Improved Information Systems for Mine Burial Prediction

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LONG-TERM GOAL

Improve the quality and availability of seabed information to modellers and operational units concerned with Mine Burial Prediction (MBP).

OBJECTIVES

(i) Improve the delivery of data on the physical properties of the seabed for use in mine burial prediction, namely in the fields of geotechnics, sediment hydrodynamics and seabed classification. Interface these with other current efforts in MBP.
(ii) Improve the delivery of indexes of the reliability of this seabed data, with development of appropriate visualizations of these uncertainties.

APPROACH

Progressive innovation in the handling of seabed data by information systems, carried out as follows: (i) incorporation of new datasets especially coastal datasets associated with beach research, (ii) development of algorithms, (iii) delivery of digital products to researchers and agencies, with feedback. The work is collaborative between Colorado and Sydney Universities and the USGS. It is being done within the framework of the dbSEABED structure, a system for the integration seafloor data from many diverse sources (Jenkins 1997, 2002, 2003). Once dbSEABED has performed its processes of integration the outputs can be used by clients in almost any software application – mapping, database, statistical or model. An expanding range of clients is engendering greater system robustness and capability.
Uncertainty – leading ultimately to indexes of reliability for Mine Burial Prediction – is an important issue in data integration and mapping. Our approach entails actual measurement of the uncertainies inherent in seafloor data, and then application of that understanding in software tools which work on large datasets like dbSEABED and output uncertainties right alongside map-grids of the data values. A PhD program of environmental classification from imagery will allow data – especially coastal data -

to be conveniently placed in an environmental setting so that: (i) interpolation of coastal zone point data is improved, (ii) spatial-temporal variabilities (uncertainties) can be attached.

WORK COMPLETED

Ingestion of new datasets.
(a) *Extended coverages.* Many new datasets were added to dbSEABED in FY03 from agencies, industry, universities and individuals. The total of attributed sites is now >1 million globally, 400,000 for US waters alone. Special effort was directed to the Gulf of Mexico and Atlantic US margins, European waters and better overall global coverage. As part of continuing extension, new input data themes for MultiSensor Core Logger and field penetrometer devices were made.
(b) *Coastal data.* The beach database of the Australian mainland was completed; it organizes and allows access to information and digital images for 9387 beach systems.
Development of algorithms.
(c) *Physical properties.* Many data handling algorithms were improved through the year, specifically on the extraction of Critical Shear Stress, Porosity and SamplerType outputs. New data on the calibration and validation of the software DataMining and Parsing processes was collected.
(d) *Uncertainties*. New methods of calculating uncertainties on seafloor data were invented and implemented (Jenkins subm.). (i) Uncertainties had to be appropriately parameterized using a Range Coefficient of Variation (RCV; σ/OR where OR is the attribute total Observed Range). CVR is a sensitivity – like % of Dynamic Range or Full Scale Deflection, to borrow electrical analogies. (ii) Actual information on the magnitudes of uncertainty was gathered including for measurement, validity and spatial variabilities. Some seafloor attributes have multiplicative error behaviour. (iii) Software tools were written to parse the data / metadata which in large databases describe data quality through site sampling and analysis methods, navigation, etc. (iv) Point-site uncertainties can now be propagated to gridded uncertainties using standard statistical techniques.
(e) *Environmental setting of datasets.* Research to extract automated environmental classifications of coastal areas directly from imagery (aerial, satellite) made very good progress (Hohnen, Sydney University PhD project). Geomorphic zones (like types of sediment, rock, weed) can now be distinguished reliably in repeat imagery of a coastal region by a combination of histogram peak clustering, texture analysis, and linearity analysis. These work separately then have their outputs combined in a consensus classification.
Delivery of digital products to community.
(f) *Seabed data*. Various forms of web interactive map servers were investigated as a means of data delivery. Although these facilities were popular, it was found that researchers still prefer to collect whole files of gridded and point datasets. This “stovepipe” type of data dissemination is simple but effective in a community where still, few operate a GIS. Accordingly, dbSEABED will shortly re-institute griddings of the West Florida Shelf, served via FTP as ASCII gridded datasets.
(g) *Coastal data handling*. Progress was also made in building a web site to host the Australian beach database and in developing a nowcast / forecast system for Australian beach systems, including tide, waves and weather conditions. These methods will be applicable in other countries.

RESULTS

i. Large improvement in data coverage; this is vital since the major source of mapping uncertainties is spatial >5km. Particular progress for inshore and coastal regions of US waters.
ii. First invention and implementation of methods to calculate uncertainty on seabed parameters that are used in Mine Burial Prediction. Propagation of these site uncertainties to map-griddings.

iii. Working prototype of automated classification of coastal substrate types from imagery, as a step towards much improved interpolations of coastal point datasets - with attached spatial/temporal uncertainties.
iv. Development of better data delivery mechanisms for seabed and beach-system datasets.

IMPACT/APPLICATIONS

i. The data systems we manage and develop are serving comprehensive datasets to a range of researchers, extending what can be done in their science and decreasing uncertainties.
ii. We have developed the first automated calculation of uncertainties for seafloor point-site data leading to grids; this is a pre-requisite for the estimation of operational risks associated with detection and clearing of buried mines.
iii. The project is developing further, data systems for dealing with beach coastal systems, their morphological and temporal complexity.

TRANSITIONS

i. The dbSEABED software now producing harbour- to national-scale mappings for the USGS (Santa Cruz, Woods Hole), Australian Defence Forces (ADF) and Defence Science and Technology Organization (DSTO) (Sydney).
ii. Forschungsanstalt der Bundeswehr für Wasserschall und Geophysik (FWG) and Institut für Ostseeforschung Warnemünde (IOW) in Germany plan to use and test dbSEABED with a view to adoption as a basis for national-scale seafloor mapping. Jenkins visited FWG in 2003 with the assistance of ONR.
iii. Data subsets were supplied to a number of researchers in ONR projects, to NAVO, and to international ecology and biodiversity research programs.

RELATED PROJECTS

i. usSEABED, joint development between The University of Colorado, US Geological Survey (M Field, J Williams) and The University of Sydney; Jenkins (2002c, Web Document).
ii. goSEABED, joint development between The University of Colorado, National Geophysical Data Center (NGDC, of NOAA); Joint web page at instaar.colorado.edu/~jenkinsc/dbseabed/goseabed/.
iii. Australian Beach Safety and Management Program (ABSMP), of Australian Surf Living Saving Association and the University of Sydney.
iv. The Hawaiian Lifeguard Association (HLA) plan to implement an ABSMP type beach management program in Hawaii a in collaboration with Prof Chip Fletcher, University of Hawaii SOEST; with the field component scheduled for November-December 2003.

HONORS/AWARDS/PRIZES

Jenkins and Short gave keynote speeches at several international meetings.

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