Research Paper

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GIS Application in Oceanography

Engineering

KEYWORDS : GIS, DEM,TIN

Prof. S. P. Mehta | Department of Zoology, Sri Venkateswara University, Tirupati – 517 502

ABSTRACT

The GIS application is not limited to terrestrial boundary., but it has expanded its tools and methodology in oceanography too. It's wide utility in ocean protection, preservation and management is truly recognized. Ocean GIS or Marine GIS has developed from application that merely collect and display data to complex simulation, modeling, and development of new coastal methodology. Numerous innovations in remotely sensed data (both satellite and acoustic) hydrographic models, and other emerging data collecting techniques have been added to information data structures. The commercial GIS sector has also continued to take interest in marine GIS and its development and its application

However there are challenges ahead underpinning the success of many of these applications. But it does provide an opportunity for further study, posing important questions about representation of spatial and temporal information in the marine environment.

The commercialization of GIS has long standing beneficial effect for users who did not need advance training in computer programming. But from information technology perspective it may have detrimental effects of limiting research into underlying data structures and algorithms. Most papers in GIS conference deal with research using GIS

While fewer deal with research on information system itself, data structures, spatial analysis and algorithms, and innovative approach to data models and analysis for use in scientific hypothesis , prediction, and decision making. The Geographic Information Science (GIS) has indeed answer to some of these questions.

Importance of GIS in Oceanography :-

The physical ,biological and social resources of our coastal and marine environment threatened by new global warming system has raised many questions. In terrestrial realm GIS has been widely used and applied to assist in precision management of agriculture, forestry, urban planning, business, and national defense.

There is now equally strong demand for precision management of coastal and marine resources. Consider for example the development of protected marine area which requires scientists and managers to asses resources usage having area time approach. So spatial as well as temporal approach needed. It requires to have balance between optimum usage of resources and biological conservation.

Marine GIS has wide range of applications and can be categorized as coastal, oceanographic, and fisheries. Oceanography describes mapping and measurement of major oceans and fisheries concern with management process of fisheries.

In practice these three are not absolutely separated and may overlap or intrude one another as far as application is concern. For example fisheries GIS require data on oceanographic processes describing how fish population and production affected

The exploration and exploitation of deep-water oil-gas are apt to be suffered from high-risk geo-hazards such as submarine landslide, soft clay creep, shallow gas, excess pore-water pressure, mud volcano or mud diaper, salt dome and so on. Therefore, it is necessary to survey the seafloor topography, identify the unfavorable geological risks and investigate their environment and mechanism before exploiting the deep-water oil-gas.

It is necessary to evaluate the geo-hazards for the establishment and safe operation of the pipeline. Based on previous scientific research results, several survey cruises have been carried out with ships and AUV to collect multidisciplinary and massive submarine data such as multi-beam bathymetric data, side scan sonar images, shallow-bottom profiling images, high-resolution multi-channel seismic data and boring test data. In order to make good use of these precious data, GIS technology is used in our research. Data model is designed to depict the structure, organization and relationship between multi disciplinary submarine data. With these data models, database is established to manage and share the attribute and spatial data effectively. The spatial datasets, such as contours, TIN models, DEM models, etc., can be generated. Some submarine characteristics, such as slope, aspects, curvature, landslide volume, etc., can be calculated and extracted with spatial analysis tools. The thematic map can be produced easily based on database and generated spatial dataset. Through thematic map, the multidisciplinary data spatial relationship can be easily established and provide helpful information

The produced thematic map of the Gas Field, reveal the strike of the seafloor topography to be NE to SW. Five geomorphological zones can be divided, which include the outer continental shelf margin zone with sand waves and mega-ripples, the continental slope zone with coral reefs and sand waves, the continental slope zone with a monocline shape, the continental slope zone with fault terraces and the continental slope zone with turbidity current deposits.

DATA COLLECTION, ANALYSIS AND INTERPRETATION :--

Mainly data collection, data integration, data analysis and data interpretation is carried out.

- Data models used in marine environment analysis and geodatabase developing
- Data acquisition and integration in GIS: PCA, temperature and depth maps on the basis of Landsat satellite images;
- Point data analysis: observational and telemetric data
- Fishing data analysis;
- Analysis of vertical measurement profiles in GIS: CTD and other data
- Maps of inundation probability and erosion analysis;
- Satellite image classification
- Bottom cover analysis on satellite and radar images
- Preparation of diversity, vulnerability and valorisation maps;
- Spatial data processing for GIS analysis

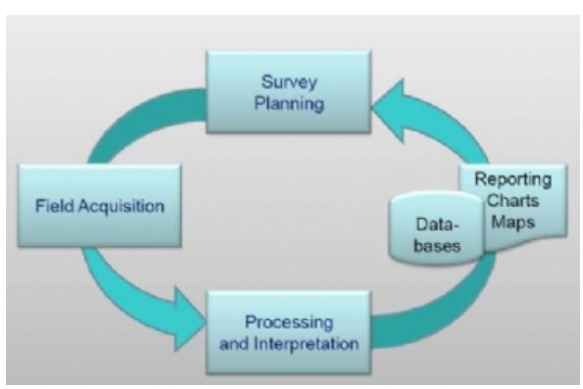

Figure 1

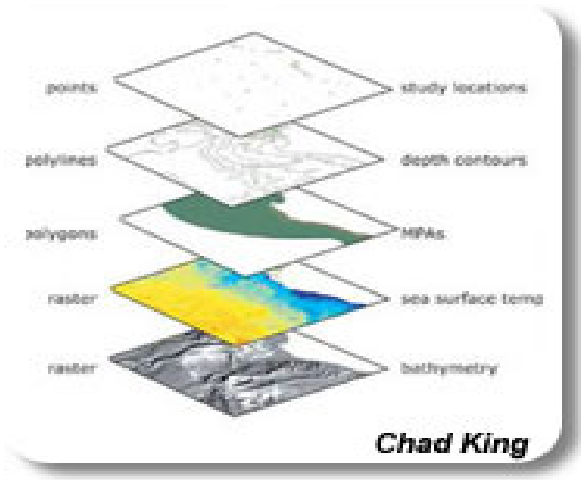

Figure 2

Marine GIS has wide application
Fisheries management and planning: e.g. Fish production data, fish habitat etc.

Coastal atlas : Mapping and measurement of oceans which may include

Spatial setting

Physical environment

Spatial structure

Use of the sea

Environment and nature

Tourism and recreation

Industry and business

Fisheries and agriculture

Culture and heritage

Living near the sea

Coastal defense

Coastal management

Gas exploration and oil exploration.

Oil spill detection and response : Oil and chemical spills in the marine environment can have widespread impacts and long-term consequences on wildlife, fisheries, coastal and marine habitats and human health. A GIS can assist oil and chemical pollution response in the marine environment. The oil spill response atlas can be used by environmental and wildlife agencies for planning and cleaning oil spills effectively and save marine life.

The GIS data set can include following :
- biological, environmental, wildlife and man-made resources,
- Geomorphological mapping and shoreline sensitivity to oil spills,
- Human-use resource considerations,
- logistical and infrastructure information to support a spill response.
- Salinity control : Saline water of ocean entering coastal area destroying fertile land The salinity expansion and control can be effectively monitor by using GIS.
- Wild life preservation : Migration of species and identifying corridors, their behavior
- Identification realization and exploration and development of marine crop.
- Marine traffic management
- Cargo handling and management

Softwares used in Marine GIS :-
- Many softwares are available for interpretation and analysis in Marine GIS.
- Most GIS software would be flexible enough to represent the marine dimension.
- The main softwares used are ArcGIS, Quantum GIS, GRASS, SAGA, DIVA GIS,

MAXENT for species distribution modelling., Erdas and SeaDAS are good GIS softwares for Marine Ecological studies. Marine Geospatial Ecology Tools (MGET),can be installed on arcgis. http://mgel.env.duke.edu/projects/tools-for-marine-gis/--Marine Geospatial Ecology Tools (MGET), is an open source geoprocessing toolbox designed for coastal and marine researchers and GIS analysts who work with spatially-explicit ecological and oceanographic data in scientific or management workflows. MGET includes over 150 tools useful for a variety of tasks, such as converting oceanographic data to ArcGIS formats, identifying fronts in sea surface temperature images, fitting and evaluating statistical models such as GAMs and GLMs by automatically interfacing ArcGIS with the R statistics program, analyzing coral reef connectivity by simulating hydrodynamic larval dispersal, and building grids that summarize fishing effort, CPUE and other statistics.Moreover

Ocean Data View is the free software,. This is very simple and will be useful. The website Homepage and Software: http://odv.awi.de/ Easy Tutorial: http://marinedataliteracy.org/odv.htm

Indian satellite in marine remote sensing :--
The latest Indian satellites IRS – 1C, 1D, P4 and P6 with their improved spatial resolution (PAN – 5.8 m, LISS III – 23.6 m, LISS IV – 5.8 m, WiFS – 188 m and AWiFS – 56 m), extended spectral range (inclusion of middle infrared band in LISS – III) and increased repetivity (5 days for WiFS data) have opened up new applications in coastal zone. Preliminary analysis of IRS – 1C, 1D data indicates that coral reef zonation, identification of tree and shrub mangroves, mudflats, beach, dune vegetation, saline areas, etc as well as better understanding of suspended sediment patterns are now possible. The PAN data combined with the LISS – III and LISS IV data are extremely useful in providing detailed spatial information about reclamation, construction activity and ecologically sensitive areas, which are vital for the coastal zone regulatory activities. The information available from merged PAN and LISS III, IV data about coral reef zonation, especially for atolls, patch reef and coral pinnacles, is valuable for coral reef conservation plans. The distinction between tree and shrub mangroves in FCC (middle infrared, infrared and red bands) of LISS III provides vital information on biodiversity studies (Ramachandran et. al., 2000a). The high temporal resolution provided by the WiFS data is found to be a major improvement in studying the behavior of suspended sediments in the coastal waters, which would help in understanding the movement of sediments and pollutants (Nayak et.al ., 1996).

But despite the great potential of GIS technology for oceanographic applications, its penetration into the field remains modest. This is due in part to:
(1) lack of awareness of the potential of the technology;
(2) the expense in achieving full operational GIS usage; and
(3) lack of a three-dimensional display/analysis capability.

Fortunately, the situation is improving. Integrated coastal zone management is now an established and internationally-recognized socio-economic necessity, and GIS tools and methodologies for achieving the relevant goals are currently being used or are under development

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At the end to summarize GIS has tremendous potentiality for use in marine field and INDIA has large coast line particularly GUJARAT. So the technology can be exploited for the best and efficient and effective use and management of marine resources.

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