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Approaches to knowledge sharing and capacity building: The role of local information systems in marine and coastal management

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ABSTRACT

This paper explores how coastal data and information can be mobilised in information systems and applied in coastal management. The concept of an Information System is defined and described, and the potential role of Local Information System (LIS) in integrated coastal management (ICM) is considered. Three examples, from the Severn Estuary, UK the coast of the North West of England and North Wales, and the Fal and Helford estuaries, are used to demonstrate the requirements of a LIS for coastal areas. The role of GIS as part of the solution is considered in detail. The paper demonstrates how ideas from the disciplines of information systems and information science can be practically applied in coastal areas. The findings promote a holistic approach for those involved in the development of technologies and dealing with data and information about coasts and oceans.

1. Introduction

As part of an integrated approach to capacity building for coastal management, the COREPOINT project (see introduction to this special issue) conducted research into data and information management at the coast. Essentially the rationale for investigating data and information management is that a combination of institutional policies (collaboration, standards and strategies) and technologies (datasets, networks and software) should be deployed to improve the quality of evidence which is used to support decision-making. The importance of good information management is highlighted in many recent national ICM strategies [1] and integrated marine policies [2].

The introduction locates this effort in its context and introduces some fundamental concepts. The first section outlines relevant coastal data and information, and describes how Information and Communication Technologies (ICT) have evolved to help the task of information management. However, since nature of decision-making is essentially political, solutions require more than technology, so the paper goes on to consider the data to knowledge pathway and the role of information in decision-making. The paper then continues by describing efforts at international, national, regional and local scales to improve the management of marine and coastal data and information. The importance of regional/local scale is justified and this serves to introduce findings of the research concerning Local Information System implementation in three case study areas. The paper concludes that the concept of an information system is a key organising idea – with two essential dimensions – the technological dimension, which provides many innovations for analysing and communicating information, and the human dimension, involving the challenge of co-ordinating multiple institutions and datasets in objective-led information management.

1.1. Coastal data and information

A huge amount of data relevant to the coastal zone has been and still is collected by a wide range of instruments, samples, and surveys from aerial remote sensing, ship-borne and *in situ* terrestrial observations, as well as socio-economic surveys. Over 25 terabytes of earth observation data alone are being collected each day worldwide [3]. There is even more processed data contained in reports, journals, grey literature, databases, models, indicator sets, GIS and policy documents. Although there remain significant gaps in data coverage, 'data and information overload' is a problem for anyone who is trying to find out about or manage the coast,

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particularly if such information is not catalogued, easily accessible and managed. It is also a challenge to ascertain the quality of available data. At major international symposia since the 1990s, coastal professionals (Engineers, Planners, Surveyors, Tourism and Recreation officers, Developers, Marine Industries, Port Managers, Environmental managers, Conservationists, Wardens, Archaeologists and Scientists) have identified that there could be more efficient and effective approaches for the coordination, sharing and re-use of coastal data and information [4,5].

1.2. Information and communication technologies in the information society

The capabilities of Information and Communication Technologies (ICT) have evolved dramatically in the three decades since Weyl [6] proposed the idea of an 'Information System for the Coastal Zone' and Ader [7] proposed a 'GIS for addressing issues in the coastal zone'. Even since O'Regan [8] sought to comprehensively outline a range of ICTs relevant to the coast there have been significant developments in technologies such as remote sensing, GIS, and the Internet. Despite such advances there are still a number of problems to overcome when trying to apply these technologies in the coastal zone. Firstly, there are technical challenges in seeking to represent the mobile 3D world of the coast, to meaningfully represent poorly understood processes and changing features.[2] Secondly, there are institutional challenges, which arise out of the fact that modern societies have developed complex bureaucracies focusing around either land or sea, with technical specialisation of knowledge. Typically there is not a single 'leading' organisation but rather many organisations that produce relevant data and information. In many respects data and information suffer from the same lack of 'integration' as the rest of coastal management. In order to overcome this fragmentation and to facilitate greater access and improved sharing of data and information a recent trend has been the development of 'networked' and 'interoperable' systems. This approach, whereby datasets are held by their original custodians and the Internet is used to provide remote access to the data and services which allow interrogation of this data (see Fig. 1).

This is the core idea of 'an information system' being explored within this paper. However, since the term 'Information System' is somewhat loosely defined [9], it is useful to set out some definitions of Information Systems as follows:

> "A set of technological, human, organizational, financial, and information resources organized in such a way to produce, archive, retrieve, modify, process, combine, represent, exchange and/or disseminate information with a view to reach the objectives the system is designed for" [10]
>
> 'A system to support the administration of environment, resources and planning tasks by… making information available to executive and public through co-ordinating existing systems and investments by a common architecture' [11]

These definitions highlight that an information system is not a particular technology, but may use different technologies to create an 'architecture' which brings together 'silos' of data to develop a more networked understanding. Intellectually, the task of constructing information systems is investigated within the academic discipline of information science. The field of information systems has developed a number of techniques for the development and assessment of such tools [12]. Increasingly these techniques have begun to attend to 'the human dimension' drawing on concepts such as Cybernetics [13], Soft Systems Methodology [9] and Public Participation GIS [14–16]. At a macro level, societies are experiencing a transformation of the way in which people organise and communicate knowledge. Social commentators such as Castells [17] and Drucker [18] have documented how ICTs have dramatically affected the methods of working in our societies. We are living in an 'information age' where the key challenge is developing the capacity to mobilise the vast amount of information for the purposes of sustainability. These changes may be recognised in the working practices of coastal professionals. The example of a government fishery officer is illustrative. Whilst their present work still includes some 'pre-information age' activities which would have been undertaken 50 years ago, such as chatting with fishermen on the dock about landings, it also includes activities such as surveying the seabed and calculating the biomass of stocks, analysing reports of the impacts of activities on species, and collecting more sophisticated surveillance data. In common with other professions, there is an increase in data and information and more powerful and complex ways of processing and analysing information [19].

1.3. The data to information and knowledge pathway and the process of decision-making

The job of sharing knowledge about the coast involves co-ordinating the efforts of different institutions. A large number of institutions are involved in the process of observing, measuring and understanding the marine and coastal environment and human activities therein. Government agencies conduct research and monitoring, often to support regulatory programmes or planning. Scientific organisations and laboratories collect a wealth of data for research, but this may focus on 'blue skies' research more than the purposes of performance monitoring and management [20]. Consultancies and commercial organisations are commonly commissioned to collect data for impact assessments, and industries such as the aggregates, ports and shipping, fisheries or energy sector require a wealth of data to conduct their operations, although these data may remain private property. Communities and volunteer groups may aim to undertake local monitoring and develop significant datasets [21,22], especially concerning ecology, or may develop a knowledge of the coastal environment through their daily work and living [23]. In the UK, a recent assessment by EFTEC [24] made a conservative estimate of £30 million per annum spent on marine and coastal science and monitoring solely by the government sector. This gives an idea of just how many people have a stake in managing coastal information, and how much must be spent on the task worldwide.

Millard and Sayers [25] use data flow modelling to conceptualise the pathways from data collection to use. This includes data suppliers such as survey companies, those who add value to the data (for example by processing data or developing models) and end users [26]. These flow diagrams reveal many inefficiencies, where it is difficult to find data, or where data get collected once but are not re-used as many times as they could be. In many nations, there is no single organisation with ultimate responsibility to co-ordinate this resource, so it remains a challenge to get organisations to consider a broader perspective for efficient and effective data management [27].

Close examination of the nature of decision-making concerning the coast [28] shows that in reality, decision-making does not happen in the neat, linear way depicted by data flow models. Most significantly, rather than a 'monological viewpoint' with decisions being made by a single person, it is more accurate to view the

[2] The technical challenges include: spatial impermanence (e.g. moving shorelines or species), fuzzy boundaries (e.g. gradients of environmental quality), defining the relationships between entities (e.g. water column and seabed), and the disjointedness of datasets across the land-sea divide (e.g. mismatch of elevation and bathymetry data)