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BUILDING A KNOWLEDGE-BASED SYSTEM FOR RIVER WATER QUALITY MANAGEMENT

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Managing water quality is considered most challenging due to the multitasking decision making and the necessity of the convergence of opinion by multidisplinary experts in the field. Many decision making models have been developed with various application tools for water quality management. Knowledge-base system-river water quality (KBS-RWQ) is a system developed using visual basic as the language platform to assist non experts in decision making in managing water quality. Application of the pollutant load concept by using the load duration curve to determine the status of water quality is the basis for the KBS-RWQ. The objective has been to support decision making addressing the following: determine the load capacity of the selected river; evaluate the field data; decide on the source of pollutant; and select control strategies. Deterioration of water quality with health threats to human kind are the result of poor planning and decision making of the past. By combining the capable modeling technique, databases, and expert intelligence, the KBS-RWQ will improve the quality of the decision making.

INTRODUCTION

Nasiri et al. (2007) and Thanapakpawin et al. (2007) state that landscape and water resource management have been considered as the most challenging areas of environmental policy due to differences in priorities and preferences from community to community, and from country to country. The complexities in water quality management not only involve technical efforts in the realm of engineering but also different professions such as planners, government regulatory agencies and other groups responsible for review and approval of policies. Sullivan et al. (2005) noted that knowledge-based reasoning provides logical and mathematically robust evaluations of imprecise information and is particularly relevant to the managing of resources, ecosystems and environmental pollution. A knowledge-based system (KBS) is a method of providing solutions to various problems that traditional or conventional methods cannot deal with (Lioa, 2005). KBS supports decision making and provides problem solving due to the fact that social, psychological, organizational, technical, economic, governmental and environmental factors influence the decision situation. Experts have difficulty in presenting facts that can lead to a decision. KBS is the transfer of a vast body of task specific knowledge from humans to a computer, and their application have proven to be critical in the decision support process and problem solving (Lioa, 2005).

The component of KBS are knowledge base, inference engine, knowledge engineering tools, and user interface (Lioa, 2005; Turban, 2005; Zhou, 2004). Starfield and Bleloch (1983) proposed that expert development of expert systems involved two stages, namely, the knowledge engineering stage and the software development stage;

(i) The knowledge engineering stage

Given the problem areas to be addressed, the knowledge engineering stage involves knowledge acquisition and knowledge representation:

- Knowledge acquisition:

This involves identifying relevant sources of knowledge and expertise, identifying objectives, goals and issues of tasks to be performed and eliciting the required knowledge / expertise from experts and other information sources.

- Knowledge representation:

Knowledge can then be presented in different ways, depending on input and end-user requirements. If practical guidelines are required for problem-specific, decision-support purposes, then normally the cause-effect type of logic and procedural knowledge needs to be separated from the descriptive knowledge. The logic and procedures can then be addressed separately. The following steps have been found useful for modeling the decision pathways suitable for encoding decision-support tools used for diagnostic and interpretation purposes. The steps are to identify all the objects which are relevant to the problem area (e.g. for water supply disinfection and monitoring, objects are: raw water, treated water, chlorination strength, treatment options, etc.). Then, amongst these, identify which ones represent issues and which ones represent goals.

(ii) The software development stage

It is important to select the knowledge management tools and the models in accordance to the type of environmental problem and the type of information and knowledge acquired. It should be able to run on a personal computer as well as web-based applications for updating, further improvement, and evaluation of the overall performance of the system.

BUILDING KBS-RWQ

The KBS-RWQ framework developed proves the potential of using KBS in the specific environmental management domain (Booty et al., 2009; Turban et al., 2005; Zhou, 2004)

. The specific activities conducted by KBS-RWQ are as follows:

⇒ Data collection

⇒ Expert agency survey

⇒ Expert domain interview

⇒ Building rules and conditions

⇒ Programming in Visual Basic language

⇒ Built the prototype: validate and verify

⇒ Apply case studies

Visual Basic 6 (VB) is used as a programming language on the Windows operating system. The Visual Basic integrated development environment (IDE) was used in which applications can be built and all the tools required can be accessed within the Visual Basic IDE. VB is an event-driven language, which means that code is executed in response to events (Sellappan, 2006). These events might come from users or from Windows itself. It is necessary to design information forms, as these forms will be constructed into user interfaces. Construction of forms for user interfaces will provide the necessary media so that the system can execute actions when the information is input. Such forms were transformed as a computer screen shown in Figure 1. Some rules and conditions must be established for the system to use these rules and conditions for processing and inferences. The basic format of rules established inside the KBS is:

Rule Condition 1

and/or Condition 2

Then Goal

Examples of the rules and conditions in the KBS-RWQ prototype are shown below. The system will assess the current scenario of the selected water quality problem then determine the recommended action. More of the rules and conditions can be generated in validating the prototype using case studies. In determining the recommended action to the user, an example of the rules and conditions applied is given here:

Rule 1: If field data load of BOD exceed the load capacity

Rule 2: If flow = low

Rule 3: If flow = high

Then: low flow = point source

Then: high flow = non point source

⇒ graphical output

⇒ integration with spatial data

Rule 4: If Point source

Rule 5: If Sewage Treatment Plant (STP)

Rule 6: if there is no treatment plant,

Then build treatment plant consisting of physical, biological or chemical treatment

Rule 7: If non point source

Rule 8: If BOD

Rule 9: If structural approach

Rule 10: If source minimization

Then build lagoon or storage area or diversion terraces

USER INTERFACE

The user interface is the communicative media between the entire system engines to interact with user requirement. Users are required to input the data on each of the screens shown below

- To start the KBS-RWQ, click the specified icon, and the first dialog box will appear.
- Users are required to input the information the area of study
- Users are required to input the information on the flow-rate of the study area in this dialogue box
- Users are require to input the information of recent concentration and flow data collected
- The computational result for flow information as shown in this dialogue box
- The flow duration curve as plotted by the KBS-RWQ of the study area
- The field data on concentration and flow must be keyed and plotted on the LDC by the system
- System produced summary of the data entered
- The map of the study area installed from the GIS
- The KBS-RWQ make recommendation as per the source/s identified
- The system generates the report for user reference.

KBS-RWQ OUTPUT

The KBS-RWQ has assisted the non expert in environmental management to help them to quantify the pollutant that is causing the pollution, and further assist in identifying the control measures to reduce or minimize the pollution caused by the identified source. The system will enable decision making process in shorter time without much data requirement; this is crucial when there is a water pollution crisis. The output of the system as listed below:

- Result of data analysis
- Graphical representation
- Spatial data
- Recommendation

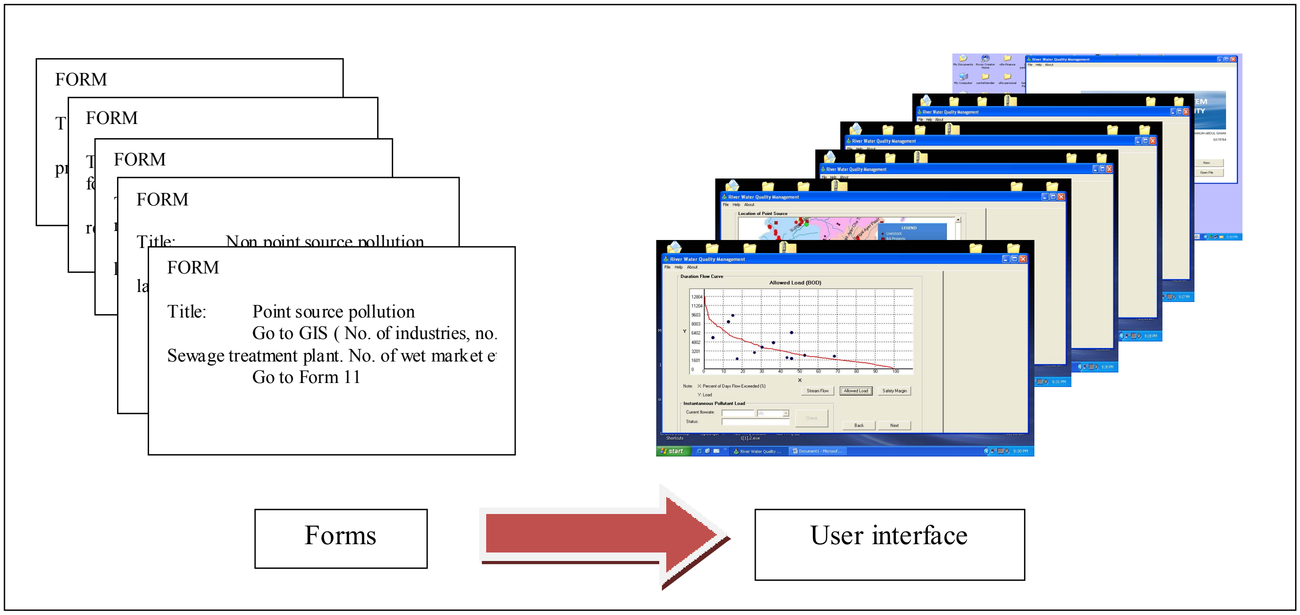

Figure 1. Forms and user interface in KBS-RWQ.

- Overall report of the output

CONCLUSION

The KBS-RWQ contains a range of facilities designed to assist the non expert to interpret and implement the necessary action in managing the water quality of the identified river. The system has included the user interface which provides the ease of use and user assistance for anyone interested in using the system.

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