parameters to allow analysis of trends or departures from a standard (usually predevelopment) which result from either natural causes or human activities (2). For many projects, the preproject planning phase is the only time when a substantial effort is made to determine how the project's products and services will contribute to larger development goals (36) and when data are collected on the resources and resource uses that are likely to be affected by the project. Monitoring, on the other hand, takes place during implementation and is intended to meet the needs of day-to-day project management. It can indicate a need to change the timetable, scale, geographic location, resource allocation, or staffing of activities (36). The difficulties in developing and maintaining a monitoring system are comparable to those of developing and maintaining ecological baseline studies.

Data Management

Within many governments, data are collected by more than one agency, sometimes leading to unnecessary duplication. Further, such information commonly is not centralized and may not be exchanged between agencies in the government. Data may be collected in different formats and at different scales, making use of the information difficult without expensive reformatting, In some cases, mapping and data collection are not comprehensive (app. F); and scales are not consistent within a territory, or even within individual agencies in the same territory (31).

An institutional Structure for Data Management

Some opportunities exist for alleviating the problem by reorganizing responsibilities for environmental data collection. A separate department or ministry might be responsible for the environment including setting standards for uniform methods of data collection, scales, and formats, which all other departments would be obligated to follow. The environmental ministry would also be responsible for obtaining and maintaining a national or territorial database, as well as conducting the needed monitoring of key data elements. A second possibility is to organize all environmental data collection under one agency responsible for national mapping. Ministries concerned with specific projects requiring baseline data would then request the national mapping organization to carry out the needed surveys. A third alternative is to leave organizations as they are now but ensure coordination among them and uniformity of environmental information by forming a coordinating committee. It would probably be wise for the coordinating committee to have its own separate staff of a small number of qualified environmental scientists who would advise on methods, techniques, scales, precision standards, and time intervals for collecting data.

An organizational structure that assures that needed data are collected and made available to all agencies, without duplication or nonuniform methods and standards is needed for sustainable resource management. Environmental data are too important and expensive to collect, to let duplication, incompatible formats and scales, and other obstacles hinder the most efficient use of information *(31).*

Resource Data Management Systems

Almost every Federal policy statement, whether legislation, executive orders, or agency guidelines, contains some requirements for data collection and monitoring (l). Most regulatory permit programs also contain data collection requirements. However, few provisions exist for updating or aggregating data. Comprehensive resource planning systems, such as geographic information systems, can centralize the storage and processing of spatial data reducing duplication, and thus, costs (20).

Many States have adopted the map overlay system developed by McHarg in *1969,* in which resources important to the decision to be made are identified, located, and mapped. By superimposing maps, areas containing many valued resources show up as dark-colored areas and areas whose resources are less affected by the proposed development show up as light colored areas. This system, however, depends on the planner's judgment as to which resources are valued and assumes that all are equally important. Much labor, time, and money also are required for map preparation and minor changes in methods or values may often necessitate complete redrafting (24).

In recent years, many local governments have graduated to computerized systems in which the maps are transformed to databases linked to a spatially divided base map. Thus, data can be updated easily, and a great number of variables can be considered in analysis. From these computerized geographic information systems, maps can be "overlain" by the computer with relatively little difficulty to produce composite maps (cf: METLAND system). A computer model can also be used to weigh the various land factors according to some measure of their importance to development to produce a capability map (20)

Feeding inventory and monitoring data into the physical and economic planning process can be relatively simple; in fact, there is a danger of imposing procedures that are unnecessarily cumbersome for island communities. Ideally, a microcomputer could be programmed to process data and present it in simple form to island planners *(11).*

ANALYTIC TECHNIQUES FOR RESOURCE DEVELOPMENT PLANNING

Analytical techniques for resource development planning are methods of manipulating data to generate and analyze information for resource management. Given the current dearth of data and skilled personnel on some U.S.-affiliated islands, analytical resource planning techniques should be inexpensive, should not require a great deal of baseline data, and should not be too complicated or sophisticated *(18).* In addition, the technique should make it clear that resource use decisions will depend on land tenure, needs, skills, available resources to invest, cultural constraints, political goals, and other factors besides biophysical suitability.

Environmental Impact Assessment

The National Environmental Policy Act requires the preparation of environmental impact statements (EISs) for "significant" Federal actions such as the construction of ports and airfields. Some States have additional EIS requirements covering certain land and water uses and/or all uses in select geographic areas.

EISs are preproject reports on possible positive/negative short- and long-term impacts resulting from some public or private policy, program, or project. The central assumption of EIS requirements is that cause and effect relationships between project activities and resource conditions can be identified with sufficient certainty to make them a valuable tool for analysis and decisionmaking. Continuous monitoring and evaluation provide mechanisms for EIS-based planning to deal with uncertainty (14), but these are only rarely practiced in the islands,

Environmental impact statements usually emphasize potential impacts on natural systems, but some jurisdictions require more extensive analysis including potential impacts on publicly funded infrastructure, historic and archeological resources, and demographic and other social and economic conditions. Most environmental assessments contain at least the following elements:

1. a description of the proposed project or activity;
2. identification of selected alternatives to the proposed project or activity;
3. description of the existing conditions (natural, social) at the proposed project site; and
4. identification of the nature and magnitude of possible project impacts at the proposed site.

Some jurisdictions also require identification of trade-offs or possible mitigative actions.

Environmental impact analysis is a short-term investigation of the likely impacts of previously identified policy or project options and, thus, does not permit evaluation of the full range of development alternatives (14). If resource planning began by incorporating the appropriate environmental and resource capability information, EISs might be rendered redundant *(18),*

Resource Suitability Analysis

Resource suitability or capability analyses provide information about the supply of resources at various levels of suitability for various uses. Such analyses generally involve delineating landscape (or seascape) units on a map, or an air photo and assessing the capability of these areas to sustain an array of potential uses without unacceptable degradation and given certain levels of management and technology *(18) (see* fig. *9-1* on p. 342). Land suitability analyses, the most common form, include agricultural classification systems and hazard maps charting flood zones or landslide areas. More complex suitability maps have been developed using multiple land characteristics, but the costs of developing such information are high and the results frequently are mixed.

Resource suitability analysis usually involves several steps:

1. identification of the uses for which suitability is being determined (e.g., agriculture, low-density housing);
2. identification of the biophysical attributes of the area in question that significantly affect suitability (e.g., soil type, slope, depth to bedrock);
3. identification of the significant categories of each attribute (e. g., slopes less than 10 degrees, between 10 and *30* degrees, over 30 degrees);
4. determination of the degree of importance of each biophysical attribute and each subcategory of that attribute to suitability of the resource uses in question;
5. development of a rating system that makes it possible to combine biophysical attributes into an index of suitability for potential land uses on different land or sea areal units; and
6. expression of these indices on maps,

The areal units identified should be part of a hierarchical system of land classification, so that they can be aggregated for general planning purposes, or subdivided for detailed on-site work. In predicting response, and then suitability, levels of most likely management inputs are assumed, and these can be varied for any socioeconomic situation with a cultural context *(18)*.

A central problem in constructing resource suitability maps is in developing methods for combining resource attributes in ways that are practical, technically correct, and easy to understand and communicate. Three basic approaches are used: mathematical combination, regional identification, and logical combination (21). Mathematical combination involves assigning weights to each biophysical attribute and then calculating weighted averages. Because underlying relationships among attributes commonly are poorly understood and do not, in practice, lend themselves to easy application in standard resource management, the mathematical approach generally is not applicable to island resource management. The regional identification approach involves identifying subregions within a larger geographical area that are homogeneous with regard to important attributes, and then identifying the suitability of each type of subregion for various resource uses.

The logical combination approach assigns suitabilities to sets of attributes (rather than single attributes) which are expressed in terms of verbal logic rather than in quantitative indices. For example, a set of simple rules can be derived that take into consideration the interdependence of slope, soil permeability, and subsurface material in determining suitability for hillside residential development. The logical combination approach to suitability analysis would seem to offer the most promise in island contexts; the rules are explicit, can be developed on the basis of known interdependent attributes and are easy to communicate (25).

The task of predicting suitability for an array of uses is the most difficult part of the process. At this stage, it is necessary to incorporate information on prevailing or likely resource management practices of the future users, and the resulting likely output for each array of potentially feasible uses. Assumptions must be made as to the likelihood of remedial measures being instituted to modify land attributes (e.g., terraces to “correct” steep slopes). Such things as custom, economics, skills, innovativeness, likely technology, and institutions come into play in making the rating. Although based in science, these interpretations are certainly partly intuitive (18).

No judgments are made as to which use is the “best” or most appropriate for a given planning unit. No master plan results. Rather, there may be several uses that can be easily sustained on a given unit of the landscape. The decision as to which use will depend on many factors such as resource tenure, needs, skills, available resources, or political plans for development. A change in technology (e.g., a new method of making terraces) may alter the suitability rating as would development of a new market. Thus, resource suitability rating is specific to the general area under planning scrutiny, and may be quite different for similar biophysical units in different watersheds or for ones close to urban centers as opposed to ones in remote areas *(18)*.

Ecologically based planning, if properly done, indicates an array of uses which are suitable and an array of uses which are not sustainable and, hence, not suitable. The specific sustainable use for a unit of land, and the mosaic of uses on several units or an entire watershed will be determined by those close to the land who have more detailed knowledge of their own goals and lifestyles, whether the land is managed by a government office, a cooperative, or a group of individual landholders *(18)*.

Although developing land suitability maps for island resource management may be appropriate and useful, a more immediate application may be ocean and nearshore suitability analyses. The same principles of logical combination of interdependent attributes might also be used for mapping nearshore areas suitable (and unsuitable) for various types of ocean-dependent uses.

Carrying Capacity

Carrying capacity analysis, when extended from its original use in determining the number of range animals capable of surviving on a piece of land to the optimal human population that can be supported at given levels of technology and amenity, has been infrequently applied. Islands would seem to be ideal contexts for application of the carrying capacity concept because the analyst is dealing with relatively closed natural systems.

The basic steps of carrying capacity analyses include:

1. identification of major systems necessary for regional development;
2. identification of geographic areas for application of carrying capacity analyses;
3. definition of limits of "critical systems" (i.e., those systems with capacities that have been exceeded or are close to overload conditions);
4. measurement of current use of critical systems; and
5. determination of the margins for growth.

Carrying capacity studies were performed in Hawaii in the 1970s in response to a legislative resolution requesting that the governor and the Department of Planning and Economic Development establish criteria which could then be used to limit, restrain, or redirect the State's growth (25). In general, these studies were complex and expensive without revealing the "critical thresholds" for resource use. Carrying capacity was not particularly useful in providing a scientifically determined population limit for particular geographic areas although it was somewhat useful in substantiating critical resource use decisions (19,26).

Benefit-Cost Analysis

Benefit-cost analysis originated in connection with the assessment of U.S. Federal flood control projects in the mid-1930s. The technology has since developed to handle more than merely the direct costs and direct benefits of water resources projects. Under the name of extended benefit-cost analysis, the methodology now attempts to encompass the array of secondary and intangible benefits and costs (22). Proponents of extended benefit-cost analysis claim that it can (13):

1. provide an orderly, systematic way to analyze a problem;
2. provide a "neutral" approach;
3. illustrate the benefits and costs of alternative land uses;
4. clarify the question of determining project boundary;
5. attempt to include the benefits and costs of unintended beneficial or adverse effects of the proposed action (externalities);
6. attempt to include intangibles; and
7. raise questions of provision of goods, services, and development options between current and future generations (intergenerational equity) (13).

This method incorporates value judgments regarding unquantifiable variables (e.g., esthetics) and social preferences, thus requiring participation by potentially affected groups as well as experts and decisionmakers. Few guidelines exist for implementing this kind of participatory planning because of the great variation in forms of economies and government, cultural backgrounds, and traditions.

Multi-Objective Analysis

Once information is available on the likely biophysical, economic, and sociocultural aspects of a development project, decisionmakers need some way to judge the relative importance of the findings. Too frequently, decisionmakers avoid confronting trade-offs among conflicting objectives and only consider the most obvious or serious effects. Considerable progress has been made in the last two decades in developing multi-objective techniques that address these trade-offs (4,32).

Multi-objective planning is broader than more traditional single-objective approaches, such as benefit-cost analysis, which require that all the effects of alternative projects be measured in terms of a single unit, usually money. Multi-objective planning attempts to compare effects within categories, but does not force effects into the same measurement units. The techniques also provide formal means for decisionmakers to assign relative values to each category (e.g., number of people employed, reduction in reservoir capacity).

Using multiple objectives in the planning process can improve resource development in at least three ways. First, value judgments are determined by decisionmakers rather than by the analysts. Second, a wider range of alternatives usually is identified, and the relationship between alternatives can be described clearly. Third, the analyst's perceptions of a problem probably will be more realistic if the full range of objectives is considered (4).

During and Post-Project Evaluations

Despite EISs and other preproject assessments, projects sometimes generate unanticipated negative impacts. Ongoing evaluations measure a project's outputs and impacts on intended beneficiaries and assess the project's unintended impacts. Evaluations begin with preproject documentation of potential impact, such as EISs, to assess the predictions of impacts. However, they should be sufficiently broad in scope to examine adverse impacts not revealed in preproject assessments and to trace causal sequences linking project activities with such adverse impacts.

Evaluations performed before project completion can be used to formulate recommendations for changes in objectives, strategies, techniques, institutional arrangements, priorities, and government policies. Their effective use depends on the project's flexibility-i. e., whether it can respond to recommended changes. Such evaluations have a secondary purpose of facilitating communication among persons concerned with the project. Evaluations conducted after a project is complete can:

- identify a need to compensate people adversely affected by environmental impacts,
- suggest followup or complementary projects that build on the original project,
- assist in reformulating broader policies and strategies, and
- provide lessons for planning other projects elsewhere (36).

Post-project assessments frequently are regarded as a luxury that most jurisdictions cannot afford. However, they should be regarded as a necessary supplement to preproject analyses, particularly to environmental impact assessments, to provide information needed to revise and reformulate EIS requirements (25).

IMPLEMENTATION OF RESOURCE PLANNING PROGRAMS

A complex array of resource management programs already exist in the U.S.-affiliated islands. Existing management programs are characterized by four basic approaches: activity management, area management, sectoral management, and integrated management.

Activity management refers to those programs that seek to ensure specific resource use activities are conducted in ways that minimize adverse impacts on resources. 'Dredging, for example, is regulated in the U.S. States, commonwealths, and territories under Section 404 of the Clean Water Act. A private developer or government agency is required to apply for a dredging permit from the U.S. Army Corps of Engineers before dredging can be undertaken. Similarly, the Environmental Protection Agency regulates the discharge of wastewater effluents under Section 402 of the same act. One form of activity management important to island resources is management of activities related to tourism, e.g., siting of hotels and resorts, and tourist transportation facilities.

Activity management is a reactive type of management. Developers propose specific resource uses or activities at a specific site and regulatory agencies must decide whether the proposed uses are appropriate at that site or, if not, whether they can be modified to make them acceptable, In this approach to implementation, the types of resource impacts likely to be associated with the proposed use commonly are well known. The degree and type of analyses associated with activity management vary greatly. However, regulation of activities usually requires some sort of environmental assessment, including formal environmental impact statements.

Area management refers to natural systems management programs that focus on specific geographic areas deemed worthy of special protection. The most common area management programs are parks and protected areas (see "Special Application: Parks and Protected Areas"). Many special area management programs are intended to achieve a single resource management objective, although "multiple-use" and "dominant-use" (in which an area is "zoned" for primary uses) plans are being developed for some protected areas in the mainland United States. Special area management usually requires detailed analysis and planning. Once the purposes of special area management are agreed on (e. g., watershed and habitat protection), the major analytic tasks involve resource surveys, mapping, boundary setting, and the development of standards governing uses of be regulated. Such tasks may require resource specialists.

Sectoral management refers to the management of a single resource such as forests or fisheries. The U.S. Forest Service and the National Marine Fisheries Service are examples of Federal sectoral resource management agencies. At local government levels, sectoral management is exemplified by water management agencies. Sectoral management usually involves substantial analysis of the supply and demand for specific resources. Hence, analytic techniques that provide information on sustainable yields and resource carrying capacity are likely to be most useful.

Integrated resource management refers to multisectoral, multidisciplinary resource management efforts, Integrated resource management plans are anticipatory in the sense of seeking to identify optimal uses of specific resources at specific sites in advance of actual development proposals. They are most frequently expressed in terms of resource maps and detailed use guidelines. Thus, they frequently require a full range of resource analysis techniques.

At the national level, perhaps the best example of an attempt to create an integrated natural systems management program is the Coastal Zone Management Program. The program focuses on a specific geographic area—the coastal zone—and seeks to harmonize multiple management objectives within that zone by providing incentives to States to develop programs that incorporate both resource development and resource protection strategies (see "Special Application: Coastal Resource Management"). Comprehensive community planning efforts at the municipal level have the same multiple objectives and methods.

Participatory Approaches to Planning and Management

The need for public participation is based on several factors. First is the understanding that the local knowledge of an area's natural systems often exceeds or complements scientific knowledge and is needed for decisionmaking. Another is the desire to design actions that respect people's priorities, which requires understanding of those priorities. And finally, the success of any action depends on public support, which is best marshaled by local involvement throughout the course of a project (15), Intensive regulation and enforcement are undesirable because of the adversary relationship they create and also are financially impossible on many islands (16).

Sound resource management requires good understanding of ecological and human use systems. The depth and quality of local knowledge of these can be considerable. Gathering this knowledge can be a cost-effective means for providing the information base needed for resource management projects. In addition, lack of necessary biological and social information is an opportunity to begin to achieve participation objectives by involving local people in the identification, design, and implementation of research activities. Data gathering also is a way to improve the resource users' understanding of the natural systems and processes on which they depend, which can give them greater control over their livelihoods and help them be better able to make informed decisions.

For example, a project supported by the Eastern Caribbean Natural Areas Management Program in St. Lucia had secondary school students carry out, as part of their regular curriculum, a study of charcoal production in the project site (a mangrove area), in which they interviewed the charcoal producers. This simple project provided:

1. information on which to base preliminary decisions about the management of the mangrove and determine additional data needs;
2. an educational lesson for the students in which they learned more about social, natural, and economic systems;
3. a way to inform the resource users about the project, gauge their needs, and solicit their involvement;
4. an experiment in alternative educational techniques for project personnel and the students' teachers; and
5. information which influenced decisions on activities in the mangrove area (15).

Generating public participation in resource management projects can be extremely time-consuming. Because of the common lack of organization of island resource users communities, simply calling public meetings, putting up posters and preparing radio programs is generally insufficient (15; app. F). Considerable effort must be expended in meeting resource users, showing interest in their problems, gaining their trust individually, and bringing them into project activities. Generally resource users are interested in finding viable solutions to local social and resource problems, but are "tired of enthusiastic plans that promise much and do little." Further, projects involving many diverse actors can create dissention and chaos rather than lasting linkages between resource users; the importance of diplomacy to the success of the project cannot be underestimated (15).

In order to tap local sources of information, it usually is necessary to give equally in return. projects that are based on people's priorities and fulfill their needs create trust and cooperation. Commonly those whose needs, as well as dependence on natural resources, are greatest are usually the most "marginalized" from the local society and so the hardest to reach. For these people especially, the need to build confidence and to demonstrate a project's tangible benefits is important. The following conditions have been suggested as guidelines for public participation in resource management:

1. **A long-term presence** to understand a community's structure, build rapport, and foster mutual respect.
2. Local involvement in all aspects of a project from design to implementation, as well as a respect for local input. Seeking ideas and advice and then ignoring them creates animosity rather than cooperation. In order to get active local involvement, project objectives must coincide with or at least include objectives of local users and groups.
3. Local participation in concrete activities from which people can gain tangible benefits.
4. Education and research activities in **which local people are equal partners** with government, project staff, and professionals. When knowledge and information are freely shared, everyone learns and disparate groups gain respect for one another.

The final responsibility for the environment falls on the shoulders of governments and of resource users and the general public. Therefore, to be effective, resource managers must understand local human needs and cooperate with government and community groups to ensure that valuable natural resources are used wisely (16).

Special Application: Parks and Protected Areas

Introduction

Protected areas like national parks and reserves are one approach to the conservation of species and ecosystems. The establishment and maintenance of parks and protected areas may, in fact, be necessary if life-support systems and essential ecological processes are to be maintained, genetic diversity is to be preserved, and use of species and ecosystems is to be sustainable.

Different kinds of protected areas are adapted to different requirements for the use and conservation of resources. In traditional Pacific island cultures, access to scarce resources was restricted through taboo areas (reserves) and temporary closed areas, among other means. Today there is a range of options for designating and managing protected areas. Which option is taken depends on the nature, status, extent, and potential uses of the resource or ecosystem in question.

In a broad sense, setting aside natural areas need not imply setting aside development: it may be a part of the development process, especially when development's objective is to sustain society. Where a species or ecosystem is sensitive to any human interference, however, a strict nature reserve may be appropriate.

Large and small areas where conservation is compatible with recreation and education can be made into national parks and natural monuments, respectively. Where some management is necessary to protect a species or maintain its habitat, managed nature reserves or wildlife sanctuaries can be created. The scenic beauty and traditional resources or lifestyles of inhabited areas can be maintained through designation as protected landscapes, anthropological reserves, or customary protected areas. Temporary resource reserves can be established in areas where decisions on development must await further study.

Marine reserves permit protection and management of important coastal resources. Strict controls over activities in the coastal zone and in adjacent watersheds, together with careful fisheries management and a network of protected areas should permit sustained use of some protected areas such as reefs. The Australian Great Barrier Reef Marine Park Authority has been successfully pioneering the balanced use and protection of coral reef areas. Other areas requiring the careful balancing of different resource requirements such as watershed protection, hunting, and gathering of traditional forest products can be made into multiple-use management areas. The kind and degree of protection can vary to fit almost every local circumstance (11)

Phofo credit Office of Technology Assessment

Multiple use protected areas integrate traditional resource uses, such as traditional subsistence gathering, with conservation.

Protected areas with suitable resources to generate tourism can stimulate the economy and provide employment. In many cases, protected areas result in increased government employment and private sector investment,

Need for Protected Areas and Selection Criteria

On some of the U.S.-affiliated islands only fragments of undisturbed natural areas remain, and many species are endangered. Natural areas serve a variety of economically and ecologically important functions. Forests, for example, provide watershed protection and water catchment, control soil erosion, and contain useful predators that control mosquitoes and other insect pests. While lowland rain forests once covered one-quarter of Puerto Rico, little of this forest remains today. Two-thirds of American Samoa's lowland rain forests have been destroyed, Pohnpei's and Yap's are mostly disturbed, and in Truk no undisturbed areas exist, Only scattered and inaccessible remnants remain on Guam and there are none remaining on the Marshall Islands or the U.S. Virgin Islands. Where such forests remain, some portions could be preserved. Forests might be managed to include protected natural areas, areas used for local wood production and/or agroforestry, and fallow areas where appropriate.

Despite unclear legislation and policies related to protected areas in the former Trust Territory of the Pacific Islands (TTPI), some protected areas have been established in the region (Bikar and Pokak in the Marshall Islands, Ngerukewid in Palau, and Maug and Sariguan in the Commonwealth of the Northern Mariana Islands) (23). Protected areas have been created in Guam and American Samoa through various Federal agencies. A number of National wildlife Refuges have been established in the Pacific, including Howland, Baker, and Jarvis Atolls, Midway Island, and Rose Atoll in American Samoa. protected areas in the Caribbean are well developed. For example, Puerto Rico alone contains 14 State forests and the Caribbean National Forest (Luquillo Biosphere Reserve), and nearly two-thirds of St, John (one of the three major U.S. Virgin Islands) is designated as both a national park and a biosphere reserve.

The concept of the biosphere reserve was introduced in 1971 by the United Nations Education, Scientific and Cultural Organization's (UNESCO) Man and the Biosphere program. Biosphere reserves are part of a worldwide network of protected environments with a primary intent of promoting international scientific cooperation and the study of human interaction with the environment. Ideally, the biosphere reserve integrates conservation with research, environmental monitoring, education, training, traditional landuse, and surrounding socioeconomic needs. Local participation and acceptance is particularly important to the concept of the biosphere reserve (39).

The typical biosphere reserve contains specific areas to accomplish a variety of research, monitoring, and conservation tasks. These areas generally are:

- *core* area—strictly protected from human disturbance, ideally containing much of the biological diversity of the area;
- *experiment] research* area—manipulative research is performed on managed ecosystems;
- *rehabilitation* area—demonstration of recovery of degraded lands;
- *traditional use* area—conservation and study of sustainable resource development practices; and
- *area of* cooperation—managed to foster understanding of the biosphere reserve, such areas may include human settlements, forests, and rangelands.

Ideally, research performed within an individual biosphere reserve can provide important information on natural and managed ecosystems for local use in resource development.

There are three designated biosphere reserves within the U.S.-affiliated Caribbean islands: Luquillo Experimental Forest (Caribbean National Forest) (28,112 acres); Guanica Commonwealth Forest Reserve on Puerto Rico (9,930 acres); and Virgin Islands Biosphere Reserve (15,188 acres) on St. John Island in the U.S. Virgin Islands. The only designated biosphere reserve in the U.S. Pacific islands is located on Hawaii (35,38).

The U.S.-affiliated Pacific islands would likely benefit from creation of biosphere reserves in the region. Sustainable resource development research performed on biosphere reserves could provide useful information for local resource development planning. Potential sites suitable for biosphere reserves would need to be identified and technical assistance probably would be required initially. Although strong local land- and sea-tenure customs in some Pacific islands may pose a major constraint to reserve development, extant parks may prove to be appropriate sites. A regional cooperative effort in developing biosphere reserves may mitigate some of the economic,

Photo credit: Office of Technology Assessment

Ngerukewid Wildlife Refuge (Seventy Islands Park) in Palau, containing considerable open marine areas and unique marine lakes, may offer a potential biosphere reserve site.

staffing, and technical constraints that exist in the islands. The Hawaiian Islands Biosphere Reserve might serve as a model and a source of technical assistance in the development of Micronesia biosphere reserves.

The Virgin Islands National Park was formally designated the Virgin Islands Biosphere Reserve (VIBR) in 1983. The reserve covers nearly two-thirds of the island of St. John and represents many of the areas ecosystems. The U.S. National Park Service (USNPS) manages VIBR and has a declared commitment to institute research, management, and education programs and further to coordinate these programs with other Lesser Antillean institutions. Ongoing VIBR educational outreach activities include environmental programs extended to primary and secondary schools, field trips, and workshops for educators (33).

The Virgin Islands Resource Management Cooperative (VIRMC), established in 1982 through an initiative of USNPS, has a primary goal of bringing local and regional expertise together to solve resource management problems. VIRMC is active in carrying out the objectives of the biosphere reserve on St. John and has performed relevant resource inventories, monitoring, and characterization studies towards that goal. Long-term projects of VIRMC include monitoring of St. John's coral reefs, fisheries resources, and vegetation (33).

Constraints to Designation of Protected Areas

On small islands it is often impossible to maintain an adequate physical separation between damaging human activities and natural systems. Certain activities (i.e., use of pesticides and other toxic chemicals, and certain types of industrial development) may simply have to be strictly regulated, avoided, or prohibited. The establishment and effective management of protected areas certainly can contribute significantly to sustainable use of renewable resources, but may be constrained by such factors as: extreme vulnerability of island ecosystems, lack of trained manpower and money, weak local institutions, increasing demand for limited resources by growing populations, lack of information on the dynamics of island ecosystems, and the deep spiritual and cultural ties of island peoples to ancestral lands (making public acquisition difficult).

Relatively few protected areas exist in many of the U.S.-affiliated islands, suggesting that Federal agencies responsible for establishing protected areas have not been very active or effective in the islands. Part of the problem may be the difficulty of adapting U.S. law concerning different types of protected areas to situations prevailing in smaller islands (11). U.S. provisions for protected areas lack a strong role for local people in planning and management such as would be necessary in many island situations. Primary responsibility for creation of protected areas may have been left to local governments with neither expertise or means to pursue such goals. Flexible programs, such as the National Marine Sanctuary Program, may prove more adaptable to island needs (11).

Local Participation in Protected Area Designation and Management

Modern attempts to protect or preserve island resources, whether through establishment of protected areas or through other means, must consider traditional factors as much as possible. Resource management technologies that reinforce traditional ways or ideas will have a better chance of success than those imposed from outside. For example, resistance exists in the Pacific islands to anything that interferes with traditional cultural practices, such as hunting native birds. On islands where land is limited and has been held in customary ownership for generations, protected areas that exclude people and their activities probably will be difficult to implement. This is even more difficult if populations are approaching or exceed island carrying capacity.

Resource protection will succeed only if it has the support of local populations, particularly resource users, traditional leaders, and the heads of land-owning families. This support can be generated if local people participate from the beginning in their planning and definition. Benefit-sharing arrangements with landowners may also help ensure public support. If enforcement can be left to landowners, protection might be achieved without actual government acquisition.

Protected areas may gain local acceptance more readily if they are carefully chosen and developed to demonstrate the value of parks and preserves to the public and decisionmakers. Interpretive materials can be developed to explain what is protected and why. Parks could become environmental education laboratories for school groups, and increase in number as public understanding and support increase. Traditional knowledge of resource use, management, and conservation remains in many island areas and could form a base for public support of park and protected area development. Parks and protected areas could be demonstrated as a method to preserve island heritage, culture, and traditional practices while protecting island ecosystems. Direction of this type may foster local support for and participation in protected area establishment and management.

The need for protection in some cases can be identified by local people rather than governments. Techniques that allow untrained local people to monitor coral reefs have been developed (12), and similar approaches could be developed for other resources. When local people see for themselves what happens to a resource, they may be motivated to modify their own behaviors if they have options to do so.

Experience in both the Pacific and Caribbean demonstrates that no substitute exists for public support and involvement (15,34).

Conclusion

Without effective protection, further species extinctions and the disappearance of some ecosystems where damage has already been severe are likely on the U.S.-affiliated islands. The broader use of protected areas for resource management will depend on comprehensive island planning and management and on practical experience with different management technologies. There will inevitably be conflicts between measures for the sustainable use of resources and desires for more rapid or immediate development. The resolution of such conflicts will, in part, determine whether the islands maintain a sustainable base for their populations, or slowly decline in productivity and become increasingly dependent on outside sources of support.

Special Application: Coastal Resource Management

Coastal resource management (CRM) is a holistic form of planning and decisionmaking that aims to maximize sustainable multiple uses of coastal resources (28). Little land in the U. S.-affiliated islands can be termed noncoastal, so that coastal resources management is, in effect, island resource management.

Although there is no set procedure for CRM, planning in this context consists of several components:

- a government commitment to CRM;
- a geographical inventory of important resources and resources uses, demands, values and functions; and
- development of policies and guidelines for resource allocation.

Management involves:

- assigning responsibilities for CRM to lead and participating agencies,
- evaluating proposed development and use options for coastal resources against the plan,
- assessing the environmental consequences of a range of options for each development proposal, and
- selecting the alternative that best maximizes economic development and conservation of coastal resources (28).

The planning process should be iterative and open to ensure that communication, understanding, and eventually agreement is established among all individuals with information, claims or interest in the resources.

Under the Coastal Zone Management Act of 1972 (CZMA), the United States provides a maximum of four annual “incentive” grants (Sec. 305) to eligible coastal States and territories to promote timely development of plans. After technical, policy, and legal review and approval by the national office (now the Office of Ocean and Coastal Resource Management of the National Oceanic and Atmospheric Administration [NOAA]), areas with approved plans become eligible for additional funds (Sec. 306) to implement and operate the plan, subject to annual reviews. Grants may also be made to areas to carry out research studies and training required to support CRM programs (Sec. 310).

Regional (State or territorial) governments are charged with the responsibility to develop and administer the CRM plan. This usually involves a geographic inventory of resources; one or more analyses; and preparation of implementation plans, guidelines, or policies applicable to the region designating preferred uses of resources. The CZMA required that an inventory of natural and manmade resources be undertaken and requires that resource use determination be based, in part, on “the capabilities of each resource for supporting various types of uses and the impact of various resource uses upon the natural environment” (37). Other analyses, such as legal-institutional analysis, public attitude-value surveys, and economic and social needs-demands studies also may be performed to fulfill information requirements for developing a coastal resources management plan.

Regional programs may sponsor participation of other State or local government agencies in research and development projects, and plans for areas of particular concern. Also, regional governments review proposed Federal or other development projects to determine consistency with the approved State CRM plan.

Puerto Rico, the U.S. Virgin Islands, and the Pacific flag territories of Guam and American Samoa became eligible for Section 305 funds under CZMA. (The Commonwealth of the Northern Mariana Islands became eligible in 1978.) By 1980, each of these areas had approved CRM plans and became eligible for Section 306 funds. All continue to receive Section 306 funds to help operate and manage their programs. Annual evaluations by NOAA and continued Federal support indicate that all five existing management programs are operating satisfactorily and in compliance with CZMA policies and regulations.

The Trust Territory of the Pacific Islands was not eligible for funds under the original authorization for CZMA. When the act was reauthorized in 1980, the TTPI was made eligible for Section 306 funds but not for Section 305 funds (28). The TTPI could not take advantage of its eligibility for Section 306 funds because they had neither the technical nor financial resources to develop the plans in the first place without Federal assistance. Because of the size of land and ocean areas comprising the TTPI, an acceptable CRM plan would have cost an amount comparable to what was spent on the Section 305 studies for the three Pacific flag territories and Hawaii. Even if initial efforts were limited to district centers, funding would have exceeded the TTPI budget (28). The Compact of Free Association does not include or mention funds specifically directed to development of coastal resource management plans although it allows for provision of technical assistance by U.S. Federal agencies (Article II; Sec. 226).

Under the TTPI, key coastal permitting responsibility was with the U.S. Army Corps of Engineers in accordance with Section 404 of the Clean Water Act. The Corps historically relied on other Federal agencies (e.g., U.S. Fish and Wildlife Service, National Marine Fisheries Service, EPA) and territorial offices for information and advice. Some large construction and piecemeal landfill projects approved in the U.S. Pacific islands have caused significant adverse impacts which could have been avoided with better planning (28).

Freely Associated States' environmental protection boards have had principal environmental responsibility, but their authority appears limited to water quality, sanitation, and the effects of earthmoving. They have been ineffective in compelling applicants to evaluate alternative sites and procedures, and lack authority over aspects of development not strictly dealing with earthmoving. Similarly, planning and marine resource management offices have had little impact on CRM: staffs are small, data are limited, and permitting and project approval authority is essentially nonexistent. Although development plans are prepared and updated periodically for major islands, comprehensive land-use planning and controls (e.g., zoning) are lacking (28).

Provide Financial and Technical Planning Assistance to the FAS

The U.S. Army Corps of Engineers has sponsored a number of coral reef and coastal resource inventories in the tropical pacific since 1978. These projects, with one exception, were supported by Section 22 (Planning Assistance to States) of the Water Resources Development Act. A Corps-managed American Samoan coral reef inventory was sponsored by CZMA funds transferred to the Corps by the American Samoan Government, at the latter's request. The Corps has received further requests to initiate resource inventories in the U.S. Pacific, but continued use of Section 22 funds for original data collection is in doubt.

Coastal resources planning and management might offer a sound means of addressing a number of important socioeconomic and resource conservation issues facing the FAS (table 9-1). These might include identification of important subsistence fishing grounds; planning for small dock, airfield, and water catchment projects in the outer islands; and means to evaluate potential agriculture or aquiculture

Table 9-1.—Selected Socioeconomic and Resource Conservation Issues Suitable for Inclusion in Future CRM Initiatives in the FAS

1. Socioeconomic issues
   A. Outer islands
      - Population density and out-migration
      - Conservation of subsistence lifestyles
      - Small dock and airfield development
      - Water supply and catchment facilities
      - Copra industry development or rejuvenation
      - Other cash crops and handicrafts
      - Commercial fishing
      - Tourism management
      - Aquiculture development
   B. Urban centers
      - Population growth, immigration, and redistribution
      - Land ownership disputes
      - Landuse planning and management
      - Water supply and quality
      - Self-reliance in energy generation
      - College and university facilities or assistance
      - Agricultural and aquiculture development
      - Tourism management
      - Controls over landfilling for houselots and other residential and urban uses
      - Commercial fishing, facilities and permits

II. Conservation of natural resources
   - Conservation of subsistence resources
   - Historic preservation
   - Protection of endangered and threatened species
   - Fishing with explosives and poisons
   - Landfilling of important coastal habitats
   - Water pollution and degradation of important habitats
   - Controls over dredging, filling, and construction in coastal waters

III. Waste management
   - Wastewater and sanitation facilities
   - **Solid waste control and management facilities**
   - Cleanup of hazardous materials and war explosives and debris
   - Contamination from nuclear testing and oil pollution

SOURCE: J. Maragos, "Coastal Resource Development and Management in the U.S. Pacific Islands," OTA commissioned paper, 1986

ventures. In urban centers, CRM planning initiatives could help to identify priorities and sites for future public works projects, especially water supply, wastewater management, energy, and solid waste management facilities. Landuse planning supported by a CRM program could mitigate ecological and public health impacts of urban development. Table 9-2 presents technologies for fulfilling the planning and CRM needs of each area.

In light of the Compact of Free Association, technical assistance for development of coastal resource management plans could be requested by the governments of the Federated States of

Table 9-2.—Potential Implementation of Planning and Management Technologies To Address Selected CRM Issues (identified in table 9-1)

- Public meetings, hearings, and workshops to evaluate needs for CRM in the FAS
- Legislative endorsement and commitment to CRM by legislatures of new countries
- Administrative reorganization to establish a CRM lead office or agency in each new country
- Coastal resource inventories of valuable resources and their uses
  —Urban centers—first priority
  —Outer islands—second priority
- Draft CRM plan development
- Public review and final CRM plan approval
- Implementation of approved plans to meet following goals:
  —promote economic development
  —promote conservation of important resources
  —waste management
  —research and management of areas of particular concern
  —others (e.g., development of institution or facilities for higher education and research)
- Education and training programs on CRM within each new country
- Publication and telecommunication of CRM activities in native languages

SOURCE: J. Maragos, "Coastal Resource Development and Management in the U.S. Pacific Islands," OTA commissioned paper, 1986.

Micronesia, the Republic of Palau, and the Republic of the Marshall Islands. Each program could be subdivided to address separately the needs of the urban centers and outer islands. Each nation would require a centralized coordinating and planning agency to develop, manage, and enforce CRM programs. Existing planning offices, marine resources offices, and environmental protection boards need substantial upgrading, reorganization, training, and staffing to assume that role, An alternative would be to establish new coastal offices, drawing on the resources of the other offices for support and coordinating with them to develop plans.

Outside expertise probably will be required, at least initially, for resource inventories, research and development projects, manpower training, planning, and evaluation of specific development proposals. Considerable assistance could come from outside universities with tropical coastal experience, such as the University of Guam, the University of Hawaii and University of the South Pacific (Suva, Fiji).

SUMMARY

Resource planning is a means of strengthening the ecological foundation for future resource management and of putting this information into the decisionmaking process along with economic, social, cultural, and administrative information (18). Planning for sustainable use of resources is not only a scientific technology but has to do with the basic topics of economic development strategy, land distribution and tenure, interagency rivalry in control of resources, peoples' wants and needs, and so forth. It is a "people-problem," extremely political in nature, and must be dealt with from the outset in a manner in which education and training are important, although slow-acting ingredients (18).

Planning and implementation require information and analysis in order to make optimal resource use decisions. Specific analytic techniques have been developed to assist those who make resource use decisions.

In the short run, EISs are likely to remain the primary technique used by island resource managers for natural systems assessment because activity management is currently the dominant approach to resource management and of several "off-the-shelf" approaches to impact assessment make it relatively cheap and easy to implement. A review of current procedures for conducting EISs could help planners identify and develop more "island relevant" EIS procedures. Post-project evaluation would be one way to reveal the strengths and weaknesses of current EIS procedures.

Resource capability assessments have some promise but, because they usually require high levels of expertise and because their value is questionable in the context of small islands, they are less likely to be adopted by island planning offices in the near term. However, the possibility of constructing capability analyses for nearshore waters has considerable potential and should be explored further.

Carrying capacity analysis also has limited immediate potential because of high costs and skill requirements. However on some islands carrying capacity analysis of certain systems, such as water supply, may be useful.

Guidelines for Information Management

The selection of specific techniques for gathering and analyzing information for resource management could be based on several guidelines.

1. *Identification of specific information needs and analytic techniques for resource assessment should be based on analyses of current and projected planning and regulatory information needs.*

A detailed survey should be performed for each island covering what types of resource use decisions are currently being made, the type and quality of information and analysis on which these decisions are based, availability of advisory services, and access to databases in other agencies. Detailed information also is needed about the present scope of data collected, methods of data acquisition, frequency, geographic scale, format of presentation, accessibility, and costs of collection (2).

Current resource management programs sometimes reflect Federal requirements or the availability of funds for management rather than locally perceived management needs. Hence, the survey of planners and resource managers also should address the issues of current resource use problems that are undermanaged and anticipated resource use problems for which information will have to be gathered for management efforts.

2. *Opportunities for sharing existing Federal and local data should be considered prior to gathering more data.*

Agency personnel frequently are unfamiliar with data collected by personnel in other agencies or, if they are aware of data acquisition efforts, commonly there are questions about the quality of the data and difficulties in receiving data on a timely basis, An island-by-island assessment of data collection could be a first step toward identifying opportunities for sharing data and collaborating on the acquisition of additional data. A preliminary study also should identify current incentives and constraints for sharing data. A long-term goal could be interagency protocols for acquisition and sharing of data useful to several agencies in their resource management efforts.

3. *Priorities should be established for the acquisition of new data or the development of an interagency information clearinghouse.*

Few islands can afford a major data acquisition effort. An initial priority for data collection would be to ensure that essential data—those which, if lacking, prevent program implementation—are being collected. After ensuring this, an incremental approach to collecting desirable data can be established. Rural island residents commonly are the best source of information based on intimate, long-term familiarity with an area's resources and trends. Information from these sources can be compiled through interviews, surveys, workshops, and other techniques.

By gathering data on a case-by-case or area-by-area basis, managers can determine what the costs of data acquisition are, what ecological and social parameters are most useful, and what the requirements are for a larger scale data collection effort, Initial data collection efforts could be concentrated in areas where development pressures are the greatest in order to identify baseline conditions from which trends in resource conditions can be determined, and on undisturbed or nearly undisturbed areas which may have species or ecosystems of particular value.

4. *Data acquisition, storage, and retrieval should be based on appropriate technologies.*

The availability and continuing improvement in remote sensing and electronic data processing pose a dilemma for island natural systems managers. These technologies commonly require high levels of skill, and are being modified so rapidly that determining which technologies are most appropriate for island management should be addressed on a case-by-case basis (25). However, satellite information and computerized geographic information systems soon may be cost-effective methods of data collection, analysis, and display (31). The Natural Systems Assessment for Development ecological surveys and monitoring program can be effective in assisting countries to make optimum use of available modern technology (31). Local residents can be used to provide observations which can be used as ground truth data for remotely sensed data, and can provide detailed knowledge about specific areas (27). Again, an incremental strategy of focusing on training and demonstration projects probably is warranted.

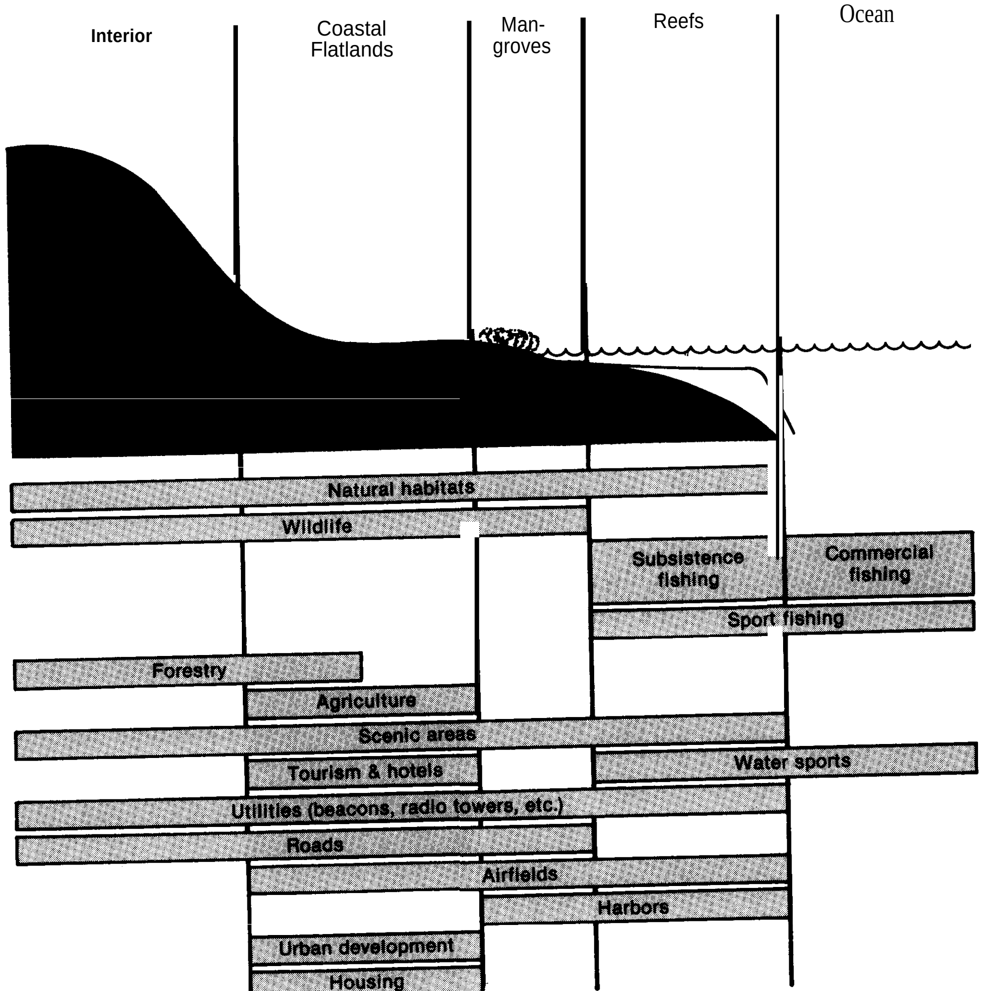
5. *Emphasis should be placed on dissemination as well as acquisition of data.*

Distribution of data to users may be encouraged through preparation of data lists and inventories, reproducing reports, air photos, topographic maps, sponsoring workshops and seminars, and adopting an "open files" policy for other agencies (25). If participatory approaches to planning are adopted, dissemination of information can be more direct.

6. *Training of local data collectors/mappers should be part of basic resource information acquisition.*

Short-course training in resource information collection and mapping techniques is needed to ensure usefulness of resource planning efforts on many U.S.-affiliated islands. Such courses are provided by many U.S. universities. An example of this kind of program is the International Land Use Planning Training Program; its first phase was held by Cornell University in 1983. Perhaps more appropriate for development of land assessment and mapping skills would be on-island training sessions—a traveling workshop. A collaboration of Department of the Interior-U. S. Man and the Biosphere program in training for land assessment, classification, mapping, and suitability rating could be initiated using the East-West Center assessment manual (3).

Figure 9-1.—Typical Siting of Land Uses on U.S.-Affiliated High Islands



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