

DEVELOPMENT OF DECISION SUPPORT SYSTEM FOR DISASTER MANAGEMENT – A CASE STUDY

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ABSTRACT:

Natural hazards or any other man-induced hazards will become a serious disaster when they strike the man-made environments causing a huge loss to human life as well as natural resources. In order to manage emergency situations in an effective manner, it is required to define a proper disaster management system. As the disaster management depends on various types of data, information and knowledge on the disasters in the recent past. Therefore, one needs to depend heavily upon various agencies for getting input and implementing the right plan by integrating various kinds of data. This necessity drives various administrators and planners to simulate the emergency response, preparedness, and application of different multi-criterion models for disaster management. Therefore, in the present study, an attempt has been made to develop a 'Decision Support System' for 'Disaster Management' (DSS-DM) with a specific case study of Kalpakkam Nuclear Power Plant site. DSS-DM has two basic components viz. simulation of the situation based on database and different multi-criteria model. The DSS-DM was developed based upon COTS software macros. As an initiative, using these macros, simulation models related with floods and nuclear disaster were developed. DSS-DM is a menu driven package, which will help decision makers to get the information on the region of interest at a click of point. Simulation process of specific disaster will indicate the possibility of loss that would happen and the emergency requirement for its response. Thus this menu driven package helps the planner or administrator can make an emergency preparedness plan for different disasters with different simulation possibilities in an automated way.

1. INTRODUCTION

Hazards, whether it may be a natural like earthquake, tsunami, floods, landslides, volcanic eruptions, fires, cyclones, etc or man-made like Nuclear disposal, dam failure, etc, causes a huge loss of life, damages to property as well as natural resources. In developing countries like India, Disaster management is one of the widely increasing difficult tasks. To effectively control this amount of losses and to minimize the potential risks a proper management systems is required. It is almost impossible to fully recoup the damage caused by the disasters. But it is possible to minimize the potential risk by developing disaster early warning strategies, preparing and implementing developmental plans to provide resilience to such disasters, and helping in rehabilitation and post disaster reduction. Decision Support System (DSS) is a specific class of computerized information system that supports in any decision-making activities. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions, (Jayashankar, 1989). Therefore, an attempt has been made in this study to develop and demonstrate the capabilities of a DSS.

2. OBJECTIVES

The objectives of the study are:

- i) To develop a decision support system for the disaster management and
- ii) To develop a geo-spatial database that can be used in any decision-making process.

3. STUDY AREA

The Kalpakkam nuclear power plant site has been selected for the study. The area is bounded by 12°25' to 12°50' North latitude and 79°50' to 80°10' East longitudes with Bay of Bengal in the east and land mass on the west. The land mass is mostly characterized by plain terrain with agriculture predominance. The dominant crops grown in the area are paddy, pulses, ragi, and groundnut. The banana plantations are also grown particularly on the west of Buckingham canal. The other land use categories dominant in the region are forest, grasses and scrub land with dry lakes/tanks.

4. METHODOLOGY

Decision support system for Disaster management (DSS-DM) is a system that has been designed to handle the disaster situations with all emergency management plans and decisions. It includes the database management system (DBMS) and the multi-criteria model based management systems (MC-MBS) with special emphasis on the disaster management. The architecture of the system has been designed and is presented in **Figure-1**. According to Malczewski, (1999) Decision support systems are basically an interactive

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computer based system that help decision makers utilize data and models to solve unstructured or semi structured problems. With this context DSS-DM had been framed with all GIS functionalities like queries and visualizations and preparing the maps.

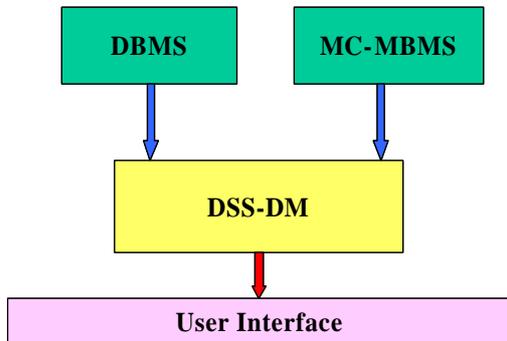


Figure-1: Framework of DSS-DM

5: DEVELOPMENT OF DSS-DM

DSS-DM had designed using macro language available in COTS package. DSS are normally developed using commonly available database management systems which lack component of spatial location. Since the spatial component is the most important parameter in disaster management, the macro language available in GIS software has been used. The backend of this system is the GRID module that supports the raster based model analysis. DSS-DM developed in such a way that it includes both the query system and multi criteria models. It will not only provide the user/managers to take quick decisions in case of any emergency situation but also allows to prepare a emergency preparedness plan for a particular site with level of different disasters. The interface development of DSS-DM is shown in the Figure-2.

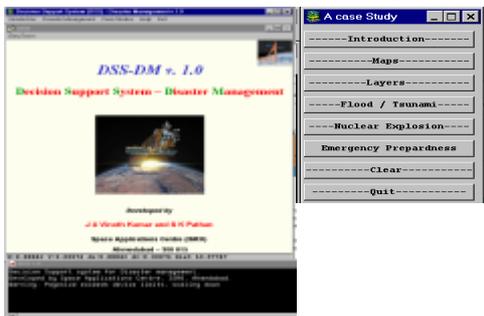


Figure-2: User Interface of DSS-DM

The DSS-DM will also provide the user to query and visualize various simulations based upon different flood levels as well as nuclear disaster. The proposed development menu card is shown in Figure-3.

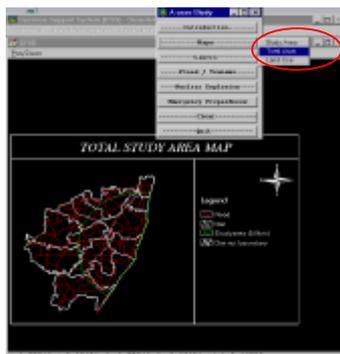


Figure-3. Query menu of DSS-DM

5.1: Flood Management Systems

The flood around the Kalpakkam nuclear power plant site occurs not due to heavy rainfall but due to the high tidal waves and Tsunami. In order to evaluate this pattern, a study has been carried out earlier and a methodology has been worked out to demarcate the flood patterns for every one meter of water level rise due to tides (S.K. Pathan et al, 2005). An attempt was also made to estimate the property loss and resources loss due to high tidal waves in this study. On the basis of this study, an automated DSS-DM, a 'Flood Management System (FMS)' module has been developed and is given in Figure-4. This FMS module identifies the inundation pattern with respect to water level rise due to tides. The inundation pattern is traced on the basis of inputs such as DEM and Land use. These inputs were taken from the study conducted earlier (Pathan et al, 2003, 2005). On the basis of these inputs, the inundation pattern has been simulated from the high tide line for every 1 m level of sea level increase. This inundation pattern can be visualized over the

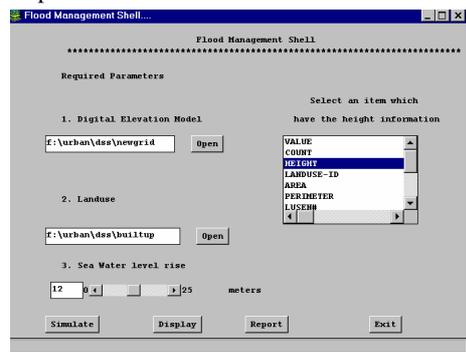


Figure-4: Flood Management System

land use pattern and also the possible affected built-up land and its population level. The FMS model can display all these simulations and the areas affected with population figures in an automated way and at a point of click. In addition to this, it allows user to prepare an emergency preparedness plan interactively with the possible affected place and the possible relocation sites and the optimum path to reach the place in time.

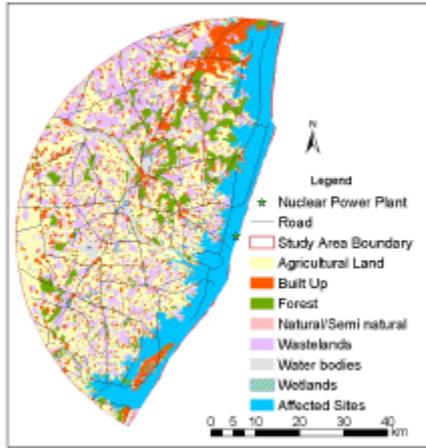


Figure 6. Flood Inundation pattern

The model is tested at 5m water level increase and the affected areas along the coast is presented in **Figure-5**. The statistics related to different land use/land cover categories is presented in **Table-1**.

Table-1: Area affected by inundation with respect different Land use/land cover categories.

DESCRIPTION	AREA (SqKm)
Built Up (Rural)	33.72
Fallow	2.43
Crop Land	295.07
Forest Plantation	9.57
Canal	146.52
Built Up (Urban)	904.88
Land without scrub	59.74
Land with scrub	58.88
Dense/Closed	22.06
Coastal Natural	326.85
Sandy area	25.43
Tanks	50.34
Lakes/Ponds	19.43
Barren Rocky/Stony waste	64.02
Waterlogged	28.01
Marshy/Swampy	9.27
Plantation	84.60
Open	366.67
Grassland & Grazing land	2.02
Forest Blank	73.16
River	22.31
Gullied/Ravinous land	21.01
Coastal Manmade	8.03
Salt affected land	2.57
Habitation with plantation	66.29

5.2: Nuclear Leakage Management

The second menu driven package has been developed to simulate nuclear leakage and its management. This module has also been developed using macro language available in the COTS package. This module allows the user to interact the level of radioactivity leakage and it can perform the simulation

of the possible area getting affected by it. The menu of this module is shown in **Figure-6**.

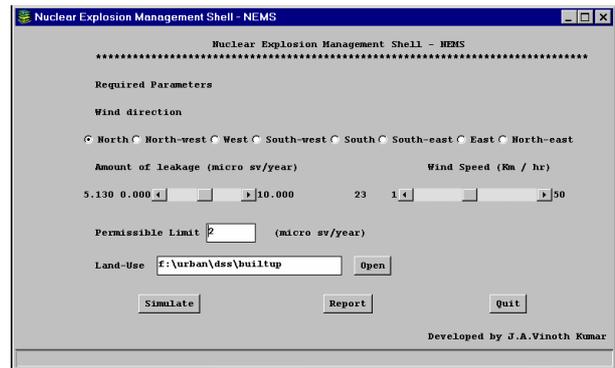


Figure-6: Menu for the simulation of nuclear leakage

The model works on inputs related to wind direction, wind speed, amount of leakage and the information on land use/land cover. The model runs on these inputs it not only finds out the possible affected areas in case of nuclear leakage sites but also evaluates the possible cause to human and the natural resources. The model runs on the basis of standard norms set by Atomic Energy Regulatory Board (AERB). Though the response time for nuclear disposal is less and is difficult to control or take immediate action, this menu driven package helps the planners in advance to work out and prioritise the possible locations for safety.

5.3: Emergency Preparedness Plan

In any disaster management, there is a need to provide immediate relief in short time. Therefore, there is a need to simulate the situations of hazard and an emergency preparedness plan. Hence, in this study, an attempt has been made to prepare a module for emergency preparedness plan to find out the ideal locations for relocating the affected population to safer places through optimum paths. So, this module allows the user to prepare emergency preparedness plans and enlist the possible affected sites and the relocation sites with the use of different multi-criteria model based systems. A sample of emergency preparedness plan generated using this module is presented in **Figure-7**. From this figure, one can observe the possible routes for relocating the affected population in case of emergency to safer places.

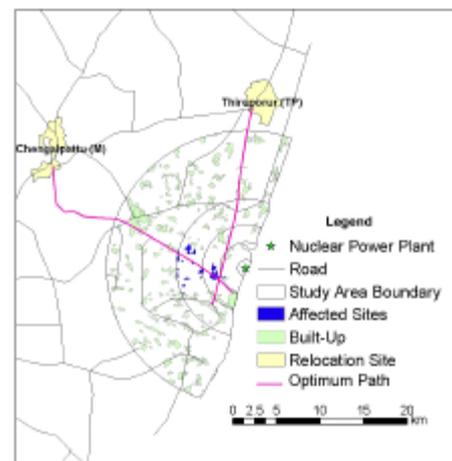


Figure 6. An Emergency preparedness plan

6.0: CONCLUSIONS

The study has demonstrated the capabilities macros to generate menu driven packages for different kinds natural hazard management. It is user friendly and requires a day training to operate the entire DSS-DM. The planner or administrator can easily work out various modes of simulations and take precautionary measures to face any eventuality of disaster. However, this particular study has highlighted to manage the disasters occurring through floods and nuclear leakage. This attempt has opened the chapter to prepare decision support system for any disaster management in future.

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