Background:
The Defense Coastal/Estuarine Research Program (DCERP), sited at Marine Corps Base Camp Lejeune (MCBCL), NC, is designed to conduct applied research on the composition, structure, and function of coastal and estuarine ecosystems. This program provides a unique opportunity to integrate the results of broadly scoped ecological research with the Base’s need for sustaining its military training mission. To accomplish this goal, MCBCL and its surrounding environment was subdivided into five ecosystem modules (i.e., Aquatic/Estuarine, Coastal Barrier, Coastal Wetlands, Terrestrial, and Atmospheric) and one Data Management Module. Each ecosystem module developed an integrated monitoring and research program to study the effects of changes across ecosystems. The backbone of the DCERP monitoring, research, modeling, and management tools is environmental data that are collected throughout the duration of the program. To facilitate the storage of this data and create a permanent repository for these data collected during DCERP, the Data Management Module is developing information management systems to support data analysis, model integration, and collaboration. The Data Management Module is highlighted in this fact sheet.

Data integration, data sharing, and data management will be key functions of the DCERP Data and Information Management System (DIMS). The Data Management Module will standardize the input format of data across the other modules, such as date and time formats, standardization of measurement units for monitoring and research parameters, and metadata collection.

Objectives:
The purposes of the DCERP DIMS are to initially support the data management needs of DCERP, and ultimately, to support MCBCL’s long-term, ecosystem-based data management needs by improving planning and operational decision-making processes. The DCERP DIMS will provide useful and scientifically sound data and information in a framework for supporting ecosystem-based management tools. Due to the extensive types and volumes of baseline data that currently exist (historic data) and that will be collected during the DCERP baseline monitoring and research program, it is essential that a comprehensive data management plan be developed and implemented to ensure that these data are accessible to researchers across modules. General categories of data to be collected and managed include the following: structured data (e.g., monitoring and research data), unstructured data (e.g., Web sites, reports, and publications), and spatial data (e.g., vector and raster).
Technology Description:
The DCERP DIMS is a Web-based information and decision-support system for ecosystem-based assessment and management. These computerized data systems will enable efficient, secure, and accurate input, analysis, integration, display, output, and sharing of data. These systems will also enable broad data management functions that are necessary to support the complex Information Technology (IT) environment, various end users, research collaboration, and complex and voluminous environmental data. The DCERP DIMS consists of the following distinctly constituent systems: Monitoring and Research Data Information System (MARDIS), Document Database, the Collaborative and public Web sites, and a Web-mapping application.

MARDIS:
MARDIS is designed to optimize data storage and retrieval for integrated analysis by serving as the long-term repository for DCERP tabular and geospatial environmental monitoring and research data collected from each ecosystem module that will be managed in a standard Relational Database Management System (RDBMS). All modules will have access to these data, which will be password protected and controlled to ensure data integrity. Metadata standards have been developed to ensure that all tabular and geospatial data in MARDIS are of known origin and known quality and that there are processes in place to assess, verify, or approve new data uploaded into the system. An important, but often overlooked, step in information management is data organization and standardization, which provides structure to the raw data so that they can be processed, recorded, and analyzed. For MARDIS, a standardized Electronic Data Deliverable (EDD) format is required to maintain compatibility across ecosystem modules and reduce complexity of the data-loading process.

MARDIS is designed to be flexible so that it can expand and grow to accommodate new types of data and data management tools and could be integrated with MCBCL’s future data management systems. Microsoft (MS) SQL Server RDBMS software will provide the required database management functions and features necessary for MARDIS. The following figure illustrates how researchers will upload and verify successful storing of data into MARDIS.

The DCERP MARDIS upload process
Document Database:
Rather than storing and managing raw data (such as monitoring data), the Document Database will store and manage a variety of documents, such as spreadsheets, SAS files, text documents, reports, maps, and research publications, that provide valuable information for DCERP. These files will be managed within the database and will be searchable via explicit metadata that describe the content of each file.

The Document Database will initially be implemented within the same interface as the collaborative Web site, but will ultimately become part of the MARDIS Web site. In addition, the Document Database will contain the metadata associated with the individual stored documents. These metadata will be maintained in tables within the same MS SQL Server database as MARDIS, and the tables will contain links to the physical location of the documents within the MS SQL Server database.

Collaborative Web Site:
The Collaborative Web site is a place where DCERP Team members can share planning documents, reports of activities, and news and events. It also includes a calendar for scheduling and managing field monitoring and research activities. This Web site is password protected and can only be viewed by the DCERP Team. The Collaborative Web Site was created using Plone™ software because it offers ease of use, functionality, low cost, and platform neutrality and provides DCERP with a system that was designed to make it easy for non-technical users to add, edit, and manage Web site content, as well as for the DCERP Team to collaborate and share information via the Web.

Public Web Site:
The public Web site, which is available at http://dcerp.rti.org, was designed to provide the general public with information about the program, including the mission statement for DCERP, as well as the background, objectives, approach, and benefits to MCBCL. This Web site contains only documents that have been reviewed and approved by the researchers, MCBCL, and the Strategic Environmental Research and Development Program (SERDP).

Web Mapping Application:
In future versions of the DCERP DIMS, there will be Web-based mapping applications, which will be tightly integrated into the query interface, creating a seamless retrieval solution. These Web-mapping applications will allow researchers to interact with, query, and visualize the spatial data in MARDIS.

To ensure compatibility with MCBCL’s geospatial IT infrastructure, Environmental Systems Research Institute (ESRI) ArcGIS Server and ArcIMS technology will serve as the primary geospatial server technology for MARDIS. ArcGIS Server seamlessly integrates the monitoring and research project data with geospatial data management functions to enable the visualization, query, and management of MARDIS geospatial data and allow for the development of sophisticated geospatial models and decision-support tools contemplated to support MCBCL’s future needs. Because MCBCL already uses ArcGIS Server technology, future compatibility issues that could be encountered when MARDIS is transitioned to MCBCL will be reduced.

The geospatial data structure for vector data will mirror the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) format, which was developed by the U.S. Armed Forces and the U.S. Army Corps of Engineers. Military installations all across the United States use this standard for their geospatial data. Because MCBCL currently uses the SDSFIE standard for its geospatial data, translation between MCBCL vector data and DCERP vector data should be relatively seamless. The MCBCL vector data supplied to DCERP and stored in MARDIS will be managed using the same SDSFIE structure used by MCBCL’s geospatial repository. Raster (or gridded) geospatial data, such as satellite imagery and other remotely sensed data files, are stored and managed in the ArcGIS Server geospatial data structures of MARDIS.
Ecosystem-Based Management Tools:
DCERP’s ultimate goal is to develop tools that enable MCBCL managers to identify adaptive, ecosystem-based management approaches. These tools will include models to forecast the impacts of military activities and other stressors and indicators to assess healthy, transitional, or degraded conditions. The complexity and scale of these tools will depend on MCBCL’s needs and the level of funding that is available to the program. The future development of integrated modeling, workflow automation, and decision-support tools will identify and prioritize tool development with MCBCL and DCERP users; identify robust, modular, and sustainable software systems for implementation; and identify data and software protocols and best practices to enhance automation and interoperability. The development of these tools will also evaluate infrastructure, data, and training needs for implementation and develop a proposed time line for implementation. The DCERP DIMS provides an integrated framework for easy access to advanced tools of data analysis; therefore, these efforts will be conducted in close coordination with the DCERP DIMS development, and outcomes of these efforts will be used to refine DCERP’s information system architecture. Module Teams will develop some modeling tools that integrate information from other modules to answer specific management objectives. These tools will serve as a starting point for developing a fully automated decision-support system.

Expected Benefits:
The DCERP DIMS will enable efficient, secure, and accurate input, analysis, integration, display, output, and sharing of data. MARDIS has been designed to allow for the comprehensive analysis of information collected from multiple ecosystem modules. MARDIS provides a standard format to share data among modules and to facilitate and expand analysis of information from the various sources.

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