

A METHODOLOGY FOR GIS INTERFACING OF MARINE DATA

Proceedings of GIS PLANET 98: International Conference and Exhibition on Geographic Information, Lisbon, Portugal, 7-11 September 1998

Vasilis Valavanis, Stratis Georgakarakos, and John Haralabous

The development of relational GIS databases from several marine data sources is presented in this paper note. The purpose of this paper is to summarise the existing methods for GIS marine database development rather than to introduce completely new GIS marine database methodologies. Specifically, the methodologies of data input of geographic location (coastline and bathymetry), acoustic (fish and plankton), CTD (conductivity, temperature, depth), SST (remotely sensed sea surface temperature), SeaWiFS (remotely sensed sea surface Chlor-A concentration), RoxAnn (bottom classification), wind, catch, landing, fishing effort, fishing gear pressure and activity area as well as benthic organism data into ESRI's ARC/INFO GIS are discussed. Prior to GIS input, each dataset is organised into MS EXCELL spreadsheets and then is inserted into the GIS database in the form of geographic covers, attribute tables, and grids.

Future advances of these data input methodologies will include sediment, sea current, and aquaculture data.

KEYWORDS: Marine Data, Hydroacoustic Data, GIS Database

INTRODUCTION

The three dimensional (3D) nature of the majority of marine datasets creates apparent problems in the organisation of such data into commercial 2D and 2.5D database structures. ARC/INFO (A/I), one of the most widely used commercial GIS package, stores these datasets primarily into 2D attribute tables (covers and/or grids) and in 2.5D triangular irregular networks (TINs) [2]. In this paper note, the methods of marine data input to A/I are discussed, highlighting the importance of data preparation for data georeference, selection, and overlay [1]. The preparation of the 3D marine data in a way that 2D GIS georeferenced data can be selected and overlaid gives in part, a solution to further analysis and integration of marine data.

DATA AND METHODOLOGY

The datasets that are discussed here, include coastline and bathymetry, acoustic, CTD, SST (AVHRR), Chlor-A (SeaWiFS), RoxAnn (bottom classification), wind, catch, landing, fishing effort, fishing gear pressure and activity area, and benthic organism data. Each dataset is categorised according to ARC/INFO database structure (point-PAT, line-AAT, polygon-PAT, grid-floating or integer type):

- POINT DATA: Point data include acoustic, CTD, RoxAnn, landing and wind information. The methodology includes generation of point coverages and definition of info tables (Point Attribute Tables). Data are inserted from comma delimited value files (.csv) into the defined info tables and are linked to the corresponding geographic point location. In the case of CTD point data, a menu interface is build that calls the corresponding CTD info file for the specified geographic

point location. Related ARC/INFO commands and functions are: <create>, <generate>, <input>, <point>, <addxy>, <build>, <define>, <add>, <joinitem>, <cursor>, <project>.

- LINE AND POLYGON DATA: Line and polygon data include coastline, bathymetry, wind, fishing effort, fishing gear pressure and activity area, and benthic organism information (Arc and Polygon Attribute Tables). Data is either extracted from GEBCO DIGITAL ATLAS CD ROM [3] as AutoCAD Drawing Exchange file (.dxf) or digitised from hardcopy maps. In the case of wind polygon data, a polygon coverage is created that hosts the average wind speed and direction from all observations that fall into a specified polygon area. Related ARC/INFO commands and functions are: <dxfinfo>, <dxfar>, <coordinate>, <save>, <create>, <generate>, <input>, <polygon>, <clean>, <build>, <joinitem>, <intersect>, <erase>, <union>, <project>.

- GRID DATA: Grid (image) data include SST and Chlor-A information. Images are converted to either floating point or integer type grids. Then, grids are adjusted to the coastline for data georeference. Related ARC/INFO commands and functions are: <imagegrid>, <controlpoints>, <setwindow>, <adjust>, <project>, <buildvat>, <resample>, <merge>.

The following table summarises the processing of the data that are discussed here:

Table 1. Initial and A/I GIS database of the various marine data sources that are discussed.

DATASET	INITIAL D/BASE	GIS DATABASE
Acoustic	MS ACCESS	Point Cover and PAT
CTD	TEXT ASCII (.csv)	Info table linked to Point Cover with PAT, and menu
RoxAnn	MS EXCELL	Point Cover and PAT
Landing	MS ACCESS	Point Cover and PAT
Wind	MS EXCELL	Point and Polygon Covers and PATs
Coastline	AUTOCAD Drawing Exchange Format (.dxf)	Line and Polygon Covers and AAT or PAT
Bathymetry	.dxf	Polygon Cover and PAT
Catches and Fishing Effort	MS ACCESS	Polygon Cover and PAT
Fishing Gear Pressure	MS ACCESS	Polygon Cover and PAT
Fishing Gear Activity Area	MS ACCESS	Polygon Cover and PAT
Benthic Organism	TEXT ASCII (.csv)	Info table linked to Polygon Cover and PAT

RESULTS AND GIS DATABASES

The GIS databases are presented and discussed in the following figures. Acoustic data info-tables and point coverages were used to generate TINs that are mapped based on depth (Fig. 1). This approach gives a first-step visualisation for fish and plankton biomass abundance in each depth layer.

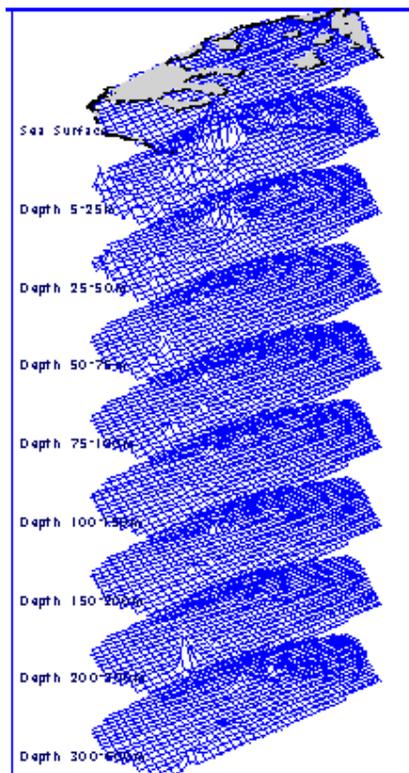


Fig. 1. Acoustic data TIN GIS database created from 3D point data (example study area: North Aegean Sea, Greece, May, 1989 data).

CTD data info-tables and point coverages are organised via a set of menus that call the corresponding CTD files for the selected CTD station (Fig. 2). Additionally, the menu system allows selection of a specified depth CTD layer via the <cursor> function for further data manipulation.

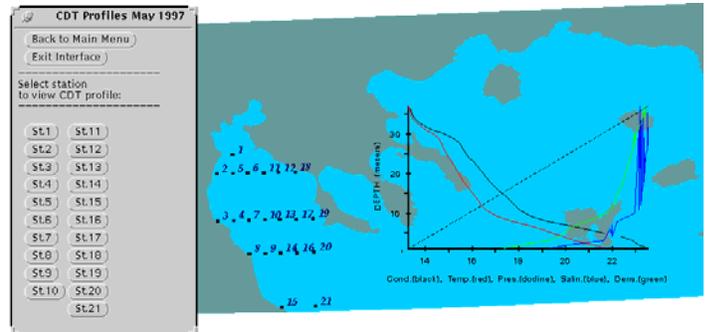


Fig. 2. CTD GIS database selection menu system based on 3D point data (example study area: North Aegean Sea, Greece, May 1997 data).

RoxAnn info-tables and point coverages were used for grid generation of bottom classification (Fig. 3). RoxAnn point coverages and the associated 2D info-tables prepared data for further analysis via ARC/INFO interpolation algorithms (topogrid, kriging, etc).

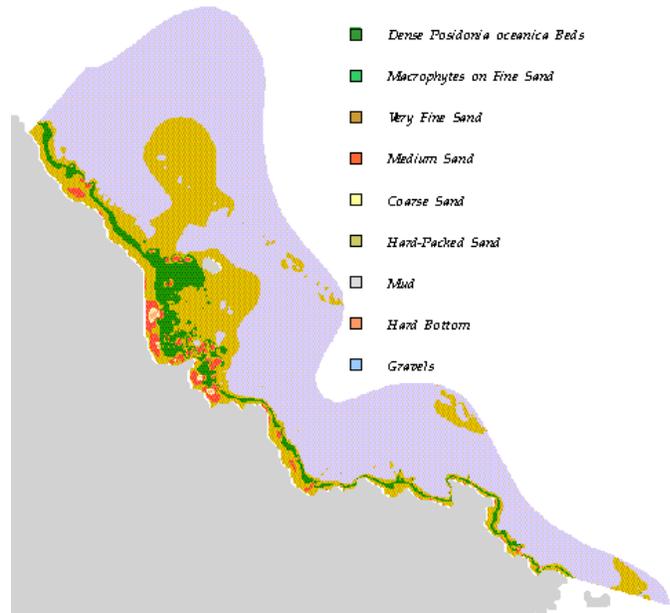


Fig. 3. GRID GIS database of bottom classification 2D point data from RoxAnn (example study area: Strymonikos Gulf, North Aegean Sea, Greece, June, 1998 data).

Research fishing sampling data (catches, fishing effort, and fishing gear pressure) are organised in info tables by specified fishing sectors, which are described by polygon coverages (Fig. 4). The resolution of the fishing sectors is approximately 60x60 Km.

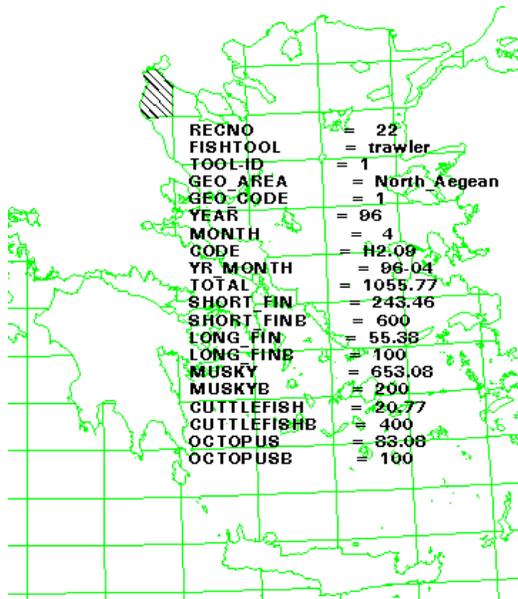


Fig. 4. Fishing sector polygons that hold research fishing sample data (example study area: Greek Seas, example dataset: Cephalopod catches, April, 1996 data).

Fishing gear activity areas were digitised into polygon coverages using survey map data obtained, in this case, by various fishing ports in Greece (Fig. 5).

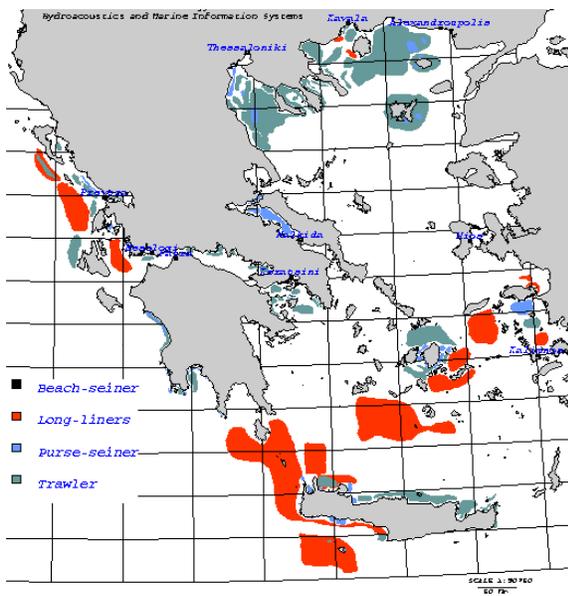


Fig. 5. Digitised polygons describing fishing gear activity areas (example study area: Greek Seas, data as of June, 1998).

The fish landings GIS database was organised in point coverages based on fishing markets (Fig. 6).

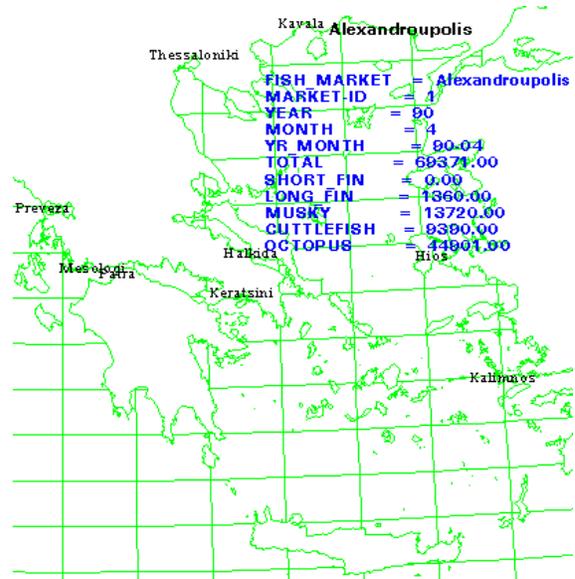
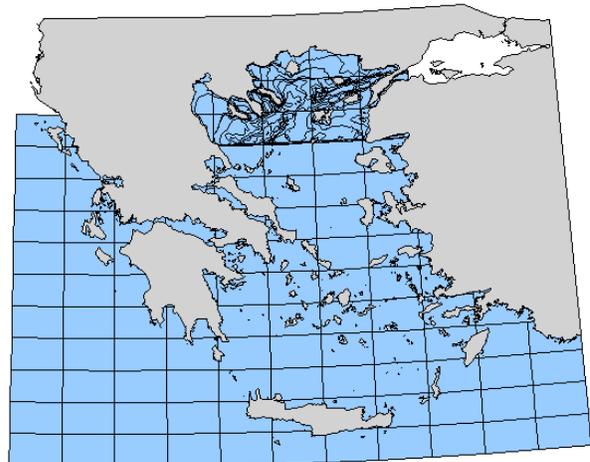


Fig. 6. Landings GIS database from point data (example: Alexandroupolis fishing market, Greece, April, 1990 Cephalopod landing data).

Coastline and bathymetry data is organised into line and polygon coverages (Fig. 7). Correction and



enrichment of the existing GEBCO DIGITAL ATLAS was extensive.

Fig. 7. Coastline and bathymetry GIS database converted, corrected, and enriched by GEBCO DIGITAL Atlas (example areas: coastline of Greek and bathymetry of North Aegean Sea).

The wind data GIS database is of point and polygon type (Fig. 8). Wind point data is stored in a point coverage describing the position of each meteorological station. Wind polygon data averages scarce point measurements in different locations into defined polygons resulting in a wind GIS database covering a wide area.

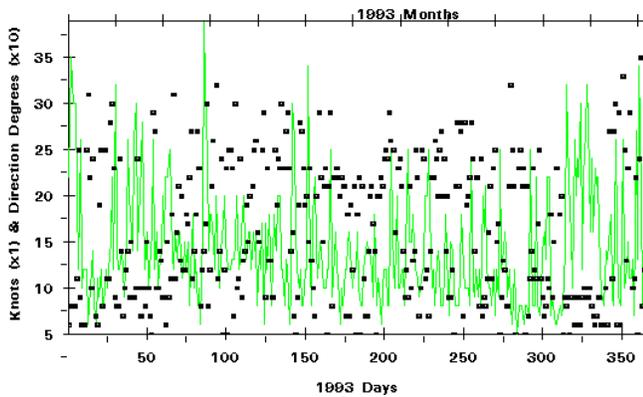


Fig. 8. Representation of a wind info-table point data showing wind force (line) and direction (point). Sample station: Eleftheroupolis, Greece, 1993 data.

Benthic organism data is organised into an info table that is linked with a polygon cover (Fig. 9). Spatial distribution of the data is based on species presence-absence and species depth-limit occurrence.

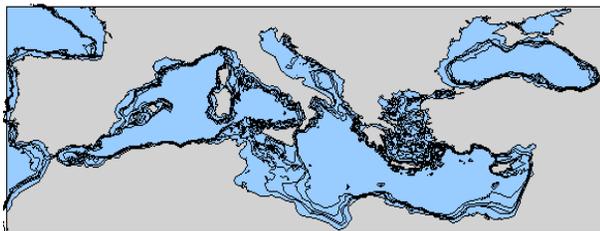


Fig. 9. Polygon cover of the Mediterranean Sea with depth up to -1500m. The associated benthic organism info-table is used for species spatial distribution based on presence-absence and depth-limit occurrence (example GIS database: Polychaetae).

AVHRR (SST) and SeaWiFS (Chlor-A) data are organised in grids (Fig. 10 and Fig. 11). Source images were converted to grids and grids were adjusted and projected based on the coastline. The problem of the different grid resolution was solved with grid resampling techniques inside A/I GRID.

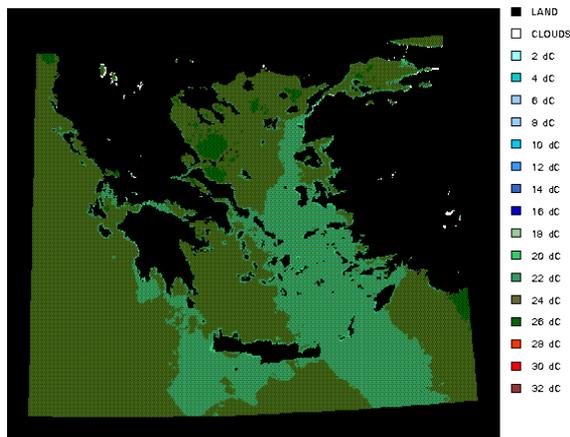


Fig. 10. A/I grid representing SST from AVHRR (data source: DLR, Germany).

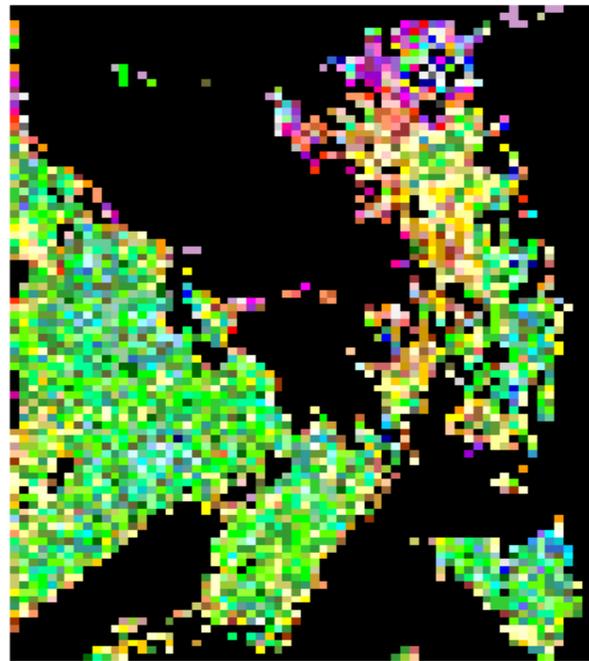


Fig. 11. A/I grid representing Chlor-A concentration from SeaWiFS (data source: NASA, USA).

CONCLUSIONS AND FUTURE ADVANCES

Planning is needed before a creation of a marine GIS database. The 3D nature of marine data and GPS errors create problems in preparing marine data for GIS input, analysis, and integration. Applying common georeference and projection systems for all data is important for the functionality of a GIS database. Finally, ARC/INFO 3D limitations are faced by storing data into 2D info-tables and selecting based on depth layer.

Future work will include GIS treatment of sediment, sea current and aquaculture data.

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Vasilis Valavanis

vasilis@imbc.gr

Vasilis Valavanis holds a BSc. in Conservation Biology with expertise in Coastal Processes and a MSc. in Remote Sensing and GIS, both degrees earned from the School of Natural Resources and Conservation of the University of Florida, Gainesville, FL, USA. His main interests are the development of functioning geographic systems, input methods of remotely-sensed data into these systems, and species population modelling based on GIS integrated data. Currently, he is working as GIS expert at the Institute of Marine Biology of Crete, Hydroacoustics and Marine Information Systems Dept.

Stratis Georgakarakos

stratis@imbc.gr

Stratis Georgakarakos has a Ph.D. degree of Zoology (University of Munich, Germany) and from 1986 is working mainly on the application of hydroacoustic methodology for fish stock assessment. From 1991 Head of the Sonar Section and from 1997 Head of the Hydroacoustics and Marine Information Systems Dept. of the Institute of Marine Biology of Crete. The Department is involved in several national and international projects and especially in the improvement of the acoustic methodology, the development of expert systems based on artificial neural networks, the development of Geographic Information and Modelling Systems and the Application of Remote Sensing techniques for monitoring the fish environment.

John Haralabous

jchar@imbc.gr

John Haralabous obtained his B.Sc. in Biology from the University of Athens, Greece in 1989. From 1989 to 1991, he has been working at the pharmaceutical company of "Laboratoires Niadas". In 1991, he left to join the research programmes in the Acoustic Group of the Institute of Marine Biology of Crete, where he is responsible for the statistical processing of the acoustic data and the fish stock abundance estimation. He is involved in several national and European projects, and he is responsible for the design and implementation of different artificial neural networks required in several pattern recognition and classification applications.

Institute of Marine Biology of Crete

P.O. BOX 2214

IRAKLIO, 710 03

GREECE

tel: +30-81-346860

fax: +30-81-241882

URL: <http://www.imbc.gr>