OIL SPILL MANAGEMENT SUPPORTING SYSTEM IN MALAYSIAN MARINE ENVIRONMENTS

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ABSTRACT
Oil pollution is one of the main problems affecting the marine coastal environments in Malaysia. This paper describes the development of a decision support system for oil spill management for the Straits of Malacca, Malaysia. Experts in different domains, including marine and coastal environment, marine pollution as well as emergency and contingency responders were interviewed both in governmental and private sectors, to provide all required knowledge for preparing knowledge based system. The system will be able to advise the user for choosing the most reasonable method for prevention, control, and/or clean up against the oil pollution. The system will be able to determine priorities in emergency response conditions, according to the coastal sensitive areas.

1. BACKGROUND

1.1. Introduction

Oil spills are serious environmental disasters, often leading to significant, long-term impacts on the environment, ecology and socio-economic activities of area. World-wide from 1978 to 1995, there were more than 4100 major oil spills of 10,000 gallons or more (Etkin & Welch, 1997). Several serious oil spill incidents also have taken place since 1995, notably examples like Sea Empress in which approximately 5000 tons of oil reached the UK coastline (Li, et. al. 2000). Oil spills also have many inland examples in industrialised cities. For example a city like Toronto, has an average 300- 500 oil spills per year with an average total volume of about 160,000 L/year (Li, 2001).

Different contaminated sites have different characteristics depending on pollutants' properties, hydrological conditions, and a variety of physical, chemical, and biological processes. Thus, the methods selected for different sites vary significantly. The decision for a suitable method at a given site often requires expertise on both remediation technologies and site conditions (Geng, et al., 2001). Management of emergencies, resulting from natural or man-made disasters, requires enough information as well as experienced responders both in technical and co-ordination matters. In this way, a great amount of information should be used to improve the management of the emergency, which generally means making the best decision at the right moment (Hernandez & Serrano, 2001).

Including more than 4670 km coastal borders with valuable mangrove swamps, shrimp prawns, birds' breed and nesting areas, turtles egg laying as well as recreation and tourist resorts, has formed Malaysia as a big and important of coastal natural resources. Malaysia's coastal waters also experience oil pollution from bilge pumping, as well as from tank cleaning, which leads to dumping of oil and sludge by ocean going vessels. Collisions and groundings of ocean-going tankers also cause oil pollution. All these encouraged the researchers to create an intelligent system for assisting the managers in process of decision making in the case of oil spill happening.

Making a multi-criteria decision support system, briefly, is the main aim of this project to advise the user for choosing the most reasonable method for prevention, control, and/ or cleanup way against the oil spills pollution. It will be an advisory service to determine the priorities in emergency response conditions that was planned according to the coastal sensitive areas in the Malaysian coastlines.

1.2. Oil spill and decision making

Decision-making is a complex process, influenced by many factors, both human and non-human. Academic research in the Decision Support System (DSS) field dates from the work of Gorry and Scott-Morton in 1971 (Keenan, 1997). A DSS may be defined as an integrated, interactive and flexible computer system that supports, not replace, all phases of decision-making with a user-friendly interface, data and expert knowledge (Fabbri, 1998).

Some, but by no means all, recent DSS textbooks are including GIS as a component of management support systems (Fabbri, 1998). GIS software provides a link between the interface and database to allow the user to easily query spatial data. Or even it can be used as a Decision Support System (DSS) generator to create Spatial Decision Support Systems (Keenan, 1997).

Some of the information, e.g. geographical, ecological, legal, containment, and clean-up equipment, and environmental sensor locations, can be acquired and organized in advance, typically through a GIS. Other types of information, e.g. winds, waves, currents, vessels traffic, and fishing fleet operations, must be dealt with in real time (Douligeris et al. 1995).

Decision Support System (DSS) serves a central role in all aspects of tactical operations. We tried to gather traditional methods of DSS, GIS, database systems and interface shells, to make a more intelligent Decision Support System which can help the environmental engineer to identify the optimal alternatives for pollution prevention and cleanup method selection processes and thereby help to reduce the costs for cleaning practices.

Considering the proposed contingency plan scheme in this project illustrates Decision Support System constitutes the central nucleon of this plan, which receives all information from different groups of contingency team. Decision Support System provides an easily understandable assistance for non-technical decision makers to be able to find the best managing method in shorter time.

3. METHODOLOGY

Comparing other various DSS models and studies indicates that most of them classify the user duties under these categories: defining the present condition of environment, identifying the conflicts or problems that environment face to them, and introducing the alternative solutions. According to this classification, the duty of DSS of oil spill management project also was considered as shown in figure 1. It shows the general, simple idea suggested for in hand project of oil spill management (Pourvakhshouri & Mansor, 2003) and figure 2 displays the more developed design for it.
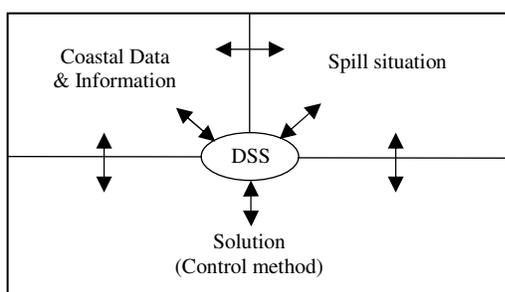
Figure 1: Three main domains of the oil spill management Decision Support System

The coastal information, as shown in figure 2, were divided three major parts of physical, biological and human use resources that was stored in system. Other stored information includes the required equipments, the maintenance ports/ agencies and access ways as well as explanatory documents like national regulations, criteria, exploitation sites, transportation routes, etc. Some part of data must enter the system as real time such as wind, current, oil spillage point, etc.

through the interface. A part also was considered for validation of system by sample scenarios and historical cases.

If the system is described simply, it can establish a linkage between spilled oil characteristics and location, shoreline sensitivity, and the different clean-up methods. Significant types of information are extracted through knowledge-based archive. And most linkages are based on expert system engineering methods like if-based rules, and backward/forward chaining.

Knowledge engineering for constructing the decision support system on oil spill management involves three stages: knowledge acquisition, conceptual design, and system implementation. In the knowledge acquisition phase the objects and decision processes were clarified and determined. In the conceptual design stage, the knowledge was formalized and represented with various representation methods. Then the formalized knowledge was represented in production rules in the knowledge base of the system.

Regarding to the project's proposed aims, some criteria such as: - availability of more data with manageable volume, having the environmental sensitivity in both natural and human activity form, and expose to oil related activities with pollution occurrence history, were considered for choosing the primary study area. Pilot study area has been selected at south east of the Straits of Malacca, from Port Dickson to Pontian Kechil Johor Baru (Fig. 3).
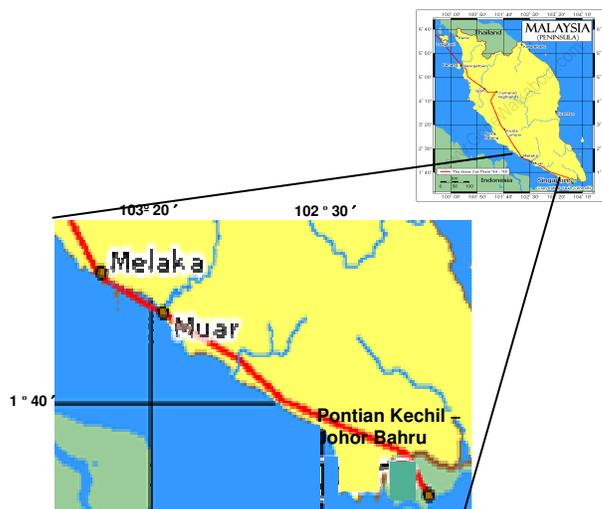
Figure 3: Pilot study area

4. RESULTS AND DISCUSSION

Categorizing of important factors in shoreline area sensitivity was done through questionnaires and interviews among governmental and private sectors as well as public who are involving in coastal activities. Shoreline area was divided to three parts of major, medium and less in danger parts according to different factors like human economic disruption, wild life mortality, habitat availability, aesthetic degradation, etc.

As well, some criteria affecting on choosing of oil response methods including of equipments, responding teams, environmental considerations, and cost were considered as base for knowledge acquisition from Malaysian Marine Department and Department of Environment, as the major responsible authorities in oil spill cases.

The whole system is being designed based on experts' knowledge and experiences and validating some sample scenarios and selected historical cases, which will be presented in conference.

5. CONCLUSION

The oil spill management system aims to achieve a knowledge-based system which can choose the most suitable method of response in shorter time by analyzing the various sensitivity factors of coastal environment, affecting parameters on oil spill movement, environmental concerns in oil spill response, and consequent monitoring and clean-up measurements. The developed system would be able to provide a reasonable 'any-time' mechanism so that in most cases some reasonable response actions can be put forward. The system is useful in speeding of response actions especially in the regions which still suffer from the shortage of enough experts for responding the disasters.

REFERENCE

Douligeris, C. et al. 1995. Development of OSIMS: an oil spill information management system. Spill Science & Technology Bulletin, Vol. 2, No. 4, pp. 255-263.

Etkin, D.S., & Welch, J. 1997. Oil spill intelligence report international oil spill database: trends in oil spill volumes and frequency. Proceedings 1997 International Oil Spill Conference, pp. 949-952.

Fabbri, K.P. 1998. A methodology for supporting decision making in integrated coastal zone management. Journal of Ocean & Coastal Management. 1998: vol. 39, pp. 51-62.

Geng, L.; Z. Chen; C.W. Chan; G.H. Huang. 2001. An intelligent decision support system for management of petroleum contaminated sites. Expert System with Applications. Vol. 20, pp. 251-260.

Hernandez, J.Z.; J.M. Serrano. 2001. Knowledge-based models for emergency management systems. Expert Systems with Applications, Vol. 20, Issue 2, pp. 173-186.Elseviet Science Ltd.
Keenan, P. 1997: Using a GIS as a DSS generator. Department of Management Information Systems, University College Dublin, Working paper MIS 95-9, 1997.

Li, J. 2001. A GIS planning model for urban oil spill management. Water Science and Technology: a journal of the international association on water pollution research. Vol. 43, Issue 5, pp. 239-244.

Li, Y.; Brimicombe, A.J.; Rlphs, M.P. 2000. Spatial data quality and sensitivity analysis in GIS and environmental modeling: the case of coastal oil spills. Computers, Environment and Urban Systems, Vol. 24, Issue 2, pp. 95- 108.

Pourvakhshouri, S.Z.; S. Mansor. 2003. Decision support system in oil spill cases (literature review). Disaster Prevention and Management, Vol. 12, No. 3, pp. 217- 221.
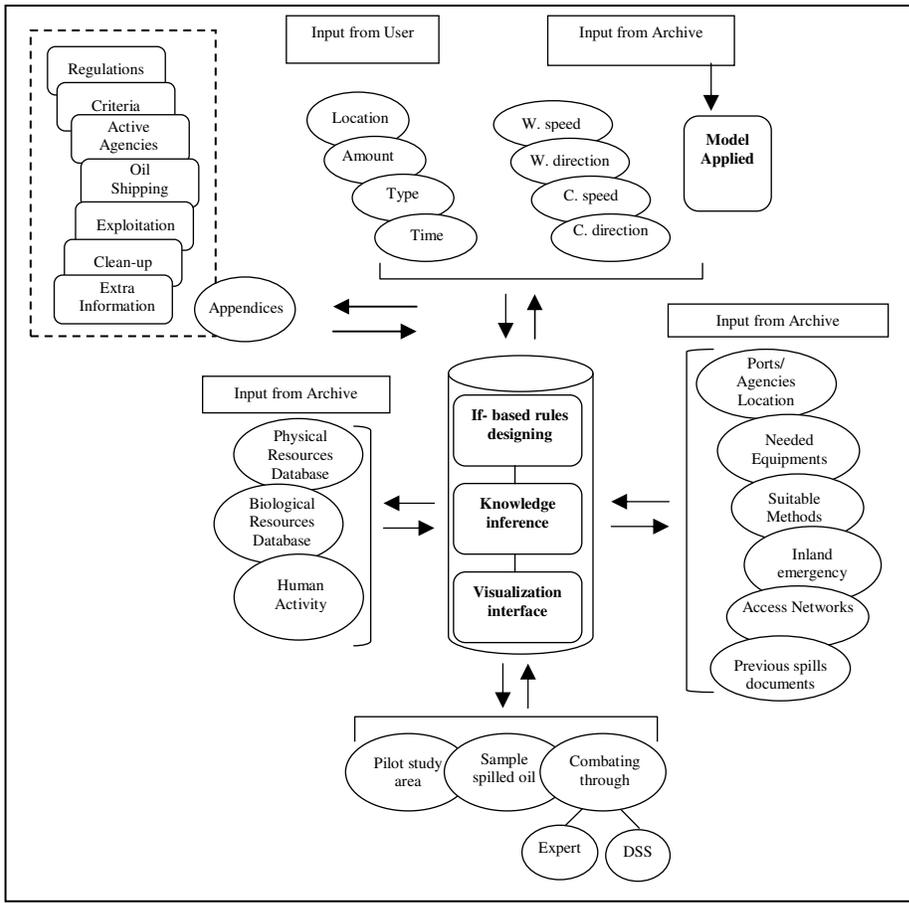
Fig. 2: Detailed domains included in oil spill management DSS planning