COASTAL AND MARINE RESOURCE INFORMATION SYSTEM (CMARIS): A SPATIAL APPROACH TOWARDS SUSTAINABLE ECOREGIONAL MANAGEMENT

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KEY WORDS: Decision Support, Databases, Mapping, Marine, Coast, GIS, Internet/Web, Ecosystem

ABSTRACT:

The Sulu-Sulawesi Seas comprise one of the most biologically diverse marine ecoregions in the world. Situated at the center of the coral triangle, the ecoregion hosts at least 450 species of corals, significant populations of marine turtles, critical mangrove and seagrass habitats, marine mammals, including commercially important species collectively supporting multi-billion dollar fishing industries and subsistence livelihoods for a population of millions from Indonesia, Malaysia and the Philippines. Dedicated to the sustainable management and conservation of the area, WWF launched the Sulu-Sulawesi Marine Ecoregion (SSME) Program in 1999 to address the continued decline of marine resources and biological diversity comprising the Sulu-Sulawesi Seas. Prior to the implementation of the project, the Coastal and Marine Resource Information System, or CMARIS, was established to support the program, as well conservation activities in the region, by providing information crucial to the strategic conservation planning and management processes. CMARIS offers a computer-based information system, featuring an online Spatial Decision Support System (SDSS) and a database retrieval system for relevant documents, statistical information, environmental law concepts, and resource centers contact information. It seeks to improve the current system for collection, organization, accessibility and delivery of coastal and marine resource information and provide an effective means to help policy makers gain understanding of the potential impacts of specific policies on the marine environment.

1. INTRODUCTION

In 1998, the World Wildlife Fund (WWF) conceptualized an ecoregion-based approach to conservation, identifying more than 200 ecoregions around the globe. An ecoregion is defined as relatively a large unit of land or water containing a geographically distinct assemblage of natural communities that share a large majority of their species, dynamics and environmental conditions. Contrary to conservation at smaller scales, this approach is more beneficial and widespread, due to the fact that key ecological processes supporting the component ecosystems are largely intact within a single ecological boundary.

The SSME is recognized as having the highest marine biodiversity in the world. With an approximate area of a million square kilometers, the ecoregion contains extensive mangrove estuarine assemblages, marine plants communities and coral reef habitats sprawled along the coastal areas of the three countries. However, these marine ecosystems and the natural resource base they support are constantly threatened as human population growth, over-consumption, destructive fishing practices, poorly planned development, pollution and insufficient conservation resources take their toll.

Recognizing this growing threat, the SSME program developed an overall framework and an ecoregional conservation plan bringing together various stakeholders from Indonesia, Malaysia and the Philippines. The plan spells out specific actions to be undertaken at the local, national and ecoregional levels for the protection of marine wildlife population, conservation of key sites in the SSME, establishment of institutional mechanisms necessary to pursue the ecoregion program, networking with relevant local, national and regional programs and institutions, and the coordination and management of the SSME Conservation Planning process.

The overall management associated with the concept of an ecoregion dictates the need for a wide variety of information available on the coastal and marine resources, development patterns, socio-economic trends, and the political context. The availability of an easily and universally accessible information database with an analytical engine for policy-support will greatly facilitate the decision making and consensus-building processes among the various stakeholders of the SSME. This recognition has led to the development of CMARIS as a system that provides an interactive display of coastal, marine and other related information and serves as an analytical and heuristic tool to facilitate a broader understanding of marine policy issues in the context and perspective of a shared marine ecoregion.

CMARIS was designed to integrate spatial environmental data with referenced legal, statistical, and institutional frameworks supporting three levels of ecoregional management –from an ecoregional-perspective, at national scales, down to site-specific conservation areas. Tools are provided to help in evaluating the constraints and opportunities in the management of these coastal and marine areas through the deployment of an online-GIS support system, integrated with a database management system to magnify the impact of geographic information technology towards marine conservation.

Overall, CMARIS supports three related core activities:
- Provision of a customized interactive computer-application capable of processing marine and coastal spatial information in GIS format and a database retrieval system for relevant documents, statistical information, environmental laws and regulations, and resource centers made available through the web (www.cmaris.net) and in CD-ROM version
- Provision of maps of various scales presenting specific levels of management – Ecoregional,

national, regional and site specific - accessible and available on-line for manipulation and analysis
- Provision of a policy-support module driven by a SDSS Engine to enhance decision-making and implementation of conservation management activities through the availability of GIS technology and spatial information on the web

In time, CMARIS plans to facilitate education, training and technical assistance in the use of spatial information technologies to accelerate the on-going shift from fragmented management of individual marine resources towards an integrated management of the coastal and marine ecosystems found in the region. It will continue to promote local, regional and international cooperation and partnership towards the establishment of a network of GIS experts/users in the ecoregion and the Asia-Pacific region.

2. COMPONENTS

CMARIS is devoted to the collection, organization, storage, retrieval and dissemination of information on coastal and marine resources in GIS format and relational databases of non-geocoded data and information.

Below are the components of CMARIS:
- Map Library
  - Spatial Decision Support System
- Statistical Information Database
- Documents Database
- Resource Center Database
- Environmental Law

Overall, the system uses GIS technology to produce large scale maps ranging from 1: 5000 to 1: 250000 scale showing the distribution of mangroves and coral reefs, coastal boundaries and bathymetry, and other hydrographic, oceanographic, and biological layers. It organizes annotated bibliographies and marine legislations and conventions in a Documents Database. Non-geocoded but essential attributes on trade and consumption, statistics on marine products, and socio-economic indicators are contained in its Statistical Information Database. The Resource Center Database provides contact information of various agencies and partners involved in coastal and marine resource conservation. While the Environmental Law Database features law concepts and regulations supporting coastal management. Most importantly, the Spatial Decision Support System or SDSS, which can respond to queries and provide decision support for various policy situations.

2.1 Map Library

The Map Library or the Marine and Coastal Spatial Database, is the primary database of CMARIS. This spatial database has been subdivided based on the data formats: a raster-based Map Library, consisting of a collection of GIS maps in (jpeg) raster format and presented in various themes and scales. It presents cartographic overlays of biophysical, social and economic information about the coastal and marine resources. Data comes from a variety of sources, including aerial photographs, remote satellite data and images, GIS maps, survey information, existing maps and other source documents.

The Map Library directly links to a policy-support module that has the ability to respond to queries and provide decision support for various policy situations using GIS-based maps.

The underlying engine of this module is the SDSS, which uses GIS technology to serve as primary and essential input to the analytical overlay of thematic maps through the web. Maps can be viewed and displayed together with its associated information (attribute). This enables various levels of management to review current projects status, undertakings and operational performance with the help of maps and other useful visual tools derived from a database of related information.

Map layers and composites are generally categorized according to the geographic coverage of the map (*Figure 1*):
- Ecoregional: Support to the Sulu-Sulawesi Marine Ecoregion Program
- National: Support to country-wide spatial data-gathering initiatives for Indonesia, Malaysia and the Philippines
- Regional / Sub-regional: Support to regional and sub regional delineations based on administrative regulations or physical characteristics
- Provincial: Information presented on a provincial scale or the corresponding level of administration among the three countries
- Site Specific: Incorporation of available and existing spatial data on WWF project sites, sites of special concern, marine protected areas, priority conservation areas and other sites of important conservation initiatives

To promote ease of use, the SDSS has been structured to provide for an easy and friendly environment to serve digital maps and update existing database over a wide area network. The user interface has been designed so new users can easily figure out how to access, edit, update, compose and view maps. The user has the ability to administer and manage the GIS maps and database online. Supplemental and useful information are also provided to users in the form of tables, charts and graphs in response to queries.
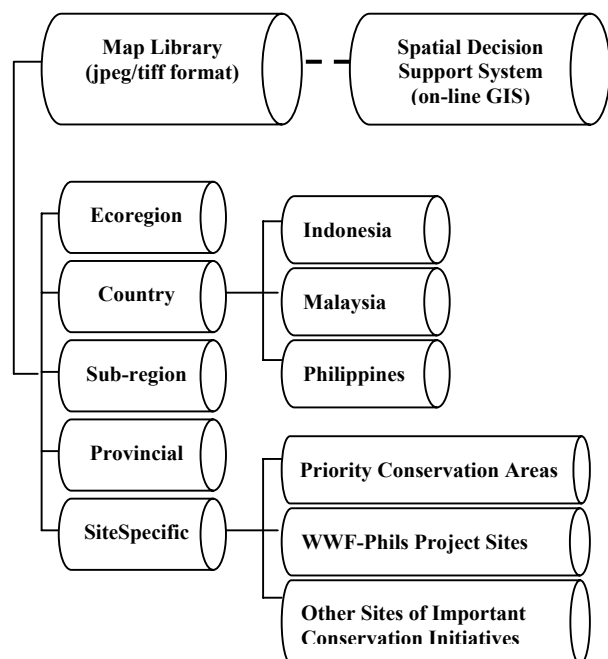

Figure 1: Map Library database structure

SDSS Design

The SDSS design requires a secure web-based system accessible through the internet. Users of CMARIS and SDSS are categorized into two classes: secure and non-secure users. Non-secure users can browse the website and view general information in a read-only fashion. Secure users can log-in using user-ids and passwords to view propriety portions of the SDSS and update information in the database. This was specifically designed for the system's future network configuration.

Overall, the system employs a fast, efficient and secure client-server multi-threaded architecture that delivers information to many users over an intranet or on the Internet. Some of the major characteristics of the design are:

- Graphic User Interface (GUI)
  The GUI is simple, fast and efficient, in recognition to a wide variety of users - from scientists, managers to researchers. It conforms to existing project structures of organizations and supports drill-down logical queries.
- Map Display and Query System
  This module support functions such as zoom, pan, query and SQL. It displays maps, photos and images, run video and audio clips. It contains predefined spatial queries and solutions, which targets spatially oriented needs, such as, Project Location, Coverage Area/Sub Areas, Project Stations or Sites, and Themes or layers of information.
- Database Engine and Architecture
  The engine provides a web updating system that automatically updates MS Access Records of the GIS, and without any difficulty in updating specific records in the databases.
- Feedback and Reporting Module
  This module enables the exchange of information between online users, based on the following options: form to email, email-to-email system, and intranet chat features. Composition of reports consisting of tables, charts and graphs is easily accomplished in response to queries.

2.2 Statistical Information Database

The Statistical Information Database contains pertinent non-geocoded marine data and information on essential spatial attribute data on trade and consumption, fisheries related matters, statistics of marine products and regional wide social economic indicators.

It allows for the storage and retrieval of attribute data in support to the GIS-based Map Library. Inputs to the system contain statistical reports and other publications, which can be easily downloaded by the user.

2.3 Documents Database

The Documents Database maintains an inventory of marine and other textual documents, which are organized to provide for on-line encoding and document search facilities.

In this section, documents are categorized into 56 categories (e.g. aquaculture, biodiversity, biological) and further subdivided into 21 document types (e.g. abstract, articles, book, CD-ROM) based on the specific author. Details of each document are provided, such as the document type, topic category, area of concern, document title, author(s), abstract, date published, and the source / resource center.

2.4 Resource Center Database

The Resource Center Database holds a directory of organizations and institutions where coastal and marine data is available. The resource name and focal person, contact information, the institution's mandate, major areas of focus/projects, and the website address are provided for each record. The user has the option to view, update a record, or add new records to the existing database on-line.

2.5 Environmental Law Database

The Environmental Law Database holds an updated textual database containing annotated information on various environmental laws and regulation concepts, sea and marine legislation, conventions, bilateral and multilateral agreements.

Data is organized based on the particular topic or theme it adheres to. Details include the title of the law/regulation, the category, and a short description citing the particular listing related to it. The user is also allowed to add new records on-line.

Currently, the database holds 981 records, which are categorized into the following:
- Biodiversity
- Constitutional Provisions on the Environment
- Energy
- Environmental Impact Assessment
- Fisheries
- Forestry
- Indigenous Peoples
- International Environmental Law
- Lands
- Marine
- Mining
- Pollution
- Protected Areas
- Toxic Waste
- Water Resources

Recently passed laws and policies in the country were added into the database as well as links to international laws, which directly affects the ASEAN region. Incorporation of such laws is seen as part of the future enhancements of the system.

3. NETWORK CONFIGURATION

3.1 Existing Set-up

CMARIS is currently being managed by the Conservation Research, Mapping and Systems Development (CRMSD) unit of WWF-Philippines, and is physically located at the headquarters in Manila. The system, as well as data from various sources, is centrally stored in the CRMSD server.

To support ecoregional spatial data gathering initiatives among the three countries, a network composed of GIS technical personnel of the WWF offices supporting SSME was established. This network aims to promote the use of CMARIS as the main repository of ecoregional spatial data and other support information. Data layers are continuously provided by the GIS teams and are standardized to promote ease of

interpretation and manipulation from an ecoregional scale down to local scales.

To cope up with the rapid increase of information entry at various levels and formats, the hardware infrastructure has been assessed and upgraded to provide for a central storage facility with easy management and access.

With the current set-up, there is a need to standardize GIS mapping and data formats within the ecoregion, as well as the parameters supporting an ecoregional-wide GIS implementation.

3.2 Future Configuration

With the availability of future financial support, it is envisioned that CMARIS will expand to create country nodes or hubs to directly support countrywide data gathering initiatives. This will reflect an enterprise-wide system of implementation catering to the mapping standards and formats set by each country, yet directly supporting the agreed ecoregional standards, when it comes to spatial information.

The existing system will be restructured to allow country nodes to access and integrate spatial data and information across the three countries. The new CMARIS will be able to simultaneously support multiple operating systems, with the capability of capturing and storing information from the different countries and external sources, unify it and leverage for the benefit of a wide range of users.

The new set-up would facilitate consistent updating of information, standardization of formats and parameters, wider data-sharing and accessibility, country ownership and full support, as well as a wider-cast information net that will allow for better decision making and planning at various scales of management. Duplication of effort will also be avoided.

Finally, in support to the new system implementation, future infrastructure and database enhancements will be in placed to meet the growing user requirements, with additional manipulation and analytical spatial tools regularly integrated into the SDSS. Hardware and software upgrades will be sustained to attain higher efficiency in implementing an extensive yet centralized system configuration.

4. CONCLUSION

The availability of vital coastal and marine information is the key towards establishing effective conservation and management plans for the ecoregion. Information is seen not only as an important dimension of capacity building and communication, but also as an important tool for decision-making processes.

WWF has recognized the importance of maintaining information on a structured and integrated database system, capable of making information accessible to a wide variety of stakeholders in the ecoregion.

With sustained efforts, CMARIS can become a powerful conservation tool for the SSME, for it is designed to be aligned with the long-term strategic direction of ecoregional management, and directly supports the future implementation of the conservation plan at the national and local scales.

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