KOREAN ATLAS PROGRAM FOR COASTAL POLLUTION RESPONSE

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ABSTRACT:

There are many possibilities of which oil spill accident happens by ship's collision or grounding in coastal area. There are a lot of oil-sensitive resources like fisheries, beaches, mud flats, wildlife habitats and so on at coastal area. These geographic features are too various to categorize their environmental sensitivity against marine pollution like oil spill accident. However, in order to respond to an oil pollution incident and to protect a coastal area, necessary datasets related to oil pollutions should be defined and their sensitivities should be classified with a scientific base. And not only precise and useful geographic information but also information application methods are needed. There are some projects which classify the sensitivity of shoreline and publish the ESI (Environmental Sensitivity Index) paper map. The first Korean ESI map was published with paper format and then it had many inconveniences to identify information and to search the specific data. And there were some problems of its sensitivity index which was not proper to Korean coastal environments. In this project, the spatial database of main resources for Korean whole coastal area has been built and GIS program for indentifying spatial information and creating thematic map has been developed. And also sensitivity index of shoreline has been refined and kinds of information for response have been defined. Korean geomorphology features like wide tidal flats and rias(heavily indented) coasts and requirements of responders have been considered. In order to build GIS database, 200 nautical charts were used as the base map and various surveying datasets and 123 satellite images were used. These built items are shoreline, beach, wild habitats, ports, fisheries, industry facilities, response companies and organizations, coastal leisure area and so on. These items have location information as well as various reference attributes. These items and attributes were decided as the results of many discussions with response actors like Korea coast guard and response companies. The key feature of this project is that this atlas is not thick and heavy paper format such as other ESI maps. In order to implement this, GIS database has been built as ESRI shapefile format using ESRI ArcInfo and GIS program has been developed using ESRI MapObjects with Microsoft Visual C++.
The final result of project is the integrated atlas of Korean map datasets and GIS program. This atlas includes rich information for supporting response works, convenient and user friendly program and the Korean specific ESI map. This atlas program is all about Korean marine oil-pollution response. Due to this project, when oil spill incident happens, a response commander can decide a response strategy rapidly and wisely with whole understanding of the incident area. And response actors and commander can communicate very precisely through this atlas.
This project has made Korean ESI standards, built GIS database for whole coastal area and developed an atlas program for utilizing ESI map. However, there are some problems such as topology errors of base map, periodical map updating and integrating dynamic information like hydrological features and atmospheric conditions. These problems will be solved in near future works.

1. INTRODUCTION

Marine pollution accidents such like oil spill and HNS(Hazardous Noxious Substance) spill cause various and severe damage to marine environment including an ecosystem. And also they cause persons who respond casualty or live near accident spot to suffer serious health problem. Therefore not only rapid and efficient response works but also proper and safe response time and method are very important. Especially coastal area is very complex and close to people life space, so it is very difficult to decide a response strategy and response completion. There was no resolution guide in Korea.

Korean coastal areas have some features; the volume of maritime transportation is very high and a lot of oil tankers and chemical ships navigate densely near shoreline. And also there are many fishing places and farms. Because of the intensive uses of coastal area, a large size pollution accident like Hebei Spirit spill incident can occur and enormous negative influence can happen on the human life and natural environment.

There are various sensitive resources to chemical pollution such as fishery place, farms, beach, and biological habitats at coastal

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area. The methods of pollution response depend mostly on geographical features of these sensitive resources. In order to cope with an accident efficiently, we should decide the response strategy according to the geographical features and the mobilization ability of the response resources. ESI (Environmental Sensitivity Index) map is a good guide to make the most optimum decision. The existing ESI maps include a lot of information about the sensitivities of shoreline, biology and socioeconomy. However ESI maps are published paper maps or digital files (PDF, JPEG…), so that utility of them is not better than what they include.

In this study, in order to improve ESI map, the ESI contents of Korean atlas have built and its application program has been developed.

2. CONTENTS OF KOREAN ATLAS

2.1 Shoreline

Shoreline features are most important information to make a coastal response strategy. Shoreline features about the pollution accidents are classified following the characteristics of shore slope, geology, wave, ebb and flow which are have an effect on removal, adherence and saturation of pollutants. The sensitivity classification of the shoreline had been studied for a long time but that classifications cannot be general standards because of the geographical diversity. Korean shoreline indexes should be defined with reflecting Korean coastal topography such like large tidal mud flats and rias shorelines.

Table 1 shows Korean classification of shoreline. Shorelines are classified by 8 ranks; higher index means higher risk and more difficult to response.

Shoreline and coastal goemophological information are extracted from Korean digital maps, nautical charts (1:25,000) and satellite images (resolution 1mX1m). Sometimes field surveys were carried out.

Index	Shoreline Section	General Features
1	-vertical rocky headland exposed wave-cut -concrete, wood or metal breakwater and pier exposed wave-cut -vertical shore protection exposed wave-cut	-high wave energy supplies -oil does not penetrate through its geological structure -angle of the intertidal inclination is more than 30 °
2	-rock platform exposed wave-cut -rocky shoreline with a gentle slope -sedimentary shoreline with a steep slope, exposed wave-cut	-high wave energy supplies -oil penetrates a little through its geological structure -angle of the intertidal inclination is less than 30 °
3	-fine grained sand beach -fine grained steep beach exposed wave-cut	-oil penetrates partly with about 10cm depth -hard geological structure -angle of the intertidal inclination is less than 5 °
4	-coarse grained sand beach	-oil penetrates with more 25cm depth -sedimentary geological structure
5	-mixed beach with sand and gravels	-oil penetrates very well with max. 50cm depth -movement of sediments is active during the storm
6 6A	-gravel beach -mixed beach with gravels and rocks	-oil penetrates very well with 1m depth
6 6B	-breakwater and shore protection with high permeability	-oil penetrates among joints and then move following a tidal movement
7	-rock, pebble, sediment beach or artificial structures with semi closure and weak wave	-slope is more than 15 ° and intertidal zone is short -geology, slope and permeability are diverse according to region
8 8A	-mud flat with weak wave	-slope is less than 3° and bio density is high -low oil permeability but oil inflows by many air pores
8 8B	-salt marsh	-habitat of various species -high bio productivity

Table 1. Shoreline Types of Korea

2.2 Biological Feature

There are diverse species in Korean coastal area. Some of them are sensitive to oil spills and chemicals. First, kinds of sensitive species are defined, which are salt plants, mammals, birds, fishes, mollusks, crustaceans and et al. Biological system is very complex as we know that the classification divides into species, genera, families, orders, classes and so on. It is difficult to classify the sensitivity index of species like shoreline.

Accordingly, biological datasets are built by biology professionals' advices of each area. This information consists of habitats, breeding places, appearance seasons and so on.

2.3 Socio-economic Feature

There are various human activities and dense facilities in Korean coastal area and then diverse items about socio-economic features should be built. These datasets are divided coastal resource utilities, water front places, port facilities and national protected area and each items have some sub items.

This broad information is provided from local governments, national park offices and port authorities.

2.4 Response Resources

Not only geographic sensitivity information but also response resource information is very important to decide a response strategy. Mobilization capability of response equipments influences on a prompt response. Response resources are distributed at Korea coast guards, port administrations, response companies and KOEM(Korea Maritime Environment Management Corporation) branches. They are categorized by response ships, response equipments and response materials. Items of response ships are consist of workboats, oil tankers, tug boats, waste oil tankers, oil fence building ships and others. Their owner, ship size, weight, maximum speed, communication methods, oil storage volume, oil recovery and storage methods, and included equipments are provided by GIS attributes. Response equipments and materials are including oil fences, oil adsorbents, dispersants, storage tools, oil cleaners, spray tools, high pressure cleaners and so on. Atlas provides the locations, organizations, contact points and holding amount of response resources as GIS database(location and attribute are combined).

3. MAP BUILDING OF KOREAN ATLAS

Map database are built using ESRI ArcGIS Desktop program. Map includes shoreline, various resources, response information and others. These datasets are mostly point types, but shoreline datasets are line types they have possibilities to have various topology errors. So validating topology and editing are necessary. Shorelines are represented by the color symbols (Figure 1.). And a lot of point type information are represented by font symbols, support someone to understand that meanings distinctly (Figure 2.).

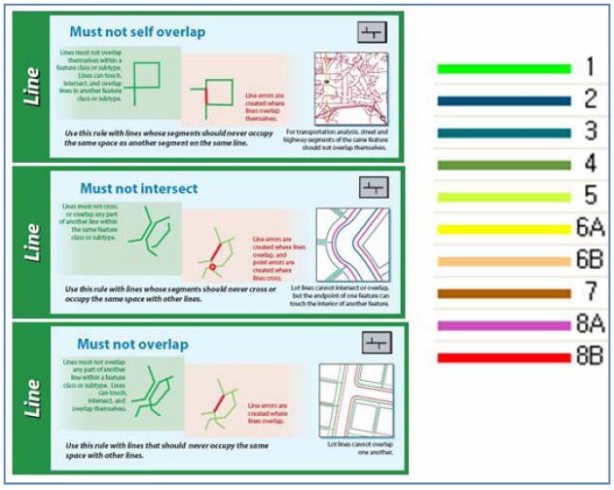

Figure 1. Shoreline Topology Rules and Symbols

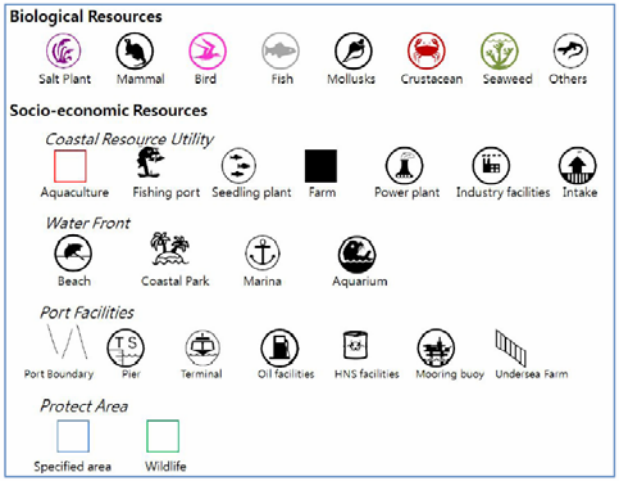

Figure 2. Symbols of Biology and Socio-economy Items

4. APPLICATION PROGRAM DEVELOPMENT OF KOREAN ATLAS

There are lots of information in atlas including spatial information and attributes. Response commanders should understand the accident area wholly and make a decision to respond rapidly. So the exclusive application of response atlas is necessary for planners and actors in fields. Application program for utilizing atlas has developed using Microsoft Visual C++ and ESRI MapObjects Windows. This program has been implemented to display, query, analyze the variety of the related spatial information and understand the response context of accident area. And also it is available to print zoomed paper map about where user want to print and to draw some figures and texts on the atlas for reporting the contexts. Following figures are screen shots of this atlas program.

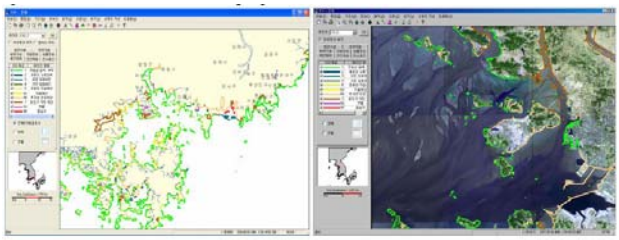

Figure 3. Displaying Sensitivity of Shoreline

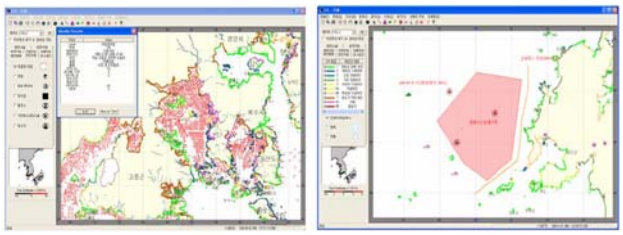

Figure 4. Identifying and Drawing on the Map

5. CONCLUSION

Coastal pollution response atlas has been developed to prepare and respond pollution accidents. These datasets represent the biological habitats and shoreline index sensitive to spilled oil. And also atlas includes information which supports establishing the response strategy. In order to use atlas efficiently, atlas application has been developed. Responders are able to recognize the feature of pollution area and the distribution of response resources and also make decision to response efficiently.

Results of this study are as followings;

- Shoreline index is redefined considering Korean coastal environment.
- Main contents and symbols of atlas are defined such as shoreline, biological resources, socio-economic resources, response resources
- Atlas about whole Korean coastal area is built using GIS technology
- Computer based atlas is developed including user's requirements

Future works for advanced atlas are as followings;

- Spatial resolution of information should be proved.
- Sensitivity index of biological resources and human resources should be redefined in detail such as shoreline.
- How to integrate with dynamic information like atmospheric items should be prepared.
- Atlas program should be advanced for easier utilizing.
- Contents of atlas should be updated whenever they are changed.

This study has lots of limitation for perfect atlas but this tryout will be a good foundation for implementing advanced atlas.

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