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PREFACE

The majority of the world's population live in coastal regions. Increasing competition for the diminishing resources in coastal areas and the growing disparity between those who have and those who have not, make coastal belts potential flash points for resource conflict. Often these conflicts may be between, on the one hand the pressures of global tourism, poorly implemented industrialisation, or inappropriate aquaculture developments, and on the other, local communities dependent on coastal resources who find these threatened by such external forces. To manage such coastal areas is a unique and complex challenge. Integrated coastal management (ICM) seeks to rise to this challenge by co-ordinated planning and action involving communities, stakeholder groups and managers at local, regional and national level as well as both natural and social scientists.

As a first step to coastal management and planning, managers need to map existing coastal habitats and resources and determine how these relate spatially to areas of urban, industrial, aquaculture, tourism and other developments. This allows sites of potential conflict, high biodiversity, inappropriate development, high sensitivity to environmental impacts, etc. to be identified and for management initiatives and scarce resources to be targeted accordingly.

The primary tool for mapping coastal habitats and resources is remote sensing using satellite sensors and, increasingly, airborne digital scanners. This remote sensing distance-learning module, the seventh in the *Bilko* series, focuses on these coastal management applications. In eight practical lessons it gives users a thorough grounding in a suite of coastal management related remote sensing tasks, ranging from acquisition of appropriate imagery and interpretation of coastal images, through radiometric and water column correction, to mapping of coastal marine habitats and quantitative assessment of seagrasses and mangroves. The module seeks through its training to improve the quality of spatial data available to coastal managers and planners and thus ultimately to improve the management of the coastal resources on which local communities depend.
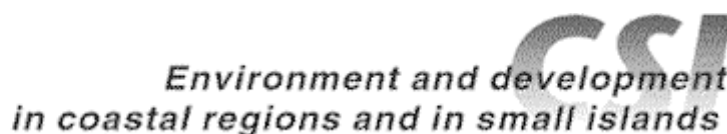
INTRODUCTION

This is the seventh computer-based learning module prepared in UNESCO's *Bilko* project and the first developed to address the objectives of the Environment and Development in Coastal Regions and in Small Islands programme (CSI: http://www.unesco.org/csi). It is the second to use a Windows based version of the BILKO software (*Bilko for Windows*). Like its predecessors which used versions of the original MS-DOS based BILKO software (Modules 1-5: obtainable from http://www.unesco.bilko.org/) and an earlier version of *Bilko for Windows* (Module 6), it contains a series of lessons based on the display of data in image form and it demonstrates the processing and interpretation of these images using *Bilko for Windows*. Unlike earlier modules, Module 7 requires that *Excel* (or a spreadsheet package which can read *Excel* files) also be installed.

Coastal management

Unlike previous modules, which had a more broadly based focus, Module 7 is strongly orientated towards coastal management applications in tropical countries.

Habitat maps derived using remote sensing technologies are widely and increasingly being used to assess the status of coastal natural resources and as a basis for coastal planning and for the conservation, management, monitoring and valuation of these resources. Digital sensors commonly used for coastal management applications have spatial resolutions ranging from about 1-80 m and spectral resolutions ranging from a single panchromatic band to around 16 precisely defined wavebands which can be programmed for specific applications. Costs of imagery range from about £0.25k for a low-resolution (80 m pixel) satellite image covering 35,000 km² to perhaps £80k for a high-resolution (3 m pixel) airborne multispectral image covering less than half this area. In addition, high-resolution analogue technologies such as colour aerial photography are still in routine use. Coastal managers and other end-users charged with coastal planning and management and the conservation and monitoring of coastal resources require guidance as to which among this plethora of remote sensing technologies are appropriate for achieving particular objectives. To this end the UK Department for International Development (DfID) have funded production of a *Remote Sensing Handbook for Tropical Coastal Management*. Module 7 complements this *Handbook* by providing training for practitioners on *how* to carry out key image processing steps that are particularly important for coastal management applications. It also guides practitioners in the mapping of coral reef, seagrass and mangrove ecosystems and the quantitative assessment of the status of the latter two resources using airborne and satellite imagery.

The satellite and airborne images used in this module are all of the Caicos Bank area of the Turks and Caicos Islands which lie to the south-east of the Bahamas. This area was chosen as a test site to discover what coastal management objectives are realistically achievable using remote sensing technologies and at what cost. This site offered good clear-water conditions, a broad mix of coastal habitat types, a very large area (>10,000 km²) of shallow (<20 m deep) coastal waters which would be amenable to the technologies. Module 7 builds on the experience gained in our investigation for DfID of the capabilities of the range of sensors in wide current use. The objectives of using remote sensing should always be clearly defined so that appropriate imagery is obtained and adequate processing is carried out. The objectives of coastal managers in using remote sensing are listed below.

Uses of remote sensing in the coastal zone

Worldwide, sixty coastal managers and scientists (out of 140 contacted) responded to a questionnaire in which they were asked a) to identify what they saw as the primary applications of remote sensing and b) to prioritise the usefulness to them of various levels of information on coastal systems.

The most in-demand applications of remotely-sensed data were to provide background information for management planning and to detect coastal habitat change over time (Figure 1). The term "background information" reflects the vagueness with which habitat maps are often commissioned and indicates a need for objectives of remote sensing surveys to be defined more rigorously. 70% of respondents who were using remote sensing for change detection were concerned with mangrove assessment and/or shrimp farming. The primary uses made of the habitat/resource maps are shown in Figure 1.
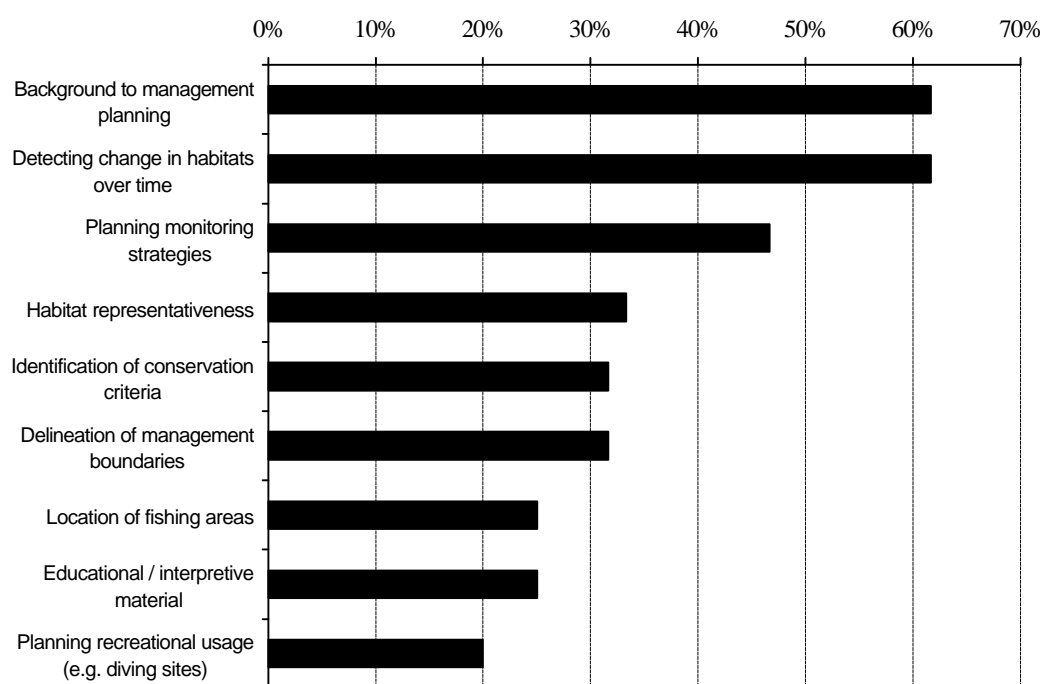

Figure 1. Responses of 60 coastal managers and scientists to a questionnaire asking them to identify what they considered the primary applications of remote sensing for tropical coastal management.

Getting started: The full list of files needed for Module 7 is detailed in Appendix A.

The minimum recommended level of computing hardware is a Personal Computer with a reasonably fast (e.g. 66 MHz) 486 processor and 16 Mbytes of memory which is running under Windows 3.1 or later. For computers running Windows 95 a Pentium with 16 Mbytes of memory is recommended as the minimum specification. However, we have run the software successfully on PCs with only 8 Mbytes of memory. About 60 Mbytes of free disk space is required for all the lesson documentation and images. A graphics card which can display 16-bit colour images (High colour) is required to view colour composites. The lessons are available over the World Wide Web (http://www.unesco.bilko.org/) and on CD-ROM.

Lesson texts and other documentation are available as Microsoft Word (.doc) and Adobe Acrobat (.pdf) files, which you can print from disk or edit to suit your specific training and educational needs.

Use of the module: Just one condition and one request are attached to the copying and distribution of the material in this module. The condition is that **the material may not be sold**. The request is that if you make use of this module, either the original or a copy, you fill in the reply sheet and return it to the

UNESCO-Bilko Project Coordinator, c/o ITC, Enschede, at the address indicated. The return of reply sheets helps us to assess whether our modules are reaching the community for which they are intended, and so serves as a guide in preparing new lesson material for future modules. A reply sheet is attached to the letter accompanying this module and it is reproduced on page 185.

Perspective: It is now over ten years since the first memoranda on what has become the *Bilko* project were circulated. For those of us who have been involved with the project since its inception, it was a pleasure to experience the warm reception accorded the first module and a relief to see the steady growth of the small community of interested teachers and researchers as subsequent modules were published. We now have lessons from all five continents and the present module will be available worldwide over the internet.

With the increasing number of lessons has come an increase in the community which surrounds the *Bilko* project. The first module was written by the founding group and distributed to colleagues known at UNESCO to be interested in the teaching of marine sciences. Recipients were asked to make copies freely available to colleagues and students, and to consider writing a lesson for publication in a future module. The number, quality and variety of the lessons received are evidence that the recipients are not content merely to use the materials provided, but do indeed think it worth while to contribute to this exercise in improving the quality of teaching.

Since its earliest days, the prime objective of this project has been, by example, to promote excellence in teaching. This is a demanding task, but the reports on existing modules are good. We are aware, however, of two shortcomings relative to the original goals: lessons, while extensively reviewed and edited, have not usually been subjected to the extensive student testing that is normally a prominent feature in the development of computer-based lessons, and the range of topics covered remains narrower than it need be given the power of the existing software.

Development: An initiative is now in hand to extend the concepts developed in the earlier *Bilko* modules and develop web-based lessons which can be run over the internet. These will build on the concepts embodied in the Windows Help file lessons developed for Module 6, will be easier for lesson creators to write, will retain the advantages of hypertext links, and will offer more interactivity as HyperText Markup Language (HTML) and Java develops.

You too can contribute: One purpose in writing this introduction is to ask your help. The project is open to development along three broad lines which may be described as relating to access, excellence and community. All are asked to take part in this development, but key contributions will come from those who teach their students using the lessons and offer their experience for the benefit of others.

The writing of *Bilko for Windows* is an important development. We know that their experience in the classroom has led many teachers to add their own questions and refinements to the published lessons. Our objective is to enrich these lessons by pooling the knowledge that already exists in the network of *Bilko* users. For this, we'd like questions, descriptions of student projects, alternative images and alternative presentations. Please do not hesitate to send exercises, modifications or additional explanations which have worked well with your students. It is a simple matter to link optional text to the main lessons, and we hope to add several tens of exercises to the published versions of existing modules.

All types of lessons are welcomed, provided they are based on data that make use of the *Bilko for Windows* software. If you would like to contribute a lesson, note that Section 3 of Module 2 contains a "Lesson for Lesson Creators" which provides guidance on the preparation of images and texts. As with most scientific educational literature, contributed lessons are subject to editorial review before publication. To find out more, a useful first step is to fill in the reply sheet at the end of this module. If you would like to discuss the matter informally, do not hesitate to contact any member of the development team.

Other modules: If you find this module interesting and would like to obtain copies of others in the series (written for the MS-DOS version of *Bilko*), these are downloadable over the internet. See World Wide Web address http://www.unesco.bilko.org/ for further details or write to (or e-mail) the UNESCO-Bilko Project Coordinator, c/o ITC, Enschede at the address given on page 185. The contents tables of these earlier modules can be browsed over the internet at the address above and are also reproduced in Appendix B.

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On-line Introductory Tutorials

The on-line introductory tutorials consist of nine lessons which have been written to help you to learn how to use the Unesco *Bilko for Windows* image processing software. *Bilko for Windows* makes use of a number of document types which enable you to interact with image data. Each lesson introduces a diffferent type of document, and the various operations and functions associated with it. As a prelude to a series of on-line lessons in satellite oceanography, each tutorial lesson uses a different satellite image of the sea. Although no direct instruction is given in oceanographic interpretation, by the time you reach the end of the Tutorials you will already have gained some experience of marine image data. The Tutorials cover similar ground to the text based Introduction to *Bilko for Windows*.

To start the Introductory Tutorials double-click on the file named IN_TUT00.HLP in **File Manager** or **Windows Explorer** or use the **File, Open** command to open it. All the other lessons can be accessed from this file.

On-line introductory tutorial lessons.

Lesson	Topic
Lesson 1	Opening and viewing images
Lesson 2	Learning about transects
Lesson 3	Histogram documents
Lesson 4	Stretch documents
Lesson 5	Palette documents
Lesson 6	Filter documents
Lesson 7	Connect multiple images
Lesson 8	Scatter documents
Lesson 9	Formula documents

Note: These on-line tutorials were written for use with Windows 3.1. Windows 95/98 and NT users should take account of this and be prepared for minor differences due to the operating systems used.

Use the <ALT>+<TAB> key combination to switch between *Bilko for Windows* and the on-line tutorials if you have a small (14-15") monitor. Alternatively, if you have a larger monitor, place the tutorial lesson window at the top right of the screen and size it so that it does not obscure too much of the screen. Then set the **Help, Always on Top** option (Windows 3.1) or **Options, Keep Help on Top** (Windows95/NT) on so that you have the lesson available as well as your *Bilko for Windows* workspace.

Comments or suggestions relating to these tutorials should be sent to:

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