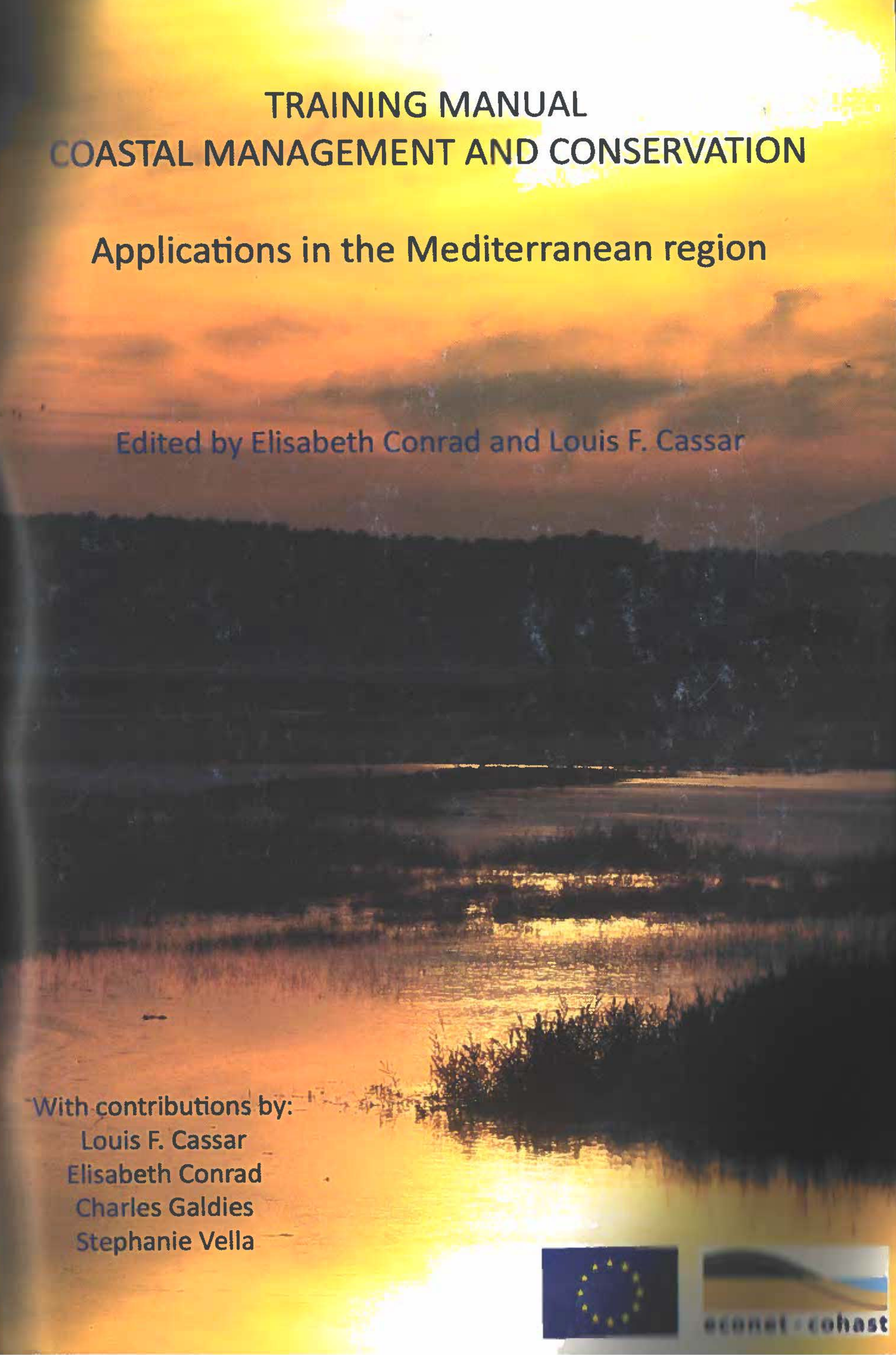

TRAINING MANUAL
COASTAL MANAGEMENT AND CONSERVATION

Applications in the Mediterranean region

Edited by Elisabeth Conrad and Louis F. Cassar

With contributions by:
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List of acronyms

CZM	Coastal Zone Management
DTM	Digital Terrain Modelling
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPS	Environmental Planning Statement
EU	European Union
GDP	Gross Domestic Product
GIS	Geographical Information Systems
GPS	Global Positioning Systems
ICAM	Integrated Coastal Area Management
ICZM	Integrated Coastal Zone Management
IK	Indigenous Knowledge
ITK	Indigenous Technical Knowledge
NEPA	National Environmental Policy Act, 1969 (USA)
NGO	Non-governmental organisation
SEA	Strategic Environmental Assessment
SQL	Standard Query Language
UN	United Nations
UNEP	United Nations Environment Programme

Introduction

The coastal zone is a resource under threat. All over the world, coastal areas are amongst the most densely populated areas of the planet, bringing together a variety of often-conflicting land uses, in an area of immense environmental sensitivity. The challenges for the coastal manager are continually becoming more formidable, given trends of population growth and resultant intensification of land uses, within a framework of global change phenomena such as climatic warming.

The Mediterranean provides a classic example of coastal management problems. The region has a long history of human land use, with each civilization leaving its mark on the landscape, whilst contributing to the evolution of a unique Mediterranean identity. Today, the Mediterranean region is best described as one of complexity. It is a biodiversity hotspot, a region of social and economic disparities and a zone of political conflict. It is also an area where coastal management needs to operate at several levels, ranging from the site to the entire Basin. Successful coastal management must bring together a variety of actors, from the individual stakeholder, to **non-governmental organisations** (**NGOs**) to planning agencies to national governments to regional pan-Mediterranean partnerships.

This training manual has been developed through the ECONET-COHAST project, an initiative of the European Union's Archimed Interreg III programme. It brings together a variety of contributions, outlining various aspects relating to conservation and coastal management, with special reference to the Mediterranean region. It is intended to provide an overview of several aspects of coastal management for various actors involved in the practice of coastal management. Although focused on the Mediterranean region, the concepts outlined in this publication may be extrapolated to various other scenarios in the coastal zone. The methods and ideas presented in this manual should thus be considered to be elements in a holistic and integrated toolkit at the disposal of the coastal manager.

1. Conservation strategies

Elisabeth Conrad

Summary

Conservation is increasingly recognised as an endeavour critical to the survival of the human species and of many other forms of life. Although species extinction is a natural process, anthropogenic activity has resulted in accelerated extinction rates that are far beyond natural background levels. In recent decades, there has been widespread decline of biodiversity in all its forms, namely species, genes and ecosystems. Conservation strategies are intended to help halt this decline, but are inevitably constrained by the reality of limited resources. Conservation must therefore be based on priority-setting, that is, on exercises which determine how limited resources are best allocated. Furthermore, such strategies also specify how conservation resources are used. Two main groups of approaches may be distinguished, namely *in-situ* and *ex-situ* techniques, with the former occurring within the natural habitat range of species, and the latter focused on efforts outside this habitat range.

Introduction

The relevance of biodiversity conservation in modern day political contexts is perhaps best summed up by the renowned scientist Edward O. Wilson. He notes:

"The worst thing that can happen...is not energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes will be for us, they can be repaired within a few generations. The one process ongoing...that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us."

(*In* Myers, 1984)

The term *biodiversity* may be most simply defined as the variety of life and the natural processes of which living things are part, including living organisms (species level diversity), the genetic differences between them (genetic level diversity), and the communities in which they occur (ecosystem level diversity). Currently described species are in the region of 1.75 million, whilst estimates of total species numbers range from 10-100 million, with approximations frequently converging around the figure of 15 million species. Continued human existence is complexly tied to the continued maintenance of other forms of life. The human species depends on biodiversity not only in terms of the direct use of several species (including crops and livestock, medicinal plants and material resources) but also due to the various services which different components of biodiversity render to humankind. Such

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The scope of conservation efforts is not, however, to weigh the relative merits of species' contributions. There appears to be some level of general consensus that we should aim to conserve as many forms of life as is possible, particularly given a realisation that we know little about the inter-linkages in many ecosystems. At best, we have only a shallow understanding of the way in which ecosystems function, thus making it prudent for us to conserve indiscriminately rather than destroy indiscriminately. However, conservation also operates within a political and economic reality of limited resources. Conservation spending is generally somewhat low on national lists of priorities, and in most countries, conservation funding in no way comes close to that devoted to other sectors such as military advancement and defence. Thus, although we may agree in principle that *"every form of life is unique, warranting respect, regardless of its worth to mankind"* (UN, 1983), Vane-Wright's (1991) question *"are all species equal? Or, is the giant panda equivalent to one species of rat?"* is very pertinent. We may not wish to choose between species, but the reality is that we often have to. Conservation therefore needs to operate on the basis of priority-setting, in order to ensure optimal use of resources. There are at least three critical questions to be addressed in the design of a conservation strategy:

1) Where will resources be concentrated?
2) On what will resources be concentrated?
3) In what way will resources be utilised?

Establishing conservation priorities

A number of approaches for establishing conservation priorities are outlined below:

- **Selection of target species**

  Some priority-setting approaches focus on particular species. These may be species that are of particular usefulness to mankind, species of particular attractiveness or species that easily attract public support for conservation efforts, such as the so-called *'charismatic megafauna'*, including species such as the tiger and panda. Other approaches may select target species on the basis of level of threat, often utilizing Red Lists of threatened species. Other species which may be the focus of conservation efforts include keystone species, which play a disproportionately important role in ecosystems, species of genetic distinctiveness, as well as endemics, which are restricted in extent to a specified geographical area.

- **Selection of target areas**

Priority-setting may also take place on the basis of specific areas. Two criteria are generally considered:

i) level of diversity; and
ii) level of threat.

In terms of the distribution of biodiversity, it is well known that certain areas of the globe are much richer than others. Of particular note are the tropical rainforests, which harbour many species which have not yet been identified. Such areas of the globe are referred to as *megadiversity* nations or areas. The term *biodiversity hotspots* is generally used to refer to areas where high levels of biodiversity are combined with high levels of threat.

Figure 1.1
Biodiversity hotspots, designated on the basis of proportion of endemic species and level of threat. The Mediterranean is one of the 34 identified hotspots.

(Source: Conservation International, 2007)

- **Utilisation of specific techniques**

Specific techniques for establishing conservation priorities have also been developed. One such technique is that of gap analysis, which involves the mapping of particular biodiversity elements (e.g. birds), the mapping of conservation efforts (e.g. protected areas), and the identification of gaps in overlap between the two. The technique thus identifies areas of biodiversity that are under-represented in terms of conservation efforts, utilizing mapping techniques, particularly **Geographical Information Systems** (**GIS**). A second technique is that of ecogeographic studies, where ecological, geographical and taxonomical information is gathered and synthesised, producing predictive results which can be used to assist in the formulation of conservation priorities (Maxted *et al.* , 1995).

'Doing conservation': in-situ and ex-situ techniques

There are two overarching groups of approaches to biodiversity conservation, namely *in-situ* approaches and *ex-situ* approaches:

In-situ conservation involves efforts to maintain, manage and conserve biodiversity within the natural habitat range of species.

Ex-situ conservation involves the removal of species, or of their reproductive parts, outside their natural habitat, for management or preservation in an alien environment.

In-situ conservation

The primary means for in-situ conservation is the establishment of protected areas. The setting aside of areas from 'normal' human activity has a long history, dating back to the protection of sacred mountains and forest groves. Such early instances of protected areas generally had spiritual or religious associations, with indirect benefits for biodiversity. The modern concept of protected areas as a specifically conservation enterprise dates back to the establishment of Yellowstone National Park in the United States, in 1872. Initial ideas of protected areas were of protection **from**, rather than protection **for**. The emphasis was thus on exclusion of people and their activities, with exceptions being made only for recreational pursuits. However, when this concept was exported to parts of the world, such as Africa and Asia, where human land use of natural areas was historically widespread and important, shortcomings of such an approach became evident. Exclusionary conservation approaches not only had severe social impacts on the people who were excluded, but also had ecological impacts on natural systems which had evolved to accommodate a degree of human use.

The concept of protected areas thus evolved into a more inclusive and holistic approach. Protected areas are now perceived less as some form of relic monument or museum, and more as a community resource that is best managed with the input of all involved and affected. There has also been a change in the criteria for consideration of protected areas. It is now not only pristine natural areas that are recognised as important biodiversity reserves, but also cultural landscapes with a long history of human land use. There has likewise been recognition of the fact that degraded areas, and other sites requiring active intervention and management, may also have a role to play. Furthermore, there is a growing emphasis on the concept of networks, that is, of linking protected areas to each other through systems of corridors and stepping stones, in order to increase their ecological viability and to enable flow of resources. In a broad sense, attitudes towards establishment and management of protected areas are changing in line with a growing recognition that biodiversity conservation cannot be an exclusively biological pursuit. Successful conservation can only result from initiatives that also fulfil social and economic needs, and protected areas must thus incorporate such concerns as fundamental components of their mission and objectives.

Figure 1.2
Parco Regionale della Maremma, Tuscany, Italy. Protected areas provide safeguards not only for ecological assets, but also for cultural heritage and landscape character, whilst also making provision for managed human use. Human activities within the Parco della Maremma include recreation, agriculture and herding.

(Credit: L.F. Cassar)

A further dimension of in-situ conservation comprises habitat management. Habitats may be managed for a variety of ends, depending on specific needs which need to be evaluated on a case-by-case basis. One aspect of population management may involve metapopulations, that is, local spatially distinct populations of the same species, that exist in a fragile balance between extinction and colonisation. Where such populations are of importance, a successful conservation strategy may involve the conservation of numerous habitat patches, and the potential for movement of species between these. In other cases, habitat management may involve the creation of specific environmental conditions. It is now a well known fact that some human-created habitats, such as agricultural landscapes and forestry areas, harbour species that may not be found elsewhere. Other forms of habitat management may include:

- Control of species populations (e.g. removal of invasive/alien species);
- Provision of resources (e.g. provision of food supplies); and

- Manipulation of physical environmental conditions (e.g. provision of shelter).

Ex-situ conservation

Conservation often requires measures beyond those that can take place within the natural habitat range of a species. The classic example of ex-situ conservation is provided by zoos, which house species (which are often threatened), outside their natural habitat. In the past, such institutions have been the subject of much controversy, particularly as their objective was often restricted to display of animals, often in inadequate living conditions, for the sole purpose of human recreation. However, the mission of zoological gardens and other ex-situ institutions has evolved to a more conservation-oriented one, and this is increasingly reflected both in the mission of zoos, and in their operations. Many zoos now operate captive breeding programs for species where wild populations are on the decline and where conservation within a natural habitat may not be sufficient to ensure survival of the species. This is especially the case when natural populations are very small, or where protection of the natural habitat is insufficient or ineffective.

There are various types of ex-situ conservation institutions. Apart from zoos, these include botanical gardens, aquaria, botanical gardens and seed banks, amongst others. Various conservation techniques are utilised. For plants, material may be stored as whole plants, seeds, cuttings, bulbs, tubers, or through *in vitro* storage or cryopreservation. Plant material may also be propagated, for distribution to other institutions, or even for reintroduction in the wild. Animal populations may be manipulated through techniques such as embryo transfer, artificial insemination, artificial rearing and fostering. As with plant species, the end target of ex-situ conservation of animals may be attempted reintroduction to the wild, although such endeavours are invariably fraught with difficulties.

Conclusions

It should be noted that although both in-situ and ex-situ techniques have value in different circumstances, the emphasis in conservation remains principally on in-situ techniques, as it is argued that conservation needs to address root challenges, namely habitat destruction, rather than merely symptoms (i.e. species decline). However, ex-situ techniques can complementarily contribute towards conservation efforts, particularly if these are well planned through a comprehensive and holistic biodiversity conservation strategy.

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2. Environmental planning and management for conservation in coastal zones[1]

Louis F. Cassar

Summary

Coastal zones are amongst the most sensitive and threatened areas of the planet. Not only are they under intense direct pressure from dense human populations and their activities, but they are also faced with the threat of abiotic and ecological changes resulting from phenomena such as global change. Achieving a balance between biophysical and ecological integrity and the various demands of people living and working in the coastal zone, requires planning and management. In particular, conservation areas in the coastal zone are of immense importance, as these represent an ecological safeguard in an area where every parcel of land is under intense land use pressures. However, such conservation areas need to be carefully planned and managed if they are to achieve their goals, and such planning and management proceeds through a series of distinct steps in an overarching framework of system planning.

Introduction

The planning and management of various elements of the coastal zone, so as to ensure that anthropogenic activities do not in any way compromise the "state-of-health" of existing resources, is referred to as **integrated coastal area management** (**ICAM**) or **coastal zone management** (**CZM**). The former term often refers to a broader geographical area, incorporating interconnected elements further inland such as watersheds, whilst the latter generally refers to the coastal zone *per se*. This interdisciplinary approach to planning and management of coastal regions may be applied at both the national and regional level. It is a dynamic process in which a coordinated strategy is developed and implemented in support of the conservation of natural resources and the general sustainable use of the coastal zone.

Integrated Coastal Area Management has a number of specific aims:

1) To provide strategic planning for the coastal region and interconnected areas distant from the coast;
2) To promote the responsible use of coastal resources using environmentally sound technologies; and
3) To balance demand for coastal resources and resolve conflicts of use.

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[1] Parts of this chapter have been adapted from Cassar L.F. (2000). Environmental planning for conservation on the coastal zone. *In* L.F. Cassar (ed.) *Training Package: Integrated Coastal Area Management. Part One: Training Manual.* Trieste, Italy: ICS-UNIDO.

Planning a system of conservation areas

The prospect of planning a regional or national system of coastal conservation areas (terrestrial reserves or marine parks) may appear daunting, particularly in countries with extensive shorelines. However, even on small islands, where the task may appear to be easier, such an initiative may prove just as difficult, if not more complicated given the socio-cultural state of affairs usually prevalent on island states and because of common land-use conflicts.

The system planning process should be able to provide an overview of prevailing problems, issues and conflicts encountered by ecosystems (*or* some of the supporting habitats and biota), and people. It is a good point of convergence for conservation and development, and every effort should be made to integrate the two. System planning consists of essentially three primary components:

1) Habitat-type classification;
2) Identification of candidate areas; and
3) Site selection for conservation.

Broadly speaking, these components follow a sequential order, starting with surveys and plans to classify habitats, followed by the other two steps. System planning can be applied at several scales, including:

- Regional planning for sustainable development;
- National planning as a process to integrate conservation into coastal zone management; and
- Analysis of critical coastal habitats of particular species within their ecological range.

A typical sequence of programme development for system planning is outlined below:

a) **Policy/legislation**
   Formalizes an administrative decision to commence a conservation programme, and, as a result, sets the goals for its implementation.
b) **Preliminary planning**
   Interprets the legal framework; sets the planning agenda; identifies the multidisciplinary planning team; and defines objectives.
c) **System planning**
   Identifies issues and conflicts; classifies habitat-types; and provides criteria for site identification.
d) **Site planning**
   Provides a comprehensive implementation schedule, including a design proposal with appropriate delineation, and a management plan for each

sector of the protected area. Site planning also makes provision for future revisions.

e) **Implementation and management**

Responsible for the operational management and development components, and, where necessary, makes recommendations for future improvement.

(Adapted from Salm, 1984)

Planning and managing the conservation area

Conservation area development requires specific planning prior to undertaking the management-related phase. The charting out of management plans takes place during *site planning* which follows the initial phases of the planning process, namely:

a) The administrative decision which, when formalized, establishes the mandate;
b) The defining of objectives; and
c) Completion of the system planning process.

A clear distinction needs to be made between the *planning* and *management* phases. The former provides the mechanism for decision-making on resource-allocation, e.g. through the analysis and selection processes, and through the design and management criteria. The latter addresses the day-to-day operational element required to satisfy the defined objectives of the management plan.

Plan-making for conservation areas

Protected area plans need to be based on sound scientific data, generally obtained through surveys undertaken by a multidisciplinary team of specialists, carrying out studies of each sector within the conservation area. The purpose is to determine and/or identify the following:

a) The type and exact location of localized and/or threatened habitats; the habitat-type's vulnerability and status; and, existence of any specific characteristics such as species diversity, population size, and degree of species dependence.
b) The type and extent of land-uses, conflicts, and other anthropogenic activities; the potential effects these may have on the habitats and biota occurring on site; the level of dependence of *resource users* and *affected locals* on current uses, and, all those activities which may potentially result in the degradation of existing habitats, subsequently leading to a depletion of species' numbers.
c) Existing and potential threats to the zone's or conservation area's resources from anthropogenic activities taking place immediately beyond the area's delimitation.

With such information in hand, the management planning process can proceed to establish objectives for management. Objectives should, in principle, conform to the SMART outline, i.e.

S = Specific
M = Measurable
A = Attainable
R = Realistic
T = Achievable within a defined time frame

A variety of different objectives may be established for conservation areas on the coastal zone. These may include:

- Safeguarding natural processes and supporting elements;
- Conserving habitats and biota;
- Enhancing social, aesthetic and cultural fabric;
- Providing a suitable venue for education and research; and
- Generating sustainable economic revenue.

Zoning is often a key element in management planning. This basically refers to the practice of subdividing an area into multiple management zones, with different objectives and management provisions for each. Intensive management practices may be required in some sectors of the conservation area, whilst other sectors will require limited attention. Zoning should be carried out during the early stages of the planning process, so that any activities within the different sectors can be established in accordance with defined objectives.

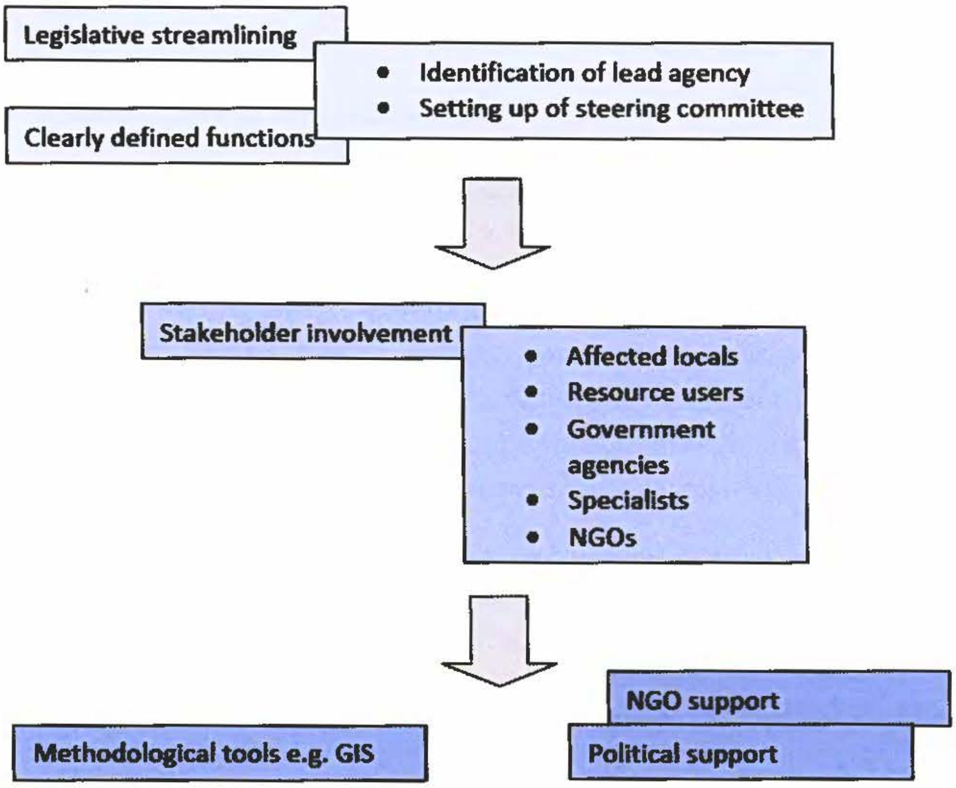
The management plan

The management plan represents a blueprint for the remainder of the management process. The value of a management plan lies in its formally documenting a mandate to follow a specific course of action, towards identified goals, thus guiding routine operational tasks. This mandate is usually established for a specific period of time, generally of three to five years. A management plan has several components, including:

- A description of the site and surrounding areas, including physical, social and economic aspects;
- A description of the policy and legislative context of the conservation area;
- An overarching long-term vision for the site;
- A statement of objectives, including time-frames for implementation;
- Identification of constraints to the achievement of objectives;
- Description of specific management measures;
- Planning of a monitoring schedule; and

- Establishment of mechanisms for evaluation of management effectiveness and management plan review.

Figure 2.1
Some key elements required for planning and management of conservation areas



(Adapted from Cassar, 2000)

Political support

Decisions of when and where to declare protected areas, or how much money should be allocated to protected areas, fall within the domain of politicians. In many countries, where public opinion is deemed important, many politicians have joined, or appear to have joined, the ever-growing ranks of the conservation conscious – their political life depends on public support. In cases where the political decision-maker may have to take an unpopular stance on a controversial issue related to environmentally sensitive areas, an informed public could influence decisions on conservation issues and thus rally the political support necessary to declare and maintain protected areas (Barzetti, 1993).

Public support for conservation areas can take the form of direct or indirect pressure on political decision-makers:

- Direct pressure may involve the provision of information to politicians that will enable them to convince their peers of the importance of establishing protected areas. Until recently, economic or conservation reasons tended to be the common justification, but social concerns are increasingly becoming relevant.

- Indirect pressure often takes the form of public opinion that influences political decisions. In this arena, non-governmental organisations can play a crucial role, in particular since they tend to be independent of official political and economic interests.

Conclusions

In places of extreme land-use conflict, as is the coastal zone, habitat and species conservation is vastly difficult. High population densities place huge demands on natural resources, resulting in complex environmental management problems. In such cases, effective management is dependent on a delicate balance between protected area size and management resources available, and on balancing ecological priorities with social and economic needs within an acceptable political context. Zoning can be an important tool and should be utilised judiciously. Furthermore, conservation areas need to be planned holistically and broadly as part of a wider system, linked by biodiversity corridors in vast ecological networks.

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3. Ecosystem management

Louis F. Cassar

Summary

Ecosystem management represents an alternative philosophy for the exploitation of natural resources by mankind. It is an approach that looks beyond the easily apparent impacts and benefits, to the more complex underpinnings of the man-nature relationship. As a result, the principles advocated by an ecosystem management approach seek to fundamentally alter the way in which we plan and manage natural resources, both for the amenity and welfare of humankind, as well as to ensure long-term ecological integrity. Through the inclusion of key elements, such as adaptive management and stakeholder involvement, an ecosystem management conceptual approach provides a blueprint for more cooperative and ecologically viable management scenarios.

Introduction

Ecosystem management has been variously defined by different authors. In essence, the term refers to an approach to conservation management which brings together a number of key components:

- A hierarchical approach to management, which considers the various levels of biological organisation, including genes, species and ecosystems;
- A focus on ecological, rather than administrative or political boundaries;
- An emphasis on ecological integrity, i.e. maintaining not only species and ecosystems but also functions, patterns and processes;
- Expansion of the information base, to incorporate not only ecological knowledge, but also social and economic knowledge;
- An emphasis on monitoring as the basis for learning, and evaluation of trends, and of impacts of management actions;
- Adaptive rather than reactive management, i.e. an approach where management is seen as an experimental process, with results continually feeding back into the management process, so that actions can be improved;
- Interagency cooperation, with management approaches being based on the combined and integrated input of various agencies, authorities and organisations at various levels, with different areas of expertise;
- A focus on organisational change, from bureaucratic and inflexible structures to flexible organisations that are capable of accommodating change and adapting;
- A perception of humans as entrenched in ecosystems, rather than external to them;
- An emphasis on the need to understand human values, which will ultimately drive conservation priorities.

Ecosystem management may thus be defined as follows:

"An approach which integrates the scientific knowledge on ecological interrelationships and the complex socioeconomic and political frame of values, aiming at the long-term sustainability of a region, i.e., the ecosystem. It includes the human, biological and natural dimensions, and can regulate the internal structures and functions of the ecosystem, and the inputs and outputs from it."

(Pavlikakis and Tsihrintzis, 2000)

Ecosystem versus traditional resource management

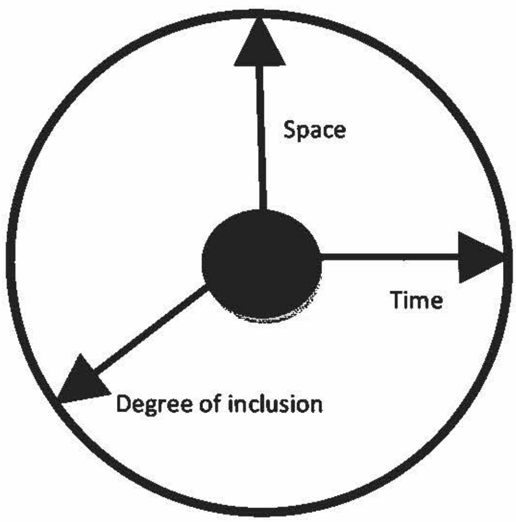
Traditional resource management tended to have a somewhat restrictive view of resources, with an emphasis on economically valuable commodities. Approaches were largely somewhat reductionist, focusing on specific disciplinary viewpoints such as those of biology or economics. Ecological perspectives tended to subscribe to the equilibrium viewpoint of stable communities progressing through a series of seres to a climatic climax community. The objective of management was perceived as predictability and control, with 'engineering-style' solutions developed by resource management agencies, with little input from other stakeholders.

Ecosystem management, in contrast, seeks to achieve a balance between economic commodities, amenities and overall ecological integrity. It embraces a non-equilibrium perspective of ecological systems, where the emphasis is on dynamic change, and where disturbance is a natural component of systems of shifting mosaics. Ecosystem management is not reductionist; rather, it seeks to consolidate a holistic and integrated philosophy. Management fully acknowledges the important role of uncertainty and flexibility, and seeks to develop solutions on the basis of consensus achieved with multiple stakeholders through participatory processes.

Ecosystem management may thus be represented as an expansion of traditional resource management into three dimensions:

i. Time;
ii. Space; and
iii. Degree of inclusion.

Figure 3.1
The expanded dimensions of ecosystem management



Traditional resource management

Ecosystem management

(Adapted from Meffe *et al.*, 2002)

Implementing ecosystem management

Shepherd (2004) identifies five main steps for the implementation of an ecosystem management approach. These are described below.

1. **Defining the stakeholders and ecosystem area**

The first stage focuses on identifying both stakeholders and ecosystem area, and on building a cohesive and logical relationship between the two. It is pointless to try to fit stakeholders to a given ecosystem area when these may not concur with the established boundaries. Stakeholders should be identified and weighted according to their interest in an issue, and relative stakeholder capacity and commitment should be assessed. Mechanisms for continued participation should also be established at an early stage.

The ecosystem area also needs to be established on the basis of logical criteria, including appropriate size and scale to meet management objectives and to fit expertise, resources and knowledge. Management area boundaries should also take account of established political and administrative boundaries wherever possible, as this will simplify the logistics of management; however, ecological boundaries should not be subservient to administrative ones.

Linkages between stakeholder groups and ecosystem areas are best established through managerial systems where different groups manage different areas according to their expertise and interests, at different intensities, within an overarching holistic management framework.

2. **Characterizing the structure and function of ecosystems and setting in place mechanisms to manage and monitor it**

A thorough understanding of ecosystems brings together the expertise of both scientists and local stakeholders, which is likely to be different and complementary. Of particular importance is developing a scientifically accurate understanding of which ecosystem functions are responsible for providing important goods and services for the community. Such a characterisation exercise also serves to identify levels of ecological integrity, and threats to such integrity, thus providing a basis for management actions. The knowledge base will inevitably grow and develop over time, as managers learn from their actions and adapt accordingly.

3. **Identifying the important economic issues that will affect the ecosystem and its inhabitants**

Ecosystem management functions within an economic reality, and it is thus important to identify economic issues that have a bearing on the future of ecosystems or of local communities. In particular, it is important to identify economic incentives and disincentives which affect behavior with regard to natural resources, and to explore ways in which these can be altered to lead to more environmentally benign livelihoods. Such economic analysis will need to be an ongoing activity, as some economic realities will only become gradually apparent, and as markets and other economic aspects change and evolve. The key challenge is transforming the costs of environmental damage from externalities, to internal components of the ecosystem itself. Environmental damage would thus translate directly into economic damage, and likewise, a healthy environment would contribute towards a healthy economy.

Figure 3.2

Washing clothes on the banks of the Oued Laou, Morocco. Many natural areas in the Mediterranean region are of immense importance to human societies. Decisions concerning ecological aspects must therefore also take into consideration the human element. Involvement of stakeholders is critical to the success of management initiatives, as is explicit recognition of the impact that decisions will have on livelihoods.

(Credit: G. Bonett)

4. Determining the likely impact of the ecosystem on adjacent ecosystems

Changes in the components or functioning of one ecosystem can have impacts on another ecosystem. The classic example is of upstream activities having an impact on downstream ecosystems. Some consequences may be less easy to predict. The exclusion of a pest species from one ecosystem may lead to aggregations of the same species in another adjacent one. This is the reason why ecosystem management needs to be adaptive, learning from its actions and changing accordingly. It is also of note that better management in one ecosystem may encourage better management in adjacent ecosystems, thus contributing to addressing of problems at a fundamental level.

5. Deciding on long-term goals, and flexible ways of reaching them

Planning for adaptive ecosystem management involves both short-term objectives and long-term goals. Monitoring is thus a key component of any ecosystem management strategy, as it serves as the guiding light for managerial change. There needs to be the capacity, both scientific and social, to identify problems or negative trends, diagnose causative factors, and develop solutions to them, whilst at the same time being open to the fact that solutions may no longer remain viable in time. It is therefore important that stakeholder involvement is not a one-off event at the start of an initiative but rather an in-built component of the management system, both in its early stages and later on.

Restoration ecology and habitat creation

One aspect of ecosystem management which was absent from traditional resource management is the focus on restoration of degraded areas. It is a sad reality that pristine natural areas are now few and far between, and the vast majority of planet Earth is affected, to some degree, by the activities of the human species. However, degraded areas represent a resource in themselves, particularly given growing expertise in the field of habitat engineering. These represent an opportunity to add to the planet's natural capital account, albeit through human intervention.

Degrees of human intervention vary, depending on initiatives being undertaken. At one extreme, habitat enhancement may simply seek to improve conditions in an impoverished or degraded community. At the other extreme, an entire habitat may be created where previously there was none. In most cases, a balance needs to be sought between the views of the nature conservationist, and those of the landscape architect or horticulturalist. The latter tend to focus more on the creation of aesthetically pleasing areas, whereas the former emphasizes the importance of compatibility with the ecological context. Both approaches have relevance, with the nature conservation emphasis being most important in rural and semi-natural environments, and the horticulturalist perspective being relevant to urban areas.

Conclusions

Ecosystem management has been criticized by some as being a vague and ambiguous term that does not really mean much in practice. Some of this criticism has derived from the difficulty of establishing rigid definitions for ecosystems, yet it is this very rigidity which ecosystem management aims to alter. In nature, there is no sharp line marking the end of a woodland and the commencement of a forest, or the boundary of a population of a species. Ecological dynamics are not constrained by artificial lines and boundaries, nor are physical flows of energy and materials. There is therefore danger in a management approach that seeks to fixedly define that which in reality is flexible and dynamic.

It is true that the implementation of ecosystem management approaches represents many methodological challenges, more so than with traditional command-and-control techniques. However, it may be argued that although it is a more difficult approach in practice, conceptually it is far more realistic and relevant than other management approaches, as it comes closer to reflecting the actual real-world situation. Furthermore, a means for overcoming methodological challenges is to some extent in-built into ecosystem management through the emphasis on stakeholder involvement, which not only leads to greater and more varied expertise, but also ensures better social, economic and cultural acceptability of management solutions, thus rendering these more viable in the long-term.

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4. Stakeholder participation

Elisabeth Conrad

Summary

The shortcoming of several environmental management initiatives in the past decade was the exclusion of social concerns. Environmental problems do not operate in a vacuum; indeed, environmental degradation often directly results in social hardship, and vice versa. Solutions therefore need to address both environmental and developmental strands, a realisation made explicit during the 1992 United Nations Conference on Environment and Development (Rio de Janeiro), where poverty was identified as one of the main causative factors of environmental degradation, and as one of the priorities for action. Even on the scale of smaller projects, exclusion of people is unlikely to result in successful conservation. Rather than being perceived as an extra obstacle, people need to be seen as a resource, and as a partner in conservation initiatives.

Introduction

A stakeholder may be simply defined as someone with an interest in a project, issue or event and who may thus have an interest in related decision-making. Anyone may choose to be a stakeholder, although most common categories of stakeholders include:

- People living/working in areas affected by a project/event/issue;
- People with an interest in resources affected by a project/event/issue;
- People whose resources (financial resources, expertise, time, etc.) have contributed to a project/event/issue;
- People interested in the decision-making process; and
- People who represent constituents or who have a political interest in a project/event/issue.

There are several reasons why stakeholders should be involved in decision-making. Some of these are outlined below:

- **Knowledge**

  People may have various types of knowledge that may complement information obtained by other means. The terms **indigenous knowledge (IK)** or **indigenous technical knowledge (ITK)** are often used to refer to the knowledge base that local populations have accumulated over time, often through oral means rather than written documentation. Such information, accumulated from day-to-day experience of natural systems, and passed down through generations, represents a valuable resource for decision-makers.

- **Effectiveness**

  There is much evidence to suggest that initiatives affecting people are far more likely to succeed when people are actively involved in the decision-making process. As a first step, involvement of stakeholders can serve to identify different perspectives, opinions and attitudes and to evaluate various ideas, all of which can serve to improve implementation of a project. In one sense, stakeholder involvement ensures that decisions are informed by knowledge of the social context. Stakeholder participation may also contribute to a sense of involvement that enhances interest in an issue and leads to higher levels of motivation.

- **Learning**

  Stakeholder involvement can be a learning process for all involved. Decision-makers, official authorities and project leaders may have much to learn from resource users, affected locals, non-governmental organisations, and other individuals from the general public, and vice versa. Public participation events can provide fora and means for such exchange of information.

- **Ethics and human rights**

  It is increasingly recognised that people have a right to a say in decisions affecting them. There have been many instances where locals have been the unwitting recipients of decisions that have fundamentally affected them in a negative manner. The ethical right to local empowerment is enshrined in many democratic societies, although there often remains a gulf between stated principles and revealed fact. In some contexts, stakeholder involvement remains something of a token gesture. However, it is of note that at least in principle, the right to a local say in decisions is now acknowledged.

It should, however, also be recognised that stakeholder involvement involves several difficulties. These include the following:

- **Representativeness**

  It is often physically impossible to have *all* affected people involved in the decision-making process. As a result, it may be difficult to ensure that those who are present truly represent the views of the remainder. Personality aspects may have a large role to play, with a danger of more extrovert and outspoken personalities dominating the process, to the detriment of less outrightly vocal members of the community. There is thus a danger that stakeholder involvement will do no more than legitimate the views of an '*elite*' subset.

- **Resources**

  Setting up mechanisms for stakeholder involvement takes time, and costs money. Such resources also have opportunity costs, as they are resources that could be invested in other ventures.

- **Risk**

  The success of the participatory process often depends, to a substantial extent, on factors such as methods used, experience and skill of facilitators, and the positions and traits of stakeholders, as well as on individual personalities. The success of a participatory approach may therefore be somewhat tenuous.

- **Efficiency**

  'Reinvention of the wheel' may occur, as stakeholders may not be aware of previous work. This may lead to a waste of resources and to piecemeal and fragmented approaches.

- **Compromise**

  The need to accommodate stakeholder views in a decision-making process often requires compromise, which although a positive thing in itself, may have negative repercussions for some environmental assets. Consider, for example, the case of having to compromise on conservation objectives. Some have therefore criticized the participatory process as legitimating the views of stakeholders, whatever their motivation, whilst undermining the viability of other environmental aspects.

Methods of stakeholder involvement

There are several participatory methods at the disposal of the practitioner. The choice of method generally depends on a number of factors, including:

- Objectives of the process;
- Expected outcomes;
- Topic at hand;
- Nature of participants;
- Amount of time available; and
- Availability of resources.

Some diverse methods of stakeholder involvement are outlined below:

Surveys

Surveys are generally carried out using interviews or questionnaires. There are various forms of interviews, depending on the number of people involved and the nature of questions asked. In some cases, interviews are based rigidly on questionnaires, whereas in others, they are based on a semi-structured format, where questions are merely used as a rough guide. The success of interviews often depends on a number of factors, including:

- The physical setting of the interview;
- The sequence of questions;
- The scope of questions; and
- The phrasing of questions.

Questionnaires can also be administered without an interviewer being present, over the phone, by mail, or via email/internet. All questionnaires need to achieve a balance between the amount of questions included, the time required for completion and ease of use, as although long questionnaires may contribute more data, respondent fatigue may compromise the quality of results obtained.

Soft-systems analysis

A distinction may be made between hard and soft problems, where the former often deal with physical components which can be well defined, whereas the latter deal with a large social and political component where rigid definition is not easy or even possible. Soft systems methodologies are guided by a broad *CATWOE* framework, where:

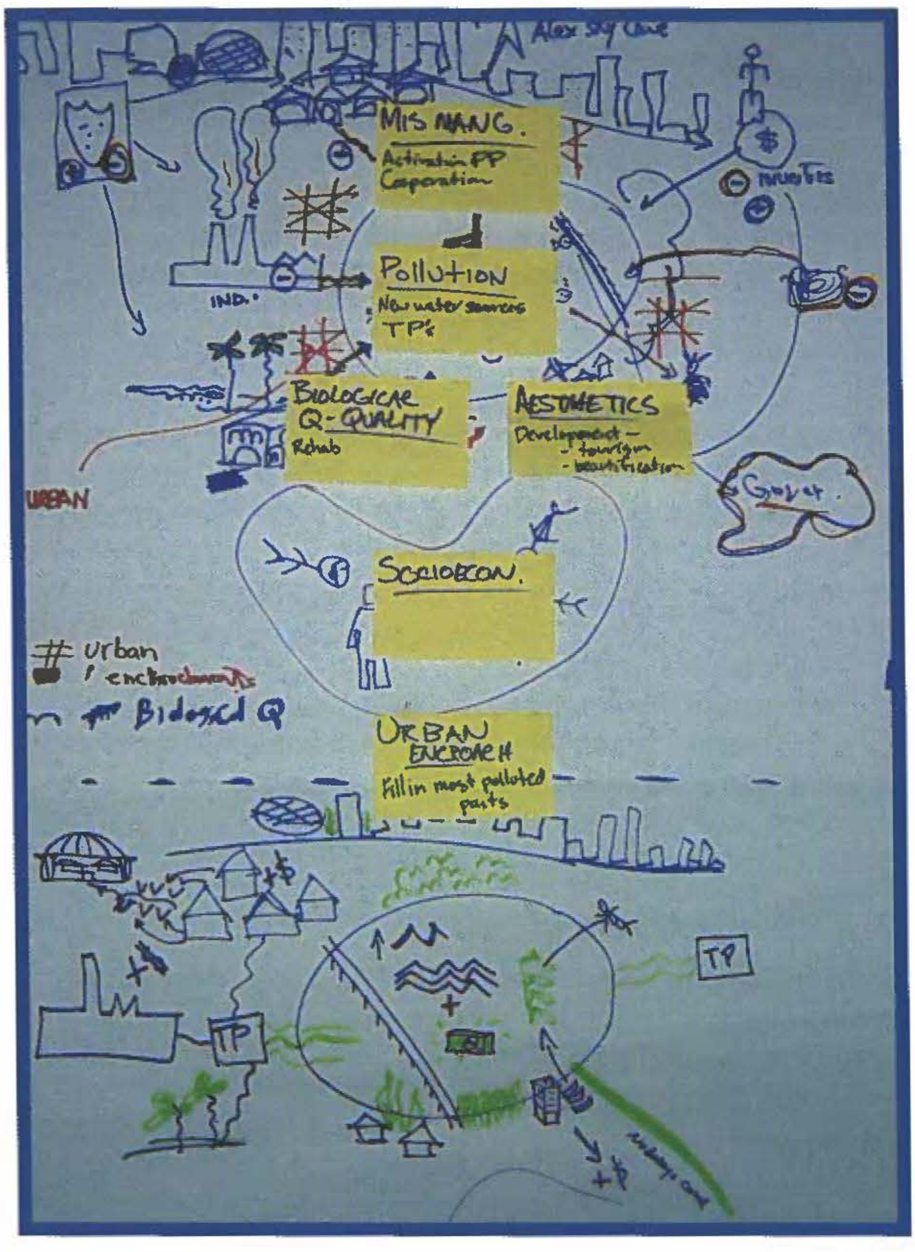
C=Customers (winners/losers)
A = Actors (people who will be 'doing' and implementing)
T = Transformations (process of transforming inputs into outputs)
W = World View (bigger picture and wider impact of a situation)
O = Owners (owners of process/situation)
E = Environmental constraints (broader constraints acting on the situation)

Although there are variants of soft systems methodologies, most involve a number of defined steps:

1) Identification of problem situation;
2) Problem analysis;
    a. Drawing of *rich pictures*
       (i.e. simple visual representations of a situation/problem scenario)
    b. Identification of primary issues/tasks
3) Formulation of root definitions of relevant systems;
4) Building of conceptual models of systems;

5) Comparison of conceptual models with real-world actions;
6) Definition of possible changes which are possible and desirable through debate with actors;
7) Taking action to improve the situation.

Figure 4.1
Extract from rich picture illustrating resource management issues in Lake Maryut, Egypt. Rich pictures provide a simple means for rapidly highlighting a variety of environmental components and interlinkages between these, as well as providing a focus for group discussions.



(Credit: L.F. Cassar)

SWOT analysis

SWOT analysis is a strategic evaluative tool designed to look at four aspects of a situation, problem or scenario, namely:

S = Strengths;
W = Weaknesses;
O = Opportunities; and
T = Threats.

Strengths and weaknesses tend to be perceived as internal value factors, whereas opportunities and threats generally represent external factors.

Participatory rural appraisal

Participatory Rural Appraisal, or PRA, comprises a variety of methods that were originally designed for use in rural contexts in the developing world. They are thus based on the premise that resources are limited, and that respondents may not be able to express their expertise in verbal, particularly written means. The approach of PRA is based on a number of key principles, including triangulation of data sources, reversal of learning such that practitioners learn from respondents, empowerment and facilitation of those involved in the process, the active investigation of exceptions to the rule, implementing trade-offs between efforts and resources and results acquired, and others. Typical methods used include:

- Semi-structured interviewing, where questions serve as a guide for the development of broader discussions;
- Transect walks, where locals walk the 'experts' through an area, indicating their perceptions of zonation for different aspects, such as land uses, geomorphology, hydrology, etc., also identifying problems and opportunities in each zone;
- Wealth ranking, where households are ranked on the basis of material wealth by locals (whether material wealth be defined financially, on the basis of livestock, or through other means) through the use of cards, in order to provide an overview of the social context of a problem;
- Participatory mapping and modelling, where locals construct their own visual representations of a situation or locality, often using very basic materials;
- Time lines and local histories, where chronological sequences are constructed by locals;
- Participatory diagramming, in which locals develop flow charts, pie charts and other analytical diagrams representing their analysis of a situation.

Figure 4.2
Illustration of matrix exercise being carried out as part of a Participatory Rural Appraisal initiative. PRA exercises can be carried out with basic materials in informal settings. In this example, villagers use local materials to highlight correlations between different components in a matrix.

(Artist: Hilda Adhiambo Obyerdyambo; Source: IIRR, 1998)

Conclusions

The suite of methods available for participatory involvement is much wider than outlined above. Each is more suited to a particular situation than others. What is needed is critical judgment in terms of the choice of method, as well as rigour and ethical conduct in its application. Stakeholder participation should not be a token gesture designed to placate but should fundamentally seek to achieve improvements in the decision-making process.

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5. Landscape Ecology

Louis F. Cassar

Summary

Landscape ecology is an emerging and growing discipline that has much potential to act as a bridge between ecological and socio-cultural concerns, thus rendering it very relevant to debates on sustainability. Landscape ecology focuses on a broader spatial context than was usual in traditional ecology, and considers the boundary of ecological problems and issues to extend beyond the ecosystem itself to the broader landscape context. The manifestation of ecological processes in the landscape is seen to be the result of a complex and dynamic interplay between pattern, process and function. The human element is considered to be integral to landscape ecology, with man being one of the main agents shaping landscapes and processes therein.

Introduction

Given that more than half of Europe's land surface is cultivated, a substantial portion of the region's biological diversity is directly or indirectly reliant on anthropic elements. The human dimension, which was added to the 'equation' over time, forms an integral part of that spatial unit referred to as the 'landscape', the study of which requires a multidisciplinary approach as a result of the convergence of various disciplines. Alexander von Humboldt, some two hundred years ago, had already described the term landscape as the total character of a region as determined by existing geophysical, ecological and anthropogenic factors (Barbina, 2001). The perspective of holistic landscape should also take into account aspects of culture and tradition, which are of particular relevance in areas with a long history of human habitation. Landscape is therefore a complex integrated system that comprises spatial patterns formed by biotic, abiotic and human elements and processes. It is a dynamic and holistic concept that bridges process studies and spatial planning.

Specifically, the discipline of landscape ecology involves a focus on the composition, structure and function of landscapes. Space has been described as the 'final frontier' in ecology. Much of ecology has been focused on non-spatial aspects such as predator-prey relationships and nutrient flows. However, if ecology discusses species interactions with a specific environment, then a spatial component is evident, as environments manifest themselves in a specified geographical area. Landscapes thus comprise a mosaic of patches, connected to each other by the intervening matrix. The scope of landscape ecology extends to a study of the patterns of such patches within a matrix, interactions between different landscape elements, both biotic and abiotic, and dynamic changes over time. Landscape ecology also has a practical focus, emphasizing the application of theoretical principles to real-world scenarios related to issues such as habitat fragmentation.

Key themes in landscape ecology include:

- The spatial pattern or structure of landscapes, ranging from wilderness to cities;
- The relationship between pattern and process in landscapes;
- The agents of pattern formation;
- The relationship of human activity to landscape pattern, process and change; and
- The effect of scale and disturbance on the landscape.

Landscape ecology, as the name implies, is the study of landscapes. It has a broader spatial focus than traditional ecology, partly due to its anthropogenic origins. The term originated with the German geographer Carl Troll in 1939, in association with his work on interpreting aerial photographs to study interactions between environmental factors and vegetation. The ideas of landscape ecology are perhaps best illustrated through the words of one of the key initiators of the discipline, Richard Forman:

Look carefully at the big picture out an airplane window or on an aerial photo. The land mosaic displays a distinctive spatial pattern or structure. It works or functions, that is, things flow and move through the pattern. The pattern is dynamic, changing over time. The structure or pattern is normally composed entirely of patches (rounded/elongated, large/small, etc.), corridors or strips (wide/narrow, straight/curvy...), and background matrix (continuous/discontinuous, perforated or not...). Such simple but rigorous attributes opened up the concept of a landscape, well known in other disciplines, to scientists as a research frontier. More to the point, landscape ecology focuses exactly at the scale of human activity.

(Forman, 2005)

The development of landscape ecology

Landscape ecology developed as a prominent sub-discipline of ecology primarily in the 1980s. Today, the discipline is established and growing, attracting interest from scientists both in the physical sciences and in the social sciences. The growth of landscape ecology can be related to a number of factors. One of these is the growth in broad-scale landscape problems, with ecological repercussions. Several issues were increasingly found to have roots in a larger geographical area. A classic example is the issue of acid rain, where source and effect are separated in space and time. Similar problems, such as the decline in fluvial habitats as a result of land use practices in agricultural lands within a watershed, highlighted the need to adopt a broad-scale landscape perspective with a strong ecological component. The urgency of such a paradigm shift was further brought home by growing public awareness of phenomena of global change, such as climatic warming, which are likely to result in ecological range shifts across vast areas of the globe.

Landscape ecology also developed out of changes in traditional ecological perspectives, namely a shift from a belief that ecosystems are balanced, equilibrium communities to acceptance of non-equilibrium views. Conventionally, ecosystems were perceived as 'clockwork' mechanisms, where communities progressed through an established and predictable series of seres to a climax community in a definable sequence. Increasingly, however, it was recognised that ecosystems are not stable and predictable. They are dynamic communities, characterised more by change than by stability, and where disturbance is often an inherent and necessary component. Furthermore, ecosystems are not closed systems, but involve important flows of materials and energy beyond ecosystem boundaries, i.e. at the landscape scale.

There are essentially two schools of landscape ecology, the European and the American.

- **The European school of landscape ecology**

  The European school of landscape ecology places emphasis on typology, classification and nomenclature, and is largely concerned with the cultural dimension and human application of landscape, which reflects the long history of human modification of the terrain within the European landscape. It has its origins in the geographical sciences, with main exponents of these views being Carl Troll and Izaak Zonneveld, both geographers, but has in recent decades veered towards the discipline of planning (Bastian, 2001). The emphasis within the European school is largely on typology and classification.

- **The American school of landscape ecology**

  The American school, which gained prominence during the early eighties, differs from the European school in that it focuses more on natural systems and heterogeneity within the landscape. It makes emphasis on organism-environment relationships, without necessarily invoking anthropogenic factors into the equation (McIntyre, 2001). In North America it is concerned with ecological consequences of larger spatial patterns of biotic and abiotic resources. Broadly, it can be characterised as the study of ecological effects of patches and their interactions. The American school places a larger emphasis on concepts of modelling and theory.

Rather than create divergence, the two schools of thought strengthen landscape ecology, making it an interdisciplinary-multidisciplinary approach that draws upon expertise from geography, ecological sciences, environmental planning, landscape architecture and various other specialisms.

Applications of landscape ecology

The ideas of landscape ecology have found resonance in various disciplines, rendering it a flexible approach with a variety of applications. In particular, landscape ecology is of importance to all aspects of resource management, for three primary reasons:

1) The effect of ecosystem context on natural resources;
2) The interplays of pattern, process and function within an area and resultant effects on resource supply; and
3) The impact of human activities on landscape pattern, process and function.

A landscape perspective thus changes the way in which we perceive, analyze and tackle a problem. As an example, where once a problem of species decline may have been considered to be related solely to predator-prey relationships, food supplies, genetic factors and so forth, a landscape perspective allows for different interpretations. The concept of metapopulations, for example, considers species populations to be spread out in geographical patches, which are linked, and between which there are flows of species, resulting in immigration and emigration. Species success is thus seen to be dependent also on proximity of habitat patches, effectiveness of linking mechanisms and ease of flows. A strategy formulated may thus focus more on reducing fragmentation of landscapes and on creating linkages for connectivity, than on interventions such as manipulating food resources or predator influence.

Figure 5.1
Agricultural landscape in Tuscany, Italy. Landscapes are comprised of mosaics of patches within a matrix, with elements that fragment and divide (e.g. water bodies) and elements that connect and link (e.g. groves of trees, which may act as a stepping stone for species such as birds).

(Credit: L.F. Cassar)

Landscape ecology has helped scientists and managers to appreciate the spatial dimension of ecosystem management, and to understand that many critical issues in ecosystem management should be dealt with at larger spatial scales than the individual patch. Landscape ecology and ecosystem management are thus two closely aligned approaches that link natural processes with the human dimension. Landscape ecology also has much relevance beyond academic dimensions. In decision-making, landscape ecology has made valuable contributions to landscape planning, including through its focus on the human dimension. This has not been limited to ecological concerns, but has also included the importance of aesthetic value. As early as the 1970s, the issue of visual landscape was already being considered an integral part of the spatial planning process, as close emotional ties with one's immediate home environment were regarded as important. It was the emerging discussion of the late 70s and early 80s about ecology and ecological planning that alienated the element of aesthetic and visual values from the central debate. However, with improvement of the possibilities of digital three-dimensional representation and GIS, the socio-cultural aspect once again became integrated into the debate. The versatility of Geographic Information Systems has revolutionised the scope of landscape planning; GIS has widely contributed to the advancement of research that evaluates change over time in the ecological and social fabric of landscapes, while there is an increasing interest in the use of spatial data and GIS in assessing the visual attributes of landscapes.

Landscape ecology in the Mediterranean context

In the Mediterranean, the landscape prescribes to the blend of natural – semi-natural – anthropic components as a result of a strong human dimension that has had considerable influence in determining landscape evolution. Makhzoumi and Pungetti (1999) describe this process as a *"structurally heterogeneous landscape"*. Naveh (1995) considers the Mediterranean landscape a consequence to a co-evolution of the Mediterranean peoples and the limited natural resources available within the region. Thus, it results in changing land-use patterns responsible for the gradual alteration of natural habitats into agricultural systems and, in places, into a semi-natural vegetation cover. Changes in the terrain and topography gradually commenced as early as the Neolithic through primitive agricultural practices and animal husbandry, which led to initial clearance of the sclerophyll Mediterranean forests. As time went by, terracing of entire hillsides took place, while remaining woodlots and forest remnants were periodically exposed to fire. By the classical period, forests were restricted to inaccessible mountainous areas, as extensive tracts of land were converted for the cultivation of cereals and to accommodate the diversion of fluvial systems as sources of irrigation.

By the Middle Ages, when population decline in considerable segments of the region led to the dereliction of entire rural landscapes, most of the forest cover had disappeared. This occurred partly for reasons outlined above and in-part because remaining hardwood was highly valued for fuel, largely for domestic firewood and charcoal, apart from the enormous amounts of wood that were consumed in the course of history for construction, furniture and shipbuilding. Political events, in particular the termination of piracy and marauding parties in the central Mediterranean that made coastal rural areas a most dangerous place, coupled with socio-economic and cultural advancement during the last two centuries, led to an intensification of agricultural systems in many parts of the region. This was followed by the phenomenon of agricultural land abandonment across many parts of the region, which led to the progressive recovery of forest and matorrals. All this and the subsequent phenomenon of mass tourism in the Mediterranean during the last decades have led to land-use patterns that have shaped the complex yet distinctive landscape that we know today. The Mediterranean thus provides a classic example of how landscapes change as an expression of the dynamic interaction between natural and cultural forces in the environment. Cultural landscapes are the result of consecutive reorganisation of the terrain in order to better adapt its use and spatial structure to changing societal demands (Antrop, 2005).

Figure 5.2

Roman ruins in Taormina, Sicily. The Mediterranean region has a long history of human residence, with traces of past civilisations reflected in the landscape to this day.

(Credit: G. Bonett)

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6. Coastal landscape issues

Elisabeth Conrad

Summary

Landscape change is not abnormal, not is it inherently a negative factor. Several of the landscapes we value today are the result of evolution over many centuries or even millennia, with gradual change producing a distinctive character and identity. However, today there is much concern about landscape change that is occurring very rapidly and in a rather standardised manner across the globe, often with a resultant loss in distinctive landscape character which is perceived to be largely detrimental. Such problems are not limited to the coastal region, but are especially marked in this area, where human pressures on land are extreme, and where various, often conflicting, land uses are concentrated in a limited and ecologically sensitive spatial area. This chapter outlines some of the major categories of landscape change issues which are of relevance to the coastal zone.

Introduction

The term *landscape* means different things to different people. The word has its etymological origins in the Dutch word *landschap*, which in turn derives from the common Germanic *land* and the suffix *–schap*, meaning 'constitution' or 'condition' (Makhzoumi and Pungetti, 1999). Early conceptions of landscape are vividly illustrated in the art of landscape painting, often equated with two-dimensional representations of pleasant views, and thus, with an overarching emphasis on the visual.

Landscape is, however, more than the visual aspects of a piece of land. Indeed, we may talk of landscape as an entire experience. Phillips (2005) notes a number of characteristics of the landscape concept, which render it more than merely a passive visual scene:

1) The impact of landscape is felt through **all** the senses – examples include the feel of a breeze, the smell of street food in a market, the taste of sea spray, and the sounds of church bells. All contribute to the landscape experience.
2) Landscape has a two-way relationship with humans. The landscape around us influences our way of life, our values and our very sense of identity, of self. At the same time, we shape the landscapes around us, modifying their physical form and characteristics.
3) Landscape embodies a record of past human land use, showing what generations of people have made of the places in which we now live, thus absorbing multiple layers of meaning.

Driving forces of landscape change

Landscapes are, by their very nature, dynamic. They evolve with altering physical conditions and with changing human cultures. As the latter change, so do land use practices and anthropogenic activities with impacts on landscape. Change is therefore not abnormal. On the contrary, when in 1986, Forman and Godron first propounded a scientific framework for landscape ecology, change (dynamics) was one of the three pillars proposed, together with structure and function. Indeed, today the study of causes, processes and consequences of land-use and land-cover change is one of the main research topics of landscape ecology (Wu and Hobbs, 2002).

However, concern is now being expressed about landscape change that is occurring much more rapidly than has been the case in the past, and that is resulting in the fundamental alteration of landscape character. Landscape character may be defined as the distinctive combination of landscape features and characteristics that together combine to give an area a unique identity, which may be manifested not only in the visual scene but also in the entire experience of a landscape. Landscape change generally has roots that are more complex than what is immediately evident. As an example, an increase in built-up area and resultant urbanisation of a landscape, may be the result of a complex mix of factors, such as population growth, population flows through migration and lifestyle and cultural changes. Bürgi *et al.* (2005) identify 5 main types of underlying forces which are driving present-day landscape change. These are:

1) **Socioeconomic driving forces**, rooted primarily in the economy, particularly the market economy, globalisation and world trade;

2) **Political driving forces**, namely political programs, laws and policy;

3) **Technological driving forces**, including infrastructure such as roads and highways, as well as information technology;

4) **Natural driving forces**, including both site factors (climate, topography, etc.) as well as natural disturbances, both slow-acting (e.g. global warming) and fast-acting (e.g. avalanches, mudslides); and

5) **Cultural driving forces**, as culture structures landscapes while landscapes affect culture.

Manifestations of landscape change

Phillips (2000) identifies at least three broad categories of landscape change. Although his work refers specifically to European landscapes, these categories of change also apply to the southern shore of the Mediterranean, and to other parts of the world, and particularly to coastal areas. These are described below:

1) Intensification

In many coastal areas, there has been an emphasis on getting the maximum utility from particular areas of land. This has been particularly the case in areas with specific place-related advantages, such as an advantageous location for tourism development, or agricultural areas with good soil fertility. The emphasis in such areas becomes maximum returns, in a sense 'squeezing' the greatest amount of use possible out of an area, and local individuality tends to be sacrificed in pursuit of this goal. Thus, as Phillips (2000) notes..."*standardised designs and materials too often replace vernacular architectural styles and local materials, thus destroying the distinctive character of local landscapes*".

Figure 6.1

Coastal urbanisation in Tunisia, enclosing a natural wetland and extending down to the shoreline. Urbanisation has altered the fabric and character of many coastal environments in the Mediterranean, particularly in recent decades. The phenomenon is set to persist given growing populations, particularly on the southern and eastern shores.

(Credit: L.F. Cassar)

The historic fabric of settlements often tends to be sacrificed along the way. The multitude of coastal resort towns clearly illustrate this phenomenon, with hotels and accommodation complexes one near the other, often with no ties to the local land. Indeed, judging by photos of many coastal resorts, these could as easily be located in Tunisia, as in Italy, Spain, Greece or Egypt! The sense of local distinctiveness is being lost.

2) Abandonment

At the opposite end of the spectrum, there have also been areas where landscape problems are the result of processes completely antithetical to those of intensification, namely abandonment and neglect. In some areas of the Mediterranean, the appeal of an urban way of life has led (and is still leading) to large-scale population movements from rural to urban areas, leading to subsequent lack of maintenance of rural features and dereliction. This phenomenon is noticeable in many areas of the Mediterranean, where breached rubble walls, ruins of dwellings and lack of activity are becoming the new characteristics of the rural landscape, a far cry from the once productive and pivotal role that such areas played in the past.

The phenomenon of abandonment is also characterised by vicious cycles. Younger generations tend to seek more vibrant areas of residence, but as these leave, the area becomes even more degraded, particularly as older members of the community pass away. The net result is that the area tends to become less and less attractive to potential residents and more and more degraded. In effect, the process can often only be altered through active intervention at a policy and strategic level.

3) Pollution and resource use/misuse

A third class of landscape changes is the result of pollution, and the use and/or misuse of the resources of land, air and water. The impacts of these on landscape can occur both at local level and at larger spatial scales, even across national boundaries. The issue of acid rain is an example of the latter, as is maritime pollution. Global warming may also be included in this category, as it is a consequence of the misuse of resources (although this point is still subject to some debate). Some landscape repercussions of resource misuse may also be more indirect. An example in coastal areas is the phenomenon of salt water incursion into fresh water aquifers, as a result of over-abstraction. As freshwater supplies are exhausted, sea water is drawn into coastal wells and boreholes. In agricultural areas, this is often the water that is then utilised for irrigation, generally resulting in reduced yields and evident negative impacts on crops. In extreme cases, such scenarios can even lead to land use changes if the land does not remain agriculturally productive.

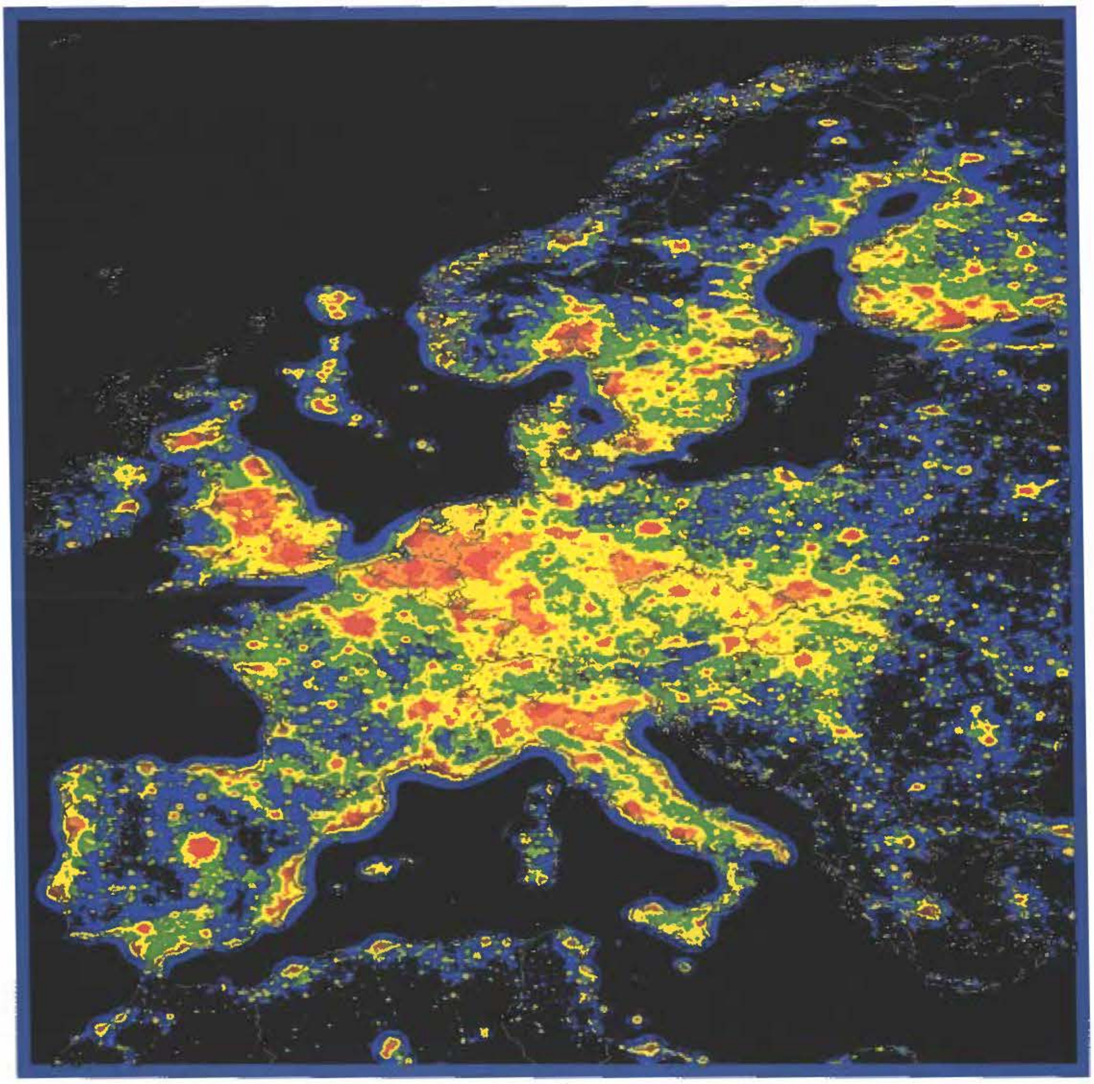
Other coastal landscape issues include the following:

- **Night landscapes**

  Landscape is not limited merely to diurnal environments but also encompasses the world at night. Night landscapes, or nightscapes, have changed rapidly in recent decades, as populations have grown, urban areas have expanded, and technology has succeeded in lighting up the night sky. It is generally recognised, however, that levels of night-time lighting are often far in excess of what is reasonably needed, resulting in light pollution. Light pollution may be of two types. Ecological light pollution has impacts on the life habits of various species of flora and fauna, whereas astronomical light pollution results in obstruction of views of the night sky.

Figure 6.2

Map of artificial night sky brightness. Colours correspond to ratios between artificial night sky brightness and natural sky brightness, with a range from black to red. Night landscapes have been profoundly altered as a result of technological advancements and growing human populations, resulting in spreading urban settlements.



(Source: Cinzano *et al.*, 2000)

- **Habitat destruction and fragmentation**

The greatest threat to biodiversity is today the destruction of natural habitats. However, in an increasingly urbanised landscape, remaining habitats are also rendered less viable through the impacts of fragmentation, which increase edge effects, change abiotic conditions, and render species movements more difficult. The resultant changes in natural and semi-natural landscape are thus not merely the additive sum of the impacts of land area taken up by urban developments. For this reason, there is a growing interest at policy and strategic levels in developing landscape-scale linkages, through wildlife corridors and stepping stones.

- **The legacy of contaminated lands**

  Insights from growing expertise in environmental management have caught up with land-use practices in recent decades. However, the legacy of unwise land use remains to this day in *brownfields* and other contaminated lands. The physical and chemical properties of such sites often severely constrain potential land uses and visual mitigation efforts. The landscape impacts of such areas may also extend far beyond their actual spatial limits, particularly in coastal areas, where the sea may represent a means for rapid diffusion of leachates.

- **Transport**

  Transport infrastructure seems to be established on an upward trajectory in most parts of the world. Car ownership levels continue to grow in most areas, parallel with growing population numbers, and thus infrastructural demands likewise grow. Transport has a major impact on landscape, not only through direct land-take and footprint, but also because it changes landscape in all its aspects. Of particular note is traffic noise, which can rapidly alter the character of an area, as well as vehicular pollution, with its attendant effects.

Conclusions

Although several of the issues outlined above are not *specifically* coastal in nature, they are of particular relevance to the coastal zone, due to a number of characteristics of such areas. The coastal zone is one of the most densely populated areas of the planet, with a concentration of people and their diversity of land uses, often-times conflicting. The intensity of landscape modification is therefore immense, and problems frequently result from the interactions of political, economic, and social activities in an area where ecology and geodynamics exist in a delicate balance. The repercussions of landscape change also extend beyond the visual. Whereas in the past, the identity of several cultures and civilizations was inherently tied to the landscape, the homogenisation of landscapes today is increasingly creating a dichotomy between the land and its people. With the loss of cultural and emotional ties to a landscape, a valuable environmental management resource is being lost. Values are a powerful motivating force for conservation, be it of species or of landscapes, and where values no longer relate strongly to a landscape, this potential is being lost.

One of the greatest challenges to landscape is conceptual, rather than physical in nature. Landscape only made its way onto policy levels at a rather late stage, primarily since the 1990s. In some contexts, landscape is still considered to be a secondary priority, whilst in others, commitment in principle has not been followed up with concrete action. There is also a general reluctance to commit in full to a holistic idea of landscape. The European Landscape Convention defines landscape as an area of land...*as perceived by people*. However, the stakeholder element in landscape management is still weak in many areas, not only due to conceptual difficulties but also due to methodological difficulties. Landscape encompasses a range of both tangible and intangible values, which differ for different people, and which may not be easy to quantify and measure. The challenges for managing landscapes in a way that safeguards physical qualities, whilst allowing for inherent dynamicity, and at the same time finding resonance with social and cultural contexts, are therefore immense. Nevertheless, continued safeguarding of the landscape resource is dependent on the achievement of such a balance.

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7. Economic Instruments and Coastal Management

Stephanie Vella

Summary

The use of economic instruments is based on the rationale that a free market does not take into consideration the environmental costs related to production and consumption. As a result these natural resources tend to be over-exploited. The aim of this chapter is to address the use of economic instruments to rectify market failure. The focus is on the different types of economic instruments including taxes, fees, charges, subsidies, emissions trading schemes and liability schemes with specific emphasis on the existing economic instruments used for coastal management. Finally, important factors which determine the effectiveness of these instruments, and which must be taken into consideration in the initial design of these instruments, are also addressed.

Introduction

The coastal zone is characterised by a wide variety of natural, economic and social conditions. Although during the course of time the importance of coastal zones has been duly recognised, natural coastal resources continue to deteriorate at an alarming rate. Indeed the quality of coastal waters is a major cause of concern, with two spectacular phenomena occurring in recent years, (oil slicks and algal blooms) both of which are illustrations of the fact that coastal communities frequently suffer from the consequences of events or developments occurring inland or offshore, and beyond their control. Concerns related to this deterioration are further exacerbated by the fact that a good proportion of the world's population lives within coastal regions and that coastal zone resources produce a large proportion of economic wealth. Coastal zone deterioration, which is not only caused by local effects but also from transboundary effects, has highlighted the need for an **integrated coastal zone management** (**ICZM**) approach. Indeed, the **European Union** (**EU**) has called on Member States to put in place national coastal zone strategies which address the main coastal zone issues, including badly planned tourism developments, declining fishing industries, poorly conceived transport networks, increasing urbanisation, erosion, pollution and habitat destruction. One of the main principles highlighted in ICZM is the use of a range of instruments, including economic instruments, to deal with the issues highlighted above.[2]

Market Failure

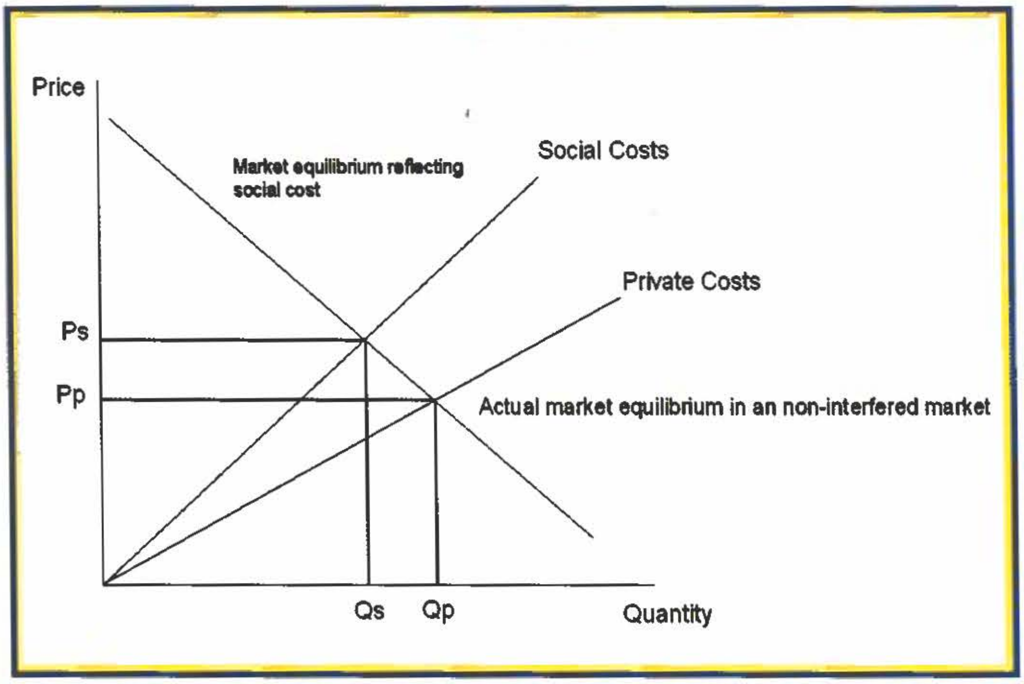
Economic theory is based on the notion that the primary virtue of a market is that it signals to consumers what the cost of a particular good is, and to producers what

[2] Com(2000) 547 Final – Communication from the Commission to the Council and the European Parliament on Integrated Coastal Zone Management: A Strategy for Europe

consumers' relative valuations of goods are. The basic assumption is that producers opt to maximize their profits, and consumers opt to maximise the satisfaction they attain from consumption. The price is the signalling device which is used to allocate resources in an efficient and effective manner. However, the market does not always provide this outcome. Indeed, there are situations where the market fails. Situations of market failure occur where property rights are not easily defined, as in the case for open access resources such as beaches. Difficulties in restricting access tend to result in over-exploitation of these kinds of resources. In this case, the environment can be considered to be a public good featuring non-excludability. However contrary to other public goods, the environment is exhaustible as the mere act of consuming natural resources results in a depletion of environmental resources, with dire consequences for future generations.

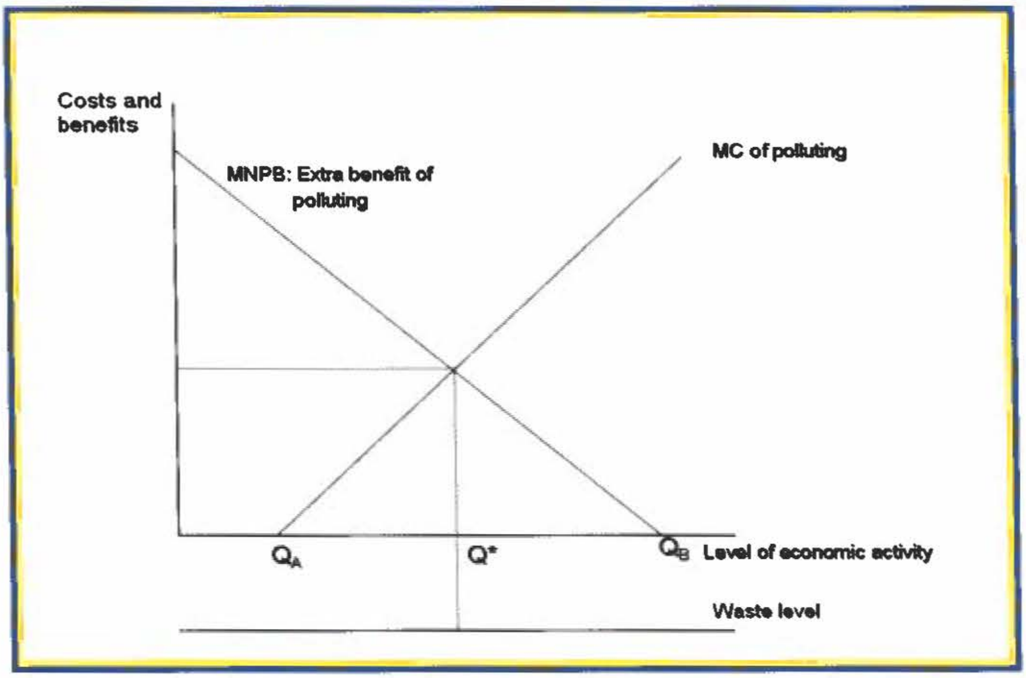
Another case of market failure occurs in situations where effects, typically harmful ones within an environmental context, occur during production or consumption, and where these effects cannot be traced or charged back to the originator. These hidden or external costs are often related to damage from issues such as air and water pollution and waste disposal, and result in soil and species losses, coastal erosion and climate change. These externalities occur because of the divergence between private and social costs as the latter are not internalised into the behavioural functions of the private sector (Figure 7.1). As a result, the outcome of the market (Qp) is not at a level which is environmentally or socially desirable (Qs) and some form of intervention is thus required to rectify this situation.

Figure 7.1
Internalisation of external costs



An important point to bear in mind in this regard is that the solution is not to stall economic activity but rather to find the right balance between economic activity and environmental protection, as shown in Figure 7.2 below. The marginal cost of pollution increases with economic activity, while the extra 'benefit' of pollution falls with economic activity. The optimal point is therefore reached where the marginal cost of pollution is equal to the marginal benefit denoted as Q*.

Figure 7.2
Optimal level of pollution



There are different forms of policy instruments which can be used for intervention purposes. Command and control techniques refer to types of environmental policy instruments that directly impose certain measures on those regulated without leaving a certain freedom of reaction (EEA, 2005). In certain cases, outright bans may be the only means of fully ensuring that the environment is not compromised, such as in the case of oil spills. However, in other cases, a compromise between economic activity and environmental protection is required and therefore an element of flexibility is necessary. In this case, economic instruments tend to be more effective. These instruments, also referred to as market based instruments, aim to bridge the gap between private and social costs by internalizing externalities to their sources. Internalizing the externality typically entails the provision of an incentive, be it remunerative and/or punitive, to induce a change in the behaviour of the entity that is generating the externality. The *polluter pays* principle, which is enshrined in EU legislation, indicates that the price of a good or service should fully reflect its total costs of production, including the costs of all the resources used.

Arguments in favour of market based instruments are based on the notion that these instruments provide an incentive to move from the market optimal level of output to a socially acceptable level (Figure 7.1). The economic rationale behind these instruments is that they provide a stimulus to consumers and producers to change their behaviour towards more eco-efficient use of natural resources. In fact unlike command and control instruments, economic instruments allow the producer/consumer an element of freedom to respond. Moreover, these instruments also tend to stimulate technological innovation (as the introduction of a tax or charge may induce producers to purchase less polluting devices) and allow for greater transparency on the price of environmental degradation thereby increasing consumer and producer awareness.

Types of economic instruments

Economic instruments can be broadly classified into five categories:

1) **Environmental taxes**

   The most widely used definition of environmental taxes is *"a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment."*[3] Environmental taxes are normally designed to change prices and thus alter the behaviour of producers and consumers, as well as raise revenues.

   These instruments are designed so as to internalise the external cost by imposing a tax on the production or consumption of the good creating the environmental damage. The imposed tax results in a change in the price of the good which in turn acts as a signalling device to change the behaviour of producers and consumers. In general these instruments work when the tax is sufficiently high to stimulate measures to abate environmental damage. However, the extent to which this can be attained depends on the responsiveness of demand to changes in prices. In general, when the good in question exhibits an inelastic demand, a 1% increase in price results in a lower than proportionate drop in the quantity demanded, and therefore the instrument is more likely to raise revenue than lower the environmental impact. This should not, however, undermine the effectiveness of this instrument, for in such cases the revenue generated from such an instrument can be earmarked for environmental purposes.

   In the case of taxes, determining the external cost is not an easy feat especially since generally there is a lack of market information. Usually a second best approach is used whereby environmental targets are set at a level and the instrument is used to achieve that target rather than to equalize marginal external costs.

   The most common environmental taxes include fuels excise tax, registration tax on motor vehicles, annual vehicle licenses, registration taxes on vessels, landfill taxes, pesticide taxes, as well as virgin material taxes.

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[3] Eurostat (2001)

2) **Environmental charges and fees**

Environmental charges and fees are defined as *"compulsory and required payments to general Government or to bodies outside Government, such as environmental funds or water management boards."*[4] Environmental charges are normally designed to cover (in part or in full) the cost of environmental services (such as water and electricity) and abatement measures (such as wastewater treatment and waste disposal). This kind of instrument encourages efficient use of the resource and therefore discourages waste.

Environmental charges are usually sensitive from a social, strategic and/or political perspective and therefore their prices often tend to be influenced by public policy, as opposed to being market driven. As a result, prices for such products do not necessarily reflect competitive market prices. In fact, in several instances they are offered at subsidized prices relative to the internal cost of production, which not only results in a misallocation of resources but also in excessive demand for such products.

The most common types of environmental charges include water and electricity charges, water abstraction charges, waste water charges, household waste charges as well as product charges.

3) **Environmental subsidies and incentives**

Environmental subsidies and incentives are defined as *"any measure that keeps prices for consumers below market levels, or for producers above market levels, or that reduces costs for consumers and producers."*[5]

Subsidies have generally been designed to stimulate development for new technologies, to help create new markets for environmental goods and services including technologies, to encourage changes in consumer behaviour through green purchasing schemes, and to temporarily support achieving higher levels of environmental protection by companies. To be effective, they should be structured in a manner so as to avoid dependency by possibly being time limited.

The most common types of subsidies include grants for investment in solar and photovoltaic technologies, water capture devices and electric devices. Other forms of subsidies include preferential loans for environmentally friendly goods. Support schemes which guarantee the purchase of renewable electricity are also proving to be effective.

4) **Tradable permits**

Tradable permits are defined as "*an economic policy instrument under which rights to discharge pollution or exploit resources can be exchanged through either a free or a controlled permit-market*".[6]

[4] European Environment Agency (EEA) (2005)

[5] OECD (1998)

Tradable permits have generally been designed to achieve reductions in pollution, such as reduced emissions of carbon dioxide, or to control use of resources, such as in the case of fish quotas through the provision of market incentives to trade. The design and implementation of this instrument are key elements which determine the success or failure of such an instrument. In fact, the initial allocation is an important factor which determines the effectiveness of tradable permits, as a high initial allocation tends to swamp the market whilst a low initial allocation will increase the price of the tradable permits, possible deterring the competitiveness of firms.

5) **Liability and compensation**
Liability and compensation schemes are aimed at ensuring adequate compensation for damage resulting from environmentally dangerous activities. These schemes can offer great potential for the prevention and reinstatement of environmental damage. However, they are still relatively new and experience shows that there are a number of limitations in the use of this instrument, including the danger of increasing right of recourse and expensive legal processes.

Rise of economic instruments

Internalizing environmental costs is an important constituent of sustainable development. In fact the critical role of economic instruments and their contribution to sustainable development was duly recognised by the United Nations Conference on Environment and Development in Rio de Janeiro, June 1992. Principle 16 of the Rio Declaration states: *"National authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution with due regard to public interest and without distorting international trade and investment"* (UN, 1992).

In terms of coastal management, this importance is reiterated in a policy recommendation by METAP III (World Bank and MAP) which states that policy should be directed towards *"exploring opportunities for the appropriate use of economic instruments related to project financing"*.[7] The OECD, in its recommendation to the Council, also recommends the *"application of regulations and economic instruments within the framework of the Polluter Pays Principle and pricing coastal zone resources to reflect social costs of use and depletion"*.[8] Moreover, the Communication from the Commission to the Council and the European Parliament on *Integrated Coastal Zone Management: A Strategy for*

[6] European Environment Agency (EEA) website: http://glossary.eea.europa.eu/EEAGlossary
[7] Ennabli and Whitford (2005)
[8] Recommendation of the Council on Integrated Coastal Zone Management, 23 July 1992 C(92)114/Final.

Europe also refers to the important use of economic instruments required for effective coastal zone management[9].

Coastal management

The importance of coastal management is highlighted by the fact that throughout the world there is a coastline of 1,634,701 km, with almost 40% of the world population living within 100 km of the coast.[10] In the EU alone, there is a coastline of 68,000 km, which is three times larger than the total land area of the US and twice that of Russia.[11] In an EU context, the significance of the coastal area is exacerbated by the fact that no European resident lives more than 700 km away from the coast and over half of the population lives less than 50 km away from the sea. Economically, maritime regions within the EU account for over 40% of **Gross Domestic Product** (**GDP**).

In most countries, coastal areas have the highest population density, the most favourable climatic conditions, the best agricultural land, and an increasing concentration of urban conglomerations, industry and tourism development. At the same time, coastal areas also host some of the most fragile natural ecosystems and historical sites (PAP/RAC, 2001). Continued environmental degradation and resource depletion in coastal areas will have severe economic implications for several important sectors, and will also threaten human health and well-being, not only of the present generation but also of future generations.

Economic instruments and Coastal Zone Management

The management of coastal zone resources is generally dominated by regulatory approaches. However a wide range of economic and financial instruments is also being used for a variety of purposes.

Juhasz (2001) indicates that based on overall experience, some of the following examples of economic instruments have been found to be most effective in coastal areas:

- Emission charges on household wastewater;
- Water pricing for household and industrial water; charges should be set to discourage waste water discharge and limit water resources;
- Sea port charges;
- License fees on fishing to limit exploitation of resources;
- Tradable permits for fishing;
- Boat registration fees, typically set according to the engine power of vessels;

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[9] Com (2000) 547 Final – Communication from the Commission to the Council and the European Parliament on Integrated Coastal Zone Management: A Strategy for Europe

[10] World Environment Day, 2000

[11] Com (2006) 275 Final – Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Towards a future Maritime Policy for the Union: A European Vision for the Oceans and Seas

- Taxes on fertilizers, to limit water and soil pollution;
- Taxes on land development to limit urbanisation;
- Reduction of subsidies on polluting activities;
- Subsidies for land conservation; and
- Energy pricing for transport activities.

There does, however, seem to be scope to increase further the use of economic instruments for coastal zone management, particularly to target the following issues:

- Uncontrolled urban sprawl and construction in near coastal areas;
- Water scarcity and freshwater demand;
- Adverse impacts of tourism;
- Pollution of coastal waters from land-based sources;
- Loss of marine and coastal biodiversity;
- Coastal erosion;
- Fisheries; and
- Operational and accidental pollution by oil and marine debris from maritime traffic.

Designing economic instruments

The effectiveness of economic instruments to target the environmental considerations strongly depends on their design. Crucial aspects to take into consideration when designing instruments include:

1. The policy objective at hand, that is, whether the aim is to reduce pollution, control resource use, reduce product use, raise compliance costs or raise revenue.

2. Matching which of the economic instruments would achieve the best results with regard to the problems identified.

3. Assessing the effectiveness of economic instruments by taking into consideration the potential of the instrument to effectively implement the *polluter pays* principle through the internalisation within market prices of the external costs of the economic activity, as well as the potential for an instrument to yield significant environmental benefits in terms of altering relative prices with a sufficiently elastic market response, while avoiding perverse reactions.

Other important considerations include the extent to which an instrument is likely to be fair (that is, propound the concept that the polluter would pay), the potential social effects of an instrument (in terms of not resulting in unacceptable burdens on society, and especially on the more vulnerable segments), as well as the consistency of an instrument with overall economic policy objectives. Policy makers must also take into account the degree to which an instrument is credible and understandable by the public, as well as the available capacity to implement and enforce the instrument.

Conclusions

There is no doubt of the environmental, social, economic and cultural importance of coastal zones, yet despite their importance, activity within these areas continues to result in an over-exploitation and degradation of resources. The reason for this degradation is that in a free market, the external costs associated with the use of these resources is not factored into the decision making abilities of consumers and producers. As a result, some form of market intervention, usually though economic instruments, is required to rectify this outcome.

A number of economic instruments such as taxes, charges and fees are already being used for coastal zone management purposes. However there is still scope for new and better instruments to target areas of particular importance such as water scarcity, marine and air pollution, the adverse impact of tourism and over-exploitation of fisheries. The effectiveness of instruments in targeting these areas depends on an array of factors which must be taken into consideration when designing instruments. Finally, it must also be borne in mind that economic instruments are not a panacea for dealing with environmental concerns, but they can help bridge the financing gap of sustainable development by encouraging behavioural change, whilst also raising revenue for environmental protection. The ability to reduce environmental degradation therefore depends on such instruments, but also on other support mechanisms including institutional factors and commitment.

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8. Geographic Information Systems

Charles Galdies

Summary

Geographic Information Systems represent a powerful tool for the coastal manager. Since its early days, the applications of GIS have expanded greatly, aided by other technological developments in fields such as remote sensing. GIS can collate and rapidly analyze vast quantities of spatially-correlated data, within different thematic fields, whilst also facilitating communication of results. Applications of GIS for habitat mapping in the coastal zone are discussed in this chapter.

Introduction

Answering spatial related questions requires access to geographical information that has to be multidimensional and arranged in a consistent and integral form. The science, engineering, and technology associated with answering geographical questions is called **Geographical Information Systems** or **Geographic Information Systems** (**GIS**). GIS is a generic term denoting the use of hardware and software to create and depict digital representations of the Earth's surface.

Since its early development in the 60s, GIS has developed into a major area of application, research and business, and is now recognised as part of the information technology mainstream. It involves a complete understanding about patterns, space and analytical processes needed to approach a spatial problem.

Several factors have assisted the rise of GIS. These include:

- Rapid advancement in information and communication technology, assisted by developments in computer technology and speed, remote sensing and **Global Positioning Systems** (**GPS**);
- Communication Technology;
- Enhanced functionality of software, their user-friendliness, and improved graphical display and mapping; and
- Recognition of GIS as a powerful business and marketing tool.

Defining GIS

GPS, aided by modern technology, is providing us with an opportunity to geo-reference every feature on the earth's surface. This has opened up the opportunity to associate any database to GIS. The term 'database' here refers to a collection of information about things and their relationship to each other, and 'geo-referencing' refers to the location of a layer or coverage in space defined by a specific co-ordinate referencing system.

A GIS is an information system designed to work with data referenced by geographical coordinates. This system is therefore both a database system with specific capabilities for spatially referenced data, as well as a set of operations for working with the data.

These operations are very often determined by the degree of complexity of the GIS software. The role of the GIS software is to integrate common database operations, such as query and statistical analysis, with the unique visualisation and geographic analysis benefits offered by digital maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for mapping baseline information, explaining events and relationships, forecasting and modelling, and planning scenarios.

The use of GIS for habitat mapping

Habitat mapping is crucial in assessing the current state and alternative designs in coastal habitat conservation and in order to understand relevant landscapes. Generally, habitat distributions of many important species are poorly known and published accounts of known populations are few; therefore, habitat modelling based on environmental characteristics needs to be carried out so as to provide the most complete, scientifically based depiction of species habitat. The process of field surveys can identify key environmental variables describing habitat and when integrated with a GIS, biologists can score environmental characteristics for each species. GIS models can then be built based on these environmental parameters resulting in maps of high, medium, and low potential habitat. The resulting habitat maps can then be reviewed, revised and modelled. This iterative process of GIS analysis and biological review should result in refined models that more closely represent particular (such as baseline or vulnerable) species habitat.

Following baseline mapping, spatial databases can be continually augmented with additional spatial features throughout the map review process. GIS can be used to generate habitat models for species by summarizing key environmental characteristics that comprise species habitat.

The quality of resulting GIS models depends on both the accuracy and resolution of environmental mapping characteristics for each species. The advantage of using GIS is that it is an unbiased, systematic approach to synthesizing large amounts of information. Furthermore, all model parameters are explicit which facilitates review and revision. Multiple updates to GIS data layers for environmental variables in the species-environment matrix can be added at a later stage.

The inclusion of a GIS component in habitat management guarantees an effective tool for current and future monitoring and planning of coastal habitats and landscapes. The following aspects can be assisted by GIS:

(a) Project Planning

The use of GIS is of particular advantage in detailed planning of projects having a large spatial component, where analysis of the problem is a prerequisite at the start of the project. Generation of thematic maps is possible on one or more than one base maps, such as the generation of a coastal habitat map on the basis of its topography and any related rural fabric.

(b) Decision Making

Better information leads to better decisions. GIS is a tool to query, analyze, and map data in support of the decision making process.

(c) Visual Analysis

Digital Terrain Modelling (DTM) is an important utility of GIS. Using 3D modelling, coastal landscapes can be better visualised, leading to a better understanding of certain relations in the landscape. Many calculations relevant to coastal landscapes, such as soil erosion risks and hydrological modelling become easier (Figures 8.1/8.2).

Figure 8.1

GIS vector coverage of assemblages located in the Ghajn Damma area of Gozo.

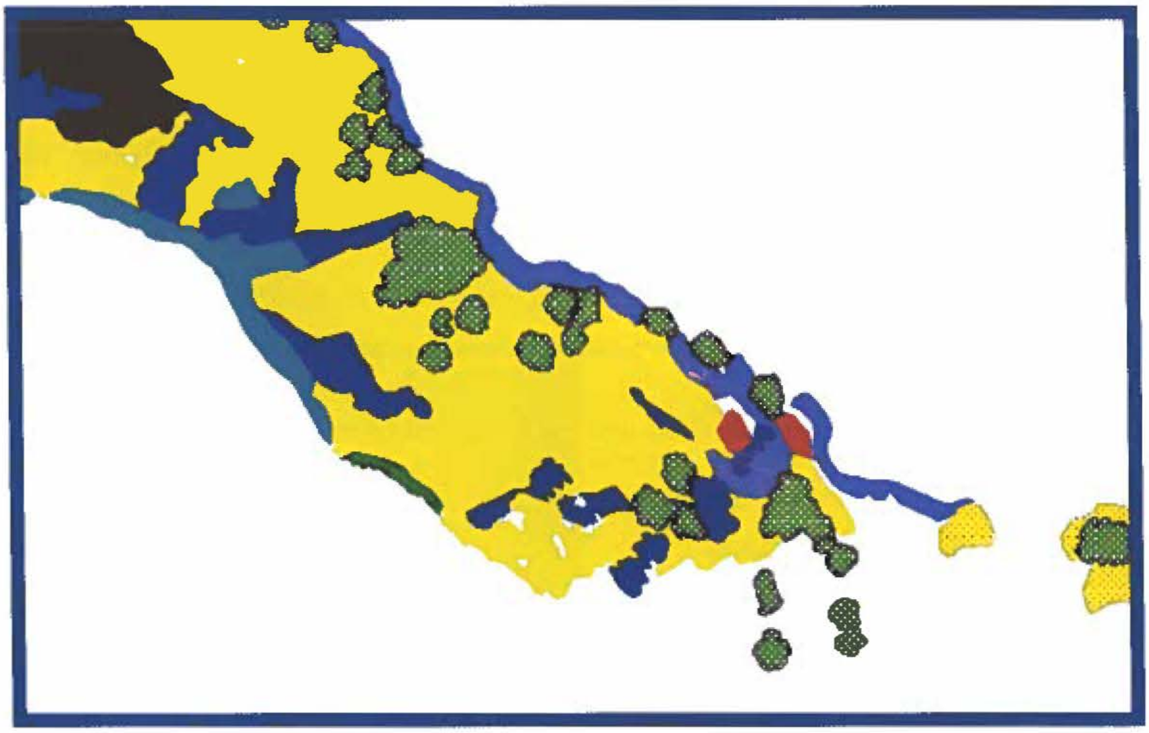
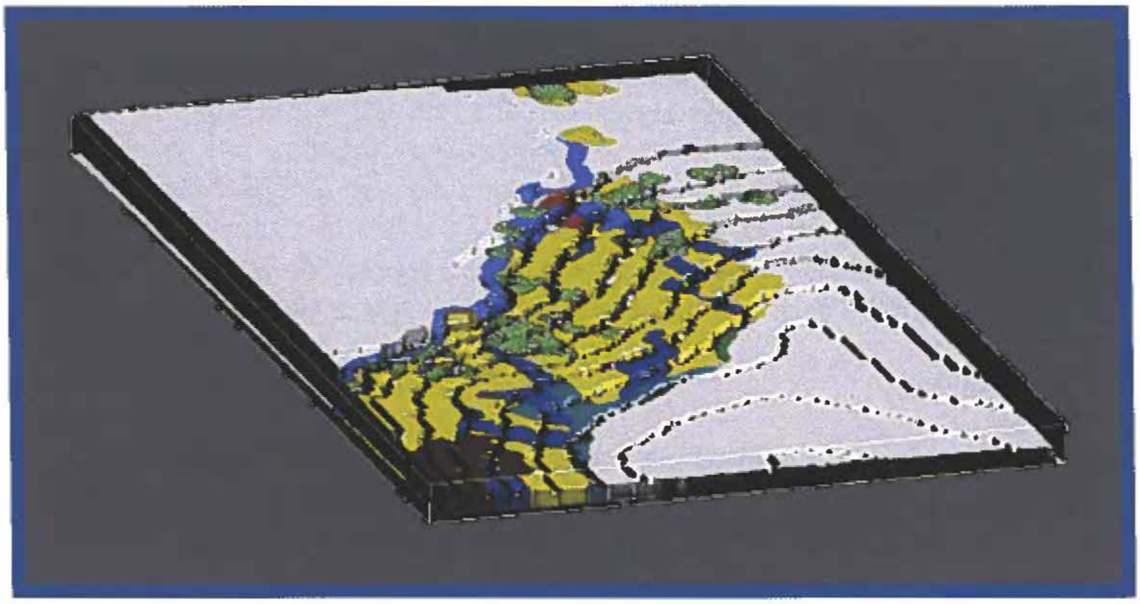


Figure 8.2
GIS vector data representing the location of different assemblages found in the Ghajn Damma area, superimposed over coastal topography.



Components of GIS

GIS comprises four key components:

(a) Hardware

It consists of the computer system on which the GIS software is executed. The computer forms the backbone of the GIS hardware, which gets its input through the scanner or digitizer. Large-scale printers and plotters are the most common output devices for a GIS hardware setup.

(b) Software

GIS software provides the functions and tools needed to store, analyze, and display geographic information.

(c) Data

Geographic data and related tabular data can be collected and generated or purchased from a commercial data provider (if available). The digital basemap forms the basic data input for GIS. Tabular data related to the map objects can also be attached to the digital data. A GIS will integrate spatial data with other data resources, including images, to better manage and understand spatial data.

(d) Method

Various techniques exist to create and use maps. Maps can be created either automatically (using raster to vector conversion) or manually vectorised from scanned images. Data can be obtained either during field surveys or through remote sensing techniques (such as aerial photographs or satellites).

The GIS Process

Case Study: Baseline mapping of floral assemblages

Mapping Concepts, Features & Properties

A map represents geographic features or other spatial phenomena by graphically conveying information about their locations and attributes. Locational information describes the position of particular assemblages, as well as the spatial relationship between them, such as proximity between different assemblages, buffering areas, and so on. Attribute information that is compiled in the spatial database for each assemblage describes their geographic characteristics, such as assemblage type, name or number and quantitative information such as its area or length.

The basic features of GIS mapping include points, lines and polygons representing the different assemblages. These map features, together with ancillary spatial and aspatial information, describe the geographic variable.

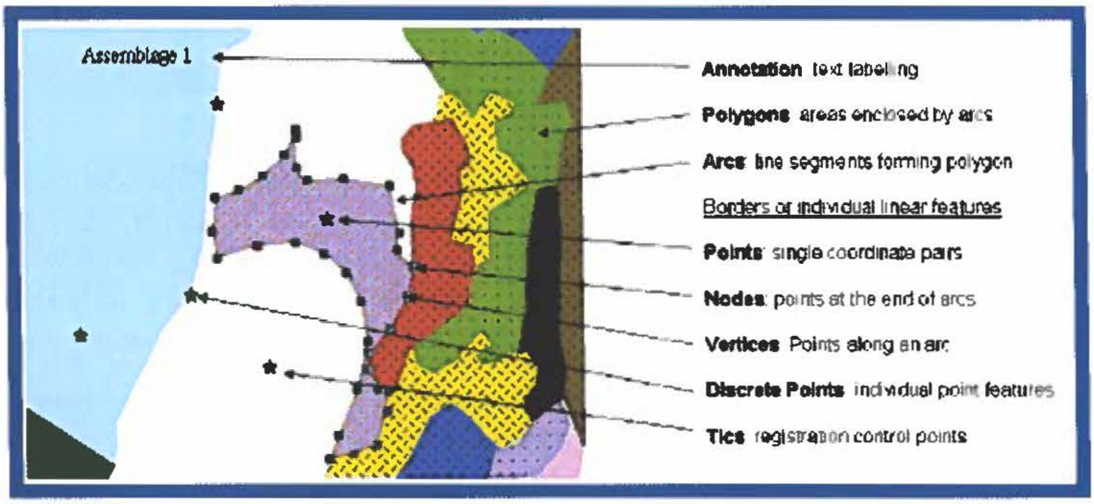
Digitisation

In a vector map representing the different assemblages, a feature's position is normally expressed as sets of X, Y pairs or X, Y, Z (height), using the coordinate system defined for the map. Most vector geographic information systems support three fundamental geometric objects (Figure 8.3):

- *Point:* A single pair of coordinates.
- *Line:* Two or more points in a specific sequence.
- *Polygon:* An area enclosed by a line.

Figure 8.3

GIS Map Structure defining the main vector features.

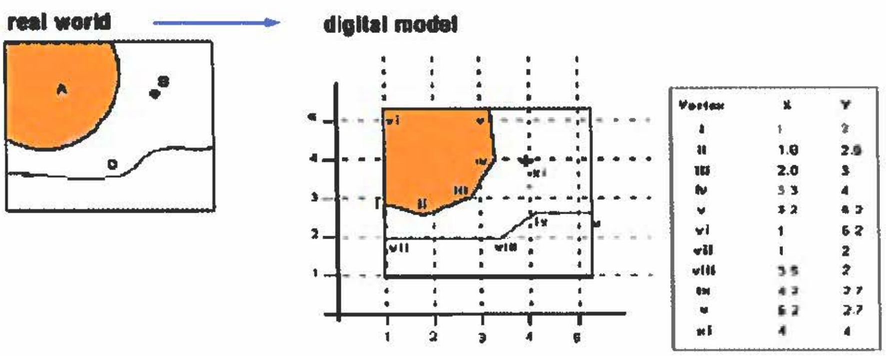


However, the majority of GIS datasets represented in vector format often have inherent representational error that arises from the vectorisation processes (Figure 8.4). GIS propagate this error through various stages of computation, yielding a GIS product or result that often has unexpected errors, which may impact the integration of additional models.

Precision in GIS is constrained by the following:

1. GIS precision is limited by computational hardware.
2. All spatial data have limited accuracy which may be expressed in terms of positional error, measurement error, surveying error, spatial error, classification, stationary error, and relational errors.
3. Other errors.

Figure 8.4
Approximation of the digitisation process.

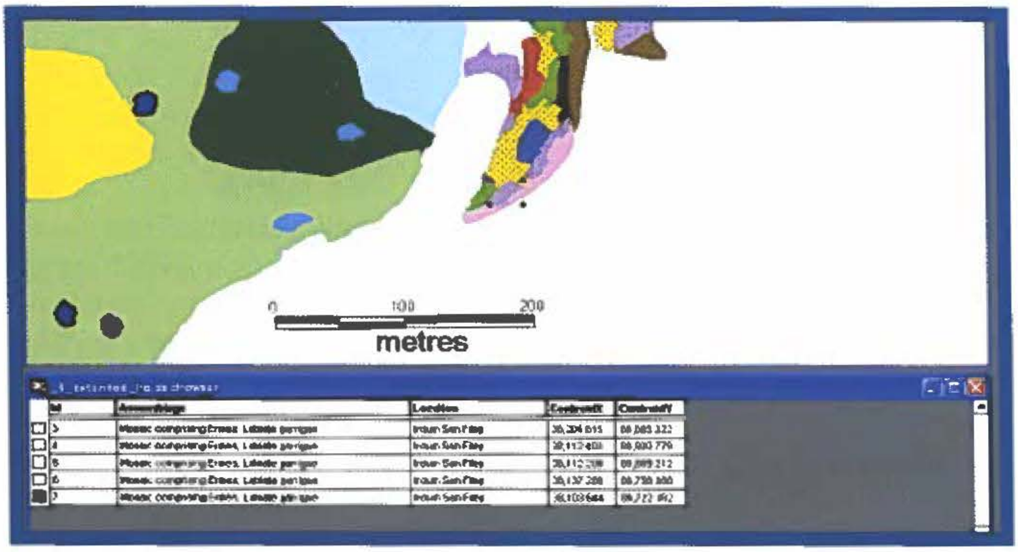


Attribute Information

Attribute data describes specific map features but is not inherently graphic. Attributes are often stored in database files kept separately from the graphic portion of the map.

GIS software packages create internal linkages between graphical maps and their attribute information (Figure 4). The nature of these links varies widely, such as those that are implicit in the system (where the user has no control) and others that are explicit (user-modified). As in any database, each feature or attribute has a key value stored with it which identifies the specific database record that contains the feature's attribute information.

Figure 8.5
GIS Attribute database linked to thematic map.



Overlaying

Various GIS enhancements increase the usefulness of the resulting maps. These include:

- Project-related feature colours and line types;
- Landmark symbols and availability of a digital base map;
- Polygon fills; and
- Zoom layer control.

Most GIS software have a system of layers, which can be used to divide a large map into manageable pieces. For example, all floral assemblages could be combined on one layer or separated according to the type. Overlayed over this information can be other relevant information such as landscape features, footpaths, or country roads.

GIS Spatial Analysis

Spatial analysis helps the GIS user to identify trends on the data including spatial and temporal trends, to create new relationships from the data and to view complex relationships between different data sets (assemblages). This analysis will ultimately lead to a better decision.

The organisation of a database into map layers provides rapid access to data elements required for spatial analysis. The objective of the analysis is to transform data into useful information to satisfy the requirements or objectives of decision-makers at all levels in terms of detail.

In the case of habitat mapping, examples of geographical analysis procedures include:

- Database query;
- Proximity analysis;
- Overlaying operations;
- Buffer operations; and
- Statistical and tabular analysis.

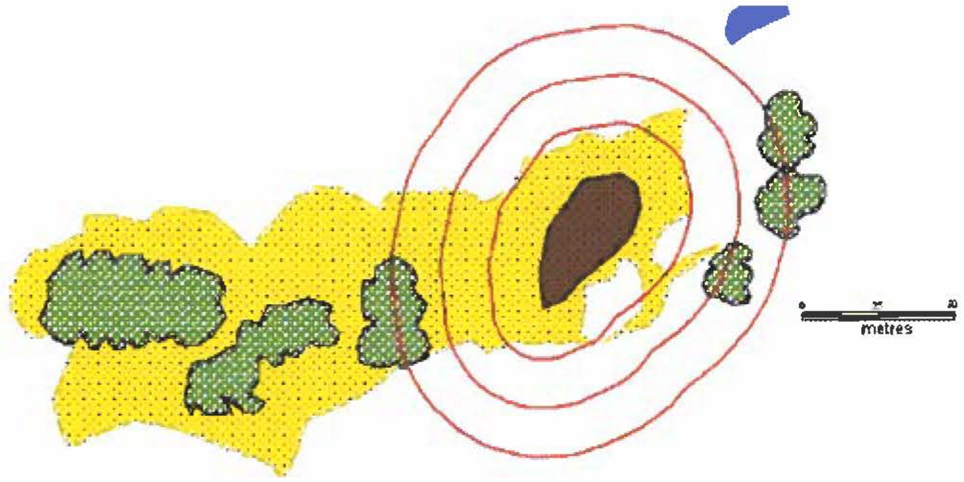
Database Query

The selective display and retrieval of information from a database are among the fundamental requirements of GIS. Database query simply asks to see already stored information. For example, the software can be asked to display all those floral assemblages that occupy an area of more than 30 m^2. Many GIS software include a sophisticated function known as **Standard Query Language (SQL)** to search a GIS database. The attribute database, in general, is stored in a table (relational database mode) with a unique code linked to the geometric data and the data can be searched with specific characteristics. More complex queries can be made with the help of SQL query facility.

Proximity Search

Using spatial proximity operations, the characteristics of an area surrounding a specified location or an assemblage can be evaluated. Spatial proximity is used whenever analysis is required to identify surrounding geographic features. The buffer operation, for example, will generate polygon feature types irrespective of geographic features, and delineates spatial proximity (Figure 8.6). Spatial questions can be analysed in a GIS environment, such as the spatial impact of widening coastal roads and footpaths on particular assemblages.

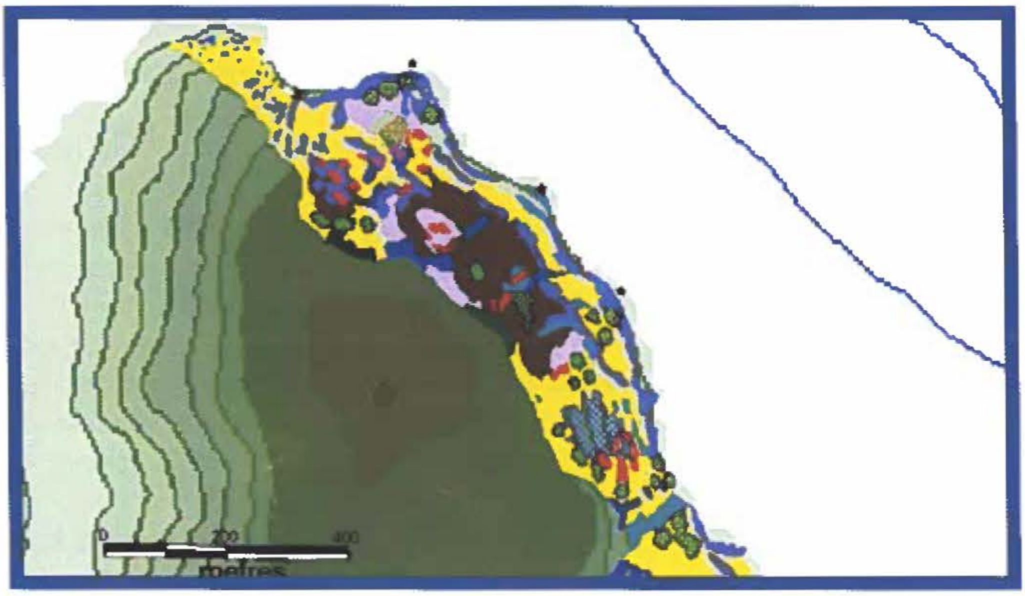
Figure 8.6
Projection of 15m buffer zones for an Ononis natrix consolidated dune area assemblage along the Qortin ta' Ghajn Damma, Gozo, Malta.



Overlay Operations

Using these operations, new spatial elements can be created by the overlaying of maps (Figure 8.7). In raster overlay, the pixel or grid cell values in each map are combined using arithmetic operators to produce a new value in the composite map. The maps can be treated as arithmetical variables and perform complex algebraic functions known as map algebra. This ability is particularly important for modelling analysis in which various maps can be combined using various mathematical functions. Conditional operators are basic mathematical functions that are supported in GIS and are used for these purposes.

Figure 8.7
Overlaying of assemblages along the Qortin ta' Ghajn Damma, Gozo, Malta, and topographic map. Highest peak is 100m above sea level (10m contour lines).



Statistical and Tabular Data

Spatial databases form the basis of a GIS. They consist of attribute features stored in a tabular form. These files have spatial relationships with mapped vector features and allow GIS users to input, query, and manipulate information within single or multiple geospatial tabular forms. Table 1 provides an example of statistical derivative (total area of assemblage in m^2) from tabular data specific to one type of floral assemblage located and mapped at the *Ta' Tocc* area, in Gozo, Malta.

Table 8.1
Statistical spatial feature (total area in m^2) of one type of assemblage located and mapped within the Ta' Tocc area, Gozo.

Assemblage	Total Area
Ermes together with Labiate garrigue based upon *Thymbra capitata* and *Teucrium fruticans*	83,592 m^2

Presentation and analysis of maps

One of the main goals of GIS is to prepare and analyze maps. The creation of thematic maps is an important feature of GIS, and this functionality constitutes one of the main tools to present baseline and modelled geographical concepts, such as density and distribution of floral assemblages, coastal land use conservation, and others.

The geographic information in a digital map provides the position and shape of each map feature. Thematic maps display information that describe and interpret the final map. Common display information includes feature colours, line widths and line types (solid, dashed, dotted, single, or double), scale-bar, and geographic positioning, amongst others.

9. Environmental Impact Assessment

Elisabeth Conrad

Summary

Environmental Impact Assessment (EIA) has become established as a key component of environmental strategies in many countries. It has its origins in the United States of America, resulting from the passage of the **National Environmental Policy Act (NEPA)** in 1969. Since that time, EIA has developed into a systematic process, and numerous methodologies have been developed to aid practitioners in their task of identifying, assessing and evaluating the impacts of a development on the natural and social environment. The application of impact assessment has also been expanded beyond the realm of the individual site, to encompass strategies and policy through the development of **Strategic Environmental Assessment (SEA)**.

Introduction

Environmental Impact Assessment may be defined as a process to determine the likely impacts of a development project on various components of the environment, both natural and human. The purpose of the EIA process is to enable decision-makers to make informed judgments about project proposals. The output of the EIA process is a report, known as an **Environmental Impact Statement (EIS)**, or **Environmental Planning Statement (EPS)**, which communicates the result of the study to decision-makers.

The EIA process

The EIA process involves a number of discrete stages, described below:

1) Screening

During the screening stage, the responsible authorities decide whether or not a development proposal merits an environmental impact assessment. Since the EIA process is costly and time-consuming, it is not feasible for EIA to be a blanket requirement for all developments. There are cases when the likely environmental impacts simply do not merit the time and resources of an EIA. Decisions made at the screening stage thus weigh the likely impacts of a proposed development, to distinguish between cases where the potential impacts are likely to be substantial and those where they are not. This is often done according to established criteria, which may cover issues such as the following:

- The characteristics of a development
  - Footprint in terms of physical size
  - Use of resources in the construction and operation of a development

- Likely production of waste
- Likely production of pollutants and nuisances
- Operational hazards and risks involved, including probability of accidents

- The location of a development
  - Environmental sensitivity of site
  - Existing land uses
  - Absorption capacity of the natural environment
  - Threats posed to environmental components
  - Cumulative effects of the development when considered in combination with other developments in the area

- Characteristics of potential impacts
  - Spatial extent of impact (including potential transboundary impacts)
  - Magnitude of impact
  - Probability of impact occurring
  - Duration, frequency and reversibility of the impact.

(Adapted from Scottish Executive, 1999)

Such criteria may be formalised through the establishment of checklists, which specify thresholds and criteria. These may be either quantitative (e.g. a specific area of land occupied, or volume of material extracted), qualitative (e.g. a location within a protected area, or waste disposal by a certain method) or a combination of both (e.g. a location within a specified distance from a protected area). The screening stage is not intended to require detailed studies. Checklists are in fact designed to be used quickly by people with the qualification and experience typically found in competent authorities.

2) Scoping

Once a decision has been made on the need for an EIA, the next stage in the process is the determination of the scope of the process. Scoping is a method of ensuring that the resources that go into an EIA are focused on those areas of concern that are of most relevance. Scoping is generally undertaken by competent authorities, but the input of the public, and of any other affected stakeholders, can also significantly enhance the process, and minimize problems at later stages of the EIA process. It is important that all people involved in scoping have sufficient knowledge of the proposed project and of the area where it will be located, in order for them to identify likely impacts, and hence important aspects to be addressed by studies.

Scoping is important for several reasons. Firstly, it helps ensure that decision-makers will be presented with a comprehensive and accessible picture of the situation at hand, rather than with reams of irrelevant data. Secondly, it helps ensure that there is little waste in terms of dedicating resources to issues of little or no relevance. Thirdly, a well-conducted scoping exercise can serve to engage developers, competent authorities and other stakeholders in dialogue at an early stage of the process, thus mitigating against confrontational positions later on. Fourthly, scoping provides an overarching framework for the remainder of the process, thus ensuring an element of consensus in terms of content and methods at an early stage.

The output of the scoping process will thus typically be a guidance document for the EIA process, such as *Terms of Reference*. Such a document will typically list the following:

- Information required about the project (e.g. objectives of development, amounts of waste to be produced, footprint, construction and operational processes, predicted emissions, raw materials required, economic feasibility, etc.)

- Information required about the environment (e.g. geology, hydrology, geomorphology, ecology, landscape, air quality, water quality, social context, etc.)

- Information required about the policy and legislative context of the development

- Information required about the impacts of the development on specific environmental components (e.g. geology, hydrology, landscape, etc.). The scoping document will typically also list the dimensions of impacts to be considered, such as extent, magnitude, reversibility, probability of occurrence and likely duration.

- Information required about potential mitigation measures to minimise the negative impacts of the development.

- Information about possible alternatives to the development, as proposed, including alternative sites and technologies.

3) Baselining

Once the scope of the EIA has been established, the collection of data may commence. Baseline data is of critical importance to provide a picture of environmental state, of the *status quo* in the absence of the proposed development. An understanding of the baseline situation is of importance, as impacts need to be understood relative to a particular context. Consider, for instance, the relative impact of a power station if it is constructed in a relatively pristine habitat, which harbours important biodiversity assets, as compared to siting in an already industrialized area. On the other hand, consider the likely social impacts of siting such a plant in an area where there are major concentrations of people, either living or working, as compared to siting in an area of low human population density. The EIA process invariably involves difficult decisions, and the detailed understanding of baseline conditions serves to ensure that judgments made are *informed judgments*, based on an up-to-date and quality understanding of the environment in question.

Baseline studies are conducted for the environmental components identified in the scoping document. The specific methods used will thus be dependent on the environmental aspects being considered. In the case of ecology, for instance, baseline studies may comprise habitat mapping and species inventories during different seasons. For air quality, baseline conditions may be established through sampling and laboratory analysis for specific pollutants. For landscape, a baseline assessment can serve to identify elements, characteristics and overarching landscape character, as well as landscape condition. In some cases, the baseline study may identify a need for further information than was originally envisaged. As an example, an ecological survey may identify the existence of a previously unknown population of a threatened species, which could merit further study.

4) Impact identification, analysis and assessment

Once the baseline analysis is completed, EIA practitioners are then in a position to predictively consider the likely impacts of a proposed development. A variety of methods may be used to assist in this task:

- **Ad hoc methods** structure a problem so that it is more amenable to analysis. An example is assembling a team of experts to reach conclusions based on the combination of experience, training and intuition, and assembling results into a report.

- **Checklists** provide standard lists of types of impacts associated with a particular type of project, which practitioners can use to evaluate whether a development will have a particular impact. Impacts may also be ranked or weighted.

- **Matrices** consist of two checklists set out at right angles to each other, with one axis listing aspects of the proposed development, and the other listing environmental or social factors that may be affected. A visual summary of interactions can thus be provided. Like checklists, matrices can simple give a yes/no answer to potential interactions, or they can also incorporate a weighting/scoring element.

- **Network diagrams** provide a visual map of primary, secondary, tertiary and higher order impacts of a development. Network diagrams indicate potential interactions between different project components and various environmental impacts, as well as likely interactions between different impacts.

- **Modelling systems** involve the integration of multiple factors in the development of scenarios of impacts, utilizing mathematical and logical techniques. Models are thus used to quantitatively predict impacts on the basis of inputted information about project components.

The choice of method is generally based on a variety of factors, including:

- Level of precision and certainty required;
- Expertise requirements;
- Cost/time effectiveness;
- Flexibility;
- Data requirements;
- Comprehensiveness;
- Ability to accommodate temporal/spatial dimensions;
- Replicability;
- Ability to accommodate uncertainty; and
- Communicability.

5) Identification of mitigation measures

An important output of the EIA process is the identification of mitigation measures. EIA is designed to be proactive, and wherever possible, means of avoiding, minimizing, and remedying negative impacts of a development should be identified. The success of the mitigation process is strongly related to the links between project design teams and EIA practitioners, as the expertise of the latter should preferably provide guidance for the former in order to ensure optimal project design and management.

Although the EIA process involves the sequence of stages described above, it is not a linear sequence. The report produced is subjected to review, following which stages in the process may need to be revisited and results revised, or further research conducted. Regular involvement of stakeholders at different stages of the process is also of critical importance.

Conclusions

Environmental Impact Assessment has expanded in focus since its early days in the 1960s. Given a growing recognition that environmental problems are multi-faceted, the process now does not look exclusively at environmental components, but also at social and economic aspects, as well as at issues of health and safety. The idea of assessing impacts has also been extended beyond the level of the individual project and site to higher-level planning dimensions, through the process of Strategic Environmental Assessment (SEA).

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