Journal of Coastal Conservation 8: 3-86, 2002
© EUCC; Opulus Press Uppsala.

The data-into-information pathway for coastal studies

Guest Editors:

David R. Green & Stephen D. King

The data-into-information pathway for coastal studies: Introduction

Green, David R. & King, Stephen D.

*Centre for Marine & Coastal Zone Management Department of Geography & Environment, University of Aberdeen, Elphinstone Road, Aberdeen, AB24 3UF, Scotland, UK; *Corresponding author; E-mail d.r.green@abdn.ac.uk*

This special issue of the *Journal of Coastal Conservation* features a small collection of internationally authored papers concerning the environmental application of geospatial technologies: Geographical Information Systems (GIS), remote sensing, aerial photography and Global Positioning Systems (GPS), visualization and the Internet, to coastal and marine environments.

These papers, nine in total, discuss a wide range of subjects, including the siting of artificial reefs (Green & Ray), marine bird habitats, (Wanless et al.), the distribution of marine benthic biotopes (Johnston & Davison), aquaculture site assessment (Simms), predicting coastal recession (Newsham et al.), the distribution of salt-marsh communities (Brown et al.), landscape ecological succession in a coastal dune system (Shanmugam & Barnsley), changes in coastal morphology (Zujar et al.), and monitoring and mapping of inter-tidal vegetation (Baily et al.).

Remote sensing has, for example, been extensively used for many years as a successful method of gathering environmental data and information that is not easily obtained by any other means. There are many advantages that, dependent upon the sensor used, can include timely, multi-temporal, multi-spectral, repetitive, and large area coverage. Where habitat monitoring is required remote sensing also has the advantage of offering the capability for non-destructive sampling of the environment. Whilst the term remote sensing is most often associated with satellite data and imagery, aerial photography is still a very valuable resource for many applications as can be seen from the work of Shanmugam & Barnesley, Zujar et al. and Simms. Some of the reasons for this are that aerial photography (whether panchromatic, colour or colour infrared) is relatively familiar to the human eye, facilitating ease of use and interpretation, provides high resolution for spatial detail, low-costs for small area studies, and in many cases the need for relatively little additional equipment for interpretation and analysis.

Satellite imagery by contrast, offers greater spectral resolution, large area coverage, multi-temporal images, and in some cases covers sensing of additional wavelengths such as the thermal wave and the microwave. Other remote sensors finding growing application are the Airborne Thematic Mapper (ATM), LIDAR (Light Detection and Ranging) and CASI (Compact Airborne Spectrographic Imager), and as discussed by Brown et al. One advantage of these sensors is the higher spatial resolution. Furthermore, unique data such as heighting for input to Digital Elevation Models (DEMs) can be included. Scale of data is also important, and where habitat mapping is concerned aerial photography from microlights, autogyros, and even model aircraft, helicopters, rockets and balloons have been widely considered. However, the application of remote sensing technology is not restricted to data acquisition above the surface of the ground, as Johnston & Davison demonstrate, showing that remote sensing technology can be applied underwater using acoustic and video remote sensing to gather information about marine biotopes.

More often than not remotely sensed data and imagery are now usually integrated with other geo-spatial data collection and handling tools, e.g. GPS and software and GIS. Good examples are where GPS is used in the field to provide accurate spatial positioning information to aid in the geocorrection of imagery for input to GIS and integration with other map and image layers (Zujar et al.). Accurate location of ground control points is essential in coastal areas e.g. estuaries, where common points on both imagery and maps are difficult to find. Increasingly remotely sensed imagery is being viewed, processed and interpreted within a GIS environment. Geo-corrected imagery can, for example, be combined and overlayed with other thematic information, either for display and viewing purposes or for mapping (Zujar et al.; Green & Ray). Most GIS (e.g. Idrisi, ArcView, ArcGIS, and Manifold) now include cartographic modules (or tools) to assist end users in deriving a map product as output from an analysis.

The visualization capabilities of GIS are also improving very rapidly, adding considerable dimensionality to the viewing environment for both data exploration and visual interpretation. Whilst not all visualization is yet carried out in a GIS environment (see for example Zujar et al.), many examples of imagery (raster) and map (vector) data 'draped' over a Digital Elevation Model (DEM) reveal clearly how the traditional definition of a 'map' is rapidly changing to include 3D representations, animations and even fly-throughs as part of the experience. Export modules also allow end-users to place their geospatial data, originating in either a Digital Image Processing (DIP) system or a GIS, in other software environments to further enhance the visual appearance. Increasingly remotely sensed data is also being analysed and interpreted using ancillary or contextual data from GIS databases. Data derived from remotely sensed data, combined with data from GIS, are also being used as input to coastal process models. Digital photogrammetry and bathymetric data can be used to create Digital Terrain Models (DTMs), and, in conjunction with GIS, they may be used to predict the volume and nature of the sediment yield (Newsham et al.).

Whilst modelling work is increasingly being considered as part of a GIS environment, constraints placed on the potential by information technology e.g. processor power, databases, display and visualization capabilities are rapidly being overcome, enabling closer links between e.g. process models and GIS. More and more opportunities are now arising to utilize the functionality of the GIS toolbox to incorporate a spatial element in the modelling process. Likewise, an increasing number of models are adding display and visualization modules to facilitate output from modelling simulations or scenarios.

Access to data and information is also an important consideration for coastal studies. Increasingly access to local, national, and global data sets is becoming practical through the Internet. A very important consideration for all end-users of such data sets concerns the quality of the data being made available for use in a GIS. To this end, metadata (information about data and information) now accompanies many data sets and metadata standards have been developed. The significance of a detailed knowledge of all data sets e.g. their origin, scale, sampling etc. is very important when it comes to undertaking GIS analyses and modelling reliant upon input from multiple archival or legacy datasets from disparate sources (Green & Ray). The assessment of error associated with a data set and cumulative error in an analysis is vital if use is to be made of the results or model output. More attention also needs to be focused on the provision of tools for error assessment and reporting in commercial GIS products, together with emphasis on raising awareness, education and guidance, particularly as the GIS end-user community profile changes and broadens.

Environmental applications of the Geospatial technologies are now evolving very quickly, largely driven by the rapid developments in IT hardware and software in the form of microprocessor speed, communication networks and software functionality. Already mobile technologies such as Personal Digital Assistants (PDAs), GIS, GPS and mobile phones are being used on a regular basis to gather spatial data in the field. Wireless technology is providing the means to remotely access Internet-based mapping systems and databases for both downloading and uploading data for use in either the field or the laboratory. GIS software is providing new functionality to accommodate geospatial analysis requirements. New remote sensors are being developed that are greatly improving the spatial, spectral and temporal resolution capabilities. Likewise, there is growing interest in empowering the end-user community with new, more user-friendly 'tools' and 'interfaces' to allow for greater use of the geospatial technologies in the workplace, whether it be directed at the research community, the coastal zone manager, or the coastal practitioner. Such developments are also seeking to greatly enhance and to improve end-user awareness and education of the applications of the technologies by the end-user community. To this end the relatively recent developments of the Internet are helping to improve familiarization and frequency of use of geospatial data and technologies through e.g. online datasets and databases, online mapping and information systems, image catalogues and online digital image processing tools, metadata catalogues, online collaborative distributed modelling, and distance learning opportunities.

An example of this type of development is the recently funded EU Nature-GIS project (http://www.gisig.it/nature-gis/), a network bringing together users and experts in IT and in nature conservation. One of the main objectives of this network is to raise awareness of GI-GIS use, to support public access to data and information via the Internet, and to identify specific GI-GIS requirements for 'Nature Conservation & Biodiversity' in European policies. Similarly the provision of online access to both geospatial data and imagery (http://www.theukcoastalzone.com).

Ultimately developments that utilize the Internet and related technologies will greatly enhance the access to data and information for public information, education and research, for input to decision support systems for planning and decision-making. Use of networking and communications technologies coupled with distributed databases, online mapping and GIS, and modelling will also provide new and important opportunities to develop collaborative, participatory distributed networking.

Despite these exciting new developments, it is also important to remember, however, that the geospatial technologies do not offer a solution to every coastal and marine problem we face. They are tools that provide access to data and information to help us monitor, map, and analyse coastal and marine environments at a wide variety of different scales over both space and time. The geospatial toolbox is increasingly an integrated one that is growing ever more powerful, more functional and more accessible to an increasingly wider end-user community from the coastal practitioner to the scientist. By embracing such technologies there are opportunities to greatly improve our spatial knowledge and understanding of the coastal and marine environment through the gathering and processing of geospatial data at a wide variety of different spatial and temporal scales from the unit to the landscape, and increased potential for expanding our capabilities for data exploration, analysis, modelling and visualization. The geospatial technologies add another dimension to our toolbox to gather environmental data and to process it into information.