KNOWLEDGE-BASED SYSTEM FOR RIVER WATER QUALITY MANAGEMENT

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Introduction

River water quality refers to the physical, biological, and chemical status of water bodies. Urbanization, population density, water shortages and pollution strongly influence the water quality (Cheng et.al. 2003). The water quality downstream is related to the proper management of the river basin and the adequacy of treatment plant within the basin concerned. Data on river water quality parameters are gathered consistently to enable the assessment of the status of the water quality be determine. However, an effective method of extracting value added information from these data to facilitate decisions on the implementation of cost-effective pollution prevention measurements to safe guard people, livestock and industrial development in a region remains a problem (Vrtačnik et.al 1992). Often deterioration of water quality caused by discharges from untreated industrial and municipal wastewater, surface and agriculture runoffs, spill of hazardous substances, illegal discharges of industrial waste and development activities in the water catchments area does not take into consideration the assimilative capacity of the river to self purified the pollutant that has been discharge into the river, thus incremental discharge of various pollutant from any sources will eventually lead to the 'death' of the river. Two extremes condition must be considered in managing river basin; disregard the generally severe damage to the aquatic ecosystems and the impairment of the utilization of the water due to direct discharge of untreated wastewater, or treatment of all the wastewater streams discharging in the receiving waters, at the highest quality level. And in-depth knowledge in this area is crucial to develop an effective management tool for solving environmental problem. An effective knowledge management tool will enhance decision making process and employing computer based-technology to capture knowledge and human expert knowledge has moved knowledge management front and centre.

Objectives of the study

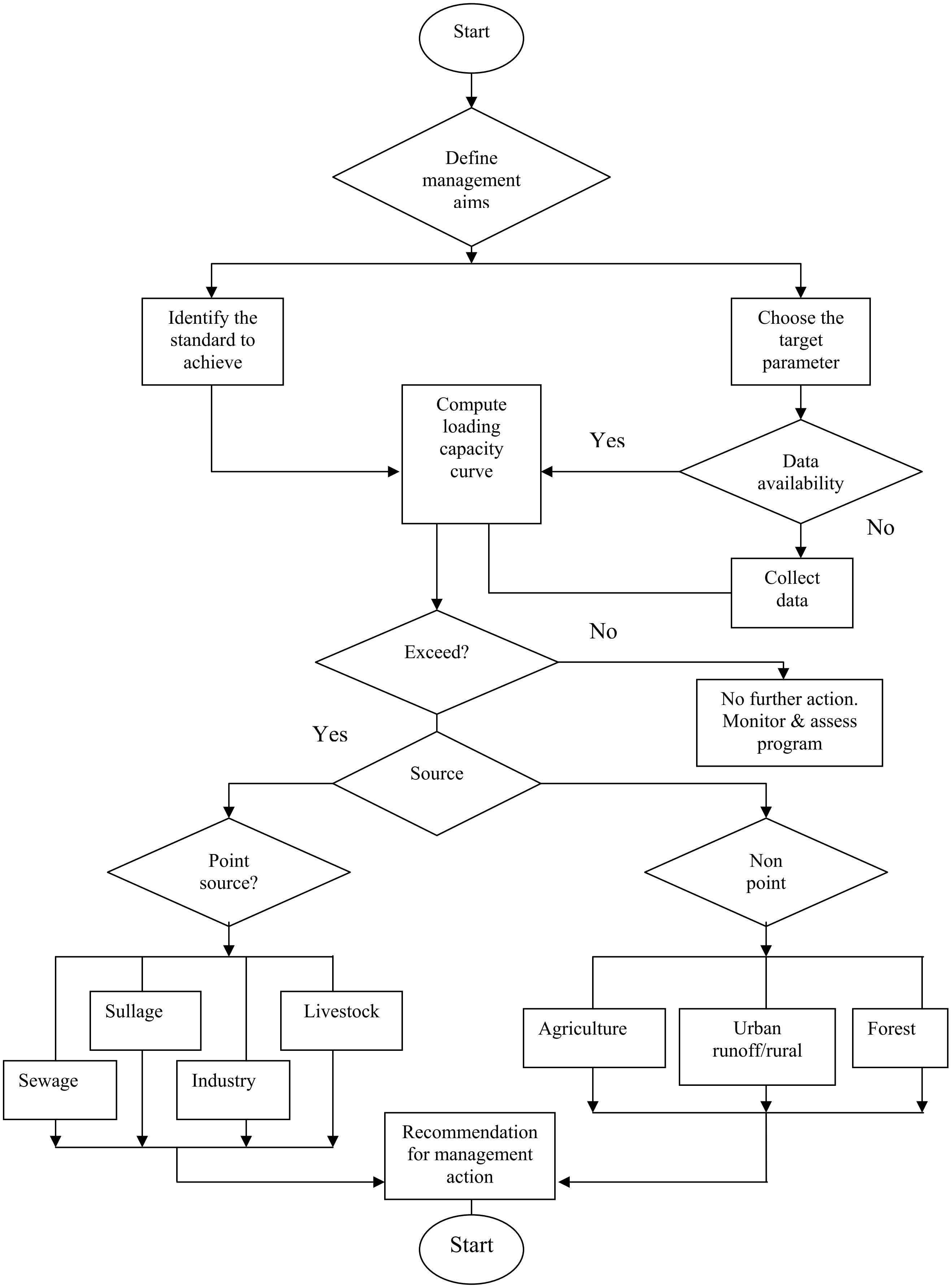
The objectives of the study are:

- To develop a knowledge-based system that support decision-making process in managing river water quality
- To identify the various sources of pollution that contribute the degradation of water quality using the load duration curve
- To determine the loading of pollutant exceeding the allowable load limit using the load duration curve
- To recommend solution/options to improve the water quality to the desired level

Research methodology

Visual Basic was selected as a tool for prototype development and the input for the system to perform the assessment of water quality and recommendation on action to be taken as shown in Figure 1. The expert system utilizes two domain experts. Meetings and discussion were held to obtain the experts knowledge. Personal interviews with the experts were also conducted. Surveys were also conducted to obtain information from various agencies related to managing the water resources. Knowledge from other sources includes textbooks, multimedia documents, databases; special research reports and information available on the web were used to build the system.

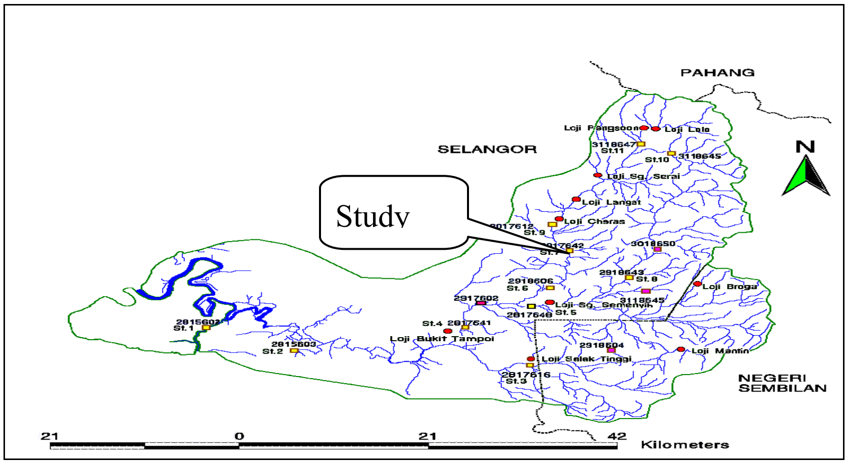
Figure 1: Flowchart for Prototype Development Project for the Decision Making Process



Results and Discussion

Sub catchment of upper Sg. Langat is located in the catchment of Sg. Langat as shown in Figure 2 was chosen as the case study area to validate the prototype. The land use of Langat catchment consists of mainly agriculture, forest and urban areas (commercial and residential). From the Table 1 shows agriculture is still the dominant land use 55.44%, forest 24.20% and urban areas 18.8% of Langat catchment. The urban land uses are along Cheras-Kajang-Semenyih corridor. Sub-catchment Sg. Langat is in the district of Hulu Langat with the highest peak of Gunung Nuang with 1 493 meter. Main town of Hulu Langat is Kajang and Cheras where most of the major activities are located. The landuse of Hulu Langat consists of commercial/business area, agriculture, industrial land and others such as residential, recreational, infrastructure, aquaculture, livestock farming etc.

Sub-catchment of upper Sg. Langat is located within two local authority; district of Hulu Langat and Kajang Municipality. Table 2 indicates some of the major source of pollution in the study area.



(source: Zahit, 2005)

Figure 2: Sg.Langat River System

Table 1: Land Use Pattern of Sg. Langat Catchment

Land use	1995		1997		2001	
	Area (km^2)	**%**	**Area (km^2)**	**%**	**Area (km^2)**	**%**
Agriculture	1300.76	57.41	1252.62	55.18	1283.07	55.44
Forest	718.58	31.71	735.52	32.40	560.05	24.20
Urban	194.23	8.57	223.08	9.83	434.13	18.76
Water body	9.67	0.43	13.53	0.60	36.96	1.60
Other	42.68	1.88	45.46	2.00	-	-
Total	2265.92		2270.21		2314.21	

(source: Rancangan Struktur Negeri Selangor 2020)

Table 2: Sources of Pollution of Sub-catchment of upper Sg. Langat

Point Source (PS)	Non-Point Sources (NPS)
Industrial Estate Wet Markets Piggeries Sand Mining Activities Landfills Public Sewage Treatment Plants Private Sewage Treatment Plants Restaurants Workshops	Construction Urban area Residential Residential and Commercial Agriculture Forest

(source: Department of Environment, 2007)

Collection of flow data was derived from Drainage and Irrigation Department (DID) for periods of 20 years or more. Concentration data for water quality was acquired through Department of Environment (DOE) but data for instantaneous load was also carried out by the researcher. Parameter Biochemical Oxygen Demand (BOD) was selected to be used for sample analysis. Flow data with the record values for 20 years were compiled and the cumulative frequencies were converted into percentages of the total number of days which is the basis of flow duration curve. The flow duration curve gives the percentage of time during which any selected discharge may be equaled or exceeded (Shaw 1985). The river flow duration curve was used to derive the load capacity of the river whether exceedances have occurred or not. The National Water Quality Standard for beneficial uses of rivers was adopted as standards to be achieved in performing the load duration curve (LDC). Integrating the River Classification standards will be the basis in deriving the loading capacity of the river. The LDC will indicate the pollutant load based on the magnitude of the stream flow and projected the expected annual trend of a particular load. The knowledge-based system river water quality (KBS-RWQ) develops the load duration curve indicating the loading capacity of the Sg. Langat. The variable chosen to validate the system was BOD. The instantaneous load was plotted on the loading curve to determine the current water quality status as shown in Figure 3-6.

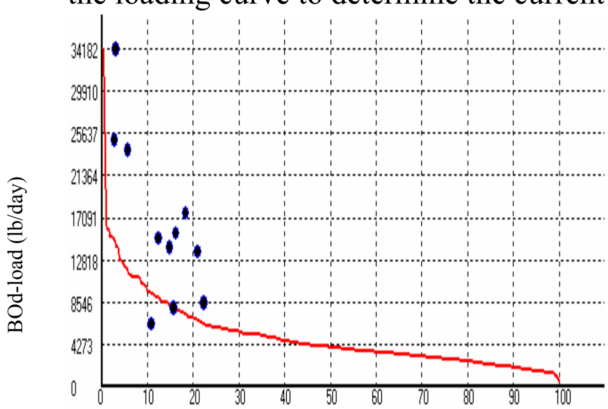


Figure 3: BOD Load Duration Curve (LDC) 2007

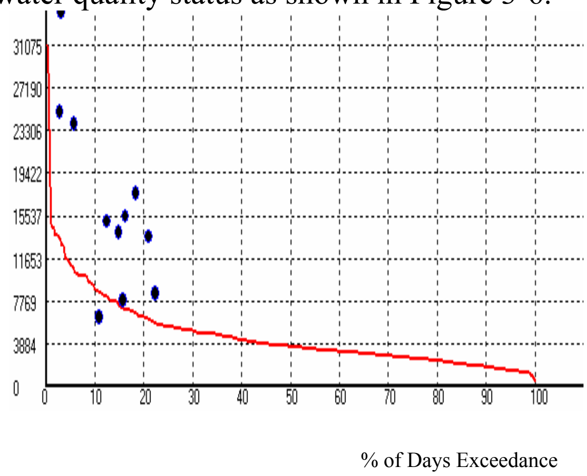


Figure 4: BOD LDC with 10% Margin of Safety 2007

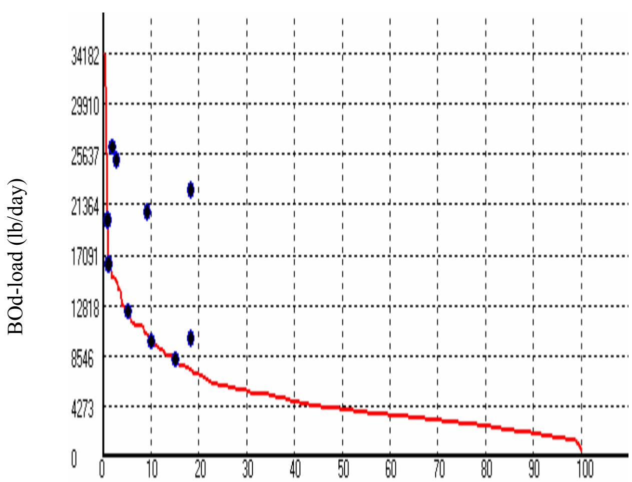


Figure 5: BOD LDC 2008

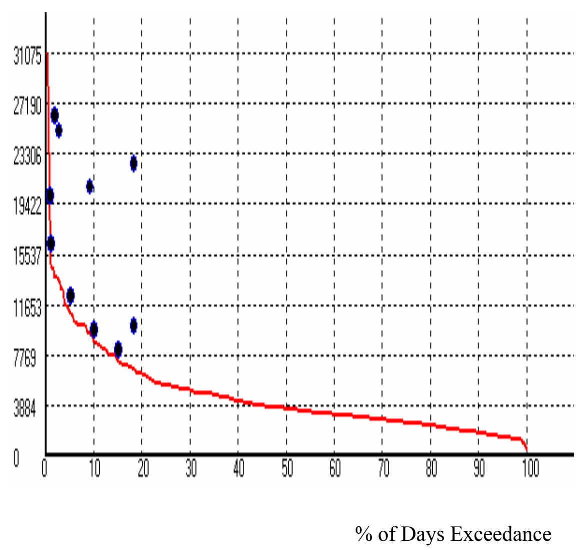


Figure 6: BOD LDC with 10% Margin of Safety 2008

Data for the year 2007 and 2008 shows that the sources of BOD were mainly from non point source because the loads plotted were in the range of high flow. The system identifies agriculture activity and urban runoff as the most probable source that was polluting the sub-catchment of Sg. Langat. The recommendation of the system was adopted from documented knowledge, Chapman (1997).

Method to control BOD from agriculture activity

Option 1: Structural Approach

- For source minimization then built lagoon or storage area or diversion terraces
- For oxygen consuming pollutant then terraces or tail water pit, runoff retention pond or wetland construction
- For animal waste then diversion pit or pond or lagoon and compost facility

Option 2: Vegetative approach

- For source minimization then grazing area management or crop rotation
- For oxygen consuming pollutant then cover crop or strip cropping or riparian(buffer)zone or change crop or grass species
- For animal waste then diversion pit or pond or lagoon and compost facility

Option 3: Management Approach

- For source minimization then grazing area management or waste composting or nutrient management
- For oxygen consuming pollutant then For oxygen consuming pollutant then recycle/reuse irrigation return flow and runoff water or nutrient management or irrigation management or lagoon

Method to control BOD from urban runoff

Option 1: Preventive Approach

- Removal of harmful compound from atmosphere by scrubbing technology
- Ban on production and application of harmful chemical
- Public education on prevention of illicit disposal
- Awareness campaign

Option 2: Source control

- Street sweeping
- Buffer strip
- Pond urban landscape features
- Reduce impervious surface

Option 3: Hydrologic Modification

- Infiltration devices
- Diverting runoff onto pervious surface
- Minor surface storage
- Increase permeability and enhance infiltration
- Increase hydrological storage

Option 3: Flow Reduction/ runoff reduction

- Swales and grassed channel and filters
- Removal of larger particles from flow or filter
- First flush control basin

Option 4: End-of pipe

- Wetland construction
- Surface storage and treatment for storm water
- Underground storage and treatment of combine sewage overflow

The selection of recommendation was based on the assessment made by the system and on the identified source. The contribution of BOD load from NPS i.e. agriculture and urban runoff are significant throughout the year 2007 and 2008. Thus the implementation of the recommendation made by the KBS-RWQ required decision makers to decide either to priorities or execute all the action needed concurrently as the system was not design to set priority on which NPS have greater impact or contribution of BOD load in upper Sg. Langat catchment.

Significance of the finding

The system provide decision maker a simple and reliable process in the determining the action needed when a water crisis happen. The assessment based on the load duration curve will provide initial assessment on the status of the in-stream water quality of the selected rivers and the information generated from the assessment will assist decision makers to make decision for continuous improvement program of the watershed.

Reference

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Skulmoski Gregory J., Hartman Francis T., & Krahn Jennifer 2007. The Delphi Method for Graduate Research. *Journal of Information Technology Education*, Vol. 6, 2007. http://jite.org/documents/vol6/JITE6p001-012Skulmoski212.pdf

Research Framework

Activity	Target date (Semester)								
	S1	S2	S3	S4	S5	S6	**S7**	S8	S9
Literature review									
Methodology 1. System architecture, designing and reviewing 2. Data collection and analysis 3. Expert opinion survey 4. Building the prototype 5. System verification and validation 6. Case study									
Result, discussion and conclusion									
Thesis writing Submission									