# Coasts & Conflicts

## Towards harmonisation and integration in the Mediterranean

Elisabeth Conrad & Louis F. Cassar

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**Errata corrige**

- Box 1a on page 9 should include:
  3) **Stable Coasts**, which exhibit no sign of change;
- The caption for Figure 3a on page 46 should be followed by:
  (Developed by Bonazountas, M. & Leivadarou, J.)
- Illustration credits (page 144) should read as follows:

**Maria Conrad**
Sketches 1.2, 1.3, 1.4, 1.5, 2.1, 4.1, 5.1, 6.1, 7.1, and 7.2

**Victor Falzon**
Drawings on pages 2, 19, 34, 52, 68, 81, 96, 111 and 125.

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*To our parents...*

*with a special dedication to the memory of Lina Cassar*
*who passed away whilst this publication was being finalized...*

*...and to the Mediterranean Region, in all its complexity...*
*the place we call home.*

## FOREWORD

When I began attending the meetings of the Convention that eventually drafted the (aborted) European Constitution, there was a fact that seemed to me not to have yet struck the mind of all the Conventioneers as forcibly as it ought to have done. When, some fifty years previously, the founding fathers of the European Union had set out on the road of European integration, already conceived by them as merely a stage towards an overall system of world governance, they very naturally and logically began by setting up a Coal and Steel Community. At that time, the dynamic pole of development in the region was the landlocked zone at the heart of the continent. There the first Industrial Revolution had achieved its greatest success; there it had resulted in the greatest concentration of Europe's capital resources and labour force. At that same time, the coastal zones were equally rationally considered marginal; they deserved attention only in as much as it was part of the European project to produce as much structural equilibrium as possible by providing aid to such peripheral regions as the coastal areas then were, in a socio-economic as well as in a geographical sense.

Fifty years later, the situation was the opposite. A second revolution, the electronic, had occurred, and the economic significance of geographic location had been reversed. The new environmental awareness had vastly increased appreciation of the vital importance of the land/sea interface. The majority of European citizens now found themselves to be living within striking distance of the Ocean. The shift from heavy industry to services meant that the tertiary sector (including sea-related tourism) had become a greater contribution to Gross National Product than the secondary. Europeans realized that they inhabited a singular peninsula jutting out from the Asian landmass, and prosperous mainly because of its being washed by seas on three of its sides. Its harbour-areas were in fact its shop-windows vis-à-vis the rest of the world. Its very indented coastline was a rare resource in respect of which Europe had the advantage even in comparison with the United States of America. The new Law of the Sea, with the establishment of Exclusive Economic Zones, raised the off-shore waters of the Union, with their now-cultivated and exploited biological and mineral wealth, to a new importance. Their management and governance, also in the perspective of climate change, can no longer be safely neglected.

Perception has occurred much more slowly of the fact that proximity to the sea implies a quite different way of life in most respects, from that of the confirmed landlubber. Those of us who have lived part of their life on a small island, where the varied sounds of the sea are never far out of earshot, and another part in the middle of vast prairies or other wide stretches of dry land know from experience that anything, from architecture to diet, will be different.

Moreover, living in coastal zones itself changes radically as different uses of sea and shore multiply and enter into competition, if not outright conflict, and as the quantity of human beings and activities increases in density in relation to the area of occupied land. Consequently, the study of coastal zones is by no means restricted (as I recall being once told when I began attempting to promote interest in all the domains to which the Law of the Sea and the concept of the Common Heritage of Humankind was relevant) to the phenomena of erosion, or of pollution. Here, if anywhere, is matter for interdisciplinary study, and holistic approaches; and reason enough why, as a long-time advocate of them, this book is such a source of joy for me.

*Peter Serracino Inglott*

*Chairman Mediterranean Institute (University of Malta), Chairman Commonwealth Science Council, former Rector (University of Malta), former President Association of Commonwealth Universities*

## PREFACE

Were the Mediterranean a desert rather than a sea, we would probably have been discussing today, rather than its coasts and conflicts, its oil-well structures and rigs criss-crossed by present-day nomads worshipping at amorphous temples oozing the grace of black gold, teasing conflict not dissimilar from the continuing tragedy of Iraq and the threats posed by and to Iran. Yet rooted in insufficient appreciation of relevant socio-economic and socio-cultural traditions and vicissitudes, tragedy and threat, in the contemporary geopolitical context of the Mediterranean and the Middle East, are not echoes of some distant fatalistic fatwa. Rather they strike discordant and menacing notes of litanies and liturgies honouring no god except the idol of greed and gluttony, capital sins transformed into sinful capital caressing humankind's boundless ego.

Had the Shah-in-Shah heeded not his fawning courtiers (as he himself admits in his autobiography) but those who pleaded that he help forge a new egalitarian society less reminiscent of the excesses of Persepolian splendour, even if more attuned to pseudo-theocratic homilies, we would not perhaps face today that nuclear crisis in a regional cold war susceptible of a warming more than climatic. As a consequence of political prerogatives today, the erstwhile Garden of Eden of Iraq may degenerate into the scorched sands of doom. In the ashes of an Iraqi bonfire and in the embers of a potential Iranian conflagration, could we not divine a message, however consumed by the smoke of rhetoric, exhorting us, in shaping a third millennium world, to respect social and cultural traditions and foundations before embarking on projects and plans meant to make that 'new' world 'better' than what we are inheriting, in turn legating, rather than pyrrhic victories, a bountiful promise?

Such are some of the reflections that suggest themselves in reading Elisabeth Conrad's and Louis Cassar's masterly treatise on Mediterranean coasts and coastlands. For rarely does one come across a discourse, essentially scientific in its methodological analysis, so well incorporated into the socio-economic texture of Mediterranean reality. Although the Authors candidly confess in their introduction that they are not making 'any revolutionary proclamation', yet the book's impact is bound to reverberate at decision-making Mediterranean organs, not only those more closely concerned with integrated environmental planning and implementation, but, as well, those with broader economic and political mandates. One has already seen, for example, the Five Plus Five Process, originally confined to very brief, if splendidly surrounded, encounters of the respective Foreign Ministers, escalate to meetings for Ministers responsible for internal, defence and environmental portfolios. That Process could be geographically extended to other reaches of the Mediterranean so that one day it may be possible to have all the Basin's states working holistically together on all issues, including the sea, its coasts and, more particularly, of course, its inhabitants through a Mediterranean Authority which (as I have argued in a contribution to the 2008 edition of the International Ocean Yearbook) could be the first step towards the creation of a Mediterranean Union.

Indeed, the brunt of Conrad and Cassar's thesis is an implicit call for such an Authority since, as they validly point out, the fragmentation of responsibilities at national, bilateral and multilateral fora has itself acted as a major brake to the sustainable development of the Mediterranean coast and its citizens. Perhaps in no other area is the world do we have a situation, admirably examined by the Authors, where about three-fourths of the population of littoral countries lives on or very close to the coast. Rural exodus and urban concentration are no longer phenomena affecting only a giant metropolis, such as Cairo. For around major conurbations, there sprout peripheral townships receiving and supplying goods and labour from the metropolis and acting as a first port of call for rural immigrants as well as for 'marginal' inhabitants spilling over, in search of work and shelter, into the periphery itself.

Thus exercised, the pressures are not only environmental even if several Mediterranean coastal (and, in the case of Cairo, deltaic) regions suffer severe capacity and sustainability constraints, worsening urban crowding and degrading further the shore landscape. While, of course, insufficient planning and inefficient administration fuel the frequent disarray of Mediterranean coastal areas, except for privileged niche areas protecting tourism development, yet the root of the problem is the absence of integrated coastal management.

In my days as Coordinator of the U.N. Mediterranean Action Plan (1991-1993), CAMPs (our acronym for Coastal Area Management Projects) were our more successful environmental ventures. But they were relatively disjointed efforts, requiring assiduous follow-up not always available. Conrad and Cassar suggest that only a fully integrated coastal management system covering all the Mediterranean coast can halt coastal deterioration. They assemble and evaluate a remarkable array of tools that today's coastal administrator enjoys, from GIS to remote sensing, and the panoply of Environmental Impact Assessment (EIA) methods that, professionally employed, could secure Mediterranean coasts for future generations.

Because of the importance of such management to the cause which the Authors passionately embrace, one must emphasize – and this point they put across very lucidly in the first part of their book – that integration implies that social, economic and cultural factors are an 'integral' component of a holistic scientific approach to the sustainable development of the Mediterranean coast.

Would such a process of itself avoid conflict? Belligerent societal human nature will probably never eradicate conflictual temptation, especially since the only *pax mediterranea* that the region arguably enjoyed was in truth a *pax romana* by armed domination forged and forced. It was not very different from lulls during intervals in those wars and sieges employed by colonial powers during the eighteenth and nineteenth centuries in their lust for hegemony, an infectious aberration that did not spare the superpowers in Cold War years.

Appropriate governance of the Mediterranean may not deter conflict for all time. But, wisely employed, it can reduce tension and introduce a measure of confidence and trust among coastal and island states. Certain problems will still be with us, but perhaps joint governance, with its implicit shared sovereignty, in that broader pan-Mediterranean perspective which a Mediterranean Authority may adopt, may push Turkey and Greece, for example, towards at least a partial solution in the disputed Aegean. Similarly, it may offer a solution to median line/continental shelf differences between Malta, Libya and Tunisia.

Interestingly, Benoit and Comeau, in their epic work "*Méditerranée, les perspectives du Plan Bleu sur l'environnement et le développement*" (with which Conrad and Cassar are familiar) cite the lack of overall coastal governance as one of the main obstacles to sustainable development. While subsidiarity is normally a principle to be cherished, yet if it is disguised as decentralization, it may produce the opposite result. Let me quote their conclusions here : "*Soumises a' la pression d'intérêts particuliers a' court terme, trop d'autorités locales ont laisses leurs territoires évoluer vers un gaspillage d'espace et une occupation déstructurée. Sans un changement drastique dans les politiques et les comportements, une remise en cause d'un développement aussi considérable du tourisme et des transports, par les résidents ou les touristes eux-mêmes, ne peut être exclue.*"

Conrad and Cassar urge us not to shirk our environmental responsibilities towards future generations. "*The deadliest issue facing humankind today is our failure*" writes Stephen Best (in the recently published '*Gaining Ground - in pursuit of Ecological Sustainability*', edited by David M. Lavigne), "*to achieve an ecologically sustainable global economy. That failure is killing more of us now than any other threat, and is wrecking any hopes or dreams we might wish for our children, our grandchildren, and the generations of children to come. It is burying our future*".

Stewards of that continual creation which we somehow desecrate, disdaining the sacrality of our destiny, we appropriate to ourselves what is clearly the patrimony of humankind. That common heritage, including of course our coasts and their resources, enjoins us to responsibly exercise our mandate over nature.

In the middle of the fourth century, Gregory Nazianzen (perhaps the most profound of the Greek Fathers of the Church) entreated us: "*Brethren, let us not be bad managers of the goods that have been entrusted to us .......Let us imitate God's law of creation..........He gives to all the creatures living on earth vast spaces, springs, rivers, forests....and his gifts ought not to be appropriated by the mighty nor by governments. Everything is common......* "

Do I discern Arvid Pardo chuckling with Gregory in that final heritage which alone is not finite?

*Salvino Busuttil*

*President (Fondation de Malte), Professor Emeritus (University of Malta), former Coordinator Mediterranean Action Plan (UNEP), former Director Human Settlements Division (UNESCO).*

## OVERVIEW OF ECONET-COHAST

Coastal habitats in the Mediterranean are of high ecological value but are also amongst the most susceptible to threat. Despite the great natural and cultural diversity of the Mediterranean, coastal landscapes throughout the region face common problems. Coastal zones have to deal with the concentration and dispersal of population and activities, with their attendant high economic, residential, and recreational demands. Land use conflicts, natural- and human-induced hazards and environmental degradation lead to loss of habitats and of biological diversity. Pollution, overgrazing and tourism development, combined with lack of public awareness, political commitment, and inter-sectoral co-operation, hinder the protection of natural habitats. Moreover, conservation effectiveness within designated Natura 2000 coastal sites is influenced by landscape processes. Despite the common nature and origin of the problems in the coastal zone, the actions/ approaches employed so far vary between or even within the countries of the region.

The team of ECONET-COHAST identified deficiencies in implementing existing regulations for sustainable coastal development, and integrating management solutions and/or already existing methodologies for holistic treatment across the environmental, economic, social, and governance sectors. Being driven and motivated by its own experiences and cooperation in research, education, and policy implementation throughout the Mediterranean, the ECONET-COHAST team responded to the EU Community Initiative INTERREG/ ARCHIMED call in the framework of Priority 3 "*Integrated and sustainable management of cultural and natural resources and of landscapes and risk management*" and is co-funded to carry out the ECONET-COHAST project.

ECONET-COHAST addresses the need to establish and adopt common tools and methodologies in ARCHIMED region to assess landscape scale processes and deliver guidelines for conservation management of coastal habitats in the long term. Networking and dissemination activities promote harmonious territorial integration throughout ARCHIMED, and thus fulfill ECONET-COHAST's aim:

*...to promote convergent conservation strategies at landscape scale for coastal habitats of Community significance...*

The activities implemented through ECONET-COHAST serve to evaluate the impact of landscape processes on coastal habitats, to assess the current *status quo*, and to develop specifications and guidelines for common strategy development that addresses both aspects common to all Mediterranean states, as well as national and local-level differences. ECONET-COHAST also aims to facilitate inter-sectoral cooperation in conservation planning, to support the operation of Management Authorities for Natura 2000 sites, to develop tools for coastal habitat planning and capacity building, and to train researchers and professionals on best practices for coastal habitats management, as well as to promote landscape scale conservation via a holistic approach.

The vision for ECONET-COHAST is for the project to act as a catalyst, now and in the future, bringing together stakeholders, authorities, organizations, institutes, universities, and management agencies involved in coastal area planning and development around the Mediterranean. All nations that share our common sea and consequently our common future are welcome to join in our networking, dissemination, and capacity building activities, prolonging the effectiveness and beneficial results of ECONET-COHAST beyond its official duration. Post project awareness activities in the form of networking, informing, and consulting are planned, and will be facilitated via ECONET-COHAST's website, www.econet-coast.eu.

*Ioannis Manakos*

*Project Coordinator*

**PROJECT PARTNERS**

Mediterranean Agronomic Institute of Chania (MAICh)
(LEAD PARTNER)

National Technical University Athens (NTUA)

Agricultural Research Institute of Cyprus (ARI)

University of Malta

University of Catania
Department of Botany

Mediterranean Agronomic Institute of Bari

## AUTHORS' INTRODUCTION

In the present day and age, environmental concerns are no longer merely the domain of academics and policy-makers. Increasingly, societal agendas are changing to include ample discussion of various aspects of the natural world, and of the human species' relation to it. Unfortunately, however, much debate tends to be polarised with, at one extreme, those who expound a bleak scenario and at the other, those who argue that environmental problems are simply in the mind. However, there is also an alternative approach. Upon being asked whether he believed the survival of the human species on planet Earth is threatened, a contemporary statesman from the Mediterranean replied as follows:

*"I think if there is a Lord in heaven, His main task is balancing opposing forces – danger and hope, life and death – because otherwise the human race would have disappeared a long time ago…In the annals of humankind, if there is a danger of destruction, there are also forces of maintenance. A fire brigade."* [Shimon Peres]

This book is intended for various members of the fire brigade - for conservationists, environmental managers, strategic planners and other key actors from different professional and academic disciplines, hailing from different spheres of the socio-political spectrum and from both shores of the Mediterranean. It is a book for all those somehow involved in managing coastal resources in the Mediterranean region and in striving for a sustainable future. In talking of both conflict and harmonisation, we have also tried to balance opposing forces and to overcome divisive dichotomies. Our environmental problems are huge and urgent, and the immensity of the task ahead cannot be downplayed. However, gloom and doom will get us nowhere. The activist is not he who ponders and reflects on the problems we face, but he who tries, to the best of his abilities, to make a difference. There is a wide range of people, from different walks of life, who bring much expertise and enthusiasm to the management of the Mediterranean coastal zone. Our target audience is anyone from this large and diverse team.

We have not made any revolutionary proclamations in this book. It is not a treatise about the Mediterranean, nor is it a detailed technical manual about coastal management techniques. There are far more accomplished examples of both. What we have tried to do is make a contribution towards the holistic management of Mediterranean coastal areas. The coast is not merely a biological asset, but is also of crucial social, cultural and economic importance. Furthermore, its management draws on a wide and varying array of techniques and approaches. We have therefore tried to give coastal managers a broad and concise perspective on where we are now, where we are coming from, what our future might look like, and how we might get there.

This book is structured in two parts. Part I provides a conceptual background to issues of coastal management, both on a global scale and within the Mediterranean region.

Part II looks at specific techniques and approaches that may, in different ways, play a role in coastal management. The multi-faceted nature of the coast often requires that mangers deal with information that may not lie within their particular field of expertise. A basic acquaintance with a variety of approaches can, however, be invaluable in facilitating dialogue. No one technique holds magical answers to our problems. Solutions will only be found through coordination and integration.

We hope that this publication will be of utility to those who strive to protect the unique coastal heritage of the Mediterranean Sea. We wish you luck in this noble and necessary endeavour.

## TABLE OF CONTENTS

## LIST OF ACRONYMS

| | |
|---|---|
| APAL | *Agence de Protection et d'Amenagement du Littoral* |
| CAMP | Coastal Areas Management Programme |
| CBA | Cost Benefit Analysis |
| CZM | Coastal Zone Management |
| DBMS | Database Management Systems |
| DEM | Digital Elevation Model |
| EIA | Environmental Impact Assessment |
| EIS | Environmental Impact Statement |
| ETM+ | Enhanced Thematic Mapper Plus |
| GIS | Geographic Information Systems |
| ICAM | Integrated Coastal Area Management |
| ICZM | Integrated Coastal Zone Management |
| IEI | International Environment Institute, University of Malta |
| IUCN | The World Conservation Union |
| LCA | Landscape Character Assessment |
| MAP | Mediterranean Action Plan |
| MCSD | Mediterranean Commission on Sustainable Development |
| MedNEA | Mediterranean Network of National Environmental Agencies |
| MedWet | Mediterranean Wetlands Strategy |
| METAP | Mediterranean Environmental Technical Assistance Program |
| MPA | Marine Protected Area |
| MSS | Multispectral scanners |
| NEPA | National Environmental Policy Act (USA), 1969 |
| NGO | Non-Governmental Organisation |
| PRA | Participatory Rural Appraisal |
| RAC | Regional Activity Centre |
| SEA | Strategic Environmental Assessment |
| SI | Sustainability Indicators |
| SIA | Social Impact Assessment |
| SPOT | *Satellite Pour l'Observation de la Terre* |
| SPSA | Systemic and Prospective Sustainability Analysis |
| TM | Thematic Mapper |
| UNCED | United Nations Conference on Environment and Development |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| WWF | World Wide Fund for Nature |

## ACKNOWLEDGMENTS

We would like to express our gratitude to Dr Ioannis Manakos, Project Coordinator representing the Lead Partner (the Mediterranean Agronomic Institute of Chania in Crete), for his support and enthusiasm throughout the Econet-Cohast Project. Sincere thanks are also due to our Project partners from the Department of Botany of the University of Catania, the Mediterranean Agronomic Institute of Bari, the National Technical University of Athens and the Ministry of Agriculture Natural Resources and Environment (Agricultural Research Institute) in Cyprus, as well as our colleagues of the Scientific Committee. We are grateful to the EU Community Initiative Programme Interreg IIIB ARCHIMED, for co-financing Econet-Cohast.

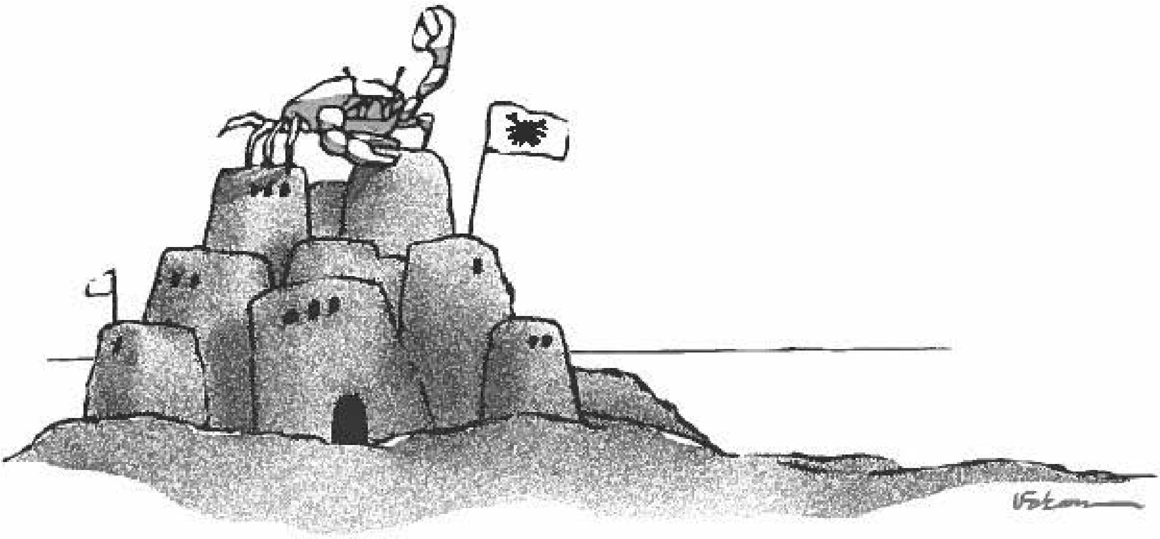
We are indebted to Mr Victor Falzon and to Ms Maria Conrad for the original drawings and sketches, respectively, reproduced in this work, as well as to Mr Guido Bonett and Dr Joseph A Borg for providing some of the photographs in the book. Special thanks are due to Ms Stephanie Vella for looking after the administrative component of the Project so efficiently, as also for reading through the draft manuscript and for providing input relating to economic issues discussed herein. We would also like to acknowledge the input of Ms Antonella Vassallo, who was involved in the initial setting up of the Econet-Cohast project.

Our appreciation goes to Professor Salvino Busuttil and to Rev. Professor Peter Serracino Inglott, for providing the Preface and Foreword. Their keen involvement in oceanic and coastal affairs over the years, manifesting itself in an unparalleled enthusiasm for an integrated approach to management of coastal and marine resources, has left its mark with those of us who have had the privilege of working with these two eminent gentlemen on matters relating to coastal management in the Mediterranean.

We would like to extend our appreciation to Professor Felicita Scapini (University of Firenze), who has led a number of coastal management research projects in the Mediterranean region, in which we have had the opportunity to participate. We would also like to thank a number of colleagues and friends for their support, which has in various ways contributed to the success of this project. These include Mr Alex Camilleri (MEPA), Mr Edwin Lanfranco and Mr Sandro Lanfranco (University of Malta), Mr Avertano Rolè (University of Malta), Dr Paul Gauci (University of Malta/ERSLI Consultants Ltd.), Dr Paul Gatt (IEI research associate), Dr Ahmed Abdelrehim and Dr Nadia Makram Ebeid (CEDARE), Dr Mohamed A. Abdrabo (University of Alexandria), Dr Lorenzo Chelazzi, Dr Isabella Colombini, Mr Mario Fallaci and Ms Elena Gagnarli (CNR), Professor Mohamed Ater (University of Tetouan), Mr Fadhel Baccar and Arch. Sihem Slim (APAL), the team at *Earth, environmental and marine sciences and technologies* of ICS-UNIDO in Trieste, as well as those involved in the management, administrative, and scientific aspects of the *Parco Regionale della Maremma* in Tuscany, with whom we have collaborated over the years.

Finally, we thank Mr Josef Grech, CEO of the Foundation for International Studies and his predecessor, Professor Lino Briguglio, for their support throughout this Project, Ms Graziella Schiavone for managing so meticulously the Project's financial aspects and Ms Maria Bugeja, Administrator within the International Environment Institute, for administrative support.

# Part I:
# Background & concepts



# CHAPTER 1
# The coastal zone in context

*I do not know what I may appear to the world, but to myself I seem to have been only a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me.*

Isaac Newton, *Philosophiae Naturalis Principia Mathematica*, 1687

**Introduction**

The coast is one of the most vast, active and varied of Earth's geomorphological features. It may be simply defined as the physical interface between land and sea, that area where atmospheric, terrestrial and marine processes act collectively to produce distinctive landforms. It provides a dynamic canvas for a multitude of human activities, and has done so ever since the early history of mankind. Man's relationship with the sea has always been complex and tumultuous. It serves as a divisive force, maintaining distances between cultures across opposing sides of the sea, whilst at the same time serving a connecting function, as a medium for communication, for the spread of civilization and for commerce and trade. It is a constructive force, gently and gradually creating complex landforms and nourishing fragile ecosystems. Yet its destructive power has also been all too evident throughout history, with vast human tragedies unfolding in a short span of time. The coastal region has very often been the focus of this drama.

The drama continues to unfold in the present day. 71% of the Earth's surface is covered by oceans and seas, and the world's total coastline exceeds 1.6 million kilometres (Burke *et al.*, 2001). Coasts harbour over half the world's population in less than 0.05% of the global terrestrial land area, and as a result, have been extensively modified and impacted upon by the broad range of human activities occurring therein. This vibrant part of the planet is now also one of the most environmentally threatened, and these threats are inextricably linked to a complexity of social, cultural and economic strands. Indeed, as discussed throughout this book, the threat to coastal environments is not merely a threat to a natural system, but is also a threat to whole cultures, to livelihoods, ways of life and economic survival. Indeed, in some cases the declining health of coastal environments may even jeopardize the very physical survival of human populations.

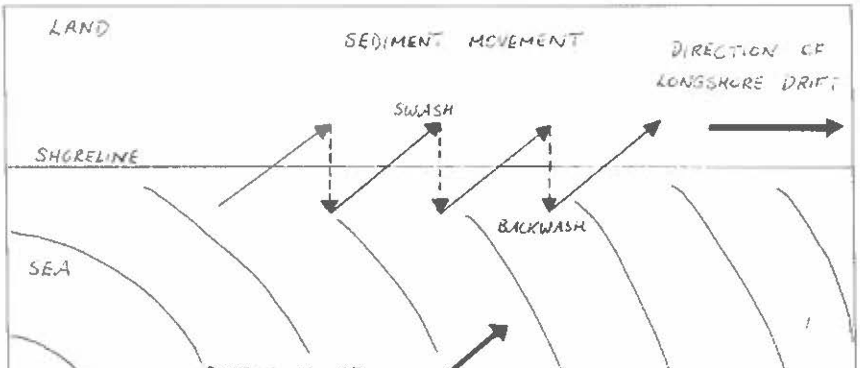
The complexity surrounding the future of coasts is further exacerbated by phenomena of global change. Despite the controversies surrounding the issue of climate change, few are in any doubt that, whatever the causes, change is occurring, and that such change will have acute impacts across the globe. The intricacies of linkages between oceanic and climatic systems ensure that coasts will be amongst the areas most extensively affected by global warming and resultant climatic changes. Indeed, with the potential of sea level rise, the very extent of coastlines may be affected, and distributional shifts in coastal areas are very likely to occur. Low-lying coastal areas may be completely inundated. Such change in sea levels is not a new phenomenon. Evidence of eustatic alterations in sea level across the globe in the distant past abounds in our present landforms and there is every reason to suppose that such changes will occur again. The issue is whether our activities are setting into motion a cycle of change that may spiral out of the control of natural feedback and regulation, and that may thus jeopardize the very foundation on which our civilization is based.

In the light of a context of increasing anthropogenic pressures on this fragile environment, the need for judicious management of coastal areas has never been more critical. Such management necessitates at least three key features. One is a thorough understanding of the physical context, of coastal landforms and of the processes to which they owe their origin and continued evolution, as well as of coastal ecosystems. Equally important is an understanding of the socio-cultural context, of the people who affect and will be affected by management decisions, of their cultures, values and activities. An understanding of the mutual interactions of the natural and human realms is likewise critical. This Chapter is intended to introduce the fundamentals for such a three-pronged understanding of the coastal zone, without which any management endeavours are rendered futile.

**The physical dynamics of the coast**

The coast owes its morphology primarily to the combined action of waves and currents, as well as to terrestrial forces. Waves are created by the transfer of energy from the wind blowing over the sea. The various wave parameters, including height, length, velocity and steepness, determine the energy of waves, whilst processes of wave refraction influence the distribution of energy along the shore. Waves act in dynamic equilibrium across the globe, creating landforms in some areas, eroding landforms in others, working to maintain a global balance and an 'average' quantity of coastline. The coast may thus be considered as an equilibrium system of inputs, storage and outputs.

*Sketch 1.1*
*The process of longshore drift*




This equilibrium system of coastal dynamics is illustrated by the simple process of longshore drift (Sketch 1.1). Waves tend to strike the shore at an angle, moving water and sediment obliquely up the beach. When the wave's energy is eventually spent, water and sediment return to the sea with the backwash, in a direction perpendicular to the shoreline. This sets up a system of sediment movement along the beach. The relative balance of swash and backwash most often determines the morphological character of the beach. With stronger swash, constructive forces predominate and sediment builds up along a beach. Where backwash is dominant, erosive action carries sediment away from the shore and into marine storage components.

In general, coastal landforms can be classified according to the dominant processes giving rise to their formation and may thus be broadly grouped into erosional and depositional landforms.

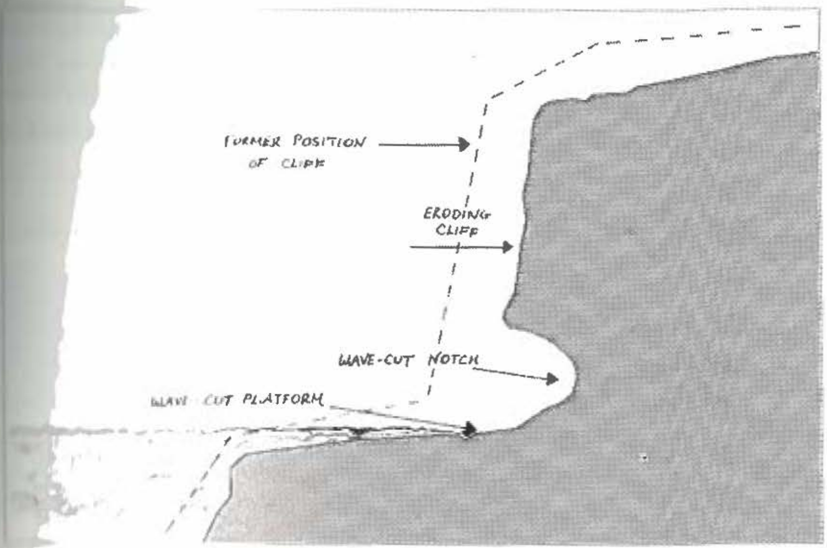
*Erosional processes and landforms*

Erosional shorelines occur in areas of high wave energy. The nature of such shorelines is the physical manifestation of a balance between the erosive strength of waves and the ability of substrates to resist this erosive energy. One of these erosive forces is purely hydraulic, exerted through the sheer power of water. Waves may break against a sea cliff with a pressure exceeding 100 $kg/m^2$. In the process, water is driven into cracks and crevices, compressing the air within and acting as a wedge to widen existing fissures (Hamblin and Christiansen, 2003). More important, however, is the abrasive action of rock fragments, sand and gravel which are hurled at the shore, gradually wearing the rock down, like sandpaper. Such material itself undergoes attrition as a result of impacts and frictional forces, and is gradually modified into rounded pebbles and particles.

As erosional action is tied to waves, it is largely concentrated in a relatively narrow band at mean sea level. Areas of softer or unconsolidated lithology, such as areas comprised of alluvium or regolith, are particularly susceptible to the erosive power of waves and water-borne material. Erosion is likewise concentrated along existing lines of weakness, such as along faults, joints and bedding planes. Stratigraphic sequences and structural geology hence determine the nature of the landforms produced. Processes of erosion are also aided by those of sub-aerial and biochemical weathering, which reduce material strength of the rock, making it more vulnerable to erosion. Climate provides an overarching framework for such processes of weathering, regulating temperature and hydrological regimes.

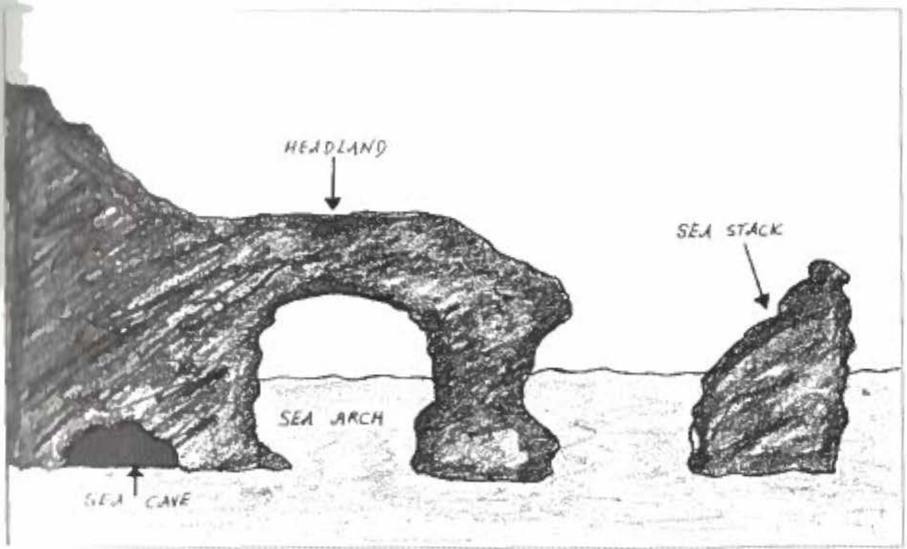
The most dramatic landform resulting from coastal erosion is that of **cliffs**. Cliffs are most vulnerable to processes of erosion at their base. Over time, the repeated actions of hydraulic force and abrasion undercut the cliff base to form a deep **wave-cut notch**. The cliff base is eventually undercut and overhangs collapse into the sea. The collapsed material temporarily protects the cliff from further erosion, but when this is transported away, the cliff face is once more exposed to erosive forces. With time, the cliff face continues to recede, leaving behind a **wave cut platform**. Negative feedback mechanisms eventually set in, however, as the wider the platform becomes, the more energy it dissipates, making it harder for erosive processes to continue. The system thus achieves a stable equilibrium state.

*Sketch 1.2*
*Cliff erosion*




Other landforms produced by coastal erosion include **caves**, **arches** and **stacks**. Erosive action may attack a joint along a headland, eventually hollowing out a cave. As a headland is subjected to erosive action from two sides, the caves excavated along a line of weakness may eventually form an arch, which may subsequently collapse to form a stack.

*Sketch 1.3*
*Landforms of coastal erosion*



*Depositional processes and landforms*

Whilst erosive action is concentrated along high energy coasts, deposition tends to predominate in more sheltered areas. Deposited sediment originates not only from erosion of cliff faces, but also from inland fluvial sources and from sea bed erosion. Of the three inputs, fluvial sources are dominant, supplying over 90% of sediments. Sediments are stored either in depositional landforms or on the sea bed of continental shelves.

A variety of coastal depositional features exist. Some of these are described briefly below.

- **Beaches** may be defined as shores built of unconsolidated sediment (Hamblin and Christiansen, 2003). Beaches can be comprised of sand or rocky shingle, and their morphological characteristics depend on a balance between sediment supply, sediment type and wave energy. Extensive beaches, many kilometres long, may form through processes of long-shore drift, whilst pocket beaches may result from the accumulation of material in embayments between headlands.

- **Spits** may form in areas of bays and estuaries, when sediment begins to build up and extend outwards from one end of the bay. This process is often a result of longshore drift, when the longshore current dissipates and sediment is hence deposited. Eventually, the spit may extend across to the opposite end of the bay, forming a **baymouth bar**.

- **Tombolos** are a product of wave refraction, leading to the formation of a bar of beach deposits which extends perpendicular to the shoreline and acts to connect the mainland with an offshore island or outcrop.

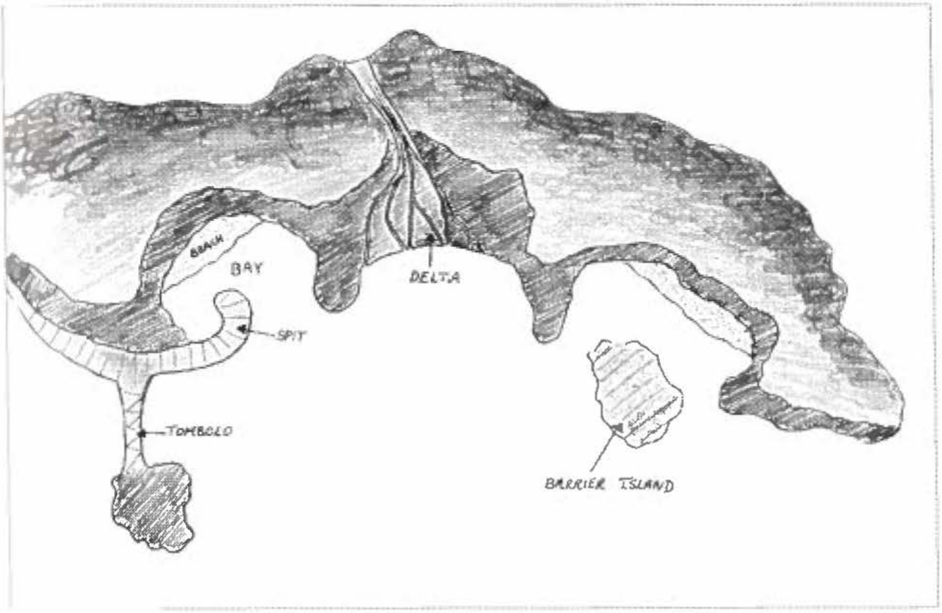
- **Barrier islands** are detached, offshore islands of sediment, trending parallel to the coast. Their formation is thought to be linked to glacial retreat at the end of the last Ice Age. Their continued existence depends on a balance between sediment supply, wave energy and tidal fluctuations.

- **Deltas** develop by seaward progradation of fluvial sediment at a river mouth. In low-velocity river mouth environments, sediments settle out, effectively extending the coastline seawards. This deposit is termed a delta because its triangular shape resembles that of the Greek capital letter *delta* Δ.

- **Coastal sand dunes** are primarily a product of aeolian rather than marine processes. A number of factors are required for their formation, including strong onshore winds, a wide foreshore in order to allow sand to dry out, a wide backshore with debris traps, and the presence of stabilizing vegetation.

Being located in areas of gentler coastal processes, several coastal depositional features play an important role as sites for human settlement and recreation. Such land uses may, however, exert pressures on the delicate dynamics which maintain such systems in existence.

*Sketch 1.4*
*Landforms of coastal deposition*




*Box 1a*
*Classification of coasts*

The complexity and diversity of coastal environments limit any attempts to develop a neat categorization of different coasts. Nevertheless, various attempts have been made to develop a standard typology of coastlines, on the basis of

Johnson (1919) attempted to classify coasts according to changes in sea level. He thus distinguished between:

1) **Submerged coasts**, resulting from a rise in sea level or a fall in land level;
2) **Emerged coasts**, resulting from a fall in sea level or a rise in land level;

4) **Compound coasts**, which show a mixture of any of the three above.

*Box 1a (cont.)*
*Classification of coasts*

Shepard (1973) used coastal processes and geologic history as his criteria for classification, and thus categorized coasts as either:

1) **Primary coasts**, formed primarily by non-marine agents, e.g. fjords and deltas; or
2) **Secondary coasts**, landscapes modified by coastal processes, e.g. beaches and cliffs.

Davies (1964) based his classification on the extent of tidal ranges. His categories are as follows:

1) **Microtidal coasts** (tidal range of 0 to 2 metres);
2) **Mesotidal coasts** (tidal range of 2 to 4 metres); and
3) **Macrotidal coasts** (tidal range of over 4 metres).

Valentin (1952) attempted to fit coasts into one of two categories, on the basis of spread or retreat:

1) **Advancing coasts,** where marine deposition or land uplift is dominant; and
2) **Retreating coasts**, where marine erosion or submergence is more significant.

**Coastal ecosystems**

The coastal zone includes the rocky shores, sandy beaches, kelp forests, subtidal benthos and the pelagic water column over the continental shelf, slope and rise, thus incorporating a wide range of habitat types. The ecosystems found at the coast reflect the unique characteristics of this interface between terrestrial and marine environments. Due to the diversity of habitats present, coastal ecosystems vary considerably in their characteristics and in the relative influence of terrestrial and marine aspects, depending on atmospheric, oceanographic, historical and geological factors.

Coastal and other marine systems differ from terrestrial systems in several important ways, both with respect to patterns of diversity and with respect to the functional implications of those patterns. High diversity is found not only at the species level as in terrestrial systems, but also at higher taxonomic levels. In general, marine systems have a much greater diversity of types of organisms and types of body plans than do terrestrial systems (Mooney *et al.*, 1996). One consequence of the high level of diversity is that functional groups often include species that are physiologically and genetically more distinct from one another than is the case within a comparable assemblage on land. There is therefore the possibility that different members of an assemblage respond differently to environmental changes, potentially conferring a higher degree of resilience (Mooney *et al.*, 1996). Primary producers in coastal systems are particularly diverse in many important ways, ranging in size from microscopic plankton to giant kelps up to 60 m long. Some species are anchored to the bottom, whilst others are suspended in the water column. Photosynthetic bacteria and protists play a much more important role than do the same groups on land, with higher numbers of relatively simple life-forms.

The coastal zones are vital to the productivity of the oceans, as the productivity of those areas forms a large portion of total marine productivity (Viles and Spencer, 1995). The shallow water of continental shelves is characterized by light availability and high nutrient levels, accounting for more energy input per unit volume when compared to offshore areas (Schembri and Lanfranco, 2001). Particularly diverse and productive coastal ecosystems include coral reefs and mangroves. The complex and diverse assemblage of organisms that constitutes the coral reef represents the oldest and largest biogenic structures in nature, with more species per unit area than any other marine ecosystem (Mooney *et al.*, 1996). Although reefs have fewer species than tropical forests, they have much higher diversity at the taxonomic level of phyla (Briggs *et al.*, 1997) and are characterized by complex biological interactions, often dependent on keystone species. Of particular note is the ability of coral reefs to construct massive calcium carbonate frameworks. Mangrove systems are likewise of great importance on a global scale. These salt-tolerant forested wetlands occur in shallow coastal areas, particularly in tropical estuarine systems. Although there are relatively few species of mangroves (Tomlinson, 1986), mangrove ecosystems are nevertheless unique because they include structural niches and refugia for numerous non-mangrove species (Mooney *et al.*, 1996), many of which are of subsistence and commercial importance.

Coastal assemblages are subjected to a range of disturbances of natural origin, which serve as controls on population numbers and help to maintain ecosystems in balance. Some of these are broad scale and affect species across many ecosystems. Such disturbances include those of tectonic origin and major storm surges. Other disturbances may have species-specific impacts, including the waxing and waning of population numbers of particular species, disease, invasions of competitor species, and others. Today, coastal ecosystems are increasingly subjected to disturbances of anthropogenic origin, often with wide-ranging effects.

**The socio-cultural fabric of coastal environments**

In 2001, the then Secretary-General of the United Nations, Kofi Annan, called for a study of the implications of ecosystem change for human well-being and of the scientific basis for action needed to enhance conservation and sustainable use of such systems. The result was an extensive study by over a thousand experts, which led to the publication of a series of reports, collectively comprising the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005). Coastal ecosystems were amongst the themes addressed in this Assessment. One conclusion of the Assessment was that coastal lands produce disproportionately more services relating to human well-being than most other systems, even those covering larger total areas. The diversity of habitats in coastal areas, ranging from wetlands and coral reefs to beaches, dunes and estuaries, host a variety of functions that are of direct benefit to humankind.

Estuaries, marshes and lagoons play a key role in maintaining hydrological balance, mixing nutrients, filtering pollutants and providing habitat for birds, fish, molluscs and crustaceans. Mangroves provide protection from flooding and erosion, serve a nursery function for many species, supply food and fuel wood and provide secure sites for agricultural production. Intertidal habitats play a pivotal role in ocean ecology, with a rate of productivity rivalling that of tropical rainforests, and providing food and habitat for a diverse range of species. Reefs provide a habitat for fisheries and a resource for tourism; they safeguard against erosion, provide biological resources and material for construction. Seagrass meadows trap sediments and stabilize shorelines. All of these ecosystems fulfil these functions and many more. Coastal ecosystems further provide for atmospheric regulation, disease control, medicinal resources, waste processing, freshwater storage, as well as recreational, cultural and aesthetic services to mankind.

It is therefore hardly surprising that since time immemorial, man has chosen to settle on the coast, close to this bounty provided by nature. Indeed, the Millennium Ecosystem Assessment noted that coastal communities tend to aggregate near the types of coastal ecosystems that provide the most ecosystem services. For some communities, the maintained provision of ecosystem services is literally a matter of life or death, as these systems provide subsistence resources on which their livelihood depends. For others, coastal areas provide employment and income, often sustaining national economies, be they dependent on fisheries, on tourism or on some other coast-related industry. The link between the growth of human civilization and coastal systems indeed appears to be documented even archaeologically. Moseley (1975) argued that zones of upwelling on the coast of Peru were a prime factor contributing to the rise of Andean civilizations. In China, dykes for salt production and agriculture may date back to over 4000 BC (Viles and Spencer, 1995). Even in its limitations, the coast has been a key factor shaping human history. Braudel (1949) documents how the low productivity of Mediterranean coastal ecosystems contributed to a scarcity of fish and hence of sailors and fishermen, and served as a restraining force on the grand projects of Mediterranean powers.

The case of the Mediterranean also illustrates another way in which coastal ecosystems have shaped the demographic, historic and social fabric. The limited productivity of the Mediterranean Basin constrained the population to look elsewhere for resource supplements. Trade therefore became an integral part of social and commercial life. Harbours and ports became hubs of urban life, setting the scene for further urbanization even after such areas had lost their pivotal role as centres of commerce. Such hubs exerted powerful pull forces, leading to demographic movements, sometimes even on a global scale. The migration of Europeans to Canada's cod fisheries is a case in point. Yet the growth of trade and powerful commercial forces also led to friction, which endures even today. Centralised powers began to accumulate wealth; such wealth was, however, not evenly distributed. Today many coastal communities are denied access to the resources on which they depend, losing out to those with greater political and economic clout. Resorts, hotels and condominiums are taking over the best available land, excluding all who are not in some way connected to such development. The expansion of luxury developments also leads to price hikes, putting coastal land beyond the financial means of many. Although overall coastal areas appear to be better off in terms of living standards, statistics tend to hide wide disparities in the distribution of such benefits. The outcome is tension and strife; one example is the pervasive conflict between small-scale artisanal fisheries and large-scale commercial fishing ventures in many parts of the world. Needless to say, it is often the former who lose out in such encounters.

*Case Example 1.1*
*The Nile Delta*

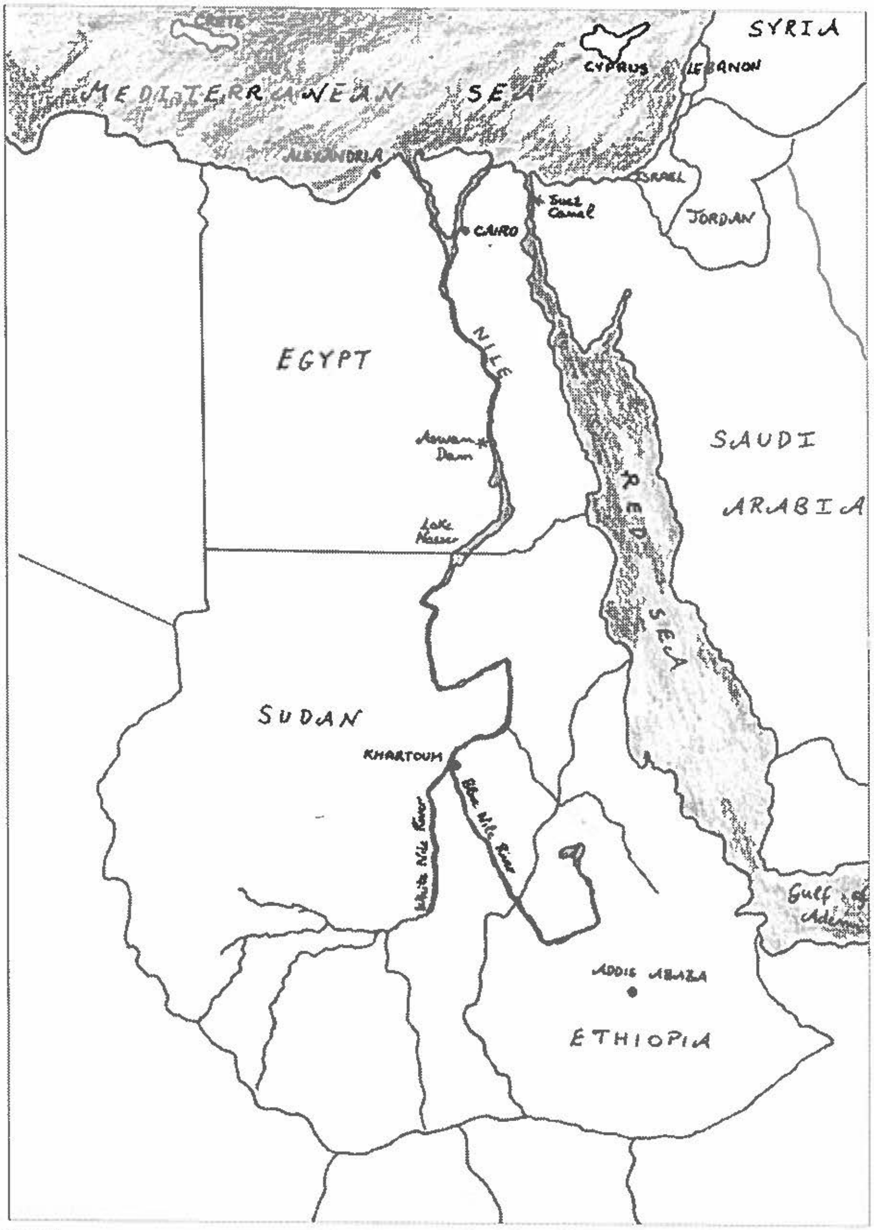
The Nile Delta is one of the world's largest river deltas. It has historically been one of the most fertile areas in the Mediterranean Basin, due to an annual influx of over 140 million tonnes of fertile volcanic soil, and has hence been the site of agricultural land uses for many centuries. The productivity of the Nile was indeed one of the pivotal forces contributing to the rise of civilization in Ancient Egypt. It is also a natural habitat of immense importance for birds migrating between Africa and Europe.

In the 20$^{th}$ century, a decision was taken to construct a dam at Aswan, in order to tame the flow of the Nile. As a result, the dynamics of the Nile delta were irreversibly altered. The fluvial influx of sediments into the delta has declined considerably, with sediments now becoming entrapped behind the dam. With the availability of less sediment to replace wave and current erosion, the erosive power of the Mediterranean Sea has taken over, and the waves are wearing back the coastal dunes along the shore at a rate of up to 120 metres per year in places (Sestini, 1992).

At the same time, the halting of a natural influx of fertilizers has necessitated the widespread use of chemical alternatives in agriculture, with all their attendant environmental impacts. The economic importance of the dam is, however, indisputable, and the case of the Nile Delta and Aswan Dam amply illustrates the difficult choices in decision-making for the coastal zone.

*Case Example 1.1(cont.)*
*The Nile Delta*

*Sketch 1.5*
*The Nile river and delta*



With a growing global population, the importance of the coastal zone for human settlement can only be expected to increase. Historically, the first coastal settlements were located in sheltered areas such as estuaries and bays, and only later extended geographically to other environments. Today, overall coastal population densities are presently nearly triple those of inland areas. Of the 17 mega-cities around the globe, 14 are located in coastal areas (Tibbetts, 2002). The majority of these are located in areas of rapid population growth. In addition, two-fifths of the world's major cities of 1-10 million people are also located near coastlines. In addition to resident populations, many coastal areas are also regularly inundated with large tourist flows, placing additional pressure on coastal systems and resources. Although tourism is essential to the economy of many coastal states, it may also be contributing to increasing social inequities, as income from visitors is only channelled to a limited portion of coastal populations.

*Table 1i*
*The world's largest coastal cities*

| **City** | **Population** (July 2007) |
|---|---|
| 1. Tokyo | 33, 400, 000 |
| 2. Seoul | 23, 200, 000 |
| 3. New York | 21, 800, 000 |
| 4. Bombay | 21, 300, 000 |
| 5. Sao Paolo | 20, 400, 000 |
| 6. Los Angeles | 17, 900, 000 |
| 7. Shangai | 17, 300, 000 |
| 8. Osaka | 16, 600, 000 |
| 9. Calcutta | 15, 500, 000 |
| 10. Manila | 15, 400, 000 |

(Source: Brinkhoff, 2007)

The economic significance of coastal resources across the world is immense. Different ecosystems directly and indirectly generate billions of pounds worth of income annually. In a seminal work on the valuation of biodiversity, Costanza *et al.* (1997) showed that while the coastal zone covers only 8% of the world's surface, the goods and services provided by it are responsible for approximately 43% of the estimated total value of global ecosystem services. Although the accuracy of such numerical extrapolations is disputed, there is little doubt that coastal ecosystem services are critical to the functioning of national economies across the globe.

**Human-natural interactions in the coastal zone**

There is no doubt that humans are a key element in many coastal zones and have been so for a very long time. The nature of man's relationship with the natural coastal environment has, however, become a subject of some concern. The Millennium Ecosystem Assessment did not only find that coastal ecosystems are amongst the most important in terms of the services they provide for mankind; it also concluded overwhelmingly that coastal ecosystems are amongst the most threatened. The impacts of ever-increasing human activities in the coastal zone have become widespread and pervasive, leading to fundamental changes in the structure, functioning and productivity of coastal ecosystems worldwide. We are thus faced with a perilous situation in which we are placing ever more heavy demands on coastal resources whilst at the same time jeopardizing the integrity, health and viability of the systems that provide these resources. Furthermore, the very ecosystems that provide the most benefits for humankind are also the worst affected by adverse impacts of human activity.

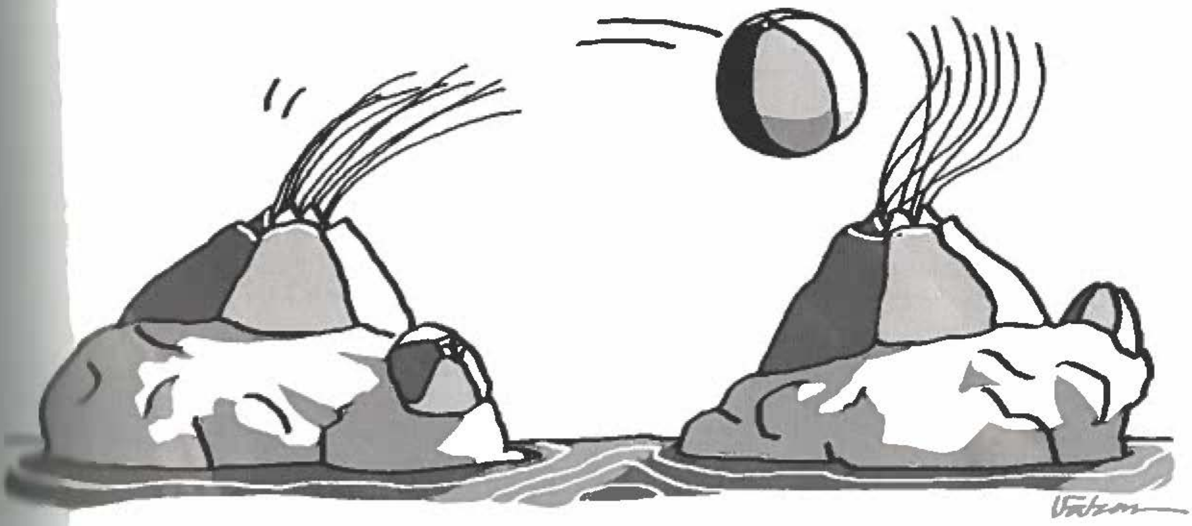
Coastal systems have also been victims of 'commons' perceptions, the view that resources are limitless and open to all. For a long time, it seemed incredible to suppose that one species could have any lasting impact on nature's bounty. However, with the collapse of fisheries, the degradation of habitats and consequent loss of species, the loss of crucial storm buffering functions and a variety of other such blows, the human race has had to wake up to the startling reality that resources are not limitless and that we may have already pushed coastal ecosystems beyond the thresholds of their survival. The technological prowess of our species gave us a belief that we were somehow untouchable. With faster boats, better navigation equipment, and deeper drills, it seemed like nature could place no bounds on the spread of mankind. However, with increased ecological understanding, we came to realize that all we had really achieved was a faster advance towards the limits of the natural resources available to us. Our targeted harvesting of particular species upset delicately balanced food webs and threatened critical keystone species. Similarly, careless introductions of species outside their natural areas of distribution wreaked havoc within the systems into which they were introduced.

The potential disaster is not only environmental. With the widespread dependence of several communities on coastal resources for their survival, impacts on coastal systems are also impacts on human health and livelihoods. Such dependence on coastal areas is increasing, even as costs of rehabilitation and restoration of degraded habitats are also on the increase. Furthermore, coastal degradation is not occurring in isolation but rather in tandem with a global ecological crisis which is also affecting terrestrial areas and global atmospheric systems. Put simply, we have nowhere left to run for cover. The tragedy is that the coastal areas likely to be hardest hit by growing risks, particularly in the light of climate change, are also those where people have the least options of relocation or of finding alternative livelihoods.

It is not only our direct impact on coastal systems that threatens our future well-being; indirectly, the sprawl of urban settlement across coastal areas has also rendered us more vulnerable. Indeed, in some cases we have expanded our settlements even into areas that have been reclaimed from the sea. One of the major threats to coastal systems is urbanization and the related loss of habitats and the services they provide. As a result, human communities are increasingly pushed onto the margins of coastal areas which are now deprived of their biological protection, and whole populations are thus rendered susceptible to events such as storms, flooding and coastal erosion. Although the Boxing Day tsunami of 2004 was the result of tectonic events beyond human forces, it provided a tragic reminder of the dangers now facing many coastal communities, which, as a result of intense demand for land, have been forced onto areas of great environmental risk. At the same time, natural coastal processes also catch up with us, despite our best efforts. Despite repeated attempts to halt or limit coastal erosion in many parts of the world through a variety of means, several settlements have had to come to terms with the fact that the land is literally receding from beneath their feet. Despite all our technological interventions, nature will run its course.

The greatest challenge in dealing with coastal systems comes from the fact that management of the coast is not enough. Many threats emanate from marine or inland areas further afield, and coastal zones are often the unfortunate recipients of the negative impacts of insensitive land practices elsewhere. Sand dunes are deprived of fluvial sediment supplies through inland networks of dams and reservoirs. Water quality in estuaries is declining due to the influx of pollutants carried by rivers. Coral reefs are subjected to devastating impacts of high nutrient loads from terrestrial runoff and dust deposition from expanding areas of desertification. The discharge of untreated sewage from land destroys entire habitats and species groups. At the same time, declines in the health of coastal systems will have repercussions that will be felt far away from the coast.

The outlook is not, however, completely bleak. Many mistakes have been made in our dealings with the coastal zone; management has often been inadequate or misguided, and for long, our ecological understanding lagged far behind the development of technological innovations to exploit resources further. However, we now have the benefit of a more thorough understanding of the systems we are dealing with, not only in terms of geomorphology and ecology, but also in terms of their capacity to continue to furnish us with services and resources. In many parts of the world, there now is the political will to ensure appropriate coastal management, not only for environmental purposes but also to ensure maintenance of the livelihood of millions of people worldwide. We now recognize the critical importance of holistic management, of integration across disciplines and sectors and of collaborative approaches that involve all people affecting, or affected by, the future of coastal zones. Although problems are far from solved, positive trends have emerged with different initiatives, and there is reason to hope that well-informed and well-implemented management efforts hold promise to reverse the trend towards declining health of coastal systems. The decision-making aids described in this book are intended to be one component of the toolkit for managers in this quest.



# CHAPTER 2
# The Mediterranean Sea and its Shores

*What is the Mediterranean? A thousand things at a time. Not a landscape, but innumerable landscapes. Not a sea but a series of seas. Not a civilization, but civilizations piled up one about the other.*

Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II*, 1972

## Introduction

The Mediterranean region is best defined as one of complexity. It is located geographically at the crossroads of three somewhat diverse continents, in a tectonically active fracture zone. Geological outcrops and geomorphological formations across the region provide insights into the dynamic evolution, oftentimes turbulent, of the physical Mediterranean Basin over time, an evolution which continues within its own unhurried time frames, oblivious to human dramas unfolding in the region. Hydrologically, the Basin exists in a delicate balance, regulated by inflows from watersheds on all shores, with the sea in turn providing source material for evaporation and continued maintenance and fluxes of the hydrological cycle. Climatically, the region is unified through its characteristic mild, wet winters and extended summer drought, and through its periodic extreme variability. Ecologically, the Mediterranean Sea and its shores harbour a most interesting biodiversity, a large proportion of which is endemic to this area of the globe. As a consequence, the Mediterranean merits consideration as one of the world's biodiversity hotspots.

The physical setting of the Mediterranean has provided a unified framework and canvas for human events. The character of the Mediterranean is indisputably and inextricably tied to its people. For millennia, the Mediterranean has served as the interface for a multitude of civilizations and cultures, each of which has made its own distinct contribution to the moulding of a Mediterranean identity. At present, the shores of the Mediterranean host a population of over 430 million inhabitants, unevenly distributed both on a national and regional basis, and also growing at different rates in different places. The region brings together three major world religions, Judaism, Christianity and Islam, in a coexistence which is not always peaceful, and indeed sometimes violently hostile. Economically, the northern and southern shores exist at different stages of development, with the divergence between the two appearing to be growing rather than lessening, and with resultant impacts on pan-Mediterranean relations.

The Mediterranean story of human-natural interactions, which has given rise to the region's unique landscapes, lifestyles, cultures and indeed philosophies, is thus now beginning to present us with new, unexpected twists. Most are familiar with the concept of sustainability, increasingly cited as the goal towards which we should strive to ensure that we endow future generations with natural, physical, social and human capital that will ensure a reasonable quality of life. Yet the Mediterranean increasingly exhibits symptoms of *unsustainable* development, most of which seem to have roots that go no further back than the last two centuries of human development, and that are concentrated within the past four decades. It is the irony of human progress extending blindly and optimistically, without a realization that there can be no human progress without a healthy environmental support system, an irony which is not limited to the Mediterranean area, but which may threaten the future of this region's environment and of its human societies.

*Sketch 2.1*
*The Mediterranean Basin*

The challenges of coastal management in the Mediterranean are huge. Nowhere is the need to achieve a balance between the natural and anthropic spheres more marked than in this area which owes its entire identity to this interaction. The coastal manager must thus have an understanding of the Mediterranean as a holistic and dynamic unit, where changes in one component will have repercussions throughout the system. This Chapter cannot hope to convey such an understanding in a few pages, and there are several excellent treatises that serve this end in a much better fashion. However, the following sections are intended to provide an overview of the unique assets, dynamics and challenges of this geographical area, which it is hoped will provide a broad context for local and regional coastal management initiatives within the Mediterranean and its shores.

## Natural characteristics of the Mediterranean Basin

### *Geological evolution and morphology*

The present-day Mediterranean Sea forms a distinct sedimentary basin (Allen and Allen, 1990), comprising an area of the Earth's crust, downwarped by comparison with the surrounding hinterlands, to provide a place where significant thicknesses of sediment accumulate (Ruffell, 1997). It is a semi-enclosed basin, with a 13 km wide connection to the Atlantic ocean through the Straits of Gibraltar, and additional connections to the Black Sea through the Dardanelles and Bosphorus, and to the Red Sea, through the man-made Suez Canal. Spatially, the Mediterranean Sea covers 2.5 million $km^2$, with a total coastline of 46,000 km. The Sea has a substantial average depth of 1,500 metres, but has very limited tides. Although the Mediterranean Sea is often referred to as an individual unit, it is in actual fact fragmented into several smaller seas. Broadly, the Sea is split into western and eastern basins by a relatively shallow submarine ridge between the island of Sicily and the coast of Tunisia. Each of these basins is further subdivided into smaller seas. Whereas the Western Mediterranean Basin is predominantly flat, the Tyrrhenian, Ionian, Levantine and Aegean seas of the Eastern Basin are characterized by alternating deep depressions and morphological highs, submarine valleys and steep slopes. The deepest point of the Mediterranean lies at 5,267 metres within the Tyrrhenian Sea.

The Mediterranean Sea owes its origin to the convergence of the Euroasiatic and African continental tectonic plates. The present Basin is the remnant of an older ocean, tens to hundreds of millions of years old, and several times wider, named *Tethys*. With the convergence of tectonic plates, this ocean began to be consumed some 50-70 million years ago, concurrently with the opening up of the Atlantic Ocean. The process persists to this day, most notably in the eastern part of the Basin, where subduction is occurring. The entire Mediterranean region is characterized by the presence of microplates resulting in very complex geodynamics, as these microplates interact. These processes are most evident in the eastern Mediterranean region, where seismic events are relatively commonplace. However, several other regions of seismic activity also occur within the Mediterranean Basin.

Geological surveys in the 1970s uncovered clues as to the evolution of the Mediterranean Basin in history, with the discovery of seabed deposits characteristic of evaporation in hot, arid desert regions and of shallow seas (Pinet, 2006), leading to the conclusion that the Mediterranean Sea may have dried up during the Miocene. Although debate persists on the significance of these deposits, it appears feasible that the inflow from the Atlantic Ocean may have been halted through the closure of the Straits of Gibraltar, and that this, coupled with an arid climate, may have led to the evaporation of water in the Basin during the so-termed *Messinian Salinity Crisis*. It is purported that the Mediterranean Sea re-filled upon the re-establishment of a connection with the Atlantic through the Straits of Gibraltar, with huge volumes of water flowing over the sill, exceeding the discharge of Niagara Falls by a factor of 1,000 (Hsu, 1983), and leading to the complete refill of the Mediterranean Sea with water in a mere century or less.

Morphologically, the Mediterranean coast has several distinguishing characteristics. Much of the land bordering the sea constitutes narrow coastal strips backed by mountainous terrain. Houston (1964) describes the relief of the Mediterranean as the Enigma Variations of tectonic geology, a symphony of the earth not easy to understand (King, 1997). Superimposed on this natural setting is the heavy hand of man, which has altered relief both directly, through processes such as terracing of slopes for agriculture, as well as indirectly, for instance through deforestation, leading to accelerated erosion and slope failure. Rocky shores predominate around the Mediterranean Sea, with coastal cliffs occurring in several regions, and with few sandy beaches, mostly of limited length, occurring in association with relatively narrow valleys cutting through the mountains, or with small coastal plains (European Environment Agency, 2000). Fluvial influxes are relatively limited, as only four major rivers flow into the Mediterranean Sea, namely the Nile, Rhône, Po and Ebro. However, the dynamics of sediment inputs have been substantially altered in some cases by artificial manipulation of river flows. The case of the Aswan Dam and its effect on the Nile delta (described in Chapter 1) is a case in point. One of the morphological characteristics of the Mediterranean Basin is the presence of several islands. Larger islands include the Balearics, Corsica, Sardinia, Sicily, Crete, Rhodes, and Cyprus, whilst smaller exemplars include the over 6,000 islands and islets dotting the Aegean and loanian seas, and the Maltese Island group.

*Climate*

The climate is often considered to be a distinguishing characteristic of the Mediterranean region. Though often simply defined as a bi-seasonal climate of mild, wet winters and a marked summer drought, it is also a climate of extremes on occasion, and of intra-regional variation. General air temperature differences between winter and summer months are limited to approximately 15º. Extremes of summer heat, as well as droughts and floods, are, however, common, and spatially uneven. High air temperatures regularly occur in areas such as Spain, Corsica, Sicily, Crete and Cyprus, whilst the lowest temperatures are often recorded in the Aegean and Adriatic.

Precipitation is likewise unevenly distributed, with annual totals varying greatly in different parts of the Basin, generally decreasing southwards, but also affected by relief. Winds are frequent, and include several local winds which develop in specific geographical areas given particular synoptic conditions. Well-known local winds include the *Mistral*, associated with fire threats in the south of France, the strong, cold *Bora* in the Adriatic, and the *Sirocco*, bringing warm, dusty air from the Sahara.

*Oceanography*

Due to the particular combinations of climate and morphology, the Mediterranean Sea may be described as a concentration basin (European Environment Agency, 2000), characterized by high evaporation, in excess of precipitation levels. Despite the freshwater deficit, a balance is maintained mainly through the inflow of Atlantic Water from the Straits of Gibraltar, as well as from the Bosphorus. Water exchanges through the Suez Canal are considered to be minimal. A circulation system operates whereby the Mediterranean imports heat and exports salts. Waters entering from the Atlantic in the surface layer are warm and of relatively low salinity. As these move eastwards across the basin, under the influence of evaporation, they become saltier, and thus denser, and eventually sink at the eastern margin of the basin, travelling back westwards as bottom water, and eventually spilling out through the Straits of Gibraltar, into the Atlantic Ocean. Changes have, however, been noted in the temperature and salinity characteristics of Mediterranean water masses since the 1950s (Bethoux *et al.*, 1990), possibly related to global change phenomena. Water in the Mediterranean Sea has a relatively long residence time of approximately 75 to 100 years, thus magnifying the problems resulting from marine pollution, which will likewise have a long period of persistence. There is a general nutrient deficit in the Mediterranean Sea, resulting both from its influx sources and from its circulation characteristics. Marked density gradients further prevent mixing of waters which could enhance nutrient exchange. Primary productivity is thus generally rather low, in comparison with other seas and oceans. However, some geographical areas of nutrient enrichment occur, particularly in river plume areas.

*Ecology*

The importance of the Mediterranean region in ecological terms is disproportionate in relation to its size. Its terrestrial biodiversity is of great richness, with an estimated 25,000 flowering plants and ferns in the Mediterranean area of about 2.3 million $km^2$, compared with just 6,000 species in non-Mediterranean Europe, an area of 9 million $km^2$ (Allen, 2001). These 25,000 species account for 10 percent of known species in the biosphere (on less than 1.6% of total land area) (Benoit and Comeau, 2005). More than half of Mediterranean species are endemic, i.e. limited geographically to the Mediterranean region. The flora of the region also includes relict associations, established under past climatic conditions which no longer persist today. Faunal biodiversity is likewise significant, particularly for amphibians and reptiles. Of 62 amphibians found in the Mediterranean, 35 are endemic, whilst 111 of the 179 reptiles living in the region are also endemic (Benoit and Comeau, 2005). Furthermore, the Basin is of importance from an ornithological standpoint, providing a variety of important stop-over habitats for migratory birds.

Marine biodiversity is also significant. The Mediterranean Sea, represents only 0.8% of the area and less than 0.25% of the volume of the world's oceans, but includes about 7% of known marine fauna, and 18% of the world marine flora. 28% of marine species are endemic to the region (Benoit and Comeau, 2005). A typical marine assemblage is represented by seagrass meadows comprised of *Posidonia oceanica*, whilst other important sources of biodiversity include sea caves, coralligenous zones and algal rims. The geographical distribution of species is uneven, with higher species richness in the Western Basin, as well as altitudinal variations with depth. Compared with other seas, Mediterranean marine communities appear to be rich in species, with smaller individuals having shorter life-cycles (Bellan-Santini, 1994).

## Humans and the Mediterranean

### *Historical overview*

The earliest evidence of nomadic human existence around the Mediterranean dates back to 400,000 years B. P. Closer to-date, the Mediterranean served as the cradle for human civilization, with the first permanent settlements established in the eastern Mediterranean, specifically in Mesopotamia and in Ancient Egypt. These civilizations were heavily shaped by their geographical context, specifically by climate, resource availability and geomorphology, and developed technologies and sedentary lifestyles that influence modern society to this day. The geographical spread of people was, for a while, checked by the natural barrier of the sea, but in time, marine navigation technology improved, and societies began to spread across the Basin. The river valley civilizations remained the larger, in terms of population size, but the trading cultures established on the shores of the Mediterranean, rapidly grew in prosperity and power.

In Classical Antiquity, the predominant influence lay with the Greek city states and with the Phoenicians. Ancient Greek civilization laid the foundations for many modern disciplines, including philosophy, mathematics and astronomy, many of which developed out of the close ties that existed between society and the natural world at the time. The Greeks spread throughout the Black Sea, and south, through the Red Sea, whilst the Phoenicians did the same in the western Mediterranean, including in North Africa and across the Iberian Peninsula. In Macedon, to the north of Greece, military forces unified under Alexander the Great turned east, and quickly spread Greek knowledge and ideas throughout the region. In time, however, and following the fall of Alexander, eastern prowess came to be overshadowed by developments further west. In modern-day Tunisia, the Phoenician colony of Carthage established an empire that contained many of the former Phoenician territories.

However, it was Rome that would establish the most lasting political unification of the Mediterranean region. Rome defeated Carthage in the Punic Wars, and the Roman Empire soon spread east, eventually enveloping the entire Mediterranean region. The intermingling of Roman and Greek culture is evident to this day, with evident overlap between the heritage of the two civilizations. The Empire was, by this time, entirely forged by the power of coastal navigation, and the Roman *Mare nostrum* ('Our Sea') provided the focus for commerce and naval development that were the backbone of the Empire. The dominance of the Roman Empire persisted for several centuries, during which time Christianity was founded in Judea. The Roman realm eventually began to crumble in the 5th century. With its demise, the eastern Mediterranean was taken over by the Byzantine Empire, whilst the western part of the former Empire was invaded by nomadic tribes from the Eurasian steppes, who formed many small and warring kingdoms.

Meantime, some centuries later, the legacy of the prophet Mohammed was shaping the course of Mediterranean history in the east, through the spread of Islam. In a series of rapid conquests, Arab armies swept through much of the Middle East, reducing Byzantine lands by half, and spreading westwards across north Africa and through to Iberia. Much of North Africa became a peripheral area to the main Muslim centres in the Middle East, although advanced societies were established in Iberia and Morocco. Europe was also reviving and seeking to regain some of its former glory, as more organized city states began to be established in the later Middle Ages. The feared rise of Islam was contested by Christian Europe through the launch of Crusades by the European Kings and nobility. Although the Crusades had limited success in curbing Islam, they did serve to further weaken the already fragile Byzantine Empire.

Europe continued to re-establish itself with the Renaissance in Italy. The Italian city-states of Venice, Genoa, Amalfi and Pisa established their own 'empires', based on naval commerce, and in this respect, found an advantage over Islamic Caliphates who had never been major naval powers. The Renaissance also made rich contributions to the cultural richness of the Mediterranean region, as new-found financial wealth was directed to development of the arts. Ottoman power continued to grow, however, and with the fall of Constantinople in 1453, and the accompanying fall of the Byzantine Empire, Ottoman supremacy was evident, as was its spread. The growing naval prowess of European powers served to slow Ottoman expansion but could not curb it, and the Mediterranean eventually found itself in a delicate balance of power between western powers and the eastern Ottoman Empire.

By this time, however, global naval exchanges had come to influence the political futures of the Mediterranean region. While once all trade from the east had passed through the region, the circumnavigation of Africa allowed gold, spices and dyes to be imported directly to the Atlantic ports of Western Europe. The Americas were also a source of extreme wealth to those with access. European power thus shifted northwards, and both the once wealthy Italy, and the Ottoman Empire, began to decline. By the nineteenth century, the European States had initiated their colonization of North Africa, with France taking Algeria in 1830, and later Tunisia (1881) and Morocco (1911), and Britain taking Egypt in 1882. Italy eventually conquered Libya from the Ottomans in 1911. The complete demise of the Ottoman Empire came about during World War I, with Turkish states subsequently re-forming as the nation of Turkey in 1922. The region again played a major role in World War II, constituting a major area of battle between Allied and Axis forces.

*Mediterranean politics today*

Today, the Mediterranean constitutes the southernmost boundary of the European Union and the northernmost boundary of the African continent, whilst also encompassing the complexities of political relations in the Middle East. The cultural differences inherent in the different cultural roots of the two shores are still evident, perhaps most obviously in the case of religion. Despite the increasing secularization of global society, the Mediterranean is at the forefront of the growing clash between western Christian civilization and growing Islamic fundamentalism. Also increasingly relevant today, is the demographic and economic disparity between the northern and southern shores. In the present reality, it is not possible to talk of the Mediterranean as a unity except in natural terms, as the physical unit contains much human content that is widely and evidently different.

The reality of the Mediterranean region is today one of growing populations, growing conflicts, and ever-increasing environmental problems. Overall, the population of the Mediterranean increased from 285 million in 1970 to 428 million in 2000 (Benoit and Comeau, 2005), and continues to grow. Population growth is, however, uneven, with a growth rate in southern and eastern Mediterranean countries five times that in northern Mediterranean countries. Thus, since 1990, population in the former has overtaken that in the latter. Blue Plan projections envisage a total population for the Mediterranean region of 523 million by 2025 (Benoit and Comeau, 2005).

Conflicts in the Mediterranean are strongly rooted in history, and tensions are evident even on small geographical scales, such as with separatist factions in Corsica and the Basque region of Spain. The geography of the Mediterranean has been re-written in recent years with the collapse of the former nation of Yugoslavia in the 1990s, and the resumption of conflicts between Israelis and Palestinians in the Middle East. Such conflicts involve huge human costs, with many lives lost, and millions more displaced. The direct environmental impacts are many, and include the destruction of habitats and the misuse and contamination of resources. Indirect impacts also result, however, and these may persist for long periods. The loss of community integrity and social capital is one such impact, as is the long-term malfunctioning of institutions and the monopolization of financial resources. It is hard to argue the case for conservation funding in a context where people lack basic amenities and live in fear of their lives! Conflicts also reduce potential for regional cooperation, and therein lies the biggest challenge for the Mediterranean region. It is a natural unity, which requires politically unified decisions for management, yet it is a region riveted by conflicts which make regional coherence difficult.

Perhaps the most significant conflict of all in terms of Mediterranean identity may turn out to be one which has been relatively silent, ever-present but low-key. There has been comparatively little blood shed in recent years in conflicts between Christian Europe and Islamic North Africa, but tensions are evident and growing. Today, it is not the same sentiment that drove clashes between Europe and North Africa in the Crusades that is behind the conflict. It is now a complexity of economic, political and religious factors that are driving a wedge, pushing north and south ever further apart. Turkey and Tunisia have a standard of living equivalent to one-third of that in the European Mediterranean countries. In Egypt, Lebanon, Morocco, Albania and Syria, it remains less than a fifth (Benoit and Comeau, 2005). Some point to colonialism as being one of the forces responsible for leaving North Africa in the lurch in terms of economic development. Population growth is certainly exacerbating social problems, as is the problem of unemployment. In particular unemployment rates in the southern and eastern Mediterranean are amongst the highest in the world, reaching 2002 levels of 18% in Morocco and 2003 levels of 14% in Tunisia (Benoit and Comeau, 2005). Meantime, populations along the northern shore are increasingly characterized by ageing, and by declining birth rates, placing greater demands on the working population which has to support a growing proportion of dependents. At the same time, there is a global context of growing Islamic fundamentalism, potentially linked to Western economic and political policies. This has had impacts on inter-religious relations even where no fundamentalism exists, as the growth of Islam in Europe is increasingly viewed with suspicion and fear by sceptical Europeans. The net result is one of growing economically and politically-motivated flows of people across the Mediterranean, largely from North Africa to Europe, often illegally, resulting in, and increasing, cultural tensions between such immigrant and native resident populations in southern Europe. Political futures of the Mediterranean Basin are certainly far from clear-cut.

## Environmental futures in the Mediterranean basin

### *Driving forces and pressures*

Threats to the environmental integrity of the Mediterranean Basin are primarily anthropogenic in nature. Man has been instrumental in shaping the present-day landscape of the Mediterranean, in various ways. The agricultural lands, evergreen woodlands and maquis habitats that dominate the region today are the result of anthropogenic disturbances such as grazing and fire, occurring over several millennia. However, the interaction of man and nature in the Mediterranean is not exclusively or intrinsically negative. It has been a force endowing the area with its particular identity, and in some instances, contributing to species richness. However, the situation is now changing, primarily due to population growth. The impact of man is now greater, more widespread and more lasting, and pressures on the natural environment are far greater than they were in centuries past. Coastal areas may be expected to be the first under fire. Benoit and Comeau (2005) note that some Mediterranean countries have more than 80% of their total population living in coastal regions. These include Greece, Israel, Libya, Malta, Cyprus, Lebanon and Monaco. For others, such as Tunisia and Italy, the figure lies between 60% and 70%, whilst in Spain, Algeria, Croatia, Egypt, Albania and the Palestinian territories, 40% to 50% of the population lives on the coast.

Population pressures are further exacerbated by phenomena of urbanization. In general, the mass migration towards urban centres has resulted in overstrained infrastructural facilities, spatial concentration of environmental problems and the decline of rural areas. The trend towards urbanization appears to be present in all Mediterranean countries, but is especially marked in the south and east. Indeed the rate of urbanization in the south and east (3.6% per year) is higher than the global average of 2.5% annually (Benoit and Comeau, 2005). The general result is an apparent spatial dichotomy between strong, heavily populated coastal areas, characterized by high intensity of land use and consumption, and inevitably weaker, thinly populated inland areas with lower housing density and a less dynamic economy.

*Case Example 2.1*
*Tourism development in the Maltese Islands*

The development of tourism in Malta began in the late 1950s, following the decline of Malta's importance as a strategic military base. Tourism was considered to be a viable replacement industry to sustain local economy. By 1969, Malta had over a hundred hotels, with over 186,000 tourists visiting the Islands. The infrastructural capacity was rapidly developed, particularly along the coast. However, the country had no formal strategic planning mechanisms at the time. It was only in 1992 that the first *Structure Plan for the Maltese Islands* was formulated, accompanied by the enactment of the first *Development Planning Act* in Maltese Law. Environmental management measures have also only been implemented since the 1990s. By that time, however, much damage had already been done. The landscape along several coastal areas has been irreversibly impacted upon, and the legacy of pollution problems is felt to this day. Furthermore, it is a major challenge for authorities to ensure compliance of constructions and facilities pre-dating all planning and environmental legislation.

Source: Malta Tourism Authority, 2005

The Mediterranean also hosts a large seasonal tourist population. Although the fortunes of Mediterranean tourist destinations have fluctuated in recent years, particularly with the emergence of new tourism markets and the facilitation of international travel, the sun, sea and sand tourism of the region continues to entice tourists. Projected tourist arrivals for the whole Mediterranean for 2020 are in the region of 350 million (World Wildlife Fund, 2006). Much of this number will stay on the

Mediterranean coast. Coastal tourism is strongly seasonal and environmental pressures are hence concentrated not only spatially but also temporally. Tourism is currently the first foreign currency source in the Mediterranean region and its contribution to a nation's Gross Domestic Product can average up to 24%, as in the case of Malta (Malta Tourism Authority, 2005). The environmental impacts of tourism are, however, far-ranging, and can be seen in spheres such as land use, pollution and waste. These impacts have been particularly severe when the development of a tourism product was not accompanied by adequate attention to spatial planning and environmental management; it is unfortunate that the latter often occurred only as an afterthought when the damage caused by unbridled exploitation for tourism became evident.

Both resident and seasonal tourist populations are dependent on the availability of resources. Due to its specific morphological characteristics, the Mediterranean lacks extensive plains suitable for agriculture. Agricultural activities are therefore intensive, often occurring in narrow coastal strips. Agriculture brings about its own share of environmental problems, ranging from pollution of water resources, both freshwater and marine, to soil degradation. Fisheries likewise bring their fair share of environmental pressures, particularly with shifts to more capital-intensive vessels which enable the harvesting of higher yields. Mediterranean fisheries are also the subject of political controversies due to territorial disputes, which are only set to worsen given marked trends toward decline of several commercial species in the region.

Fisheries are also being increasingly affected by degradation of marine habitats. Industry is one of the culprits in this regard. There is a large range of different industrial activities occurring on the shores of the Mediterranean, including a number of large industrial complexes concentrated in the northwest, together with sizeable commercial harbours. Industries range from petrochemicals to mining, metallurgy, printing, tanneries and treatment of wastes. The impacts on coastal areas are both direct and indirect, with direct impacts including emissions of effluents and pollutants, and indirect impacts including locational factors, where industrial areas often serve as hubs for further urban development. Maritime transport also represents a key environmental pressure, with several major commercial routes crossing the Sea. On average, there are about 60 maritime accidents in the Mediterranean annually, of which about 15 involve oil or chemical spills (European Environment Agency, 2000).

*Future scenarios*

The variety of environmental pressures operating in the Mediterranean has taken an evident toll on the health of the region, both on the physical environment and on human societies. The current state of the environment is far from ideal, as numerous studies on various subjects attest, and pressures only appear to be increasing and growing, begging the question 'what future for the Mediterranean?'. The future for the region's natural capital appears somewhat bleak. Profound negative impacts have occurred on biodiversity. Habitat fragmentation is severe, with the little remaining original vegetation now existing largely in small, scattered patches whose long-term integrity and viability is doubtful. Several endemic species have been severely confined, in some cases to individual rock outcrops, and are hence extremely vulnerable. A number of species, both floral and faunal, are now classified as critically endangered, rare or vulnerable. Species such as the Mediterranean monkseal, the Barbary macaque and the Iberian lynx may soon become no more than a record in history books. The situation of Mediterranean species is rendered even more precarious by competition from invasive aliens which are becoming established in the region. It is a situation of ever-decreasing refugia for nature within an increasingly anthropogenic matrix. The scenario for other natural resources is likewise sobering, with mineral reserves running out, fish stocks on the decline and natural sites becoming increasingly degraded.

*Case Example 2.2*
*Carpobrotus edulis: an invasive alien*

Kaffir Fig (*Carpobrotus edulis*) is originally a native of the Cape Peninsula, South Africa, and was introduced into the Mediterranean mainly for ornamental use. It is often planted in coastal regions, where it tends to form large 'carpets' or 'curtains' that are quite attractive when in flower. However, due to its invasive nature, this species, and the related *Carpobrotus acinaciformis*, pose a serious threat to the flora of many Mediterranean coasts, including cliffs and dunes. *Carpobrotus* very often smothers and displaces the native flora wherever it is planted. It is also spread by seed that may be dispersed by birds.

Sources: Fox, 1990; Quezel *et al.*, 1990; Schembri and Lanfranco, 1996; Mayer, 1995

Water is also likely to be an issue of concern for future Mediterranean societies. Freshwater, an essential component of life and modern society, is becoming a scarce and valuable commodity, either because of decreasing quantities or because of inadequate quality. Although the diversion of water resources to agricultural areas through damming initially appeared to be a technological break-through that would improve human well-being, today it is evident that long-term and large-scale changes in hydrology may threaten the physical basis of societies in the Mediterranean region. Meantime, technological fixes such as desalination have come at other environmental costs, with reverse osmosis technology consuming vast amounts of energy. Some predict that the conflicts of the future will be 'water wars', strife between nations over scarce water resources. The Middle East has already provided ample examples of the volatile nature of negotiations over water resources, particularly across national boundaries. The expected continued decline of freshwater resources in the Mediterranean can in no sense bode well. Public health implications of contaminated water resources further complicate future scenarios. The Mediterranean will need to cater not only for deficiencies due to declining resources, but also for excesses of unwanted ones. Disposal of the huge amounts of waste produced by a growing population is likely to present a challenge across all shores of the Mediterranean for the foreseeable future, particularly given the difficulties of managing waste in ways that do not negatively impact on an already strained natural environment. The control of pollutants presents similar problems, as technological prowess in pollution control must be matched by economic viability.

Climate change will play a major role in the future evolution of the Mediterranean Basin. Potential climate change impacts include drought, floods, changes in land conditions, changes in oceanic circulation and sea level rise. The latter will directly affect coastal regions, with likely repercussions on national economies, particularly where these are directly dependent on natural resources or on tourism. Water shortages are likely to worsen in many areas and the future of tourism in the Mediterranean may be in jeopardy. The biodiversity and functioning of terrestrial and marine ecosystems is likely to be altered, and vulnerable species may be wiped out. Extreme weather events may increase in frequency. Climate change may therefore alter the identity of the Mediterranean region, as it is today. Whether such change can be halted remains to be seen.

The region's destiny is not, however, inscribed in stone. As described elsewhere in this book, Mediterranean countries have implemented several initiatives seeking to address the problems of the region. In practically all Mediterranean countries, efforts have been made to protect biodiversity, prevent pollution, control wastes, and ensure better environmental quality overall. Mediterranean society's strong ties with its natural setting may prove particularly valuable in combatting environmental degradation, particularly where environmental protection can be tied to economic feasibility. Where the area once marketed primarily sun, sea and sand to tourists from outside the region, it can now market that which is intrinsically Mediterranean – its threatened natural heritage, its unique cultural heritage, and the landscape which reflects interactions between the two over several millennia. The critical factor for the future of the Mediterranean region is likely to be that of cooperation, as environmental problems are not constrained by arbitrary political boundaries. Numerous successful pan-Mediterranean projects have been initiated and implemented, but much still remains to be done. The unique challenge for coastal management in the Mediterranean region is that of dealing with a physical whole on which are superimposed various cultural parts. Ensuring the health of the former is increasingly proving necessary to ensure the survival of the latter.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# CHAPTER 3
# A Framework for Coastal Management

*Hope, creativity, imagination…[are] the traits that first enabled and inspired explorers to take to the sea…In the 21st century, these traits…must lead us to preserve our living oceans as a sacred legacy for all time to come.*

US President Bill Clinton, during speech at US National Oceans Conference, June 1998

## Introduction

The late 20th century brought with it numerous innovations in terms of the philosophy of how we, as the human species, interact with our natural surroundings. During the post-war period, people began to understand that with so much environmental degradation, one cannot envisage a healthy global society, nor can one expect a thriving, well-balanced, world economy. At first, challenges came from lone dissenting voices of concern, such as that of Rachel Carson, the author of *Silent Spring*, whose achievement went far beyond simply highlighting the dangers of pesticide use. Carson was one of the first to openly challenge an established and accepted order, and to suggest that economic pursuits could come at an unacceptable environmental price, and *Silent Spring*, in which she outlined bleak scenarios in which pesticide use had wrought havoc with biodiversity and with human health, alarmed the western world.

Ten years later, at the 1972 United Nations Conference on the Human Environment, held in Stockholm, it became apparent that issues pertaining to environment and development could not be regarded as separate concerns any longer, nor could the two issues remain in conflict. It also became abundantly clear that although economic development could not be halted, attitudes had to change in order to alter the course of events. The Stockholm Conference marked the launch of environmental awareness worldwide and boosted the grassroots environment lobby. Concurrently, the Club of Rome, also in 1972, initiated studies and calculations based on the assumption that natural resources of the earth would not suffice to satisfy the increasing needs of an ever-growing population. The resulting publication *Limits to Growth* (Meadows *et al.*, 1972) predicted that population pressures would bring about various environmental crises at the beginning of the 21st century.

The idea of linking environment and development was further developed by the United Nations Environment Programme (UNEP). After years of endeavouring to define a terminology that would capture the implications of environment and development, UNEP joined forces with the Worldwide Fund for Nature (WWF) and The World Conservation Union (IUCN) to integrate the two widely divergent themes into an umbrella concept of conservation. This was attempted through the First World Conservation Strategy, issued in March of 1980 (IUCN *et al.*, 1980). A year later, Lester R. Brown published *Building a Sustainable Society*, which summarized views suggesting ways of harmonizing the material needs of society, population growth and the rational use of natural resources, so that environmental degradation and pollution would be minimized (Brown, 1981). Some years later, in 1987, the World Commission on Environment and Development, also known as the Brundtland Commission, presented the report entitled *Our Common Future* (World Commission on Environment and Development, 1987). Unlike *Limits to Growth*, it did not suggest that economic growth should be restrained, but rather proposed a scenario of integrated economic and environmental policies. The Brundtland Commission further stressed that fundamental changes in society were needed before sustainability could be achieved.

The challenge of the nineties lay in putting this understanding into action. Theoretical concurrence was swift and vocal. At the 1992 Earth Summit in Rio de Janeiro, more than 170 heads of state pledged to cooperate for our common future, adopting the Agenda 21 global plan of action. Whether humankind has actually made concrete progress towards true sustainability is less clear. If we have failed, it is certainly not for want of discussion! The term sustainability has been rendered almost infamous by the frequency of usage in the environmental context during the past two decades. Yet at a follow-up conference in Johannesburg, ten years after Rio, little progress had been registered. Johnson (2002) notes that in the ten-year journey, much seemed to have been lost along the way and that environmental protection had been rendered an even tougher battle.

With over half the world's population living within a few kilometres of the coast, and with a multitude of land-uses concentrated in this limited land area of ecological importance, the coastal zone provides the perfect example of such management challenges. Yet its importance has also made the coastal zone a prominent concern, and as a result, much has been done in terms of developing management concepts, frameworks and methodologies. Some would argue that theory is a waste of time and resources in a context of urgent actual environmental problems. However, intervention and management can do more harm than good when these are not prudent, appropriate and well-informed. Such conceptual work is therefore of critical importance in guiding management of coastal zones worldwide. This chapter will attempt to outline some of these approaches, drawing out key concepts and highlighting the challenges of implementation. The chapter will also consider the policy and legal aspects of coastal management in the Mediterranean region, as these provide an important bridge between academic theory and real-world implementation. Finally, a framework for coastal management, specific to the Mediterranean, will be proposed.

## Approaches to coastal management

Coastal management has taken many forms and structures in the past decades. Some approaches have involved a very specific focus, on the basis of particular academic disciplines. One such group of approaches has limited the remit of coastal management to coastal defence in the face of erosion problems. Such outlooks have generally evoked command and control solutions, based primarily on engineering interventions. More broadly, however, coastal management has now come to be understood to refer to management of activities and land uses in the coastal region, in synch with an understanding of physical and ecological processes. It is therefore not so much management of the coast as a physical entity *per se* as much as management of human activities in this area. Nevertheless, even within this broader understanding of the term, much diversity exists in terms of approaches, in terms of resources or resource users targeted, in terms of decision-making powers, and in terms of time-frames, amongst others.

One broad conceptual approach which has become established as a mainstream framework for policy making is that of **Integrated Coastal Area Management (ICAM)**, or **Integrated Coastal Zone Management (ICZM)**. A related approach is that of **Coastal Zone Management (CZM)**. Although subtle differences, related mostly to scale, distinguish between the different terms, all refer to an approach towards 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. This approach has been formally recognized at the 1992 UNCED Conference in Rio, at the 2002 Johannesburg Conference, and by the European Union, amongst others.

The fundamental premise of ICAM is that the multiple uses of the coast require management approaches that are integrative rather than having a narrow sectoral focus. Thus, rather than considering the needs of tourism, agriculture, fisheries and so forth in isolation, the ICAM approach looks at the coast as one holistic entity, and interventions relating to tourism are thus assessed also in terms of their impact on agriculture, fisheries, and all other land use sectors, as well as in terms of their impact on the physical coastal system. All components are therefore seen to be interdependent.

*Box 3a*
*Potential goals of ICAM*

1. Safeguarding of natural assets and associated processes including, *inter alia*, geological, geomorphological, palaeontological and ecological resources;
2. Ensuring the maintenance of natural processes of coastal dynamics;
3. Comprehensive land-use planning, for present and future uses of coastal areas;
4. Ensuring an adequate quality of life for coastal human populations;
5. Providing for equitable and sustainable use of resources, either for subsistence purposes, or as the basis of economic progress;
6. Management of the coast as part of a broader spatial system which extends both into the terrestrial and the marine environments;
7. Integrated planning and management of coastal activities at a strategic level, with the participation of all affected stakeholders;
8. Respect for cultural diversity and preservation of the distinct traditions of indigenous peoples;
9. Resolution of conflicts between different stakeholders;
10. Improvement, rehabilitation and/or restoration of degraded habitats and biota;
11. Mitigation of risks to public health and security;
12. Forecasting of future pressures and needs, and of the ability of natural systems to accommodate such demands.

*Box 3b*
*Stages in the ICAM process*

*Initiation*
The initiation phase comprises the initial analysis of the system and includes tentative definition of the problems and of the geographical areas to be considered, as well as establishment of work plans, timetables, financial mechanisms and other logistical necessities. An ICAM process may be initiated at various levels, either by centralized government, or by decentralized organizations.

*Planning*
The planning phase incorporates the development of a coastal profile, including a geographical definition of the area, an analysis of the natural, human and economic systems involved, identification of problems, causes and effects, and analysis of stakeholders involved. Subsequently, the coastal profile serves as the basis for preparation of the ICAM programme, including proposals of goals and objectives, identification of information gaps, analysis of legal and policy requirements, and proposal of institutional arrangements for implementation. The planning phase also incorporates an element of forecasting, including potential future pressures and the preparation of alternative management scenarios.

*Implementation*
The final phase of the ICAM process involves the translation of agreed management measures into formal documents, ideally with legal weighting, and their on-the-ground implementation, in a coordinated manner. Measures may be gradually implemented over a pre-established time-period.

Monitoring and evaluation should occur throughout all stages, particularly during the implementation phase, and the conclusions should, where necessary, feed back into the prior stages of ICAM.

Source: Trumbic and Bjelika, 2000; UNESCO, 1997

The ICAM approach is necessarily interdisciplinary, seeking to bring together natural and social scientists, coastal managers and policy makers, sectoral and public interests, in achieving identified goals. It is also broad in spatial scale, looking beyond the immediate coastal areas to the watersheds which may in some way affect activities at the coast. The approach is also based on an extensive temporal view, which considers not only short-term concerns but also long-term viability of the entire coastal system. ICAM also addresses ethical issues of participation, representation and democratic governance, and as a process is designed to be transparent and inclusive of all affected stakeholders. The latter initiative is also motivated by a pragmatic realization that only few behavioural changes required to implement sustainable coastal management practices can be imposed by regulation. Unless both individuals and institutions feel adequately involved in a management programme that appears to address their needs and views, and is consistent with their value systems, then the success of management will be limited at best.

Effective ICAM programmes rely on a diverse mix of methods to develop and implement their plans of action. Although guidance frameworks may be agreed at an early stage, ICAM is led by the idea of adaptive management (discussed further in Chapter 4), i.e. progressive learning from results, which is implemented through regular monitoring and evaluation. To this end, several ICAM programmes have come to make increasing use of environmental indicators, which can provide specific measures of system state, pressures and responses. ICAM is therefore not a single event, but rather a strategic and iterative process. Three main stages can be identified: initiation, planning and implementation (Trumbic and Bjelica, 2000).

### Coastal management initiatives in the Mediterranean region

*Examples of regional cooperation*

As noted in Chapter 2, the key challenge for coastal management in the Mediterranean region is that of overcoming political differences in order to develop coordinated management measures that encompass the entire Mediterranean basin. Despite the evident difficulties of achieving such agreement, there have been numerous successes recorded, largely initiated as a result of region-wide dissatisfaction and concern over growing environmental degradation. Over thirty years ago, in 1975, 16 countries from across both shores of the Mediterranean, together with the European Community, adopted the Mediterranean Action Plan (MAP), the first-ever Regional Seas Programme under the umbrella of the United Nations Environment Program (UNEP). The distinguishing feature of MAP has been in bringing together very diverse countries for discussions on an equal footing, with a common aim of creating a better Mediterranean environment for present and future generations.

A year later, in 1976, the MAP Parties adopted the Barcelona Convention for the Protection of the Mediterranean against Pollution (since replaced by the 1995 Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean). There are now 22 Contracting Parties. The Barcelona Convention requires Parties to individually or jointly take all appropriate measures to protect and improve the Mediterranean marine environment in order to contribute to sustainable development in the area. The Convention further lays down provisions on cooperation and information among the Parties in the event of a critical situation causing pollution in the area of the Mediterranean Sea in order to reduce or eliminate any damage resulting. Cooperation between parties to the Convention in the fields of science and technology is also advocated, as are improvements to quality of life, protection of natural and cultural heritage, and integration of environmental, social and economic goals. The legal framework is further strengthened by a number of related Protocols.

Although MAP's initial focus on regional cooperation was limited primarily to marine pollution control, its mandate has gradually widened to include broader concepts of coastal planning and management. Thus, in 1995, concurrent with the revision of the Barcelona Convention, the Contracting Parties adopted the *Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean (MAP Phase II)*, to replace the Mediterranean Action Plan of 1975. MAP Phase II affirms the extension in conceptual focus, presenting frameworks for the integrated application of a proactive policy option, with the participation of a wide range of partners, including Regional Activity Centres (RACs) and authorities within Contracting Party countries. The Mediterranean Commission on Sustainable Development (MCSD) was also established, with the remit of focusing on the sustainable management of coastal zones at a regional strategic level.

1995 also saw the establishment of the Euro-Mediterranean Partnership (Barcelona Process), a joint endeavour by 27 Mediterranean countries to set up a wide framework of political, economic and social relations between the Member States of the European Union and partners of the southern and eastern Mediterranean. The Partnership has three main objectives, namely:

1. The definition of a common area of peace and stability through the reinforcement of political and security dialogue;
2. The construction of a zone of shared prosperity through an economic and financial partnership and the gradual establishment of a free-trade area; and
3. The *rapprochement* between peoples through a social, cultural and human partnership aimed at encouraging understanding between cultures and exchanges between civil societies.

The success of the Barcelona Process has to date been mixed (Halliday, 2005), with progress in some aspects (e.g. the political engagement of Libya and the re-instatement of some measure of stability in the Balkans) but bleak outlooks in others (e.g. lack of progress in Israeli-Palestinian conflicts and the continued tense political subdivision of Cyprus). Nevertheless, the Euro-Mediterranean Partnership may be considered a significant step towards providing a political framework which facilitates region-wide cooperation for environmental ends. The objectives of the Environment Programme within the Partnership include halting environmental degradation in the region, contributing towards sustainable development, integrating environmental concerns into sectoral policies, highlighting the relationship between trade and the environment, and contributing to the creation of employment opportunities.

Other initiatives include the Mediterranean Environmental Technical Assistance Programme (METAP), launched in 1990 by the World Bank and the European Investment Bank, in partnership with the European Union and the United Nations

Development Programme (UNDP). The Programme has the stated aim of strengthening the capacity of Mediterranean countries to address common environmental issues, and is motivated by a desire to give a regional dimension to national environmental issues. METAP's mission is therefore to generate funds in order to assist Mediterranean countries, particularly those along the less economically developed southern and eastern shores, to formulate policies and plans in pursuit of a healthier environment and sustainable livelihoods. METAP focuses specifically on policy and legislation tools, water quality, waste water, coastal zone management, and municipal and hazardous waste management. Limitations have, however, been identified with respect to initiatives to date involving the Mediterranean coastal region, with claims that projects may have been limited in scope and ineffective in terms of clarifying investment actions (UNEP/MAP/PAP, 2001). An evaluation of such management initiatives served to identify the need for better involvement of different governance levels in ICAM.

The above description of region-wide efforts is by no means exhaustive. There have been several other initiatives, including MedWet (Mediterranean Wetlands Strategy), MedNEA (Mediterranean National Environmental Agencies network), the Mediterranean Education Initiative for Environment and Sustainability, the Horizon 2020 strategy, and the Regional Euro-Mediterranean Programme for the Environment, amongst others. Nevertheless, despite the importance of pan-Mediterranean cooperation, this needs to be accompanied by efforts at smaller spatial scales, as identified in the METAP evaluation process. The reality is often, however, that operational capacities of national and local organizations is limited, particularly along the southern and eastern Mediterranean shores. In this regard, national and grassroots initiatives in the Mediterranean region are also critical, and some examples of these are reviewed below.

*Examples of national and local-level initiatives*

Worldwide, ICAM has often been the prerogative of centralized administrative governments, particularly where mechanisms for local government are either non-existent or weak. Even where effective decentralized governance institutions exist, their activities are often constrained by broader national level frameworks. In this regard, it is important to also consider national responses to coastal management problems, and within the Mediterranean region, these have varied widely. The resolution of coastal management issues in countries such as Malta has been carried out primarily on a sectoral basis, as there are no organizations with a specific mandate for coastal management. The responsibilities for different management issues are therefore ascribed to other relevant bodies such as tourism authorities, industrial bodies, environmental organizations, and so forth. In other countries, specific agencies with a coastal management focus have been set up. The Tunisian *Agence de Protection et d'Amenagement du Littoral* (APAL) is a case in point, having been established specifically for the protection and management of the coast. Other Mediterranean states have developed their ICAM approaches around legal frameworks, such as the Spanish 1988 Shores Act, whilst others have used strategic master planning as their basis (such as the Israeli National Master Plan for the Mediterranean Coast). More innovative approaches have also been implemented, such as the French *Conservatoire du Littoral* initiative.

*Case Example 3.1*
*Conservatoire du Littoral*

In 1975, the French Government created a public administrative organization with the remit of ensuring the definitive protection of outstanding natural areas on the coast, banks of lakes and stretches of water of 1000 hectares or more. The *Conservatoire du Littoral* operates an acquisition programme, defined by an administrative council comprised of elected members and individuals with specialist knowledge. The Conservatoire has defined three main criteria for selecting land for acquisition:

1) the site is threatened by urbanization;
2) the site has deteriorated and needs rapid restoration; or
3) the site is closed to the public whereas it should be open to everyone.

The organization can acquire such areas of land through three means: private agreement, pre-emption in coastal areas defined by departments, or by expropriation for reasons of public interest. Once acquired the land cannot be re-sold, and the management of sites is then entrusted to local authorities, overseen by the *Conservatoire*. The *Conservatoire du Littoral* presently manages over 300 sites, covering an area in excess of 180, 000 acres.

Source: Conservatoire du Littoral, 2007

Several local initiatives have also been undertaken across the Mediterranean region. MAP has not only been involved in broad pan-Mediterranean initiatives for coastal management but also in developing capacity for ICAM at local levels. The establishment of the MAP *Coastal Areas Management Programme* (CAMP) in 1989, set the foundation for the successful completion of practical coastal management projects in a variety of Mediterranean countries, including Malta, Cyprus, Algeria, Lebanon, Morocco, Syria, Greece, Croatia, Tunisia and Turkey. Key objectives of the CAMP programme include the development of strategies and procedures for sustainable development, environmental protection and the rational utilization of resources, the development of appropriate methodologies, and capacity building at national and local levels. The CAMP framework also addresses multiple scales, seeking:

1. The formulation and implementation of national level policies and strategies, appropriate to local geographic and social contexts;

2. The dissemination of knowledge, exchange of experience, and implementation of policy at regional level; and
3. The consolidation of cooperation and sharing of experience and knowledge at international level.

*Case Example 3.2*
*CAMP Lebanon*

The CAMP Lebanon initiative incorporated an area of 615 $km^2$, almost 6% of the Lebanese territory, and 33% of the total coastline. Main concerns identified along the coastal strip included water resource pollution and urban expansion, with major infrastructural problems resulting from industrial and touristic developments, with resultant negative impacts on land, ecology and agricultural activities. Identified objectives of the CAMP Lebanon programme included:

- the identification and elaboration of strategies, solutions, tools and actions for sustainable development, environmental protection and rational utilization of coastal and marine resources of the national coastline;
- the application of methodologies, tools and practices of sustainable coastal management and of ICAM;
- contributions to the upgrading of relevant national and local capacities;
- provisions for the application in practice of project results and experiences; and
- utilization of experiences and results achieved by the project in other areas at national and regional levels.

The project was implemented through a series of thematic activities focusing on ICAM, tourism and sustainable development, integrated water resource management, systemic and prospective sustainability analysis, data management, public participation and marine conservation areas. Capacity building initiatives were also implemented.

Source: CAMP Lebanon, 2004

The European Union has also sought to address local level ICAM through its ICZM Demonstration Programme, established in 1996. This has the aims of identifying appropriate measures for upgrading the state of European coastal zones, providing technical information about sustainable coastal zone management, and stimulating broad debate amongst the various actors somehow involved in the management of the coastal zone. The Programme was designed around a series of 35 demonstration projects, located in the Mediterranean basin as well as elsewhere in Europe, and 6 thematic studies. The latter cover legislation, participation, information, technical solutions, European Union (EU) policy, and territorial and sectoral cooperation. Each project addressed the operation of integrated management and cooperation procedures and their efficiency. The conclusions of the Programme included the necessity of addressing the specific local context for successful implementation of ICAM projects, and the need for broader and longer-term perspectives for management.

**Econet-Cohast methodology: conservation of Mediterranean coastal habitats**

In 2006, a coastal management project was initiated under the European Community Initiative Programme INTERREG IIIB ARCHIMED. The project, led by the Mediterranean Agronomic Institute of Chania, and including partners from Greece, Cyprus, Italy and Malta, is entitled Econet-Cohast (ECOlogical NETwork for the promotion of convergent conservation strategies in Coastal HAbitatS of CommuniTy significance), and has the aim of promoting convergent conservation strategies at the landscape scale for coastal habitats of Community significance. The initiative is based on a recognition of the importance oι several habitats in the Mediterranean coastal zone and of the extent to which many such habitats are influenced by inland processes, hence necessitating broad landscape scale approaches to management. The project is also based on a realization that although broad spatial scales have been addressed in developments such as ICAM, in practice there is often little integration between the concepts of ICAM and actual biodiversity conservation initiatives. The objectives of Econet-Cohast therefore include the development and adoption of common tools and methodologies for conservation management of Mediterranean coastal habitats, the establishment of common knowledge bases and of research networks, and the training of professionals and coastal management practitioners. Within the ambit of the project, a broad methodological framework for conservation of Mediterranean coastal habitats has been developed. The methodology is designed to be practical for managerial purposes, whilst also supporting a long-term and holistic understanding of coastal habitats. Application of the methodology can be undertaken within a general planning process/cycle at a variety of spatial scales, following eight broad steps:

1. Problem definition;
2. Determination of objectives;
3. Analysis of system;
4. Determination of alternatives;
5. Selection of most suitable plan;
6. Elaboration of management measures;
7. Implementation; and
8. Monitoring and evaluation.

The Econet-Cohast project is based on what has been termed a 4x4x4 structure, with four basic pillars, which in turn serve as the basis for specific themes and indicators (Figure 3a). Indicators have particular utility in the quantification, simplification and communication of complex phenomena to policy makers and the wider public, and hence have much potential for application in coastal management, where human aspects interact extensively with the natural setting. The environmental pillar includes indicators mostly related to the natural sciences and focused on an understanding of the particular physical environment under consideration. Social and economic pillars include indicators relating to human activities and conditions. Indicators within the governance pillar are designed to measure the performance of organizational responses in pursuit of coastal management. Outline lists of indicators have been identified (Table 3i) although these will have different relevance in different contexts across the Mediterranean. Similarly, although some proposals concerning measurement methodologies and datasets are included in Table 3i, these are guidelines rather than prescriptive instructions, and appropriate measurement provisions are expected to be addressed with reference to the specific context in which the methodology is to be applied. The overall methodology incorporates the main general considerations of ICAM, whilst allowing for adaptation as necessary. The latter consideration is of critical importance, as the methodology is not designed to be rigidly applied but needs to be modified to the particular setting in which it is used. The feasibility of the methodology has been tested and evaluated through the Econet-Cohast project.

*Figure 3a*
*The Econet-Cohast 4x4x4 methodological structure*

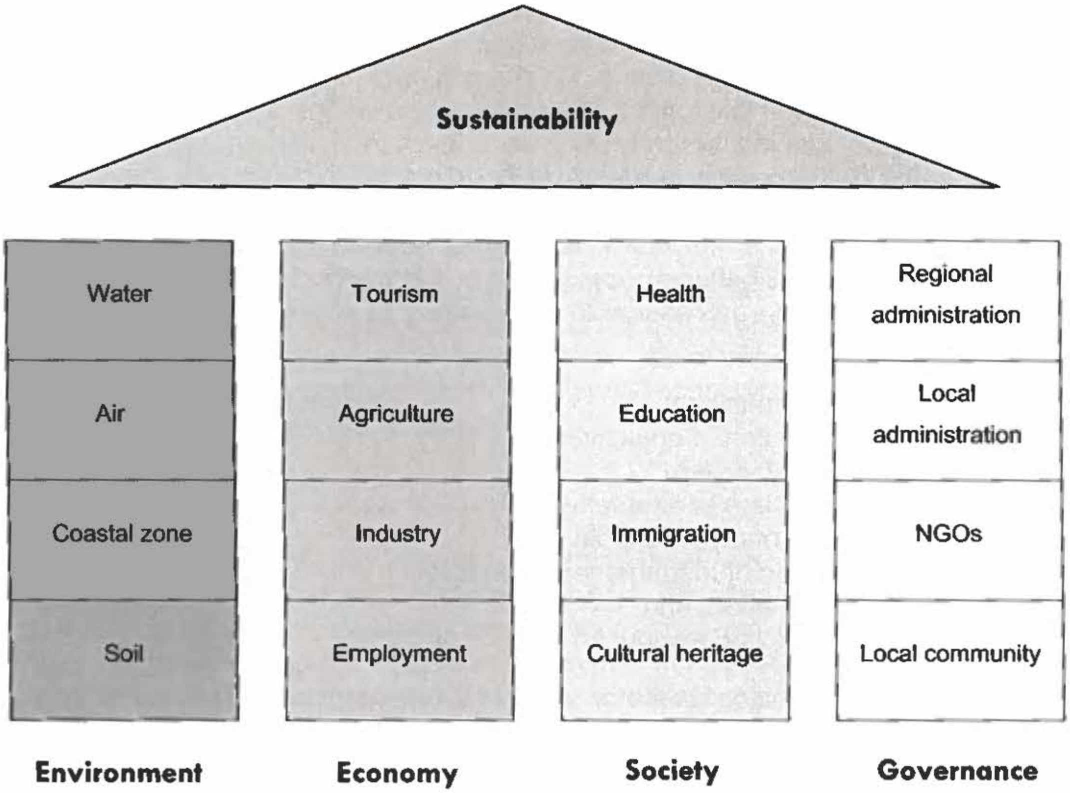


*Table 3i*
*Outline list of indicators, including suggestions for measurement*

## Environmental pillar

| Indicator | Parameter | Measurement guidelines | Potential methodologies and datasets |
|---|---|---|---|
| Biodiversity | Species diversity | Number of species | Inventories |
| | Invasive species | Percentage of total species | Inventories |
| | Species at risk | Percentage of total species | Red data lists |
| | Distribution of key species | Key species | Species/habitat mapping |
| Water quality | Drinking water | Various parameters (e.g. turbidity) | Field sampling and lab analyses |
| | Groundwater | Various parameters (e.g. iron concentration) | Field sampling and lab analyses |
| | Wetlands | Extent in hectares/% of total area | Wetland and land cover mapping |
| Soil | Sedimentation/erosion | Discharged sediments and nutrients ($m^3$/yr) | Mapping and remote sensing data relating to land cover, digital elevation, soil and geology |
| | Depth | Horizons and total depth (m) | Soil mapping and analysis |
| | Mineral resources | Type and quantity | Geological mapping |
| Landscape quality | Habitat types | Number of habitat types | Habitat mapping |
| | Landscape fragmentation | Combined indices of landscape or habitat fragmentation | Habitat map analysis using GIS |
| | Land use changes | % changes in land use categories over a given period | Land use map analysis using GIS |

*Table 3i (cont.)*
*Outline list of indicators, including suggestions for measurement*

## Social pillar

| Indicator | Parameter | Measurement guidelines | Potential methodologies and datasets |
|---|---|---|---|
| Population dynamics | Resident and total (seasonal) population | No of residents | Census/demographic agency statistics |
| | Public Access | Proportions of private/public land | Census/land registry statistics/maps |
| Coastal integrity | Protection of coastal heritage | % of protected coastal heritage | Cultural heritage agency statistics/maps |
| | Use of cultural heritage resources | Number of visitors/year | Cultural heritage agency/tourist agency statistics/maps |
| | Land and water managed by local people | % area | Census/agricultural agency statistics/maps |
| Human pressure on habitats | Land use patterns and composition | % land use categories | Land cover maps |
| | Extent or density of hard-surface areas | % area | Land cover maps |
| Pollutants and introductions | Litter and debris | Extent | Inventory and mapping |
| | Eutrophication | Nitrogen/phosphorus inputs | Field sampling and lab analyses/agricultural agency statistics |

*Table 3i (cont.)*
*Outline list of indicators, including suggestions for measurement*

## Economic pillar

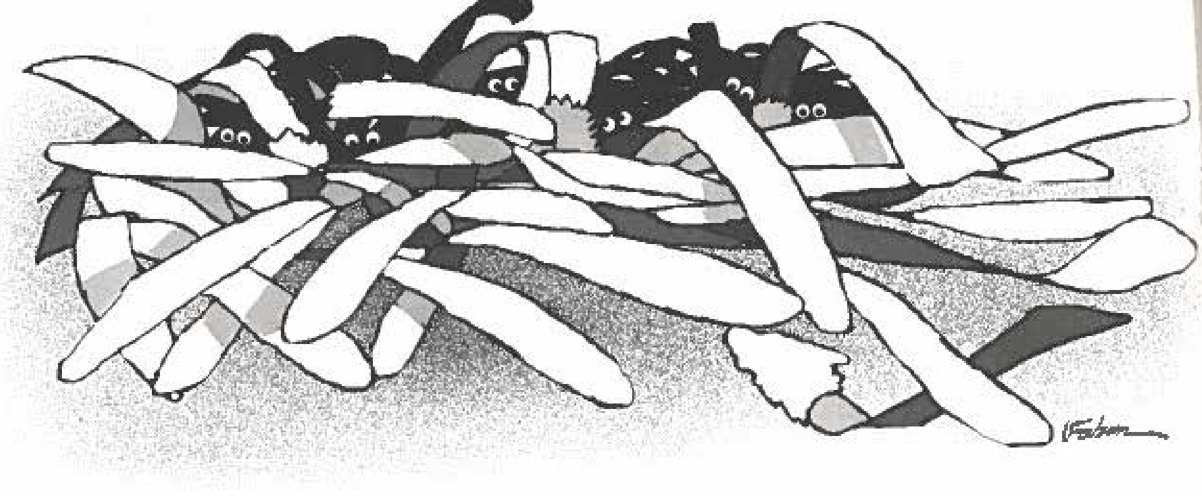
| Indicator | Parameter | Measurement guidelines | Potential methodologies and datasets |
|---|---|---|---|
| Domestic performance | Economic value | GDP | Census/economic agency statistics |
| | Investment by government | % of national/regional budget | Census/economic agency statistics |
| | Employment | %/ of population/rate | Census/demographic agency statistics |
| | Unemployment | % of population/rate | Census/demographic agency statistics |
| Local labour | Average regional income | Euros/month | Census/economic agency statistics |
| | Diversity of labour | Typology | Census/economic agency statistics |
| Structure | Relations between business | Compatibility of businesses | Economic agency statistics |
| | Infrastructure – roads | Extent (km) and quality | Mapping |
| | Infrastructure – air | Facilities within range | Mapping |
| Innovation | Information technology infrastructure | | Economic agency statistics |
| | Jobs and companies created | Number of jobs | Economic agency statistics |
| | Attractiveness | | Economic agency statistics |
| | Active management | Level of implementation | Economic agency/environmental agency statistics |

*Table 3i (cont.)*
*Outline list of indicators, including suggestions for measurement*

## Institutional pillar

| Indicator | Parameter | Measurement guidelines | Potential methodologies and datasets |
|---|---|---|---|
| Legislation | Local / regional legislation | Laws; decrees | Legal data |
| | National legislation | Laws, Decrees | Legal data |
| | European Union legislation (transposed into national law) | Laws, Directives | Legal data |
| Human, technical and financial resources | Staff | Persons | Environmental agency statistics |
| | Budget | Euros/year | Environmental agency statistics |
| | Facilities | Qualitative/quantitative assessment | Environmental agency statistics |
| Education and training activities | Educational and training programmes | Number of events | Environmental agency statistics |
| | People having completed educational and training programmes | Number of trainees | Environmental agency/management staff statistics |
| | Employment of people with education and training | Staff qualifications | Environmental agency/management staff statistics |
| NGO and stakeholder involvement | NGOs active in coastal area management (CAM) | Number of NGOs | Environmental agency statistics/NGO data |
| | Stakeholders groups involved in CAM | Number/typology of stakeholder groups | Environmental agency statistics/qualitative assessments |
| | Level of NGO involvement | Number of events/year | NGO data |
| | Level of stakeholder involvement | Number of events/year | Qualitative assessments |

# Part II:
# Approaches and techniques



# CHAPTER 4
## Ecosystem Management in Coastal Regions

*We might…have looked upon the Earth as if it were alive, and known that we cannot pollute the air or use the Earth's skin – its forest and ocean ecosystems – as a mere source of products to feed ourselves and furnish our homes. We would have felt instinctively that those ecosystems must be left untouched because they were part of the living Earth.*

James Lovelock, *The Earth is about to catch a morbid fever,* 2006

## Introduction

The way in which modern human society relates to its natural surroundings has much to do with the predominant cultural and political norms of our time. These have in turn been shaped by what has come to pass in prior decades and centuries of human history. Natural resources once seemed near nigh inexhaustible. The capacity of the oceans to absorb human-generated wastes seemed infinite. The impact of our industrial activities on the atmosphere seemed negligible. Then reality set in. Losses of seemingly plentiful species, such as the extinction of the passenger pigeon (once the most common bird in North America), brought home a realization that society's understanding of nature and natural processes left much to be desired, and acted as a trigger for the creation of a new environmental ethic in the early 20$^{th}$ century.

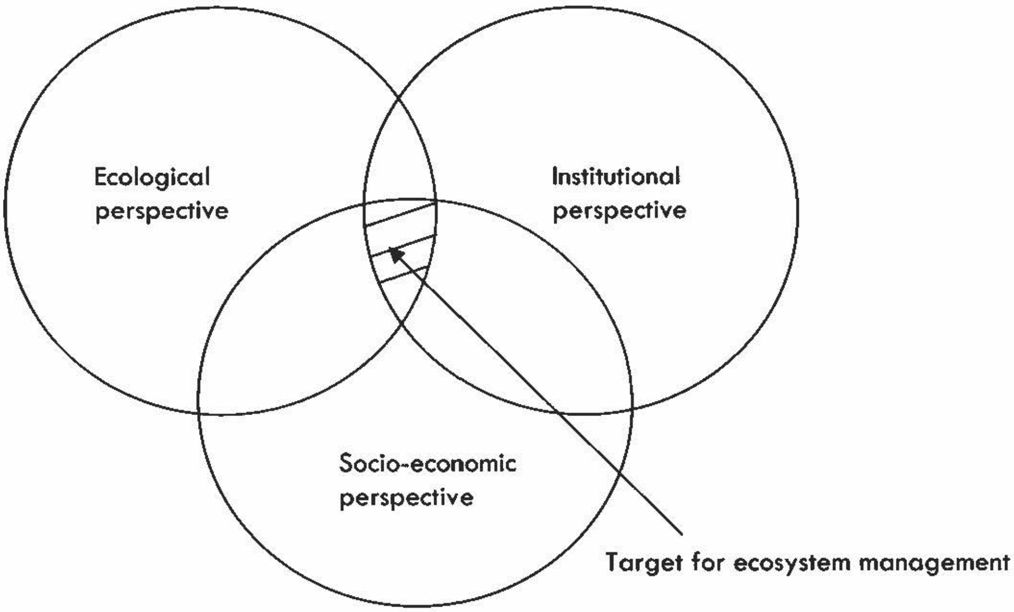
The specifics of such an environmental ethic were widely debated. Some, such as US President Theodore Roosevelt, considered wise use of resources to be an undertaking necessary purely and solely for the sake of the human species. This utilitarian viewpoint considered conservation to be a matter of providing the greatest good for the greatest number of individuals within the human race in a manner that may today be described as sustainable use. At the other end of the philosophical gradient, individuals such as author and philosopher Henry David Thoreau, argued that nature had inherent value, regardless of its worth to mankind. In this perspective, nature was perceived quasi-religiously, and the protection of pristine areas of land was widely advocated. Other proposals were also put forward. Naturalist Aldo Leopold argued for a land ethic, alternative to both biocentric and anthropocentric views, and advocating conservation based on utilizing nature without changing its fundamental structures and functioning.

Political developments continued to shape environmental philosophies throughout the later 20$^{th}$ century. Following World War II, many western societies experienced booms in economic production and the growth of their cities. Somewhat blinded by dazzling economic progress, western society needed to be reminded that there was an environmental price to be paid. Through the initiative of individuals such as Rachel Carson, Lois Gibbs and Paul Ehrlich, a new environmental awareness was re-awakened in the latter half of the 20$^{th}$ century, providing the foundation for the growth of conservation disciplines in the 1980s and 1990s. Today, much of modern society is aware that nature is not a passive recipient of anything we choose to do with it. The challenge now is to chart the course of our relationship with the natural world for the future. Ecosystem management has been proposed as one aid in this formidable task.

The term ecosystem management has been widely used and widely debated in the past few years. It is a concept which has evolved gradually, drawing on all the developments in environmental thought outlined above. At first glance the term seems to represent an oxymoron, as our present environmental understanding suggests that it is more appropriate to think of us being managed by ecosystems rather than vice versa. However, the critical element of many environmental crises is related to humans and what humans do. What ecosystem management proposes is an approach which questions the presumption at the heart of many environmental problems, that is, the belief in the virtual superiority of man over the rest of nature. It is an approach which seeks to put man back in nature, as just one of many inter-related components, whilst dealing with the reality that no other species has as much hold over the future of the natural world. This chapter outlines the fundamentals of this approach, whilst also identifying the challenges it represents. Potential applications of the ecosystem management approach in coastal management are also discussed.

## Components of ecosystem management

*Figure 4a*
*Conceptual basis for ecosystem management*




Source: Meffe and Carroll, 1997

Several definitions have been proposed for ecosystem management, with many subtle differences. Some definitions highlight the management element of the definition, whilst others focus more on the aspect of ecosystem processes. Some make direct reference to the requirements of human society, whilst others emphasize the responsibilities of the human species. Definitions also vary in terms of scales considered, objectives identified and methods proposed. However, all can be envisioned as bringing together three conceptual perspectives (Figure 4a). A successful ecosystem approach can only occur at the interface of ecological, socio-economic and institutional domains, as all are necessary for effective environmental management. Focusing only on one aspect, or even on two, represents too narrow a focus, since all three are directly relevant to environmental problems.

Meffe *et al.* (2002) identify several traits of an ecosystem management approach. One is an expansion of concern beyond natural resource extraction. The ecosystem approach emphasizes the need to safeguard the health and integrity of the natural system that provides commodities and amenities, both tangible (e.g. timber) and intangible (e.g. nature appreciation) for mankind. This consideration resonates with Aldo Leopold's land ethic, in which he likened nature to a machine, arguing that "*to keep every cog and wheel is the first precaution of intelligent tinkering*". Ecosystem management thus takes a broader conceptual view than much traditional resource management, asking not only about the sustainability of resource supply but also about the sustainability of the system underlying the supply of resources. It is also a view that acknowledges that nature cannot be reduced to mere statistics of fossil fuel reserves and timber yields. The natural world is fundamental to human well-being in a multitude of complex ways, which extend far beyond numbers.

A second trait relates to the recognition of non-equilibrium situations in ecology. Much of the early history of ecology was based on a classical equilibrium paradigm, which implied that ecosystems are stable, independent and self-regulating entities (Simberloff, 1982). This was the view that suggested that all ecological communities progress systematically through a series of seres to reach a defined and distinguishable climax community. However, numerous challenges to the classical paradigm have been put forward. For one thing, many natural communities were noted to have multiple stable states, or multiple pathways of vegetation change. Disturbance has come to be recognized as a critical component of many ecosystems, without which natural systems lose resilience. Natural systems were found to be interdependent, contingent not only on direct physical conditions, but also on temporal sequences of events and on influences of other systems, both adjacent or further afield. Ecosystems were also noted to be dependent on external fluxes of materials and energy. The equilibrium view of ecology has thus come to be replaced by a non-equilibrium view, which accepts flexibility and change in space and time, leading to shifting mosaics of communities across the landscape (Pickett *et al.*, 1992).

Ecosystem management is also characterized by holism and contextuality, as opposed to reductionism and site-specific concerns. Traditional environmental management tended to address specific, immediate problems within a clearly defined geographical area. This focus was understandable in the past given that environmental concern often emerged from specific problems, such as declines in numbers of a particular species in a particular area. Today, however, it is increasingly recognized that problems in one geographical area are not necessarily linked solely to causes limited to that same area. This is especially the case in coastal regions, which may be affected by events occurring many kilometres away, either inland, within coastal watersheds, or within the marine environment. Many environmental problems now extend even across national borders, necessitating challenging transboundary collaborative management initiatives. The fundamental unit in ecosystem management is defined on the basis of the physical characteristics of an environmental problem, rather than on administrative ones. It thus tends to function more in terms of landscapes than small-scale sites, and hence is closely related to landscape ecology approaches (discussed in Chapter Six).

One revolutionary element in ecosystem management is that of humility. In the past, it was often concluded that human understanding of natural processes was sufficiently advanced to permit us to prescribe specific interventions, leading to desired outcomes. Such command and control approaches rely on the assumption that there are no unforeseen externalities affecting final results. This is far from the case in the context of ecology. A fundamental premise of modern day ecological understanding is uncertainty. At best, we have a very limited understanding of natural systems, and are certainly far from being able to predict the impact of an intervention on the multitude of elements, linkages and flows, especially where these may interact in ways that are not simply additive, but also synergistic and cumulative in complex ways. As Meffe *et al.* (1997) note, human control of systems is not only difficult but illusory. Ecosystem management is therefore guided by the fact that we know little about natural systems, and that we have to constantly monitor the effects of any interventions taken, in order to learn and subsequently determine appropriate courses of action. Management and research are seen to be two sides of the same coin, with each feeding into the other. This philosophy of adaptive learning is described further below.

*Case Example 4.1*
*Coastal erosion at Zouara, north-west Tunisia*

The coastal strip in the north-west of Tunisia encompasses a series of linear beaches, linked through processes of sediment dynamics. Sediment supply occurs as a result of longshore drift from eroding headlands, cliffs and other coastal formations, as well as by fluvial sources, and directly via the seabed. The presence of an active dune field is highly dependent on interactions between a number of key elements required for coastal dune development, including a sediment bank located in an offshore or foreshore zone; the wet/dry transitional beach boundary, and an active foredune area, known as the transit zone; and, a resting zone, which comprises the stable dune area. For these to occur, an ample supply of sediment is required, together with the principal agents or geomorphological processes involving aeolian sand transport and deposition, and, a characteristic vegetation.

*Case Example 4.1 (cont.)*
*Coastal erosion at Zouara, north-west Tunisia*

Infrastructural development in the Chatt el-Zouara region, notably the construction of a dam in the 1990s close to the coast (aimed at harvesting water run-off upstream of the Zouara dune-field), has led to considerable changes in the hydrological regime and, as a consequence, in the sediment dynamics of the coastal area. Over a relatively short span of time, a transformation was noted along the beach and foredune zone at Zouara beach, as a result of a marked decreases in sediment fluxes. Studies conducted in subsequent years revealed significant increases in levels of erosion on the coast immediately downstream from the dam, such that a previously extensive beach has almost disappeared and a number of constructions previously located on the beach collapsed. Changes have also been noted in other coastal locations downstream of Zouara.

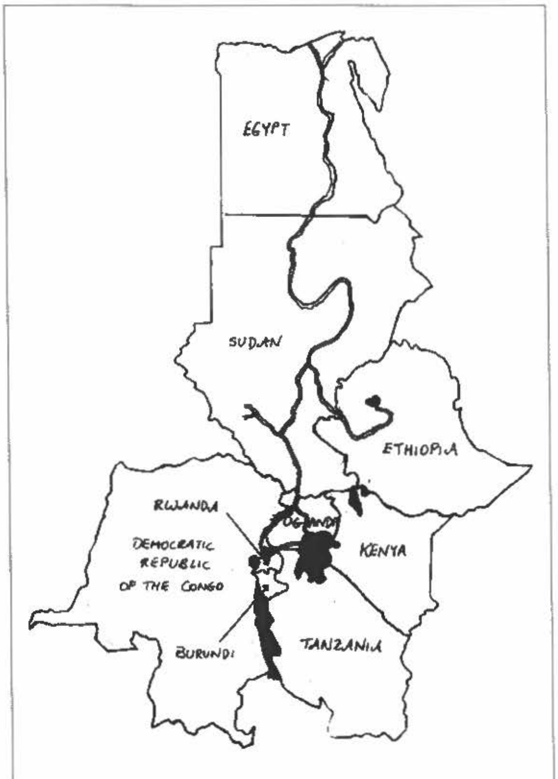
In the case of Zouara, it is largely assumed that the prevailing situation was due to the interruption of sediment, both in a spatial and temporal context, as a consequence of the new dam construction. Before the dam was constructed, the Zouara coastal sand dune system may have been described as a fluvial delta sediment system, whereby the main source of sediment was the system of oueds that eventually culminated in the river downstream, which flowed out into the sea at Zouara beach. However, with the relatively recent damming of the fluvial source and consequent decrease in sediment supply, the foredune zone experienced a sustained loss of its accumulated mass. Some of the foredunes appeared to have become quite flat-ridged due to an evident loss in aeolian dynamism and, as a result, a number of blow-out formations (resulting from excessive wind erosion and lack of sand material input) and gullies had formed on and around the foredunes' area. In a relatively short time-span, the Zouara foredunes became less stable and it soon became evident that dunal vegetation established itself with difficulty. Throughout the years of observation at this site, degradation was observed to rapidly set in. This was largely due to a number of factors, namely the significant decrease in sediment supply coupled by a lack of adequate vegetation cover to effectively stabilize the dune face and to act as an interception medium for descending saltating sand grains. Higher rates of sand transport and low deposition levels often result from the latter. The presence of dune vegetation increases the amount of humus and other detrital material resulting in better soil conditions and water retention capabilities. In the case of the Zouara dunes, the situation is likely to worsen since a considerable section of the foredune had already begun to lose much of its vegetation cover.

Source: Cassar *et al.*, 2002

*Case Example 4.2*
*Transboundary concerns and the Nile delta*

Chapter 1 outlined some of the environmental issues pertaining to the Nile delta. The geographical area of concern with respect to the delta extends far beyond the shores of the Mediterranean. The Nile river flows through nine nations: the Democratic Republic of Congo, Tanzania, Uganda, Burundi, Rwanda, Kenya, Ethiopia, Sudan and, finally, Egypt, before it drains into the Mediterranean near Alexandria. These nations are located in one of the most arid parts of Africa, and the Nile is absolutely vital for agricultural production in countries such as Sudan and Egypt. Any regulation of water flow in upstream countries will inevitably impact on downstream users, and the Nile river has, for this reason, represented a volatile political concern for many years. A treaty signed in 1959 resolves a number of important issues, but it was negotiated and signed by only two nations, Sudan and Egypt. Additional water development in the other upstream nations could greatly increase tensions in a region that is already politically unstable.

*Sketch 4.1*
*The political context of the Nile*



The ecosystem management approach also challenges traditional views of who should be involved in management. Recognising that environmental futures are ultimately dependent on the actions of the billions of people living in the world today, broad stakeholder involvement is considered to be critical to management initiatives. It is no longer deemed acceptable to have an elite group of managers making decisions on everyone's behalf. People are increasingly clamouring for a direct say in decisions that will ultimately affect their lives, and ecosystem management has sought to develop mechanisms to enable dialogue and discussion. Concurrently, the approach also advocates a move towards consensus building rather than confrontation. Whilst diverse interests necessarily result in differences of opinion, concerted action can only be achieved once some level of agreement has been reached. Conflict resolution processes are therefore of great importance, as is the realization that there may be no one right answer and that all stakeholders have relevant insights to contribute. People are also perceived as a resource rather than a hindrance, bringing unique expertise to the table that may be unavailable through other means. Concepts of stakeholder involvement are discussed in further detail in Chapter 5.

Ecosystem management may thus be defined as a holistic learning-based approach towards the mitigation of environmental problems through consensus building, based on broad spatial and temporal scales, recognizing the inherent complexity and variability of natural processes, and acknowledging stakeholder involvement and resolution of human concerns as critical elements of management. It is an approach strongly rooted in the natural sciences, yet inclusive of a wide range of disciplinary inputs. Despite its conceptual appeal, it is, however, not an easy approach to implement. Its broad focus necessitates many resources, and its recognition of uncertainty can present many challenges to the organizational philosophy of traditionally bureaucratic management institutions, where roles and tasks are clearly defined. Ecosystem management thus represents more than a change in the way management is done; it necessitates a change in the entire way in which management is conceived.

**Adaptive management**

As noted above, ecosystem management is based on uncertainty, on a recognition that we know very little about the natural world which surrounds us. We therefore need to be open to learning throughout the course of all our conservation and management initiatives through processes of adaptive management. Salafsky *et al.* (2001) define adaptive management as incorporating research into management action, through integration of design, management and monitoring, to systematically test assumptions in order to adapt and learn. There are several conditions that warrant adaptive management. Natural systems are complex and unpredictable. Our lack of definitive understanding in pursuit of extensively studied issues such as climate change is a case in point. Furthermore, the world is not static. Both natural and human systems are constantly changing and evolving. Nevertheless, action is needed now, and it is simply not feasible to perform studies *ad infinitum*, even because there can never be such a thing as complete information. Adaptive management proposes positive exploitation of the human capacity to learn and change. The ideas of adaptive management are not new. The scientific method is based on the concept of observation, positing a set of circumstances in relation to testing of a hypothesis, in order to reach a result. Similarly, adaptation has been recognized as a fundamental component of social learning, with human beings learning through trial and error from a very young age. However, bureaucratic set-ups have tended to lead to expectations of clear, rigid processes giving rise to results which vary only within defined thresholds. Ecosystems can not, however, conform to such a framework, and it is only by adapting our management framework to the reality of natural systems that we can truly progress in pursuit of sustainability.

*Box 4a*
*Implementing an ecosystem-management approach*

Shepherd (2004) has developed a five-step approach to implementing ecosystem management, based on a logical sequence designed to facilitate discussion and planning. The five steps are as follows:

1) *Determine the main stakeholders, define the ecosystem area, and develop the relationship between them.* This stage involves identification and weighting of all stakeholders, an assessment of their capacities and commitments, and establishment of discussion forums. It also includes an assessment of the appropriate size and scale for management.

2) *Characterise the structure and function of the ecosystem, and set in place mechanisms to manage and monitor it.* Characterisation includes the establishment of a baseline ecosystem description, on the basis of inputs of scientists as well as other stakeholders.

3) *Identify the important economic issues that will affect the ecosystem and its inhabitants.* Economic assessment is critical for real-world viability of management initiatives; this stage includes identification of economic incentives and disincentives that may affect human behaviour.

4) *Determine the likely impact of the ecosystem on adjacent ecosystems.* In line with the principle of contextuality, this step includes consideration of the way in which ecosystems relate to each other.

5) *Decide on long-term goals and flexible ways of reaching them.* Management measures need to be defined with reference to an expansive vision, whilst being inherently flexible and adaptable on the basis of monitoring.

Salafsky *et al.* (2001) propose eight principles for adaptive management. The first is that adaptive management has to be done by all involved; it is not a process that can be delegated. Anyone involved in management has to be open to learning and changing in response to results. Secondly, adaptive management stems from a philosophy of curiosity and innovation, where experimentation to evaluate different possibilities is considered to be positive. The third related principle is that of valuing failures. Indeed, with adaptive management, failure is merely a result that adds to the knowledge base, and that should contribute to the learning process. Fourthly, adaptive management requires that managers expect surprises and capitalize on crises. Although unexpected development can shake the most stable of organizations, such events can serve as the basis for innovation and as opportunities for action. The fifth principle is that of encouraging personal growth, as organizations can only improve with betterment of their component parts. An emphasis on training and learning, and on the development of new skills and experiences, is of great importance. The sixth principle leads on from this idea to encompass the creation of learning organizations and partnerships. The seventh principle likewise calls for learning at a global level, by encouraging the implementation of good scientific practices worldwide, through capacity building and by establishing widespread contacts. The final principle relates to the 'art' of adaptive management, as opposed to the 'science' of it. As with all arts, the skills of adaptive management are only truly acquired with first-hand experience and many years of practice and perfection of the craft.

**Habitat restoration**

One increasingly important component of ecosystem management relates to the restoration and rehabilitation of degraded sites. Despite widespread conservation efforts, the extent of intact natural habitats continues to decrease rapidly, and those that remain are increasingly small and fragmented, subject to a variety of external influences that reduce their long-term chances of survival. Restoration and rehabilitation therefore have a role to play, not only in increasing the global extent of natural and semi-natural assemblages, but also in providing for better connectivity between habitats, thus improving the viability and effectiveness of conservation efforts. Restoration and rehabilitation are not intended to serve as replacements to protection efforts. The discipline rather provides a complementary tool, enabling the extension of conservation efforts beyond natural areas in adequate condition, to encompass degraded habitats which presently represent under-utilised land. The value of such efforts was explicitly recognized by the 1992 Convention on Biological Diversity, Article 8 of which calls for Contracting Parties to, "*as far as possible, rehabilitate and restore degraded ecosystems and promote the recovery of threatened species*".

At present, much restoration work is somewhat experimental in nature. In particular, there is much debate between the two extreme views of restoration, regarding the extent to which the practice should seek to imitate nature. On the one hand, the horticulturalist view is that restoration should seek to create diverse and aesthetically pleasing habitats for general enjoyment. On the other, the nature conservationist argues for caution in dealing with natural habitats and tends to advocate minimal unnecessary intervention. Both these approaches may be appropriate in different circumstances. In urban environments, visually pleasant restoration efforts can serve to improve the quality of life of residents and to bring people closer to an understanding of nature. Although all species have intrinsic worth and merit conservation, it is also a reality that some species have more immediate appeal, and there is no harm in utilizing these to contribute towards the development of societies that are more appreciative of biodiversity. In more natural settings, the nature conservationist ethic of cautious restoration using native stock, with minimal unnecessary intervention, may be more appropriate. Many natural ecosystems exist in a delicate balance, and inadvertent alterations of small components may result in unforeseen consequences. Where restoration is taking place on land adjacent to natural habitats, it is therefore wise to err on the side of caution, and to aim at re-creating habitats that are complementary to what already exists. Each situation should therefore be evaluated on a case-by-case basis.

*Box 4b*
*Terminology of habitat restoration, re-creation and rehabilitation*

**Habitat restoration**: 'Bringing back' an ecological system into a former or original state.

**Habitat rehabilitation**: Any attempt to restore elements of structure or function to an ecological system, without necessarily attempting complete restoration to any specified prior condition.

**Habitat reclamation**: Rehabilitative action carried out on severely degraded sites.

**Habitat re-creation**: Attempts to reconstruct an ecosystem, wholesale, on a site so severely disturbed that there is virtually nothing left to restore.

Source: Meffe and Carroll, 1997

The ideas of habitat restoration have not been accepted without question. In particular, there is much concern that its ideas and techniques may be misused to justify the destruction of pristine habitat. It must, however, be clearly acknowledged that restored habitat is no replacement for natural habitat. Restoration can re-create state, and possibly processes, to some degree, but never to the extent found in natural environments developed through centuries of evolution. Furthermore, restoration is far from easy, as well as being labour and capital intensive, and success may be very difficult to achieve. The priority must therefore remain protection and conservation of existing habitats. However, part of this may include restoration of degraded habitats in order to contribute to the creation of a viable and functional ecological network.

**Challenges of ecosystem management**

Ecosystem management has not been without its critics. Some have argued that the approach is nothing more than a cover for government appropriation of private lands, under the pretext that these form part of an ecological whole. However, the rights of private land owners have been explicitly recognized in several ecosystem management initiatives, and although private-public partnership remains challenging in many political contexts, there is no implicit presumption that private land ownership rights can simply be overruled for ecological ends. Other critics have pointed to difficulties in the definition of ecosystems, arguing that the approach is fuzzy, and that an ecosystem may be defined as any area that a manager wants it to be. However, although precise and rigid definition is not conformant with the ecosystem management framework, boundaries need not be fuzzy but can rather be flexible. This does not mean that management areas should be established arbitrarily, but they should rather be defined on the basis of clear and justifiable natural factors, such as watersheds or landscape units.

Others have argued that in making extensive allowance for human factors, ecosystem management is compromising on ecological conservation, reducing protection in exchange for increased societal acceptance. It is however an indisputable reality that conservation will only succeed if it can be rendered compatible with societal values. Conservationists are too few and far between to single-handedly challenge a world philosophical and economic order that sees the preservation of species as a waste of time and resources. What is needed is change within those world orders, so that conservation is recognized as a fundamental prerequisite for the continued survival of the human race. In seeking to operate within such societal frameworks, ecosystem management therefore seeks pragmatic, long-term and sustainable change.

It is true that ecosystem management is a comparatively young approach, and that its practitioners are still learning about appropriate implementation and practices. Our society's environmental ethic will undoubtedly continue to evolve and shape conservation practices in the decades to come. With increasing practice of ecosystem management, tools and techniques will evolve and improve, and true to principles of adaptive management, we, as managers, will surely learn from our successes and failures. At present, however, ecosystem management provides a very valuable framework for implementing a sustainable use and stewardship ethic in order to safeguard the health and integrity of natural systems. Its challenges, and hitches encountered, should merely serve as triggers to improve our understandings and management processes.

*Box 4c*
*Example 1 – An ecosystem management approach to fisheries and aquaculture*

The United Nations Atlas of the Oceans is an information system designed for use by policy makers. Amongst several other analyses, it identifies several foundations and components of an ecosystem management approach to fisheries and aquaculture. These include the following:

1. Involving all stakeholders in knowledge-sharing, decision-making and management partnership;
2. Decentralising decision and action at the lowest appropriate level;
3. Avoiding irreversible ecosystem impacts from fisheries;
4. Reducing reversible impacts to the minimum possible (e.g. by-catch and discards);
5. Considering transboundary impacts of fisheries on adjacent or other ecosystems;
6. Understanding of ecosystems in an economic context;
7. Introducing ecological accounting into fisheries management;
8. Improving collaboration between environmental and fishery management organizations;
9. Matching fisheries management system boundaries with ecosystems boundaries;
10. Lobbying to reduce negative impacts of non-fishery activities on aquatic ecosystems;
11. Mobilising all scientific disciplines;
12. Recognising uncertainty, and as a consequence applying the precautionary approach and adopting adaptive management practices;
13. Ensuring quality and independence of scientific advice;
14. Establishing effective conflict resolution and enforcement mechanisms;
15. Adopting the concept of protected areas (e.g. marine protected areas).

Source: United Nations (2006)

The various components of ecosystem management find much resonance in the coastal zone. The coastal area incorporates a variety of diverse ecosystems, many of which are still poorly understood. It is also dependent on geographical scales which may extend far beyond the interface of sea and land. Superimposed on this setting is the heavy hand of man, with a multitude of often-times conflicting anthropogenic activities manifesting themselves in the coastal zone. Coastal management cannot

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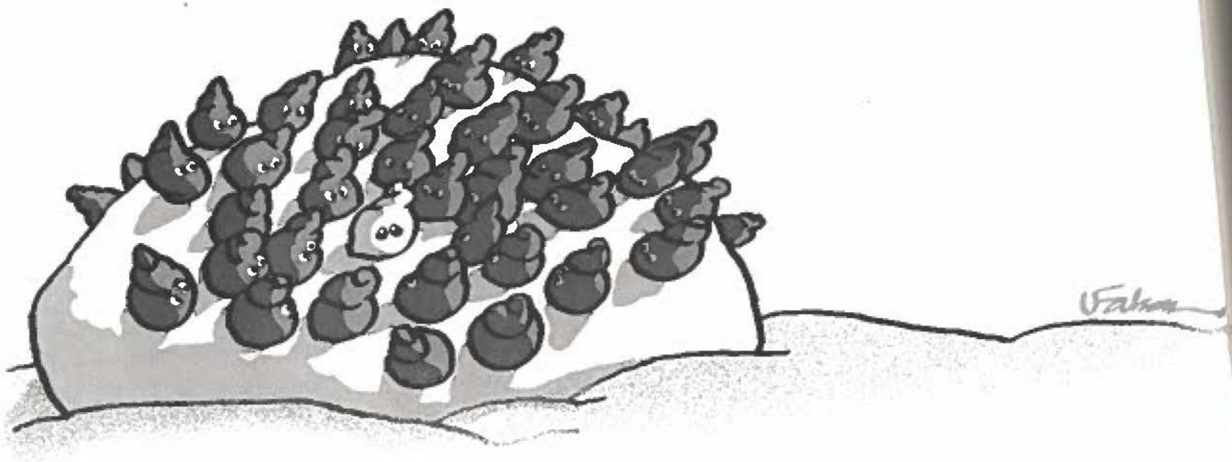
*Box 4d*
*Example 2 – Ecosystem management and coastal dune conservation*

Coastal dunes are dynamic systems, dependent on sediment dynamics occurring within a broad geographical area and encompassing fluvial, aeolian and marine processes. Dunal systems are not static, but evolve in space and time at a relatively rapid rate. Furthermore, dynamics may involve cyclical processes of gains and losses, and processes such as erosion may, in some cases, be fundamental to the functioning of the system. Coastal dunes in many areas are, however, now influenced to a very large degree, and often in a negative manner, by human activities occurring on the coast and beyond. The net result has tended to be accelerated erosion, and declines in the integrity of dunal systems. The challenges for managers are substantial. Intervention at one site may result in negative effects elsewhere. Adaptive management is therefore fundamental, as the effects of any management measure must be carefully monitored and evaluated. Proactive efforts are also urgently needed, and these must address the underlying causes of dune degradation, which often lie in human demands for coastal land. Solutions may involve developing alternative land use plans whilst also seeking to alter underlying perceptions of coastal resources. The development of such solutions will comprise not only ecological evaluation, but also social and economic assessments. The management and conservation of coastal dunes must further allow for the possibility of future changes. In the event of impacts such as sea level rise, the viability of many dunal systems may be affected; indeed, the processes maintaining dunes in present climatic conditions may cease to operate. In such a scenario, difficult decisions may need to be made on whether continued conservation of such geomorphological systems is possible or even desirable.

The considerations of ecosystem management therefore have much utility in providing a framework for approaching coastal management. There is certainly room for habitat restoration and rehabilitation at the coast. There is much scope for improving stakeholder relations and for establishing conflict resolution and consensus building mechanisms. There is an urgent need to address issues within natural units of relevance, even when these extend far inland or far into the marine environment, or when these cross national borders. There is most certainly room for an adaptive management approach, as even with a wealth of experience, we are still far from resolving many of our coastal management problems. Ecosystem management need not, however, replace existing methodologies of coastal management. Indeed, several of the components of this approach have similarities to the concepts of Integrated Coastal Area Management, and the two may be considered to be complementary frameworks for application in coastal areas.



# CHAPTER 5
## Stakeholder Involvement

*There are no passengers on Spaceship Earth. We are all crew.*

Marshall McLuhan, 1964

## Introduction

One of the first books to emerge from early voices of environmental concern was George Marsh's *Man and Nature*, published in 1864. Its title highlights the dualism that lies at the heart of many environmental problems to this day. Man occupies an ambiguous place in the continuum of what is natural and what is less so. On one level, humans are simply one of the over 14 million (estimated) species on the planet. Our biological functions are not outstanding in any way. Just like other species, we are born, we survive on the basis of exploitation of other species and resources, and we die. On another level, however, the human species is unique. Whereas all species have some degree of impact on their surrounding environment, none has had as widespread and extensive an impact as man. Marsh's achievement was to be amongst the first to highlight the magnitude of human impact on the remainder of the biosphere. His provisional title for *Man and Nature* was *Man, the Disturber of Nature's Harmonies*. His warnings went largely unheeded at the time of publication, being unable to resonate with the dominant political climate of the time. With the benefit of hindsight, we now see the wisdom of his reflection on human behaviour. In a sense, *Homo sapiens* has, for much of his history, endeavoured to somehow place himself outside nature, seeking command and control of natural resources for his own well-being.

In many ways, humans appear to have been successful in this endeavour. On the basis of highly debated attributes such as intelligence and intellect, the human species has managed to domesticate wild animals, to control and eradicate unwanted species and to modify geomorphology so as to provide easier living space. We have shaped and modified planet Earth for our ends. Humans have also increasingly managed to overcome natural factors of population control, such as disease, and have pushed life spans of human individuals beyond natural limits. We have, to some degree, been attempting to play God. Yet our successes have been limited and have come at a hefty price. In seeking short-term societal gratification and betterment, humans have sacrificed the health of many natural systems along the way. Even more significantly, humans have undermined their own well-being by destabilizing the physical systems which ultimately determine the survival of all species, man included. Although we speak of man and nature, man *is* nature, or rather man is *in* nature. Despite our best efforts, we are not separate from nature, nor are we above natural constraints. Entire populations are still wiped out by the physical forces of the planet, just as our fragile bodies still fall victim to viruses which we have not yet managed to conquer. Indeed, in cocooning ourselves within the comforts of modern society, we have progressively lost much of our ability to cope in nature. At most, humans are more successful than other species in altering physical environmental conditions, but that is about all that can be said.

Or is it? Without going deep into philosophical and psychological territory, we can assume that man has one ability that no other species seems to possess, and that is the capacity for critical self-reflection and awareness. Our biological functions may not be unique, but, as far as we are aware, no dolphin, dragonfly or lichen theorises about its proper place in nature, or about its impact on surrounding environmental conditions, or about the meaning of life. Therein lies the key resource for environmental management. Many species have come and gone. Extinction is a natural process and all species appear to have finite life-spans. Yet survival instincts flare strongly in all individuals, of any species. Humans are no different, and with our capacity for thought and rationalization, we have the ability to look back on where we have gone wrong, and to seek to rectify the situation, if for no other reason, merely to ensure the survival of our species. We have learned from our presumptuousness in thinking that we were somehow superior to the rest of nature, and can now seek to learn to live in ways that do not compromise the integrity of natural systems.

Acting on this realization will not be easy. Much of the modern world still functions with institutional structures based on the concept of man being above nature, based on unsustainable exploitation of natural resources, and based on short-term perceptions of well-being. Radical change has never occurred smoothly in human history. Even with overwhelming evidence of environmental degradation, there is still much criticism of what is perceived as environmental extremism, and a reluctance to change ways of life. Few of us would be willing to give up our creature comforts for the sake of Mother Nature, yet some feel that nothing short of major societal changes are required for environmental survival. The situation is rendered more complex by the inequalities existing between different members of the human species. It is a far cry from the slums of Calcutta to the mansions of Beverly Hills, and our 'blame' for current environmental problems is likewise uneven. Environmental responsibilities can thus not be apportioned without due consideration of social conditions.

In essence, environmental problems are not ecological in nature. They are social problems, with social roots and social consequences, requiring social solutions. The fundamental cause of environmental degradation still remains the relationship between man and nature. We do not have the power to alter nature in any significant capacity, and it is thus the 'man' side of the equation that needs to be the focus of our attention. Changing human behaviour towards something that is more environmentally benign can only occur with the full involvement of the billions of people populating the world today. The environment is not the domain of a few academics or professionals. Their behaviour is ineffectual on a global scale. Environmental well-being is dependent on global human behaviour and is likewise fundamental to the livelihoods of all, and environmental management can thus only succeed when it gives due consideration to people. This chapter introduces concepts of stakeholder participation, drawing on developments in participatory environmental management occurring in the latter half of the $20^{th}$ century, particularly since the 1992 Rio Earth Summit, when the link between environmental and social conditions was made explicit.

## Identifying and engaging stakeholders

Under an ecosystem management approach, a stakeholder may be simply defined as anyone with an interest, either indirect and implicit, or direct and stated, in the issue at hand. Anyone has a right to be a stakeholder, although the characteristics of stakeholders may be expected to vary according to the way in which they relate to an issue. People may live or work in or near to a particular ecosystem, and will thus be directly affected by its future. A resident of a particular neighbourhood may, for instance, have his future activities constrained by the declaration of a nature reserve close by. People may also be interested in a particular resource, either in its use, or in its preservation. A fisherman may have an interest in seeing the safeguarding of fishery resources, as his livelihood may depend on the continued health of the resource base. People may also be interested in the process of decision-making, particularly within democratic societies. An environmental non-governmental organization (NGO) may have an interest in ensuring that decisions are made through a transparent and fully accountable process, which allows for everyone to express their views. The network of stakeholders may extend quite broadly, beyond evident direct impacts and interests. In many countries, all taxpayers may be considered to be stakeholders in government decisions. Whilst some may be in favour of expenditure for biodiversity conservation, others may be less sympathetic and may push for such spending to be directed to directly social or economic ends. All have a right to express their views.

*Box 5a*
*Indigenous knowledge*

Indigenous knowledge is the local knowledge that is unique to a culture or society. Also known by other terms such as folk knowledge, traditional knowledge or traditional science, this knowledge is accumulated over many generations, tested over centuries of use, and generally passed on by word of mouth. Indigenous knowledge encompasses information commonly known only within a community, as well as knowledge which may be known only to particular individuals, such as tribal elders. Indigenous knowledge is often distinguished from the global information system, developed by universities, research institutions and private firms. Indigenous knowledge is particularly important for purposes of biodiversity conservation. Much of the world's biodiversity is located in areas which have been populated by indigenous peoples for centuries, and it is through their land use practices that many species continue to survive. Locals can also provide valuable knowledge on aspects such as current, past and potential uses of species, husbandry methods, ecosystem conservation procedures, and traditional classification systems.

## Interacting with stakeholders

The specifics of stakeholder involvement depend directly on the reasons why people are engaged in the first place. On the one hand, participation can be a means to improve efficiency of interventions, resulting in change that is (hoped to be) sustainable and that meets with the approval of a larger number of people. It has been repeatedly noted that involving people in projects and plans increases the probability of obtaining support for these, and the related likelihood of their eventual success. Involvement in decision-making can, at the very least, contribute to a sense of ownership and genuine involvement in a project. Furthermore, people may have knowledge that may not be available from other sources. This is particularly the case with regard to locals living close to complex environmental systems; no amount of short-term scientific observation can rival the depth of knowledge obtained from life experience of day-to-day changes in nature, and from accounts passed down through generations. Participation may also be an end in itself. Managers may wish to understand the perspectives and opinions of different groups. Different people will comprehend a situation differently, depending on numerous factors. Thus, where an environmentalist may oppose the construction of a new hotel in a semi-natural area, on the grounds that this will have adverse ecological and aesthetic impacts, an unemployed local may favour such a development if this provides job possibilities. Each viewpoint is valid. There are no right and wrong answers, nor is there any moral high ground involved. People's views are rooted in cultural elements, ranging from background to education to current life situations, and these will all influence the way in which they perceive a particular situation, and its environmental impacts. Understanding such different viewpoints and languages is critical for successful management. Participation can also be an end in that it may provide for empowerment of certain societal groups through democratic processes. Although often limited to the expression of views, participation may involve delegation of decision-making power to local levels, conformant with processes of decentralization. This is particularly significant when the people involved have traditionally had little say in official decisions.

*Case Example 5.1*
*Unearthing indigenous knowledge in Algeria*

Algeria has a long history of cereal cultivation. Durum wheat, in particular, is a commodity of vital importance, central to the life and culture of many Algerians. The vital importance of durum wheat and other crops is reflected in verbal heritage, namely proverbs and tales, both Arab and Berber. These not only explain the social context of crop cultivation, but also provide information about agricultural techniques, and about edaphic and climatic factors relating to crop cultivation. Ancestral agricultural calendars, passed down through generations in the Maghreb, represent another valuable resource for present-day farmers. Indeed, there are increasing numbers of projects that seek to blend traditional and modern-day western knowledge, for the benefit of both indigenous people and farmers employing modern practices.

Source: Korichi Hamana and Hamana, 2007

Meffe *et al.* (2002) identify three principles of stakeholder involvement. The first is the principle of inclusivity. Several environmental management decisions will potentially affect hundreds or even thousands of people, and it is impossible to involve every single individual. However, it is important to invite all interested stakeholders or their chosen representatives, and not merely those whose views may support the desired decision. Inclusivity presents challenges, as it generally implies bringing together people with opposing views, potentially leading to conflicts. The challenge of effective participatory mechanisms is in seeking dialogue between such divergent viewpoints and in progressing towards some level of consensus, through conflict resolution. A second principle is that of self-selection, which states that stakeholders should be free to choose their own level of involvement, based on their interest and comfort. There is a range between those who are deeply interested in an issue, and who thus demand extensive and continuous involvement in decision-making, to those who are marginally interested and thus content with limited participation. The position of a particular stakeholder may change during the course of discussions, as interest increases or wanes. The third principle is that of diversity of representation. Ideally, people involved should provide a cross-section of the demographic characteristics of the community. Participants should include different genders, age groups, employment groups and political affiliations. Managers thus need to have a thorough understanding of the communities in which they are attempting to work.

Participation is in itself an ambiguous term that may hide a great deal of divergence in processes. Effectively, there is a continuum of participation, from simple sharing of information to delegation of decision-making power and responsibilities. At one end of the continuum, there may be little or no true participation. In such cases, contact is sporadic and there are no formal functional mechanisms for regular interactions with stakeholders. Local needs are therefore presumably not taken into account. Further along the continuum, there may be information sharing, with stakeholders being passively informed of changes or events, rather than actively involved in decision-making. Alternatively, information may be passively sought from stakeholders. Such information may include both knowledge of a site or system, as well as opinions and perspectives. True participation only begins to take place, however, when interactive mechanisms for information exchange are set up. Active discussions between different stakeholders and between stakeholders and decision-makers help to better frame subsequent management decisions. At the far end of the participatory continuum, participation may include delegation of decision-making power. This can range from nominal participation, to, for instance, the inclusion of local representation on decision-making committees, through to full delegation of autonomous decision-making powers to the community. The continuum thus represents a gradual shift in power from managerial authorities to local stakeholders.

**Stakeholder participation in coastal management: concepts and methods**

Coastal problems are invariably multi-faceted in nature. The coast is geomorphologically and ecologically important and is critical to the continued operation of several dynamic processes. However, the coast is also important to people. Coastal systems provide a wide range of services to human beings (Wilson *et al.*, 2005) including shoreline stabilization, nutrient regulation, carbon sequestration, supply of food, fuel wood, energy resources and natural products, and amenity services such as tourism and recreation. From an economic standpoint, coastal systems are amongst the most productive in the world. However, the system is now out of balance. The Millennium Ecosystem Assessment (2005) notes that whilst human dependence on coastal systems has greatly increased in the last centuries, the impacts on the ecology of these habitats have become so severe that their productivity and functioning has been altered, and it is increasingly difficult for coastal systems to accommodate the increased collective demands of growing populations and markets. In the face of declining resources and increasing hardships, resulting in growing tensions, collaborative and consensus building efforts become even more challenging, yet never have they been more necessary.

There are many means of involving stakeholders in coastal management decisions. Some examples of less conventional approaches are described in this chapter. These, together with the more traditional questionnaires and interviews, can yield a significant depth of data that enhances the decision-making process. The choice of method will depend on the context, as not all methods are appropriate or useful in certain circumstances. Considerations in choosing research methods must include the objectives of the exercise, time, money, the topic at hand, and the characteristics of the participants themselves. Whatever method is used, managers need to seek to accommodate the diverse interests of a wide group of people. Resource users, such as fishermen or tourism entrepreneurs will articulate their own needs and concerns relating to future resource supply and to conflicts between their diverse interests. Non-governmental organizations play an important role in giving a voice to less represented groups, such as women and minorities, and in putting forward ecological concerns. NGOs may also be able to provide extensive knowledge about coastal systems, particularly relating to observations of status and trends. Land owners seek to guarantee the future of their land resource, either for amenity reasons (such as the maintenance of pleasant sea views) or for commercial reasons (such as the possibility of selling undeveloped land for future construction). Land owners may further seek to ensure the stability of their assets in the face of natural threats such as erosion. Furthermore, stakeholders extend beyond the immediate geographical coastal area, as the practices of inland inhabitants may ultimately determine what happens at the coast. Universities and other scientific and research institutions also play an important role in ensuring that decisions are made on the basis of good science.

Management authorities therefore face a formidable task in integrating all these diverse interests. This is particularly true where management resources are not consolidated in a single agency but are sectoral in nature, and where coordination of efforts is thus difficult. Managers must be prepared to face the backlash resulting from dissatisfied stakeholders. Such reactions may extend beyond the particular issue under discussion. Disgruntled stakeholders may simply opt out of the decision-making process altogether in the future, destabilizing participatory efforts. The best that managers can do is to ensure that the way in which participation is done is transparent, accountable and inclusive, and that no groups are marginalized or ignored. The views of all should be noted but also critically evaluated. Stakeholders should feel that, even if the final decision is not to their advantage, they have been given a fair shot at making their case, and that the decision can be publicly justified, for the 'greater good'. Perhaps the biggest challenge for coastal managers lies in taking decisions that safeguard the integrity of natural systems in the face of widespread public opposition, oftentimes justified in terms of direct social and economic impacts. Coastal managers are endowed with the responsibility for looking beyond direct and short-term impacts on society, to the long-term health and stability of coastal systems, and within an ecosystem management approach for sustainability, stakeholder interests must necessarily be placed within this broad framework for decision making.

*Box 5b*
*Systemic and Prospective Sustainability Analysis (SPSA)*

Systemic and Prospective Sustainability Analysis (SPSA) is a process designed to produce Sustainability Indicators (SIs) in a manner which maximizes their chances of producing a holistic perception of the context in question, and in an inclusive and participatory manner. The process involves 12 stages, outlined below:

1. *Find out how things are*. This initial 'soul-searching' exercise is done by bringing into play the various stakeholders involved to identify controversial and common interests in the system.
2. *Understanding the context for SIs.* This stage extends the exercise of step one to pictorially represent the system under review through the derivation of a 'rich picture'. The rich picture presents formal and informal elements, structures and processes, which are then translated into tasks and activities necessary to address the various problems of the system.
3. *Gather the stakeholders in the SI process*. It is important to find a common definition of sustainability with regard to the system being reviewed, in order to condition the process and the outcomes of the subsequent stages.
4. *Get clear on methods*. This stage seeks to clarify the outputs, and the form these will take, depending on the methods to be used.
5. *Identify stakeholder coalitions*. During this stage, stakeholder groups define and agree on the basic vision of the system, with this stakeholder perception becoming the basis of subsequent decisions made.
6. *Identify and agree the main SIs*. Indicators should provide a variety of measures, including pressure, state and responses.
7. *Identify and agree the band of equilibrium*. The band of equilibrium is a range within which a particular indicator can be considered as having reached a sustainable level.

Plate 1: Coastal erosion landforms and 17th century coastal tower, Ghajn Tuffieha, Malta

Plate 2: Coastal geomorphology including cliffs, arches, stacks and solution hollows in Dwejra, Gozo

**Plate 3:** Scree formation resulting from coastal dynamics along the north-western coast of Malta

**Plate 4:** Coastal wetland at El Hondo, Spain, an ecosystem of international importance

Plate 5: *Podarcis filfolensis* ssp. *kieselbachi*, endemic to Selmunett Islands (area of 0.101km²), Malta

Plate 6: Detail of *Posidonia* meadow, which serves several ecological functions

**Plate 7:** White Stork (*Ciconia ciconia*) adult with young, a most common occurrence in the Maghreb

**Plate 8:** The Barbary Macaque (*Macaca sylvanus*), under threat from habitat loss

**Plate 9**: Moray eel in Mediterranean waters

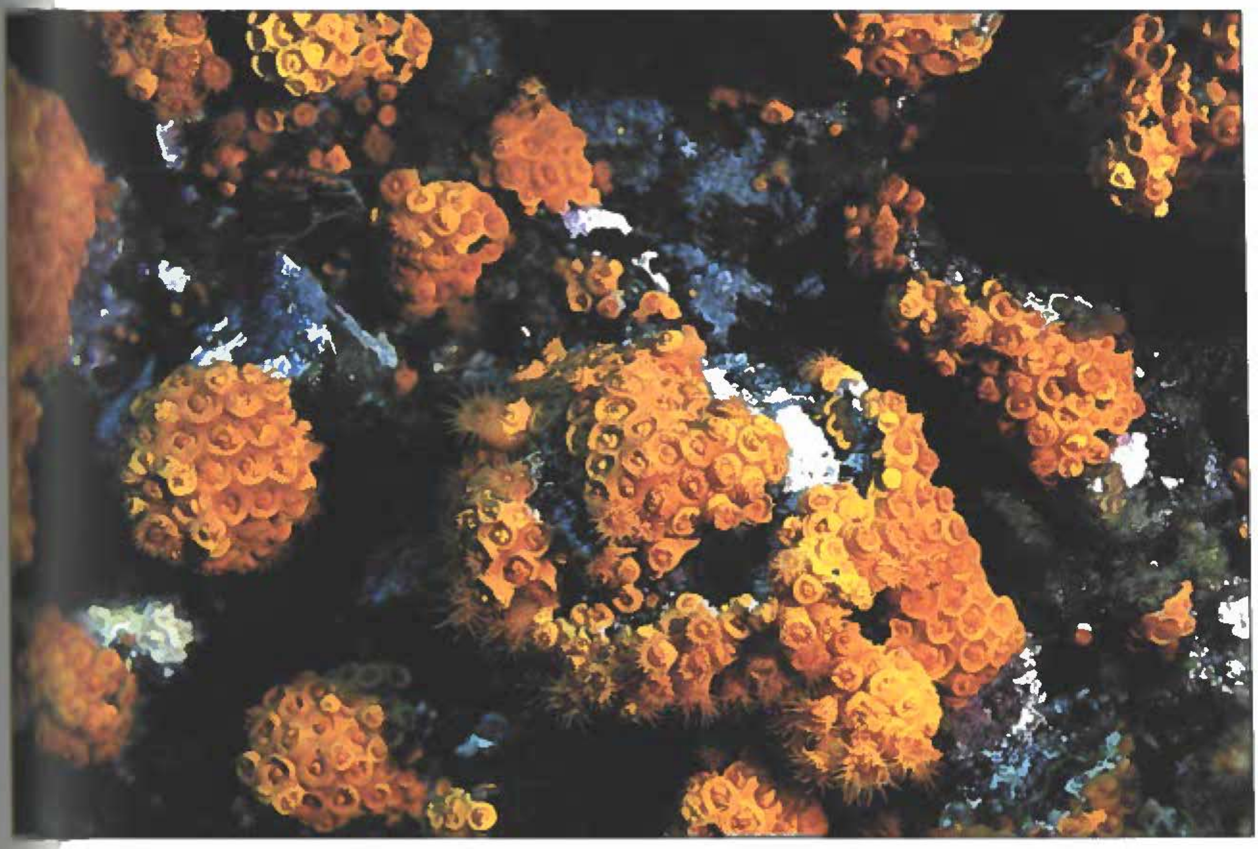


**Plate 10**: *Astroides calycularis*, a species of coral endemic to the Mediterranean Sea

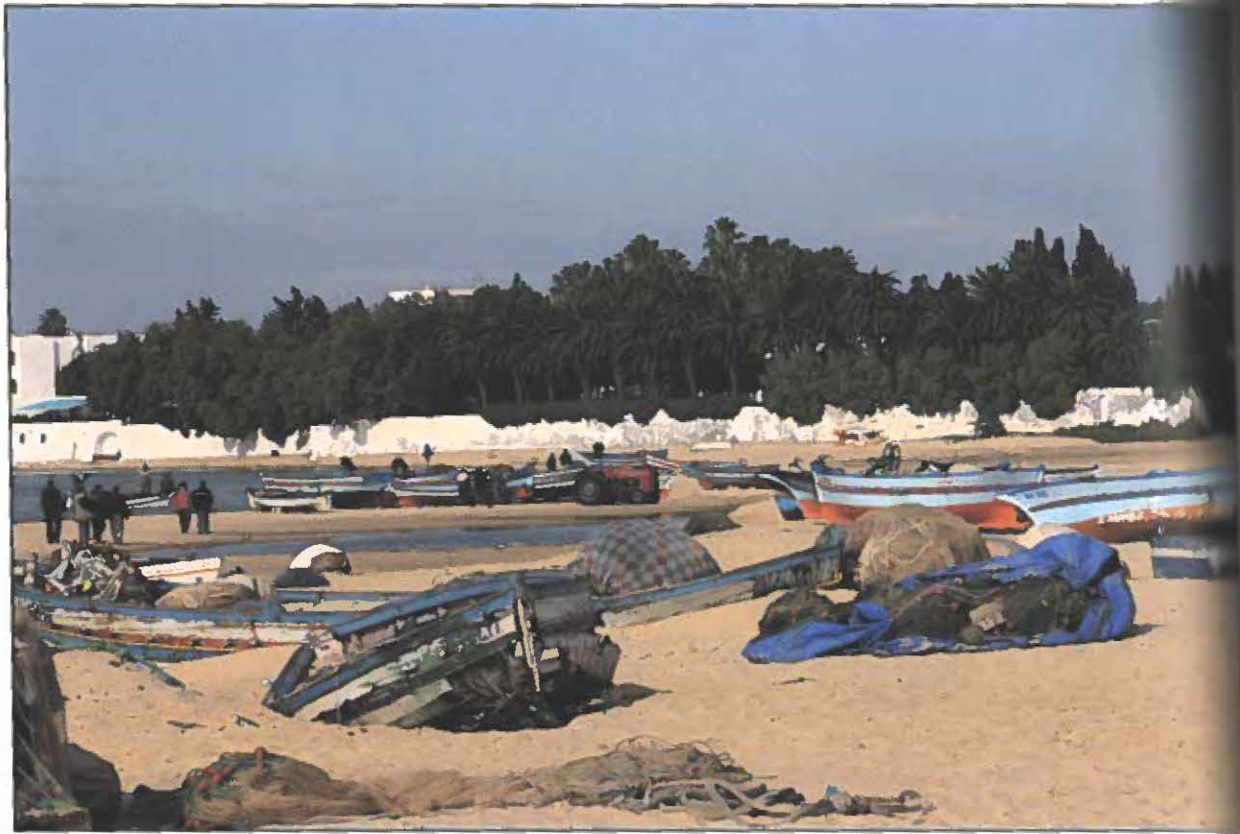


**Plate 11:** Small-scale traditional fishing paraphernalia on a sandy beach at Hammamet, Tunisia

**Plate 12:** Fishermen at work at Oued Laou, Morocco

Plate 13: Abu Mandur Mosque on the banks of the Nile, close to where the river meets the Mediterranean

Plate 14: A canal off the Nile, Alexandria, Egypt

**Plate 15:** 19th century water retention structure on the Ombrone River, Tuscany

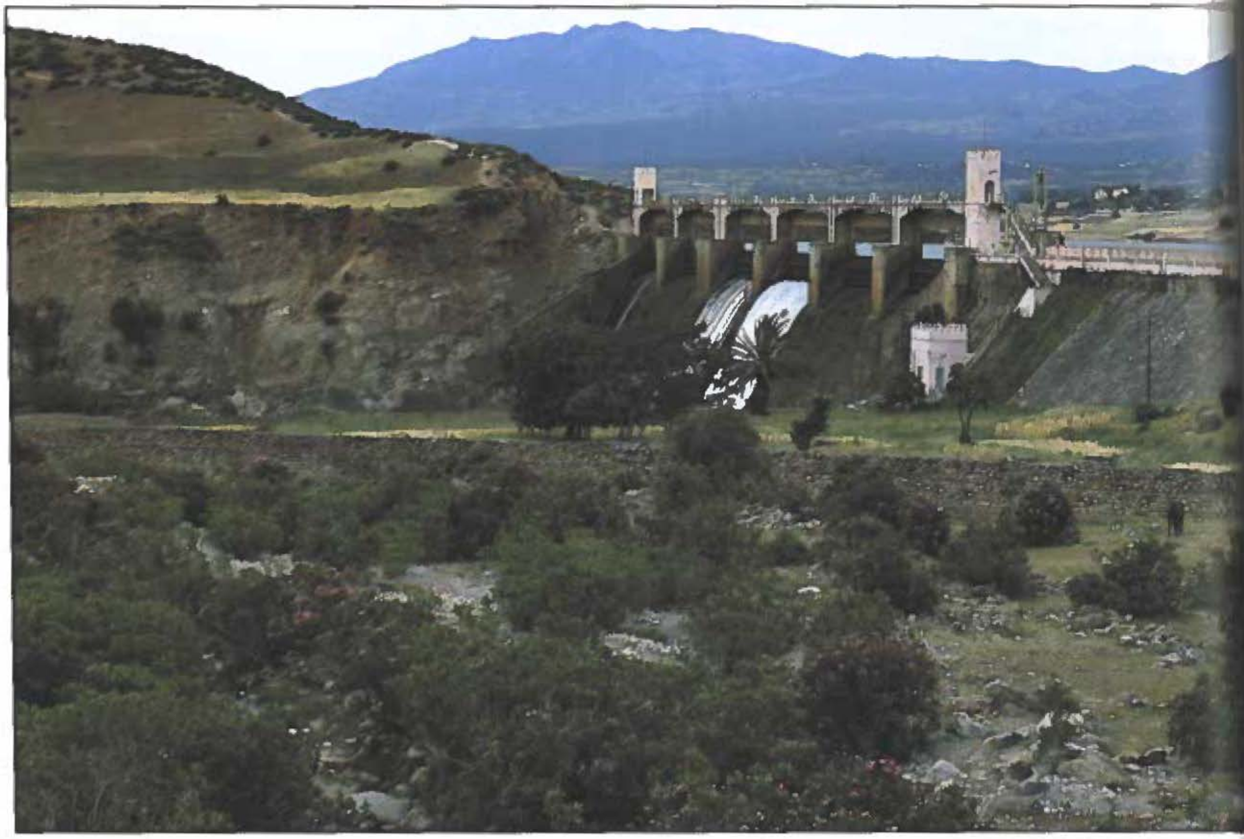


**Plate 16:** Dam regulating downstream flow of Oued Laou, Morocco

Plate 17: A blend of historic and modern architecture on the Alexandria seafront, Egypt

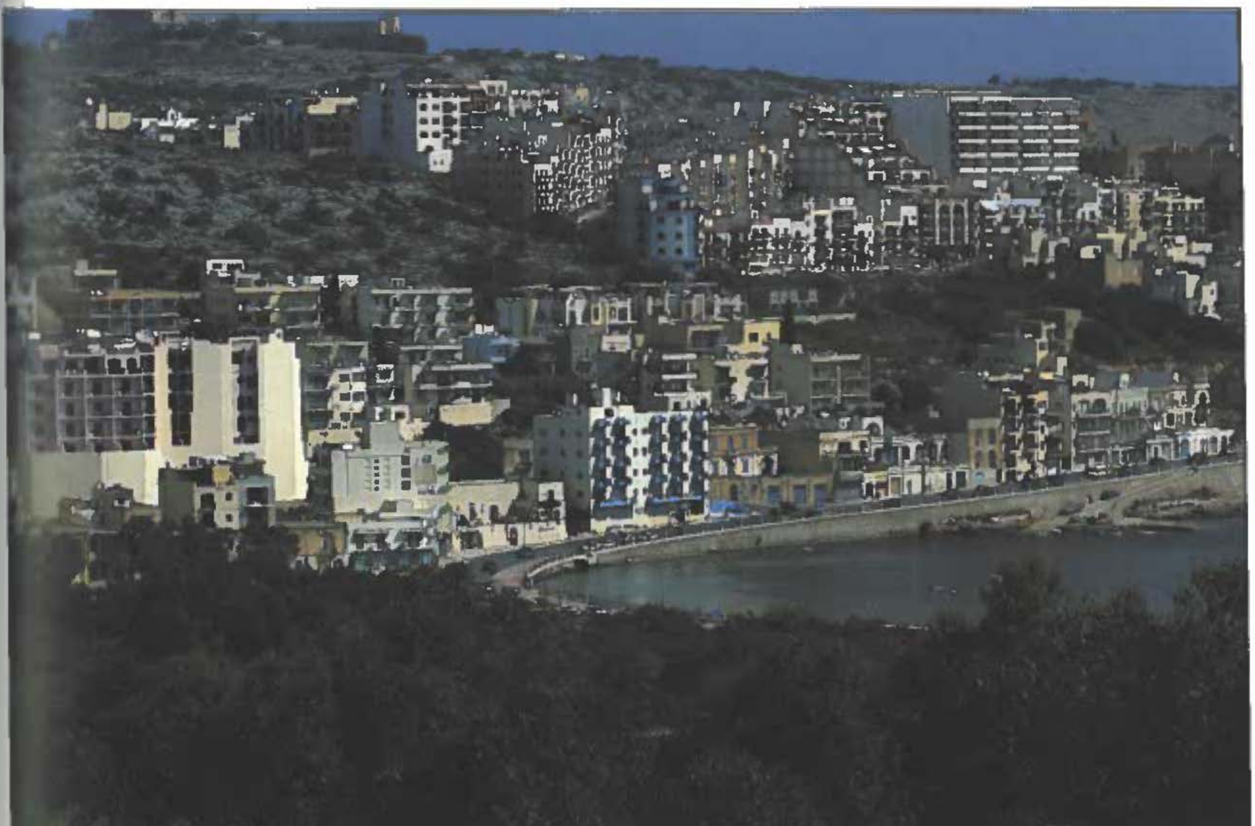


Plate 18: High density urban development on the coast of Xemxija, Malta

**Plate 19:** Characteristic rolling rural landscape in Tuscany, Italy

**Plate 20:** *Buttero* herding the traditional cattle breed known locally as *Vacca Maremmana* (Maremma, Italy

Plate 21: Settlement in the Nebrodi Mountains, Sicily

Plate 22: Agriculture in Ghar El Melh, Tunisia, with potatoes grown on sand, using traditional techniques

**Plate 23:** Manufacturing of traditional Tunisian *fez* (*chechia*) near the port of Ghar El Melh, Tunisia

**Plate 24:** Vendor at a *souk* in Tunis wearing traditional *chechia*

**Plate 25:** Animated discussion at the market in Chefchaouen, Morocco

**Plate 26:** Array of carpets and *kilms* on sale at a roadside market, Morocco

**Plate 27:** Open-air weekly market at the coastal town of Oued Laou, Morocco

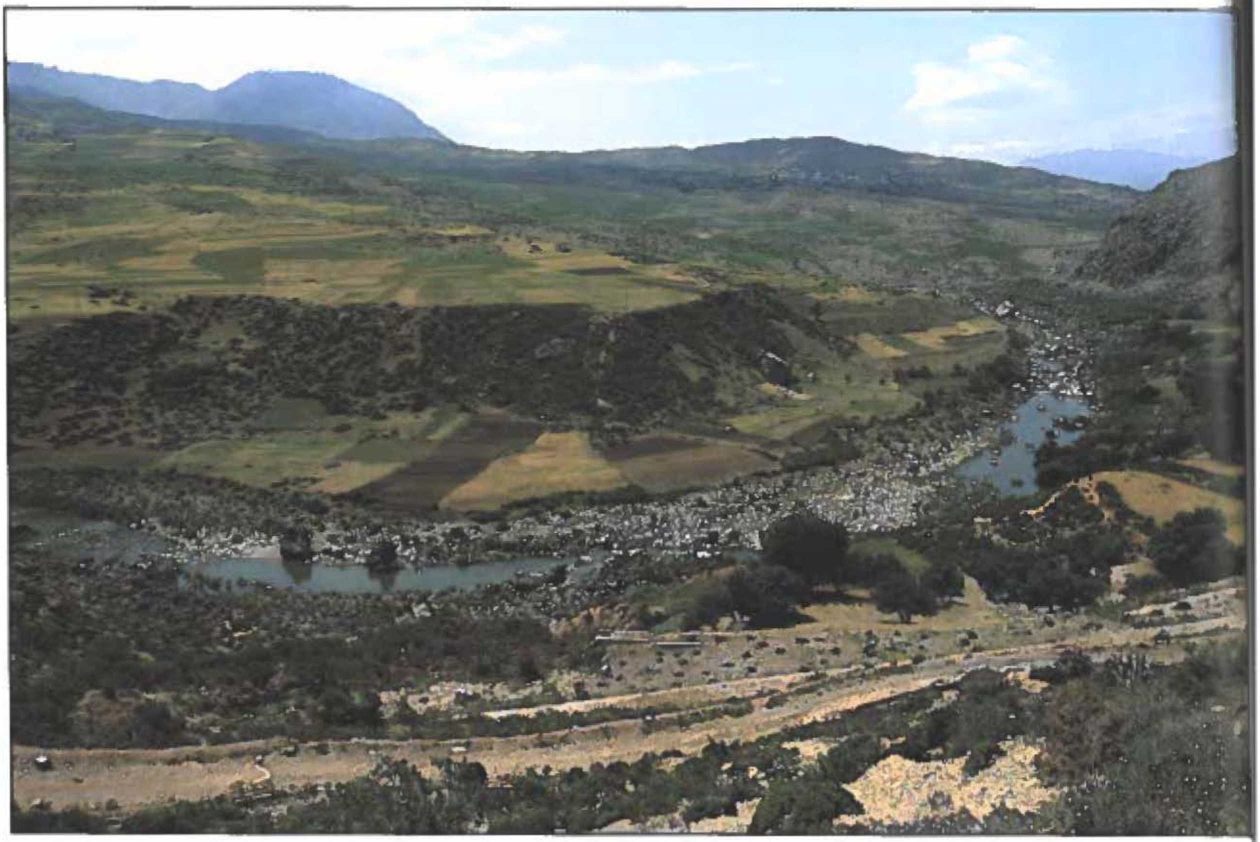


**Plate 28:** Rural and semi-natural landscape bisected by the flowing waters of Oued Laou, Morocco

Plate 29: Urban encroachment onto coastal dunes, Cap Bon peninsula, Tunisia

Plate 30: *Carpobrotus edulis*, an invasive alien which competes with indigenous Mediterranean species

**Plate 31:** Urban sprawl extending outside the historic fortress and onto the coastal fringe, Kélibia, Tunisia

**Plate 32:** Canal on the Adriatic coast of Trieste, Italy

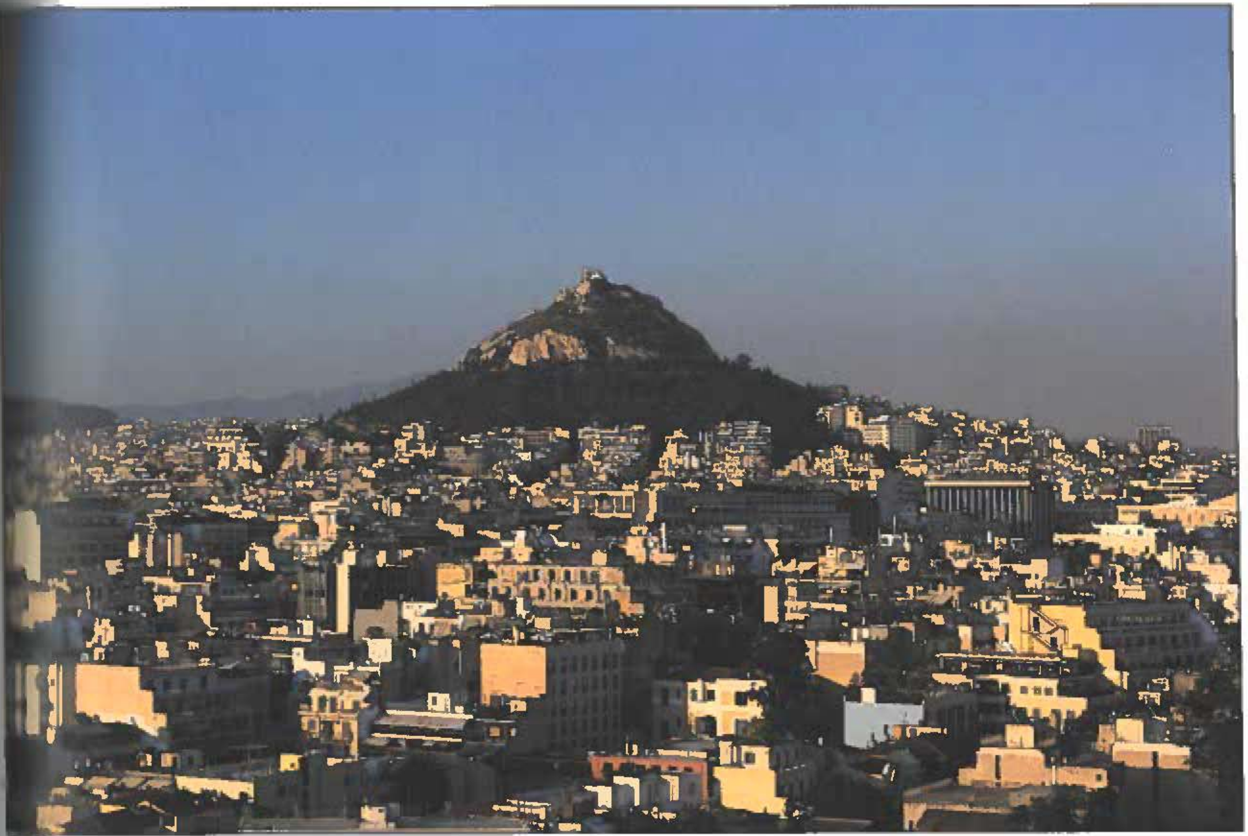


**Plate 33**: The sprawling city of Athens

**Plate 34**: The World Heritage Site of Dubrovnik, historically important for maritime trade (Croatia)

**Plate 35:** The 16th century tower of *Collelungo* at the *Parco Regionale della Maremma*, Italy

**Plate 36:** Erosion causing accelerated beach-line retreat at the *Parco Regionale della Maremma*, Italy

Plate 37: Coastal dune field at Berkoukech, north-western Tunisia

Plate 38: Collapse of coastal constructions following extensive beach erosion at Zouaraa, Tunisia

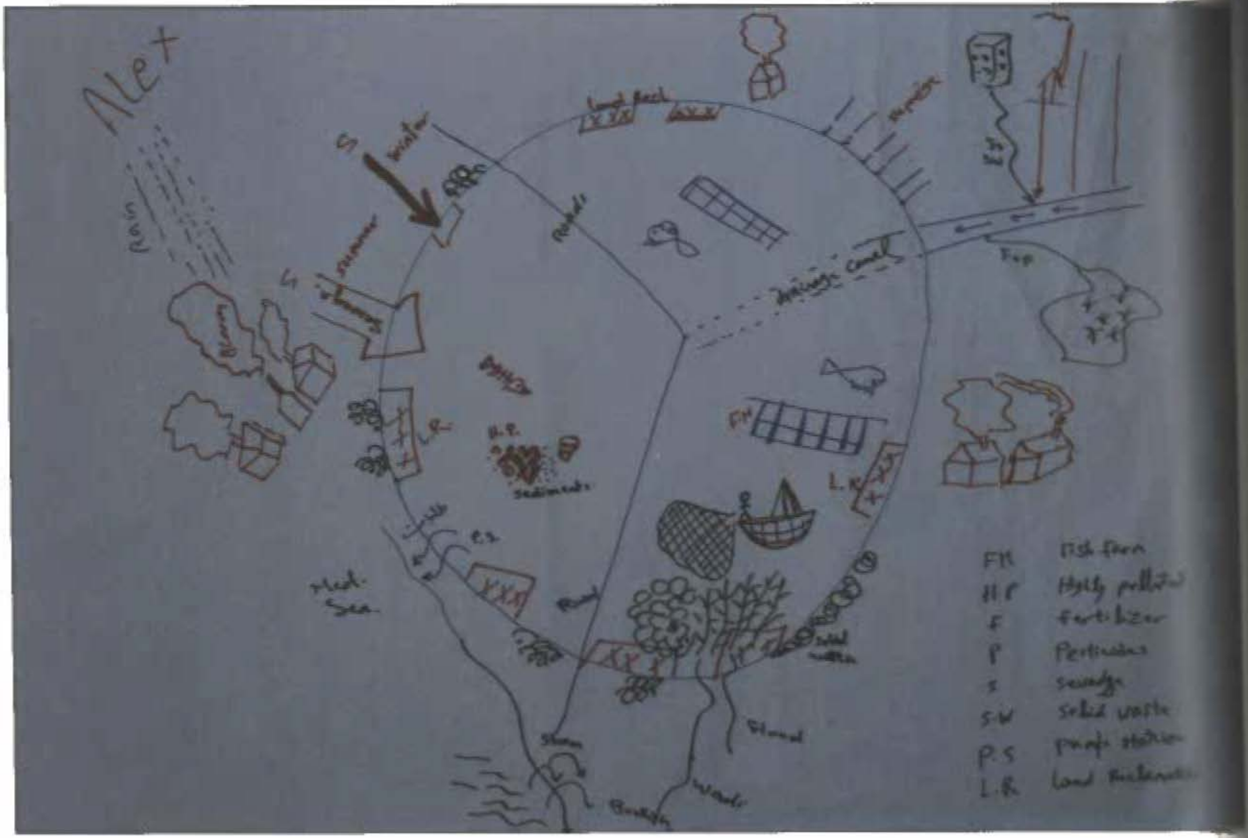



**Plate 39:** Example of rich picture produced through SPSA process

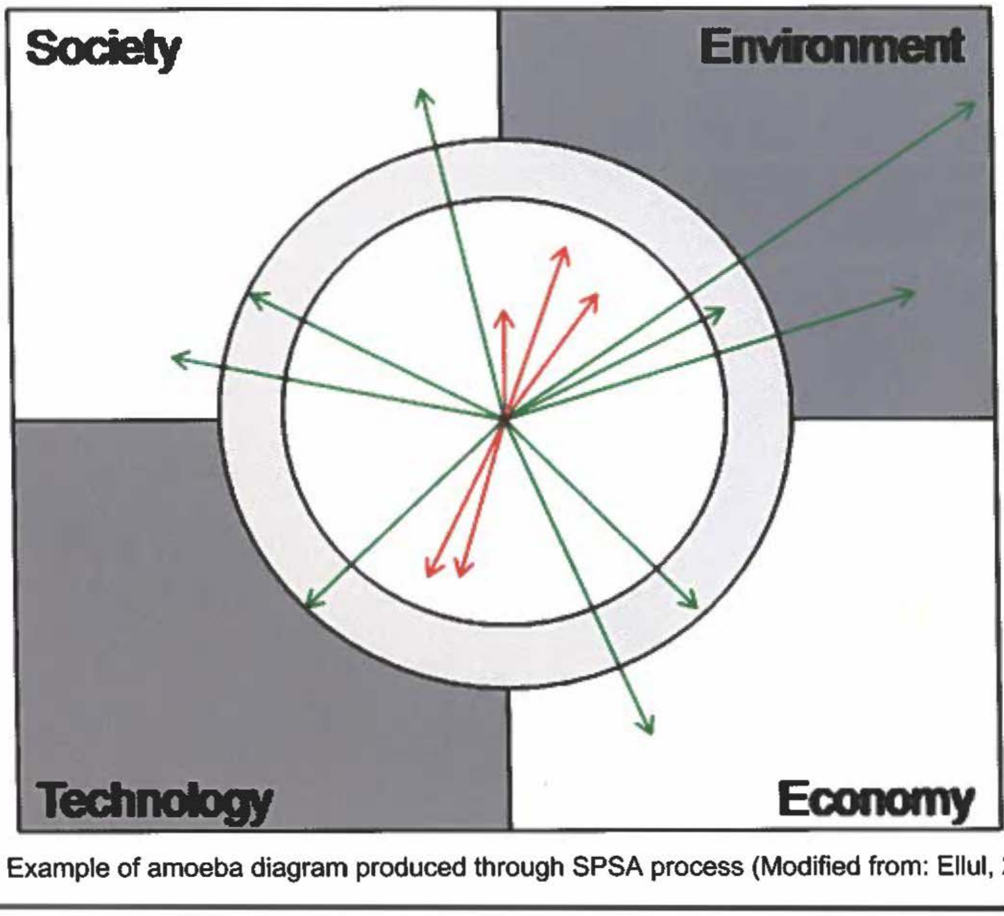



**Plate 40:** Example of amoeba diagram produced through SPSA process (Modified from: Ellul, 2005)

*Box 5b (cont.)*
*Systemic and Prospective Sustainability Analysis (SPSA)*

8. *Develop AMOEBA in a collaborative manner.* During this stage, SIs are distributed into four categories (economic, social, environmental and technological), represented on an AMOEBA diagram in four quadrants. Bands of equilibrium and SIs are visually represented on the diagram (Plates 19/20).
9. *Think about how the AMOEBA extends over time.* This stage examines extending the AMOEBA over time and projecting SIs into the future to gain an understanding of what is likely to happen, based on past trends and data.
10. *Unpack and understand the AMOEBA (forecast potential).* SIs which exhibit problematic trends are identified, bringing into play the vision of stakeholders with regard to the sustainability of the system.
11. *Responding to 'good and 'bad AMOEBA (policy implications).* Management measures are devised on the basis of AMOEBA. Satisfactory AMOEBA should not, however, become grounds for complacency, as the representation may miss out on particular elements of the system.
12. *Making changes to the SI mix in the light of practice.* The AMOEBA is a means to an end. It should encourage debate and subsequent action to achieve the desired state.

Source: Ellul, 2005

*Box 5c*
*Visitor Employed Photography*

It is said that a picture is worth a thousand words. Photographs may be a potentially powerful research tool, particularly in communicating aspects of perception. Although specific applications of visitor employed photography vary, the general method involves providing stakeholders with cameras, and asking them to document aspects of an area, such as what they find most appealing or most distressing. Such photos may then serve as the basis for interviews or discussions. The method delegates power to the participants, in that they are free to choose the subjects for photographs. Because of this, the resulting vision is one that comes directly from community members and not from outside experts. The results can serve to provide insights into the nature of stakeholder perceptions, as well as indications of reasons for these perceptions.

Sources: Jenkins and Jenkins, 1998; Stedman *et al.*, 2004

*Box 5d*
*Participatory Rural Appraisal*

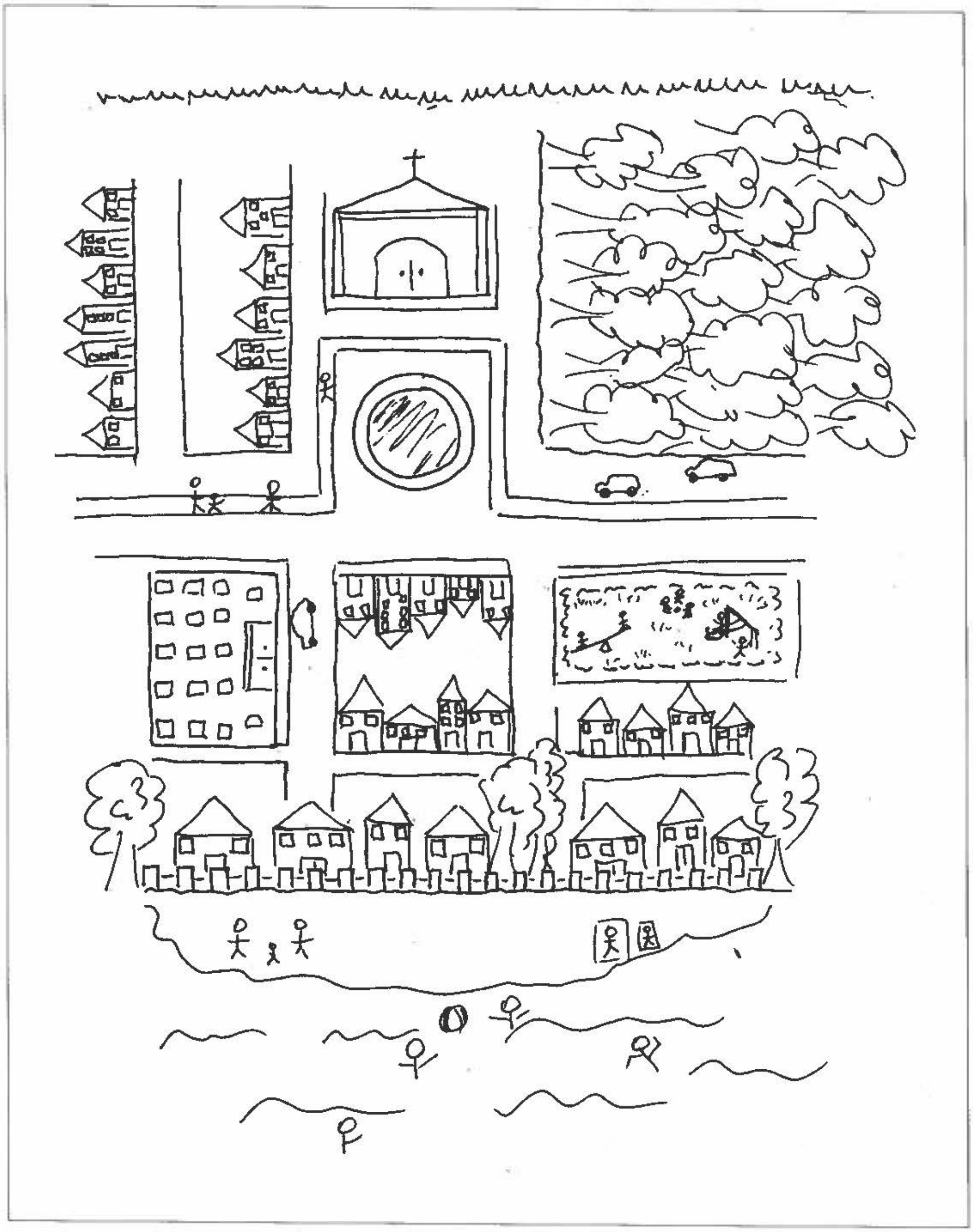
Participatory Rural Appraisal is a methodological approach first introduced by Robert Chambers in the 1970s and 1980s. Its emphasis is on local knowledge and on enabling local people to make their own appraisal, analysis and plans. Although originally developed for use in rural areas, PRA has been successfully applied in several settings. PRA highlights a number of innovative components in research, including flexibility, seeking diversity, optimization of chance opportunities, triangulation of data, reversal of learning in that researchers learn from participants, and optimal ignorance in terms of trade offs between time and resources and data acquired. The PRA toolkit incorporates various methods, including semi-structured interviewing, focus group discussions, preference ranking, mapping and modelling, seasonal and historical diagramming, and transect walks. PRA methods seek to improve on conventional approaches, rendering research more relaxed, with a more visual focus and with an empowering goal.

*Case Example 5.2*
*Applications of SPSA in the Mediterranean region*

Variants of the methodology outlined in Box 5b above have been applied by the authors at several sites across the Mediterranean, including in Italy, Tunisia, Egypt and Malta, through focus group seminars with a diverse range of stakeholders. The SPSA methodology was found to have numerous advantages over more conventional approaches, with the informality of drawing 'rich pictures' making it easier for some respondents to express themselves, and with the entire process being met with enthusiasm by most respondents. The 'rich pictures' themselves enabled the presentation of complex data in relatively simple fashion, and also served as a good focus for subsequent discussions between stakeholders. The fact that the process is largely led by participants themselves, with facilitators' role being to help, rather than to control, further contributed to ownership of the process by participants. Although the specific results obtained were related to the particular context of the site, common pressures were noted across the different countries. In particular, urbanization was highlighted as a major environmental pressure in the Mediterranean.

Source: Cassar, 2006

*Sketch 5.1*
*Example of community map derived through PRA techniques*



*Case Example 5.3*
*Ecosystem services and human well-being – PRA in Northern Portugal*

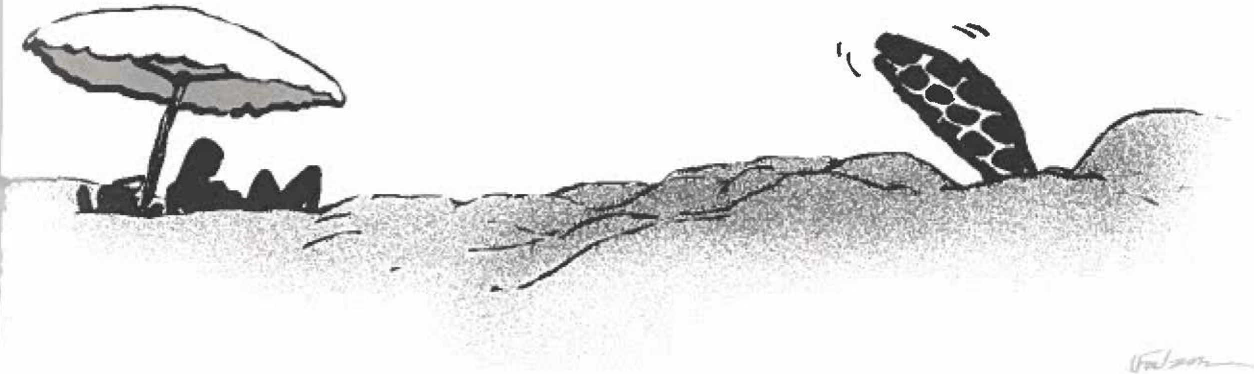
The rural community of Sistelo, in northwestern Portugal, served as a study case for the assessment of the condition and the valuation of ecosystem services and biodiversity in a mountain system. Forty individuals participated in the study, which utilized a variety of methods from PRA. These included direct observation, semi-structured interviews, trend lines, ranking and scoring. In addition, familiarization with the community, and participation in community daily activities, was considered important in order to learn more about their way of life and in order to establish a relaxed rapport and some measure of trust. The research provided data on community well-being, on temporal changes, on community priorities and on community values. Data triangulation was employed throughout.

Source: Pereira *et al.*, 2005

**The challenges of participation**

Participation requires resources, financial and otherwise, and takes up valuable time. At times, participation may not be possible or appropriate, such as when emergency actions need to be taken in response to environmental crises. Other criticisms have focused on the nature of the participatory process. There may be much diversity within a stakeholder group, and dominant spokespersons may not necessarily represent majority views. Minority views may go unheeded, particularly where participants may not feel comfortable expressing themselves. Participants may also be motivated by purely selfish interests; the entire process may disintegrate into jostling for personal advancement, without any overarching objective of acting for the benefit of all. Others are cynical about the entire concept, arguing that for all the fuss and rhetoric, it has changed little in terms of power structures and the ways in which decisions are made.

However, although participation may not have provided magical solutions to environmental problems, it has represented a major step forward in terms of democratic and effective decision making. Participatory initiatives have served to communicate the fact that environmental resources belong to all, and that all have interests and responsibilities in safeguarding environmental futures. The problem is not that participation is ineffective. It is rather that the term has been mis-used to refer to initiatives that were inappropriately designed, conducted or managed. It is important to ensure that the right people are involved in the right way through well-managed and well-facilitated processes. If successful participatory mechanisms can be established, the outlook for partnerships in environmental management, both in coastal areas and elsewhere, will be much brighter. The challenge of balancing diverse human needs with the maintenance of ecological integrity is huge, but we can have hope that, for the sake of our common interest in ensuring the continued wellbeing of the human species, we can somehow work together towards a common end.



# CHAPTER 6
# Landscape Approaches to Coastal Management

*We are the children of our landscape; it dictates behaviour and even thought in the measure to which we are responsive to it.*

Lawrence Durrell, *Justine*, 1961

## Introduction

A key concern in environmental management is that of the scale of analysis. Environmental issues may appear to have different causes, effects and solutions when viewed at different spatial levels. Much of the early work in environmental management tended to focus on the relatively small scale of specific sites, addressing a particular problem within a particular area. However, a water quality issue within a nature reserve may have causes that extend outside the reserve boundaries to the far limits of the watershed. Increasingly, therefore, it came to be seen that environmental systems extend across broad geographical areas, and that activities occurring at one site can affect, and be affected by, activities occurring many hundreds of kilometres away. Analysis at site level, though useful, is thus limited. Furthermore, it also became increasingly evident that the complex interactions between natural and anthropogenic activities make it necessary to use analytical tools that allow for adequate consideration of human factors. The physical aspects of ecosystems cannot be evaluated in isolation but need to be considered within a broad context. It is not enough to measure, for example, water quality parameters; the social causes and driving forces behind water quality problems also need to be addressed.

The landscape unit increasingly came to be seen as an ideal unit for such analyses. It is not only geographically broad, but it is also defined on the basis of physical factors, rather than arbitrary political decisions. A landscape unit is a defined physical entity, with particular patterns and processes occurring within it, and which distinguish it from other landscape units. Landscape is also inclusive and flexible as a concept, being able to accommodate both natural and human aspects of land. The term itself is complex in meaning. The English word landscape is a derivation of the Middle Dutch word *landtscap*, which in turn derives from the Germanic *land* and the suffix *–schap* meaning 'constitution' or 'condition'. In present-day usage, the word has a plurality of meanings and associations. Makhzoumi and Pungetti (1999) distinguish between four major perspectives: landscape as scenery, as a specific place, as an expression of culture, and as a holistic entity. Landscape as scenery derives from the Dutch expression noted above, and includes the more romantic connotations of landscape. Landscape as a specific place refers to physical and geographical aspects of the landscape of particular regions, including a region's geological and topographical features. Landscape as an expression of culture illustrates how people have modified their environment from the natural state to the man-made. Finally, landscape may also be presented as a holistic entity, as a focus for the integrated study of the natural environment, comprehending not only natural geological, geomorphological and ecological factors, but also those involved in land use, urbanization and society.

In the plurality inherent in the concept of landscape lies both the strength and the weakness of landscapes as a setting for conservation. Because landscapes are multifunctional, encompassing many facets, and because they can be identified with easily, providing as they do a backdrop to everyday life, they provide an ideal broad and holistic arena for conservation efforts. On the one hand, they are functional and viable analytical units from an ecological point of view. On the other hand, landscapes are cultural constructs, often contested. Where one person may see a vacant plot suitable for large-scale development, another may see a valuable natural space. This also occurs on much larger scales; rugged Alpine scenery that eighteenth century travellers found repugnant later became the heartland of the Romantic movement (Phillips, 2005). Landscape also has a range of often-unquantifiable values, ranging from pragmatic economic values to ecological, spiritual, recreational and health-related values. In addition, landscapes are often required to accommodate multiple, at times conflicting, land uses. As a result, landscapes can only be managed through broad approaches, as the interlinkages between ecological, social, political and economic forces are generally complex. One example is the case of economic situations triggering agricultural intensification and resultant ecological and visual impacts on landscape. For this reason, much landscape planning and design depends on the character of social structures, institutions and systems which have control over the change (Roe, 2000). All of this presents a major challenge to management efforts at the landscape scale.

Nevertheless, landscape is increasingly being recognized as being particularly relevant to the search for more sustainable ways of living. It has several characteristics which echo concepts from sustainable development, such as its universality, its dynamicity and the fact that it is holistic yet hierarchical. In this sense, landscape is not merely an environmental resource in its own right, but also a medium through which to pursue sustainable development (Phillips, 2005). The value of landscapes is also now being recognized at the level of policy. The Pan-European Biological and Landscape Diversity Strategy (1996) represented a significant step forward at the regional European level, and this was followed by the European Landscape Convention, the world's first landscape treaty, which came into force in March 2004 (Phillips, 2000). Prior to this, in 1992, the World Heritage Convention became the first international legal instrument to recognize and protect cultural landscapes. Protection is particularly important in a context of growing threats. Several common dangers can be identified, including insensitive land use and development, pollution and resource abuse, and neglect and abandonment (Phillips, 2000). Whilst there are some exceptions, most modern development has been large in scale, insensitive in design and dominating in its impact. The challenge now is to ensure the survival of a rich heritage of landscape, both natural and cultural, in a period of accelerating economic growth and social change.

This chapter introduces some approaches to the analysis of environmental issues from a landscape scale, both from a predominantly ecological perspective, as well as from a more cultural standpoint. Potential applications of landscape approaches in the Mediterranean region and in coastal areas in particular, are also discussed.

## Landscape interfaces

Widgren (2002) notes four things to bear in mind when studying landscapes: forms, functions, processes and context. All together contribute to a landscape analysis of a problem. Forms have meaning in a specific context. Landscape decisions often relate to restoring the state of the landscape, or the processes that endow it with specific functions (Palang and Fry, 2003). No one aspect has meaning without the others. Decisions relating to landscape management are thus invariably complex, particularly due to the numerous interfaces between different interpretations of landscape. The most evident is the interface between natural and social sciences. Both lay claim to the concept, but whilst one focuses on the material landscape, the one we can touch and measure, the other focuses more on landscapes as constructed and interpreted in our minds. The two may be complementary but are not necessarily so, and there has been much conflict between the interpretations of the natural sciences and those of the humanities. Linking the two approaches together is challenging, although not impossible, and interdisciplinary studies hold much potential in this regard, particularly as both perspectives are critical to holistic management. The landscape also provides an interface between past, present and future. The landscapes we see around us today are products of past land uses. Every civilization has left its mark on the landscape, some more than others. Widgren (2002) claims that landscapes can be read, interpreted and understood only in the historic and political context specific to the time the objects originated from. At the same time, landscape management addresses future trends through scenario building, as past and present landscapes provide the foundation for future landscapes. There is also an interface between time and space. Landscapes are not static, but rather dynamic, evolving both temporally and spatially. We thus evaluate not only when changes take place, but also where they take place, combining inputs from both history and geography. Time and space find their expression through combinations of physical, biological and anthropogenic factors in the landscape.

## Landscape ecology

Landscape ecology is a holistic approach to ecological studies which emphasizes interactions between spatial patterns and ecological processes. The subject matter is the landscape, its form, function and genesis (Zonneveld and Forman, 1990). Makhzoumi and Pungetti (1999) identify several differences between traditional ecology and landscape ecology. In the first place, landscape ecology focuses on land or landscape as an object, utilizing spatial and ecosystemic and, to a limited extent, aesthetic perspectives. Furthermore, it operates within a holistic framework, understanding wholes or systems without necessarily knowing all their internal details. Landscape ecology also recognizes the dynamic role of man as a central component of landscape. The discipline is therefore integrative in focus, rather than reductionist.

*Box 6a*
*Key terms in landscape ecology*

**Habitat**: The ecosystem where a species lives, or the conditions within that ecosystem.

**Patch**: A relatively homogenous area that differs from its surroundings. Patches are the basic units of the landscape, with a definite shape and spatial configuration.

**Matrix**: The background ecological system, characterized by expanded surface covering, high connecting degree, and/or main control of system dynamics.

**Corridor**: A strip of a particular type that differs from the adjacent land on both sides.

**Mosaic**: A pattern of patches, corridors and matrix, each composed of small, similar, aggregated objects.

**Edge**: The portion of an ecosystem near its perimeter, where influences of the surroundings prevent development of interior environmental conditions.

**Network**: An interconnected system of corridors.

Source: Forman, 1995

One branch of landscape ecology derives from the theory of island biogeography, first introduced by MacArthur and Wilson in 1967. This theory related biodiversity on islands to aspects of size and distance from mainland populations. In landscape ecology, this idea has been adapted to analyse what is arguably the most significant threat to biodiversity globally, i.e. habitat destruction. At a broad landscape scale, natural habitats are being increasingly modified, altered or exterminated. The impact of this is two-fold. On the one hand, there is the direct result that habitats, including all their attendant species, are lost. On the other hand, remaining habitats are also affected through the process of fragmentation, which creates habitat 'islands' in a midst of non-natural land uses. Habitat fragmentation involves the disruption of once large blocks of habitat, into smaller parcels, which are less continuous. This has several negative effects. Based on species-area relationships, the number of species in smaller parcels of land can be expected to be less than would be found in larger parcels. Several small parcels of land also have a larger total perimeter, when compared to one large continuous area of habitat. This is considered to be a disadvantage, as perimeter areas are susceptible to edge effects, including altered abiotic conditions (such as differences in light, temperature and moisture) and increased exposure to predation. Fragmented patches are also isolated, and dispersal between different areas of habitat thus becomes more difficult. This is particularly the case if the intervening matrix is hostile to movements of particular species. Consider, for example, the case of bears trying to cross between different patches of forest, when the intervening areas are urban.

A key focus of landscape ecology is thus connectivity, through the establishment of networks of corridors. Corridors are essentially linkages across terrain intended to facilitate movement of species (or parts thereof, such as seeds, rhizomes, etc.) between landscape patches, and vary, according to the species under consideration. For some species, fences, rubble walls, hedgerows and continuous rows of trees and shrubs can serve as corridors. In other cases, species may require human-engineered structures such as underpasses and overpasses across highways, consequent to fragmentation of habitat through the development of infrastructure. On a broader scale, corridors can be very extensive spatially, even crossing national boundaries. In North America, for instance, the Wildlands Project is seeking to establish continent-wide networks for the movement of various species. Corridors need not, however, be limited to continuous strips of land. Some species can utilize 'stepping stones', spatially discrete habitats at regular intervals. Migratory birds provide an example of such an approach, stopping at appropriate sites during the course of their annual movements. Research concerning the practical design of corridors is still in its infancy, and the identification of effective design features requires adaptation on the basis of experience. In general, the approach involves a number of stages, including the selection of a species of concern and evaluation of its needs, identification of its habitats and potential linkages, mapping of viable corridors and evaluation of their features, implementation of the corridor system, and monitoring and evaluation of effectiveness.

**The cultural dimension of landscapes**

Landscapes do not only have geological, geomorphological and ecological significance, but also cultural significance. Landscapes possess tangible physical qualities but they also have intangible or 'associative' values, including spiritual, cultural and aesthetic values (Brown *et al.*, 2005). One can talk of landscape psychology (Makhzoumi and Pungetti, 1999), which brings together ideas of landscape perception and landscape experience. Phillips (2005) notes that landscape is interactive rather than passive. Firstly, the impact of landscape is felt through all the senses; it is seen, heard, felt, smelt and even tasted. Secondly, landscape shapes and reinforces our values, ideas and sense of identity. A particular culture is very much a product of the particular landscapes of a geographical area.

In many areas of the world, people have also directly shaped physical aspects of landscape. In 1992, UNESCO's World Heritage Committee made a landmark decision to encompass cultural landscapes as heritage, setting the scene for international recognition of cultural landscapes by several other agencies. Such landscapes are distinctive precisely because of the interaction between people and their environment. As such, they are shining examples of the fact that an ecologically sustainable human way of life is possible. Within the World Heritage Convention category of *organically evolved landscapes*, locals have, through sensitive land use practices over millennia, safeguarded or enhanced biodiversity whilst satisfying their own needs. *Associative cultural landscapes*, on the other hand, are protected by virtue of the religious, artistic or cultural associations of the natural element, rather than material cultural evidence.

*Case Example 6.1*
*The Loire valley between Sully-sur-Loire and Chalonnes*

The Loire valley, located in north-western France, was inscribed on the World Heritage List in 2000. It is noteworthy for the quality of its architectural heritage in its historic towns and castles. It is also an outstanding cultural landscape along a major river, bearing witness to the harmonious interaction of man and nature over two millennia. The diversity of settlement reflects both the physical characteristics of different sections of the river and their historical evolution. The landscape is the product of traditional land use practices, such as the spatial distribution system *domus-hortus-ager-saltus* (home-garden-cropland-pasture). It was also a major inspirational muse for artists and poets, particularly during the Renaissance.

Source: UNESCO, 2007

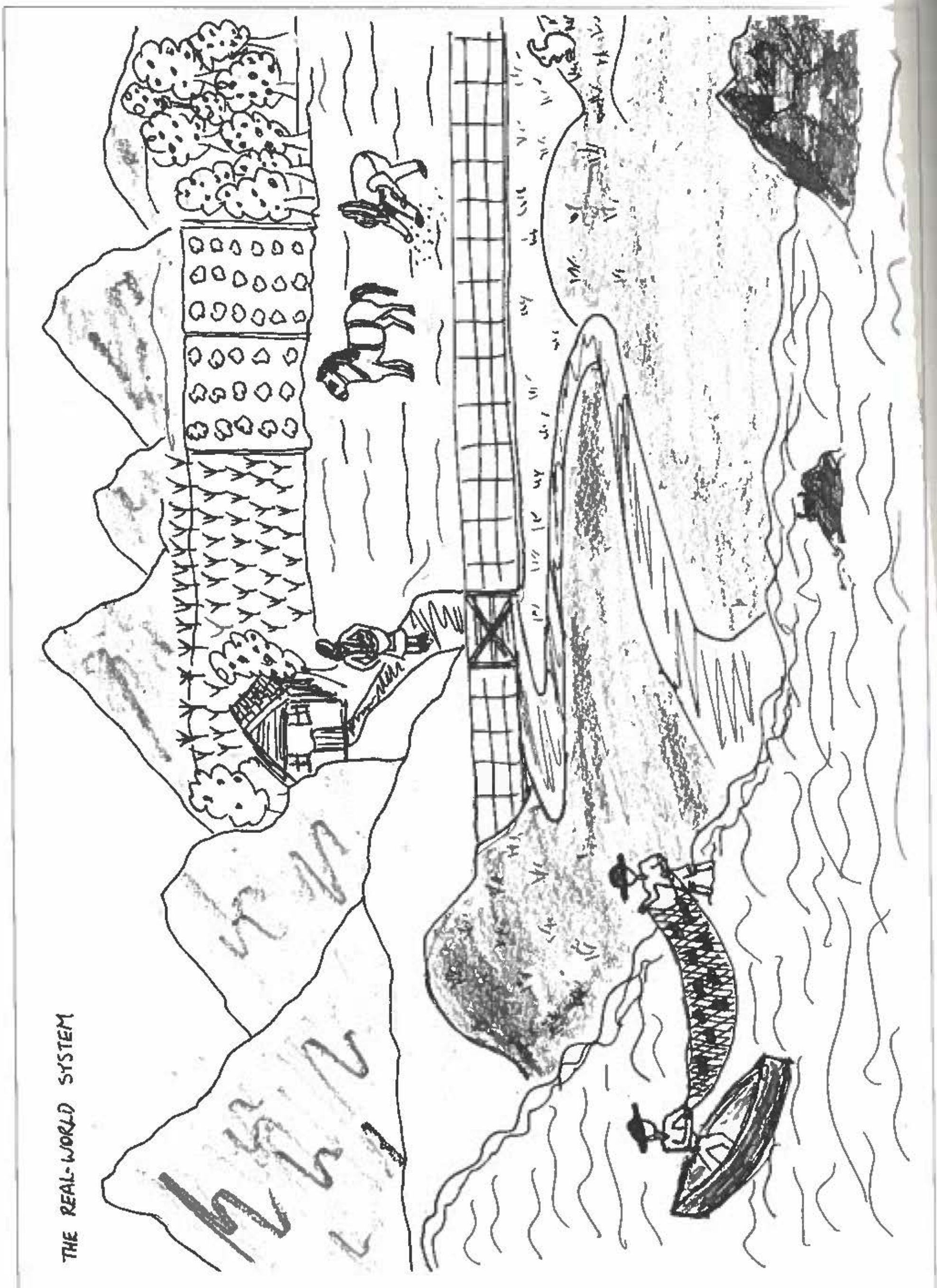
Rössler (2005) has identified a number of implications that the move towards recognition of cultural landscapes has for conservation. First, the explicit recognition of intangible values in landscape has contributed substantially to the safeguarding of heritage of local communities and indigenous people. This represented a fundamental shift towards acceptance of the significance of communities and of their relation to environment. Second, recognition of cultural landscapes gave recognition to land-use systems that represent the continuity of people working the land over centuries and sometimes millennia, to adapt the natural environment and retain or enhance biological diversity. We have increasingly come to realize that many indigenous people have lived in ways that have not harmed the biosphere; indeed, the immense genetic diversity associated with several traditional agricultural systems suggests that the opposite may be true. The ecological aspects of such systems are often tied to complex social systems; both therefore need recognition and protection. Conservation in such cases may equate to protection of particular types of livelihoods. Third, the inscription of sites as cultural landscapes on World Heritage Lists has had important impacts on the interpretation, presentation and management of the properties, leading to increased awareness, increased pride relating to cultural landscape heritage, and even to the revival of traditional techniques. Cultural landscapes are now increasingly recognised as a valuable, fragile and unique resource, deserving of protection as much as the most outstanding natural sites or cultural monuments.

## Landscape management in the coastal Mediterranean

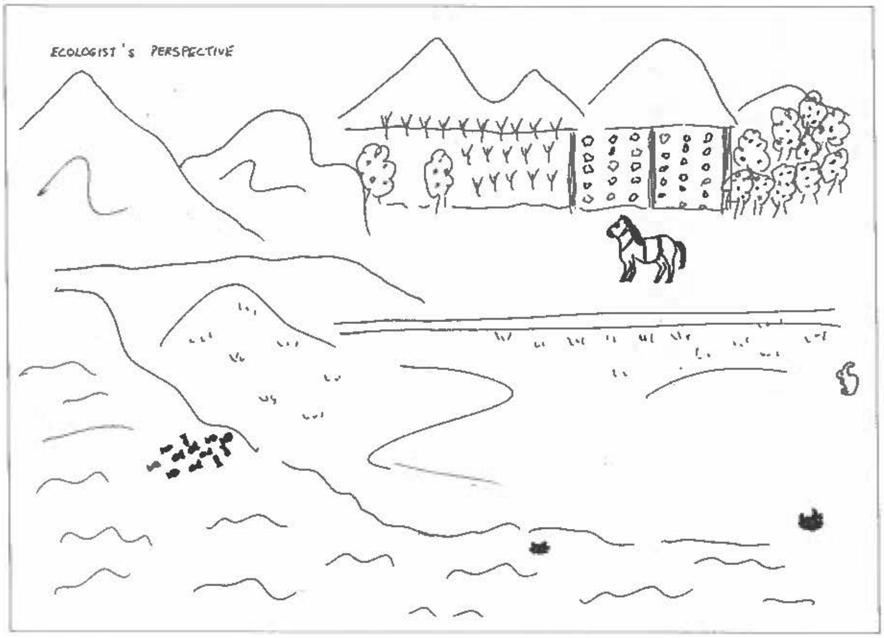
Mediterranean coastal landscapes today are the outcome of a long history of interactions between successive civilizations and nature's resources. The present-day landscape is diverse and complex. The region's fragmented topography, together with climatic conditions, render the landscape unstable, vulnerable to a variety of erosional and mass movement processes. Its ecological, archaeological and historical heritage is immense. The Mediterranean landscape is very much cultural, both in terms of physical manifestations and in terms of associative values. On the one hand, the landscape is a product of millennia of past land uses, both in urban cities and in rural areas. The terracing of slopes for agriculture in the latter is a distinctive feature of the Mediterranean landscape, often accompanied by the construction of traditional dry stone rubble walls. On the other hand, the landscape also has a range of associative values. Mediterranean culture is itself, to some extent, a product of the physical landscape. The tradition of street life in urban areas is a direct result of the physical climatic conditions, just as the distinctive cuisine is likewise a reflection of climate, soils and agricultural practices. The combination of factors, physical and anthropic, endows the region with a particular identity, embodied both in its people and in its physical landscapes. Thus, the term *Mediterranean* conjures up images of olive groves, of traditional irrigation features, of bright sunlight and blue skies, of fertile arable land and a rolling agricultural terrain, of fresh vegetables and fruits, of evening gatherings of women in village streets and of men in local cafes, of impressive fortifications, of street markets, and of a particular way of life.

Mediterranean identity is, however, under increasing threat. The traditional landscape is now being diluted, with insensitive modern developments cropping up adjacent to historical buildings, or large-scale mechanized practices taking the place of traditional agriculture. In some cases, Mediterranean identity is being extinguished completely. There is practically nothing that is characteristic of the Mediterranean in many coastal resort towns today. Taken out of their geographical contexts, these could as easily be located on another continent! Ecological and rural settings are also falling victim to urbanization at a rapid rate, as populations grow and cities likewise expand. At the same time, the pull of urban areas has left rural villages and lands prone to abandonment and neglect, leading not only to a decline in the visual amenity of such areas, but also to increased problems of erosion and mass movement, as retaining features fall into disrepair. Further landscape changes are resulting indirectly from cultural factors. Growing populations place ever-growing demands on water resources in a region that is characterized by aridity. In several areas, this is leading to over-exploitation of aquifers and resultant saltwater incursions, which in turn leads to landscape changes in semi-natural areas and agricultural lands.

*Sketch 6.1*
*Landscape as a cultural construct*



*Sketch 6.1 (cont.)*
*Landscape as a cultural construct*




*Case Example 6.2*
*A study of landscape change in Sardinia*

Sardinia is the second largest island in the Mediterranean. The landscape was evaluated using an approach that is both ecology and anthropology oriented, with the intention of exploring the interactions between natural and cultural processes which have modified the Sardinian landscape. The methodology is based on historical review of published literature. Within Sardinia, the link between man and landscape has strong implications for the island's history. The shortage of both fertile and pastoral land led to antagonism between sheep-farming and agriculture, which in turn contributed to the development of a nomadic and warrior class characterized by a closed mentality and confined to the mountainous inland. Peasants, by contrast, were sedentary and pacific and practiced an archaic type of agriculture close to villages. In the post-war period, Sardinia underwent a rapid shift from rural to urban, with major impacts on culture and on the natural environment. Since that time, Sardinian landscapes have undergone rapid modification. Agricultural improvement has produced the widespread establishment of greenhouses, hence changing rural lowland landscapes. In addition, industrial and residential spread has encroached on fertile land, affecting agricultural ecosystems, while tourist expansion has often destroyed seaside bushland, affecting coastal ecosystems.

Source: Makhzoumi and Pungetti, 1999

*Box 6b*
*Landscape assessment*

Landscape assessment is a term used to refer to a suite of techniques used in landscape management. At one level, landscape assessment provides for a detailed description of landscape, encompassing a variety of physical and anthropic elements, which together contribute towards specific landscape characteristics and character. This may take the form of qualitative description, of quantitative measurement through landscape indices, particularly using Geographic Information Systems (discussed in Chapter 7), or of spatial mapping. In the latter case, elements, characteristics or character may be classified into a series of categories, which are subsequently mapped. Landscape assessment may also include value judgments, particularly in relation to the impacts of a specific development on a landscape. Such judgments weigh the perceived magnitude of landscape change with aspects such as landscape sensitivity, uniqueness, typicality, diversity and conservation interest, to derive a measure of significance.

Against this background, the Mediterranean region urgently requires efforts for the management of its landscapes, particularly in coastal regions which are most severely under threat. Such landscape approaches need to be ecologically founded, culturally informed and sustainably anticipated (Makhzoumi and Pungetti, 1999). Landscape management needs to integrate the rich natural heritage of one of the world's biodiversity hotspots and the cultural heritage of a region which has been inhabited for millennia, whilst tackling the challenges of population growth and of mass tourism, and ensuring economic feasibility. There is no one solution to this immense task. The approach of protected landscapes, discussed further in Chapter 9, is one of great promise. Similarly, landscape assessment and characterization exercises have much utility. Landscape architecture also has many contributions to make, in ensuring compatible and sensitive design. There are therefore several tools that can be employed within a broad sustainable landscape management framework.

*Case Example 6.3*
*Ecological landscape design in Kyrenia Region, Cyprus*

Tourism in Cyprus has increased considerably since its early beginnings in the 1950s, both in physical extent as well as in its contribution to the island's economy. In the past, tourist developments tended to be intensive, extensive in the amount of land used and exploitative of natural and cultural resources. An alternative approach was explored in connection with the Dik Burun project, conceived in the early 1990s and located in the Kyrenia Region of North Cyprus. Three levels of commitment to a sustainable and ecological approach were outlined. The first level involved a passive ecological option, entailing an awareness of the principles of passive solar design and the application of ecological landscape design principles in organizing the site layout. The second is the active ecological option, which targets the design of the development's operational systems, rendering them partially or totally autonomous, with the aim of lowering over-use of natural resources. The third option addresses the social and cultural aspects of tourism, targeting harmonious social and cultural integration with the local community, and highlighting the need for an understanding of the host people, their culture and traditional way of existence. This latter option also includes the tourist industry's active financial support of landscape protection and heritage interpretation. The landscape design for the Dik Burun project thus attempts to accommodate the requirements of the programme of facilities, whilst taking into consideration the environmental, ecological, aesthetic, economical and socio-cultural context of the site.

Source: Makhzoumi and Pungetti, 1994

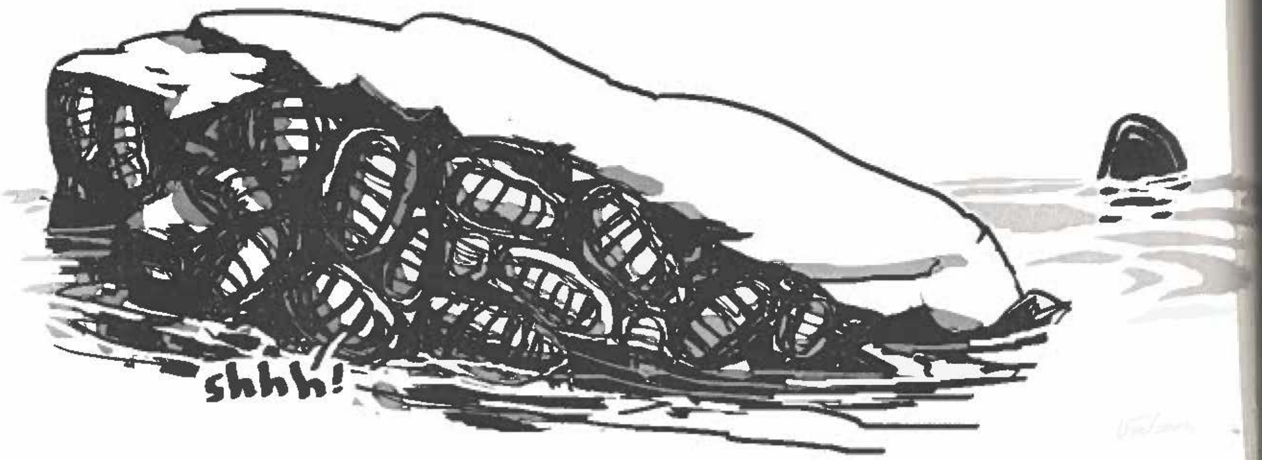
*Case Example 6.4*
*Landscape characterization of the Tunisian coast*

*Landscape Character Assessment* (LCA) is defined as a set of techniques and procedures to map the differences between landscapes, based on their historical evolution and physical characteristics (Griffiths *et al.*, 2004). The methodology was applied by UNEP in order to derive a characterization of the Tunisian coast. Tunisia has a great variety of coastal landscapes that reflect differences in biophysical conditions and cultural heritage. At the same time, coastal landscapes are under significant threat from a variety of pressures, including tourism, urbanization, pollution and over-exploitation of resources. The derivation of Landscape Character Areas was made on the basis of hierarchical levels within a spatial framework, with landscapes first being characterized into physiographic units from contour and geological data, and then being further sub-divided by soil type and cultural aspects. The exercise served to develop a series of landscape character maps for Tunisian coastal areas, as well as to identify threats to landscape character and to formulate management recommendations.

Source: Vogiatzakis and Cassar, 2007

Kendle *et al.* (2000) identify two primary perspectives within sustainable landscape management. The first explores the environmental impacts of inputs and activities (with relevant techniques described further in Chapter 8), whilst the second necessitates a better understanding of outputs and values of landscapes and of the management process. It is the latter which has perhaps been most lacking in landscape management efforts to date. Piecemeal assessment of environmental impacts of individual developments is not sufficient at a landscape scale, although it is a necessary component of coastal and environmental management. It needs to be accompanied by wider scale approaches, ranging from Strategic Environmental Assessment (described further in Chapter 8) to methodologies focusing on anthropic and social aspects. The Mediterranean has unique potential in this regard. The strong ties between Mediterranean people and Mediterranean lands may be the strongest force available for conservation efforts. Environmental management, both at the coast and elsewhere, needs to focus on maintaining the integrity of ecological and physical processes whilst safeguarding the traditional Mediterranean identity, potentially using landscapes as a unit of analysis. People can identify with the landscapes they have known throughout their lives, and cultural pride can be a strong motivator for efforts to maintain the traditional interactions that resulted in the region's unique landscapes. There is also much potential for economic exploitation of such cultural ties, through the marketing of the Mediterranean as an ecotourism and cultural tourism destination. Mediterranean landscape management should, however, ideally encompass both local, national and regional efforts, with pan-Mediterranean agreements to safeguard the heritage common to all the nations on its shores. To date, landscapes are addressed only indirectly in other Mediterranean-wide environmental policy initiatives.

The challenges of managing landscapes relate primarily to the factor of change. Landscapes evolve before our very eyes, and landscape management is not equivalent to the preservation of landscape as state rather than process. Had our ancestors halted the evolution of landscapes in order to maintain these in an ideal static form, we would not have the heritage that we have today. The difficulty lies in identifying where the dividing line lies between sustainable change and complete alteration of character. This is rendered even more complex by the fact that the cultural aspects of landscape also evolve. How we perceive landscape depends also on our personal circumstances, and societal values of landscape are not fixed. The task for managers therefore lies in managing the physical and perceptual aspects of landscape, whilst preserving both its identity and its potential for dynamic evolution. Such an effort cannot be undertaken by a few landscape specialists. It is an effort that requires integrated inputs from many disciplines, together with the extensive involvement of stakeholders in a proactive process that is designed to build on the past, without destroying it, in a collaborative effort, to shape a sustainable future.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# CHAPTER 7
# Geographic Information Systems and Remote Sensing

*There are three principal means of acquiring knowledge...observation of nature, reflection and experimentation. Observation collects facts; reflection combines them; experimentation verifies the result of that combination.*

Denis Diderot, 1713-1784

## Introduction

Maps have been an integral part of human societies every since the early days of civilization, pre-dating the written word. Some form of graphical representation of the Earth on a flat surface is known to have existed in ancient societies of Europe, the Middle East, China, India, and others. A Geographic Information System (GIS) is, however, far more than simply maps. Perhaps the closest historical equivalent dates to 35,000 years ago, when on the walls of caves near Lascaux, France, Cro-Magnon hunters drew pictures of the animals they hunted. Associated with the animal drawings are track lines and tallies thought to depict migration routes. In a primitive form, these drawings incorporated the two principal elements of a GIS, combining spatial images and attribute data. The utility of the GIS concept was also evident historically, before its metamorphosis in modern technology. In 1854, John Snow depicted a cholera outbreak in London, using points to represent the locations of some individual cases. His graphical results made it possible to identify the source of the disease, a contaminated water pump. These early predecessors of GIS revolutionized the concept of maps, using them not only for spatial representation but also for spatial analysis.

Modern uses of GIS concepts have their origins in the field of planning. In 1912, the geographic extent of the Germany city of Düsseldorf was mapped at different time periods, and maps for traffic circulation and land use were prepared for Billerica, Massachusetts. By 1922, these concepts had been refined to the extent that a series of regional maps were prepared for Doncaster, England, which showed general land use and included contours or isolines of traffic accessibility. Similarly, the 1929 *Survey of New York and its Environs* clearly shows that overlaying maps on top of each other was an integral part of the analysis, in this case of population and land value (Clarke K.C., 2001). Subsequent years saw further elaboration of these concepts, together with the development of computer hardware, building up to a full-blown GIS industry from the 1970s onwards. The technology continued to evolve throughout the remainder of the 20th century, as the utility of GIS was recognized in a variety of applications, including the context of environmental management.

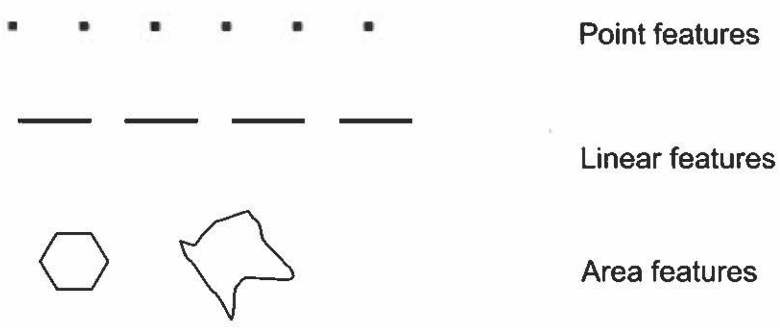
Meantime, with the invention of photography in 1826, the scene was set for the development of remote sensing technology. One of the first to introduce the idea of observing phenomena from a distance was Gaspard Felix Tournachon, who in 1859, took to the skies in a hot air balloon and proceeded to photograph his surroundings. Half a century later, the Wright brothers provided the technology for a more sophisticated approach to distance observation, with their invention of the airplane. It was, however, the World Wars in the 20th century that provided a major stimulus for the development of remote sensing technology, fuelled by military demands. There thus began a systematic search through the radiation spectrum and into the realms of acoustical, chemical, gravitational and radioactive energy, to discover fresh means whereby aspects of natural and cultural environment might be investigated. It was in 1960 that reference was first made to 'remote sensing', and since that time, particularly with the dawn of the satellite era, and with rapid advances in space exploration, the technology has evolved significantly, as has the spatial scope of application. As with GIS, the potential of remote sensing for a suite of different environmental applications was rapidly recognized.

This chapter outlines some of the basic concepts of GIS and remote sensing, highlighting the possibilities and constraints for use in coastal management applications.

**Basic concepts of GIS**

The term GIS has been defined, in many ways, by many individuals and organizations. Common to all definitions is that one type of data, spatial data, is unique, because it can be linked to a geographic map (Clarke K.C., 2001). GIS involves three principal components, namely 1) a database with attribute information, 2) spatial or map information, and 3) a means to link the two together. The components are linked through systems of computer hardware and software, which enable not only the input of data, but also its manipulation and transformation. GIS is thus both a storage and an analytical tool. In the latter capacity, it can be used to provide answers to specific queries or problems, such as the ideal location of a nature reserve, the proximity of incompatible land uses, and contingency planning or environmental emergencies. We can use GIS to attempt to solve problems, by analyzing situations, querying data or experimenting with possible solutions.

*Figure 7a*
*GIS feature categories*




A key element in GIS is geo-referenced data. Information provided about a feature is related to a location on a map within a standard world reference system of coordinates. In addition to information about where a feature is located, the GIS contains other information about the feature itself, depending on what application it is being used for.

This constitutes the attribute data. There are three kinds of features in GIS, namely point, linear and area features. A point feature is correlated to a geographic location but has no significant areal extent. A borehole may thus be mapped as a point feature, and linked to attribute data such as water quality parameters. Linear features are one-dimensional, and can be described by a line joining a series of points of known location. Roads are one example of a linear feature in GIS. Area features include two-dimensional space and real extent, and examples include plots of land.

The GIS process includes five main stages. During the first **input** stage, source data is inputted into the system. In some cases, spatially referenced GIS-compatible digital maps may be readily available, but in other cases, paper maps must be converted into a suitable digital format, through the process of digitizing. The two broad categories of digital data used are raster and vector. Each has its advantages and disadvantages. Advanced technology can today allow for automation of the digitization process through large scale scanning, although automated input sometimes presents problems during subsequent editing stages. Manual digitizing of paper maps is often done in the case of smaller jobs. The first stage also includes inputting of attribute data related to point, linear and area features. The process of data input can be time-consuming and expensive and it is thus important that the goals of the analysis are defined at the start, so that any data entered is of relevance and good quality.

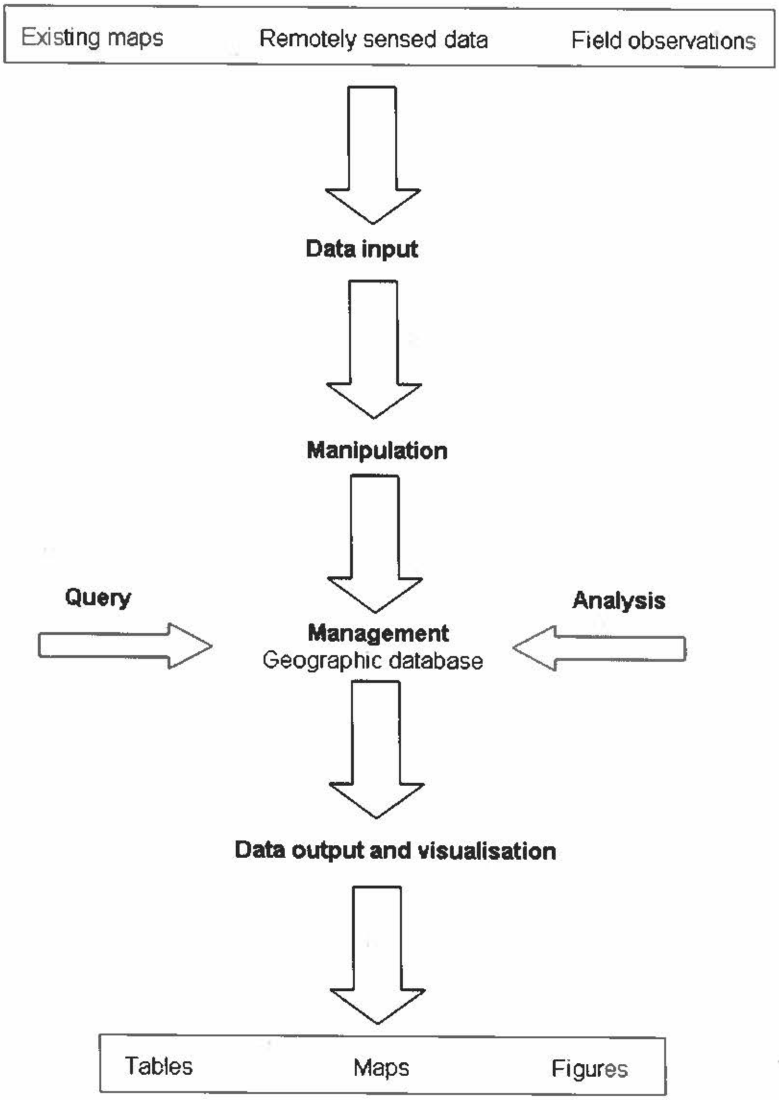
The second stage is that of data **manipulation**. It is likely that data types required for a particular GIS project will need to be transformed or manipulated in some way to make them compatible with the system. Scales of different layers of spatial data may need to be adjusted, or attribute data may need to be standardized. Data transformations can be temporary, for display purposes, or permanent, for analysis purposes. GIS software packages today offer many tools for manipulating spatial data and for weeding out unnecessary information. During the manipulation stage, data layers may also be combined to show regions with specific attribute combinations, thus creating new layers.

During the third stage of **management**, data stored within a GIS is organized through the use of a database management system (DBMS). This is particularly important where large volumes of data are involved. Typically a DBMS contains routines for data input, verification, storage, retrieval and combination. There are many different designs of DBMS, but in GIS, the relational design has found most favour. In this design, data are stored conceptually as a collection of tables, with common fields in different tables being used to link them together. The relational design has the advantage of being flexible, and thus amenable to a wide range of applications, both within and outside GIS.

The fourth stage is that of **query and analysis**. Once the GIS is set up, with all data appropriately manipulated and managed, the system can now be used to answer specific questions. These can relate to several categories, including:

- Identification (e.g. what is at a particular location?);
- Relative importance (e.g. what is the dominant soil type in an area?);
- Location (e.g. where can habitats of a species be found?);
- Proximity (e.g. what features are located close to each other?);
- Trend (e.g. which features have changed over time?);
- Pattern relation (e.g. what are the interactions between soil type and crop yield?); and
- Forecasting (e.g. what will happen if there is a change in the extent of urban coverage?).

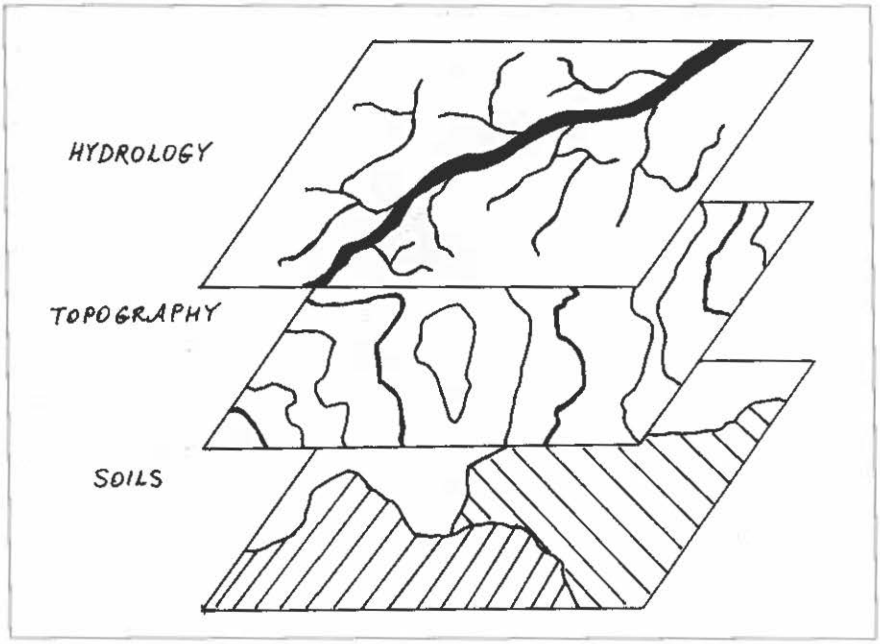
*Figure 7b*
*The GIS process*



A GIS can respond to such queries by presenting data in views within the software, and allowing the user to interact with each view. Modern software systems have many powerful analytical tools, but two are especially important, namely proximity analysis and overlay analysis. In the former, the GIS can be used to quantitatively assess the relation between features, such as the proportion of a population living within 10 kilometres of the coast. Through attribute data, the qualitative characteristics of the population within that spatial area can also be evaluated. Overlay analysis involves the integration of different data layers. The idea dates back to 1969, when Ian McHarg used blacked-out transparent overlays to assist in finding locations in New York's Staten Island that were solutions to multiple siting control factors (Clarke K.C., 2001). The same idea can be applied in a wide variety of contexts, for instance to integrate data on soil, slope, vegetation, land ownership, settlement, and so on.

The fifth and final stage of the GIS process involves **visualization**. For many applications, the results of a GIS analysis are best presented as graphical images such as maps or graphs. Nowadays, the visualization possibilities offered by GIS include not only two-dimensional representations but also three-dimensional images. GIS visuals also have advantages over traditional paper map representations, in that they are fully interactive, allowing the user to move in and around the display, or to modify aspects of the image.

*Sketch 7.1*
*The concept of overlay analysis in GIS*



## Basic concepts of remote sensing

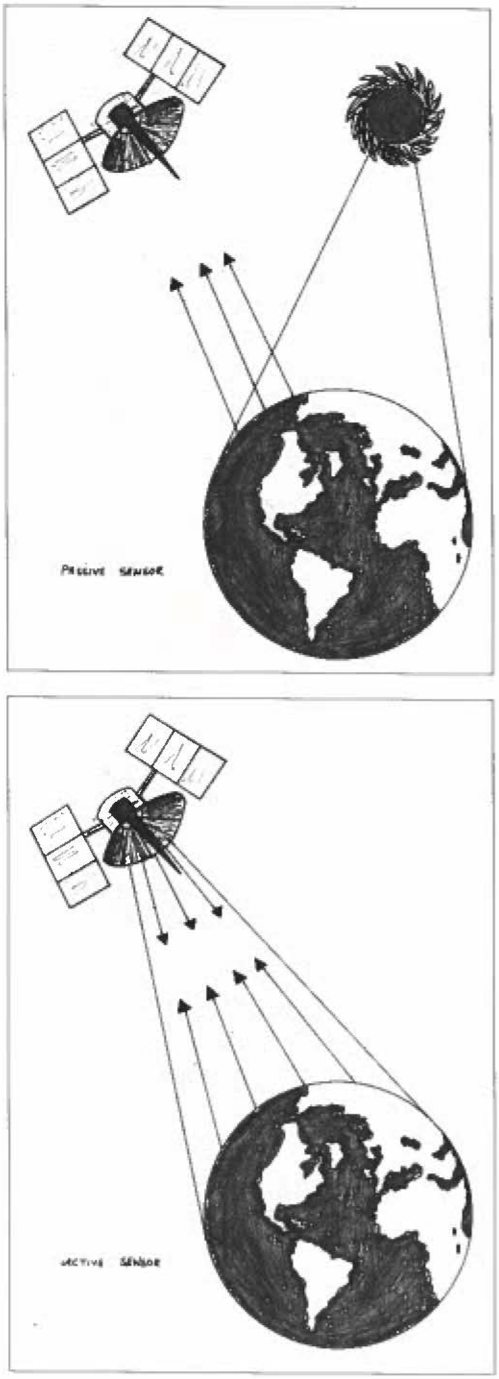
Remote sensing can be simply defined as the science of observation from a distance (Barrett and Curtis, 1992). More specifically, it has come to refer to a suite of techniques used for the collection of information about the earth's surface and lower atmosphere from a distance above. This is done largely through the use of a sensor mechanism, fixed some height above the ground, and used to detect and record radiation which has been reflected or emitted from the earth's surface.

Remote sensing platforms are today most commonly aircraft or satellites. There are two main kinds of remote sensing mechanisms. Passive sensors detect natural radiation that is emitted or reflected by the object or area being observed. Reflected sunlight is the most common source of radiation involved in passive remote sensing, and is captured by sensors such as photographic film and radiometers. Active remote sensing involves the emission of energy in order to scan objects and areas, with a passive sensor then detecting and recording the radiation that is reflected or backscattered from the target. One of the most commonly used examples of this technology is RADAR, where the delay between emission and return of radiation is used to establish the location and characteristics of the target. There are thus four basic components of a remote sensing system: the sensor, energy source, transmission path and target.

The physical basis for remote sensing is the electromagnetic spectrum, with electromagnetic energy being the medium for transmissions between sensor and target. Electromagnetic energy, or radiation, is one of the many forms of energy, and can be generated by changes in the energy levels of electrons, acceleration of electrical charges, decay of radioactive substances, and the thermal motion of atoms and molecules. The fundamental principle of electromagnetic energy that is used in remote sensing is that different objects return different types and amounts of radiation. Thus different land cover categories, such as vegetation, water and soil, will absorb and reflect energy differently in different parts of the electromagnetic spectrum. The objective of remote sensing is to detect these differences, making it possible to identify and assess a broad range of earth surface features.

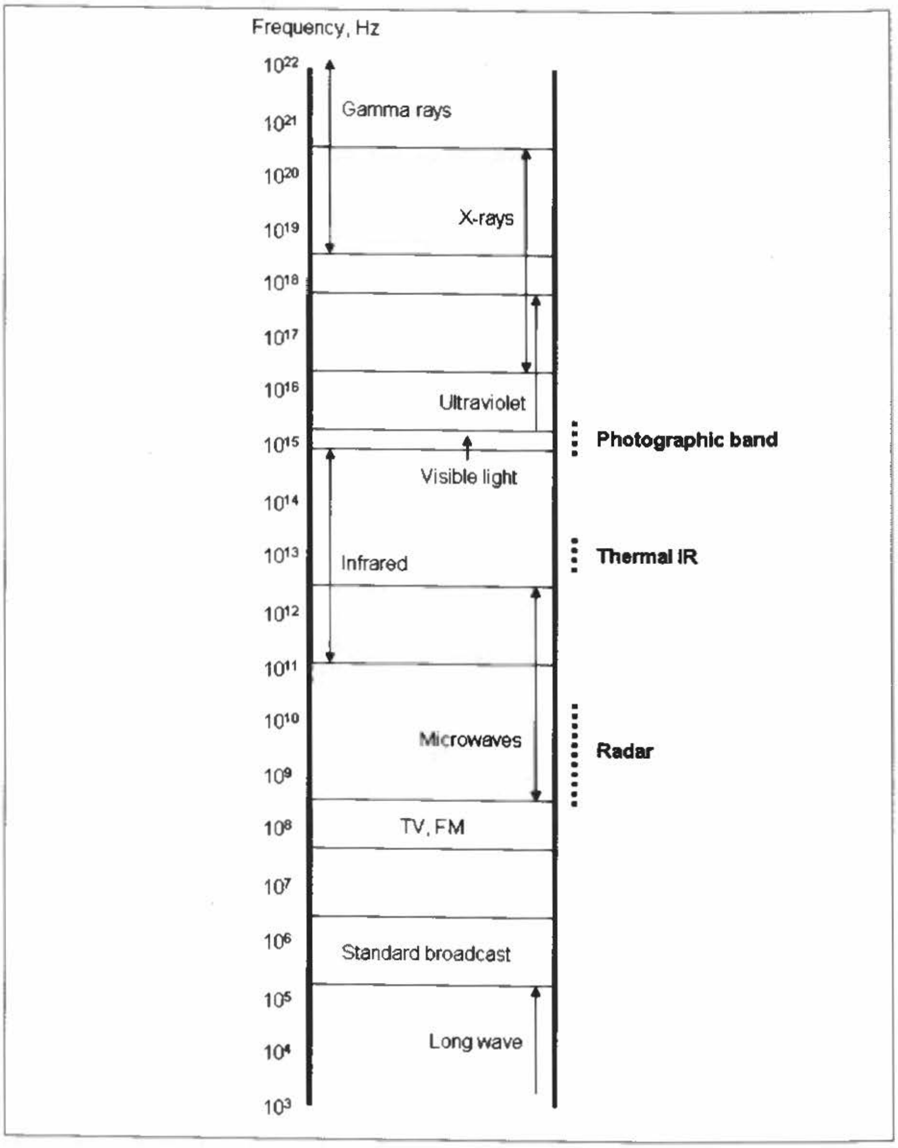
The electromagnetic spectrum represents the continuum of electromagnetic energy from extremely short wavelengths to extremely long wavelengths, and is arbitrarily split into a number of divisions. Not all parts of the electromagnetic spectrum can be utilized in remote sensing, as some types of radiation are entirely absorbed by the atmosphere. Much remote sensing work involves visible wavelengths, infra-red energy and microwaves. Different remote sensors are used for different parts of this range, and the different bands also have particular advantages for specific applications. Remote sensing within visible wavelengths, for example, gives images with a familiar appearance, most useful for topographic mapping of terrain and landscape features. Infra-red, on the other hand, has the advantage of being detected at night or through cloud cover, and is ideal for applications related to surface temperature variations.

Some multispectral sensors can detect several parts of the spectrum simultaneously thus providing more data than sensors that only record a single spectral band.



*Sketch 7.2*
*Types of remote sensors*

*Figure 7c*
*The electromagnetic spectrum and bands used in remote sensing*




Adapted from Kemp (1998) and Sabins (1978)

Much remote sensing is today carried out using satellite technology. The first meteorological satellite, TIROS-1, was launched by the United States in 1960. This early weather satellite used vidicon cameras to scan wide areas of the Earth's surface. Most present-day earth observation satellites are in orbit between 800 and 1000 kilometres above the earth, and pass over different parts of the Earth's surface in the course of their orbit, as the earth rotates beneath them. From their high vantage point, satellites have a greatly extended view of the Earth's surface, enabling the collection of more data in a more rapid manner. It often takes many hundred aerial photos to cover the same spatial extent as a single satellite image. In reality, however, sensors tend to be switched off for much of the time to avoid collecting huge amounts of data which may never be used and which require large amounts of storage space. Of particular importance for earth observation today are the Landsat satellites, which began to be deployed in the 1970s. The multispectral scanners (MSS) on these satellites have now been providing continuous coverage of the Earth for over 30 years. Other satellite systems launched for remote sensing purposes include the French SPOT (*Satellite Pour l'Observation de la Terre*) and the Canadian Radar-Sat 1.

*Box 7a*

*Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+)*

The Landsat Thematic Mapper (TM) is a sensor carried onboard Landsats 4 and 5, and, together with the Enhanced Thematic Mapper + (ETM+) carried onboard Landsat 7, has acquired images of the Earth nearly continuously from July 1982 to the present, with a 16-day repeat cycle. Image data from the Landsat Thematic Mappers consists of seven spectral bands, ranging between wavelengths of 0.45 and 2.35 micrometers. Six spectral bands acquire Earth reflectance data, and one acquires Earth temperature data. The spatial resolution of images varies between the different bands. To date, the Landsat TM and ETM+ sensors represent the most sophisticated sensors to provide Earth observation data, with multispectral capabilities providing comprehensive sets of data for land and water surface mapping, monitoring and analysis.

Source: NASA, 2007

Two key considerations in remote sensing are scale and resolution. The scale at which remotely sensed data is presented affects the areas covered, and the amount of information which can be shown. It also affects the resolution, or level of detail, of images obtained. The scale of data is related to the distance of the sensor platform from the target. The higher above the earth a sensor is placed, the greater the area it covers. This area is however, represented at a smaller scale. Standard scales for LANDSAT images are 1: 250,000 to 1: 1 000,000. As an indication, in the latter case, 1 centimetre on the image is equivalent to 1,000,000 centimetres on the ground. Resolution, though related to scale (with smaller scale images generally having higher resolution), is also affected by characteristics of the sensor. Resolution is effectively a measure of detail, and aerial photos tend to have higher resolution, and better detail, than distant satellite images. Scale and resolution have implications for the applications to which remote sensing is put. Where detailed information about relatively small areas is required, then high resolution is the priority, whereas when large scale information over an extensive area is used, scale may be a more important consideration.

However, a variety of images can also be used in combination. An example is the use of air photos to verify information from satellite images.

Remotely sensed data is one important data source for GIS. Data can be entered manually, but digitally inputted data can also be analysed directly in GIS through a process of digital image classification. In the latter, spatial patterns may be detected by comparing results from one pixel with surrounding pixels, whilst temporal patterns may be detected by comparing images taken at different times. Most GIS software packages also allow the integration of remotely sensed data with other spatial data layers from other sources, thus enabling verification of data and further analysis. Remote sensing data can also be used to enhance the accuracy of topographical digital elevation models (DEMs) in GIS.

**Applications of GIS and remote sensing in coastal management**

Both GIS and remote sensing have a multitude of valuable environmental applications. Broad categories within which these technologies are used include observation, monitoring, detection of change, comprehensive data analysis, site selection, impact assessment, as well as contingency planning. Whilst remote sensing provides a wealth of data, that could only be acquired with significantly more time and effort through the use of other means, GIS provides the capability to use this and other data for several ends. It allows planners and managers to weigh different scenarios and to make trade-off decisions concerning resource allocation. It allows rapid and easy update of data. With the advance of technology, GIS analyses have also been rendered very cost effective, although remote sensing images still involve substantial costs in acquisition. A key advantage of both technologies in the environmental field is the visualization of results, often rendering communication of data to a non-technical audience much easier.

The data requirements of coastal managers are various and complex. Attempting to manage multi-faceted and dynamic systems requires tools, such as GIS, that enable integration of a variety of data inputs. In many ways, GIS provides a technical means for implementation of inter-disciplinary approaches. Although the synthesis of different disciplinary perspectives has long been advocated in theory, this has often been difficult to implement in practice. With GIS technology, the pedologist's soil map can now be analysed in conjunction with the demographer's population map, and with the maps produced by ecologists, hydrologists, geologists and so forth. GIS is thus one important tool in providing the *integrated* element of Integrated Coastal Area Management.

The utility of GIS and remote sensing technologies in coastal management also relates to the rapidity with which data can be provided over large scales. Satellite remote sensing can, for instance, provide measurements of shoreline change across entire regions in response to storm erosion with little effort over a matter of days. Achieving an equivalent result through conventional ground surveys would require huge efforts and resources. Rapid availability of good scientific data is of importance particularly where urgent action may be needed. Such technologies are therefore invaluable for applications such as risk management and contingency planning (Box 7b). The measurement of change, both spatial and temporal, is also of great utility given the inherently dynamic nature of coastal systems, where the extent, shape and orientation of features can be expected to change regularly on a short-term basis. The use of remote sensing and GIS technologies thus enables the provision of data for larger areas more rapidly, facilitating implementation of ecosystem management and landscape approaches.

*Case Example 7.1*
*Using remote sensing to detect agricultural encroachment on coastal dunes of Turkey*

The contemporary state of Mediterranean land cover is a constantly changing mosaic of cover types, determined by both the physical environment and human activities. The aim of this study was to develop an effective procedure for detecting changes in land use and land cover resulting from agricultural encroachment on coastal dunes in the Tuz lagoon in Turkey. Historic land use and land cover information was extracted from aerial photos taken in 1976, and satellite imagery was acquired in 2002. The aerial and satellite data were integrated using a variety of image processing techniques. Results indicate dramatic changes in land cover and land use over the 26-year period, with destruction of 94% of bare sand dunes, and 30% of dune vegetation. Meantime, the agricultural land area increased substantially. Differences also appear to have arisen due to coastal erosion, possibly linked to upstream damming.

Source: Berberoglu *et al.*, 2003

GIS also has a valuable predictive capacity. Coastal management is very often concerned with interventions, of one form or another. GIS offers the possibility to assess the likely outcome of certain management interventions before these are actually implemented, thus providing the ability to test the likely feasibility of a management option. With advances in computer technology, complex simulations are becoming possible that enable predictions of the future on the basis of many complex data parameters. Such capacities are of growing importance, not only because we can ill afford to make mistakes in our management interventions, but also because coastal managers increasingly need to address aspects of global change. Although predictive scenarios should be treated as such, rather than as fact, at the very least they provide important indications of future changes that management may need to accommodate.

*Case Example 7.2*
*Use of GIS to predict potential erosion areas in a Mediterranean watershed*

Erosion is a major environmental problem in several areas of the Mediterranean. In this study, Geographic Information Systems were used to establish an information base, enabling the characterization of the Olynthos watershed in northern Greece. Source data inputted into the system included topographic, geologic, soil, vegetation, climatic and orthophoto maps, together with black and white aerial photos. The data was then used to locate potential erosion areas, using proximity analysis and modelling. The model was developed mathematically, by summing the coincidences of maps in different layers, to give a final map with low to high values. Areas of lowest erosion potential were under forest, whilst areas of highest vulnerability included agricultural areas and mixed maquis. Such results can provide the basis for implementation of control and preventive measures according to the degree of erosion risk.

Source: Belaid and Karteris, 1995

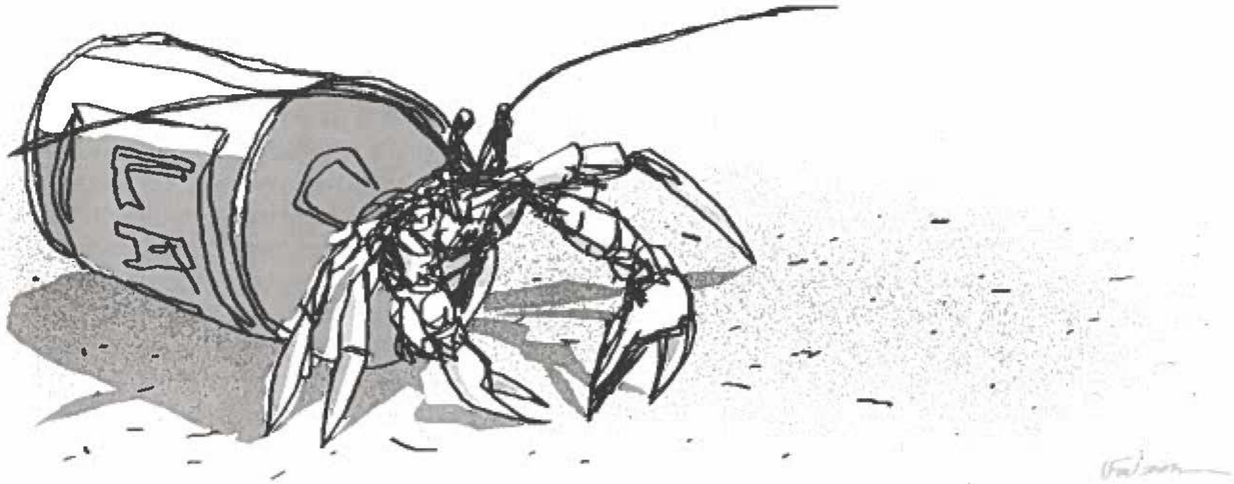
Despite the numerous strengths, it is also important to acknowledge the constraints of technologies such as GIS and remote sensing. They are valuable tools in coastal management, but they should not be considered to be the only tools. For one thing, there is much important data, particularly socio-economic data, which cannot be easily rendered spatially. The intangible cultural and spiritual values of a site to stakeholders are a case in point. Furthermore, the applications of such technologies are often constrained by technical factors, such as the length of time required for digitization of maps, or the poor quality of existing hard-copy data. The outputs of GIS are only as good as the quality of the inputs into the system. The technologies also require considerable expertise, particularly remote sensing. Such expertise may not be available everywhere, yet coastal management still needs to be done. The problem with GIS and remote sensing may also be data overload, as too much information can provide challenges for management, just like too little information can. There are also issues with the cost of setting up GIS technology and the purchase of remotely sensed images.

The key point about the use of such technologies in coastal management is therefore the need for wise management decisions, as to the advantages and disadvantages of their use in different contexts, as well as the need to ensure that any applications are carried out well, and that results are used prudently. GIS is not a panacea but it is certainly a valuable analytical resource. As additional tools in the coastal management toolkit, GIS and remote sensing have much potential to simplify the formidable tasks of coastal managers and to test-drive management decisions. At the same time, it must be borne in mind that coastal systems go beyond what can be physically monitored, measured, and mapped, and scientific technologies must therefore be complemented by appropriate socio-cultural analyses, in order to achieve a thorough and holistic understanding of the coastal zone.

*Box 7b*
*Remote sensing and surveillance of marine oil spills*

Remote sensing is a critical element for an effective response to marine oil spills. Timely response to an oil spill requires rapid reconnaissance of the spill site, to determine its exact location and extent of contamination. Predictions also need to be made on the basis of physical and meteorological conditions as to the likely movements of the slick. This is necessary in order to make the most effective use of remedial measures, such as containment booms and application of dispersants. Remote sensing is able to provide essential information to enhance strategic and tactical decision-making, decreasing response costs by facilitating rapid oil recovery and ultimately minimizing impacts. Remote sensing of marine oil spills can be undertaken by plane or helicopter. Satellite-based remote sensing systems can also detect oil on water, although non-radar systems require clear skies. To date, the operational use of satellite imagery for oil spill response has remained limited, because of limited spatial resolution, slow revisit times, and long delays in the receipt of processed images. However, satellite imagery, used in conjunction with aerial images obtained from helicopters or planes, can help provide a wider picture of the extent of pollution. There is also hope that remote sensing technology can provide solutions for dealing with oil spills in situations that are technically challenging, such as in dealing with oil trapped under, or in, ice. Developments such as ground-penetrating radar have much potential in this regard. There is also potential in infra-red technology to develop means of detecting the thickness of spilled oil on water.

Source: MMS, 2007



# CHAPTER 8
# Environmental Assessment

*There is nothing in which the birds differ more from man than the way in which they can build and yet leave a landscape as it was before.*

Robert Lynd, *The Blue Lion and other essays*, 1923

## Introduction

Oftentimes we focus our attention on the negative impacts that human activities have on the surrounding natural environment. Whilst recognition of pressures and threats is important, we likewise need to focus our attention on appropriate responses. The human population is not going to stop growing any time soon, nor are radical changes in lifestyle forthcoming in the short term. Environmental managers must therefore seek to do the best they can to minimize and mitigate the negative impacts of anthropic activities on the surrounding environment, within mainstream political and economic frameworks. Environmental assessment is a critical tool in this mission.

Environmental assessment has its origins in the practice of cost-benefit analysis (CBA). The focus of CBA was limited to the assessment of economic characteristics of a particular project, and attempts to render environmental aspects in monetary terms were limited at best. The practice of CBA, though appropriate to engineering and economic perspectives, was thus insufficient for environmental applications. The foundations for an alternative approach were laid with the passage of the National Environmental Policy Act (NEPA) in the USA in 1969. The aims of NEPA were several, and included the safeguarding of the environment for future generations, the balancing of a wide variety of land uses whilst maintaining environmental quality, and the minimization of impacts on non-renewable resources. The significant milestone with NEPA was the requirement that proposed projects and policies be accompanied by an Environmental Impact Statement (EIS), which was required to comprehensively evaluate likely impacts on the environment, the minimization of adverse impacts, and the proposal of alternatives. This symbolized not only a new commitment to environmental protection but was also a vote of confidence in the use of science for planning and decision making (Sadler, 1996). Furthermore, the Act gave the public who were interested in environmental issues a statutory right of participation in the planning and appraisal of major development projects in which the US Federal government had a role. This established an important precedent for formal public participation mechanisms.

Today, environmental impact assessment (EIA) has come a long way from the days of NEPA. The scope of EIA has broadened to include not only direct impacts on the natural environment, but also indirect impacts and the cumulative effect of impacts over time and space. The concept has also been applied to other fields that are not directly environmental, but that have implications for the environment, such as social impact assessment (SIA). The shortcomings of early EIAs were in fact often related to their biophysical bias and inadequate consideration of social elements. EIA has therefore become increasingly multidimensional, and its practitioners now have many sophisticated analytical techniques at their disposal that were not in existence at the time of NEPA. The concept of environmental assessment has also been expanded beyond the level of an individual project, to include the environmental implications of large-scale policies and plans, through strategic environmental assessment (SEA). Environmental assessment has thus evolved into a tool that has an important role to play in the pursuit of sustainable development. This chapter introduces the basic principles and elements of the EIA process, as well as related developments of SIA and SEA.

**Stages in environmental impact assessment**

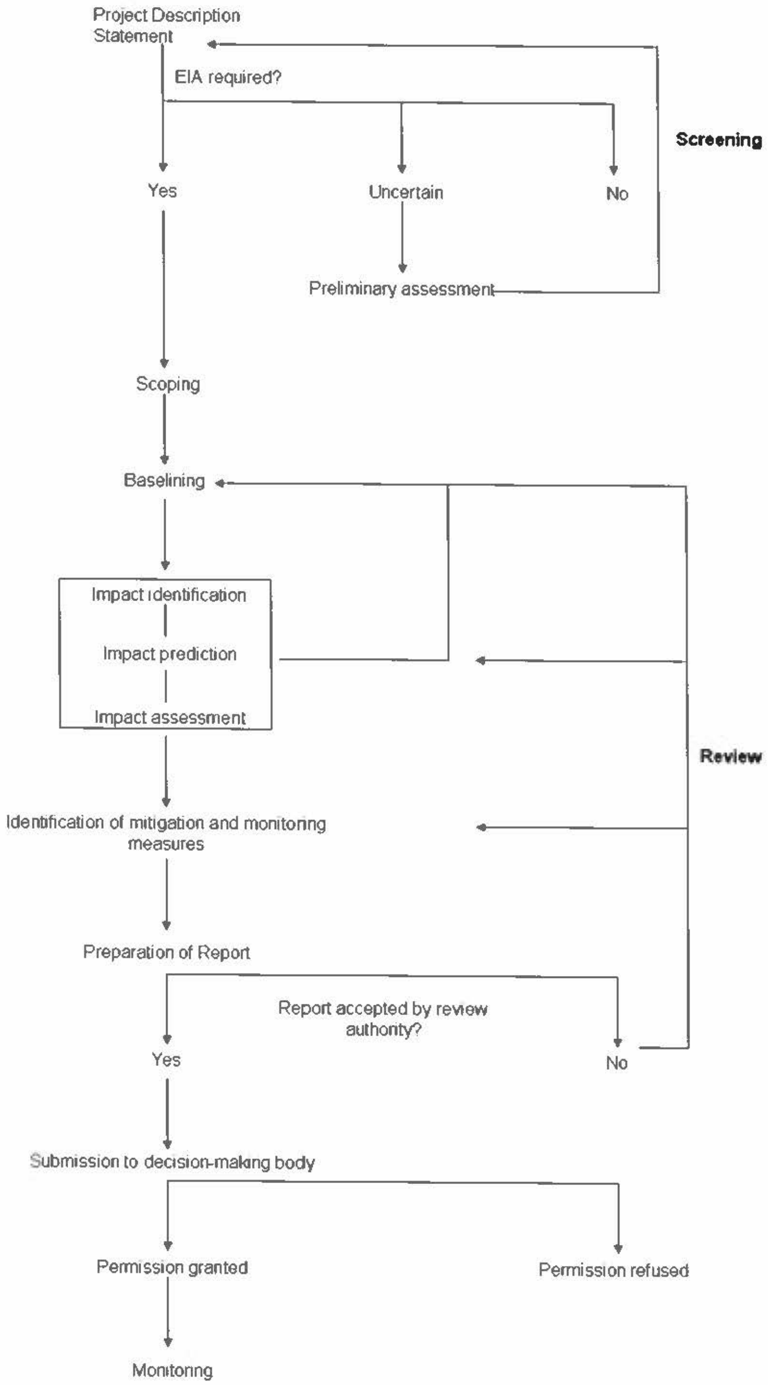
The main objective of an EIA is to provide decision-makers with an account of the implications of proposed courses of action before a decision is made (Clarke, 2001). Specifically, an EIA determines the potential environmental social, economic and health impacts of a proposed development. The formulation of an Environmental Impact Statement (EIS), the documentary outcome of an EIA, is based on a number of discrete stages.

When a development proposal is first submitted to a planning agency, this undergoes **screening**. Screening is the process of deciding whether or not the actions proposed are likely to have significant enough impacts to warrant a detailed assessment. It is thus the stage at which a decision is made to identify proposals which warrant an EIA and those that do not. In some legal systems, the screening process also distinguishes between different projects that require an EIA, restricting the scope of the assessment in cases where impacts are likely to be more limited.

The screening process should follow systematic and clearly defined criteria that are applied in a similar way to all development proposals. The outcome of the screening process will depend on the sensitivity of the environmental systems in question, on the magnitude, complexity and nature of the development being proposed, and on the likelihood and severity of potential impacts.

Once it has been determined that an EIA will be conducted, **scoping** is carried out in order to identify the main issues that the assessment will need to address. This is a means of ensuring cost-efficiency by prioritizing those issues of most concern. EIAs are practically always carried out under constraints of time, money and resources. It is therefore important to focus attention on those issues of greatest relevance and concern. The scoping stage is when the tentative boundaries of an EIA are first established. The conclusions of scoping are used as the basis for the definition of Terms of Reference, which guide the remainder of the EIA process. Scoping should ideally be carried out with the involvement of stakeholders, as these are likely to be familiar with the environmental systems in question, and can hence identify priority areas for study. Involvement of stakeholders in scoping can also ensure that any public concerns are fully addressed in the EIA.

*Figure 8a*
*The EIA process*



The screening and scoping exercises are generally carried out on the basis of a detailed **project description**. A project description should comprehensively describe what the proposed development would entail, in terms of footprint, physical characteristics, raw materials, operating processes, wastes and architectural design. It should also detail the economic, social and political objectives of the proposed development, as well as its likely financial feasibility. The state of the site pre-development should also be outlined, with particular reference to present land uses. In the preparation of an EIS, alternatives to the development being proposed should be actively considered. These may include alternative sites, processes, technologies, structures and materials, amongst others. Conclusions should be established regarding the preferred options, and the justification for such conclusions should be clearly provided.

On the basis of Terms of Reference provided by management authorities, **baselining** is then carried out, to study specific aspects of the existing physical, biological, chemical and/or social environments which could be affected by the proposed development. Baseline studies provide a measure or description of state, against which predicted impacts may be assessed. Although baseline studies are carried out at an early stage in the process, further baseline data may also be required at later stages, particularly when the prediction of impacts is being refined. The specific requirements of the baselining stage depend on the specific aspects being addressed. Ecological surveys can require significant resources, particularly where the baseline environment needs to be assessed during different seasons. In other cases, it may be possible to make extensive use of existing studies and literature, thus reducing resource requirements.

Once baseline studies have been completed, the EIA process proceeds to the **identification, prediction, evaluation and assessment of key impacts**. Clarke (2001) defines an impact as a change in an environmental parameter, over a specific period and within a defined area, resulting from a particular activity, compared with the situation which would have occurred had the activity not been initiated. The key challenges of impact assessment relate to the likely magnitude of impacts, and their expected significance. The determination of magnitude and significance are often complicated by the difficulty of establishing firm cause and effect relationships in environmental systems. Furthermore, available information, based on feasible methods of measurement, is invariably limited, and may be unable to account for external factors producing changes from baseline conditions. With some parameters, mathematical prediction of impact magnitude may be possible. Often however, determination of magnitude is based on best judgment with respect to clearly defined criteria on the basis of knowledge systems to date, and thus must be interpreted with allowances for some level of uncertainty. Evaluation methods to establish significance are likewise far from rigid. They range from qualitative to quantitative, with a diversity of combinations in between. Wherever possible, determination of impact significance should be based on objective, replicable criteria. However, judgments for aesthetic, cultural and social factors also inevitably include an element of personal bias, despite practitioners' best efforts. The guiding best practice therefore needs to be one of ensuring that judgments are as objective as possible and that any subjectivity is suitably informed by scientific knowledge and made explicit and justified in the EIA.

*Box 8a*
*Dimensions of environmental impacts*

- Temporal nature (continuous/intermittent)
- Magnitude (severe/moderate/low)
- Spatial extent (area/volume covered/distribution)
- Order (first-order direct impacts/indirect impacts)
- Nature (adverse/beneficial)
- Reversibility (reversible/irreversible)
- Probability of impact occurring
- Level of uncertainty with regard to impact prediction
- Potential for mitigation of adverse impacts/ enhancement of positive impacts
- Significance

*Box 8b*
*Indirect and cumulative environmental impacts*

**Indirect impacts** may be defined as impacts on the environment, which are not a direct result of the project, but result from other impacts. They may thus be produced away from the development site. A decision to construct a building will have a direct impact in terms of demand for raw materials. It will also have indirect impacts, in that the demand for raw materials will necessitate mineral extraction activities, with attendant impacts such as dust generation and production of waste material.

**Cumulative impacts** may be defined as those impacts on the environment which result from the incremental impact of an action or development, when considered in conjunction with other past, present and foreseeable future actions or developments. Thus, although individual actions might appear to be minor, the collective effect over a period of time may be substantial. As an example, an individual decision to purchase a car may appear to make an insignificant change to air quality. On the level of an entire national population, however, widespread car ownership may result in significant declines in air quality.

EIA is not intended to be merely a descriptive document of state and impact. It should also include a proactive element through the proposal of **mitigation** measures.

Mitigation may be defined as measures envisaged in order to avoid, reduce, and if possible remedy significant adverse effects. The purposes of mitigation measures include the elimination or minimization of negative implications of the development, the enhancement of any predicted positive environmental impacts, the documentation of the developer's future commitments and responsibilities, and the setting of foundations for monitoring programmes and contingency plans, as necessary. Any residual impacts that will remain after the implementation of mitigation measures should also be clearly identified. Any difficulties envisaged with the implementation of mitigation measures should also be explicitly stated.

*Case Example 8.1*
*Deficiencies in the EIA system in Egypt*

EIA processes were legally established in Egypt relatively late in the day when compared to other countries. The enabling legislation, Law No. 4 of 1994 on Environmental Protection, came into effect in 1998. Deficiencies identified include the following:

- Lack of specifications of sectoral authorities' responsibilities
- No legal requirement for public participation
- Weak interagency coordination
- Insufficient number of local qualified and experienced personnel
- Monitoring only in response to problems and complaints
- Subjective reviewers
- Weak enforcement of legislation
- Insufficient environmental data.

Source: El-Fadl and El-Fadel, 2004

Once the coordinated EIS report has been prepared, this is generally presented for **review**, either to an environmental authority or to an independent auditor. The review authority will ensure that the EIS is of adequate quality to be used by decision-makers. Amongst other considerations, reviewers assess the degree to which the EIA has addressed the scope established in the Terms of Reference, the quality and reliability of baseline information provided, the methodology used for determination of impact magnitude and significance, and the objectivity of the entire process. Given that EIAs are generally funded by project developers, the objective professionalism of practitioners is often strongly scrutinized, as public allegations of bias can severely jeopardize the entire process. During this review stage, the document may also be made available to the public for any interested parties to submit comments. In some cases, an EIA may be formally presented at a public meeting. Following the review process, any recommended changes to the EIS are incorporated into the document, and this is then submitted to decision-makers, as an aid for a final judgment on the proposed development.

*Case Example 8.2*
*Public participation in EIA in Italy*

The level of power assigned to the public in the EIA process in Italy is the minimum expected and required by law. The public is informed, consulted and their opinions are taken into consideration. Other aspects of public involvement take on a discretionary nature. The *Atto di indirizzo e coordinamento* allows the competent authority to hold a public inquiry if considered appropriate; a discussion may also be held between the proponent and a person submitting a comment or view. There is therefore some potential for collaboration. The researchers note, however, that limited opportunities for involvement in EIA, and the token nature of most public participation initiatives, tend to aggravate the tendency for the public to oppose outright any development proposals. Encouraging developments include the establishment of an Italian EIA centre in Milan, which, amongst other activities, offers assistance to developers in organizing public involvement opportunities.

Source: Del Furia and Wallace-Jones, 2004

**Methods for impact assessment**

As noted above, the objective assessment of impact magnitude and significance is often fraught with difficulties. However, there are several methodologies that can facilitate the process. These include checklists, matrices, networks, modelling systems and overlay mapping.

Checklists are standard lists of features or factors that may need to be addressed when identifying the impacts of projects and activities. They aim to promote thinking about impacts, providing a concise summary of the effects of proposals, identifying factors, and the trade-offs between alternatives (Smith, 1993). Checklists can vary in complexity and purpose, from simple lists of potentially affected factors to more structured methodologies that also make provision for weighting and assignment of significance. In general, checklists are useful in the initial stages of a development, when they provide guidance that can help focus the assessment process. As the sole means of impact assessment, however, they have several limitations, including a rather inflexible format, and the tendency to view environmental factors in reductionist rather than integrated fashion. Furthermore, for complex developments, checklists can become unwieldy.

Matrices consist of two checklists, set out at right angles to one another. One axis usually lists the environmental components that may be affected by a development, whilst the other lists the various aspects of the development. Interactions are then noted. Matrices were developed from a desire to link project activities with environmental factors. The most well-known example of an interaction matrix is that designed by Leopold in the 1970s, which provides a systematic checking of 100 development actions against 88 environmental parameters within 4 general categories. The matrix incorporates several functions of the checklist, as well as providing for a relatively rapid and comprehensive impact assessment tool. However, for many developments, extensive matrices may be time-consuming and are also limited to direct impacts.

For evaluating complex interactions between impacts, network diagrams may be more suitable. Developed expressly to illustrate complexities of primary, secondary and even tertiary impacts, networks are directional diagrams designed to trace, in two dimensions, the higher-order linkages between project actions and environmental factors (Smith, 1993). The strength of networks lies primarily in their ability to accommodate secondary effects of a development, and in providing a visual representation of activities and impacts. However, they are used mainly for identification rather than evaluation, having no mechanisms to determine the significance of impacts indicated. Furthermore, network diagrams may also show several linkages that could potentially occur, but that are unlikely to. Like checklists, they can also become too complex and unwieldy.

Modelling systems build on the concept of networks, whilst also applying a variety of mathematical and logical techniques. There are various types of modelling systems, many of which involve the integration of multiple factors in the development of scenarios of differing impacts, which can be visualized and assessed. Models are thus used to describe, explain or predict the behaviour of environmental systems, in response to varying anthropogenic factors. In complex systems, models can provide valuable descriptions of likely impacts, whilst also allowing changes and effects to be visualized and assessed rapidly. However, the technical expertise often required for their use limits the practical application of modelling systems. The complex logistics involved may also be a disadvantage, as the methodology may not be easily understood by the layman who is interested in knowing how and why certain conclusions regarding a development were reached.

The concept of overlay mapping has been described briefly in Chapter 7. The approach involves the superimposition of different thematic maps of the same area. In its application to EIA, impacts on different environmental components can be shown through shading, with darker shading highlighting the more sensitive areas or areas where the impact is expected to be of greater magnitude. When all results are superimposed, overlay maps can provide a concise and visually accessible summary of the likely spatial effects of a development. The widespread use of GIS has facilitated the implementation and ease of use of this technique. The method does, however, have limitations. It is limited to representing those features that can be rendered in spatial dimensions. Certain impacts, such as some classes of social impacts, may not always be easily mapped. Furthermore, like the other methods listed above, overlay maps only address particular dimensions of environmental impacts, without considering aspects such as impact duration and probability.

*Box 8c*
*Social Impact Assessment*

As experience in the field of EIA grew, it became increasingly evident that most development proposals did not only have direct environmental impacts, but also impacts on the social environment. Social Impact Assessment (SIA) focuses on the impact of development proposals on people. The main types of social impacts can be grouped into five overlapping categories (CGG, 2006):

1) **Lifestyle impacts** refer to impacts on the way people behave and relate to family, friends and acquaintances on a day-to-day basis;
2) **Cultural impacts** refer to impacts on shared customs, obligations, values, language, religious belief, and other elements which make a social or ethnic group distinct;
3) **Community impacts** refer to impacts on infrastructure, services, voluntary organizations, activity networks and cohesion;
4) **Quality of life impacts** refer to impacts on sense of place, aesthetics, heritage, sense of belonging, security, livability, and aspirations for the future;
5) **Health impacts** refer to impacts on mental, physical and social well being.

The social impact assessment process commences with an analysis of the project at hand, and identification of all relevant stakeholders. An effective and appropriate non-confrontational public participation mechanism is fundamental to the entire SIA. Once stakeholders have been involved, baseline social conditions are established, through whatever methodology is deemed most appropriate. In some circumstances, formal interviews may be effective, whereas in others, more informal techniques such as Participatory Rural Appraisal (PRA) techniques may be more useful. The assessment of baseline conditions should include demographic factors, socio-economic determinants, social organization, socio-political context as well as needs and values. The likely impacts of the development on people, within any of the categories listed above, need to be established and evaluated, together with secondary and cumulative impacts. Issues of impact equity should also be addressed. Recommendations for mitigation, where applicable, should also be made.

Source: Centre for Good Governance, 2006

## Strategic environmental assessment

Strategic environmental assessment (SEA) represents an extension of the concept of EIAs to policies, plans and action programmes. Like EIA, the process seeks to identify, describe, assess, mitigate and communicate to decision-makers, the likely impact of a planning decision at a higher level than that of the individual development. The process of SEA is similar to that of EIA. Screening is carried out to determine whether an SEA is required, whilst scoping identifies the key issues that need to be addressed in the appraisal. Baseline information is collated, in order to enable impact prediction and assessment to be made. Such information is generally much broader, both in content and in space, than with EIAs, as plans and policies usually cover broad areas. Impact evaluation is often more difficult than in EIA as the predictions of impacts are often imprecise and general, and as the acceptability of impacts is more ambiguous.

There are several key differences between EIA and SEA. One is that of scale. SEA tends to involve much larger scales than EIA, because plans and policies generally incorporate a range of activities with more geographically diffuse impacts. The geographical range of alternatives considered will also be greater. On the other hand, the degree of detail required is generally lower than in EIA. The temporal dimension of the assessment is also different, with SEA considering the projected environmental impacts over time of multiple actions within a region or ecosystem. Cumulative impacts, though also relevant to EIA, are of great importance within SEA. There are further differences in the timing of the process, with the time interval between assessment and planning decision being greater in SEA. The process is therefore imbued with more uncertainty, as environmental conditions may change even as the process is being carried out.

SEA is more of a process than a one-off event. The idea of systematically evaluating the likely impacts of a decision should guide the entire planning process. Although difficulties still exist with regard to its application, SEA can make significant contributions to ensuring that planning is conformant with sustainable development ideals. It gives decision-makers the broader picture. As an example, individual EIAs for power stations may find little to object about in terms of sites proposed, technologies used, and mitigation of impacts. However, a broader SEA of energy policy may question the wisdom of continued reliance on politically volatile and non-renewable energy supplies, rather than investing in developing technologies for renewable energy. SEA can therefore also incorporate transboundary considerations more easily than EIA. The process can furthermore serve to streamline other development activities, such as EIA, and it can likewise establish mechanisms for public participation at a more fundamental level in the planning process. It also facilitates the implementation of landscape scale ecosystem management approaches. An ideal approach is one in which SEA provides a broad planning framework, indicating, amongst other things, appropriate sites for specific types of development. Individual EIAs can then further assess the likely impacts of particular developments at those sites.

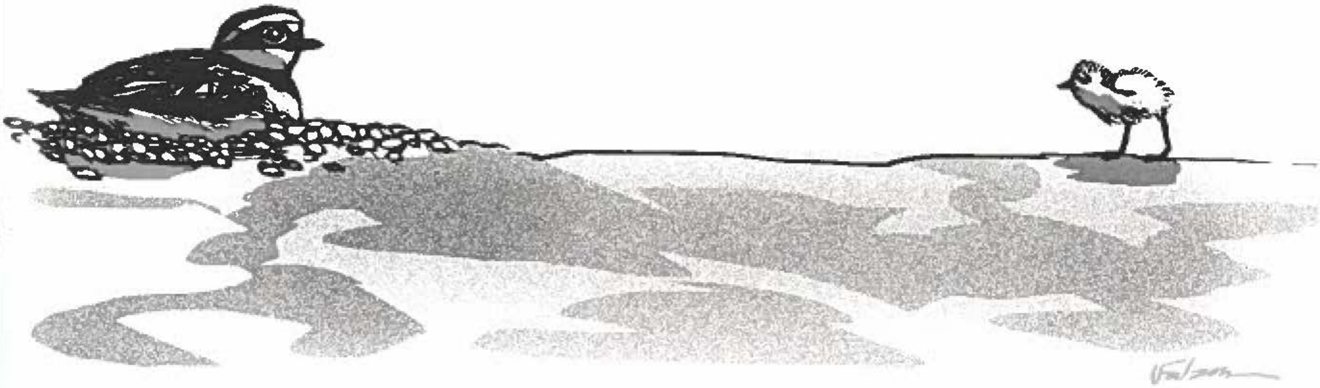
**Effectiveness of environmental assessment**

The effectiveness of EIAs and SEAs in informing decision-making will depend on a number of factors. First, an environmental assessment is only as effective as it is good. Work has to be of high quality in order for it to be useful for decision-makers. An assessment should be comprehensive, based on clear and specific legal provisions, with explicit explanation of impact assessment methodologies used and justifications for conclusions reached, inclusive of indirect and cumulative impacts as well as impact interactions, and with concrete and implementable proposals for mitigation and monitoring. Ethical conduct should be ensured by all involved throughout the process, and impartiality and objectivity should be guiding principles. Independent auditing has an invaluable role to play in ensuring adequate quality of assessments. Furthermore, procedures must be just and equivalent for all development applicants. Similar development proposals should therefore be subject to the same impact assessment requirements.

The effectiveness of environmental assessment is also strongly related to mechanisms for public participation. More and more, it is becoming evident that early involvement of the public in the assessment process can minimize problems at later stages. The key to success of public involvement is three-fold (Wiesner, 1995). First, the provision of full and easy access to all information about the project is vital. This should include accessible summaries of complex technical content. Second, there must be adequate opportunity available for concerned individuals to voice their concerns to the decision-making body. Third, developers and stakeholders must be prepared to work together and to compromise to achieve a resolution of issues to best serve the interests of all.

Ultimately, the effectiveness of environmental assessment may be determined mostly by what is done with the information provided. In the absence of clear legal safeguards to ensure that planning decisions fully reflect the conclusions of an environmental impact assessment, the process risks becoming simply a formality, and effectively a waste of time and resources. Furthermore, the public must be ensured, not only verbally but through concrete actions, that their inputs are not only acknowledged, but also actively considered and evaluated. If their opinions are repeatedly ignored when decision-making time comes around, the whole public involvement process will be jeopardized, as people become disillusioned and opt out of participating. The effectiveness of the assessment system can be improved if it is undertaken at an early stage, when scientific and public concerns may be addressed through modifications to the project design. Alterations at a late stage may otherwise involve substantial cost, and may serve to further polarize debates between developers and other stakeholders.

Environmental assessment must therefore strike a balance between various demands, including the generation of economic growth and safeguarding environmental quality, between public and private interests, and between the realities of limited resources and the need for good scientific knowledge. The relevance of such dualisms for the coastal zone is evident. Clarke (2001) notes that if the concept of sustainable development is to be achieved, and if Agenda 21 is to be implemented, as agreed at the Rio Earth Summit in 1992, environmental assessment will be a key element in the process. The various levels at which the process is carried out should together provide a framework for the implementation of environmental management and planning decisions, in the coastal zone as elsewhere. As with all mechanisms however, it should be remembered that a tool is only as good as the use it is put to, and environmental assessment must therefore continually be guided by clear legal provisions and should be scrutinized by interests from across the board, from auditors to NGOs, to ensure good practice.



# CHAPTER 9
# Conservation Strategies

*In the case of such global issues as the conservation of the earth, and indeed in taking all problems, the human mind is a key factor. Whether they are problems of economics, international relations, science, technology, medicine or ecology, though these issues seem to be beyond any one individual's capacity, where the problem begins and where the answer must first be sought is within. In order to change the external situation we must first change within ourselves.*

His Holiness the Dalai Lama, 2005

## Introduction

In his book *The Diversity of Life*, renowned conservation biologist Edward O. Wilson discusses the critical importance of insects and arthropods in ecosystems, noting that if these were to disappear, humanity probably could not last more than a few months. As a society, we dedicate a lot of importance and resources to maintaining and improving our material wealth and well-being, often measured in terms of our anthropogenic constructions. Yet the vast majority of us are barely aware of the intricate physical natural systems on which the very survival of the species depends. Such systems are maintained by complex interlinkages between vast numbers of species, providing a suite of ecosystem services that keep natural systems in balance. We have to date barely identified a tenth of all estimated living species, far less come close to understanding their behavioural mechanisms. The priorities of human society appear to lie elsewhere.

However, conservation is not a luxury concern, nor is it merely an emotional call for the preservation of life. Put simply, there will be no human life on earth, without conservation of other forms of biodiversity. A number of factors have conspired to make conservation a matter of unprecedented urgency (Wilson, 1988). First, human populations are growing at a rapid rate, with an ever growing footprint and accelerated degradation of natural environments. Second, science is discovering new uses for biological diversity in ways that can relieve both human suffering and environmental destruction. Third, much biodiversity is being irreversibly lost through extinction caused by the destruction of natural habitats, especially in the tropics. We are thus facing an uphill struggle of urgently needing to conserve that which we know far too little about.

The world's coasts and oceans play an important role in this unfolding drama. Lovelock (1979) observes that less than a third of the Earth's surface is land, and goes on to note that the reason why the biosphere has been able to cope with the ravages of mankind so far may be simply that degradation has been, so far, spatially confined, concentrated on land. The impacts of extending that degradation into the seas and oceans, and indeed of continuing the degradation of terrestrial ecosystems, remain uncertain, but experience does not bode well. The coastal zone certainly needs to be a focus of conservation efforts, including as it does the extents of continental plains and continental shelves (Ketchum, 1972), and covering more than 8% of Earth, equivalent to about an Africa and a half (Carleton Ray, 1988). This area encompasses a variety of ecosystems, ranging from mangroves to coastal forests, marshes, coral reefs and several others, many of which provide services critical to the maintenance of life on earth.

Major challenges in conservation efforts in coastal and marine systems have to do with knowledge and global recognition. Despite the extent of our oceans, we know very little about them, and in our haste to develop the coast, we have not made the effort of understanding well the physical processes operating at this interface. Carleton Ray (1988) insightfully notes that "*the last fallen mahogany would lie perceptibly on the* *landscape, and the last black rhino would be obvious in its loneliness, but a marine species may disappear beneath the waves unobserved and the sea would seem to roll on the same as always.*" Yet our actions are now starting to catch up with us, not only within inland terrestrial systems, but also on the coasts and in our oceans. We may not understand the damage we are inflicting on nature, but we can understand the implications of nature hitting back. With the destruction of mangroves, flooding has worsened, jeopardizing human lives. With overexploitation of particular species, fisheries have collapsed, with severe economic repercussions. With incessant dumping into the marine environment, the health impacts of pollutants are being felt. The list goes on and on. The impacts are particularly severe given our economic dependence on the seas and oceans, with an estimate that these provide 63% of all goods and services provided by world ecosystems (Costanza *et al.*, 1997).

Time to act to preserve the biodiversity of coastal and marine systems is therefore short. This is all too much the case in the Mediterranean Sea, where physical, biological and human characteristics combine to render the region a biodiversity treasure trove with a sword of Damocles hanging over it. The loss of biodiversity in the Mediterranean would not only result in direct biological impacts, but would also have major economic repercussions on revenue-generating activities, as well as cultural repercussions on the identity of the Mediterranean people. Urgent conservation efforts are critical, and these must draw on all available tools. This chapter introduces some of the strategies for biodiversity conservation which are at the disposal of the coastal manager. Not all will be equally appropriate in different contexts or with regard to different species. However, an understanding of a diversity of options available is useful for a holistic understanding of biodiversity issues in the coastal zone, and for the formulation of integrated strategies.

## Setting priorities for conservation

Whilst it would be theoretically desirable to conserve all forms of life on the planet, conservation resources are always limited. Conservationists therefore need to make decisions to prioritize conservation efforts, either on a geographical basis, or on the basis of particular species or taxa. Any set of conservation priorities invariably reflects human values, whether on an economic, ethical, social or cultural basis. No one conservation strategy is applicable in all contexts. The relative merits of each need to be weighed on a case-by-case basis, whilst insights from all methods should be incorporated into conservation strategies.

Many methods of establishing priorities on a geographical basis have been established. One approach is simply to focus on those areas of most importance to biodiversity, most commonly areas of highest species richness or of high endemism. On a global scale, many conservation efforts have focused on tropical rainforests, due to the immense diversity they harbour, the vast majority of which has yet to be identified and studied. Other approaches have sought to link the aspect of biodiversity importance with aspects of threat, to give a measure of the urgency of conservation action required. The conservation hotspots approach, developed by Norman Myers in 1988, is one example, and under the criteria of plant endemism and level of habitat loss, 34 biodiversity hotspots have to date been identified (Conservation International, 2007), including the Mediterranean Basin. Other geographical approaches to priority-setting focus on 'gaps', identifying areas where there are no conservation efforts, or where these are insufficient. Some approaches also emphasize the need to be proactive, as well as reactive, thus protecting not only vulnerable areas of the planet, but also those that are least vulnerable.

Conservation priorities may also be established on the basis of specific species and/or taxa. Many conservation efforts have utilized flagship species, such as the panda or the tiger, which can easily capture public sympathies and thus serve as a catalyst for conservation funding. Others have focused on keystone species, which play a disproportionately important role within an ecosystem. The concept of Red Lists has also been important in guiding conservation priorities on a species basis. Red Lists provide indications of the conservation status of different species, ranging from low risk to vulnerable, endangered or critically endangered, to extinct. Criteria for the placing of a species within a particular category vary with different national Red List systems, but many include population size, trends in population numbers, and range extent. However, Red List criteria, though useful, may inaccurately account for genetic diversity. The preservation of genetic diversity should also be an important component of conservation initiatives. The World Conservation Union (IUCN) has now in fact adopted new criteria for its Red List systems that also give information about gene pool composition. From a more utilitarian viewpoint, conservation efforts may also focus on those species of most direct value to humankind. Also from a more practical viewpoint, many conservation efforts tend to focus on species that are easier to conserve, such as those confined to a clearly delimited area. Implementing conservation strategies for species that migrate long-range is evidently much more challenging.

**In-situ conservation**

There are two broad categories of conservation techniques. In-situ conservation is, as the name implies, carried out on site, within the home range of species. Ex-situ conservation, on the other hand, takes place away from the natural habitat. In-situ conservation was recognized by the Convention on Biodiversity, as the primary approach to be adopted wherever possible. This implies making efforts to conserve species within their natural habitat ranges. In-situ conservation strategies vary, and may focus either on specific species or on entire habitats, often combining biological aspects with legal measures.

*Protected areas*

The main technique for in-situ conservation worldwide is the establishment of protected areas. The concept of setting aside areas from normal human activity has a long history, with the earliest protected groves and mountains having been established for spiritual reasons. However, the modern concept of protected areas originates in 1872, when Yellowstone National Park was formally declared in the USA. The establishment of Yellowstone was a significant milestone in conservation. For the first time, a national government set aside an area the size of a state, protected in perpetuity, banning settlement, occupancy or sale, and establishing recreation and tourism as the primary objectives. The concept was far from perfect, particularly when it was applied indiscriminately outside the USA, in areas with a long and important history of human occupancy. However, Yellowstone served to establish an important conservation precedent. By 2003, more than 12% of the Earth's land surface lay within a global network of 102, 102 protected areas over more than 18.8 million $km^2$ (United Nations, 2003).

In a world of limited conservation resources, protected areas have several advantages. First, they counter several of the problems of species-based conservation. Species-based approaches are inevitably limited to a minute proportion of the global complement of biodiversity. As noted in the introduction to this chapter, some of the more critical species to life on earth may not be particularly charismatic or attractive to look at. Furthermore, we know nothing of the specific existence of the vast majority of species. Species-based approaches therefore have evident limitations, and although their contribution is important, on a global scale, and given the urgency of threats, it is surely not sufficient. Protected areas serve to protect a multitude of species within them, both evident and attractive floral and faunal species, as well as insect and microbial diversity. Protected areas also address the major cause of biodiversity destruction worldwide today, i.e. habitat destruction. As a conservation strategy, protected areas therefore do not merely address effects, but also fundamental causes. Furthermore, the protection of entire habitats or ecosystems also serves to safeguard ecosystem services, such as nutrient cycling, the filtering of water or the buffering of shoreline environments.

Protected areas also have much potential to provide a bridge overcoming the gulf between man and nature. The initial Yellowstone model made little allowance for human use of nature, but the concept has evolved into a much broader understanding of what role protected areas should serve. Although the importance of strictly protected conservation areas is not disputed, there is also a growing recognition that strict protection may not be suitable in all circumstances, and that more collaborative approaches are not only possible but also desirable. The concept of protected areas has evolved from one of protection from people, to protection for and with people. Connections and linkages are increasingly being sought, both physical linkages between different protected areas, to overcome problems of fragmentation, as well as conceptual linkages between conservation and economic, social and political agendas. The management of protected areas is also expanding to include a number of partners, including local stakeholders, and multidisciplinary skills, in order to enable effective adaptive management. In some cases, management of a protected area has been effectively delegated to locals, with successful results.

*Box 9a*
*Assessing protected area management effectiveness*

Whilst the establishment of protected areas is of critical importance to any biodiversity conservation strategy, their success is dependent on implementation and management. Many protected areas in the world today are little more than 'paper parks', designated by law and in principle but with no on the ground manifestations. Other protected areas are managed in a token manner, with no clear objectives or without achieving stated objectives. Periodic management reviews are therefore of vital importance. These should assess various factors, including the biogeographical situation of the protected areas, infrastructural capacities, adequacy of staff numbers and training, the effectiveness of the legal framework for protection, compatibility between different uses, the provision of information, mechanisms for stakeholder participation, and integration with broader regional and national plans.

Of key importance has been the concept of protected landscapes. Brown *et al.* (2005) describe protected landscapes as cultural landscapes that have co-evolved with the human societies inhabiting them. They are protected areas based on the interactions of people and nature over time, living examples of cultural heritage that are rich in biological diversity, not in spite of, but rather because of the presence of people. They thus hold much potential for learning to integrate biodiversity conservation, cultural heritage protection and sustainable use of resources. The World Conservation Union (IUCN) formally recognized the value of such areas through its designation of protected landscapes as Category V of its revised protected area classification system, published in 1994. Protected landscapes may have particular potential in areas such as the coast of the Mediterranean Sea, where there is a long history of interaction between man and nature, where it is impossible to exclude human activity, and where cultural identity is related to the natural environment. The approach represents one way in which conservation can be compatible with economic objectives, with protected landscapes having much appeal for sensitive forms of tourism.

The concept of protected areas has also expanded to include the marine realm. Both coastal and open sea areas are in dire need of protection, being susceptible to threats from a variety of sources and often affected by tragedies of open access, and the presumed limitless ability to supply resources and to absorb wastes. Marine systems are highly interconnected, with free movement of fish, algae, nutrients and pollutants, and few natural boundaries. Management is therefore highly challenging, particularly due to transboundary political issues and due to the legal complexities of the open seas. Although enforcement of management boundaries is more challenging in the sea, the designation of Marine Protected Areas (MPAs) can, at the very least, help to safeguard the vital life-support processes of the sea, including photosynthesis, maintenance of food chains, movement of nutrients, degradation of pollutants and conservation of biological diversity and productivity (Kelleher, 1999). MPAs are also important for the continued health of fisheries, and thus for the survival of many fishing cultures. In combination with other fishing control techniques, MPAs can allow fish stocks to regenerate and rebuild, restoring some level of stability to natural populations. MPAs can be set up for a variety of reasons, depending on the particular context. In some cases, they may target specific species, habitats, fisheries or natural features. In others, they may also seek to protect cultural heritage. Uses allowed or prohibited are thus conformant with the particular objectives of management. Although the relationship with local communities is often tenuous, particularly where restrictions are placed on the short-term exploitation of resources, in the long term, MPAs have been found to have several economic and social benefits. Like protected landscapes, they also have considerable potential for ecotourism and nature tourism.

*Case Example 9.1*
*Protected areas in southern Europe*

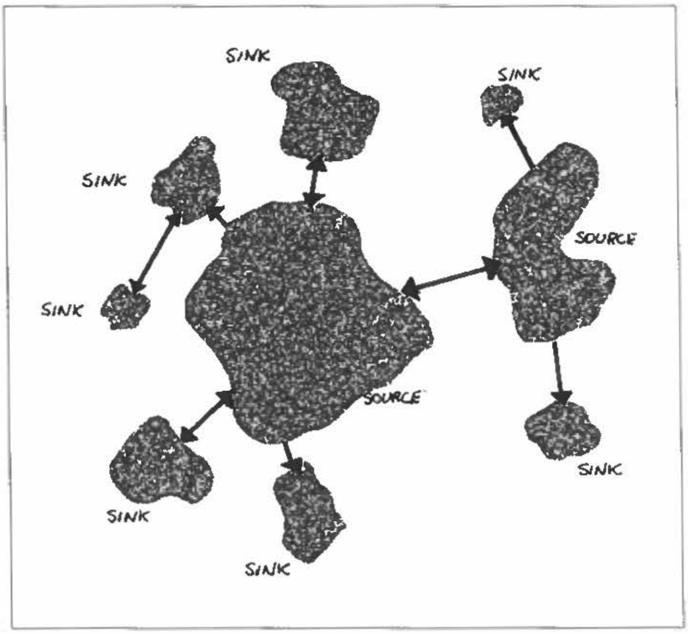
The coverage of protected areas in Southern Europe as a whole is very uneven, with some countries and some habitat types far better covered than others. Similarly, some countries have very precise inventories of what needs to be protected, while others do not. Corridors between protected areas are especially needed to permit migration of birds and movement of animals like wolf, lynx and bear, as well as smaller invertebrates. Marine protected areas are inadequate in coverage and in most Mediterranean countries, their management is almost non-existent. One of the most acute needs in Southern Europe is for trained personnel. Closer collaboration and links between experts in different countries are also needed. Better public awareness about conservation is likewise wanting.

Source: IUCN, 1994

*Species-based approaches*

In-situ management for conservation is not limited to protected areas. Important species-based approaches are also appropriate in many circumstances. As noted above, certain categories of species can act as a very successful focus for conservation efforts, resulting in the implementation of measures that benefit not only that species but also a suite of others within the same habitat. For many species, habitat protection, though critical, may not be enough, and specific measures may be required to address other causes of decline. This is the case for example where direct population losses result from activities such as hunting. Appropriate management measures in such cases may range from legal regulation of the activities causing population decline, to monitoring of populations in order to understand status and trends, to broad educational efforts designed to raise public awareness and to seek to alter behavioural trends.

*Sketch 9.1*
*The concept of metapopulations*




Species-based in-situ approaches may also focus on concepts of metapopulations. A metapopulation consists of a group of spatially separated populations of the same species, which interact at some level. An area may thus have different sources and sinks for populations of a species, with sources being areas of net emigration and sinks being areas of net immigration. The concept is increasingly relevant given increased habitat fragmentation, resulting in spatial separation of populations. A successful management strategy for metapopulations requires not only conservation of individual patches, but also of the potential for dispersal between them, as without adequate possibilities for movement, small populations are likely to become extinct. Other management concerns may include the control of alien species within a habitat, particularly where such alien species are invasive and compete with native stocks. Managers may also seek to manipulate species populations for particular ends. This may include augmentation of populations under threat, re-introduction of species into areas in which they formerly occurred, and biotechnological manipulation of species to address genetic concerns.

**Ex-situ conservation**

Although in-situ conservation is recognized as the main approach to conservation, many times measures are required beyond those that can take place within the natural habitat of the species concerned. In some cases, ex-situ conservation may be required to ensure the survival of a species or to recover declining populations. Ex-situ conservation typically takes place in zoos, aquaria, botanical gardens, seed banks, arboreta, and other similar institutions. Originally the emphasis of many ex-situ conservation bodies was collection or display. Today, many of these are actively involved in captive breeding and research, as well as education, and their focus is not the institution itself, but rather supplementing in-situ conservation efforts.

Plant species are being lost at an unprecedented rate. These include both wild and cultivated plants. The ex-situ storage of plant material, either as whole plants, seeds, pollen, vegetative propagules, tissue or cell cultures, can serve several purposes. It can provide storage of threatened germplasm and species, as well as producing materials for research. The maintenance of populations of threatened species acts as insurance that these species will not be entirely lost, should wild populations be wiped out. The restricted spatial extent of many species, with some plants limited to an area of a few metres, means the threat of extinction from the wild looms all too real. In other cases, genetic variation is being lost, even if species continue to exist. The breeding of plant species ex-situ can also reduce pressure on wild reserves, particularly where these have economic uses. Botanical gardens and similar institutions also provide source material for reintroductions, augmentation of populations, and habitat restoration and management, through propagation.

The ex-situ conservation of animals has perhaps been the subject of more controversy than its floral equivalent. This is largely due to the tradition of zoos, which for long functioned more as living museums than as conservation entities. However, in recent years many institutions have undergone a radical evolution of purpose and structure. The World Zoo Conservation Strategy (IUDZG, 1993) now explicitly states that zoos should support and consolidate processes leading to nature conservation and sustainable use of natural resources, and to develop understanding and support for the conservation potential of zoos and aquaria. A major role for such institutions in conservation is through captive breeding of threatened species. At present, the reality is that few zoos hold populations of threatened species, and where such species are kept, the populations are too small for the maintenance of genetic diversity. However, some successes have been recorded, particularly through experimental breeding techniques such as fostering, cloning and embryo manipulation. Techniques of cryopreservation may also hold potential for future reintroductions of species. Zoological institutions can also play a major role in research and education, providing a link between science and the public, with the goal of garnering support for conservation and raising awareness of the impacts of human activities.

Ex-situ conservation has also focused on the preservation of economically valuable domestic plant and animal species. Perhaps due to the more immediate benefits to mankind, there have been long-standing efforts to preserve the genetic diversity contained within domestic varieties of plants and animals, more so than with wild counterparts. Attention has been focused especially on conserving the diversity within the few species on which human populations are dependent for agriculture, such as rice, wheat, sheep and pigs. Crops, in particular, have been the subject of much attention. Seed banks presently have substantial stores of agricultural crop plants, whilst in-situ measures have also been implemented to attempt to maintain landraces in the areas where they evolved. Livestock genetic resources are less well preserved, with several breeds having died out as they were replaced by new ones. This relates also to the greater logistical difficulties involved in preserving livestock diversity. There have also been initiatives to conserve micro-organisms ex-situ, although the sheer numbers of these organisms severely limit the efficacy of such efforts.

Ex-situ conservation has several limitations. In the first place, it is often very expensive, particularly for faunal species. Initiatives such as captive breeding generally register low success rates, due to the complexity of factors involved. Some argue that ex-situ techniques may remove the focus from in-situ conservation, and that once a species is established in captivity, maintenance in its original habitat loses its urgency, particularly in the eyes of the public and policy makers. There are also risks with using ex-situ techniques for reintroductions into natural areas, as individuals may introduce diseases into already vulnerable habitats. The genetic characteristics of captive individuals may also evolve away from those of wild populations. The removal of species from the wild is sometimes frowned upon, especially when these are breeding members. The physical capacity for ex-situ conservation is also limited, as zoos, seed banks, botanical gardens, and so forth, have a limited spatial capacity. Finally, ex-situ conservation does little to address the underlying causes of biodiversity loss, and cannot help the myriad species that have not even yet been identified.

**Formulating an integrated biodiversity conservation strategy**

The focus of conservation strategies today needs to be integration. The suite of techniques and concepts available is useful only in so far as it is used wisely. It is pointless to designate strict protected areas, with bans on resource use, in regions where populations have no feasible alternatives. On the other hand, it is short-sighted to put resource needs before the long-term integrity of a natural system. Likewise, whilst it is important to focus on issues of habitat loss, it is also a reality that without urgent remedial measures, several species will be permanently lost. The conservationist must therefore balance several biological, social, economic, political, cultural and legal concerns. This is best done by drawing on a variety of options, utilizing those most appropriate for a particular purpose. Both in-situ and ex-situ strategies have their difficulties. However, both can provide complementary solutions in the face of major threats to biodiversity. The focus has to remain on the root causes of biodiversity loss, as it is useless to minimize symptoms without tackling the disease. In-situ protected areas, either strictly protected or of a sort that can accommodate sustainable human uses, are therefore the key component of any biodiversity strategy. Where appropriate complementary ex-situ measures can be used to enhance in-situ measures, so much the better.

The strategy for conservation also has to extend deeper, however. With climate change, the ranges of many species can be expected to change. As a result, protected areas may no longer be suitable habitats for those species that they were established to protect. Despite the importance of protected areas, it is increasingly true that conservation cannot succeed solely through islands of protection. Much will depend on the quality of the intervening matrix, and on the potential for connectivity to establish biodiversity networks. This requires at least two crucial components. One is international cooperation. Effective conservation decisions can no longer be limited within a nation's boundaries. The natural heritage of the Mediterranean is regionally important and regionally threatened. Responses therefore must also have a regional focus. This is particularly the case for marine species, where the impacts of one country's activities may extend far beyond its shores, highlighting the importance of stable political relations. For this reason, successful conservation can never be solely the domain of biologists. It is also important to understand how conservation decisions impact on society, on economic resources, on political relations, on cultural identity, and so on and so forth.

The second crucial component is a change in culture and mentality. We can seek to address habitat loss through the establishment of protected areas, yet we are doing little to change the driving forces underlying habitat loss. Our world economic and political systems still perpetuate the lifestyle that results in extinctions and species declines. Although some call for radical change, it is more likely that change will occur gradually, as generation after generation, humanity becomes more aware of the need to respect the limits of the natural world and of possibilities for a sustainable co-existence of man and other species. As environmental managers, we therefore must devote sufficient resources to education and awareness raising, as these are critical in any conservation strategy. In the coastal zone, education may indeed be considered to be an urgent priority. The extent of threat in coastal areas necessitates change in the short-term, before any remaining resources are destroyed. At the same time, the extreme dependence of coastal populations on natural environments necessitates that change occurs in a manner that is sustainable, both from a biodiversity perspective as also from the perspective of mankind. There is no easy solution. The brief is simply for coastal managers to use all available means at their disposal to do the best they can.

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## About the Authors

The authors have a long-standing interest in coastal management concepts and practices, derived both through professional experience and through their academic training. Elisabeth Conrad is currently pursuing doctoral studies at the University of Wales, Aberystwyth, focusing on the valuation and management of cultural Mediterranean landscapes. Louis F. Cassar has researched the valuation of ecological resources at landscape scale and the integration of stakeholder concerns in landscape ecology through his doctoral studies at the University of Reading. The authors have collaborated on numerous research and professional initiatives for the past several years.

**Elisabeth Conrad** is an environmental management consultant, and research associate of the International Environment Institute of the University of Malta. She is a geographer and environmental management specialist by training. She has been involved in the coordination and compilation of several environmental impact assessments and protected area management plans, as well as in coastal management projects across a number of Mediterranean sites, spanning both shores of the Basin. Her research interests include the management of protected areas, the involvement of stakeholders and cultural concerns in biodiversity conservation initiatives, the management and valuation of cultural landscapes, the integration of social agendas in environmental management and environmental philosophies.

**Louis F. Cassar** is Director of the International Environment Institute of the University of Malta, and serves as scientific advisor on coastal management to the International Centre for Science and High Technology of United Nations Industrial Development Organisation (ICS-UNIDO). He is a landscape ecologist and environmental planner by training, and has also been involved in several environmental appraisal assignments. His research interests include coastal management (with specific reference to sand dune environments), landscape ecology (particularly corridor ecology, habitat fragmentation and restoration ecology), and participatory methods for stakeholder involvement in conservation. He is also active in the study of orthoptero-fauna of the central Mediterranean region and Maghreb. His experience in coastal management and conservation extends to various countries of the Mediterranean region as well as to West Africa and South America.

The **International Environment Institute** (IEI) was founded in 1987 within the framework of the Foundation of International Studies and, in 1993, it became a conjoint entity of the FIS and the University of Malta. The Institute is now based on campus in Msida, where its resources are more accessible to the student body. Twenty years on since its establishment, the Institute still regards human resource capacity building as its *raison d'étre*, and works towards training specialists in aspects of coastal management, environmental assessment, landscape ecology, environmental planning and resource management, environmental ethics and conservation. To this end, the Institute runs interdisciplinary courses at both undergraduate and postgraduate level and conducts research activities pertaining to the areas outlined above, with a main focus on the Mediterranean. The Institute also maintains a close links with foreign universities and various international agencies, as a result of which, Institute staff and research associates have, over the last decade, collaborated closely with the *Università degli Studi di Firenze* (*Dipartimento di Biologia Animale e Genetica*), *Consiglio Nazionale delle Ricerche* in Firenze (*Istituto per lo studio degli ecosistemi*) *Agence de Protection et d'Aménagement du Littoral* of Tunisia, *Université Abdelmalek Essaâdi* of Tetouan (*Faculté des Sciences*), *Institut Scientifique* of the *Université Mohammed V*, and the Centre for Environment & Development in the Arab Region & Europe (CEDARE) in Cairo, during joint field research on the coasts of Morocco and Tunisia, as well as the Tuscan coast of Italy. More recently, the Institute has cooperated with The University of Reading, the Cambridge Centre for Landscape and People (Univ. of Cambridge), the Landscape Research Group and the Priority Actions Programme Regional Activity Centre of UNEP, among others, on coastal landscape-related projects and assignments.

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This book provides a concise and holistic overview of coastal management issues and techniques in the Mediterranean Basin. It combines conceptual approaches and theoretical background with techniques for day-to-day management of coastal environments in this unique Region.

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