

Implementing an interoperable global Mangrove dataset in Oracle Spatial

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Abstract

UNEP World Conservation Monitoring Centre (UNEP-WCMC) has been compiling mangrove data for over 10 years. In 1997 this led to collaboration with the International Society for Mangrove Ecosystems (ISME) to combine and improve mangrove information holdings.

The mangrove dataset is now under review and UNEP-WCMC, as part of a joint initiative with other organisations, is working towards the release of a major update. The implementation of an interoperable system has improved the efficiency and quality of the updating process for both the spatial and aspatial databases. Utilisation of an online interactive map service (IMapS) is bringing together all the contributions that are being made around the world by different collaborators, providing a quick and easy way to validate, submit and track information provided from a multitude of sources. The IMapS has been developed using ESRI and Oracle Spatial technologies to utilise the tools and capabilities of both systems.

Introduction

Mangroves are of great environmental and economic importance. They contribute a rich genetic diversity, provide homes for a wide variety of species and act as a buffer zone between terrestrial and marine ecosystems. They also provide valuable goods and services for many local communities. However, mangrove ecosystems have also been severely damaged

by human activities including urban development; agriculture; development of shrimp aquaculture; and influxes of pollutants. Drastic loss of mangrove forests has been observed in tropical and sub-tropical countries all over the world. Close ecological connections exist between the three major tropical coastal ecosystems (coral reefs, seagrasses and mangroves) and therefore the conservation of mangroves is essential for the survival of all these ecosystems.

History of the Dataset

In 1997, UNEP-WCMC, in collaboration with the International Society for Mangrove Ecosystems (ISME¹), compiled a global dataset showing mangrove distribution, broad species ranges and species diversity. These data were published in a "World Atlas of Mangroves". The next major revision of these data is now underway and is working towards the release of the next edition of the Atlas. This review of the Mangroves dataset is being undertaken in collaboration with the Food and Agriculture Organization of the United Nations (FAO²), the International Tropical Timber Organisation (ITTO³), ISME, the United Nations Educational, Scientific and Cultural Organization - Man and the Biosphere Programme (UNESCO-MAB⁴) and the United Nations University (UNU⁵).

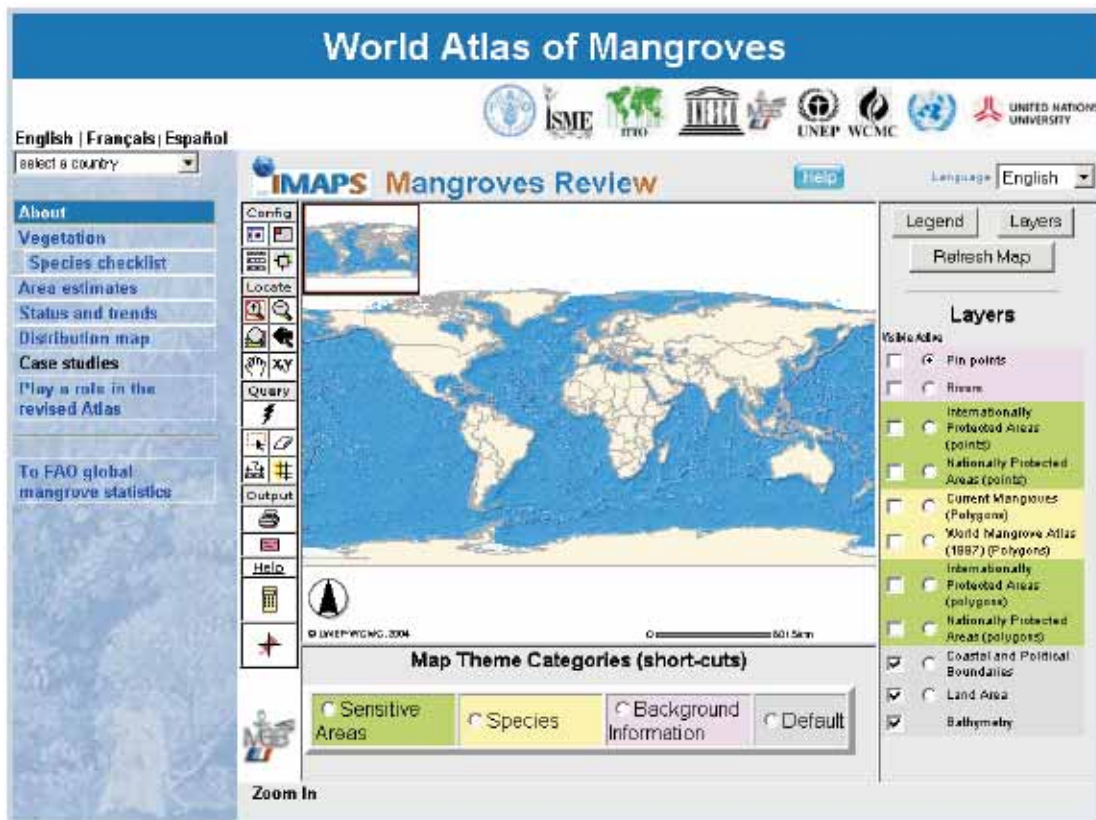
Management and Development of the dataset

To develop a global dataset that is accurate and consistent for all areas around the world requires input from a large number of local and regional experts as well as a standardised evaluation process of existing data. The majority of the GIS data collected for the 1997 mangrove atlas was originally sourced from paper maps and was hand digitised at UNEP-WCMC. Some sources also came from data provided digitally by other organisations but these are virtually all were vector based. In the current update the range of data sources has increased, utilising both vector and raster data (including information produced from satellite images). The scales of the acquired data currently vary from very high resolution to some low resolution depending on availability of information for all mangrove areas across the globe. This means that a very robust system is needed for storing and managing and analysing this variety of data. Depending on funding it is hoped that this major review will update mangrove information for every country.

The current global dataset of Mangroves is held as a polygon layer within ArcSDE on SQL Server 2000. The dataset represents the result of data collected and collated for the 1997 Atlas of Mangroves (Spalding et al, 1997), the Mangroves of East Africa (Taylor et al, 2003) and recent data updates as part of this latest initiative. Alongside this is a raster layer containing 'potential' mangrove areas generated from in-house processing of satellite images which is currently in the development and review stage. To add value to the data collected for the Mangroves Atlas and to give full acknowledgement to the contributors, the individual features source information and associated metadata is stored in a separate database linked to the Mangrove layer using a unique code. The structure of the feature attribute table has recently been reviewed to allow the incorporation of species information within the layer where such information is available. This global mangroves data is accessible through a customised interactive map service (IMapS) (see Appendix 1) that has been developed as part of the data update and review process. When displayed through the IMapS the source information is available as a hyperlink from the specific feature selected. In addition to this the mangrove layer and associated IMapS each have an ArcCatalog record that will be made available through online metadata catalogues. UNEP-WCMC extensively customises ArcIMS to meet the differing requirements of different projects.

IMapS Review

The Mangroves Review Interactive Map Service (IMapS) has been developed by UNEP-WCMC to provide access to the global mangrove dataset. During the development phase, the aim of the IMapS is to facilitate discussion and collaboration between the partners in the World Atlas of Mangroves initiative. The core functionality allows users to compare the data from the 1997 World Atlas of Mangroves and the Mangroves of East Africa report (2003) as well as the data collated under this World Atlas of Mangroves Initiative. The IMapS hosted by UNEP-WCMC is a central part of the data gathering and review process and has been fully integrated into the project website hosted by FAO.



To access the Mangrove IMapS go to the FAO website and click on Distribution Map via: www.fao.org/forestry/site/mangrove-atlas/en

Or directly from UNEP-WCMC at:

<http://stort.unep-wcmc.org/imaps/marine/mangroves/>

IMapS Review – Customised tools

The Mangrove Review IMapS contains all of the standard functionality that allows the user to zoom in, zoom out and pan around the map as well as special customized tools that have been

developed to improve the functionality of the IMapS. UNEP-WCMC has developed a unique functionality using Oracle Spatial technology that enables users to submit a comment on a specific location or upload electronic files such as GIS data, photos or reports that may be of use for improving the dataset. All contributors are encouraged to use the IMapS to focus discussions on the data quality and ultimately to agree the layout of the final maps for the atlas. An online calculator tool has also been developed to generate mangrove area statistics in km² from the latest dataset for a user-selected country. A particularly useful feature allows collaborating Centres can also share map views with other collaborators via the e-mail map tool, which sends an email that provides a link to the same map extent and visible data layers as the current map view. This eliminates the need to send large images via e-mail and has the advantage of always linking through to the latest information within the current mangrove dataset.

(See Appendix 2 for further information regarding the customised tools.)

Once the Atlas is completed it is envisaged that the IMapS will continue to be made available providing the public with online access. This will encourage the continual development of the global mangrove dataset, always displaying the latest information. This will supersede the Atlas which will contain a snapshot of the dataset at the time of publication.

How is this implemented through ESRI and ORACLE?

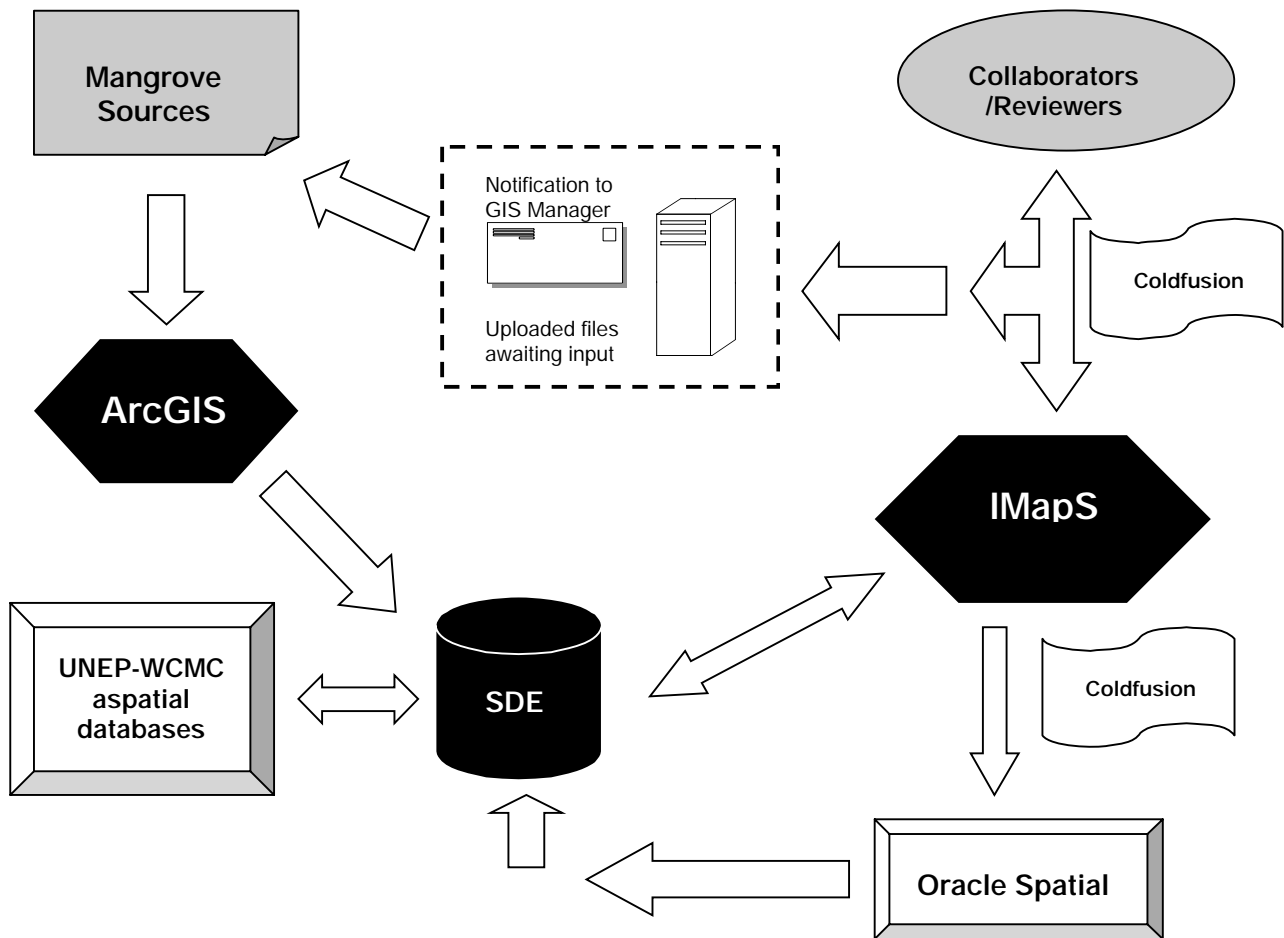
UNEP-WCMC has had a long history of links with ESRI and has maintained a GIS Programme since 1989. As such all management, analysis, storage and presentation of GIS data are undertaken within the Centre using ESRI products. The Centre is currently using ArcGIS 9.0 to manage the spatial data, ArcSDE 9.0 for storage and ArcIMS 4.0.1 to present data over the Internet. The latter is currently in the process of migrating to ArcIMS 9.0.

In terms of UNEP-WCMC's spatial databases, the Centre uses both SQL Server 2000 and Oracle 9i with a long-term plan to migrate completely to an Oracle based database structure. Spatial database management is beginning to utilise a combination of both ArcSDE and Oracle Spatial to maximize the functionality available within both systems. In order to access these layers via ESRI front end tools it is necessary to register the Oracle Spatial layers with the ArcSDE.

The Mangrove polygon layer is based on Oracle Spatial to allow the generation of GIS based instantaneous statistics using Oracles SQL queries for spatial tables. These statistics include the area of Mangroves in a country and the area of Mangroves under protection through international or national conventions. All layers involved in such analyses need to be imported into Oracle Spatial database.

UNEP-WCMC has also made extensive use of Macromedia Coldfusion MX to access data from its databases over the web. ColdFusion allows connection from the GIS attributes through to additional information held within different databases such as the World Database on Protected Areas (WDPA), map data source and species data. The Mangrove IMapS utilises ColdFusion to add a point to the mangrove comments layer held within Oracle Spatial when a reviewer adds a comment using the customized comments tool, it also sends an email alerting the GIS data manager of the submission and stores any uploaded files onto the UNEP-WCMC server (see Figure 1). The immediate updating of the mangrove comments layer allows the reviewer to track the progress of the comment and see when their information has been incorporated into the mangroves layer.

Figure 1: Flow diagram to show the interoperability of the global mangrove dataset.



Internal and external Interoperability

Current activities at UNEP-WCMC are linking GIS information with aspatial information held within the Centre and within other organisations. The mangroves review process links the spatial mangrove data containing species information to related information held in the Species Conservation Database (SCD) and the World Database on Protected Areas. This will add value to both the spatial and aspatial data.

Externally, the mangrove layers can be incorporated in reviewers' own GIS systems by connecting to the image server housed at UNEP-WCMC. Reviewers can then produce maps that incorporate the current global layer alongside their own datasets.

Conclusion

Mangrove ecosystems are of huge environmental and economic importance. The Mangrove GIS layer held within UNEP-WCMC represents the best estimate of their Global distribution. By updating the layer with the best available information from national and regional sources it is hoped that the layer and associated outputs will provide a valuable resource for planners, policy-makers and decision-makers to better manage their mangrove ecosystems.

Through the development of the interoperable mangrove dataset combining the ESRI, Oracle Spatial and Macromedia technologies it has been possible to create a system that allows the

full participation of national and regional experts whilst maintaining a high level of quality control within UNEP-WCMC. By making the process as transparent as possible it is hoped that it will encourage collaboration as well as assist the end users in understanding the data provided. By combining the Mangrove layer with other data layers and aspatial datasets it is been possible to produce analyses that draw upon wide and varied data holdings.

Acknowledgements

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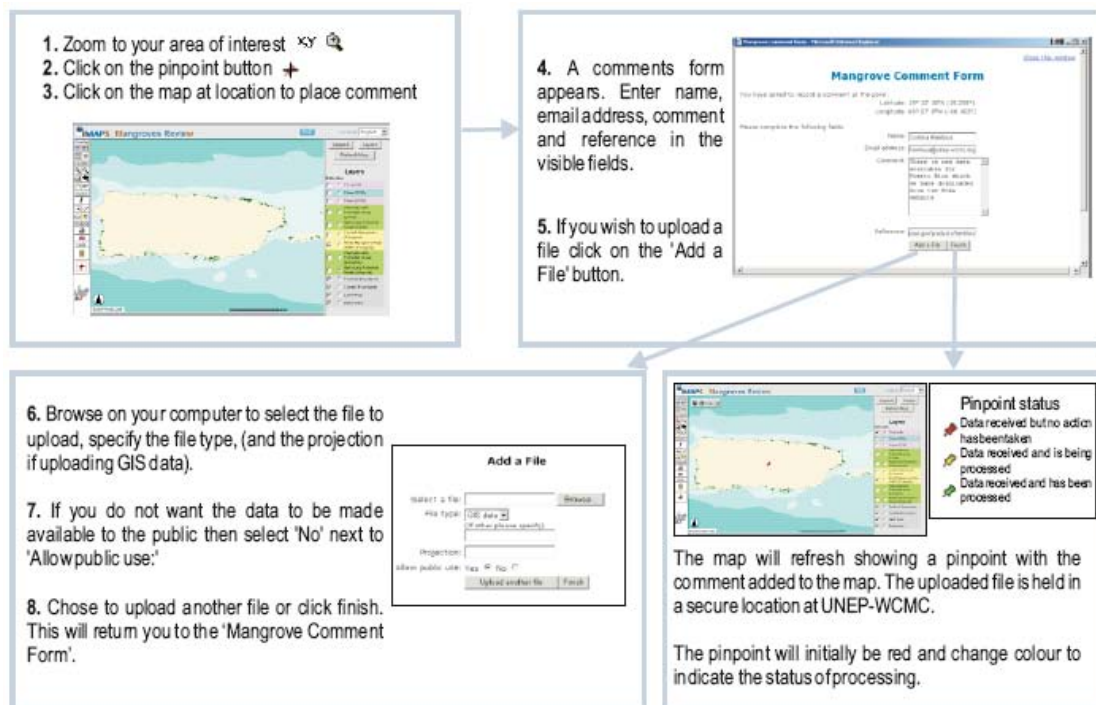
Appendices

Appendix 1 Interactive Map Services (IMapS)

IMapS is the umbrella term used to define a series of online mapping services provided by UNEP-WCMC to facilitate access over the Internet to their GIS based environmental data. Individual IMapS have been developed to provide different functionality and mapped products to support different needs. The outputs range from small static maps created dynamically with no additional functionality through to complicated fully interactive maps that allow the user to display a range of different layers together to produce a highly individualised map of anywhere in the globe as well as obtain other information related to that location.

Appendix 2 Mangroves Review IMapS Customized Tools

Comments / Upload Tool



E-mail Map Link

The e-mail map tool is designed to allow users to share their current map view with colleagues by sending an email which provides a link to the same map extent and visible data layers as the current map view. This eliminates the need to send large images via e-mail and has the advantage of always linking through to the latest information within the current mangrove dataset.



Calculator

The online calculator tool generates mangrove area statistics in km² from the latest dataset for a user-selected country. Alternatively the query tools can be used to view the area and other attributes of individual selected mangrove areas

Hyperlink Tool

The mangrove and protected area layers have specialised attribute information available for querying through the hyperlink tool. To access the attribute information:

1. Make the layer active by clicking on the radio button (☐) next to the layer name.
2. Click on the hyperlink button (⚡) in the left-hand toolbar.
3. Click on the feature of interest on the map.

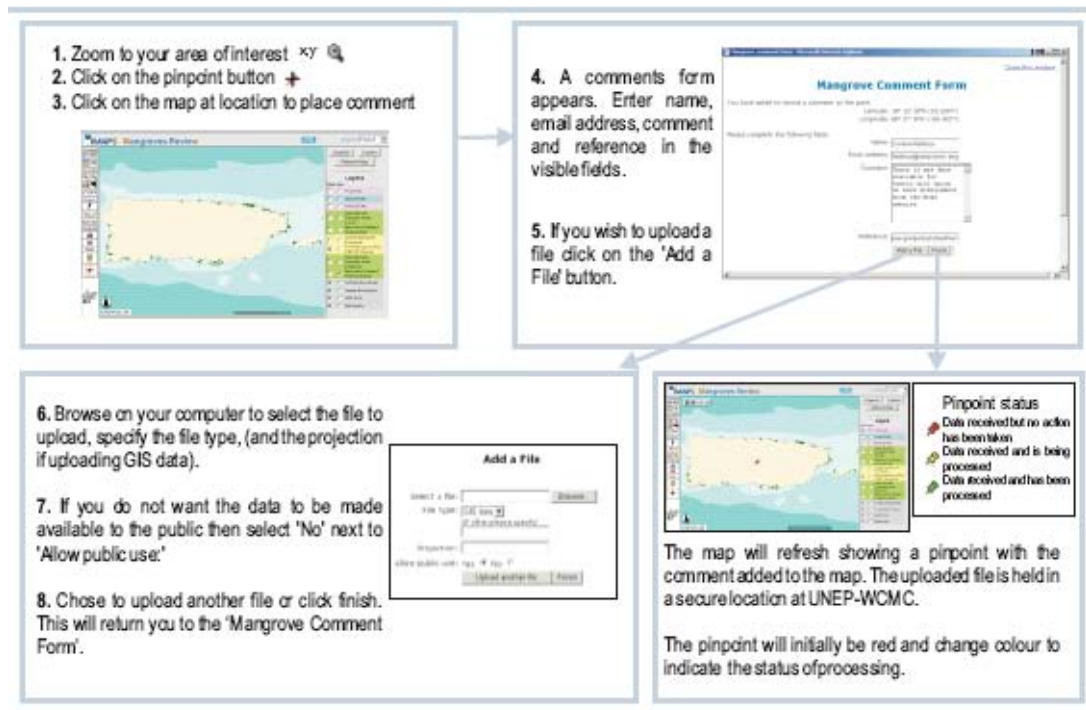
If your selected feature has this attribute information a new pop-up window will open containing that data.



How to add a comment and upload a file

The Mangrove IMaps can be used to send information about mangroves to UNEP-WCMC. These can be in a wide variety of formats, whether it be purely a comment on the known existence of mangroves at a particular location, photographs, textual reports, map images or GIS data.

For mangrove distribution we prefer to receive information in a GIS format, i.e. georeferenced data files. We can deal with many file formats either in vector (e.g. shapefiles) or raster (e.g. images such as grids, geotiffs or .img files). We can deal with any necessary data conversion into a standard format at UNEP-WCMC. However if GIS data are unavailable, maps in formats such as .tif, .jpeg, .bmp or .gif are much better than no data at all. If data are not available in electronic form, paper maps can be sent to UNEP-WCMC at the postal address below.



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² The Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla, 00100 Rome, Italy (www.fao.org)

³ The International Tropical Timber Organisation (ITTO), International Organizations Center, 5th Floor, Pacifico-Yokohama 1-1-1, Minato-Mirai, Nishi-ku, Yokohama, 220-0012 Japan (www.itto.or.jp)

⁴ The United Nations Educational, Scientific and Cultural Organization - Man and the Biosphere Programme (UNESCO-MAB), 7, Place de Fontenoy, 75352, Paris, 07 SP, France. (www.unesco.org/mab/)

⁵ The United Nations University (UNU), United Nations University Centre 53-70, Jingumae 5-chome, Shibuya-ku, Tokyo 150-8925, Japan. (www.unu.edu)