# CHAPTER 3

# MATERIALS AND METHODS

## 3.1 Data Acquisition

This study was based on a study in 2005 on the conservation and protection of endangered dugongs in Johor, Malaysia. The study was a joint project by TITAN Chemicals Corp. Bhd., United Nations Development Programme and University Malaya Maritime Research Centre (after this will be referred as UMMReC Project). Data from the UMMReC Project that will be used in this study are:

(i) Seagrasses data for Sungai Johor.;

(ii) Locations of survey; and

(iii) Water quality data at sampling sites (field work data).

Apart from that, Johor marine water quality data for the year of 2005 and locations of Johor Water Quality Monitoring Stations was obtained from the Department of Environment (DOE) Malaysia to ensure the objectives of this study fulfilled.

## 3.2 Study Area

UMMReC Project research team has given some description about the study area and the occurrences of seagrass along Sungai Johor, observed during boat surveys. Since the project was about conservation of dugong, any sighted of dugong in the past or present also been mentioned. All survey locations have been marked in the Johor map as shown in Figure 3.1.

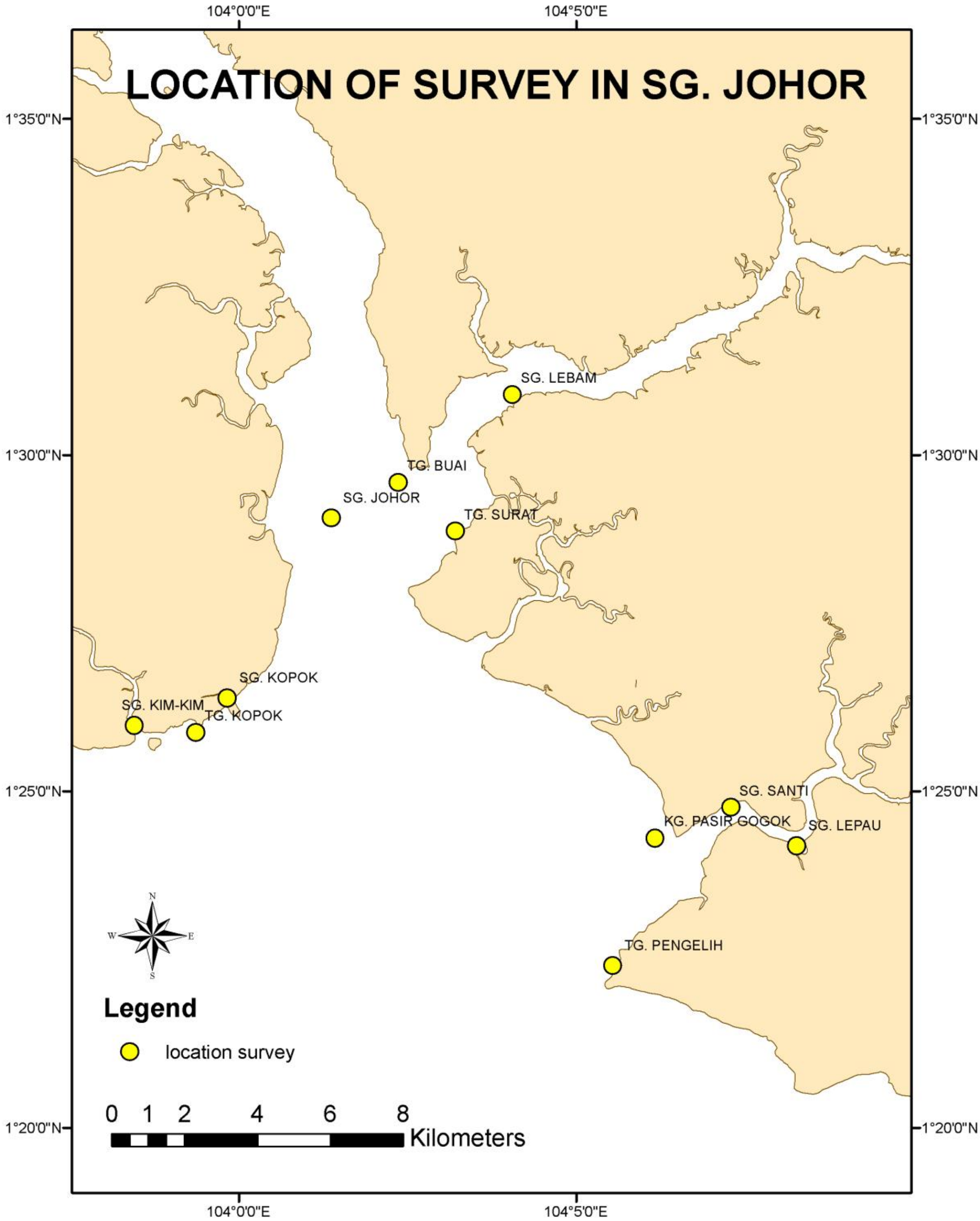


Figure 3.1: Map showing the locations of surveys in Sungai Johor

Extensive seagrass beds in Tg Surat, Pasir Gogok, and Tanjung Kopok occur in exposed areas on the tidal flats. Poor visibility due to high suspension content of the water failed the attempts to study the area below the low-tide. The sediment of these tidal flats are silts-clay and in places, older coral reefs protude through these sediments. Crocodiles and dolphins were observed and documented in the area during the boat surveys.

The Tanjung Surat (N1 27.956, E104 02.417) seagrass meadow was the largest of the three (3) meadows. This tidal flat is located on the island that faces the estuary of Sungai Lebam. It stretches from the Tanjung Surat headland and south west to Kg Linting in the north east. Fringing this tidal flat is a sandy beach in Tanjung Surat which is replaced in the northeast by 42 thick mangrove swamps. Only in Tanjung Surat some development has taken place, with the building of a concrete jetty and shops to service a school, and a customs complex. From the interview with the locals, dugongs were sighted in the past at Tanjung Buai, a quiet bay situated across Tanjung Surat.

The tidal flat fronting the village of Pasir Gogok (N1 25.052, E104 05.994) supports a thriving seagrass meadow which extends southwards towards Pasir Bunga, where the meadow then thins out as the sediment becomes coarser at the mouth bar of Sungai Santi. This rather narrow (about 100m wide) meadow passes into mud towards the center of Sungai Johor. To the south of the Sungai Santi estuary is a broad shallow water bay near the mouth of Sungai Lepau (N1 24.180, E104 64.8) to Tanjung Pengelih (N1.383, E 104 58.2). This mangrove-lined bay has been known to the locals as a resting place for dugongs.

The seagrass meadow at Tanjung Kopok tidal flat was transected by Sungai Kopok (N1 25.828, E103 59.227). At its eastern side, it is bounded by the Tanjong Kopok headland and on the western side by some rock outcrops. These rock outcrops separate the seagrass meadow from another bay which are mainly colonised by seaweeds, and extend to the mouth of Sungai Kim Kim. A small island, Pulau Nenas shelters this bay where, according to the locals, several marine otters, crocodiles, dolphins and dugongs have been sighted at various times.

## 3.3 Water Quality Data from DOE

Data for water quality was obtained from the Department of Environment (DOE), Malaysia. The DOE started the marine monitoring programme in 1978 for Peninsular Malaysia and in 1985 for Sabah and Sarawak. The programme included in-situ measurement and laboratory analysis for parameters listed in Table 3.1. Adding to that, there are several parameters (Table 3.2) was released by DOE for the purpose of this study. Marine water quality data for the year of 2005 is in Appendix I.

Table 3.1: Malaysia Marine Environmental Quality Parameters

| In-situ Measurement | Unit | Parameter (Laboratory Analysis) | Unit |
|---|---|---|---|
| Temperature | $^{o}C$ | *Escherichia coli (E. coli)* | MPN/100ml |
| pH | - | Oil and grease (O & G) | mg/l |
| Dissolved oxygen | %Sat | Total Suspended Solid (TSS) | mg/l |
| Dissolved oxygen | mg/l | Arsenic (As) | mg/l |
| Conductivity | mS/cm | Cadmium (Cd) | mg/l |
| Salinity | ppt | Total Chromium (Cr) | mg/l |
| Turbidity | NTU | Cuprum (Cu) | mg/l |
| Tarball | g/100m | Lead (Pb) | mg/l |
| | | Mercury (Hg) | mg/l |

(Source: DOE, 2006)

Table 3.2: Marine Environmental Quality Parameters
(data released for this study only)

| Parameter | Unit | Parameter | Unit |
|---|---|---|---|
| Total Coliform | MPN/100ml | Ion (Fe) | mg/l |
| Ammonia-N ($NH_3$-N) | mg/l | Zinc (Zn) | mg/l |
| Nitrate ($NO_3$-N) | mg/l | Nickel (Ni) | mg/l |
| Total Nitrogen | mg/l | Manganese (Mn) | mg/l |
| Phosphate ($PO_3$) | mg/l | | |

## 3.4 Marine Water Quality Standards

Marine water quality plays an important component particularly in marine resources conservation that contributes to the stability of marine ecosystem. Sources of land-based pollution as well as from the sea can be a threat to precious resources. Every country has different interpretations regarding water quality standard but the main purpose is to protect human health and preserve the environment. Two (2) water quality standards were used in this study i.e. the Interim Marine Water Quality Standards (IMWQS) and the Marine Water Quality Criteria for the ASEAN Region. Both water quality standards were show in Table 3.3 and Table 3.4 respectively.

Table 3.3: Malaysia Interim Marine Water Quality Standards

| Parameter (Laboratory Analysis) | Unit | Standards |
|---|---|---|
| *Escherichia coli (E. coli)* | MPN/100ml | 100 |
| Oil and grease (O & G) | mg/l | 0 |
| Total Suspended Solid (TSS) | mg/l | 50 |
| Arsenic (As) | mg/l | 0.1 |
| Cadmium (Cd) | mg/l | 0.1 |
| Total Chromium (Cr) | mg/l | 0.5 |
| Cuprum (Cu) | mg/l | 0.1 |
| Lead (Pb) | mg/l | 0.1 |
| Mercury (Hg) | mg/l | 0.001 |

(Source: DOE, 2006)

According to DOE (2006), causes of contaminant of total suspended solid are from agricultural activities, tourism development, coastal reclamation, logging and road construction. Meanwhile discharge from vessels, tank clearing; de-ballasting, bilges, leakages and disposal of engine oil from ferries and boat and bunkering are the possible sources of oil and grease pollutant. Industrial development and land-based sources contribute contaminant of heavy metal to marine environment.

Table 3.4: Marine Water Quality Criteria for the ASEAN Region

| Parameter | Unit | Criteria Values |
|---|---|---|
| Ammonia ($NH_3$-N) | mg/l | 0.07 |
| Dissolved Oxygen (DO) | mg/l | 4 |
| *Escherichia coli (E. coli)* | MPN/100ml | 100 |
| Nitrate ($NO_3$-N) | mg/l | 0.06 |
| Nitrite ($NO_2$-N) | mg/l | 0.055 |
| Oil and Grease (O & G) | mg/l | 0.140 |
| Phosphorus (P) | mg/l | 0.015 (coastal)<br>0.045 (estuaries) |
| Temperature | $^oC$ | Increase not more than $2^oC$ above the maximum ambient temperature |
| Total Suspended Solid (TSS) | | Permissible 10% maximum increase over seasonal average concentration |
| Tributyltin | mg/l | 10 |
| Arsenic (As) | mg/l | 0.12 |
| Cadmium (Cd) | mg/l | 0.01 |
| Chromium (Cr) VI | mg/l | 0.05 |
| Copper (Cu) | mg/l | 0.008 |
| Cyanide | mg/l | 0.007 |
| Lead (Pb) | mg/l | 0.0085 |
| Mercury (Hg) | mg/l | 0.00016 |

## 3.5 Preparation of Geospatial Data with ArcGIS

To enable results of the study be tied to corresponding geometry of the area, spatial database were generated. Spatial data preparation which involved the processes of georeferencing, dissolve, labelling and mapping are detailed out in Appendix II. Output raster in *.png* format in this example was named “Johor Water Quality Monitoring Stations” (Figure 3.2), shows the DOE water quality monitoring stations, boundary of Johor and boundary of the UMMReC Project study sites, which later will be used in the selection of the DOE stations.

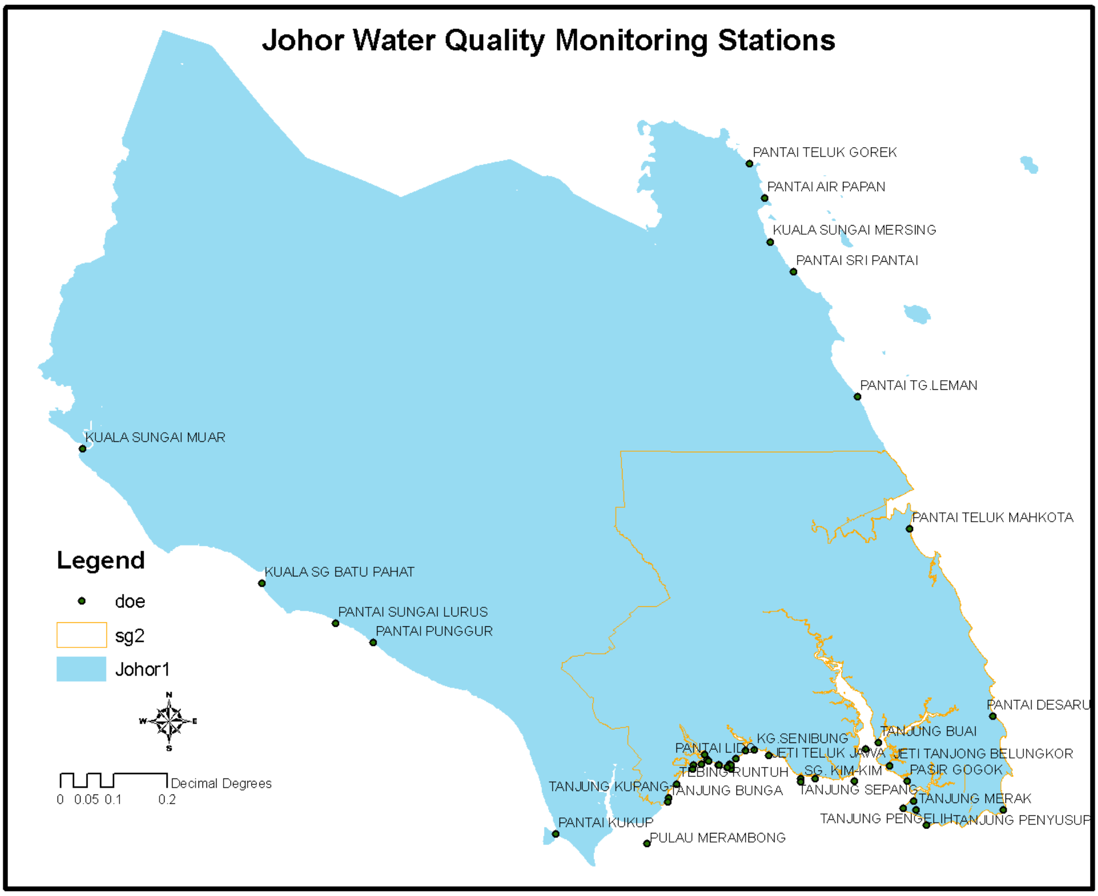


Figure 3.2: Johor Water Quality Monitoring Stations

### 3.6 Selection of DOE Water Quality Monitoring Stations

There are 45 DOE Water Quality Monitoring Stations (WQMS) distributed along Johor shoreline as shown in Table 3.5. Therefore a selection has to be made to determine the relevant nearest WQMS to the seagrass area. Only water quality data from the selected WQMS will be used in the study.

Table 3.5: Johor Water Quality Monitoring Stations

| Num. | Station Name | Latitude | Longitude |
|---|---|---|---|
| 1 | Kg.Tanjung Kopok | N 01° 25' 31.0" | E 104° 00' 03.0" |
| 2 | Kg. Pasir Putih | N 01° 25' 48.0" | E 103° 55' 40.0" |
| 3 | J/K Sultan Iskandar | N 01° 26' 49.0" | E 103° 46' 09.0" |
| 4 | Kg.Senibung | N 01° 29' 01.0" | E 103° 48' 47.0" |
| 5 | Kuala Sg.Tebrau | N 01° 28' 56.0" | E 103° 47' 48.0" |
| 6 | Tanjung Putri | N 01° 27' 20.0" | E 103° 46' 09.0" |
| 7 | Hadapan MPJB ( W.F.CT ) | N 01° 27' 00.0" | E 103° 45' 43.0" |
| 8 | Tanjung Danga | N 01° 27' 24.0" | E 103° 42' 52.0" |
| 9 | Kuala Sg.Skudai | N 01° 27' 46.0" | E 103° 43' 22.0" |
| 10 | Depan Pusat Islam | N 01° 27' 19.0" | E 103° 44' 51.0" |
| 11 | Tebing Runtuh | N 01° 25' 10.0" | E 103° 40' 06.0" |
| 12 | Kuala Sg.Melayu | N 01° 26' 53.0" | E 103° 41' 53.0" |
| 13 | Tanjung Bunga | N 01° 23' 07.0" | E 103° 39' 02.0" |
| 14 | Tanjung Kupang | N 01° 23' 36.0" | E 103° 39' 11.0" |
| 15 | Kuala Sg Batu Pahat | N 01° 47' 44.0" | E 102° 53' 22.0" |
| 16 | Kuala Sungai Johor | N 01° 29' 04.0" | E 104° 01' 22.0" |
| 17 | Kuala Sungai Melayu | N 01° 27' 15.0" | E 103° 41' 56.0" |
| 18 | Kuala Sungai Mersing | N 02° 26' 10.0" | E 103° 50' 35.0" |
| 19 | Kuala Sungai Muar | N 02° 02' 54.0" | E 102° 33' 11.0" |
| 20 | Kuala Sungai Segget | N 01° 27' 21.0" | E 103° 45' 58.0" |
| 21 | Kuala Sungai Skudai | N 01° 28' 28.0" | E 103° 43' 12.0" |
| 22 | Kuala Sungai Tebrau | N 01° 28' 56.0" | E 103° 47' 48.0" |
| 23 | Jeti Tanjong Belungkor | N 01° 27' 14.0" | E 104° 04' 03.0" |
| 24 | Jeti Teluk Jawa | N 01° 28' 22.0" | E 103° 50' 23.0" |
| 25 | Pantai Air Papan | N 02° 31' 05.0" | E 103° 50' 00.0" |
| 26 | Pantai Desaru | N 01° 32' 48.0" | E 104° 15' 41.0" |
| 27 | Pantai Kukup | N 01° 19' 30.0" | E 103° 26' 29.0" |
| 28 | Pantai Lido | N 01° 27' 56.0" | E 103° 43' 29.0" |
| 29 | Pantai Sri Pantai | N 02° 22' 45.0" | E 103° 53' 19.0" |
| 30 | Pantai Stulang Laut | N 01° 28' 02.0" | E 103° 46' 46.0" |
| 31 | Pantai Sungai Lurus | N 01° 43' 14.0" | E 103° 01' 43.0" |
| 32 | Pantai Tanjong Setapa | N 01° 20' 33.0" | E 104° 08' 09.0" |
| 33 | Pantai Teluk Gorek | N 02° 34' 57.0" | E 103° 48' 18.0" |
| 34 | Pantai Teluk Mahkota | N 01° 53' 52.0" | E 104° 06' 15.0" |

Table 3.5: continued

| | | | |
|---|---|---|---|
| 35 | Pantai Tg.Leman | N 02$^{o}$ 08' 43.0" | E 104$^{o}$ 00' 24.0" |
| 36 | Pasir Gogok | N 01$^{o}$ 25' 28.2" | E 104$^{o}$ 05' 59.7" |
| 37 | Pelabuhan Pasir Gudang | N 01$^{o}$ 25' 44.0" | E 103$^{o}$ 54' 03.0" |
| 38 | Tanjung Buai | N 01$^{o}$ 29' 48.1" | E 104$^{o}$ 02' 43.4" |
| 39 | Tanjung Merak | N 01$^{o}$ 21.76.5' | E 104$^{o}$ 06’ 59.2' |
| 40 | Tanjung Pengelih | N 01$^{o}$ 22. 24.5' | E 104$^{o}$ 05’ 32.5' |
| 41 | Tanjung Penyusup | N 01$^{o}$ 22' 12.9" | E 104$^{o}$ 16' 48.3" |
| 42 | Tanjung Sepang | N 01$^{o}$ 23' 01.2" | E 104$^{o}$ 06' 44.8" |
| 43 | Sg. Kim-Kim | N 01$^{o}$ 25' 24.0" | E 103$^{o}$ 54' 03.0" |
| 44 | Hadapan HSAJB | N 01$^{o}$ 27' 19.0" | E 103$^{o}$ 44' 44.0" |
| 45 | Pantai Punggur | N 01$^{o}$ 41' 05.0" | E 103$^{o}$ 05' 54.0" |

To carry out the selection, one of the tools in GIS Proximity Toolset named Point Distance was used. Point distance analysis is the most suitable tool for this purpose because it could computes the distances between point features in one feature class to all points in a second feature class that are within the specified search radius (see http://webhelp.esri.com). The two spatial data used in this method were the DOE WQMS (Figure 3.2) and the locations of survey by the UMMReC Project team (Figure 3.3).

Point distance analysis for the selection of DOE WQMS is defined in Appendix III.

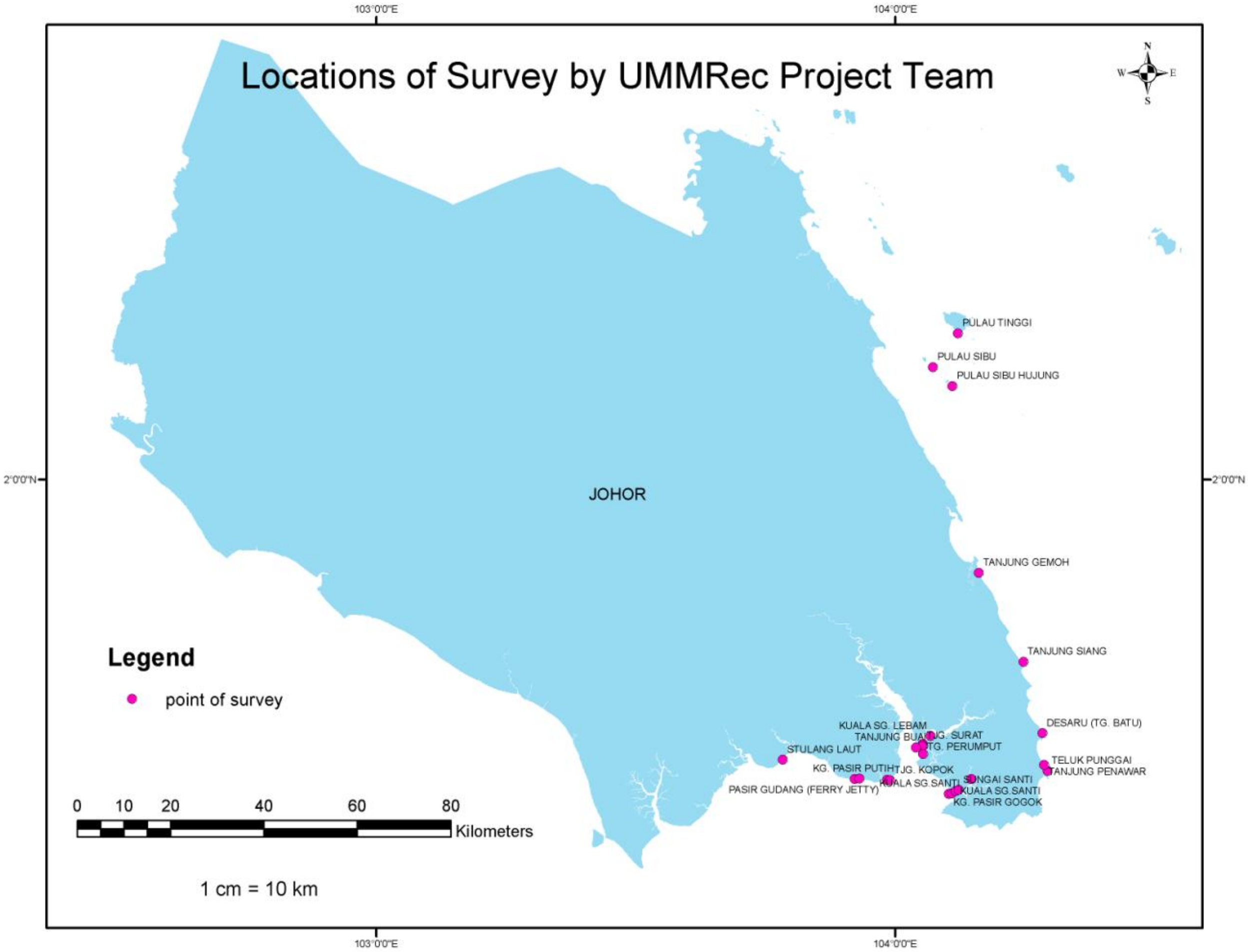


Figure 3.3: Locations of survey by the UMMReC Project Team

The UMMReC Project team determined the survey locations based on the questionnaire surveys and interviews on dugong sighting, sites where carcasses of dead dugongs were found in the past and the extent of seagrass beds. Detailed of the locations and dates of the survey carried out by the UMMReC Project researchers is listed in Table 3.6.

Table 3.6: List of locations (WGS84) and dates of survey

| Date | Location | Latitude | Longitude |
|---|---|---|---|
| 30/04/2005 | Kg Pasir Gogok | N01°24'18.3" | E104°06'10.3" |
| | Kuala Sg. Santi | N01°24'21.8" | E104°06'33.1" |
| | | N01°24'37.5 | E104°06'57.2" |
| | Sungai Santi | N01°24'45.7" | E104°07'17.1" |
| | Sg. Santi (up river) | N01°26'01.9" | E104°08'45.7" |
| | Perigi Acheh (guard post) | N01°75'55.6" | E103°59'01.7" |
| 01/05/2005 | Tanjong Kopok | N01°25'52.5" | E103°59'21.6" |
| | Kuala Sg. Lebam | N01°30'54" | E104°4'3.2" |
| | Tanjong Perumput | N01°29'58.4" | E104°3'9.6" |
| | | N01°29'45.7" | E104°3'12.6" |
| | Tanjong Surat | N01°29'45.7" | E104°36.8" |
| | Tanjong Surat (right hand) | N01°28'52.12" | E104°3'12.6" |
| | Tanjong Buai | N01°29'35.6" | E104°02'21.4" |
| 20/05/2005 | Stulang Laut | N01°28'11.5" | E103°47'0.02' |
| | Pasir Gudang (ferry jetty) | N01°26'02.2" | E103°55'16.5" |
| | Kg. Pasir Putih | N01°26'02.8" | E103°55'50.6" |
| | Tanjong Balau | - | - |
| 21/05/2005 | Teluk Punggai | N01°26'057" | E104°17'34.7" |
| | Tanjung Penawar | N01°27'36.3" | E104°17'10.9" |
| 22/05/2005 | Telok Mahkota | - | - |
| | Tanjong Gemoh | N01°49'25.3" | E104°09'39.3" |
| | Tanjong Siang | N01°39.314' | E104°14.8' |
| | | N01°39'18.9" | E104°14'47.9" |
| | Desaru (Tg. Batu) | N01°31'12.2" | E104°16'59.2" |
| 07/06/2005 | Pulau Tinggi | N02°16' 35.9" | E104°07' 14.2" |
| | Pulau Sibu | N02°12' 46.0" | E104°04' 20.1" |
| 07/07/2005 | Pulau Sibu Hujung | N02° 10.600' | E104° 06.590' |

Besides that, map of seagrass area (Figure 3.4) was also taking into consideration for point selection. From analysis of spatial attributes of UMMReC.shp and doe.shp, point selection is performed by it’s nearest to the seagrass bed using the overlay technique. Results are the selected points, named Site 1, Site 2, Site 3, Site 4 and Site 5.

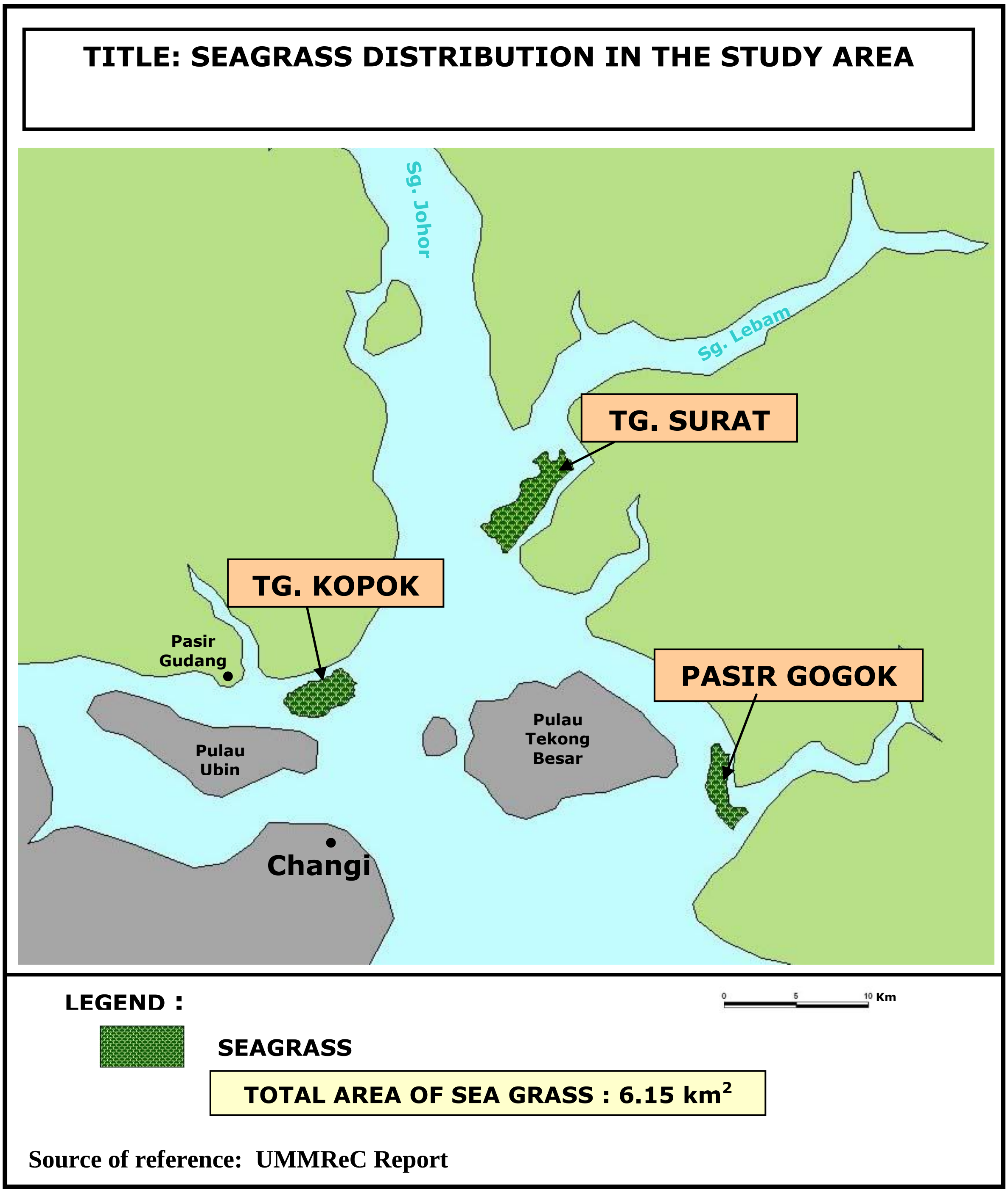


Figure 3.4: Distribution of seagrass in the study area

## 3.7 Statistical Analysis

### 3.7.1 Data Availability

This analysis was based on data availability at selected DOE Water Quality Monitoring Stations (WQMS), from January 2005 to December 2005. Selected DOE stations (as a result from point distance analysis and overlay technique in paragraph 3.6) and the availability of water quality data is shown in Table 3.7.

Table 3.7: Selected DOE WQMS and the availability of data

| Sites | Location | Data Available |
|---|---|---|
| Site 1 | Pantai Stulang Laut | 2005: Jan, Apr, Aug, Oct |
| Site 2 | Pel. Pasir Gudang | 2005: Jan, Apr, Aug, Oct |
| | Sg. Kim-Kim/ Kuala Sg. Kim-Kim | 2005: Jan, Apr, Aug, Oct |
| | Kg. Pasir Putih | 2005: Mac, June |
| Site 3 | Kg. Tanjung Kopok | 2005: Mac, June |
| Site 4 | Tanjung Buai | 2005: Feb, May, Aug, Nov |
| | Kuala Sg. Johor | 2005: Jan, Apr, Aug, Oct |
| Site 5 | Pasir Gogok | 2005: Feb, May, Aug, Nov |
| | Tanjung Sepang | 2005: Mac, June, Sept, Dec |

DOE provide 24 parameters of water quality that has been group into 5 (five) as below:

- Physical parameters: temperature, conductivity, salinity, DO, pH, TSS and turbidity;

- Chemical parameter: Oil & Grease;
- Nutrient parameter: Nitrogen Ammonia, Nitrate, Total Nitrogen and Phosphate;
- Biological parameter: Total Coliforms and E-coli; and
- Metals: Cd, Cr, Hg, Pb, As, Ni, Cu, Fe, Zn, Mn.

Preliminary analysis of all water quality data indicates that most of the parameters do not experience significant changes throughout this sampling period i.e. from January 2005 to December 2005. From the 24 physicochemical parameters, only six (6) physical parameters, one (1) nutrient parameter, one (1) chemical parameter and two (2) heavy metals can be considered to be analyzed statistically. Other parameters with value too small (e.g. <2, <0.04) to be calculated at exact value were excluded.

### 3.7.2 Descriptive and Inferential Statistics

In most social research the data analysis involves three major steps, done in roughly this order:

- Cleaning and organizing the data for analysis (Data Preparation);
- Describing the data (Descriptive Statistics) and
- Testing Hypotheses and Models (Inferential Statistics).

Data Preparation involves checking or logging the data in; checking the data for accuracy; entering the data into the computer; transforming the data; and developing and documenting a database structure that integrates the various measures. In this study, data preparation was only for the selection of water quality data from DOE that are suitable to be analyzed. GIS analysis method was use to prepare the geospatial database and the selection of DOE water quality monitoring stations.

Descriptive Statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually every quantitative analysis of data. With descriptive statistics you are simply describing what is or what the data shows. In this study, the univariate analysis (involves the examination across cases of one variable at a time) that been done on water quality data was the central tendency. The central tendency of a distribution is estimates of the "center" of a distribution of values such mean, median or mode. Although we can calculate these univariate statistics by hand, it gets quite tedious when you have more than a few values and variables. Every statistics program is capable of calculating them easily. The table that was given as a result usually has the mean, median, mode, standard deviation, variance and range.

Inferential Statistics investigate questions, models and hypotheses. In many cases, the conclusions from inferential statistics extend beyond the immediate data alone. For instance, we use inferential statistics to try to infer from the sample data what the population thinks. Or, we use inferential statistics to make judgments of the probability that an observed difference between groups is a dependable one or one that might have happened by chance in this study. Thus, we use inferential statistics to make inferences from our data to more general conditions; we use descriptive statistics simply to describe what's going on in our data.

### 3.7.3 Descriptive Statistic on DOE Data

Descriptive statistic for determination of Minimum (Min), Maximum (Max), Range, Mean and Standard Deviation (Std Dev.) were performed to selected parameters (physical, nutrient, biological and heavy metal) from DOE. All calculation was done in Microsoft Office Excel 2007.

### 3.7.4 Inferential Statistics

Inferential statistics that has been used are the Correlation and Regression. Correlation and linear regression are the most commonly used techniques for investigating the relationship between two quantitative variables. The goal of a correlation analysis is to see whether two measurement variables co vary, and to quantify the strength of the linear relationship between the variables, whereas regression expresses the relationship in the form of an equation.

Correlation and regression analysis was done for these variables:

(i) Water quality from UMMReC Project (i.e. from the field work) (Table 3.8) versus DOE water quality parameters; and

(ii) DOE water quality parameters versus Dry Weight (DW) Biomass of seagrasses from UMMReC Project. Correlation of water quality data and dry weight biomass of seagrass can only been perform for Site 3, Site 4 and Site 5 because Site 1 and Site 2 were the areas without the seagrass.

All calculation and figure sketch was done in Microsoft Office Excel 2007 and the regression selected in this analysis is a linear model.

Table 3.8: Water Quality Data from the Field Work (UMMReC Project)

| Date | Location | Surf Temp (°C) | DO (mg.L-1 ) | Salinity (ppt) | Secchi depth (cm) | Conductivity (mS) | pH | Light (k lx) |
|---|---|---|---|---|---|---|---|---|
| 1 May 2005 8.50 am | Site 3 Tg. Kopok | 30 | 3.8 | 33 | 26 | 43.8 | 7.5 | 37 |
| | | 31 | 3.2 | 33 | | 43.1 | | |
| | | 31 | 3.4 | 33 | | 43.3 | | |
| | Average | **30.67** | **3.47** | **33** | **26** | **41** | **7.5** | **37** |
| | Std Dev | **0.58** | **0.31** | **0** | - | **0.4** | - | - |
| 1 May 2005 10.45 am | Site 4 Tg. Surat | 31 | 6.6 | 27 | 33 | 40.6 | 7.5 | 18 |
| | | 30 | 6.4 | | | 41 | | |
| | | 31 | 6.7 | | | 41.4 | | |
| | Average | **30.67** | **6.57** | **27** | **33** | **41** | **7.5** | **18** |
| | Std Dev | **0.58** | **0.15** | - | - | **0.4** | - | - |
| 30 Apr 2005 9.20 am | Site 5 Pasir Gogok | 25 | 5.7 | 32 | 15 | 42.9 | 6.6 | 20 |
| | | 24 | 5.7 | 32 | 17 | 42.6 | 6.6 | - |
| | | 30 | 5 | 32 | 18 | 41.9 | 6.6 | - |
| | Average | **26.33** | **5.47** | **32** | **16.67** | **42.47** | **6.6** | **20** |
| | Std Dev | **3.21** | **0.4** | **0** | **1.53** | **0.51** | **0** | **0** |

## 3.8 Building Geodatabase

Geodatabase is a cylinder that compiles various types of geographic information layer and dataset. It let user manage data file and store it in same tube or folder. Geodatabase user is range from single user database to enterprise. In this study, personal geodatabase was use for creating seagrass and water quality data in a single cylinder. Figure 3.5 shows the three primary dataset types that geodatabase can support, namely: Features classes; Raster datasets; and Tables.

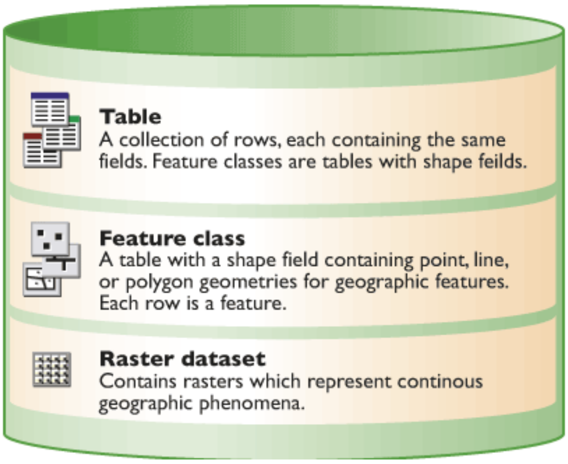


Figure 3.5: Dataset support by Geodatabase
(http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm)

Using geodatabase allow user to arrange dataset for its attribute, type and file. Three types of Geodatabase are: Server Geodatabase; File Geodatabase; and Personal Geodatabase. In this study, personal geodatabase was used and demonstrated because only two (2) sources of data being analyzed and personal geodatabase is comprehensive to support both data. Personal geodatabase save data in *.mdb* format which Window view it as Ms Access database. Personal geodatabase is a small database with only 2GB or less storage on single database. It is only suitable for individuals to manage their own data. Personal geodatabase can be converting into file geodatabase or server database for more data storage.

### 3.8.1 Designing Geodatabase

In this study, geographic features that are to be represented is water quality station point, seagrass observation point and its attributes, raster topographic map and statistical analysis. Steps taken in designing the geodatabase were detailed out in Appendix IV.

Figure 3.6 shows the output of Personal Geodatabase for the seagrass study, which include the entire data table from the analysis than have been done.

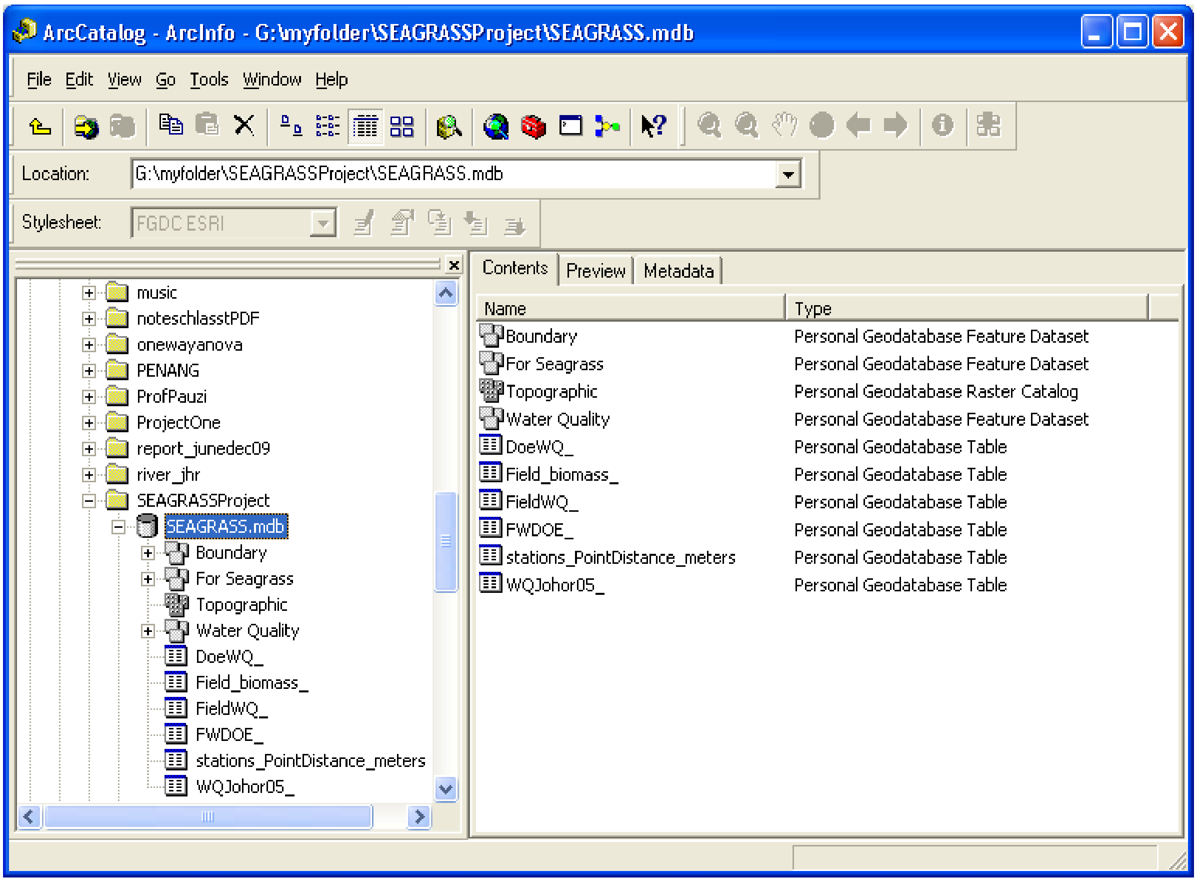


Figure 3.6: Output of Personal Geodatabase for the seagrass study