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THE MARINE IRISH DIGITAL ATLAS: A WEB PORTAL TO COASTAL AND MARINE DATA IN IRELAND

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Abstract

Currently in Ireland, there is no single source where people requiring coastal and marine information can go to visualise and identify relevant datasets and determine where to acquire them. The Marine Irish Digital Atlas (MIDA) will be both a repository for geospatial data and an informational tool, incorporating text and multimedia elements related to coastal and marine resources in Ireland. The atlas will be easily accessible via an Internet browser, therefore enabling experts and general users to identify, visualise, and query all datasets and information relevant to their interests. A web-enabled GIS based on the open source software MapServer forms the core of the system, allowing the user to select and view multiple layers of geospatial information. Comprehensive metadata is provided via an XML database. Additional educational information on the various thematic data is available in the form of text, audio, video and other multimedia elements. When complete the MIDA should become the most comprehensive source available of data and information on Ireland's coastal areas.

1. Introduction

In comparison with many other European Union countries, Ireland has a significant quantity of data for the coastal environment available in digital format. Nonetheless, those interested often find it difficult to identify and retrieve relevant data. This is in part due to its being dispersed among numerous organisations that play different roles in the management and research of coastal areas. While this may give the impression that there is a lack of coastal and marine information, in reality much of this data is trapped by institutional, technological and political factors that impede its accessibility (Furness, 1994).

The Internet provides an increasingly powerful and popular means of disseminating up to date information to a wide audience. In Ireland, Internet usage rates are currently estimated by the Commission of Communications Regulation to be approximately 40% (Scope Communications Group, 2003). With the Irish Government committed to increasing broadband availability, usage of the Internet will increase over the coming years. Some Irish organisations have plans to take advantage of this medium and make inventories of their data holdings available over the Internet (e.g. Irish Marine Institute, Geological Survey of Ireland). These initiatives will certainly improve awareness of datasets within these particular organisations, however they only partly respond to the needs of users for improved information and access to data and information on coastal resources.

The Marine Irish Digital Atlas (MIDA) project, a three year project which started in September 2002, is using the latest in web-enabled GIS technologies to bring data and information on Ireland's coastal and marine resources to this growing on-line audience. The key objective of the project is to develop an Irish digital marine web portal which will be both a repository for geospatial data and an informational tool that will appeal to a wide audience, ranging from marine scientists and administrators to educational establishments and the general public. Geospatial datasets from numerous organisations across Ireland will be collected for display in the atlas. Data, text and multimedia elements related to resources and activities in coastal and marine areas of Ireland will be incorporated into the atlas to make it informative for anyone interested in the Irish coast. It is imperative that the atlas provides technical data and information to experts while also being a source of general information which can improve awareness of coastal issues for the general public.

The specific objectives of the project are:

- To develop a **web-based atlas** for the presentation of georeferenced coastal and marine datasets that are relevant to end user needs.
- To improve accessibility to data and information by developing a customised **open source web GIS**.
- To provide an **intuitive interface** that is rich in functionality.
- To enable users to access extensive **metadata** via an **XML database**.
- To encourage a greater appreciation of Ireland's coastal regions by incorporating **educational and informational materials** based on multimedia technology.

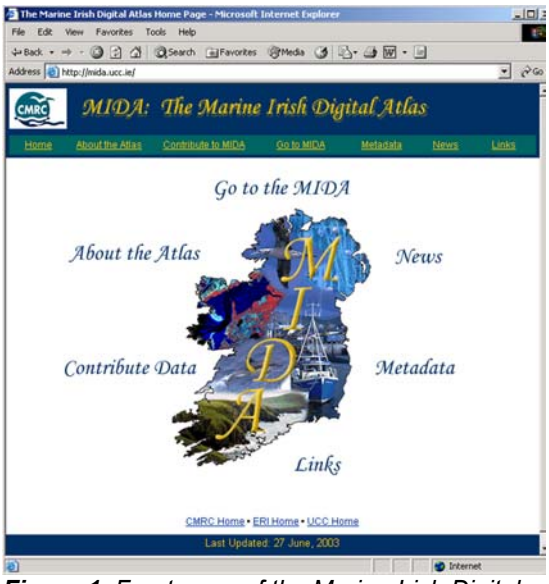

Figure 1. *Front page of the Marine Irish Digital Atlas (http://mida.ucc.ie/).*

This paper describes the current status of the atlas. A description of the technology chosen for use is given, and the various components in the atlas are discussed, including data, metadata, and educational features. The initial atlas prototype is then described. Finally, significant issues which have arisen in the development of the system to date and plans for the future are discussed.

2. Overview of Digital Coastal Atlases

A number of digital inventories or atlases of coastal information have been compiled over recent years. As technologies have developed, digital atlases have progressed from simple customised GIS distributed via CD-ROM to more complex and easily accessible web-based GIS. In 1998, the United Kingdom Digital Marine Atlas (UKDMAP) brought together over 1600 thematic charts of information on the coastal and marine areas of the UK in a simple GIS, which was distributed to interested users via CD-ROM (BODC, 1998). Since then, web-enabled GIS have been developed and are quickly being adopted by many organisations to generate coastal atlases around the world in order to improve visualisation of and access to coastal data. These systems allow users at remote locations to view and analyse geographical data held on one or more servers via an Internet-connected web browser. A number of online coastal atlas systems are currently available. The Australian Department of Environment and Heritage have coordinated the development of an Australian Coastal Atlas (2003), which is a network of Commonwealth and state/territory nodes using a variety of interactive mapping tools to provide information about the Australian coastal environment. A number of US states have also produced coastal atlases (e.g. Oregon Coastal Atlas (2003); Washington Coastal Atlas (2003); Florida Coastal Atlas (2003)). In France, the French Research Institute for Exploitation of the Sea (IFREMER) has developed an information system focused on its coastal regions (IFREMER, 2003). Many other examples of web-enabled GIS used for presenting natural resource data exist (Dwyer & O'Dea, 2002).

The MIDA Project aims to take the concept of a national web-based coastal atlas to a new level. Existing atlases tend to target a particular audience and may be too simplified for an expert or too complex for a member of the general public to use. MIDA intends to address this by consulting with representatives from a broad spectrum of potential user groups during the prototype evaluation phase. There is also a tendency for existing web-based atlases to serve simply as data display tools which provide basic GIS functionality, without providing a generalised educational component about the various layers included. MIDA will offer a web GIS based multimedia educational resource that will appeal to a broad audience, while also providing a comprehensive inventory of coastal dataset

holdings across Ireland in order to facilitate data and resource sharing between organisations and scientists. This will be done using open source technology wherever possible to enable sharing of technological knowledge and resources.

3. System Architecture

3. 1. Overview

The MIDA system is made up of a number of interrelated parts, as shown in the generic model displayed in Figure 2. A server stores the data and atlas elements, as well as carries out the geoprocessing tasks, while user access is via a web-enabled interface. The main components are described below.

Server and Data Repository: A dedicated computer contains the data and the software required to implement and enable the system. Three types of data are held in the data repository:

Geospatial Data: The main datasets to be served by the system consist of vector and raster geographically referenced data and imagery.

Non-geospatial Data: Non-geographically referenced datasets (e.g. photos, text, animations, audio) are also to be served by the system.

Metadata: Metadata for all geospatial data held in the atlas are accessible to the user, and are presented in three levels of increasing detail.

Geoprocessing Services: A range of basic GIS tools such as zoom and identify functions are provided to allow interractive exploration and real-time processing of the geospatial data.

User Interface: The atlas will be accessible via a web browser. From the MIDA web site, the user will be able to visualise and query geospatial data. Non-proprietary datasets will be downloadable. Users will also be able to query the metadata database and access relevant educational information.

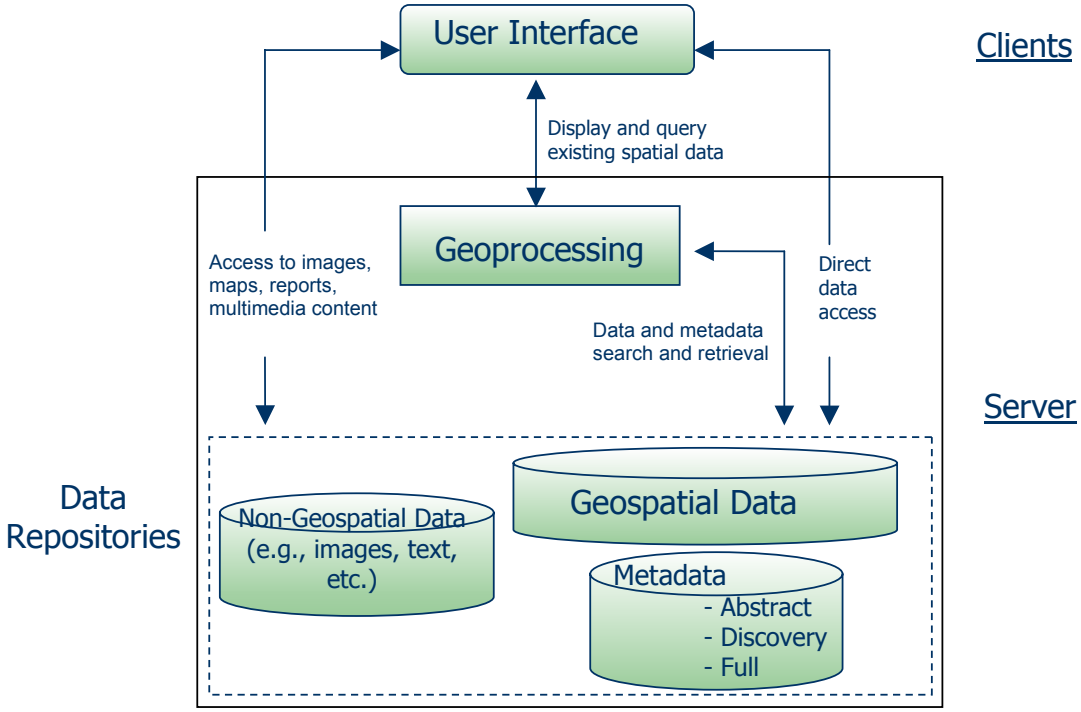

Figure 2. *Elements that make up the MIDA system (based on the INSPIRE model, Smits et al., 2002).*

3.2. Hardware Characteristics

Due to the highly interactive nature of both the web GIS and metadata server components of the MIDA, the server must be able to handle network traffic to receive and respond to user queries. In addition it must handle security issues and maintain the integrity of the database. Table 1 shows the characteristics of the server.

Requirement	Specification
Data Repository	292 GB
CPU	1.8 GHz Single Processor
Operating System	Linux Red Hat 7.3
RAM	1 GB
Bandwidth	100 MB
Backup	LTO Tape, RAID 5 System (redundant power supply)
GIS	MapServer
Database	XML

Table 1. *Characteristics of the MIDA server.*

3.3. Web-Enabled GIS Software

As web-enabled GIS is still a young technology, the number of web GIS programmes that can be considered for operational use is still relatively limited. The MIDA team evaluated several programmes that are sufficiently developed to offer a minimum of "out of the box" functionality for the MIDA (Dwyer & O'Dea, 2002). Those reviewed include ESRI ArcIMS, Intergraph GeoMedia WebMap, and the open source software MapServer. Criteria considered included (i) range of functionality, (ii) ease of customisation, (iii) dependencies on other software, and (iv) cost. Expertise of researchers with hands-on experience of different packages assisted in the evaluation process.

Based on this review, MapServer was chosen as the system to use to develop the initial prototype atlas. MapServer is an open source development environment for building spatially enabled Internet applications. While it is not a fully featured GIS system, it does provide enough core functionality to support MIDA's needs (MapServer, 2003). In addition to the core functionality, it can be customised and expanded using scripting languages such as JavaScript, Perl, PHP, and Java, among others. Code can also be shared, which improves the flexibility of the package. MapServer is working towards compliance with the Web Mapping Testbed (WMT) criteria of the OpenGIS consortium. As open source software, there is no financial cost involved in acquiring or using it, which is a significant advantage.

4. Data Management

4.1. Data Organisation

Spatially-referenced data is the main constituent of the data repository, consisting of raster and vector layers displayed in the Irish National Grid System. As the final atlas is expected to hold up to a few hundred data layers, it was imperative to develop a structure into which the many datasets could be organised. There is no accepted schema for categorisation of coastal and marine related datasets; it very much depends on the goals and aims of an individual project. The categorisation implemented in the MIDA is hierarchical, with four main categories which contain a number of sub-categories. Figure 3 shows the first category levels and some sub-categories for one level within the atlas. The hierarchy attempts to group similar entities into meaningful sub-categories so that the data and information can be quickly and easily navigated. The hierarchical data structure will facilitate the addition of data layers as they become available without impacting the overall structure, so the atlas can be easily expanded.

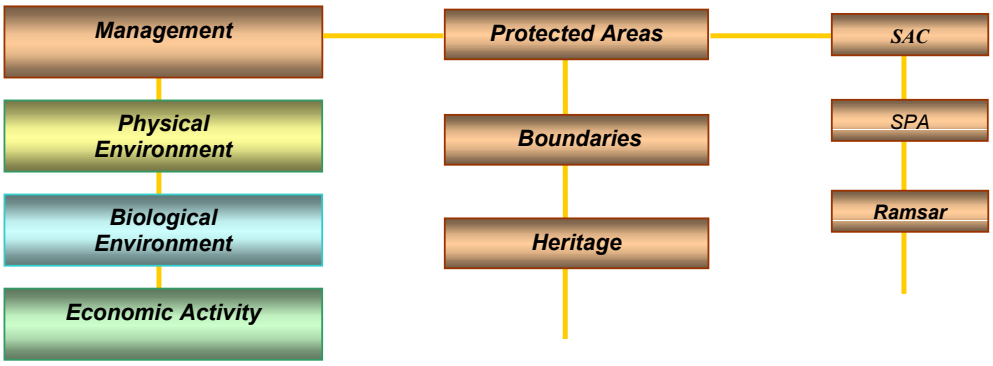

Figure 3. *The four main data categories and some of the sub-categories within the MIDA.*

4.2. Geographical Extent of Datasets

There is no consensus as to how far on either the seaward or landward side a coastal atlas should extend. There is a plethora of definitions of the coastal zone, where often the definition fits the context of the application under discussion. This may be because no two coastal areas are the same, and therefore no two coastal areas can be managed in quite the same way (King and Green, 2001). A pragmatic approach is taken in defining the coastal zone in the context of this project. On the seaward side, the atlas will attempt to be as complete as possible to the 50 m depth contour. There will be exceptions, especially in relation to the definition of administrative boundaries (e.g. fisheries boundary), where the limit will extend to the boundary itself. On the landward side it is even more complicated. The coastal area may be influenced by phenomena occurring many kilometres away (e.g. pollution from rivers). Administrative boundaries also vary near the coast, with different administrative bodies having jurisdiction over areas that extend landward and seaward by different amounts. The terrestrial area to be considered in this atlas will be defined on a case-by-case basis for each thematic topic.

Ideally, datasets for the atlas will cover the entire coast of Ireland, however many important and comprehensive datasets exist for particular regional and local areas (e.g. Bantry Bay, Co. Kerry; Lough Hyne, Co. Cork). Where such datasets are considered to be of significance and interest to users and are informative in their own right, they will be included in the atlas. These will enable scientists to determine more easily existing research and potentially reduce redundancy as well as encourage cooperation.

4.3. Data Scale and Quality

In GIS it is common to utilise layers from multiple sources, and therefore most likely generated at multiple scales. This can lead to inaccuracies, particularly when the GIS is used as a decision-making tool. With a web-based mapping system, it can be assumed that the general user will not be aware of this issue. In the MIDA this problem will be taken into consideration in the representation of the various datasets, partly by setting scale limits for each dataset in the atlas in order to restrict the range of scales at which a particular layer can be viewed. For example, a coastline layer that was generated at 1:250,000 is best viewed at a small scale (e.g. Ireland), and a separate 1:15,000 coastline layer is best viewed at a large scale (e.g. a bay). By setting scale limits on both layers within the web GIS, the small scale layer will appear when the user views the full extent of the atlas. As the user zooms in and the scale drops to 1:15,000 or less, the 1:250,000 layer displayed in the browser is replaced by the 1:15,000 layer.

As the data to be incorporated in the atlas is sourced from many organisations and is heterogeneous by nature, the quality also varies. As discussed in Bartlett and Bruce (2001), the concept of data quality is difficult to define. In the context of a GIS it could include, at a minimum, consideration of *scale, accuracy, data precision, logical consistency*, *dataset completeness* and *data lineage*. Although it is impossible to influence these characteristics of the data during the assemblage of the atlas, it is

important to document each dataset as fully as possible using the metadata associated with each layer. This enables users to judge for themselves if the data meets their needs.

4.4. Data Collection

Once the hierarchical structure of all datasets to be incorporated in the atlas was defined, organisations and contact names where the data could be sourced were noted. A collection priority was then assigned to each layer. Certain baseline information such as coastline, transport links, etc. were seen as vital base information, therefore data from Ordnance Survey Ireland were sourced first. Data within the CMRC and the university were then identified and collected in order to build the protoype atlas, discussed below. Currently, contact is being made with various potential data suppliers within both public and private organisations across Ireland to inform them of MIDA activities and to encourage them to supply data and information for the atlas.

5. Metadata

Metadata forms an integral part of the MIDA by documenting each dataset held in the atlas in a consistent way. ISO 19115 was adopted as the metadata standard, because most key organisations handling spatial data in Ireland and internationally intend to adopt it. Existing standards bodies such as the Federal Geographic Data Committee (FGDC) in the US and the European Committee for Standardisation (CEN) also intend to migrate their existing metadata standards to correspond with the ISO standard. The atlas contains three levels of metadata: *abstract*, which provides a brief summary of the dataset; *discovery*, which consists of core metadata elements and serves as the central MIDA metadata database; and *full*, which is supplied by data owners. Hyperlinks within the atlas will allow users to move easily between the different metadata levels.

5.1. Abstract Metadata

The abstract metadata consists of a simple description of each dataset. It is the first level that a user sees when they choose to view the metadata for a particular layer. It is simply extracted from the discovery metadata database and displayed.

5.2. Discovery Metadata

The Spatial Data Infrastructure (SDI) Cookbook, produced by a working group of the Global Spatial Data Infrastructure (GSDI), describes discovery metadata as “the minimum amount of information that needs to be provided to convey to the inquirer the nature and content of the data resource. This falls into broad categories to answer the ‘what, why, when, who, where and how’ questions about geospatial data” (GSDI, 2001). Because of the diversity and number of organisations that will be contributing datasets to the MIDA, the creation of a discovery set of metadata selected from ISO standards best serves the project’s efforts, rather than attempting to conform to the complete, comprehensive ISO standard. Various examples of discovery metadata that are used internationally were evaluated and referenced to determine what would be best for the MIDA (e.g. ANZLIC, Australia; NGDF, UK). The eight categories of data in which elements are placed are shown in Table 3. The section names are not those of ISO, but were chosen to aid navigation and understanding of the table by users. A total of 55 elements are included in each record. Of those, 35 are displayed in HTML for each data layer; the others are hardcoded and are included in order to conform to ISO core metadata requirements.

- Dataset
- Dataset Source
- Contact Information
- Description
- Dataset Status
- Metadata Information
- Geographical Information
- Access and Use

Table 3. *Section headings for MIDA discovery metadata elements.*

A web-based discovery metadata entry tool was developed which saves metadata records in an XML database that can be queried by the atlas user. XML was chosen because it is an open standard, is platform independent and enables easy exchange of information with other organisations. The XML tags used are defined in the ISO standard, and individual records can be exported and stored locally by a user if desired.

5.3. Full Metadata

The full metadata files displayed in the atlas are supplied by the data owners who contribute their datasets, and are not stored in the MIDA XML database. Each full metadata page is displayed in HTML as the owner provides it, therefore its quality, standardisation, and completeness is the responsibility of the data providers themselves and not of the MIDA development team. The full metadata can be downloaded in its native format.

6. Educational Resources

Fundamental to the atlas are informative and educational materials on each data layer. This material is presented as text, image, video and other multimedia elements and can be accessed by selecting a layer within the atlas. An example is shown in Figure 4. The aim is to give the audience an understanding of the environment, research areas, resources, and management issues regarding Irish coastal regions. As well as data collection, an important task for the project team will be to distill related information by editing text and selecting appropriate imagery in order to provide informative material that is understandable to all users.

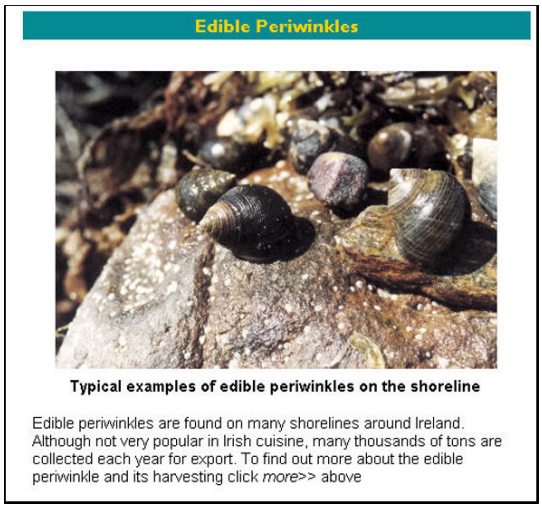

Figure 4. *Example of educational materials presented using text and images.*

7. Prototype Development

The atlas prototype demonstrates some of the functionality of the MIDA and displays a selection of data layers that will be contained in the completed atlas. This demonstrator will be used to solicit data contributions from various organisations around Ireland. In order to incorporate end-user feedback in the final atlas design, the prototype will also be shared with a selected group of people that span the various potential audience groups.

The atlas design process began by researching numerous existing web GIS sites and determining features that were either useful or burdensome. From this list, a model was designed on paper which brought together the best features and took negative qualities into account. Several issues had to be considered, including maximising the utilisation of space in the web browser, the best means for handling the large number of layers, what tool functions would best suit the atlas goals, and how to

present educational information on particular layers. Figure 5 shows the main page of the prototype. Note that the information frame is a dominant feature, the map view takes up a large proportion of the browser window and the layer list is expandable. The majority of the functionality occurs in the tabbed windows below the map frame. Datasets selected for inclusion in the prototype were chosen from the four main categories (table 2), in order to represent the full range of data to be included in the atlas.

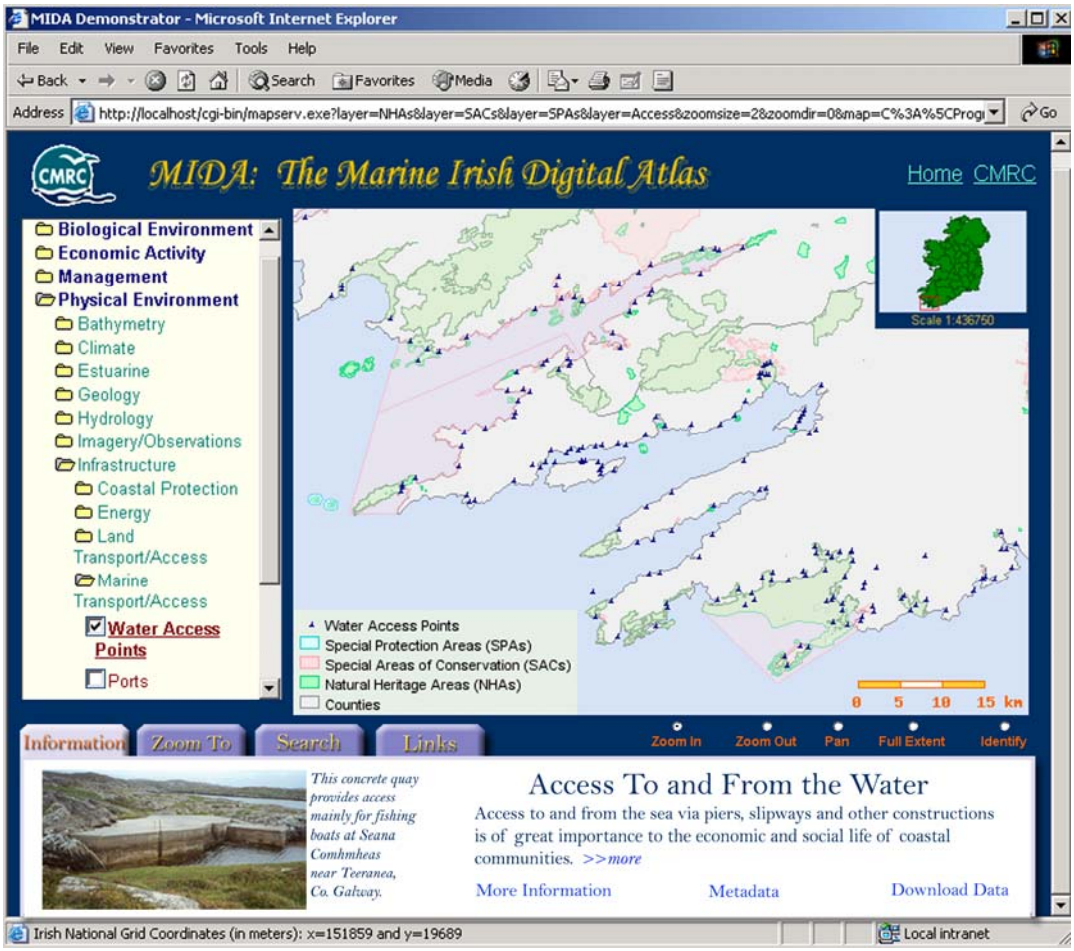

Figure 5. *Main prototype atlas page. This prototype is in its early stages of development, but displays some of the basic functionality that the main page will have.*

8. Discussion

The MIDA project faces a number of challenges, including those related to the sourcing and acquisition of data, preparation of data for presentation, acquiring and handling of metadata, and data cost and licencing. Encouraging institutions and individual researchers to provide data to the MIDA is a significant task. There is often a fear among data holders that ownership of the data may be lost or that MIDA will disseminate commercial or sensitive information. It is vital to explain that the atlas is a medium for publicising data availability and that the characteristics of datasets supplied can be tailored to the data owners' requirements. For example, the prototype layer of a periwinkle survey carried out on the Irish coast identifies the geographical location and survey data of all the sampling points, in addition to general information on the periwinkle industry in Ireland. Sensitive information, such as mollusc density and wholesaler financial details, are not displayed. Users who are interested in this information must make direct contact with the data owner, whose details are provided in the discovery metadata. The prototype demonstrator will be used to show the flexiblity of the MIDA during this data acquisition phase.

Despite the availability of a large quantity of digital data, much of it cannot be directly input to the MIDA without some manipulation. Small changes involve conversion of files into Shapefile or GeoTiff format, reprojection to Irish National Grid and resampling. Larger changes such as the cleaning of the vector layers, the creation of polygons from line features, and generating features from coordinates in data tables are very time consuming. For this reason the MIDA team will only collect data that is in a completed state and requires minimal manipulation in order to be included in the atlas.

Acquiring adequate metadata is another challenge for the MIDA. For many datasets in Ireland, metadata is poor or non-existent, so much so that even generating discovery metadata is difficult. It is hoped that the MIDA's web-enabled metadata entry tool will ease the burden for data suppliers to provide a minimum level of metadata.

The cost of displaying some datasets may be a limiting factor in the quality and quantity of data presented. Use of data from organisations such as Ordnance Survey Ireland and the U.K. Hydrographic Office has significant financial costs due to the licencing agreements. In the current phase of the project, some key datasets (e.g. high and low water marks) are provided for the MIDA project at academic cost, however when the atlas goes live on the Internet, the licence agreements will have to be reviewed and costs are likely to increase significantly. A recent study by the U.K. Department of Environment, Food and Rural Affairs (DEFRA) investigated challenges and developed a strategy regarding dissemination of geographic information for the U.K. marine and coastal zone. In the study, the cost of key base maps was seen as a blockage to the adoption of digital products. A key recommendation of their report was that government be encouraged to adopt a strong policy regarding provision of base datasets at a reasonable cost, particularly those produced by the Ordnance Survey and Hydrographic offices (DEFRA, 2002). The EU INSPIRE initiative also encourages the wider dissemination of key datasets by providing access and visualisation of certain key datasets free of charge, while having harmonized pricing across the European Union for delivery and download of such data (DPLI Working Group, 2002). Within the MIDA project, a budget for acquiring data has been allocated. However, the long term sustainability of the atlas will have to be addressed during the lifetime of the project in order to avoid developing a product which will have no ongoing maintenance and where certain datasets may no longer be available due to lapsed licenses. The MIDA will therefore help draw attention to costs for certain key datasets which are relevant to public needs in Ireland as well as participate in the base dataset costs debate within EU member states.

The major objective of the project will be to meet user needs and to raise the profile of the MIDA, so that the atlas is identified as the main entry point for anyone interested in finding information on Ireland's coastal and marine environment. The atlas can achieve this by becoming the repository for the largest quantity of high quality data and information regarding coastal areas in Ireland available on the Internet today. Information on the existence of the atlas will need to be disseminated to as large an audience as possible, via newsletters, academic and general publications, newspapers, other organisations' websites, conferences and personal contacts.

9. Conclusions

In Ireland there is a pressing need to pull together existing sources of coastal and marine data and provide an accessible and intuitive portal for people requiring coastal and marine information. The MIDA intends to do this through the power of the Internet by centring the portal on a web-enabled GIS, while also providing an educational resource on various aspects of the Irish coast. Users will be able to visualise available datasets, query specific features, determine dataset sources through metadata, as well as learn about subjects of the various data and pertinent coastal and marine issues in Ireland. As a result, the Marine Irish Digital Atlas should become an indispensible resource for both marine professionals and the general public alike.

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