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Preliminary Design of the MEIA System Based on 3S

Yan Tian[1,a], Wei LI [*1,2], Changfa LIU[1,2] , Zhongping Jiao[1]

[1] *College of Marine Environmental Engineering, Dalian Ocean University*
[2] *Key Lab of Offshore Marine Environmental Research of Liaoning Higher Education*
Dalian, P.R.China
[a] *li_xiuyan37@yahoo.cn*

Abstract

For the sustainable development of oceans, we need a reliable, effective and fast MEIA (Marine Environmental Impact Assessment) System. According to the certain goal of MEIA system, this paper design a preliminary MEIA System based on 3S technology. The system consists of a database management subsystem, statistical analysis subsystem and MEIA subsystem.It will put the 3S technology to the best use to achieve the analysis, evaluation, decision automation,technology process and visualization of MEIA. Taking into account the scalability of the system, it will reserve the interface for secondary development.

Key words： 3S; MEIA; Frame Design; Function Design

Introduction

The marine, which accounts for nearly 71% of earth's surface area, is about 362,000,000 square kilometers. It is the cradle of life, the treasure trove of resources and the important regulator of the environment. The 21st century is the century of ocean. The level of the marine development and utilization has been rising dramatically. There are a lot of actions, like the development of marine fisheries resources, marine engineering and marine chemical, that bring a lot of economic benefit to humans, but at the same time, they bring great influence on the marine environment. The MEIA (marine environmental impact assessment) is that after implementation of sea area planning and construction projects, people should analysis, forecast and assess the possible environmental impact of marine, give some advice on preventing or mitigating adverse environmental impacts, and at the same time , track and monitor the adverse effects[1]. People now have realized the importance of the marine environment. For the sustainable development of oceans, we need to evaluate its environmental impact before any exploitation of marine resources. Therefore, we urgently need to establish a reliable and effective MEIA system.

In recent years, 3S technology has been widely used in EIA. 3S includes Global Positioning System (GPS), Remote Sensing (RS) and Geographic Information System (GIS) [2]. It played a huge role on EIA. It is formed by the RS and GPS data collection, GIS data integration management and analysis[3].

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University of Utah have undertaken an EIA in areas bordering Mexico and the United States by GIS technology, then they established a path model of surface water and groundwater; U.S. Environmental Protection Agency's CGS, EC ECDIN, UNEP GRID, and national conditions of China's environmental quality systems are environmental management information systems[4]; Chinese Academy of Sciences, the National Planning Commission, Institute of Geography, Resources and Environment Information System State Key Laboratory who built a major natural disaster monitoring and evaluation information system by RS and GIS technology; Institute of Geography and Limnology, Chinese Academy of Sciences in Nanjing, as the study area in East China, with environmental and ecological factors like Bedrock, soil, vegetation, humidity, etc, established the evaluation system and evaluation model based on GIS; Peking University built a water environment in Dianchi Lake Basin and dynamic monitoring system based on 3S technology[5]. It can be seen that 3S technology has been gradually applied to the various aspects of EIA; however, the establishments of study of MEIA are so rare.

Data is foundation and core of the MEIA. Data is the prerequisite for achieving other functions. Conventional marine data is in accordance with point to measure, and RS can obtain real-time, macroscopically marine data which based surface, GPS can provide accurate spatial information and a wide range of reliable basic data for the MEIA, moreover, the capabilities of GIS like spatial analysis, spatial models, evaluation of decision-making and visualization are also currently required for MEIA. Therefore, with increasingly developed of 3S technology, for the sustainable development of oceans, we need a reliable, effective and fast MEIA System based on 3S.

System design goals

The system wants to achieve the following objectives in this paper:

(1) Integrated massive remote sensing data. For example, hyper spectral remote sensing images, visible light remote sensing images, thermal infrared remote sensing images, microwave remote sensing images, marine basic background vector data ,etc.

(2) Fast processing of spatial data and attribute data. Two kinds of data must be classified management and stored in different databases. The spatial data stored in document form, and the attribute data is saved through SQL Server, Oracle's relational database or directly recorded in the description of spatial data file[6].

(3) Updating and maintaining a variety of marine data. The marine environment is a dynamic environment, and a variety of marine data is also in dynamic changes from hour to hour. Therefore, the timely tracking and monitoring of data, updating and maintaining the marine environment is able to ensure the accuracy of the impact assessment results.

(4) Stored information can be rapidly inquired, retrieved and displayed to ensure to provide effective information for users.

(5) System can simulate, analysis and forecast the environmental impact of marine planning and construction project implementation.

(6)System enables to provide users with aided decision after environmental impact comprehensive analysis, at the same time, the bad influence can be tracked and monitored.

(7)The results of MEIA can be visually displayed and output. Namely, the science and technology of information visualization and spatial visualization are to be achieved.

(8)The system can achieve MEIA processes of office electronics and automation.

(9)The system will reserve the interface for second development. MEIA is not only for a certain construction project, but also for MREIA (marine regional environmental impact assessment), MCEA (marine cumulative environmental impact assessment) and MERA (marine environmental risk assessment) in the future. Therefore, it will reserve the interface for secondary development.

Preliminary design of the system

MEIA requires different expertise to analyze, predict and evaluate, therefore, the system must be able to handle a variety of marine data, extract useful information and reserve the interface for second development. System modules must be standardized and normalized which can interoperate better. Thus the system can use GIS as a platform. Using the professional software tools based on the secondary development of GIS, and advantages of powerful management, spatial data analysis functions, efficient visual development languages and convenient programming, the efficiency of application development has been greatly improved. So it is very reliability, easy to transplant and easy to maintain.

The MEIA system consists of a database management subsystem, a statistical analysis subsystem and a MEIA subsystem. As indicated in Figure 1, there is the system overall frame design.

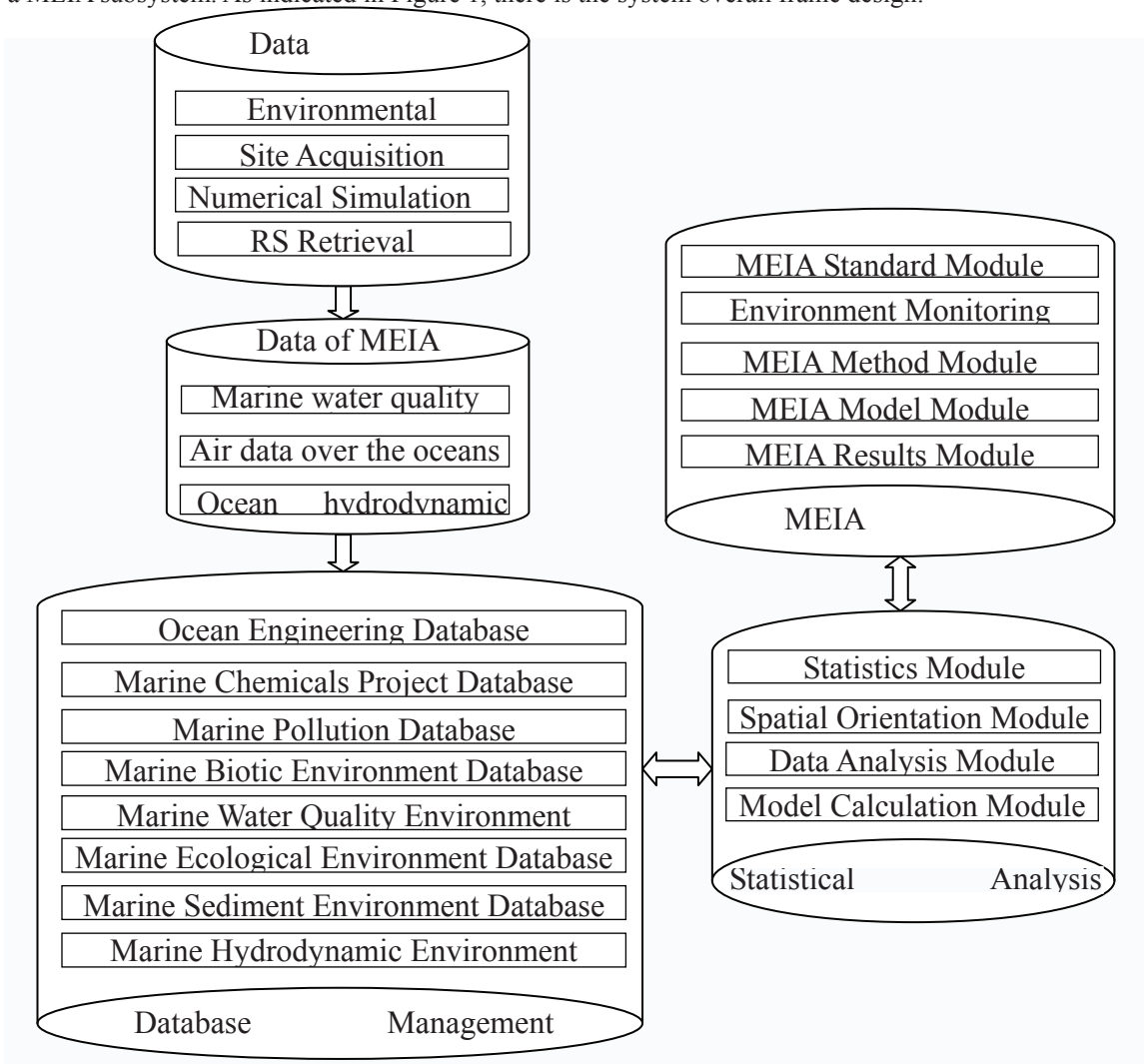

Fig. 1 Overall frame design of the EMIA system.

Database management subsystem. The database is the foundation which the information system can run, it completes an storage of all MEIA information, and provides strong access control and database

management capabilities[7]. The MEIA project types are as follows: Ocean Engineering, including Coastal Engineering (mainly of the Reclamation Projects, Marine Works, Estuary Project, Tidal Power, Sea Ranch, Fisheries Engineering, etc.), Offshore Engineering (mainly of Offshore Platform, Artificial Island, oil or gas exploration and production platforms, floating refineries, etc.), Deep-ocean Engineering (Submersible, Remote seabed mining facilities, etc.); Marine Chemicals, including Sea Biochemistry Project, Marine Chemistry Resource Projects(Such as sea salt, Potassium water condensed, etc.) ,Marine Ore Resource Projects and Type Oil and Gas Resources Projects[8];Marine Pollution, including pollution of fossil fuels (mainly oil), pollution of heavy metals and acid-base, synthetic organic chemical pollution (mainly pesticides), organic matter and nutrient salts pollution (mainly red tide), man-made radioactive nuclides substance pollution, solid waste pollution and waste heat pollution[9].; Marine Water Quality; Marine Biotic Environment; Marine Ecological Environment; Marine Sediment Environment; Marine Hydrological Dynamic Environment.

Therefore, the subsystem consists of eight databases: Ocean Engineering Database, Marine Chemicals Project Database, Marine Pollution Database, Marine Water Quality Environment Database, Marine Biotic Environment Database, Marine Ecological Environment Database, Marine Sediment Environment Database, Marine Hydrological Dynamic Environment Database.

MEIA is inseparable from the data, each MEIA project requires some specific data for monitoring and analysis. Thus, the data, which each type of MEIA project needs, are required to be put into the appropriate database. People obtain marine data through environmental monitoring, site acquisition, numerical simulation, remote sensing retrieval and other means. There are three types of marine data: marine water quality data, air data over the oceans and ocean hydrodynamic data. Marine water quality data, including SST, salinity, PH, chlorophyll, inorganic suspended solids, POC, DOC, heavy metals, DO, nutrient salts (Nitrate, phosphate, silicate, ammonium salt), marine bacteria and viruses; Atmospheric data over the oceans, including SST, relative humidity, atmospheric aerosols, rainfall and CO_2; ocean hydrodynamic data, including sea-ice ocean power, tidal, ocean currents ,waves and so on.

System needs to handle large amounts of data, so each of the eight databases needs two databases: Fixed database and variable database. Fixed database which form an essential element of system operation includes long-term statistics of marine data and GB, and it can't be modified in general; Variable database stores recent data, the data need to update and maintain timely, then import the data into a regular fixed database. The subsystem functional designs are as follows:

（1）Map management: Map view, map search, graphic editing and layer management.

（2）Data collection: Timely investigation and collection the required data of MEIA project, the data should be the latest data.

（3）Data editing: There are three types of marine data: marine water quality data, air data over the oceans and ocean hydrodynamic data. This feature makes the MEIA data read, imported, edited, converted, deleted, exported, etc. Rational unified data management system is conducive to the operation and maintenance.

（4）Data maintenance functions: Data file maintenance, system data backup and recovery; Maintenance of data security and dynamic update.

Statistical analysis subsystem. When the system carries out MEIA，it needs to analyze and address specific issues. GIS as a system platform should inset statistical analysis subsystem to solve the object analysis, forecast and management issues. Statistical analysis subsystem not only achieves the effective integration of GIS and statistical analysis, but also achieves the effective integration of geographical entity attribute data and spatial data through the GIS database engine[10]. The subsystem functional designs are as follows:

（1）Spatial orientation Module: Attribute query function and spatial query function; Locate and view the surface features information which the MEIA projects relate to.

（2）Statistics Module: All fields attribute data for display according to different statistical methods; It

outputs the results with the form of tables, statistical charts or thematic map so that users can easily make a strategic decision[7].

（3）Data analysis Module: You can identify the different among symbols, color and size of different classified object by using macro-analysis function; you also can make spatial statistical analysis reflect the spatial distribution and trends of data by using spatial analysis model.

（4）Model calculation Module: Different MEIA project using different models and methods appropriate for data analysis and calculations. Model calculation results output by GIS to make forecasts and assess.

MEIA subsystem. According to the main contents and the basic assessment process of China's EIA, the subsystem functional designs are as follows:

（1）MEIA standard Module: In MEIA preparation stage, people need to study state and local's laws and regulations, development planning, environmental function zoning, related standard, feasibility studies and other information. All the information can be stored in the subsystem in order that the user query.

（2）Environment monitoring Module: People need to investigate present situation and track monitoring the MEIA projects.

（3）MEIA method Module: EIA methods conclude that: impact identification method, impact prediction method and impact evaluation method. Users can select an appropriate method for specific EIA project.

（4）MEIA model Module: Users can select an appropriate model to analyze and calculate for specific EIA project.

（5）MEIA results Module: This module is able to visualize the expression of MEIA data, generate thematic maps of single factor or the evaluation results. It has the printing and the output function，its results can become a part of EIA report to play a supporting role in decision making. Moreover, this module has a function of predictive analysis of the graphical display.

Conclusions

In this paper, the MEIA System based on 3S is a preliminary design; it will play the advantages of 3S technology. The development of this system is just a beginning, moreover, the work of MEIA is not confined to this, it also relates to MREIA (marine regional environmental impact assessment), MCEA (marine cumulative environmental impact assessment) and MERA (marine environmental risk assessment).Therefore, the system will reserve the second development interface in order to improve and perfect the system for the further software development.

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*author for corresponding.

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