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DEVELOPMENT OF A RIVER WATER QUALITY MANAGEMENT INFORMATION SYSTEM

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Abstract. Rivers provide water for domestic consumption, agriculture, industry and recreation. Thus, to ensure consistent high quality, river water quality should be monitored on a regular and systematic basis. In the event of pollution occurring, prompt remedial action needs to be taken. In this paper, we describe the development of a river water quality management information system. The system, which consists of three modules (database, graphical user interface, diagnostic) and uses e-mail, overcomes the deficiencies of current manual practices of monitoring river water quality and facilitates information transfer.

1 Introduction

Developing countries now recognize that environmental protection must be coupled with economic growth. For these countries cost-effective, control based strategies could provide a means of controlling pollution and ensuring a high quality of life (Chapra, 1997). There have been major advances in computer technology over the past decade, which have lowered the costs of computer hardware and software whilst increasing significantly efficiency. Examples include the Internet, graphical user interfaces (GUI), laptop computers and database technology. These advances now make possible cost- effective technological improvements in the area of water quality monitoring in many developing countries.

Sampling of river water needs to be carried out on a regular basis to ensure pollution remains within permitted levels. If the level of a pollutant exceeds the prescribed permitted level then remedial action needs to be urgently carried out. Sampling and remedial action are sometimes carried out by different units of the same water authority or by different water authorities altogether. This can lead to inefficiencies in river water quality management. Environmental decision support and management systems are increasingly being used in water quality monitoring (Labadie et. al., 1989; Lam 1997). In this paper we describe the development of a river water quality management information system. This system, which consists of three modules (database, graphical user interface, diagnostic) and uses e-mail, overcomes the deficiencies of current manual practices of monitoring river water quality and facilitates information transfer and communication between units responsible for sampling and remedial action.

2 Overview of system

The system consists of three major modules: database, GUI and diagnostics. The database module also includes two sub-modules: work schedule and action management. User friendly interfaces are used in the system and security is ensured by allowing access only to registered users with passwords. The system utilizes client Oracles at sampling stations to ensure proper integration of data and information before being sent to an Oracle server at headquarters. The software used to develop the system were: Windows 98, Oracle 8i, Visual Basic 6.0, Microsoft Paint and Adobe Photoshop and the hardware used were: Pentium II computers with 64 MB memory, network cards, scanners and printers.

3 Database module

The main features of the database module can be illustrated by some of the available menus.

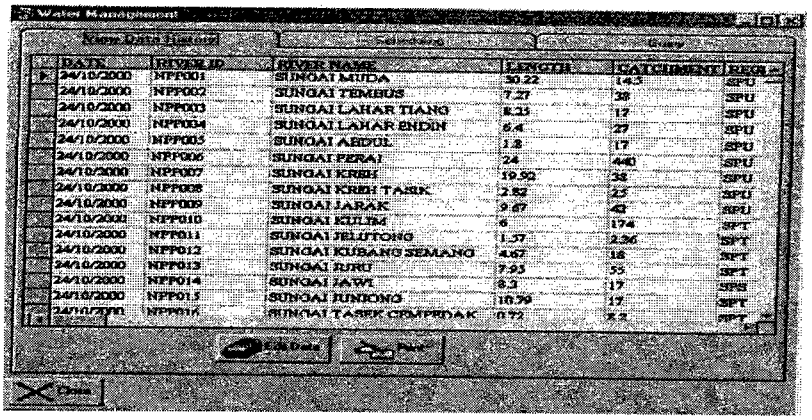

Figure 1. Database menu showing "View Data History".

The menu in Figure 1 displays data kept in the database `River_Info'. Data stored include river name, lining type, region, length and sampling date. Users may also add and delete data as well as print the information. Using the menu in Figure 2, a user may obtain information regarding a river based on some criteria: for example by region, by state.

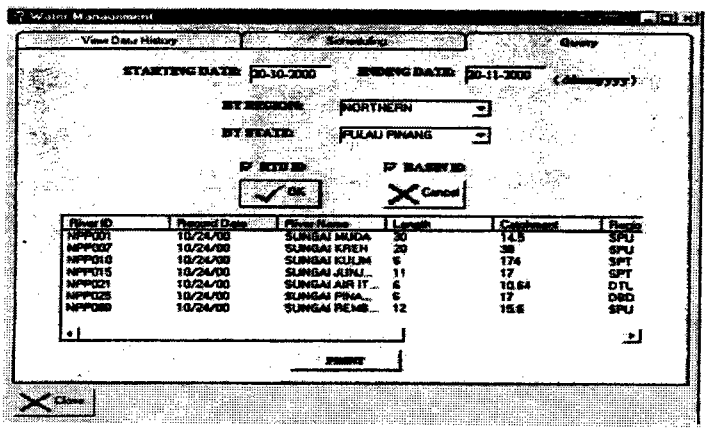

Figure 2. Database menu showing "Query Interface".

The menu in Figure 3 enables users to view the daily work schedule of the sampling workers. The schedule for a particular day will be displayed when a particular date on the calendar control is clicked. Double clicking a group ID will display workers in a particular group. Data can be added, deleted and modified using buttons on the toolbar provided. Pressing the query icon will enable other inquiries to be made. Hence with this system, a manager can systematically and automatically schedule staff for samples collection.

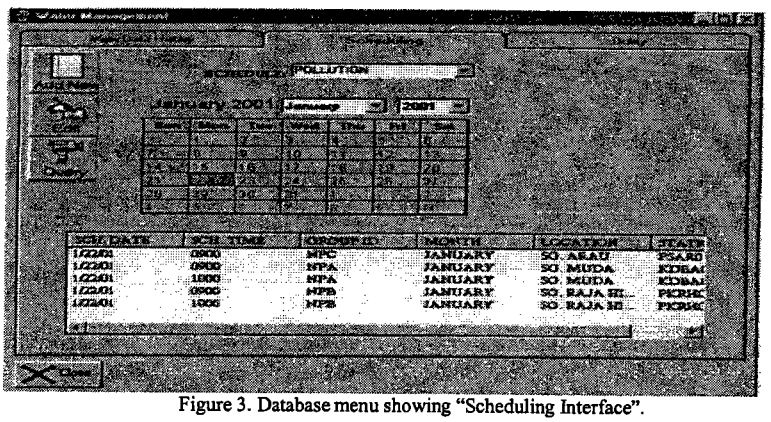

Figure 3. Database menu showing "Scheduling Interface".

4 GUI module

Friendly user interfaces are likely to have the greatest impact on whether or not a particular decision support system is actually used by decision makers (Watkins and McKinney, 1995). Over the past decade GUI has increasingly been used in water quality management information systems. GUI have been developed for the validation and verification of expert system in resevoir management (Bender et. al., 1993). Briggs and Lumb (1996) described the development of a hydrologicc database system called the National Water Information System-II which provides a graphical user interface under the X Window System for data entry and retrieval and includes extensive reference lists. Simulation and optimization modules, combined with a GUI permit efficient and convenient study of various resource management scenarios for wetland development DSS (Vadas et. al., 1995). Numerous other researchers have also commented that appropriate and intelligent use of GUI can help increase the effectiveness of management information systems. The system which has been developed makes significant use of GUI.

The concept behind the use GUI is to allow interactive queries about rivers via a GUI module. Users can use the GUI module to view maps which show the rivers, to find out detailed information about particular rivers, to quickly identify via flashing coloured icons, highly polluted rivers or rivers on the brink of flooding, and users can also seamlessly glide to other modules via this GUI. The GUI component is divided into 2 sub-modules : Graphical Interface Query and Graphical Interface Editing sub-modules.

In the Graphical Interface Query sub-module, the following services are available :

- Displays maps of regions.
- Displays warning icons on maps.
- Enables users to query warnings till exact location found.
- Display information regarding rivers and their problems.
- Enable entry into diagnosis modules.

Figure 4 shows the snapshots of services in the order described above.

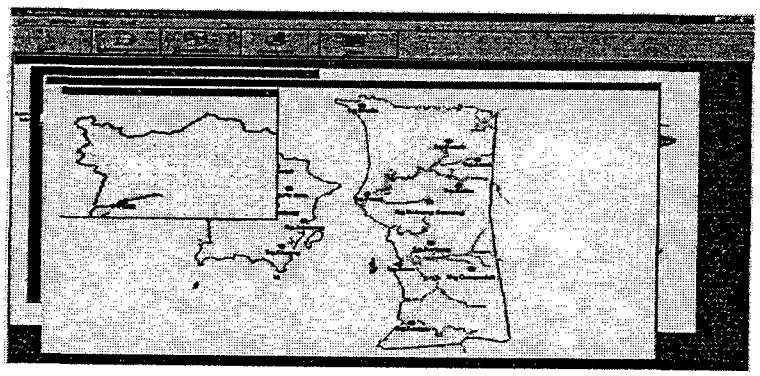

Figure 4. Zooming area of interest.

A good system should be generic and extensible. The system offers a Graphical Interface Editing Sub-module, which allows a system administrator to *customize* graphical information on the maps. Using this sub-module, a system administrator can easily add new maps, change graphical information in existing maps, delete, add or update graphical information of rivers, such as their location, and names. The framework of the underlying database is also general (and standardise) enough to allow users to add new data without major hassle. This sub-module offers the following services :

- Users can build new data or edit data
- Users can enter new maps into the application
- Users can enter information about images of new location on maps
- Display information which has been edited.

Figure 5 show a snapshot of the services offered by this sub-module.

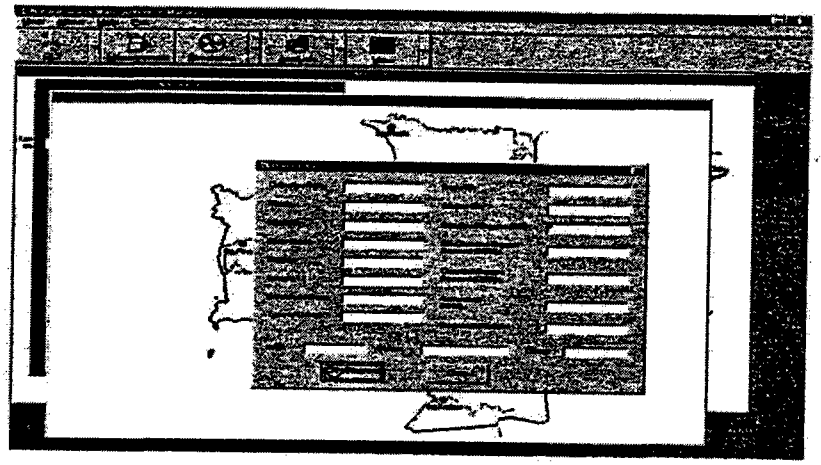

Figure 5. GUI for editing river information.

5 Diagnostics module

The diagnostics module will identify rivers where readings indicate that the levels of a pollutant has been exceeded. Users can also view pollutant levels in a particular river .

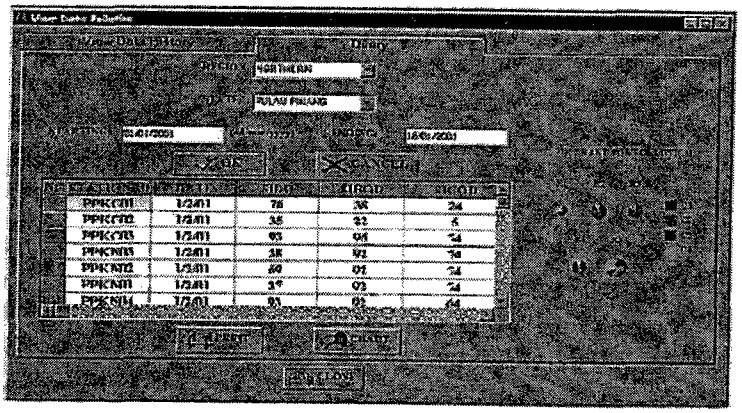

Figure 6. Data pollution query interface.

A water quality index is an empirical expression which integrates water quality parameters into a single number (McClelland, 1974). Such indices were developed in response to the need for a consistent and comprehensive method of measuring water quality. In the system that has been developed, a water quality index based on a weighted sum of six water quality parameters (pH,DO,COD,SS, Ammoniacal Nitrogen, BOD) is computed. The river is then classified as clean, slightly polluted or very polluted according to the value of the weighted sum. The relevant department responsible for locating the source of the pollution would then be contacted by e-mail.

6 Future work

The database currently consist of major rivers in the northern states of peninsular Malaysia. This database will be expanded to include major rivers in the whole of Malaysia. Field testing of the system has not been carried out and the next phase in the development would be to have it used in the field and obtain feedback from users

Acknowledgements

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