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µRAISON GEOGRAPHIC INFORMATION SYSTEM FOR
RURAL DRINKING WATER SOURCES MANAGEMENT

by

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Introduction

A user-friendly software package - µRAISON - for rural drinking water sources management jointly developed by the University of Malaya, Malaysia and the National Water Research Institute of Canada under the sponsorship of the International Development Research Centre (IDRC) of Canada will be outlined in this presentation. The main objective of the package is to provide an efficient means for the storage, analysis and presentation of large volume of monitoring data and related health and general information encountered in rural drinking water sources management. The salient features are the ease and rapid access to the relevant information databases and the multi-mode graphical presentation capability in relation to the geographical locations.

Basically the package is a tailored geographic information system which incorporates a database system, a spreadsheet unit and a map/graphic interface. The system is designed to run on IBM PC/AT or compatible microcomputer with 640 K RAM memory, a hard disk with 20MB or more capacity, and a dual-monitor display with an EGA colour monitor and a monochrome monitor.

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System Configuration

The overall configuration of uRAISON water quality data management system is shown in Figure 1.

As illustrated, the setting up tasks involving map digitization and database files creation or updating can be entered externally.

The digitization of maps employs packages such as CROSS-TALK or AUTOCAD for the generation of digital graphic files. These are then converted using the "Calibration/Conversion Programmes" developed in this study to mapfiles for incorporation into uRAISON.

The main database files including the water quality database and the sanitary survey database were created in dBASE III+ environment. These are readily exported to uRAISON database for direct source classification and map presentation. These database files can be imported into SPSS PC+ for statistical analysis to determine the appropriate objective classification followed by map presentation in uRAISON.

Also shown are the two main options in operations of uRAISON after system startup, namely accessing the general operational commands of RAISON through the main menu, or to perform specific water quality data management tasks using the Geographic Information System (GIS).

Via the main menu, it allows the users to generate the various map icon files, map snapshots and geographic information displays in an unguided manner.

The GIS option is a multi-level menu-driven system for performing the various specific tasks in water quality data management for rural water supply. The multi-level structure is built up from local village level where individual water sources are monitored. These are then compiled and analysed at the district, state and national levels.

Targeted Users

The uRAISON system was targeted for two levels of users. Using the menu-driven GIS options, users with minimum computer knowledge can easily access various water quality data and statistical information accumulated in the system, execute specific data analysis and GIS presentation and update data inputs. For technical management users who are responsible for water quality management at the state or national level, the setting up and expansion of a complete GIS similar to the Malaysian system could be achieved by following the procedures given in the users manual. Flexibility is built in to allow users to add or change functions in data analysis and map presentation to meet their needs in management and planning.

The Map Interface

Maps are entered into the uRAISON system by means of digitizing the cartographic maps for the states, districts and villages as map files using suitable digitizing software such as "Autocad". Figure 2 shows the map of West Malaysia, with icon assigned to each state. Map regions of greater details, such as those for individual states, districts and villages can be accessed sequentially back and forth by moving the cursor on the map display to the appropriate icon locations and make the selection

The uRAISON Geographical Information System

Once the map system (including the national, state, district and station location maps) has been set-up, any needs of further manipulation can be carried out via the MAIN MENU. The uRAISON system has a set of built-in RPL programmes that enable a selection of data analysis and graphical presentation tasks by means of easy-to-follow menus. The menu-driven GIS operations have been arranged in simple logical level structure, i.e. LEVEL 0 - NATIONAL, LEVEL 1A - STATE, LEVEL 1B - DISTRICT, AND LEVEL 2 - STATIONS IN VILLAGE.

A flow diagram of the uRAISON Water Quality Data Management System is as shown in Figure 1 where the built-in facilities and capabilities are indicated.

The starting of the system will provide options to access the geographical information system (GIS) directly, or through the main menu to select database, spreadsheet, or statistical analysis operations.

Level 0- National

The entry level of the GIS (Figure 2) allows the display of the relevant information at the national level. The addition of the programmes written within the R-M environment has made it possible to have more user-friendly and easy to use features to be incorporated. The available options are shown in the submenu (Figure 1). Figure 3 show displays of three different types of statistical information which were retrieved automatically from the database to the spreadsheet and then display on the map screen. Similar displays of statistics on water-borne disease occurrence, health services provision etc. can be incorporated. The 'COLOUR STATES' functions can be used to classify, for examples, the relative magnitude of any of the above-mentioned statistical information in maps following a chosen colour scheme. (e.g. Figure 4).

The programmes developed also allowed labelling with text in any part of the graphic screen. The size, type, position and number of graphs overlaid on the display can be determined by the user. All maps generated with overlaid information can be saved as graphics file for rapid and easy retrieval later for browsing and analysis when required.

Level 1A - State

The functions are similar as in level 0, but information is accessed on state basis. Typical displays are shown in Figure 5 & 6.

Level 1B - District

The submenu for this level in Figure 1 shows that all the facilities for level 0 and level 1A were available here. In addition, two more functions were introduced to allow users to add new sampling region if necessary, and to incorporate digitized village station icon file to the corresponding district file. Figure 7 shows a typical district map with 4 sampling regions.

Level 2 - Village Water Quality Display

This is the level where individual water supply sources are shown on the map display. Figure 8 shows at this level a typical digitized map of sampling stations (wells). Three basic functions are available and described as follows:

"COLOUR STATION" - Via Submenu "Level 2.1", this allows classification of the water quality of water sources (stations) using appropriate colour scheme. e.g. class I - blue; class II - green; class III - yellow; class IV - bright red; and class V - dark red.

Different shades were used for monochrome display and black/white print-outs. The classification of the water sources based on the water quality measured in terms of MFC and coliphage counts have been incorporated into the uRAISON system. The results of this simple classification scheme for the water sources of a few sampling regions based on coliphage counts and MFC data are shown in Figures 9 - 10. The relevant data were extracted through the built-in program from the R-M databases into the spreadsheet; and the map display of the water quality is by means of the "BACK - COLOUR" function in the spreadsheet. These processes are essentially transparent to the users. Options are built-in to display the data used and classes assigned to the water sources into the spreadsheet

for inspection (an example is shown in Figure 11). The map files showing water quality classification can be saved for quick browsing later when required.

"BROWSING WQ MAPS" - Via submenu "Level 2.2", this allows rapid scanning of time-series water quality map displays, in terms of coliphage counts, MFC counts, sanitary conditions, or overall water quality ranking.

"ADD STATIONS TO MAPS" - Via submenu "Level 2.3", this allows easy updating of new stations in map files.

The uRAISON Database and Spreadsheet Subsystems

The uRAISON Database subsystem provides a few essential functions such as "CREATE", "UPDATE", "LINK" and "IMPORT". Currently five basic types of uRAISON database files have been created. Fig. 12 Shows typical screen displays.

The icon files are created to link the map files with the screen displays at the various levels, namely, national, state and district levels. The station icon files link the station locations display with the water quality of the stations. The other database files are water quality data files, sanitary survey data files, and general statistical information data files.

The system permits importation of data files from dBASE III+. Primary water quality data and sanitary survey records were input into dBASE III+ files. More descriptions of uRAISON database are given in the User Manual and NWRI User Manual.

The uRAISON spreadsheet system has two principal functions, namely, to perform various types of data analysis on data retrieved from uRAISON database and to enable the map system to present data from the database in map or graphical form. The display of database information on map files is carried out using the "BACKCOLOUR" function. The "GRAPH" enables the generation of overlay graphs (bar, line or point charts) to the map

displays as described earlier. Other functions common in other spreadsheets such as "REACL", "RANGE", "RETRIEVE" are also available.

The "POLYGON" function of the spreadsheet system allows the retrieval of data on spreadsheet using polygon selection on the map screen (see Figure 13).

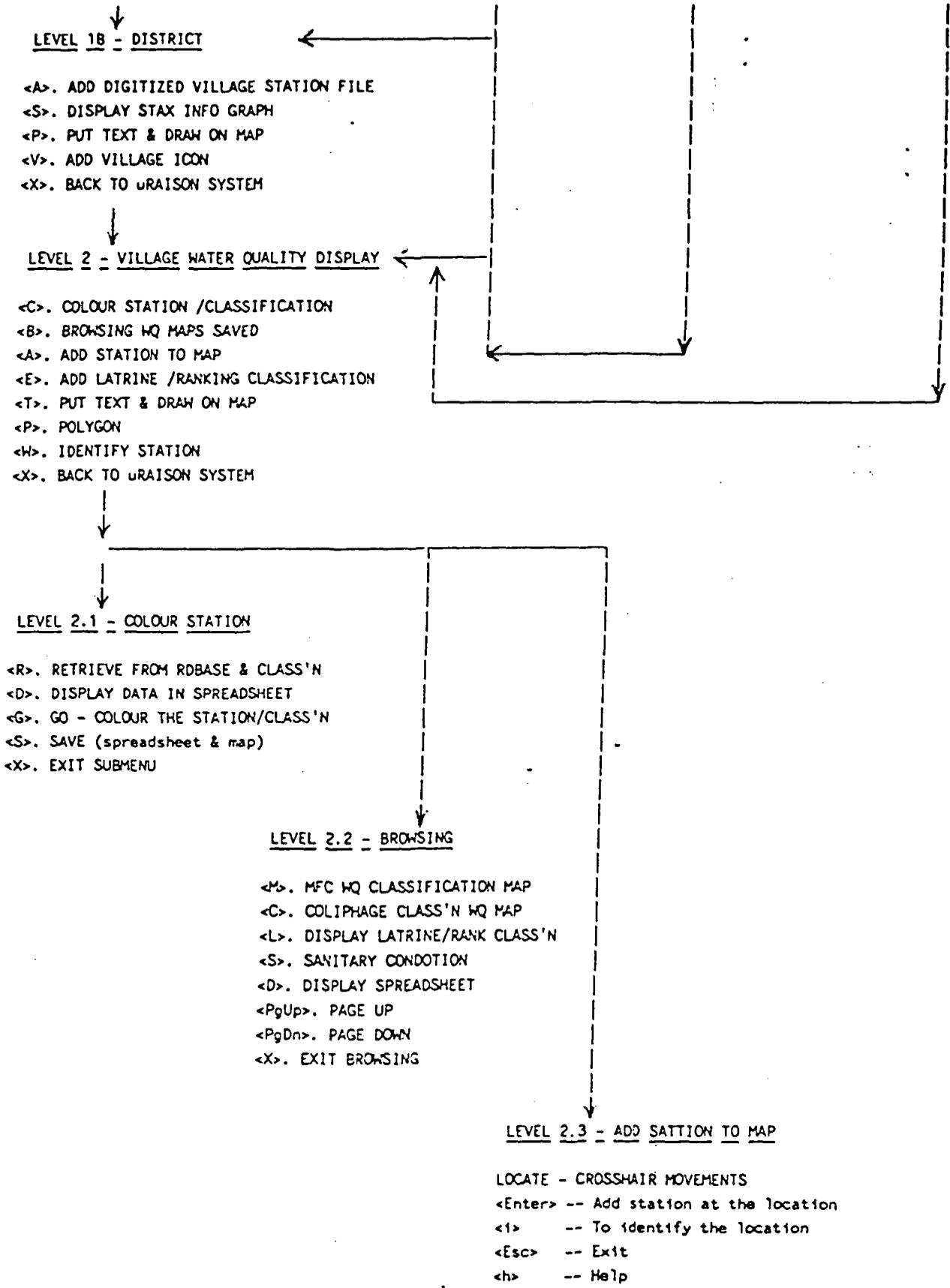


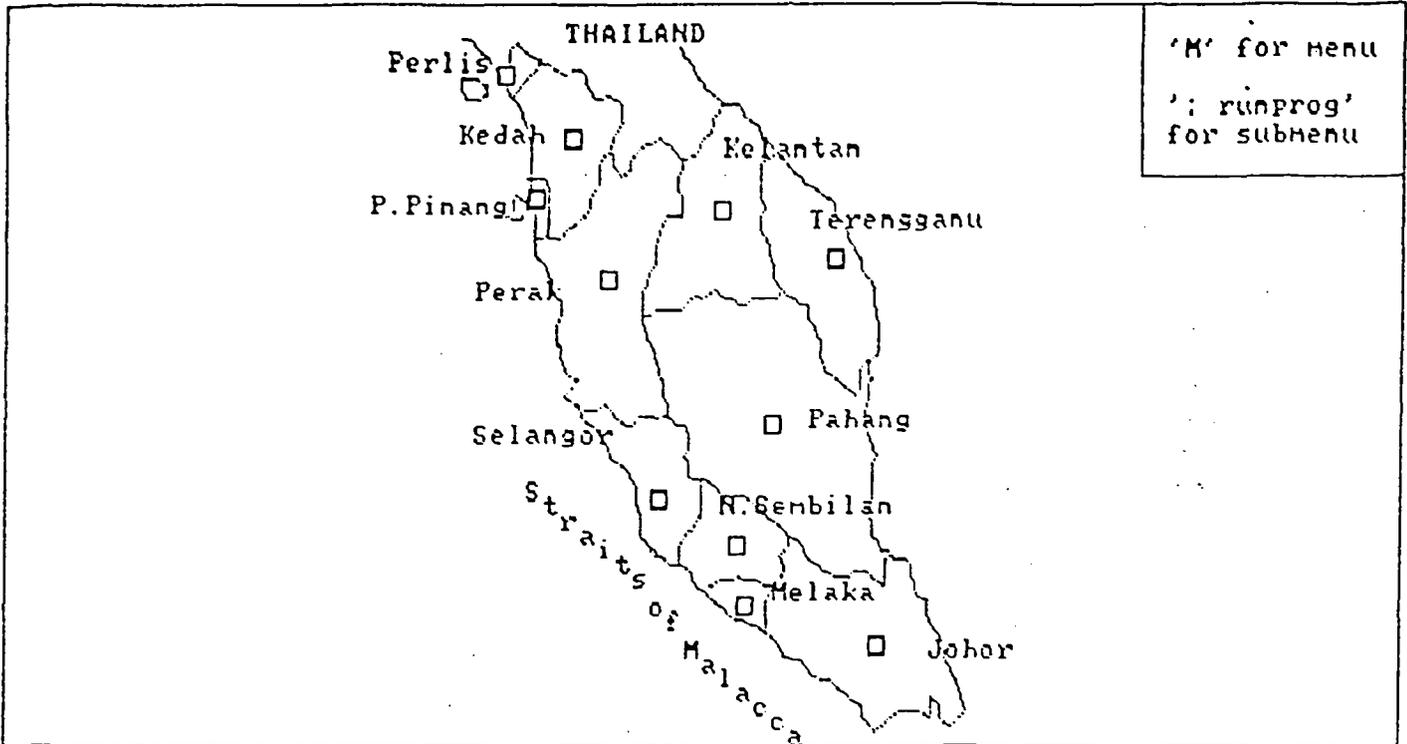
Figure 1. (2/2) uRAISON System Configuration

menu

help

background

Level 0
Malaysia



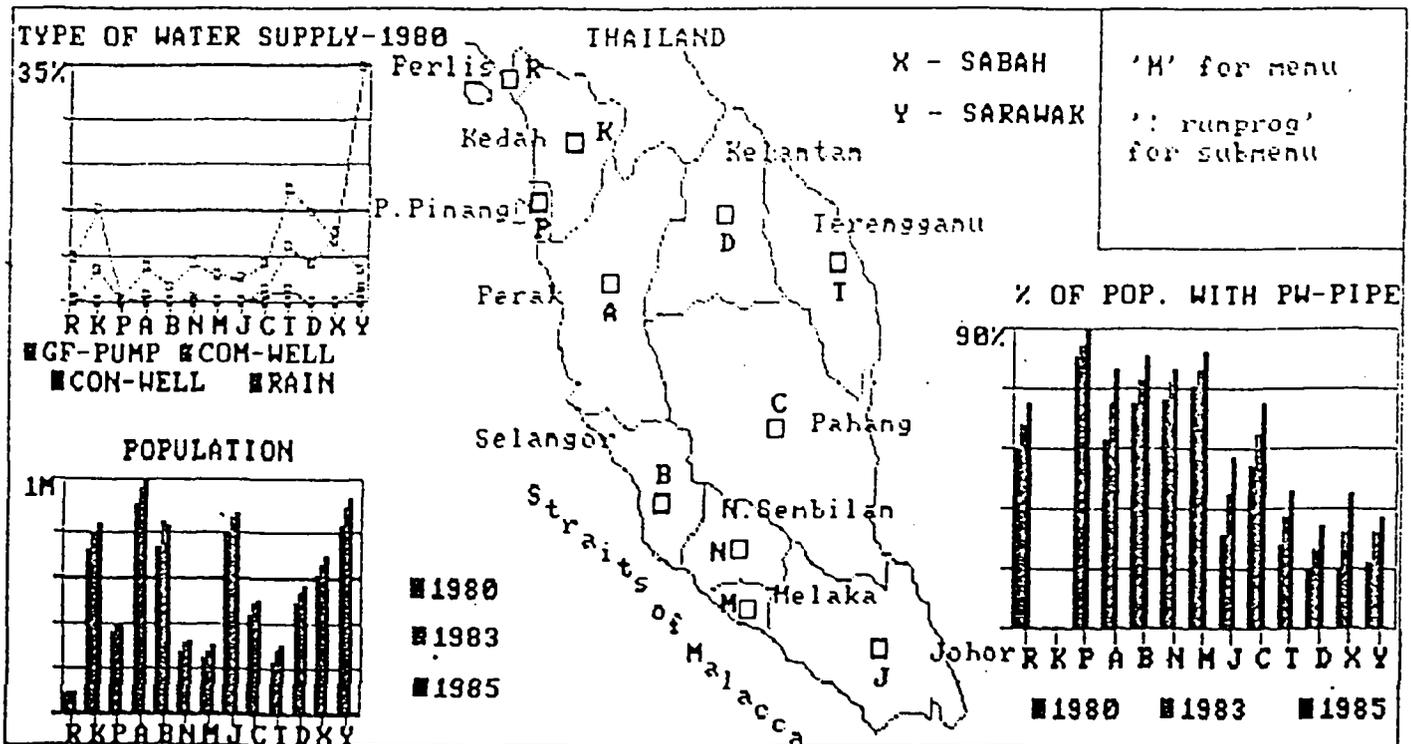
(Fig. 2)

menu

help

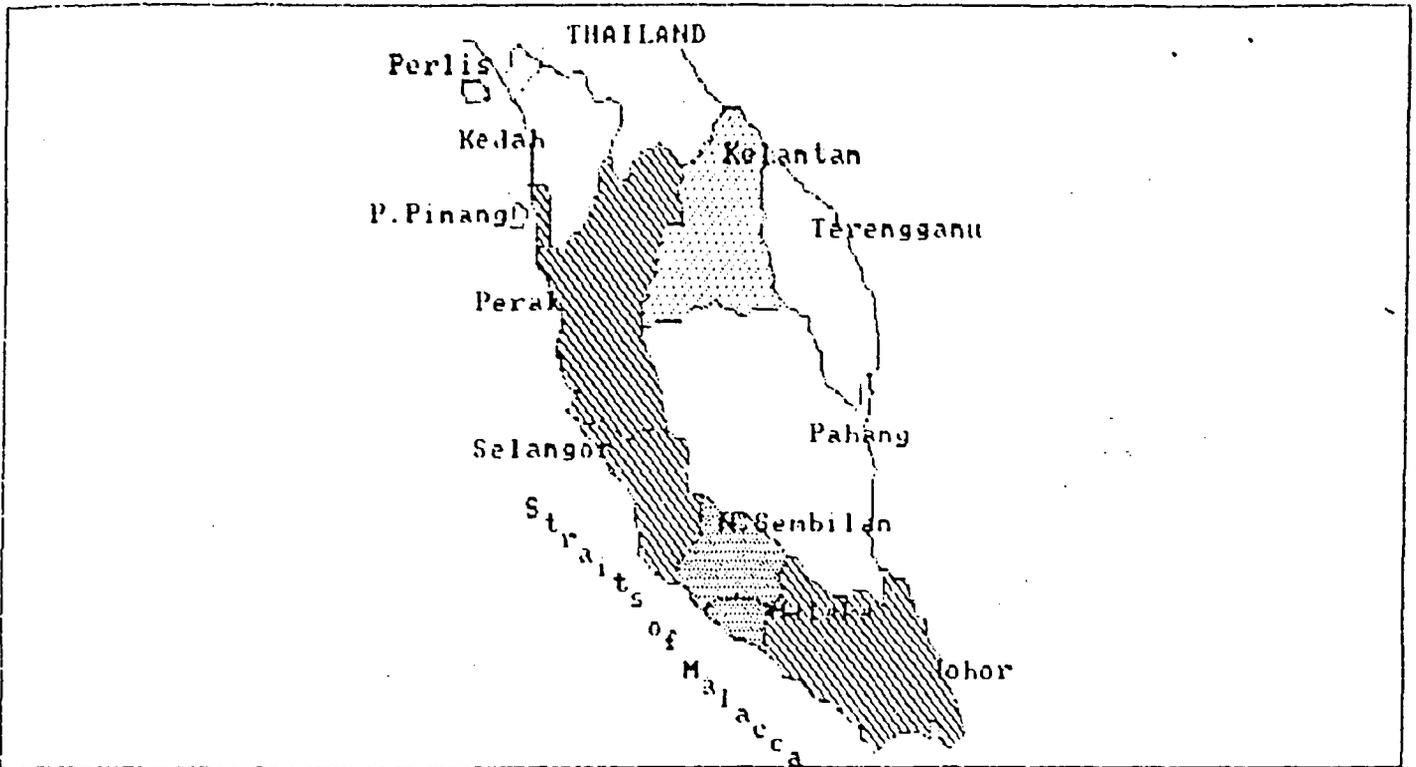
background

Level 0
Malaysia



(Fig. 3)

% OF PIPE USED IN EACH STATE



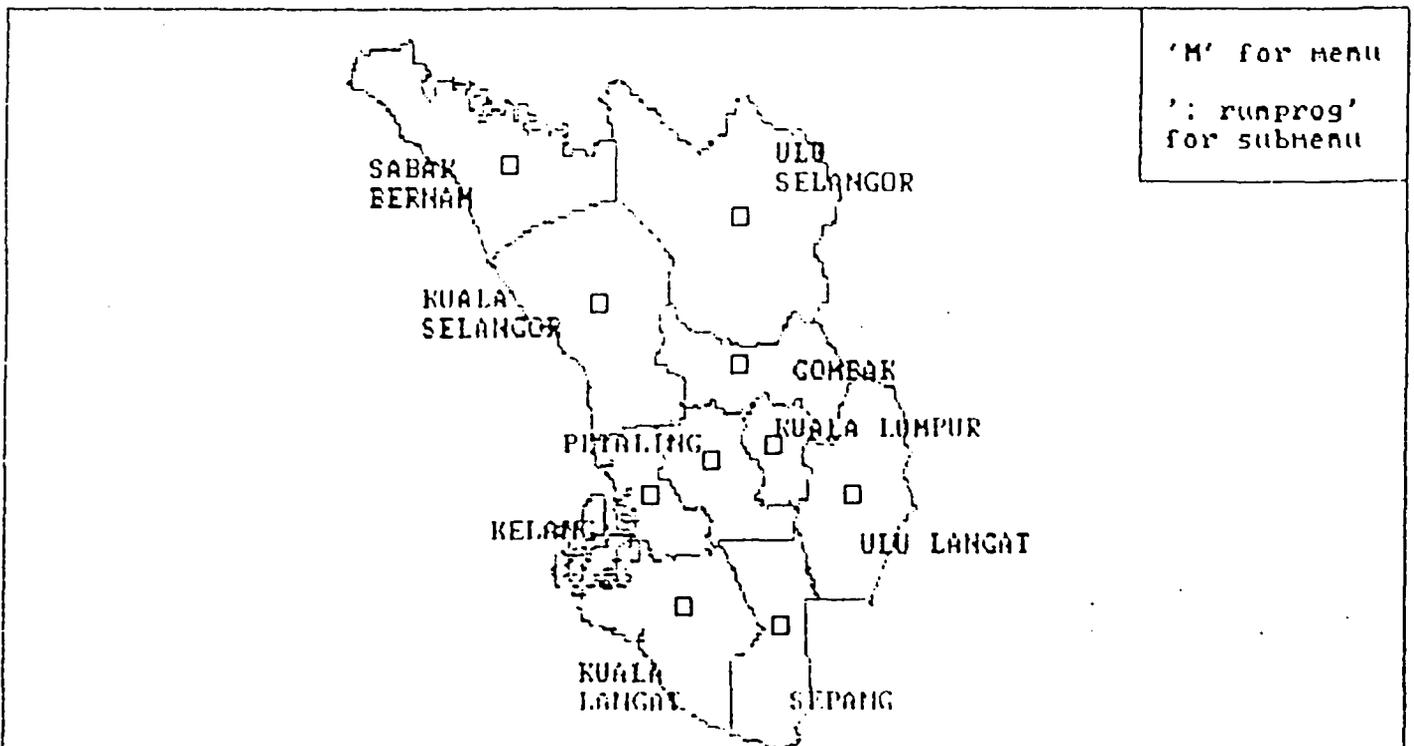
(Fig. 4)

menu

help

background

Level 1
SELANGOR



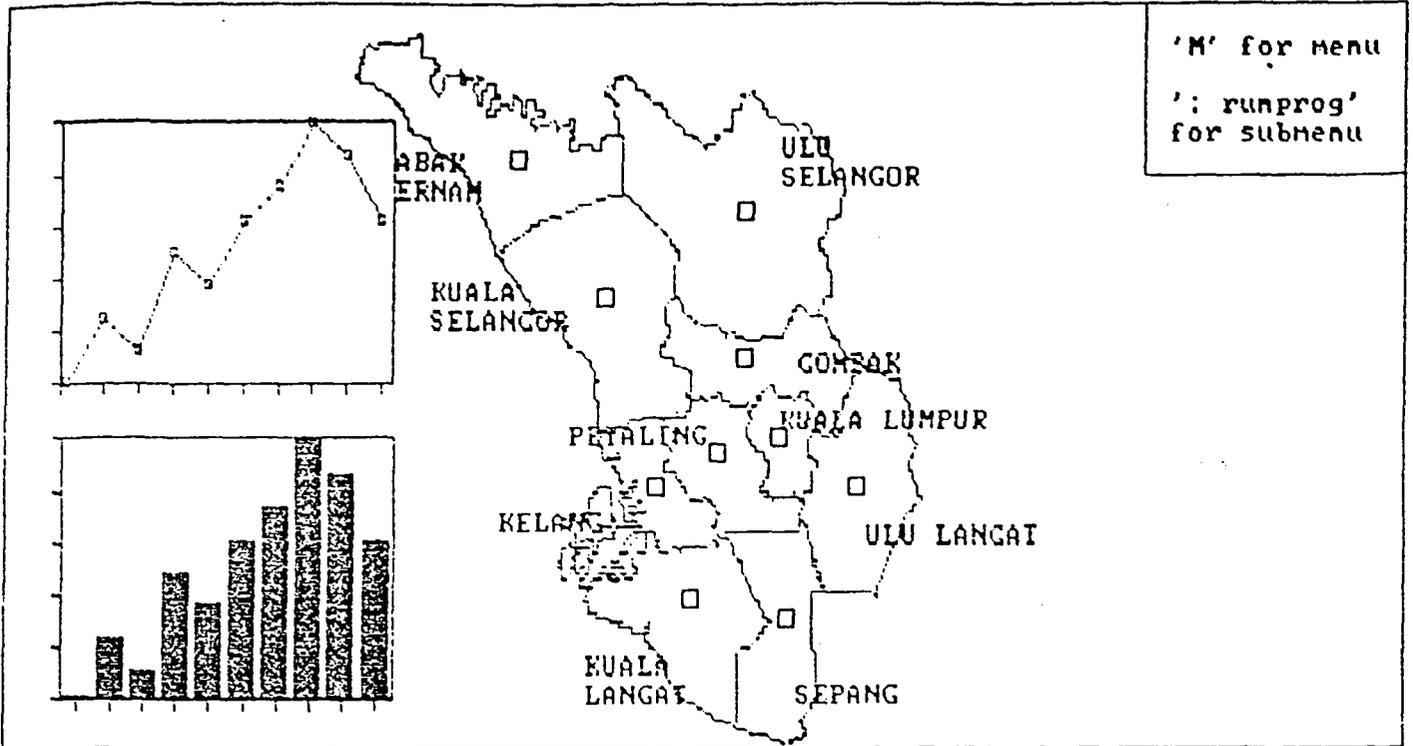
(Fig. 5)

menu

help

background

Level 1
SELANGOR



'M' for menu
' : runprog'
for submenu

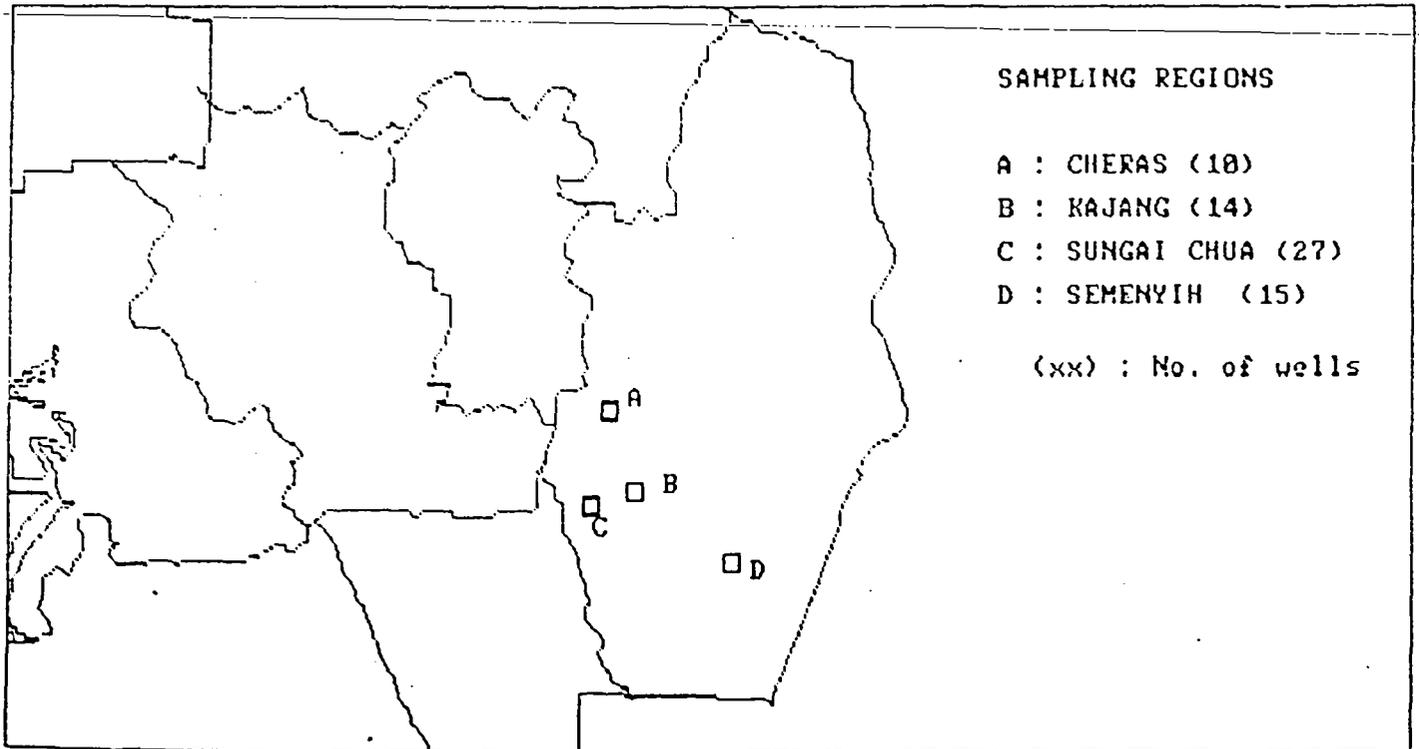
(Fig. 6)

menu

help

background

Level 1
ULU LANGAT



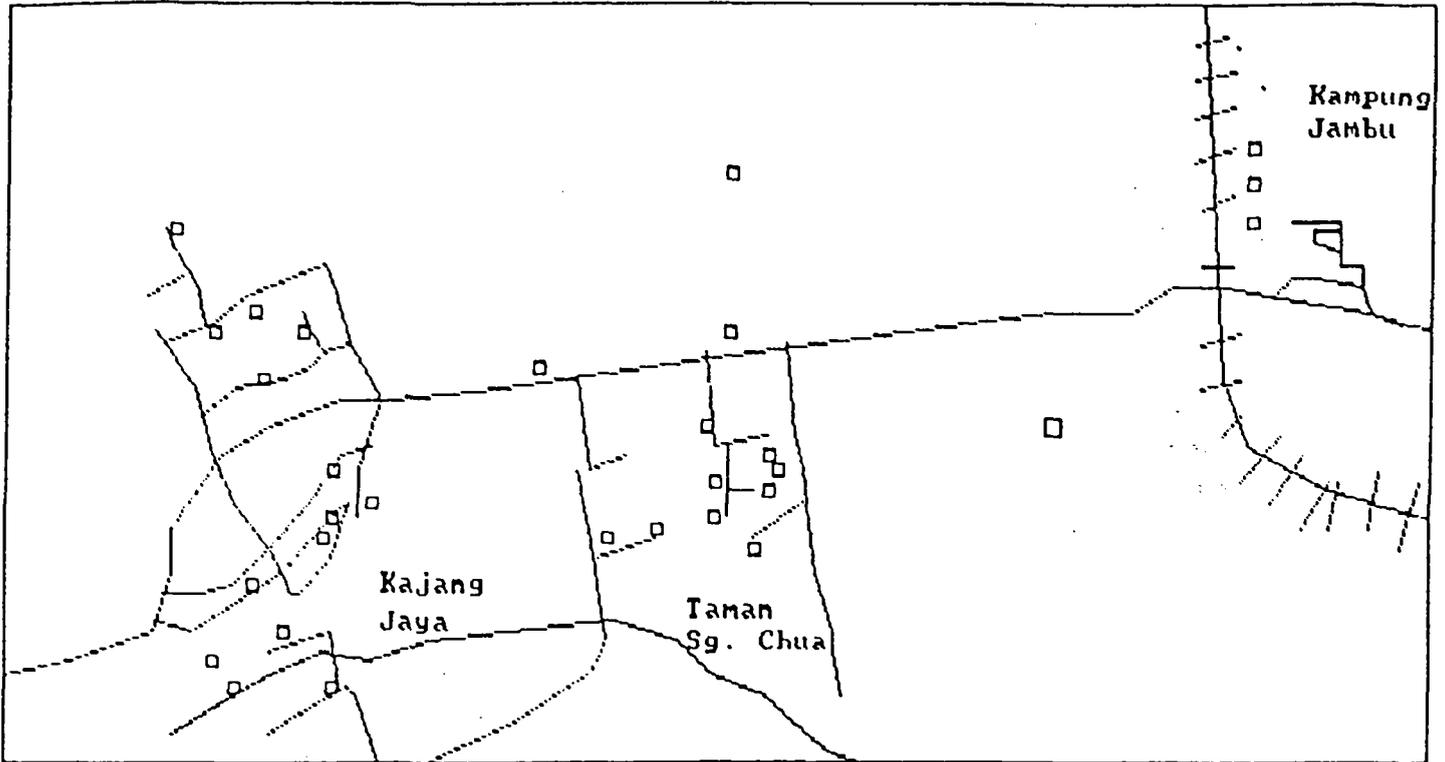
SAMPLING REGIONS

- A : CHERAS (10)
- B : KAJANG (14)
- C : SUNGAI CHUA (27)
- D : SEMENYIH (15)

(xx) : No. of wells

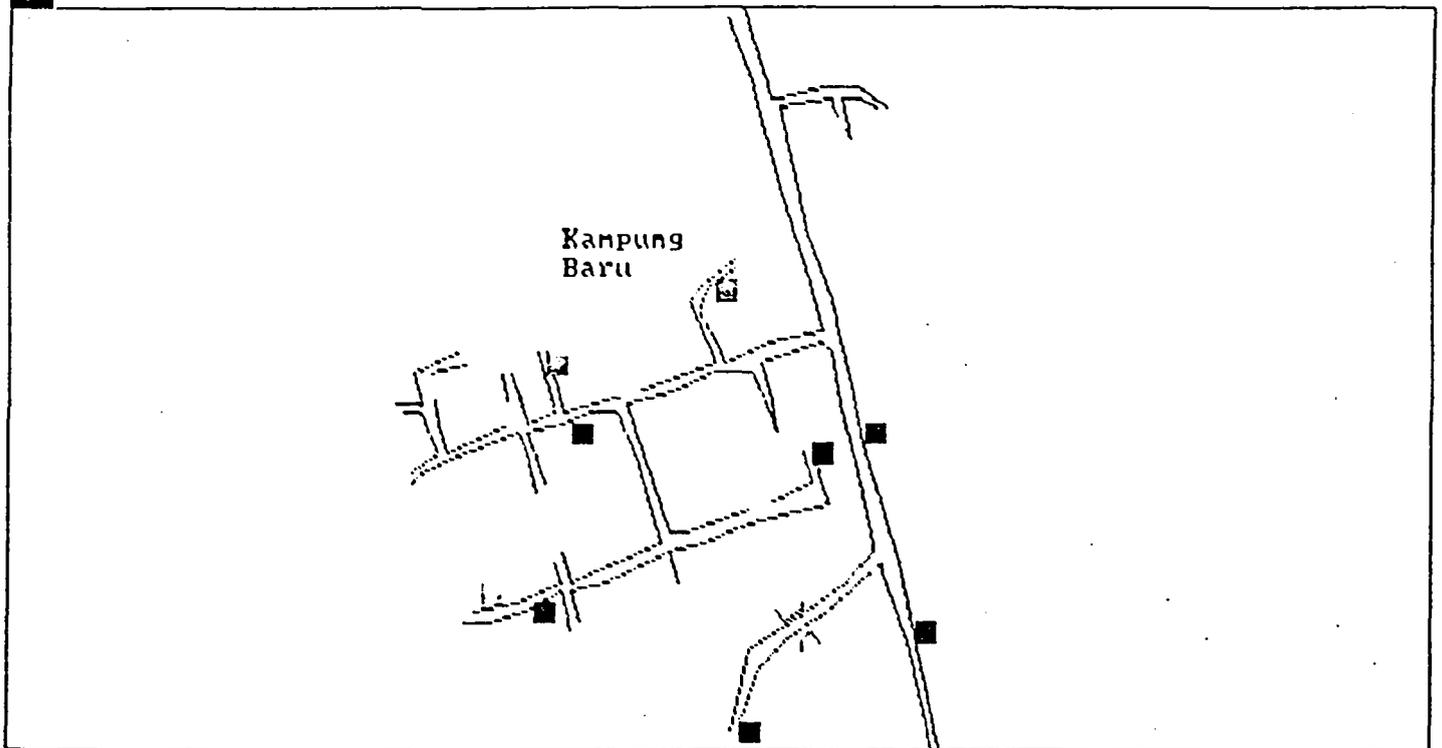
(Fig. 7)

Level 2



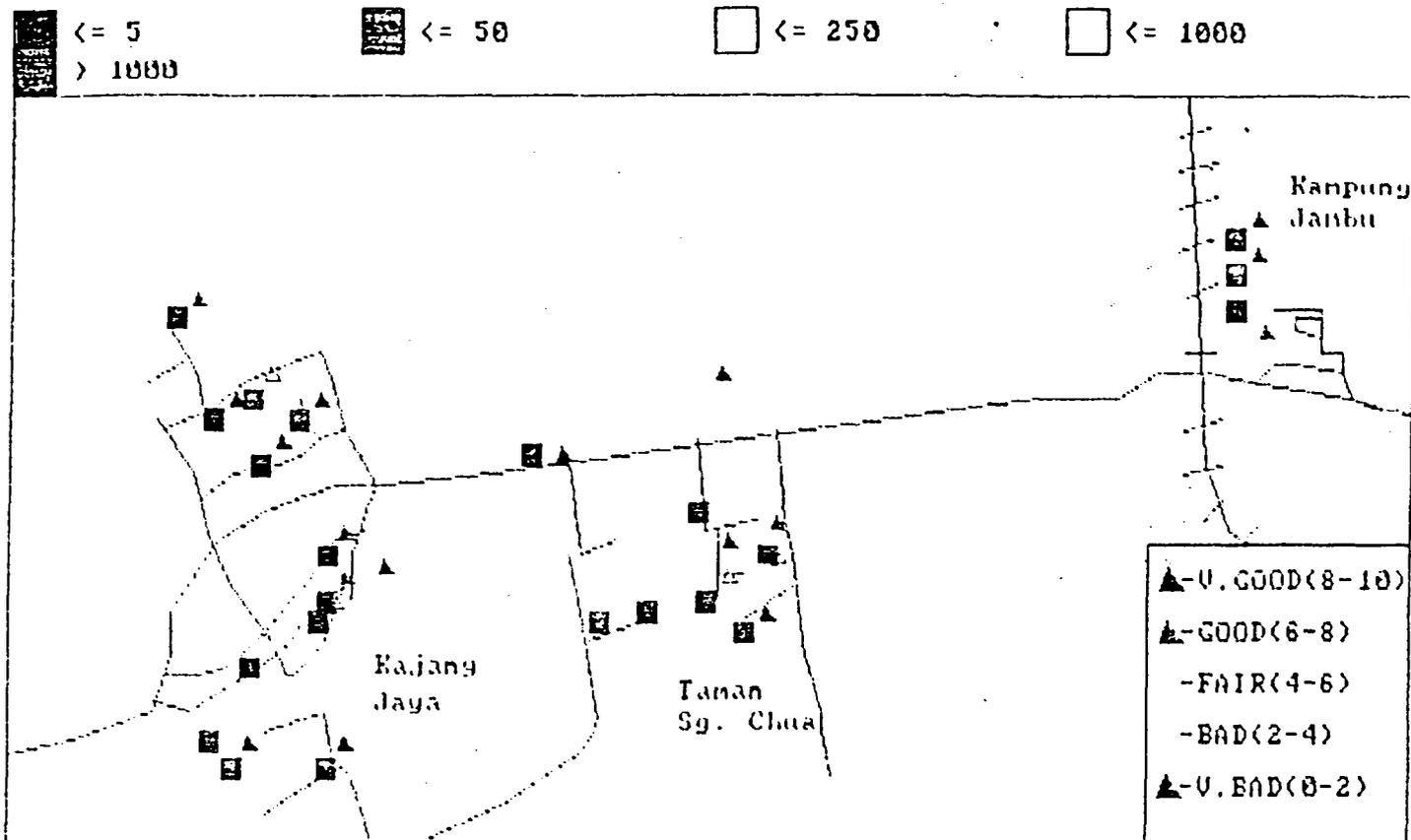
(Fig. 8)

WATER QUALITY FOR SEMENYIH
ULU LANGAT, SELANGOR



(Fig. 9)

WATER QUALITY FOR SG_CHUA
 ULU LANGAT, SELANGOR



YEAR : 88

MONTH : 3

MFC

(Fig. 10)

K2: *IF J2 <15 THEN *GREEN*ELSE IF J2 <30 THEN *YELLOW*ELSE *RED*
 Column containing COLOURS :K

B2	B3	B4	B5	B6	B7	AVG	Colour
25.00000	42.00000	8.000000	13.00000	4.000000	0.000000	13.25000	GREEN
0.000000	10.00000	21.00000	13.00000	17.00000	16.00000	13.12500	GREEN
22.00000	17.00000	13.00000	9.000000	4.000000	34.00000	14.75000	GREEN
24.00000	37.00000	22.00000	8.000000	11.00000	14.00000	19.62500	YELLOW
19.00000	27.00000	23.00000	48.00000	24.00000	29.00000	28.87500	YELLOW
32.00000	91.00000	111.0000	51.00000	33.00000	32.00000	57.37500	RED
25.00000	42.00000	29.00000	23.00000	27.00000	44.00000	33.12500	RED
32.00000	91.00000	111.0000	51.00000	33.00000	32.00000	57.37500	RED
25.00000	42.00000	8.000000	13.00000	4.000000	0.000000	13.25000	GREEN

Figure 11. Typical spreadsheet display of water quality classification of water sources.

FIGURE 12

- (A) RAISON DATABASE SYSTEM;
 (B) SANITARY DATA OF WELL NO. SC01 IN THE WELLS.DAT FILE;
 (C) WATER QUALITY DATA OF WELL NO. JB837 IN THE SEMENYIH.WQD FILE

(a) Raison Database System
 Create Update Link Import Options Quit

Create Layout

Create Database

Create Alternate

(b) Enter/Change Data

F1-Help	F2-Edit Data	F3-Enter New Data	F10-Quit
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----- Add/Update Database -----

Well:SC01	Code:	Date:88/03/16
Rain:3	Type:42	Depth:1
Habitation:1	Number_us:4	Surnd_are:2
Wtr_logge:1	Protectio:881331	Drainage:44000404
Wash_bath:2	Is_storage:2	Is_treatm:2

Record #1 of 75.

Data File: wells.dat

(c) Enter/Change Data

F1-Help	F2-Edit Data	F3-Enter New Data	F10-Quit
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----- Add/Update Database -----

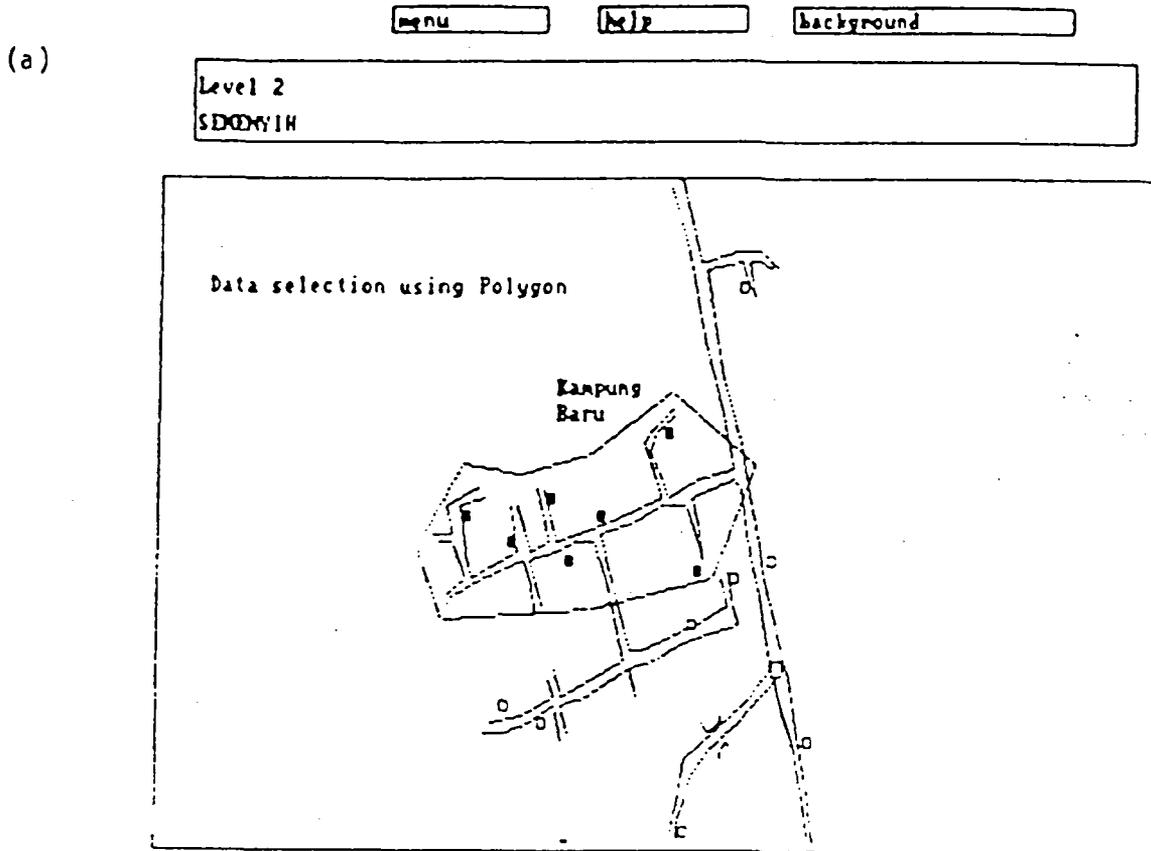
Well:JB837
Date:88/04/06
WFC:1200
COLIFORM:205

Record #1 of 15.

Data File: semenyih.wqd

FIGURE 13

- (A) RETRIEVAL OF DATA WITH THE "POLYGON" COMMAND;
- (B) SPREADSHEET SHOWING THE DATA WITHIN THE POLYGON



A1: 'W=11

	Date	NFL	LULIFRAGE
KBS225	88/04/05	500.0000	2540.000
KBS211	88/04/05	1.000000	5.000000
KBS240	88/04/05	7600.000	5350.000
KBS251	88/04/05	49.00000	10.00000
KBS108	88/04/05	800.0000	15.00000
KBS221	88/04/05	100.0000	10.00000
KBS258	88/04/05	-1.00000	20.00000