A portable marine geophysical data access and management system

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The marine Geophysical Data Access and Management System (GPDAMS) is a portable software system designed for computerized storage, selective retrieval and management of marine geophysical data. It constitutes an integral part of the larger Geophysical Oracle Database Management System (GPODMS) that is residing on UNIX True 64 Compaq Alpha server. GPODMS is a stable Oracle database system for long-term storage and systematic management of geophysical data and information of various disciplines. The Indian Oceanographic Data Centre (IODC) of the National Institute of Oceanography (NIO) has archived 1,356,833 records (fixes) of marine geophysical data pertaining to 58 scientific cruises in GPODMS database. This dataset is of 190,690 line-km profile data and includes different marine geophysical parameters like bathymetry (corrected depths), magnetic (total magnetic field and magnetic anomaly) and gravity (observed gravity, Eotvos correction, free-air, Bouger anomalies, etc.). For the purpose of portability, geophysical data have been migrated to GPDAMS Microsoft Access-based database on compact disk. GPDAMS consists of both indigenously collected and international geophysical database, and management and presentation software modules to run on Windows PC. GPDAMS consists of four modules, namely data import module, query builder or search module, data visualization and download module, and data management (administration) module. GPDAMS is a complete marine geophysical data management system that provides user-friendly access to large volume of marine geophysical data and means to visualize and extract selected data according to need. The software requires a minimum of computing expertise as it is controlled by a system of 'pull-down' menus, backed up by a context-sensitive help system.

Keywords: Compact disc, database management, marine geophysical data, user-friendly modules.

THE Indian Oceanographic Data Centre (IODC) at the National Institute of Oceanography (NIO), Goa manages a broad spectrum of marine geophysical data, including measurements of bathymetry, magnetics, gravity, seismic reflection, sub-bottom profiles, etc. acquired by research vessels in the world's oceans. Digital data encompass the first three, while the latter are mostly in analogue form. The marine Geophysical Data Access and Management System (GPDAMS) constitutes an integral part of the lar-

ger marine Geophysical Oracle Database Management System (GPODMS) that resides on a UNIX True 64 Compaq Alpha server. GPDAMS is a portable software system, designed for the computerized storage, selective retrieval and management of geophysical data. GPODMS is a stable Oracle-based system for long-term storage and systematic management of geophysical data and information of various parameters.

Description, contact address, etc. of various geophysical databases available worldwide have been reported earlier[1]. National Geophysical Data Center, Boulder, USA is the largest depository for marine geology and geophysical data and exchanges all kinds of marine geophysical data in MGD-77 format[2]. For easy accessing, a marine geophysics database management and supportive graphics system[3] was developed, which was later modified as GEODAS on-line data search and retrieval system[4] for accessing marine geophysical data over the Internet.

At IODC, two fundamental philosophies drive the practices of data management, archival, and dissemination. The first is that the data should be self-documenting, that is the inventory (abstracted data) should describe content, format and access methodology, and data should be intimately linked with abundant metadata: data describing the primary details in terms of who collected them, how it was processed, necessary supporting information that went into the processing, intermediate stages of data processing, etc. These metadata not only provide some degree of quality assurance to the data, but also make them accessible for purposes not necessarily envisioned at the time of the original collection and processing. This linking of both documentation and metadata to the data set is designed to ensure the integrity of the data and to facilitate access to the data. The operational philosophy regarding quality assurance of data is: 'the prime responsibility for quality of data rests with the originator (collector) or custodian of the raw data'. Most often, it is the originator alone who has the only reliable information by which right corrections can be made. The IODC accepts processed and corrected geophysical data made available after extensive research and publication by the originator. The IODC, in its quality assurance function, can only act as a filter, to screen out erroneous data as it has neither the resources nor the requisite information to edit and correct data submitted from outside sources.

All marine geophysical data are collected with reference to the navigational points or fixes. A navigation point is defined as the location of a fix or a point at which either geophysical data were collected or the ship changed its speed and/or direction. The navigation data obtained from satellite navigation system (SAT-NAV) contain date, time, latitude and longitude, speed and course for each fix along with 'satellite pass' information. An inventory quality control program carries out pre-processing of navigational data. The program calculates/generates the accurate position data for each fix after considering the turning

Table 1. Database structure with field ranges used while importing data from text files

Field name	Max value	Min value	Data type	Length	Units/remarks
CATEGORY_NO	2	2	INT	1	Data type
IODC_CR_NO	1000	1	INT	4	Primary key
IODC_ST_NO	99999	1	INT	5	Primary key
SHIP_CD			VARCHAR	2	Ship identity code
LINE_ID			VARCHAR	5	Survey/line id.
ORG_CR_NO			VARCHAR	4	Originator cruise n
ORG_ST_NO			VARCHAR	5	Originator station n
COUNTRY_CD	41	41	VARCHAR	5	Country code
INST_CD	NIO	NIO	VARCHAR	5	Institute code
YEAR	–	1900	INT	4	Year
MONTH	12	1	INT	2	Month
DAY	31	1	INT	2	Day
HOUR	24	1	INT	2	I.S.T.
MINUTES	60	1	INT	2	I.S.T.
SECONDS	60	1	INT	2	I.S.T.
LATITUDE	+90	–90	FLOAT	7.5	Degrees
LONGITUDE	+180	–180	FLOAT	8.5	Degrees
ACT_DEPTH	10000	10	INT	5	In metres
EEZ			CHAR	1	Exclusive eco-zone
CORR_DEPTH	99999	50	INT	5	In metres
TOTAL MAG_ FIELD	43000	38000	INT	5	Nano Tesla
MAG_ANO	+1000	–1000	FLOAT	5.1	Nano Tesla
RES_FIELD	+200	–200	FLOAT	4.1	Nano Tesla
OBS_GRAVITY	–2100	–2300	FLOAT	5.1	mGals
EOTVOS	–2130	–2370	FLOAT	5.1	mGals
FREE_AIR_ANO	+150	–150	FLOAT	4.1	mGals
BOUG_ANO	+200	–200	FLOAT	4.1	mGals
SEISMIC_SHOTPT	10000	0	INT	5	Number

point, speed and satellite pass values. The program finds obvious spurious values like the inability of the ship to travel at a speed of 50 knots, or be at 400-degree longitude and flag it accordingly. After data standardization, IODC cruise and fix numbers, ship code, country code, security code, line identity code, etc. are assigned. The parameter codes are also assigned depending on whether measurement of the particular parameter corresponding to a particular fix is made. Each navigation fix of every cruise is considered as a single record and information pertaining to 29 fields is stored against each fix while generating an exhaustive geophysical database (Table 1). Each fix and cruise is assigned a specific IODC code number and considered as a key field.

Corrected bathymetry measurements corresponding to navigational fixes are stored in the bathymetry database. Fields like collected and corrected bathymetry, IODC cruise and fix number, originator's cruise and fix number, sampling interval, number of sets, time intervals, etc. are also included in this database.

Magnetic observations, residual field, diurnal correction, depth of the sensor, IODC cruise and fix number, originator's cruise or fix number, sampling interval, number of sets, time interval, etc. form the magnetic database.

Observed gravity, Eotvos correction, free-air and Bouger anomalies, depth of the sensor, IODC cruise and fix number, originator's cruise or fix number, sampling interval, number of sets, time interval, etc. constitute this database.

Merging the above databases with navigation data creates the geophysical database. This database contains corrected values of marine geophysical data (bathymetry, magnetic and gravity) in a correlative manner along with the corresponding navigation fix data.

The IODC of NIO has archived 1,356,833 records (fixes) of geophysical data pertaining to 58 scientific cruises in a GPODMS database residing on a UNIX True 64 Compaq Alpha server. This dataset of 190,690 line-km covers different geophysical parameters like bathymetry data (corrected depths), magnetic data (total magnetic field and magnetic anomaly) and gravity data (observed gravity, Eotvos correction, and free air and Bouger anomaly). Geographical Information System (GIS) is being used for searching, plotting and retrieving required geophysical data. However, the usage of Oracle database and GIS software requires expertise and the portability of such a database and software is inconvenient. For easy portability, the above geophysical data have been migrated to GPDAMS access database. In addition, GPDAMS is capable of (structurally and software-wise) accommodating world geophysical data available in MGD-77 format (international data). Indigenous as well as international data for the Indian Ocean region is migrated to a compact disk along with the GPDAMS software.

Based on previous experiences, GPDAMS is designed and developed for the computerized storage, selective retrieval and management of high volume geophysical

data and information keeping the following requirements in mind:

- System needs to be portable
- Process the variations in raw data and import into the database
- Generates inventory-level information
- Reasonable execution speed for managing/accessing high volume of data
- A flexible and multi-track querying system
- Facilities to save, open, edit and resubmit the query
- Plotting the queried data on the map with zoom, pan and distance calculations facilities
- Provide appropriate access for appropriate data users
- Allow field selection before downloading data
- Handle international data and provide same facilities as indigenous data.

This communication examines the principles underlying GPDAMS, the philosophy behind data management, and describes functionalities, limitations and usage of GPDAMS.

Data management at IODC begins with the receipt of incoming data on a magnetic tape, by direct file transfer using network, a CD or specially agreed-upon transfer media, from ships, scientists, other institutes or agencies. Data provided in formats other than the standard one are also accepted, if accompanied by adequate metadata and format documentation. Upon arrival, the data are scanned to confirm the format and transferred to a high-end PC. On the PC, the data file is read using Excel and is submitted to the first module, i.e. the import module of GPDAMS. The import module screen has a facility to view the file in Excel format on a Windows screen (Figure 1). Scientists/ administrators require to fill in the IODC cruise and fix numbers, and other header information before importing. The import module is equipped with a quality control program that checks data values outside expected ranges and improbable navigational patterns, etc. and reformats the data to a 'perfect' Geophysical Data Format (GPDF) and stores it in an Access database (Table 1).

Following these quality assurance checks, the data are passed onto an administrator module of GPDAMS to generate an abstract (inventory) and statistics of the data, which ultimately become the basis for providing basic as well as 'complete' (data and meta data) data. This inventory file includes just enough data to define the track (survey) line of the original cruise, and is usually about 2% of the total data, along with various quantitative and qualitative information about the data. GPDAMS manages national and international geophysical data as two separate databases and the data management module provides selective user passwords for accessing suitable database. This module allows an import of indigenous as well as international data, generates inventory information and assigns Exclusive Economic Zone (EEZ)/non EEZ tag to every record.

According to the nature and requirements of geophysical data, the 'query builder' module provides the user with maximum flexibility to build a query using several options like parameters, data source, ship identification, from date and to date, within or outside an EEZ area, etc. A user can select the data area graphically or in the text mode by providing geographic positions. Query builder provides an input to the data visualization and download module. It operates initially on a small volume inventory data and provides inventory data and a less accurate line survey plot speedily. The user has an option to plot an accurate fix-wise survey plot. A user is expected to utilize several options to select required data appropriately and then opt for retrieval from a large dataset. Here, the user again has an option to select only required fields for downloading. This module checks the user's authentication and provides appropriate downloadable data.

All non-NIO, national as well as international users can access the system as well as data on a CD-ROM, by requesting the authors. Also, according to guidelines, the Data Centre provides geophysical data to all those users who request for data. However, considering the importance of geophysical data and the present dissemination policies of the NIO Data Centre, every individual user is provided with a user identification name, a password and user level. GPDAMS allows every user to select and display all inventory-level information, but selectively allows export of data.

GPDAMS CD includes geophysical databases; software modules developed using Visual Basic 6.0 to run on commonly available Windows PC, installation and mapping software. An outline of GPDAMS with four major software modules and associated options is given in Figure 2. Following are four major software modules:

- Data import module
- Query builder or search module
- Data visualization and download module
- Data management (administrative) module.

On execution of the GPDAMS program, the main title screen (initial screen) appears on the VDU, which provides options for module selection.

In the query builder or search module, for building a query, a search screen (Figure 3) prompts the user to provide the search key and title for the search. The user is prompted to select either indigenous or international database. The other options provided are area selection, parameter surveyed, contributing organization or vessel participated, survey identifier, survey date and within or outside EEZ. Each option opens a new screen and provides more detailed options to choose, like include/exclude option, and from-to-option. Search area option allows the user to select graphically or by providing numerical values. The user can build his query based on the various options and data parameters. Upon selecting the required fields, the

Figure 1. Import module screen of GPDAMS. Data file to be formatted is viewed in lower window screen and administrator requires filling-in of IODC cruise and fix number, and other header information before importing in main database.
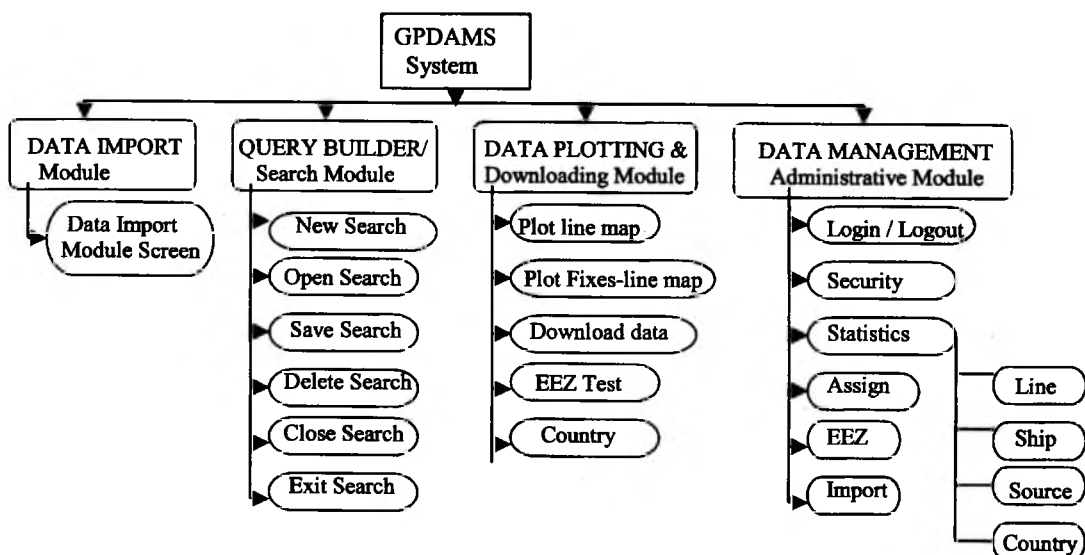

Figure 2. GPDAMS with four major software modules and associated options.

Figure 3. Search screen allows user to select various options like area selection, parameter surveyed, vessel and survey identifier, from date and to date, within or outside EEZ, etc. and help in building the query for retrieving desired data.
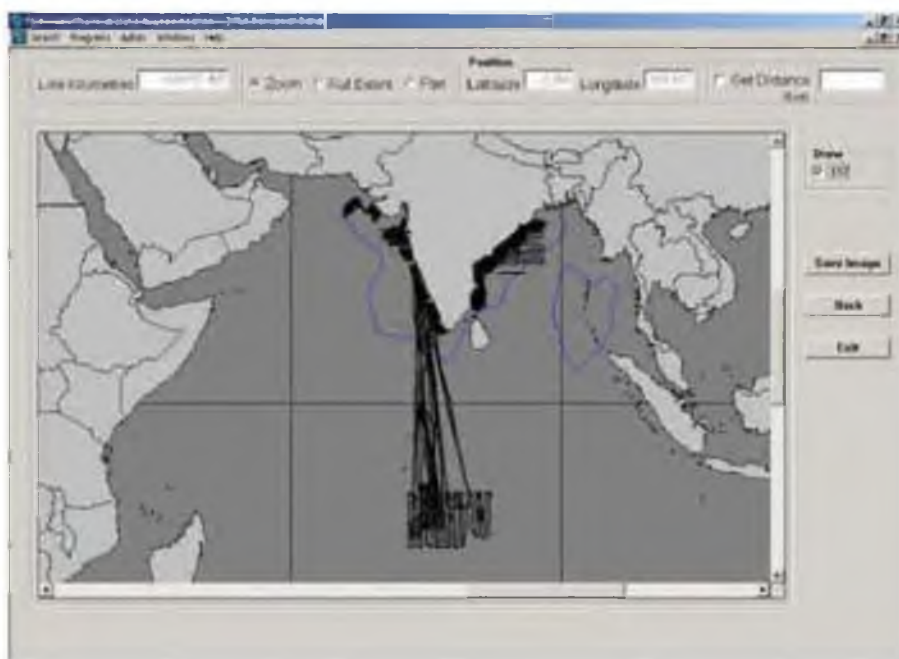

Figure 4. Screen map showing queried data in line form by joining each fix selected by the user. Map also shows EEZ limits of India within the Indian Ocean region.

user has to click the button 'Search' that will open the options form. Here the user can either plot the data, download the data, save the search, exit the search or go back to edit the search. The software will flash the status and error messages. The form will not be invoked, if no data are selected.

The data visualization and download module enables the user to plot the queried data in line form (Figure 4) as well as by joining each fix. Both the plots show distance covered by the cruises for the queried data in line-km. This evokes the distance facility to measure the distance between any two points on the map. Besides these, the zoom, pan and full extent facilities are available to view data at a convenient resolution.

This module further takes the user to the inventory form, which gives the inventory-level information generated from the queried data. This form gives a link to data download. Before downloading the data, the user needs to enter a password for authentication. The user is guided to a field selection form where he/she can select one, more or all of the fields to download. The user is shown the selected data on a monitor. The user can then press the download button and select a path for saving the download file.

This module allows the administrator to change user password, to process the data or to import new data into the database or allows generating statistics for line, source, ship or country. The module accepts data generated by the 'data import module' and deposits data into the main database. If the variations are beyond the capabilities of the system, then manual intervention and processing may be required.

The GPDAMS has a few limitations like: (1) Its performance depends on the complexity of the query and database size. (2) The accuracy of the line plot is based on the correctness of the line details assigned. (3) The system interface is designed for a 1024×768 monitor resolution. The system checks and adjusts to the required resolution and readjusts to previous setting on exit.

Having the GPDAMS package on a PC, users enjoy access to large volume of multi-disciplinary geophysical data and the means to visualize and extract selected data according to their needs. The software requires a minimum of computing expertise as it is controlled by a system of 'pull-down' menus, backed up by a context-sensitive help system. Efforts are underway to develop a similar system on the Intranet for institutional users and subsequently on Internet for national/international users. It is expected that geophysicists will use GPDAMS for selecting required data. Cruise planners are expected to take advantage of select and display modules for planning purpose. The corporate sector is likely to make use of this information for developmental purpose.

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Studies on the identification of suitable solvents for microbial bioassay

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The toxicity of five organic solvents, viz. *N,N*-dimethylformamide (DMF), dimethyl sulphoxide (DMSO), 1,4-dioxan, formamide and *N*-methyl-2-pyrrolidone was evaluated against *Colletotrichum capsici*, *Drechslera oryzae*, *Fusarium oxysporum f.* sp. *cubense*, *Pyricularia oryzae*, *Pythium aphanidermatum* and *Rhizoctonia solani* through poisoned agar bioassay. *N*-methyl-2-pyrrolidone was found to be the most toxic solvent with EC_{50} values of 0.36, 0.70, 0.87, 0.29, 0.83 and 0.36% for the test fungal organisms respectively. DMSO showed the least toxicity with EC_{50} values of 2.91, 3.43, 4.78, 1.46, 3.63 and 1.93% respectively. DMF, formamide and 1,4-dioxan exhibited moderate toxicity. Among the test fungi, *P. oryzae* was the most sensitive with least EC_{50} values and *F. o. cubense* was the least sensitive with high EC_{50} values to all the solvents.

Keywords: Bioassay, EC_{50}, fungi, solvents, toxicity.

USE of organic solvents in pesticide bioassay is often unavoidable, as many of the pesticide technicals have low

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