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WEBGIS BASED DATABASE INFORMATION AND MANAGEMENT SYSTEM (DIMS) FOR MALAYSIA, SINGAPORE AND INDIA

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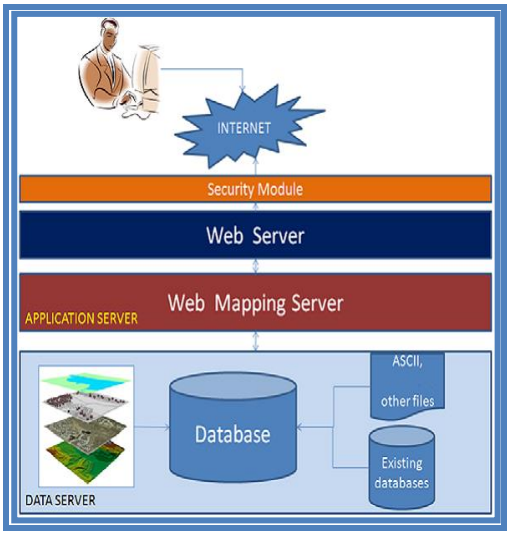
Graphical abstract



DIMS Architecture

Abstract

The main aim of the project is to develop a new Database Information and Management System (DIMS) which is available and accessible online. Success of any modeling is embedded in using the perfect and adequate length of data. This is vital for studying or developing a scientific model for natural processes such as climate change and geo-hazards. Thus a geo-referenced meteorological, coastal and hydrological database for decision-making and policy formulation according to climate change impact has been developed. The objective of this study is to provide the DIMS that will allow sharing of climate change parameters that has impacted on the coast of selected countries. The methodology has online hosting of database combined with rapid data retrieval for both analytical and modeling functions. The outcome of the Web-GIS based DIMS would serve as a decision-support tool and aids for development of an integrated and sustainable management strategies for climate change and geo-hazards. The project has currently a database relevant to selected stations along the coasts of Malaysia, Singapore and India available on the project webpage www.globalclimate-engine.org. The project could be extended to cover the entire database pertaining to the in-land areas of these regions.

Keywords: Database information; geo-natural resource; geographical information systems

1.0 INTRODUCTION

Natural resource management requires a spatial data management with geo-referencing its latitude, longitude and its elevation. The increasing demand for analysing complex environmental issues such as geographical, hydrological and coastal needs a spatial data use. GIS applications are tools that allow users to create interactive queries, analyse spatial information, edit data, maps, and present the results of all these operations. Determining and monitoring changes due to the geo-natural resource zone, sea-coast erosion, bio-diversification, eco-system and climate change assessment, land use changes, etc., for the planning and response to nature and also, man -made disasters are some critical concerns in Natural resource management on geo-Natural resource zones.

Since the demand for sea coast construction and exploitation of resources are ever-growing globally, firm policies are to be developed. A fine decision-making tool is needed to have a control on exploitation of coasts in terms of land and water to a perfect management on these resource

In other words, a readily accessible database which is reliable, updated would be suitable for solving

any such problem. Since a spatial component is likely to be used, an online resource with abundant potential for contributing to geo-Natural resource management should be adopted. Thus the research work's main objective is to develop a new database system for coastal areas of the selected countries namely, Malaysia, Singapore and India.

2.0 LITERATURE REVIEW

Coastal zone management (CZM) has been an issue on both the national and European Union (EU) political agendas for at least 25 years [1]. Coastal areas, around a land-sea interface have become living place for majority of the world's population [2]. Therefore, determining the coastal zone, climate change assessment, land use changes, etc., for the planning and response to nature, and also man-made disasters are some critical concerns in Natural resource management on coastal zones. This has made coastal zones to become Natural resource pressure highest areas [3].

There is an increased potential for holistic defense planning which an international arena has and demonstrates how this can produce a need for improved information systems and the development of international standards [4]. Impacts at the coast depend on on-shore topography. Coastal regions having a gentle topography are more vulnerable than those having a steep topography. The east coast of India is more vulnerable than the west coast, because the former is low-lying and more prone to the occurrence of cyclones than the latter [5]. The detailed review on literatures related to coastal management revealed a need for a perfect database for a better solution.

3.0 DIMS METHODOLOGY

DIMS consist of five applications in its development. (i) Capable of handling much larger database, integrate and interpret data from a voluminous source that might be difficult to achieve by manual methods. Thus, a balanced and coordinated management strategy has been developed for considerably lengthy coast. (ii) DIMS support the development and use of standards for geo-natural resource data definition, collection, verification and storage, which enhances compatibility of data processing techniques between projects and departments, as well as ensuring consistency of approach for a given set of data over a period of time. (iii) The benefit of a shared database (particularly, if the access is provided through internet) is for updating of records, and the accessibility to a common set of data by many different departments or regions that are involved in management of a single project say, a stretch of coast and so on. As a shared database, DIMS framework support reduction or elimination of duplicated records, filling in missing data and thus a potential database for significant economic savings as well as improving efficiency, (iv) Offer efficient data storage and retrieval options and (v) DIMS also provide the ability to model, test and compare alternate management scenarios before a proposed strategy can be planned and implemented to practice.

Computer tools such as ARCGIS allows handling of more complex simulations, apply to voluminous database and also enables compression of temporal and spatial data scales and standards to more manageable scale dimensions.

3.1 DIMS – Content Management System

The Database and information system host on webpage http://www.globalclimate-engine.org uses the content management system JOOMLA which is available online [6]. A Content Management System - CMS is a tool that enables users to create, edit, manage and finally publish a variety of content such as text, graphics, video, document and others, whilst being constrained by a centralised set of rules, process and workflows that ensure coherent and validated electronic content [7].

3.2 Hardware used in DIMS

The University of Nottingham Malaysia has provided with the following VMWARE based system: VMWARE CPU Intel(R) Xeon(R) CPU E5335 @ 2.00GHz VMWARE Memory 1024Mb. The http://www.globalclimate-engine.org website is located at /storage/www folder. The software is the JOOMLA CMS has been used with the software components as shown in Table 1.

Table 1 List of software specifications used in DIMS

Technologies/ Software	PHP 5.1.6
	JOOMLA Content Management System
IDE	Dreamweaver
Web Server	Apache 2.2.3
Database Server	MySQL Ver 14.12 Distrib 5.0.77

3.3 Database Design and Scheme

The architecture of DIMS development is shown in the graphical abstract. The main aim is to design a robust schema in order to accommodate the dataset from the national data collection sheet template and regional data collection sheet template. The template will cover, a large and diverse range of geo-Natural resource and marine aspects including quantitative and qualitative natural and social-economic parameters. In order to host all collected information a detailed robust database schema was designed to accommodate the contents of both national and regional data collection sheet.

4.0 WEBGIS BASED DIMS

The GIS based DIMS displays climate change related parameters and database information on large interactive maps using Mapserver. It is a web mapping server available online as open source server. The application requests GIS data and MapServer-specific files, namely, Map file and HTML template files through the Mapserver program. In fact, every object is defined on the online map, including data layer, scale bar, geo-map, legend, location, projection and web object.

The object definition is used to define how the map would look if it is presented. The defined objects such as map, legend and scale bar are presented on the online map interface. But for designing the interface, the template files are used instead of Map files. The template file (Mapper) serves the purpose of designing the interface, generating mapping tools etc. This DIMS – GIS framework uses all open source datasets as well as dataset provided by country representatives.

4.1 System Development

The system development includes the organization of spatial data, GUI and interactive Web mapping and development of data management tools - catalog tools to provide metadata information about the spatial layers.

The development of the system is based on web based client-server architecture. The server side software components consist of several servers working in tandem, including Apache, web mapping server, and Java applications for visualisation. The web mapping server handles the linkage between spatial objects and non-spatial attribute data stored in a relational database. Together, relational databases and GIS provide powerful tools for organising and analysing environmental data. The climate change coastal resource information system has been designed to be simple, yet flexible [8]. The web based system will allow the users to interactively query and visualise data.

4.2 Graphical User Interface - GUI

The Graphical User Interface (GUI) design contains four parts 1) Map Viewer 2) Tool box 3) Table of Contents 4) Index map as shown in Figure 1. The map viewer will display the various thematic layers compiled through map composition and controlled by set of scripts based on the user selection.

The tool box consists of basic and advanced controls for thematic layers in map display. The table of contents basically lists the thematic layers and their display properties such as legend and symbol properties. The Index map provides the thumbnail view of the each countries like Malaysia, Singapore and India. The map viewer contains the below thematic layers for each country.

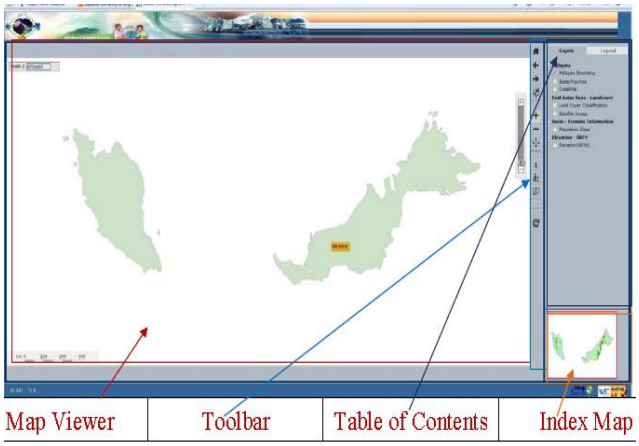


Figure1 Graphical user interface

Legend tab, displays the names of the selected layer and the associated colors of the each layer. To access the each countries datasets CMS will have the link to web mapping server. Below the URL to access the each countries web map portal. The list of data available on the webpage is given in the following paragraphs for three chosen countries for public use.

4.2.1 DIMS for Malaysia

The thematic layers host on the web page http://dims.globalclimate-engine.org/apn/malaysia/map.phtml consists of geo-referenced meteorological and geo-spatial data viz., Country Boundary, Coast Line, City Locations only for West Malaysia, State Boundary, Land Cover Classification, WMS service - Satellite image from NASA, Elevation – SRTM, Climate Parameters, Annual Rainfall, Annual Rainfall Rain day, Wind Speed, Max. Wind Direction, Evapotranspiration, Normal Precipitation, Rain Comparison, RH, Solar Radiation, Temperature Radiation, Maximum Temperature, Mean Temperature, Minimum Temperature and Temperature Comparison.

A sample view of database is shown in Figure 2. Projects and research works related to meteorological studies, climate change and impact on meteorological parameters could be accessed at this webpage. The webpage has graph editor to plot and check for preliminary studies on the data before any modeling and its tests.

4.2.2 DIMS for Singapore

The second major database host online at the project webpage is for Singapore. The portal under the link: http://dims.globalclimate-engine.org/apn/singapore/map.phtml provides Singaporean data for Country Boundary, Coast Line Land Cover Classification, Elevation – SRTM, Population Class and WMS service - Satellite image from NASA. A sample datasheet is shown in Figure 3.

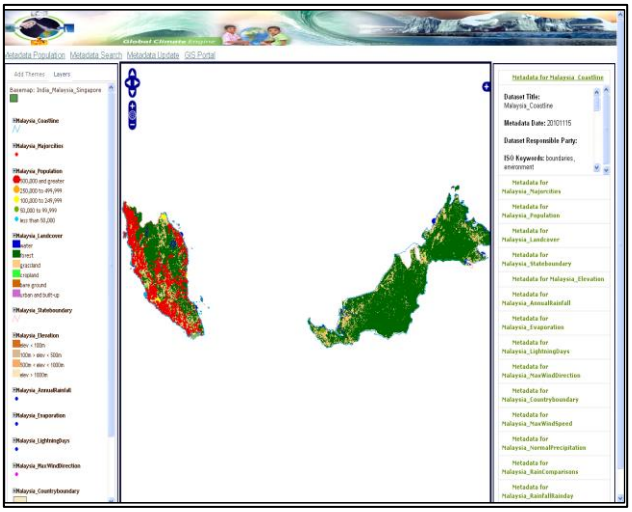


Figure 2 The GIS portal for Malaysia

Figure 3 The spatial data for Singapore with metadata

4.2.3 DIMS for India

Indian database for selected stations are host under the webpage http://dims.globalclimate-engine.org/apn/india/map.phtml. It has Country Boundary, Coast Line, City Locations, State Boundary, Coral Reef – Boundary, River Drainage Network, Land Cover – Classification and WMS service - Satellite image from NASA. A sample datasheet is shown in Figure 4.

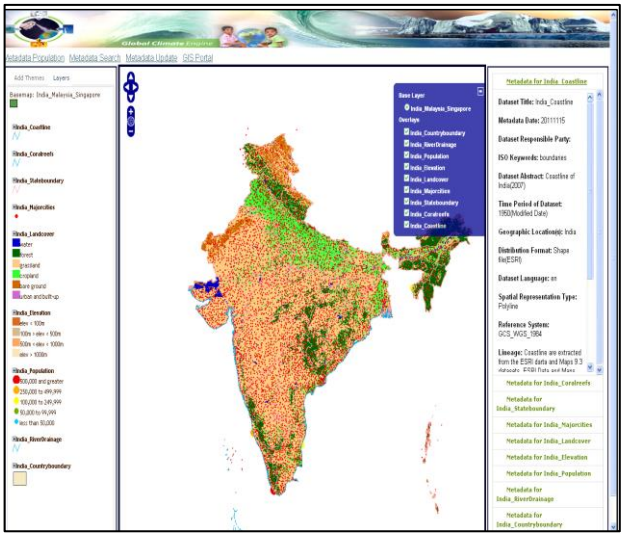


Figure 4 The Spatial data for India with metadata

5.0 GRAPH GENERATOR

Graph generator is a Joomla Component that we developed and integrate into Joomla website. Its main function is to generate a graph based on the tabular data that will be uploaded by application user. Graph Generator can be separated into 2 sections namely Frontend and Backend Administration.

5.1 Frontend Administration

This is the normal application user interface. Once user reached this frontend page, it will be forced to choose either one of the following options namely in- built Data or upload New Data. For "In-built data", the graph generator system will actually read the data from the local database which has been uploaded and recorded from the Graph Generator Admin Page. The user can generate the graph based on the inbuilt data and will able to filter according to a set of queries viz., Country, Station, Parameter, Graph Format, Minutes, Hourly, Daily, Monthly, and Yearly. User is also able to select Graph Type as Normal, Average, Minimum and Maximum.

Normal graph will produce graph as per in the database. Average graph will produce average plot graph in selected period. Minimum graph will produce minimum plot graph in selected period. Maximum graph will produce maximum plot graph in selected period. Once the user click "Generate" button after all filter has been selected, the Graph Generator will produce the graph in Flash format in which can be exported to JPEG image format.

For "Upload New Data", it will force user to upload their own data in CSV format. The sample CSV file also can be downloaded here at http://www.globalclimate-engine.org/components/com_graphgenerator/asset

s/sample/newdata_sample.csv. Once the user uploaded the CSV file, the graph generator will plot the graph in FLASH format, in which later can be exported to JPEG image format.

5.2 Backend Administration

Backend administration is the administration page for the application admin. In this page, the application admin can upload new data for "Inbuilt Data" selection in the front end page. Figures 5 shows the screen shot of Graph Generation online.

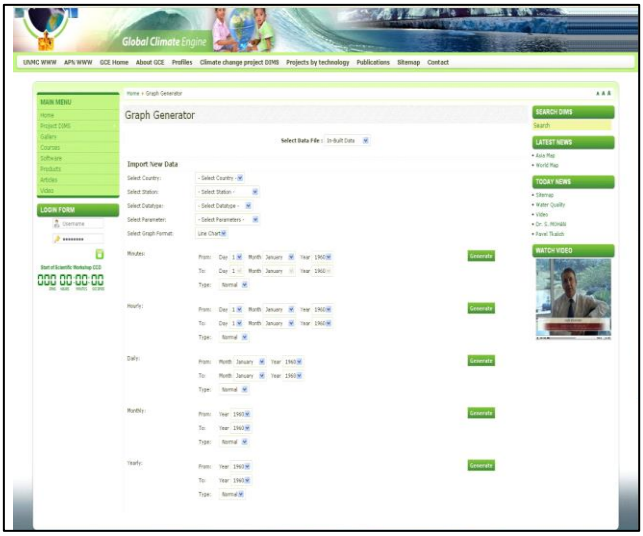


Figure 5 Graphical user interface - in built data import

6.0 FLOOD PREDICATION SOFTWARE ONLINE

Flood Prediction is a Joomla Component that we developed and integrate into Joomla CMS website. Its main function is to generate a graph based on the tabular data that will be uploaded by application user and predict the flood based on the number of years entered in the input box. This Flood Prediction application will be based on data uploaded in CSV format. Sample CSV format data for Flood Prediction application also can be downloaded at http://www.globalclimate-engine.org/components/com_graphgenerator/assets/sample/unmc2.csv.

After the data is uploaded, the graph will be generated and user can then enter the number of years they would like to predict in the "Enter number of years you would like to predict based on the uploaded data:" input box. The graph also can be exported to a jpeg image by clicking "Export Image" link. Figure 6 represents the screen sort of the software available online.

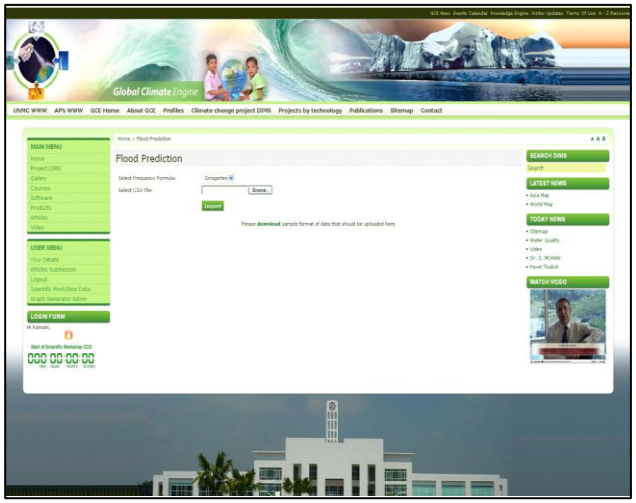


Figure 6 The flood prediction software online

7.0 CATALOG AND METADATA SYSTEM

A metadata catalogue system is developed to store, update, and search for metadata that describe the datasets used in the project. The screenshot below shows the metadata population page where data custodians can use this page to create metadata for their dataset. The standard for the metadata is based on the ISO 19115 standard as located on the web page, http://www.iso.org/iso/catalogue_detail.htm?csnumber=26020).

7.1 Metadata Population and Update

After populating the metadata, in later times, the custodians can update their metadata through the metadata update page. Below shows the metadata update page that demonstrates a list of metadata that are previously entered. Figure 7 shows a sample of how the custodians can click on the buttons, which are located at the end of each metadata record, to either edit or delete the respective record.

If the edit button is clicked, a page similar to the metadata population page will be displayed with the metadata information previously entered by the custodians. When the delete button is clicked, the record will be deleted otherwise.

7.2 Metadata Search

Figure 8 shows the searchable data page for metadata. Using this page, the users can search metadata with the search term appeared in the ISO keywords and/or title and/or abstract of the metadata. As can be seen in the screenshot, the user entered "landcover" as the search term. When the search button is hit, the returning result as demonstrated in the screenshot below shows the metadata that contain the search term "landcover".

When the "detail" link is clicked, the full detail of that metadata will be displayed.

Figure 7 A list of in-built metadata at the metadata update

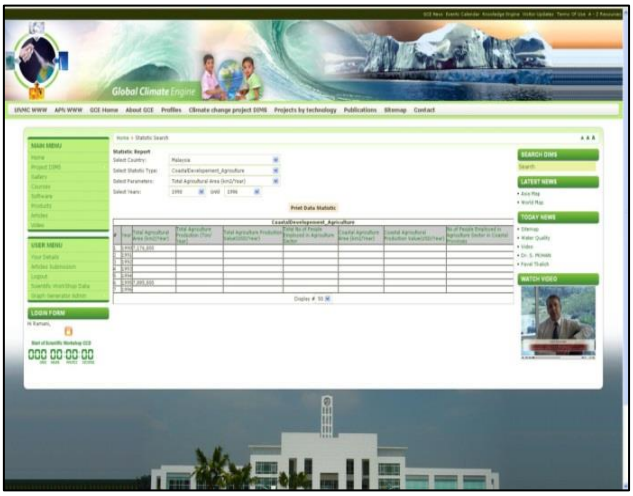


Figure 8 Searchable database – a sample

7.3 Metadata GIS Portal

The metadata GIS Portal is also developed to visualize the spatial data along with their metadata. Figure 7 and 8 are the main interface of the metadata GIS Portal. The interface is divided into three panels. The left panel shows a list of spatial data available, the middle panel shows the spatial data, and the right panel demonstrates corresponding metadata.

To include the spatial data for display, the users need only check on the checkbox of the spatial data, as shown in the left panel. After hitting the "Display Map with Metadata" button at the bottom of the left panel, the spatial data and their respective metadata will be retrieved from the database and displayed in the middle and right panels respectively. Please note that any update done in the metadata update page, will be instantly refreshed in this GIS Portal page (http://dims.globalclimate-engine.org/Metadata_UNM/GISServer).

8.0 RESULTS AND DISCUSSION

DIMS should be used as an important tool for the natural resource modeling and to advance in the field of geo-natural resource zone management and its monitoring especially due to climate change. The in built DIMS in ARCGIS represent the latest tool to provide solution for geo spatial and temporal data-handling problems. For an appropriate use of DIMS based on GIS requires knowledge of map composition, data handling, skills of an experienced cartographer, the data base management skill of the data processing person, the scientific insight of modeler, the computer knowledge of a system analyst and the personnel and organisation skills of the manager.

The DIMS concepts ensure the level of interest and there are grounds for optimism towards natural process modeling such as climate change, flood modeling, sea-level rise, and watershed studies etc. At the end, it is concluded that the use of DIMS in geo-natural resource zone management would be interesting and stimulating to any user.

9.0 CONCLUSION

In today's technology, the geographic information system (GIS) and remote sensing (RS) are very important tool for planning, management and monitoring of natural resources. Thus the DIMS project by utilising its objectives could support for rehabilitating the country's resources and alleviating the climate change issues.

Hence, DIMS technology is considered as an important online resource for users who are badly in need of understanding, acquiring knowledge on the issues, managing resources and so to improving and preserving the country's environment.

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