GIS Application on Development of Decision Making System for Oil Spill Response in South Korea

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Abstract

The Korea Oil Spill Prediction System (KOSPS) is a cooperative project between the Korea Ocean Research & Development Institute (KORDI) and the Korea Coast Guard (KCG) to develop a GIS database and program to support oil spill contingency planning in South Korea. KORDI has developed GIS application and built GIS database for oil spill prevention and response. KCG has analyzed their work for controlling oil accident and designed this system with KORDI. KCG has used this system for controlling oil spill accident at some coastal area. This project is going on and extending its geographic scope to whole Korean coast. There are three parts of this project. First, numerical models for contingency planning and real time coastal features have implemented in FORTRAN. Second, GIS database including ESI (Environmental Sensitivity Index) map has been built using ArcInfo. Third, GIS functions have been developed with Visual C++ and MapObjects. Finally we have integrated all of these three parts into decision making system.

Introduction

In order to respond an oil spill accident, information on the potential risk for oil spills, weather of sea area and the sensitivity of coastal zone to oil spills is required. Prompt decision making is based on a rapid production of this information. For providing the response information, oil spill model and weather prediction model should be developed. These resulting models should be integrated into making decision system, that is based on GIS for interactive display, query and analysis by emergency response planners. GIS can be a powerful integrating technology for emergency responders during actual oil spills or virtual preparedness drills.

The objectives of this project has built GIS database and integrated the numerical models and GIS. In other words, a simple and powerful making decision system for emergency planning and responding has been implemented by MOERI. This project has used GIS for modern oil spill prevention and response including the use of real time weather, report writing and aerial photo mapping for damage assessment and documentation. This system provides the main functions as the followings:

-Patterns and routes of spills

-Sensitivities of landscape to the risk of spills
-Plans of emergency response to spills
-Report of the emergency context
-Risk analysis and the risk map creation
-Sensitivities of areas to oil spill mitigation efforts including spill caching

This project consists of three parts: numerical modeling, building database and implementing the application. In this paper, building database and developing GIS for decision making will be discussed.

Building Database

Building database is important for more informed and intelligent response. For that, the emerging technology has been applied for making the smart dataset. This project has analyzed its own dataset and defined the topology rules following the results of analysis.

S-57 datasets have been converted to shapefiles and projected into WGS84 projection coordination system. Lots of shapefiles have been integrated into each one shapefile thematically. Most of shapefiles are simple point type so union of them has no problem. However, shoreline shapefile is the line type and very complex and it is very key feature in ESI(Environmental Sensitivity Index). Because building S-57 dataset has some problem, shoreline of SENC has the same problem. For example, there are line overlapping, self-overlapping, line entangling, etc. These datasets should be cleaned. To do that, topology skills of ArcIno have been used. In order to apply the topology rule, file format should be converted to GeoDataBase(GDB) Feature Dataset. In this work, three rules for shoreline have been defined as the followings:

- Must Not Overlap
- Must Not Intersect
- Must Not Self-Overlap

Topology errors have fixed and the edited features have validated in ArcMap. After cleaning, these datasets were reconverted into shapefile to use them in MapObjects. Fig.1 shows the data process.

Fig.1 Data Process

To response the oil spill accident effectively, understanding the shoreline information, especially Environmental Sensitivity is required. The ESI shoreline classification represents an index of relative exposure to shoreline slope, wave and tidal energy, substrate type, and biological productivity and sensitivity. The ESI, protected resources and response resources affect the decision making to control oil accident. As S-57 data has no ESI information, environmental sensitivities of shoreline should be surveyed in the field. In case of impossible surveying, they were obtained through the aerial photo images. According to the results of surveying the shoreline, 8 indexes for ESI have been classified and edited the shoreline features in ArcMap.

It also requires information about response resources around the accident area. To cope with oil accidents, the information was collected by referencing the local government control action plan and they were used in building database. These datasets have been built up of DBF or shapefile format. They include the controlling resources, local communities for the controlling assistance, biological information and high dangerous facilities.

For enhancing the spatial awareness, aerial photo images were used for the backdrop of vector datasets. These images were obtained from Ministry of Maritime Affairs and Fisheries. GCP correction and projection were necessary to be used as a spatial data. Our vector data was used to provide ground controls so that the imagery could be referenced to the same projection. Correction of the imagery was accomplished by selecting multiple ground control points (GCPs) on vector map. As a result, worldfiles were created for MapObjects.

Implementing Application

This project has designed the GIS program to integrate results of numerical model and spatial information. The system consists of two modules: the oil spill prediction and sea area features calculating module and GIS manipulating module.

Modeling the sea area features and the oil spill features has been developed by FORTRAN with our own algorithm and the module has been operated in the exclusive computer. It provides the sea surface temperature, air temperature, sea depth, the speed and direction of wind, current, tide and wind driven current with the GIS application. If the GIS application sends the location and date of the oil spill accident to this computer on TCP/IP, the oil spread features, time series changes and risk map can be calculated and sent to GIS application.

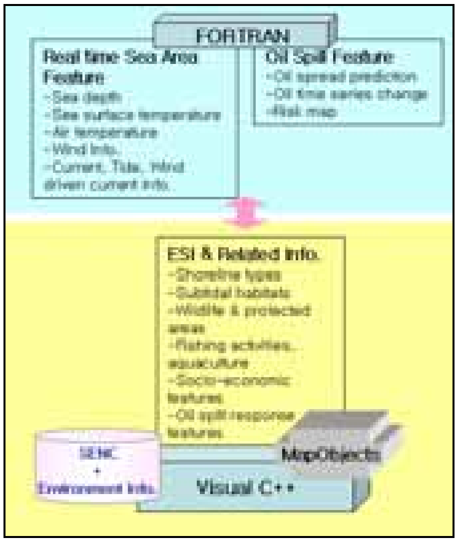

Fig.2 Construction of Modules

On the other hand, for manipulating GIS functions, MapObjects was used with C++. GIS module interacts with the numerical module through communication technology. The application has been implemented to display, query and analyze the variety of the related spatial information and ESI. In addition, it allows users to input the accident information (ex. accident location, oil type, spill volume and prediction period) for calculating oil spread prediction, draw something to report the accident and create the simple shapefiles.

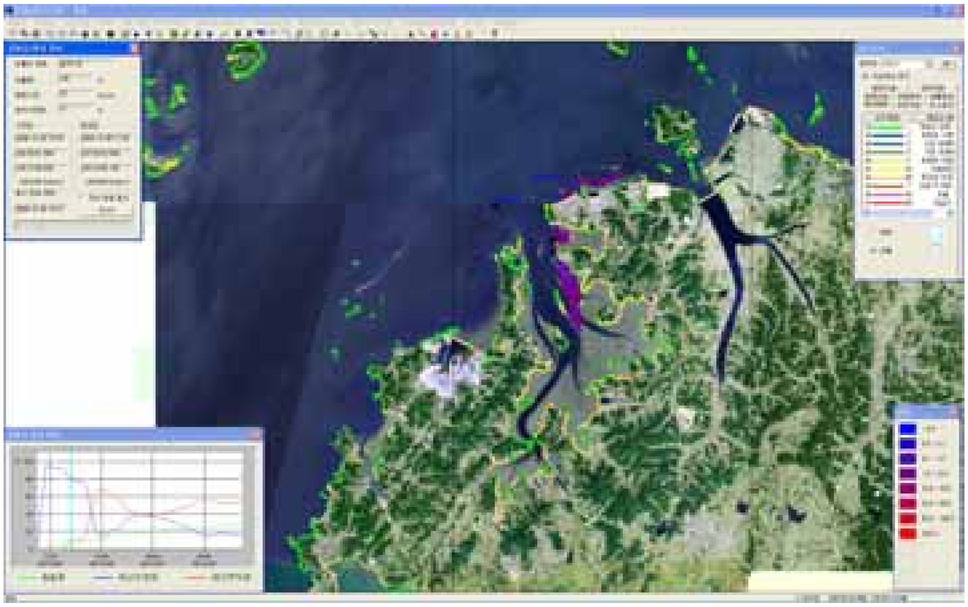

Fig.3 Snapshot of GIS application

This project has implemented an application for easy to use. Korea Coast Guard is applying this system to response their work. GIS allows quick and accurate decision making using various information.

Conclusion

The Korea Oil Spill Prediction System (KOSPS) has been developed as integration system of numerical models, environmental sensitivity information and information on oil spill response resources based on GIS. KOSPS has been applied to several accidents occurred in the sea off coast of Korea. In the application, it is validated that KOSPS is excellent solution to support response strategy of oil spill. KOSPS has been developing for 2 years under supporting of Korea Coast Guard, and its service area has covered western and southern seas of Korea. The development project of KOSPS is in progress and will be completed after 2 years. For 2 years, service area of KOSPS will be expanded to cover whole Korean and adjacent seas including the Yellow Sea, East Sea and South Sea of Korea. With the expansion of geographic scope for service, the accuracy of numerical model for prediction will be also improved.

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