4. RESULTS AND DATA ANALYSIS

4.1 INTRODUCTION

In this chapter, the results of the final product of the customized ambient air quality monitoring tool in the ArcView environment is discussed. The interfaces created in this customized application were screen-captured and presented as graphics for better visualisation. Initially, an overview of the application termed as AMAQUM is discussed and followed by the three main components of AMAQUM namely ISCST3 air quality modelling interface, ground level concentration interface and ambient air quality result interface. Discussion on additional interface created for the monitored stack result is added in this chapter. To conclude this chapter, discussion on AMAQUM as a customized GIS application is presented.

4.2 OVERVIEW OF AMAQUM

The ambient air quality monitoring tool developed for this research work is termed as AMAQUM which is an abbreviation of AMbient Air QUality Monitoring system. Figure 4.2.1 shows the ArcView banner of the tool when the application is started. AMAQUM foundation is a geographical information system (GIS) database supplemented with basic GIS functionality provided by ESRI's ArcView 3.1 GIS software.
FIGURE 4.2.1: ARCVIEW'S BANNER OF AMAQUM

In AMAQUM, there is three main interfaces established or created namely:

1. ISCST3 Air Quality Modelling;
2. Ground Level Concentration; and
3. Ambient Air Quality Monitoring Result.

Figure 4.2.2 shows the main menu of the AMAQUM GUI application. The basic concept of AMAQUM is to be as user-friendly as possible for the end-user and easy navigation of the application by using dialog box and window-
based application. The detail of the three components or interfaces is further discussed in the following section.

FIGURE 4.2.2: AMAQUM MAIN MENU

4.3 ISCST3 AIR QUALITY MODELLING INTERFACE

The first part of the AMAQUM application is the air quality modelling interface which require the end user to have a certain knowledge of air quality modelling using ISCST3 model. He/she is able to understand the modelling process and interpolate the air quality modelling output or result in the ArcView environment. In AMAQUM, a dialog as shown in Figure 4.3.1 will pop out to notify the end-user of this requirement before proceeding to the actual modelling interface. The ISCST3 main dialog will appear if the yes selection is chosen as shown in
Figure 4.3.2. If the user decides not to proceed to the next section, the main menu of AMAQUM will appear.

![AMAZUM - AMbient Air Quality Monitoring](image)

**FIGURE 4.3.1: CONFIRMATION DIALOG OF THE AIR QUALITY MODELLING SECTION**

As observed from the Figure 4.3.2, the main dialog consists of the following components:

- Creation and modifying the ISCST3 model input parameter
- Running the ISCST3 model under MS-DOS environment
- Viewing the ISCST3 model output
- Pre-processing of the ISCST3 output for interpolation purposes
- Creation of the ground level concentration (glc)
- Adding the predicted glc to a new view within ArcView
FIGURE 4.3.2: ISCST3 AIR QUALITY MODELLING MAIN DIALOG

The main objective of this interface is to enable the end user who is usually an experienced air quality modeller to undertake the modelling exercise or simulation with ease by using the window based application. The interface created in AMAQUM had ultimately reduced the modelling time for each simulation due to the fact that the application could be run automatically from
the ArcView program and does not require the end user to run the modelling simulation separately in the MS-DOS environment. Modifying the model input parameter and running the model itself in MS-DOS is a tedious job and requires a certain degree of understanding or knowledge of MS-DOS command which is always lacking in most user.

4.3.1 MODEL INPUT PARAMETER

The first stage of the air quality modelling is creation of the ISCST3 model input parameter. For this research work, the main pollutants considered is total suspended particulates (TSP), sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and volatile organic compounds (VOCs) as these pollutants are the parameters analysed for the quarterly ambient air quality monitoring. However, in AMAQUM, a model input for other parameter is also being included in Others. The selection dialog of pollutants for the model input mentioned above in the application is as shown in Figure 4.3.3.
FIGURE 4.3.3: SELECTION DIALOG OF POLLUTANT TO BE MODIFIED

As discussed and described in Chapter 2 of this dissertation, the ISCST3 model uses the keyword approach for modelling purposes. Upon choosing the appropriate pollutant in the selection dialog, the desired input file is display in a Notepad word processor as shown in Figure 4.3.4. The user will be able to modify the appropriate keyword and value of the input file in this word processor application. Upon completion of the modification process, the selected file is then saved and the application is closed.
### FIGURE 4.3.4: EXAMPLE OF ISCST3 MODEL INPUT PARAMETER

The user had an advantage in AMAQUM as he/she is allowed to modify as many pollutants as one desired due to the fact that each pollutant has its own input file which could be modified individually before processing the input file. The interface allow the user to have a better control on the input data and only modified certain values that is affected for a particular parameter such as the emission rate in the source parameter and the modelling duration in the meteorology parameter as other keyword in the control and receptor parameters is not affected.
4.3.2 MODEL RUN

The ISCST3 model is a MS-DOS based air quality model which reduces the computer memory and processing time required to process the input data or input runstream file. The selection dialog of the pollutant input data to be run is as shown in Figure 4.3.5. The AMAQUM application enables the run to be carried out in the MS-DOS environment from ArcView with just a click of a button. An example of the ISCST3 model processing in the MS-DOS environment is shown in Figure 4.3.6. By running the air quality model in a separate environment, it reduces the processing time as compared to running it in ArcView environment which requires large computer memory for processing the input data. Running the model in MS-DOS is also much stable than in ArcView which is well known for its segmentation error when the system does not has enough computation memory.
FIGURE 4.3.5: SELECTION OF POLLUTANT INPUT FILE TO BE MODELLED
FIGURE 4.3.6: EXAMPLE OF ISCST3 MODEL RUN IN MS-DOS ENVIRONMENT

4.3.3 MODEL OUTPUT

After the processing of input data is completed, the user will need to check whether the run or simulation completed was successful or ran correctly. As an experienced modeller, the user will need to examine the model output for error and verification. This is made possible by viewing the output using Notepad word processor. The selection dialog of the model output for pollutant to be viewed is as shown in Figure 4.3.7 and Figure 4.3.8 shows an example of the model output for run/simulation that had been carried out by the user. The model output contained the full detail of the result for each scenario or simulation. An example of the model output is appended in Appendix 4.1.
FIGURE 4.3.7: SELECTION DIALOG OF POLLUTANT OUTPUT FILE TO BE VIEWED
CO STARTING
TITLE ONE, AMAQUM - TSP - 3RD JULY 2000
MODELOPT DEFAULT URBAN CONC
AVERTIME 24
POLLUTID TSP
TERRHTS FLAT
RUNORNOT RUN
CO FINISHED

SO STARTING
** Point Source QS HS TS VS DS
** Parameters: ------ ------ ------ -----
** ST1=C RP Boiler (TSP, NO2, SO2, CO)
  LOCATION ST1 POINT -84.0 99.0 25.0
  SRCPARAM ST1 2.58 35.0 310.0 6.3 1.9
** ST2=ARP Acid Scrubber (CO, HCl)
** LOCATION ST2 POINT 60.0 66.0 25.0
** SRCPARAM ST2 0.0 31.0 353.0 20.5 0.8
** ST3=CCL/CQU Boiler (TSP, NO2, SO2, CO)

FIGURE 4.3.8: AN EXAMPLE OF ISCST3 MODEL OUTPUT

4.3.4 MODEL OUTPUT PRE-PROCESSING

The output data generated from the ISCST3 model requires pre-processing in order to create a suitable text file for data interpolation in the ArcView environment. This could be easily carried out in Excel spreadsheet by creating a simple macro for automation of the pre-processing process. The final output in the text format to be interpolated will only contain the x-coordinates, y-coordinates and the predicted concentration as z. Figure 4.3.9 shows the pre-processing menu available in AMAQUM application. The actual ISCST3 model output is shown in Figure 4.3.10 and an example of the completed pre-processing output text file in Excel spreadsheet is shown in Figure 4.3.11.
FIGURE 4.3.9: PRE-PROCESSING MAIN DIALOG

FIGURE 4.3.10: THE ISCST3 OUTPUT DATA IN EXCEL SPREADSHEET
FIGURE 4.3.11: AN EXAMPLE OF PRE-PROCESSED FILE IN EXCEL SPREADSHEET

Upon completion of the pre-processing, the saved text file is then imported to ArcView application (document) or AMAQUM for interpolation process. The addition is done by clicking the "adding processed table in AMAQUM" button. In AMAQUM, a dialog as shown in Figure 4.3.12 will be display and the user need to choose the desired text file to be added.
4.3.5 DATA INTERPOLATION

The pre-processed output data will be interpolated using the ArcView built-in spatial interpolator. The built-in interpolator provides three type of interpolator method namely Inverse Distance Weighted (IDW), Spline and Kriging.

A preliminary exercise was carried out to determine the most suitable interpolator method for the interpolation of the predicted ground level concentration in this study. ArcView offered three types of interpolator namely, Inverse Distance Weighted (IDW), Spline and Kriging. There is two types of Spline interpolator namely Regularized and Tension while Kriging interpolator offered numerous choices, i.e. Universal Linear, Universal Quadratic, Spherical, Circular, Exponential, Gaussian and Linear. The default value in the interpolator method was used in this exercise.
Table 4.3.1 summarizes the result of the interpolation exercise. For this research work, the most suitable interpolator method was found to be IDW. The advantage of using IDW as the interpolator is that the interpolation surface is smooth and the predicted data point value does not change upon interpolation. The surface created also does not contain negative value, as the lowest value of air pollution contour is null. The result of the interpolation exercise is compiled as Appendix 4.2.

In order to determined the most suitable interpolator, a rating method was established considering four main criteria, namely:

1. Maintenance of the predicted value;
2. Presence of negative value in the interpolated grid;
3. Smoothness of interpolated surface; and
4. Relationship of two predicted point or data point.

The interpolation method rating procedure flowchart is shown in Figure 4.3.13. Point is given for each criterion and the point of each criterion is then totalled. The interpolator method with the least total points is evaluated to be the most suitable for this modelling exercise.
<table>
<thead>
<tr>
<th>Interpolation Method</th>
<th>Figure</th>
<th>Observation (Points)</th>
<th>Total Points</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverse Distance Weighted (IDW)</td>
<td>1</td>
<td>Predicted value is maintained during processing (1)</td>
<td>4.5</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No negative value is obtained (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smooth surface (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate relationship between two predicted point or data point (1.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spline</td>
<td>2</td>
<td>Predicted value changes during processing (2)</td>
<td>7</td>
<td>Low</td>
</tr>
<tr>
<td>• Regularized</td>
<td></td>
<td>Negative value is obtained (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smooth surface (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tension</td>
<td>3</td>
<td>Predicted value is maintained during processing (1)</td>
<td>5</td>
<td>Medium High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative value is obtained (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smooth surface (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher relationship between two predicted point or data point (1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(...CONTINUATION OF TABLE 4.3.1: COMPARISON OF INTERPOLATION METHOD AVAILABLE IN ARCVIEW)

<table>
<thead>
<tr>
<th>Interpolation Method</th>
<th>Figure®</th>
<th>Observation (Points)</th>
<th>Total Points</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kriging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Universal Linear</td>
<td>4</td>
<td>• Predicted value is maintained during processing (1)</td>
<td>5.5</td>
<td>Medium High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Negative value is obtained (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Smooth surface (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Moderate relationship between two predicted point or data point (1.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Universal Quadratic</td>
<td>5</td>
<td>• Predicted value is maintained during processing (1)</td>
<td>5</td>
<td>Medium High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Negative value is obtained (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Smooth surface is created (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Higher relationship between two predicted point or data point (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Spherical*</td>
<td>6</td>
<td>• Predicted value changes during processing (2)</td>
<td>8</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Negative value is obtained (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Uneven or jagged surface is created (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Low relationship between two predicted point or data point (2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ⑧Figures 1-10 is compiled as Appendix 4.2.

*The result obtained for Spherical Kriging is the same with Circular, Exponential, Gaussian and Linear (Figures 7-10)
FIGURE 4.3.13: FLOWCHART OF INTERPOLATION METHOD RATING
Due to time constraint and in order to fulfil the aim of this research study, the default value for the IDW interpolator was used throughout the study. Hence, further study solely of the determination of the suitable value for the IDW interpolation method for air pollution concentration could be carried as an extension of this research work. However, for this research study, the default method was found to be good enough for creation of smooth surface.

Figure 4.3.14 shows the flowchart of data interpolation procedure as described and elaborated above which is mainly made up of three components namely process, theme and table. The final product, i.e. the predicted ground level concentration contour, is added as new theme in the next interface (i.e. ground level concentration interface).

In AMAQUM, a customized view for the interpolation process is as shown in Figure 4.3.15 is created to expedite the process. The first stage of the interpolation process is to add the required text data as a theme in the view or known as "Add Event Theme" process as shown in Figure 4.3.16 and Figure 4.3.17 shows the added theme in the interpolation view.
FIGURE 4.3.14: DATA INTERPOLATION FLOWCHART
FIGURE 4.3.15: INTERPOLATION MAIN VIEW
FIGURE 4.3.16: ADD EVENT THEME INTO INTERPOLATION VIEW

FIGURE 4.3.17: DISPLAY OF MODEL OUTPUT GRID DATA

The next stage in the interpolation process is using the interpolation system command as shown in Figure 4.3.18 and 4.3.19. For air quality modelling in AMAQUM, the default value of IDW was used which produces a fairly smooth concentration contour. In order to obtain a smoother contour or smaller pixel size, a lower grid size output is specified. However, with smaller grid size, more processing time is needed for each interpolation. Figure 4.3.20 shows the interpolation in progress and the final output of the interpolation process is added as a new theme in the view as shown in Figure 4.3.21.
FIGURE 4.3.18: INTERPOLATION METHOD OF THE GRID DATA

FIGURE 4.3.19: SPECIFYING THE OUTPUT GRID SIZE
FIGURE 4.3.20: INTERPOLATION PROCESSING IN PROGRESS

FIGURE 4.3.21: DISPLAY OF INTERPOLATION RESULT AS A NEW THEME
The generated surface or interpolated concentration will then need to be reclassified into a uniform or desired interval as shown in Figure 4.3.22. The new theme or reclassified layer is then added into the view as shown in Figure 4.3.23. Before proceeding to the next stage, the reclassified theme needs to be converted into a shape for permanent database entry in the application as the surface generated and the reclassified layer is temporary in nature.

FIGURE 4.3.22: RECLASSIFICATION PROCEDURE
FIGURE 4.3.23: DISPLAY OF RECLASSIFICATION RESULT AS A NEW THEME

A fixed contour line is created using the system command from the generated surface as shown in Figure 4.3.24. The generated contour with the desired interval is added as a new theme in the interpolation theme as shown in Figure 4.3.25. The generated contour is then converted into a new shape for creation of permanent database in the application.

FIGURE 4.3.24: CONTOUR INTERVAL
FIGURE 4.3.25: DISPLAY OF CONTOUR LINE GENERATED

The next step is creation of a concentration table for the particular interpolated database. The user will need to key the desire concentration interval as shown in Figure 4.3.26 and saved as a new database table. The newly created concentration table is then joined to the reclassified shape database in order to display the correct concentration interval in the interpolation view. The joined reclassified shape is then converted to the final shape or output as shown in Figure 4.3.27. This shape will be added into a new view in the following section.

FIGURE 4.3.26: CREATION OF CONCENTRATION TABLE
4.4 GROUND LEVEL CONCENTRATION INTERFACE

The second component of AMAQUM is the visualization of predicted ground level concentration (glc) of EIA and post-EIA stage. The EIA ground level concentration was adapted from the detailed EIA report of the iron and steel plant (Perunding Utama Sdn Bhd, 1997) while the predicted ground level concentration is simulated from monitored stacks emission for the plant obtained from the quarterly and half-yearly EMR (Perunding Utama Sdn Bhd, 1998–2001). A separate interface for the monitored stacks was created in AMAQUM and is further discussed in the following section.

Figure 4.4.1 shows the selection dialog of the ground level concentration for EIA, 1998, 1999 and 2000. New addition of glc is addressed in the "Other" selection. For the EIA selection, the next dialog will display the predicted pollutant and the average time selection as shown in Figures 4.4.2 and 4.4.3. An example of the EIA view for a particular pollutant and averaging time is shown in Figure 4.4.4. The user had a choice to choose the predicted glc for different scenario such as emission from existing facilities, existing and proposed, and uncontrolled scenario.
Select the Ground Level Concentration to be viewed.

Select One:

- View EIA Ground Level Concentration
- View 1998 Ground Level Concentration
- View 1999 Ground Level Concentration
- View 2000 Ground Level Concentration
- Other

FIGURE 4.4.1: SELECTION OF GROUND LEVEL CONCENTRATION VIEW
FIGURE 4.4.2: SELECTION OF PARAMETER TO BE VIEWED FOR EIA

GROUND LEVEL CONCENTRATION
For the predicted ground level concentration for a monitored period, the input data for the air pollution modelling was based on the highest monitored emission concentration of the existing stacks for the monitored period. The term maximum average incremental concentration (MAIC) was coined for the predicted glc for the monitored period as the level predicted was not overlay with the background concentration for the pollutant monitored. This is due to the fact that the ambient air quality monitoring result in the EIA study included some of the existing stacks contribution. However, with the predicted MAIC, the user could examine and deduce the total contribution of the facilities towards the surrounding air quality. A query tool from the system command is included in the view in order to display the desired monitoring result for a particular period. An example of the MAIC with the query tool is shown in Figure 4.4.5.
FIGURE 4.4.5: AN EXAMPLE OF THE PREDICTED MAXIMUM AVERAGE INCREMENTAL CONCENTRATION FOR A PARTICULAR DURATION
4.5 AMBIENT AIR QUALITY RESULT INTERFACE

The ambient air quality monitoring result interface enable the user to update the existing database or monitored result table through a dialog box or window. The monitoring station interface for the monitored stations is illustrated in Figure 4.5.1. Figure 4.5.2 shows an example of the multi-input dialog for database updating of a particular monitoring station. The user only need to key in the monitored result into the desired column.

However in ArcView document table, value below the detection limit and not available is treated as null value as the system could only record numerical value and not a combination of alphanumeric value. The user had to treat the null value with cautious when interpreting the monitored result. If this is not kept in mind, the value might give a false impression to the viewer.

Upon updating the existing monitored database, the user has the option of viewing chart of each particular monitoring station as shown in Figure 4.5.3. A line chart for the desired pollutant of the monitored station will be display as illustrated in Figure 4.5.4. Figure 4.5.5 shows the line chart for all the parameter for a particular monitoring station. This chart will enable the user to observe the trend for all the monitored parameter for the period monitored. This allows the visualization of the temporal trend for each monitoring station of a particular pollutant.
Select Monitoring Station to be updated:

A1 (Taman Pelangi)

A2 (Kg Tun Razak)

A3 (Taman Muzaffar Shah)

Cancel

FIGURE 4.5.1: MONITORING STATION INTERFACE
FIGURE 4.5.2: AMBIENT AIR MONITORING RESULT UPDATE INTERFACE

FIGURE 4.5.3: AN EXAMPLE OF THE MONITORED AMBIENT AIR QUALITY RESULT
FIGURE 4.5.4: AN EXAMPLE OF LINE CHART FOR A PARTICULAR PARAMETER AT A PARTICULAR MONITORING STATION

FIGURE 4.5.5: AN EXAMPLE OF LINE CHART FOR MONITORED PARAMETERS AT A PARTICULAR MONITORING STATION
The advantage of updating availability of the monitored result in the GIS environment or more accurately in ArcView is that the chart displayed will be updated automatically without having to recreate the intended chart again. For example, in Excel spreadsheet a new chart will need to be recreated when new entry is added into the existing database.

A flaw was observed during the data updating exercise for new data entry which is being treated as a new record and is always found below the table without considering the date hierarchy. Hence entry of past record will be treated as a new record and the chart updated will show the record as the latest entry and the date is observed will not be in order. These phenomena occurred because in ArcView all new entry is given individual identification number and has a running number from the last entry. Although the table could be sorted accordingly, the new entry will not be sorted accordingly in the display chart as shown in Figure 4.5.6.
FIGURE 4.5.6: AN EXAMPLE OF THE UNSORTED CHART ACCORDING TO DATE
4.6 MONITORED STACK

During the development of AMAQUM, a new interface was created for data entry of monitored stacks result. Figure 4.6.1 shows the view of the stacks location of the plant with linked button for data updating and chart visualization of the monitored result. An example of table updating window is shown in Figure 4.6.2 and a bar chart of a monitored stack for a particular pollutant is shown in Figure 4.6.3.

This interface enables the user to visualize and examine the monitored result for each stack with ease. The user could also print out the database from the application for selected entry or the overall table for its calculation of pollutant emission rate from each stack to be incorporated in the ISCST3 model input data.
FIGURE 4.6.1: STACK LOCATION VIEW

FIGURE 4.6.2: STACK MONITORED RESULT INTERFACE
FIGURE 4.6.3: AN EXAMPLE OF POLLUTANT BAR CHART FOR MONITORED STACK
4.7 AMAQUM AS A CUSTOMISED GIS APPLICATION

In AMAQUM, the user could easily visualize the dispersion contour spatially for a particular pollutant at a particular period. For this research work, four pollutants i.e. total suspended particulates (TSP), sulphur dioxide (SO$_2$), nitrogen dioxide (NO$_2$) and volatile organic compounds (VOCs) were simulated for each monitored period i.e. from 1998 to 2000. The predicted maximum average incremental concentration (MAIC) for all the pollutant is compiled in Appendix 4.3.

From the simulations obtained, it could be observed that the direction or pattern of the pollutant dispersion could be easily visualized in AMAQUM spatially. This will enable the user to identify the direction of the dispersion on a particular period. With the generated contour, the user could compare the monitored result with predicted level with the query tool button. For simulations of the predicted concentration, a few assumption was made and is described below:

1. The total nitrogen oxides (NOx) which consist of nitrogen monoxide (NO) and nitrogen dioxide (NO$_2$) gases emitted from the monitored stacks were simulated as NO$_2$ in the ISCST3 model. From the monitored stacks result, it was observed that all the NOx emitted from the stacks consists only NO. Therefore the predicted NO$_2$ could indicate the conversion percentage of NO to NO$_2$ in the atmosphere as nitrogen monoxide is easily oxidized to nitrogen dioxide.
2. The PM$_{10}$ monitored at all the ambient air monitoring station is assumed to made up half of the total suspended particulates (TSP) released from the sources. Therefore the TSP concentration predicted in the simulation is an over prediction of the monitored PM$_{10}$ level.

Hence, the over prediction of the simulated MAIC for TSP and NO$_2$ could be further examine or study. Generally, the AMAQUM had served its purpose as an ambient air monitoring tool for this research work. Appendix 4.4 lists the Avenue scripts created for the AMAQUM application.