



**UNIVERSITI PUTRA MALAYSIA**

***HEALTH RISK ASSESSMENT OF NITRATE EXPOSURE IN  
GROUNDWATER AMONG RESIDENTS AT THREE VILLAGES IN PASIR  
PUTEH, KELANTAN***

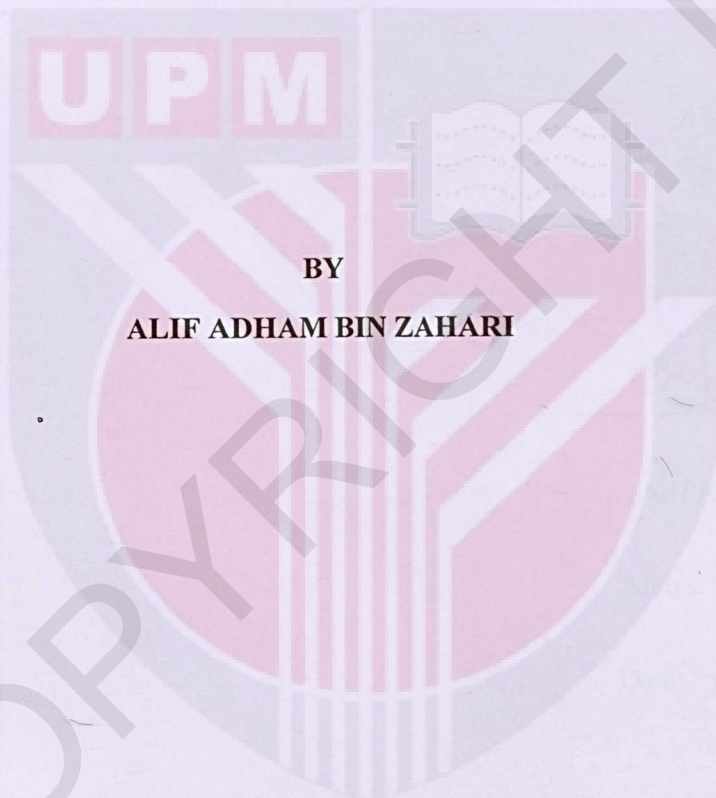
**ALIF ADHAM BIN ZAHARI**

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DECLARATION

**HEALTH RISK ASSESSMENT OF NITRATE EXPOSURE IN GROUNDWATER  
AMONG RESIDENTS AT THREE VILLAGES IN PASIR PUTEH, KELANTAN**

I declare that this thesis is my original work except for quotations and references  
have been acknowledged.



BY

**ALIF ADHAM BIN ZAHARI**

**This is submitted in fulfillment of the requirement for the degree of Bachelor Science  
(Environmental and Occupational Health) from the faculty of Medicine and Health  
Sciences, Universiti Putra Malaysia**

1000718352

## ACKNOWLEDMENT

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Kampung Batu Sebutir participated in the survey and had therefore made this study possible and successful.

HEALTH RISK ASSESSMENT OF NITRATE EXPOSURE IN GROUND  
WATER AMONG RESIDENTS AT THREE VILLAGES IN PASIR PUTIH,  
KELANTAN

ALIF ADHAM BIN ZAHARI



## ABSTRACT

### HEALTH RISK ASSESSMENT OF NITRATE EXPOSURE IN GROUND WATER AMONG RESIDENTS AT THREE VILLAGES IN PASIR PUTEH, KELANTAN.

ALIF ADHAM BIN ZAHARI

**Introduction:** The nitrate exposure in groundwater especially in agricultural areas has become a major public health issue. Methaemoglobinemia is the most common disease that is related to nitrate exposure. **Objective:** This cross-sectional study was conducted in Pasir Puteh, Kelantan with an aim to determine the nitrate exposure levels in groundwater and to perform health risk assessment among respondents at the respective areas. **Methodology:** Seventy (70) respondents were selected in this study based on the inclusive and exclusive criteria. The groundwater samples were taken from each respondent's well, and was analyzed with a Hach DR/2500 Spectrophotometer to determine nitrate levels. Questionnaires were used to determine respondents, water daily intake, socio-demographic background and status of water supply quality. The body weight of respondents was measured using a Seca Body Weight Scale. The health risk assessment was calculated using the Chronic Daily Intake (CDI) and Hazard Index (HI). **Results:** Nitrate level in this study was below Concentration Limit of National Drinking Water Quality Standard Malaysia (NDWQS) (<10mg/L) with the mean  $\pm$  SD of  $2.11 \pm 1.24$  mg/L and ranged between 0.20 to 5.20mg/L. The highest mean  $\pm$  SD was determined in Kampung Batu Sebutir ( $2.28 \pm 0.9$  mg/L) while the lowest mean  $\pm$  SD was determined in Kampung Panggong ( $1.98 \pm 1.21$  mg/L). The mean  $\pm$  SD for CDI was  $0.06 \pm 0.038$  mg kg/day and the HI was <1. This indicate the health risk of residents from nitrate were in acceptable range. **Conclusion:** As far as nitrate exposures are concern, the groundwater would not cause non-carcinogenic health effect to those who use it for daily purpose.

**Keywords:** Nitrate, groundwater, National Drinking Water Quality Standard Malaysia, maximum concentration limit, chronic daily intake, hazard index, Pasir Puteh.

## ABSTRAK

### KAJIAN PENILAIAN RISIKO KESIHATAN TERHADAP TAHAP NITRAT DI DALAM AIR PERIGI DI TIGA KAMPUNG DI PASIR PUTEH, KELANTAN

ALIF ADHAM BIN ZAHARI

**Pengenalan:** Pendedahan nitrat dalam air bawah tanah terutama di kawasan pertanian telah menjadi satu isu kesihatan awam yang utama. Methaemoglobinemia adalah penyakit yang paling biasa yang berkaitan dengan pendedahan nitrat. **Objektif:** Kajian keratan rentas telah dijalankan di Pasir Puteh, Kelantan dengan tujuan untuk menentukan tahap pendedahan nitrat dalam air bawah tanah dan melaksanakan penilaian risiko kesihatan di kalangan responden di kawasan masing-masing. **Metodologi:** Tujuh puluh (70) responden telah dipilih dalam kajian ini berdasarkan kriteria inklusif dan eksklusif. Sampel air bawah tanah diambil dari setiap rumah responden, dan dianalisis menggunakan Hach DR/2500 Spectrophotometer untuk menentukan tahap nitrat. Borang soal selidik telah digunakan untuk menentukan responden, pengambilan harian air, latar belakang sosio-demografi dan status kualiti bekalan air. Berat badan responden diukur menggunakan Berat Badan Skala Seca. Penilaian risiko kesihatan telah dikira menggunakan Pengambilan kronik harian (CDI) dan Indeks Bahaya (HI). **Keputusan:** Tahap nitrat dalam kajian ini adalah di bawah Had Kepekatan Piawaian Kualiti Air Minum Kebangsaan (NDWQS) ( $< 10 \text{ mg / L}$ ) dengan min  $\pm$  SD sebanyak  $2.11 \pm 1.24 \text{ mg / L}$  dan julat adalah antara 0.20 sehingga  $5.20 \text{ mg / L}$ . Min tertinggi  $\pm$  SP telah dikenal pasti di Kampung Batu Sebutir ( $2.28 \pm 0.9 \text{ mg / L}$ ) manakala min terendah  $\pm$  SP dikenal pasti di Kampung Panggong ( $1.98 \pm 1.21 \text{ mg / L}$ ). Min  $\pm$  SP untuk CDI adalah  $0.06 \pm 0.038 \text{ mg kg / hari}$  dan indeks Hazad (HI) adalah  $< 1$ . Ini menunjukkan risiko kesihatan penduduk terhadap nitrat berada dalam julat yang selamat. **Kesimpulan:** Merujuk kepada kebimbangan pendedahan terhadap nitrat di dalam air bawah tanah, ia didapati air bawah tanah tidak akan menyebabkan kesan kesihatan bukan karsinogen kepada mereka yang menggunakannya untuk tujuan harian.

**Kata Kunci:** Nitrat, air perigi, piawaian kualiti air Malaysia, pengambilan kronik harian, indeks hazard, Pasir Puteh

# TABLE OF CONTENTS

TITLE	Page
DECLARATION	i
APPROVAL	ii
ACKNOWLEDGEMENT	iii-iv
ABSTRACT	v-vi
TABLE OF CONTENT	vii-xii
LIST OF TABLES	xiii
LIST OF FIGURES	xiv
LIST OF ACRONYMS AND ABBREVIATIONS	xv

## CHAPTER 1: INTRODUCTION

1.1 Background	1-2
1.2 Problem statements	3
1.3 Study Justification	4
1.4 Conceptual Framework	5
1.5 Definition	6-7
1.5.1 Conceptual Definition	
1.5.1.1 Drinking Water	
1.5.1.2 Nitrate Level	
1.5.1.3 Health Risk Assessment	
1.5.2 Operational Definition	
1.5.2.1 Drinking Water	
1.5.2.2 Nitrate Level	
1.5.2.3 Health Risk Assessment	
1.6 Research Objectives	8-9
1.5.3 General Objective	
1.5.4 Specific Objectives	
1.5.5 Hypothesis	

## **CHAPTER 2: LITERATURE REVIEW**

2.1 Nitrate in environment	10
2.2 Sources of Nitrate	10-11
2.2.1 Natural Resources	
2.2.2 Anthropogenic Sources	
2.3 Exposure to Nitrate and health effects	11-13

## **CHAPTER 3: METHODOLOGY**

3.1 Introduction of methodology	14
3.2 Study design	14
3.3 Study location	14-16
3.4 Study population	17
3.5 Sampling	17-19
3.5.1 Study sample	
3.5.2 Sample size	
3.5.3 Sampling method	
3.5.4 Sampling unit	

3.6 Study instrumentation and data collection	19-24
3.6.1 Questionnaire	
3.6.2 Body weight	
3.6.3 Drinking water daily intake	
3.6.4 Water sample	
3.6.4.1 Water analysis	
3.7 Risk Assessment	25-26
3.8 Data analysis	26-27
3.9 Ethical consideration	27
3.10 Study limitation	27-28
<b>CHAPTER 4: RESULTS</b>	
4.1 Background of respondent	29-36
4.1.1 socio-demographic information	
4.1.2 Well information	
4.1.3 Drinking water information	

4.2 Nitrate level in groundwater	36-37
4.3 Comparison of nitrate between each house (one sample t-test)	37
4.4 Comparison of nitrate levels between villages (Kruskal-Wallis test)	38
4.5 Comparison nitrate level of each house with national standard	39
4.6 Exposure information (Chronic Daily Intake)	40
4.7 Health risk assessment information (Hazard Index)	41

## **CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATION**

### 5.1 Discussion

5.1.1 Socio-demographic data	42-47
5.1.2 Nitrate level in groundwater	
5.1.3 Comparison of nitrate level between location (between respondent's house)	
5.1.4 Comparison of nitrate levels between villages	
5.1.5 Comparison nitrate level national standard	
5.1.6 Exposure and Health Risk Assessment information	

5.2 Conclusion

47-48

5.3 Recommendation

49

Tables      Captions

**REFERENCES**

50-54

Table 4.2      Comparison between male and female respondents

**APPENDICES**      Summary of respondents' subject ratings

Table 4.1

Questionnaire (Borang soal selidik)

Ethic Consent Letter (Surat persetujuan ethic)

Table 4.3

Table 4.4

Table 4.5

Table 4.6

Table 4.7

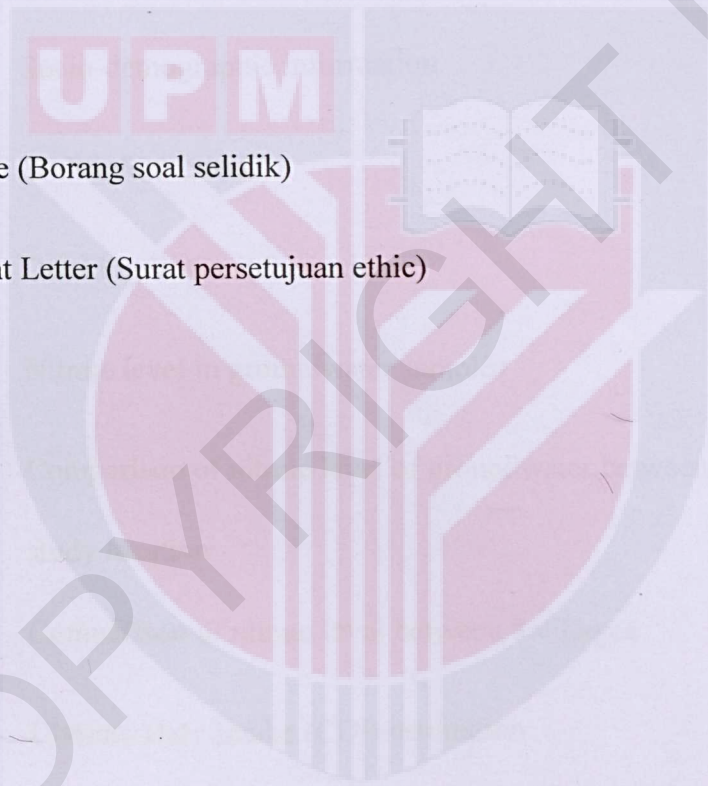
Table 4.8

Table 4.9

Table 4.10

Table 4.11

Table 4.12



## LIST OF TABLES

<b>Tables</b>	<b>Caption</b>	
Table 4.1	Number of respondents	30
Table 4.2	Comparison between male and female respondents	30
Table 4.3	Frequency of respondents between villages	31
Table 4.4	Socio-demographic information	32
Table 4.5	Well information	34-35
Table 4.6	Drinking Water information	36
Table 4.7	Nitrate level in groundwater samples	37
Table 4.8	Comparison of nitrate level of groundwater between each study location	37
Table 4.9	Comparison of nitrate level between 3 villages	38
Table 4.10	Chronic Daly Intake (CDI) estimation	40
Table 4.11	Hazard Index (HI) estimating among respondents	41

## LIST OF FIGURES

Figure	Caption	page
Figure 1.1	Conceptual framework of nitrate	5
Figure 3.1	Study Locations	16
Figure 3.2	Seca Weight Scale	20
Figure 3.3	DR/2500 Spectrophotometer	21
Figure 4.1	Comparison of nitrate level among study locations with national Standard	39

## LIST OF ACRONYMS AND ABBREVIATIONS

ATDSR	Agency for Toxic Substances and Diseases Registry
WHO	World Health Organization
Mg/L	milligram per litre
RfD	Reference Dose
USEPA	United States Environmental Protection Agency
USGS	United States of America Geological Survey
NJDEP	New Jersey Department of Environmental Protection Division of Air Quality
NSDWQ	National Standard for Drinking Water Quality for Malaysia
MOH	Ministry of Health
CWC	Community Water Center's Health & Drinking Water Series
ANL	Argonne National Laboratory

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

Agriculture activities in Malaysia have increased from time to time. Modern agriculture has been practiced by farmers to increase their productivity. Modern agriculture means intensive farming or intensive agriculture is an agricultural production. This involves high use of inputs such as capital, labor, and heavy use of pesticides, herbicides, insecticides and chemical fertilizers relative to land area.

Nitrogen fertilizer is used mostly by farmers in rural areas. These fertilizers contain nitrates and nitrates are known to be essential components for making protein in plants. As a result, plants grown on nitrogen fertilizer are healthier and yields are better and bigger. However, exposure to nitrate results in multiple health effects, and it particularly affects human health. Groundwater contamination is frequently associated with agricultural activities such paddy plant. Fertilizers that are spread on the fields or

stored can actually leach into an aquifer and contaminate drinking water when nitrate that originates from these fertilizers reach a well. Nitrate could affect human health when its level exceeds 45 mg /L of  $\text{NO}_3$  (US EPA, 1991).

High nitrate levels in water can cause methemoglobinemia or blue baby syndrome, a condition found especially in infants under six months and, in the long term, could be potentially carcinogenic to humans (INSPQ, 2003). US EPA (1991) suggests a threshold for nitrate in drinking water between 50 and 90 mg/L of  $\text{NO}_3$  and points out that no risk for human health has been observed for infants consuming water containing less than 44 mg/L of  $\text{NO}_3$ . The protection of sources of groundwater in regions with intensive agriculture often creates conflicts. On one hand, farmers grow crops and produce food to satisfy consumer demand and, on the other hand, health authorities must protect public health by ensuring adequate drinking water quality from well water. Like cadmium or lead, it is difficult to understand why lead in drinking water is a potential health hazard or even a concern. Most people believe that water comes from pure sources without any contamination or that the water has been treated.

Although nitrate occurs naturally in some groundwater, in most cases higher levels are thought to result from human activities. Common sources of nitrate from fertilizers or manure, animal feedlots, municipal wastewater or sludge, septic systems, and N-fixation from atmosphere by legumes, bacteria and lightning. Intensive of agricultural practices present a threat to the world's clean water supply. The excess

application of nitrogen fertilizer in crop production has led to major nitrate pollution in groundwater (Reyes Tirado, 2007). Water quality around agricultural areas is decreasing, primarily due the leaching of fertilizers and pesticides (Scanlon et al., 2007).

## **1.2 Problem Statement**

Poor water quality remains an important issue throughout the developing nations nowadays (Wan Ruslan et al., 2004). Currently, the degradation of quality of water supply has risen due to anthropogenic factors including agricultural practices and industrial activities (Azwan et al., 2010).

Agriculture is an important sector to the Malaysian economy in which there has been substantial development in the cultivation of rubber, oil palm, cocoa, fruits and vegetables. The developments of agriculture activities have also resulted in increased use of commercial fertilizers (Phosphate fertilizer, urea and NPK fertilizer)

Moreover, nitrate is one of the most common contaminants in groundwater that originate from either fertilizer or sewage that leads to nitrate contamination of groundwater. The problem to be highlighted is whether the level of nitrate in well water is safe or not for drinking and cooking purposes. Some parts of rural Kelantan

especially in Pasir Puteh are equipped with the rural water supply system, in which some residents are still using groundwater as a main water source.

### 1.3 Study Justification

This study was carried out to determine nitrate concentration level in groundwater at three villages, name Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir in Pasir Puteh, Kelantan. The main economic activity in Pasir Puteh is agriculture for example paddy, watermelon and vegetables. The main crop is paddy. Usually, they use urea and NPK fertilizer to support plant growth. NPK stands for the nutrients available in it which are nitrogen(N), phosphorous(P) and potassium.(K) Many studies showed high usage of fertilizer in agriculture activities.

In Kelantan, there are still many people using groundwater as their drinking water resources. Groundwater also plays a very important role in public water supply system. Approximately 70% of total water supply in the state including Pasir Puteh is derived from groundwater (Azwan et al., 2010).

Mostly residents of Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir live near the paddy fields. Therefore, nitrate in well water may exists due to the location of the well which is near the paddy fields thus obtaining data on the nitrate

concentration is essential for further plan to overcome this problem because it is greatly can give effect to human health.



### 1.4 Conceptual framework

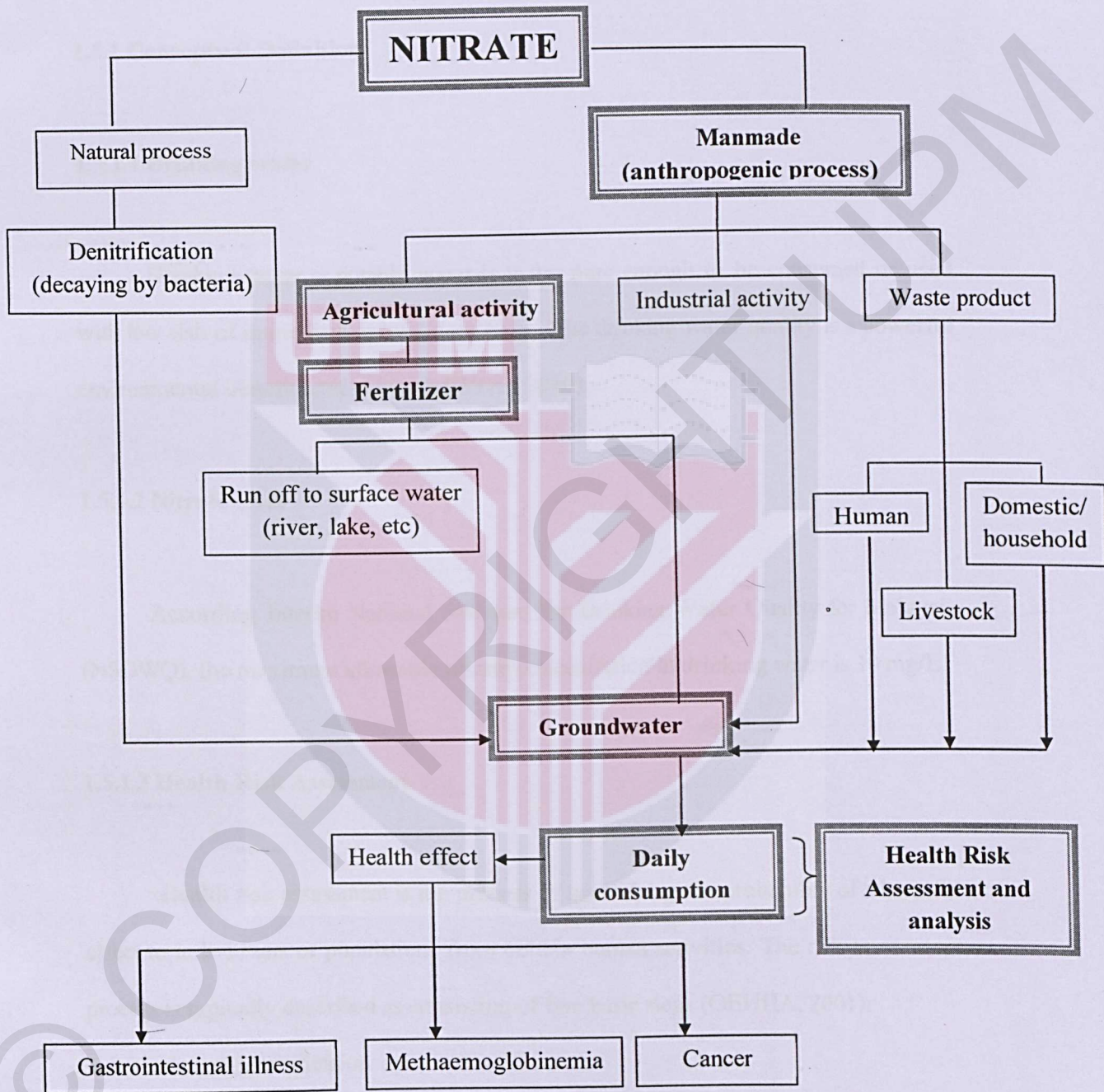


Figure 1.1: Conceptual framework (CWC, 2011 ; Rosen and Kropf, 2006)

## **1.5 Definition**

### **1.5.1 Conceptual Definition**

#### **1.5.1.1 Drinking water**

Drinking water or potable water is water pure enough to be consumed or used with low risk of immediate or long term harm. The drinking water quality is a powerful environmental determinant of health (WHO, 2010).

#### **1.5.1.2 Nitrate level**

According Interim National Standard for Drinking Water Quality for Malaysia (NSDWQ), the maximum allowable nitrate concentration in drinking water is 10 mg/L.

#### **1.5.1.3 Health Risk Assessment**

Health risk assessment is the process of quantifying the probability of a harmful effect to individuals or populations from certain human activities. The risk assessment process is typically described as consisting of five basic steps (OEHHA, 2001):

- I. Hazard identification
- II. Exposure assessment
- III. Dose-response assessment

IV. Risk characterization.

V. Analysis

## **1.5.2 Operational Definition**

### **1.5.2.1 Drinking water**

Drinking water samples are collected direct from each respondent's groundwater source. Then, the water was poured into pre-clean 250ml high density polyethylene (HDPE) bottles.

### **1.5.2.2 Nitrate level**

Nitrate in groundwater samples were analysed singly for nitrate using DR 2500 MR of cadmium reduction method with electronic spectrophotometer (method 8171) (HACH Company, 2003; Patton et al. 2002 cited by Campbell, 2006).

### **1.5.2.3 Health Risk Assessment**

According to USEPA (1992), estimation of daily exposure of individuals for nitrate through ingestion is by calculating the chronic daily intake (CDI) as the exposure metric. Then, to estimate the non-carcinogenic risk of nitrate, the hazard index (HI) is calculated using the equation in Chapter 3.

## 1.6 Objective

### 1.6.1 General Objective

To determine the levels of nitrate in groundwater and to perform health risk assessment among respondents in Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir in Pasir Puteh, Kelantan.

### 1.6.2 Specific objective

1. To determine nitrate level in groundwater
2. To compare nitrate concentration between the three villages.
3. To compare nitrate level of groundwater with national standard
4. To determine the  $HI = CDI/RfD$

Where, HI= Hazard Index,

CDI=Chronic Daily Intake (mg/kg/day),

RfD=Reference dose (mg/kg/day)

### 1.6.3 Research Hypothesis

1. There is a significant difference of nitrate level in groundwater among each study location.
2. There is a significant different of nitrate level in groundwater between the three villages.
3. HI of the respondents  $< 1$ .
4. Nitrate concentration in groundwater in Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir is higher than the NSDWQ, Malaysia.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Nitrates in Environment

Nitrite oxidizes easily into nitrate. Nitrate thus more frequently occurs in groundwater and surface water. Nitrate-containing compounds in the soil are generally soluble, which means they dissolve easily in water. Nitrates thus flow easily into groundwater. Nitrates and nitrites both occur in soil and water. Microbes break down animal and human organic wastes in soil and water. This breakdown process converts wastes into ammonia, which then oxidizes into nitrite and nitrate. Nitrate is also an inorganic ion and common nitrogenous compound that occur from nitrogen cycle and anthropogenic (man-made) sources (ATSDR, 2011).

#### 2.2 Source of Nitrate

Nitrate accumulates from both natural and anthropogenic sources. Nitrates occur in soil, in water, and in some foods (ATSDR, 2011).

### **2.2.1 Natural source**

The nitrogen cycle represents one of the most important nutrient cycles found in terrestrial ecosystems (Pidwirny, 2006). The nitrogen cycle is the natural process by which nitrogen is converted between its various chemical forms and this transformation can be carried out via both biological and non-biological processes. Important processes in the nitrogen cycle include fixation, mineralization, nitrification, and denitrification. The nitrogen cycle is of particular interest to ecologists because nitrogen availability can affect the rate of key ecosystem processes, including primary production and decomposition (Absolute Astronomy, 2011).

### **2.2.2 Anthropogenic source**

Anthropogenic activities or man-made source such as use of fertilizers, fossil fuel combustion and release of nitrogen in wastewater have also dramatically altered the global nitrogen cycle (Absolute Astronomy, 2011).

### 2.3 Exposure to nitrate and health effects

Excessive nitrate or nitrite exposure can result in acute acquired methemoglobinemia, a serious health condition. Hemoglobin in blood carries oxygen from the lungs to tissues and helps carry carbon dioxide back to the lungs. Hemoglobin in blood contains iron normally found in the Ferum (II) (ferrous) state. But excessive nitrates or nitrites can alter the iron in hemoglobin to the Ferum (III) (ferric) state. This forms methemoglobin, an abnormal form of hemoglobin. As methemoglobin forms, the blood loses its ability to carry oxygen to tissues (anoxia). Methemoglobinemia is actually an excess of methemoglobin in the blood. Methemoglobinemia can cause cyanosis (blue skin) of limbs/trunk, weakness, and rapid heart rate. If methemoglobinemia progresses in severity, central nervous system depression can occur, as can headache, dizziness, fatigue, difficulty in breathing, and nausea. Finally, severe methemoglobinemia can cause lethargy, brief loss of consciousness, irregular heartbeat, shock, convulsions, coma, and even death. In fact, methemoglobin levels greater than 50% are potentially fatal (Nathan et al 1977).

Nitrate and nitrite medications may cause hypotension (low blood pressure). But ingestion of nitrates and nitrites in food and water does not commonly result in hypotension.

Maternal exposure to environmental nitrates and nitrites may increase the risk of pregnancy complications such as anemia, abortion, premature labor, or preeclampsia. Methemoglobinemia can also occur from other causes. Exposure to oxidizing drugs or chemicals, systemic acidosis (a generalized, abnormal increase in body fluid acidity), diarrhea, or some genetic disorders such as infant cyanosis (bluish discoloration of skin and mucus membranes) shortly after birth can all result in methemoglobinemia. (ATSDR, 2011)

Peter Weyer who hold Ph.D. and also as an associate director of the University of Iowa, Center for Health Effects of Environmental Contamination (CHEEC) mentioned that even low level exposures to nitrate over many years could be problematic in terms of certain types of cancers (Pedersen, 2001).

Many gastrointestinal illnesses are related to nitrates. The consumption of nitrate contaminated water causes multiple digestive tract impairment (Rao, 2006). There is some evidence that long-term effects, such as gastric cancer, might result from exposure to even smaller amounts of nitrate if they expose to the N-nitroso compounds; the form when nitrate reacts with certain conditions and in which it is a potent carcinogen in many species (Walter et al., 2009).

## CHAPTER 3

### METHODOLOGY

#### 3.1 Introduction

For the methodology part, it was divided into few subsections which are study design, study location, sampling, data collection method and instrumentation, risk assessment, quality control, ethics committee approval and data analysis.

#### 3.2 Study Design

This was a cross-sectional study. The equipment used in this study include, plastic bottle and bucket. The plastic bottles were used to store samples to analyze for nitrate content in the water. The bucket was used to take water from the well water. Sample analysis was analyzed with Hach DR/2500 Spectrophotometer Water. For the data collection technique using water sample for analysis and questionnaire for respondent.

### 3.3 Study location

The study locations were Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir in Pasir Puteh, Kelantan. These locations were chosen due to its agricultural activities as main activity and mostly the houses of the residents are quite near to the paddy field (less than 30 meter) and most of the residents still rely on groundwater for their daily needs. This is believed to consist of nitrate in groundwater with regards to usage of inorganic fertilizer for their crops. Thus, these areas were at high risk for nitrate residue to leach down into the groundwater.

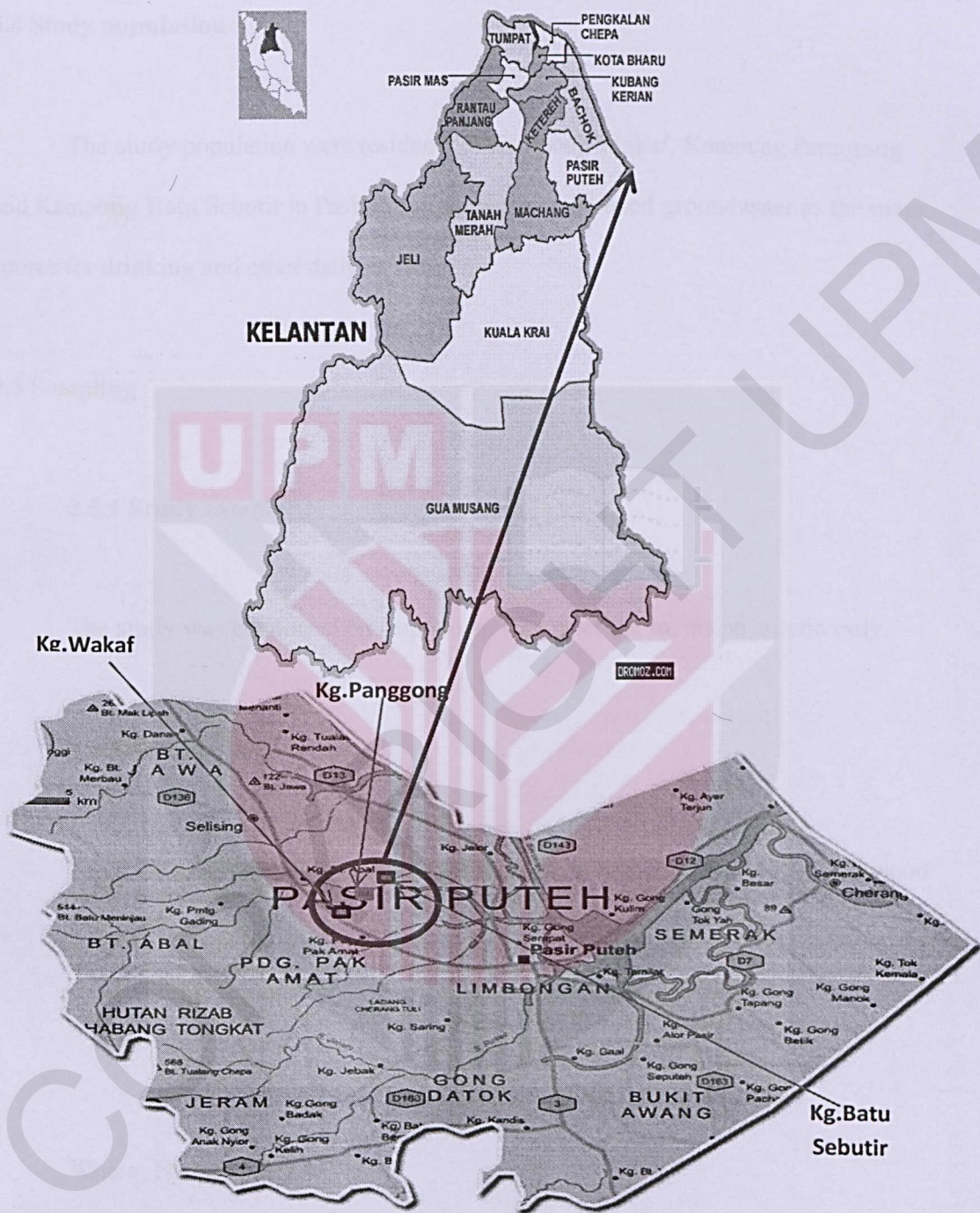


Figure 3.1 Study Location

### 3.4 Study population

The study population were residents of Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir in Pasir Puteh, Kelantan, who used groundwater as the main source for drinking and other daily usage.

### 3.5 Sampling

#### 3.5.1 Study sample

The study was conducted on respondent who meet the inclusion criteria only.

#### 3.5.2 Sample Size

The sample size was calculated using formula (Equation 1) by Kirkwood and Sterne (2009).

$$N = \frac{P(1 - P)}{e^2}$$

Where, N= sample size

P=Prevalence

e=Probability error

According to Amirah (2013), the prevalence of nitrate level of groundwater from wells sampled which was above of 45mg/L is 8.7% (0.087). So the sample size was calculated as below.

$$N = \frac{0.0875(1-0.0875)}{0.05^2}$$
$$= 32$$

Based on the calculation above, the value of 32 was considered as minimum sample size needed. To ensure that the study was statistical significant and taken into consideration damaged data and non-response survey, the sample size was increased from actual sample size. So the sample final sample size was 50

### 3.5.3 Sampling method

The sampling method used in this study was purposive sampling. The respondents were selected based on a few inclusive and exclusive criteria.

### 3.5.4 Sampling unit

The sampling unit for this study was a resident living in Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir, who fulfilled the inclusive criteria.

#### Inclusion criteria:

- I. Aged 18 years old and above which is considered as an adult.
- II. The respondent is a lifelong resident of Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir in Pasir Puteh, Kelantan.
- III. The respondent uses groundwater as his/her main source of water supply for his/her daily usage.

#### Exclusion criteria:

- I. Respondents who use water filtered systems.
- II. Respondents who used other than groundwater as their main water supply for their daily needs.

### 3.6 Study instrumentation and data collection

#### 3.6.1 Questionnaire

A set of questionnaire comprising of three sections were administered to each respondent. Part A of the questionnaire contain questions regarding the socio-demographic information, Part B contain questions related to duration of residence. Part C contained questions about the information of daily intake of drinking water.

#### 3.6.2 Body weight

The body weights of the respondents were measured using a Seca Weight scale. The readings was taken three times and then averaged. The unit is in kilogram (kg).

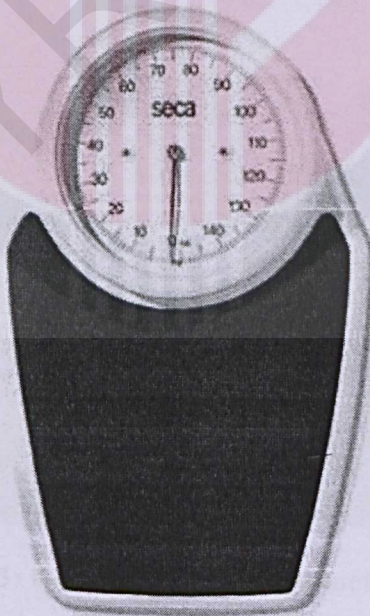


Figure 3.2 Seca weight scale

### 3.6.3 Drinking water daily intake

The daily intake rate of water among respondents was measured by using a standard cup of 250 ml, and every respondent need to recall back their water consumption amount in a day based on that standard cup in order to calculate the Chronic Daily Intake (CDI) and Hazard Index (HI).

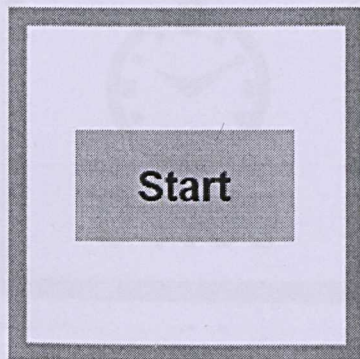
### 3.6.4 Water Sampling

#### 3.6.4.1 Water analysis

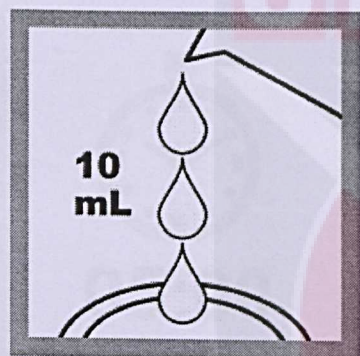


Figure 3.3: DR/2500 Spectrophotometer

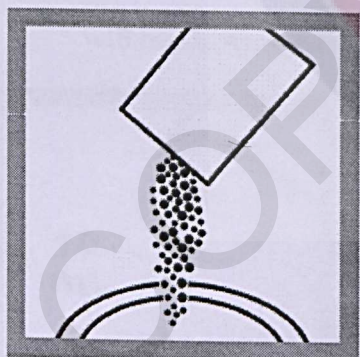
## Powder Pillow Procedures



1. Touch **Hach Programs**. Select Program **353 N, Nitrate MR**. Touch **Start**



2. Fill a round sample cell with 10mL of sample.

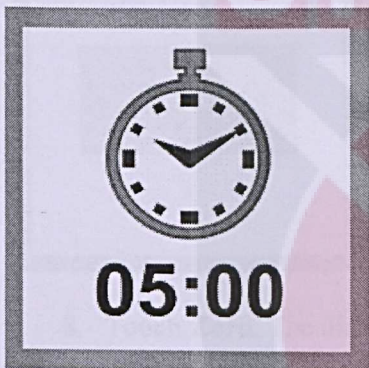


3. Add the contents of one Nitra Ver 5 Nitrate Reagent Powder Pillow (this is the prepared sample). Cap.

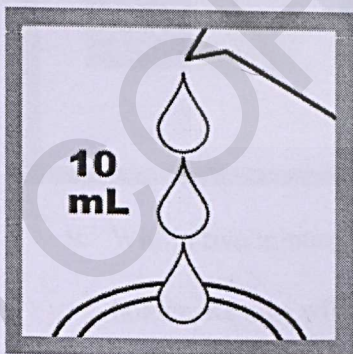


4. Touch the timer icon. Touch **OK**. A one-minute reaction period will begin.

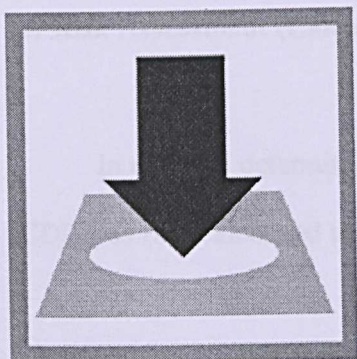
Shake the cell vigorously until the timer beeps.



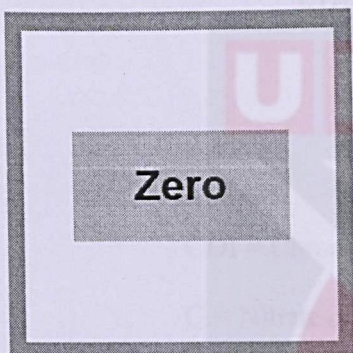
5. When the timer beeps, touch the timer icon. Touch **OK**. A five-minute reaction will begin. An amber colour will develop if nitrate is present.



6. When the timer beeps, fill a second round sample cell with 10mL of sample (this is the blank)



7. Place the blank into the cell holder.



8. Touch **Zero**. The display will show: **0.0 mg/L NO<sub>3</sub><sup>-</sup> -N**



9. Within two minutes after the timer beeps, place the prepared sample into the cell holder. Results will appear in mg/L NO<sub>3</sub><sup>-</sup> -N

### 3.7 Risk Assessment (Calculation)

In order to determine exposure of nitrate in drinking water, chronic daily intake (CDI) was first calculated using the following equation.

$$CDI = \frac{C \times DI}{BW} \quad (\text{Equation 2})$$

Where,

CDI = Chronic Daily Intake (mg/kg/day),

C = Nitrate concentration in water (mg/L),

DI = Average daily intake rate of water (L/day),

BW = Body weight (kg).

Then to conclude the significant different exposure and overall potential for non-carcinogenic health effects posed by nitrate in drinking water, the Hazard Index (HI) was calculated using the following equation:

$$HI = \frac{CDI}{RfD} \quad (\text{Equation 3})$$

Where,

HI = Hazard Index,

CDI = Chronic Daily Intake (mg/kg/day),

RfD = Reference dose (mg/kg/day)

HI value more than 1 ( $HI > 1$ ) will show a significant risk level, the higher the value, the greater the likelihood of adverse non-carcinogenic health impact. RfD value that used in this study was 1.6 mg/kg/day (USEPA, 2000).

### 3.8 Data analysis

Data analysis was performed using the Statistical Program for Social Science software (SPSS for Windows) version 22.

For descriptive data, univariate analysis was used to determine nitrate level, socio demographic information of respondents, water consumption and results of water analysis in percentage, mean, standard deviation, range, percentiles, maximum and minimum values.

Then, the normality test in this study was performed by using Kolmogorov-Smirnov Test where  $p > 0.05$  indicated a normal distributed data. The parametric test was

used if data was parametric or normal distribution. While, if it was not normally distributed, non-parametric test was used to analyse the data

### 3.9 Ethical consideration

Ethical issues pertaining to this study was presented and approved by Ethics Committee, Faculty of Medicine and Health Science, Universiti Putra Malaysia.

- i) The respondents were given some explanation about the whole of the study activities involved.
- ii) The respondents were given some explanation about the health risk assessment that were held in term of the purpose of the assessment, the procedure taken, and also respondents' right in this study.
- iii) Approval letter were given to the village representative to obtain the consent of the resident involved in this study.
- iv) Approval letter was given to the respondents to get their consent to be participant in this study.

### 3.10 Study Limitation

1. The information given from respondents could not be determined to be 100 % valid in term of this limitation we assumed the answer and the information given met validity purposes. Recall bias may contribute to this study.

2. This study was a cross-sectional study that measure nitrate for specific period only. The data which was collected in this study might be insufficient to support the argument on ground water contamination in Pasir Puteh.
3. The study was conducted during the planting season, in which indirectly affect the outcome of study once fertiliser is applied. If the usage of fertilizer was high, nitrate level will also increase or vice versa.



## CHAPTER 4

### RESULTS

#### 4.1 Background of respondent

##### 4.1.1 Socio-demographic of respondent

The data collection was carried out from February to March 2014 at the respective areas.

The total number of respondents who participated in this study was 70 and samples collected were 50 (Table 4.1). All of the respondents were Malays (100%). There were more male (39 - 55.7%) compared to females (31 - 44.3%) respondents. (Table 4.2).

The mean and standard deviation for age of respondents was  $49.3 \pm 9.924$ . The median was 47 years old. Age ranged from 28 to 68 years old.

This study was conducted in three villages, namely Kampung Wakaf (24 respondents-34.3%), Kampung Panggong (21 respondents-30%) and Kampung Batu Sebutir (25 respondents-35.7%). (Table 4.3).

**Table 4.1 Number of respondents**

Statistics				
Valid	70		70	
Missing	0		0	

**Table 4.2 Comparison between male and female respondents**

	Frequency	Percent	Valid Percent	Cumulative Percent
Female	31	44.3	44.3	44.3
Male	39	55.7	55.7	100.0
Total	70	100.0	100.0	

**Table 4.3 Frequency of respondents between villages.**

	Frequency	Percent	Valid Percent	Cumulative Percent
Batu Sebutir	25	35.7	35.7	35.7
Panggong	21	30.0	30.0	65.7
Wakaf	24	34.3	34.3	100.0
Total	70	100.0	100.0	

For information on education level, the highest percentage was respondent who had never attended school (17 respondents-24.3%), followed by Penilaian Menengah Rendah (PMR) (16 respondents-22.9%), Primary School which was 15 (21.4%) respondents and Sijil Pelajaran Malaysia (SPM) which was 13 (18.6%) respondents. For Sijil Tinggi Persekolahan Malaysia (STPM), there were only 7 (10.0%) respondents. Lastly only 2 (2.9%) respondents had higher education (diploma and degree).

With regards to information on occupation of respondents, the highest was farmers (23 respondents- 32.9%), followed by the self-employed (22 respondents- 31.4%), unemployed and other which was 18 respondents (25.7%) and 7 respondents (10.0%) respondents, respectively.

On information regarding income of respondents, there were 33 (41.3%) respondents who had a salary of less than RM500. Those with income from RM500 to RM1000 followed, with 35 (43.7%) respondents. While; only 8 (10.0%) respondents was within RM1001-RM1500 income bracket and 3 (3.8%) respondent had income of more than RM2000. (Table 4.4)

For information period of residency, 60 (85.7%) respondents stayed more than 20 years at the respective areas. A total of 6 (8.6%) respondents resided from 10-20 years, 1-10 years (3 respondents-4.3%) and only 1 (1.4%) respondents resided less than 1 year. (Table 4.4)

**Table 4.4 Socio-demographic information**

Variable	No. of Respondents	%
<b>Race:</b>		
Malay	70	100
Chinese	0	0
Indian	0	0
Other	0	0

---

**Occupation:**

farmer	23	32.9
unemployed	18	25.7
self-employment	22	31.4
Others	7	10.0

---

**Income (RM):**

<500	13	18.6
500-1000	37	52.9
1001-1500	16	22.9
1501-2000	1	1.4
>2000	3	4.3

---

**Period of Residency:**

>20 years	60	85.7
11-20 years	6	8.6
1-10 years	3	4.3

---

<1 year	1	1.4
---------	---	-----

#### 4.1.2 Well Information

Table 4.5 showed 70 respondents (100.0%) at Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir used electric pumps. No respondent used manual hand pump.

For age of well, 49 (98.0%) wells were more than 15 years old. There was only 1 (2.0%) well which was more than 1 year. Please refer to Table 4.5.

**Table 4.5 Well information**

Variable	No. of Samples	%
<b>Type of well:</b>		
Pump well	50	100.0
Manual well	0	0.0
<b>Age of Well :</b>		
<1 year	0	0.0

1-5 years	1	2.0
6-10 years	0	0.0
11-15 years	0	0.0
>15 years	49	98.0

#### 4.1.3 Drinking Water Information

Based on the questionnaires, all the respondents used groundwater for drinking and cooking purposes. Table 4.6 shows information about daily water intake (L/day) and complaints on detection of water odour and colour change.

For daily water intake, the mean  $\pm$  S.D (L/day) was  $1.83 \pm 0.32$ . While median was 1.75 L/day. The range was between 1.25 – 2.5 L/day.

Furthermore, only 16 (22.86%) respondents complained about the colour and odour change of groundwater (Table 4.6)

**Table 4.6 Drinking Water information**

Variable	No. of respondent	%	Mean ± S.D (L/day)	Median (IQR) (L/day)	Range (L/day)
Daily water drink (L/day)			1.83 ± 0.32	1.75	1.25 – 2.5
Colour and odour change:					
Yes	16	22.86			
No	54	77.14			
N=70					

#### 4.2 Nitrate level in groundwater

Table 4.7 shows the mean ± S.D for nitrate levels mg/L was  $2.11 \pm 1.24$ . The range was from 0.20 to 5.20 mg/L.

**Table 4.7 Nitrate level in groundwater samples**

Variable	Mean $\pm$ S.D (mg/L)	Range (mg/L)
Nitrate level (mg/L)	2.11 $\pm$ 1.24	0.20 to 5.20

N=70

#### 4.3. Comparison of nitrate level between each study location (one sample t-test)

Table 4.8 shows the comparison of nitrate levels of groundwater between each study location. The mean  $\pm$  S.D (mg/L) was 2.11  $\pm$  1.24. One sample t-test was used to compare the difference of nitrate levels between each house.

p-value for this comparison was 0.00. Therefore, there was a strong significant difference of nitrate levels between each house in this study areas since p-value was less than 0.05 ( $p < 0.05$ ) (Table 4.8).

**Table 4.8 Comparison of nitrate level of groundwater between each study location**

Variable	Mean (mg/L)	± S.D	Range (mg/L)	p-value
Nitrate level (mg/L)	2.11	± 1.24	0.20 to 5.20	0.00

#### **4.4 Comparison of nitrate levels between villages (Kruskal-Wallis test)**

Kruskal-Wallis test was used to compare nitrate levels between the three villages studied. The highest mean ± S.D of nitrate levels (mg/L) was Kampung Batu Sebutir which was  $2.28 \pm 0.9$ . The mean ± S.D (mg/L) for Kampung Wakaf was  $2.06 \pm 1.59$ . Lastly, the mean S.D (mg/L) for Kampung Panggong was  $1.98 \pm 1.21$ .

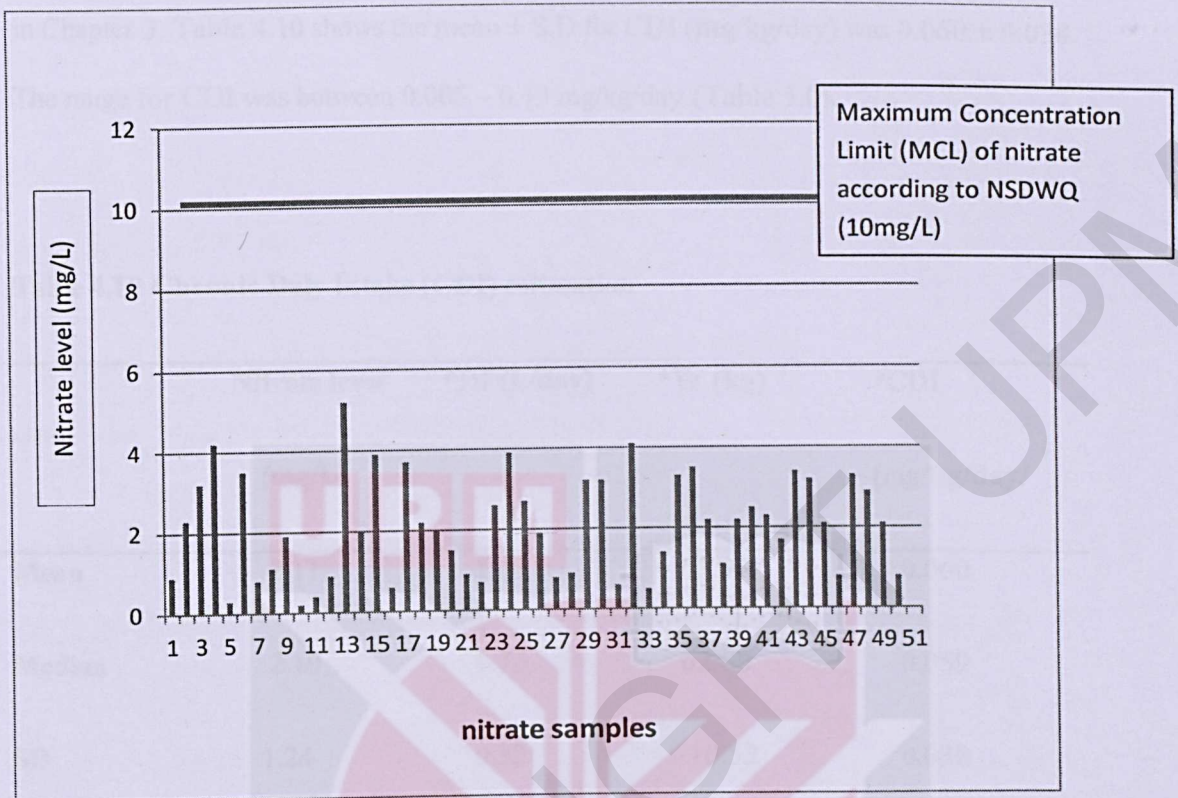
According to p-value (0.608), there was no significant difference of nitrate levels between these 3 villages. (Table 4.9)

**Table 4.9 Comparison of nitrate level between 3 villages**

Village	No. of well	Mean $\pm$ S.D (mg/L)	Range (mg/L)	p-value
Kg. Wakaf	17	2.06 $\pm$ 1.59	0.2-5.2	
Kg. Panggong	16	1.98 $\pm$ 1.21	0.5-4.1	0.608
Kg. B. Sebutir	17	2.28 $\pm$ 0.9	0.8-3.5	

#### **4.5 Comparison of nitrate level of each house with national standard**

With regards to Malaysian National Standard of Drinking Water Standard (NSDWQ), the maximum concentration limit (MCL) for nitrate is 10mg/L (MOH, 2011). Figure 4.1 indicated that nitrate levels from all sampling sites were below 10mg/L, which was the maximum limit of NSDWQ.



**Figure 4.1: Comparison of nitrate level among study locations with national standard**

#### 4.6 Exposure information (Chronic Daily Intake)

Table 4.10 shows the mean  $\pm$  S.D for respondent's body weight as  $63.96 \pm 10.52$  kg. The range for respondent's body weight was between 45 – 98 kg.

Based on the table below, the exposure of nitrate on respondent was estimated as Chronic Daily Intake (CDI). The CDI value was calculated using an equation as stated

in Chapter 3. Table 4.10 shows the mean  $\pm$  S.D for CDI (mg/kg/day) was  $0.060 \pm 0.038$ . The range for CDI was between 0.005 – 0.13 mg/kg/day (Table 5.0).

**Table 4.10 Chronic Daily Intake (CDI) estimation**

	Nitrate level (mg/L)	*DI (L/day)	*W (kg)	*CDI (mg/kg/day/
<b>Mean</b>	2.11	1.83	63.96	0.060
<b>Median</b>	2.10	1.75	62.00	0.059
<b>SD</b>	1.24	0.32	10.52	0.038
<b>Range</b>	0.20-5.20	1.25-2.5	45-98	0.005-0.13

#### 4.7 Health risk assessment information (Hazard Index)

To estimate non-carcinogenic risk, Hazard Index (HI) was calculated by dividing the CDI value with reference dose (RfD) as shown in Chapter 3. Referring to United State Environmental Protection Agency (USEPA), reference dose (RfD) for nitrate is 1.6 mg/kg. A Hazard Index reading greater than 1 indicates potential for an adverse effect to occur (NJDEP, 2007).

Table 4.11 shows the result of HI. The range of HI was between 0.003-0.08. The mean  $\pm$  S.D was  $0.037 \pm 0.024$ . As shown in Table 5.1, HI value for all respondents was less than 1 (70 respondents-100%).

**Table 4.11 Hazard Index (HI) estimating among respondents**

Hazard Index (HI)	No. of Respondent	Percentage (%)	Mean $\pm$ S.D	Range
HI<1	70	100	$0.037 \pm 0.024$	0.003-0.08
HI>1	0	0		

## CHAPTER 5

### DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Discussions

##### 5.1.1 Social Demographic Data

For this study, all respondents were Malay. Based on table 4.2, the study comprised of 31 female (44.3%) and 39 male (57.7%) respondents, aged between 28 to 68 years old. The mean  $\pm$  S.D for respondent age was  $49.3 \pm 9.924$ . The majority of respondents were more than 47 years old. This study was conducted in three villages which were Kampung Wakaf (24 respondents-34.3%), Kampung Panggong (21 respondents-30.0%) and Kampung Batu Sebutir (25 respondents-35.7%).

Majority of respondent never had any formal education (17 respondents). Most respondents worked as farmers (23 respondents). Majority of the respondents' income was between RM500 to RM1000. Majority of respondents lived in the study areas for more than 20 years and all of them used electrical-pump well. Most of the wells were more than 15 years old (49 wells – 98.0%).

### 5.1.2 Nitrate Level in groundwater

In this study, the mean  $\pm$  SD of nitrate level was  $2.11 \pm 1.24$  while the range was from 0.20 to 5.20 mg/L. This is considered as a normal level of nitrate in groundwater. This is because according to Schmoll (2006), the normal concentration of nitrate in surface or groundwater is between 0 to 18 mg/L. However level of nitrate can increase due to a few factors such as use of fertilizers, waste disposal especially from animal farms, and septic tank (Haycock 1990). But in this study is to relate the relationship between the nitrate level and use of fertilizer. This is because irrigated agriculture practice utilizes a huge amount of fertilizers, which may lead to groundwater contamination (Ghaderi et al., 2012).

Low level of nitrate in this study could probably caused by the rainy season. Nitrate sampling has been done after rainy season which was March 2014. According to CCME (2007), rainfall influenced the concentration of nitrate, as it entering the

groundwater at high rate at the beginning of rainy season, decrease throughout the rainy season and remain at constant low level during dry season, water table rises and nitrate in unsaturated zone (such as soil) become mobilized into groundwater. Therefore, nitrate level is high at this condition. Nitrate level will accumulate in soil during dry season, decrease of mobilization into stream and groundwater, thus resulted to lower nitrate concentration in the groundwater.

Another factor that may cause low nitrate levels in this study could be due to sampling time. Water sampling had been done after the paddy rice had been harvested. This may caused fertilizer had not been applied extensively. This caused low amount of leaching of fertilizer into the groundwater.

### **5.1.3 Comparison of nitrate level between each study location**

Result in this study indicated a significant difference of nitrate levels between each study location. p-value for this comparison was 0.00. This was consistent with a study by Rajmohan and Elango (2005) indicated that nitrate levels of groundwater were varied between each sampling location.

The distance of agriculture land to the well also plays an important role in determining the nitrate levels in groundwater. Many studies have shown agriculture activities contribute to high nitrate levels in groundwater (Wan Ruslan et al., 2004; Weyer, 2001).

Furthermore, the distance of septic tanks to the sampling point or well may be one of the possible factors influencing nitrate concentration, as well as small distance to septic tanks may cause high nitrate levels (Mohamad Azwan et al., 2010)

#### **5.1.4 Comparison of nitrate levels between villages**

The highest mean  $\pm$  S.D of nitrate levels (mg/L) was Kampung Batu Sebutir ( $2.28 \pm 0.9$  mg/L) followed by Kampung Wakaf ( $2.06 \pm 1.59$  mg/L) and Kampung Panggong was ( $1.98 \pm 1.21$  mg/L). The quantity or rate of fertiliser application during the previous season to crop may be another factor. The leaching process of excess nitrate to the groundwater in this study area might happened Excessive fertilizer application will lead to state pollution in groundwater as stated by Roy et al., (2000). However, there was no significant difference of nitrate levels between these three villages.

### 5.1.5 Comparison of nitrate level to the national standard

The highest reading of nitrate level in this study was 5.20mg/L. Thus, results in this study did not exceeding the maximum concentration limit (MCL) for nitrate which is set at 10mg/L which referred to Malaysian National Standard of Drinking Water Standard (NSDWQ, 2011) and USEPA standard (2000).

Furthermore, previous study conducted in Kelantan by Abdul Rashid, the results showed that 35 percent of the areas around Kelantan River Valley included Kota Bharu, Tumpat and Pasir Mas district have nitrate level exceeding the threshold value, 10mg/L while 2 percent exceed 45mg/L or the permissible World Health Organisation (WHO, 2008) value. Generally, groundwater with elevated nitrate content appears to be related to areas with cultivation.

As we know the maximum level of nitrate in this study was 5.20 mg/L and this is considered safe for drinking and cooking purpose.

### 5.1.6 Exposure and Health Risk Assessment

Chronic daily intake (CDI) was used to estimate the individual daily exposure of nitrate USEPA (2005). The mean  $\pm$  S.D for CDI (mg/kg/day) was  $0.060 \pm 0.038$ . The range for CDI was between 0.005 – 0.13 mg/kg/day.

To estimate non-carcinogenic risk, Hazard Index (HI) was calculated by dividing the CDI value with reference dose (RfD). Hazard index (HI) value greater than 1 indicates potential for an adverse effect to occur (NJDEP, 2007). HI value in this study ranged between 0.003-0.08. The mean  $\pm$  S.D for HI was  $0.037 \pm 0.024$ . HI values for all respondents were less than 1 and this indicated the risk of adverse effect of nitrate pollution in groundwater in the respective areas was negligible.

## 5.2 Conclusion

Water is one of the most important elements in our daily life. Everyone has to make sure the quality of water for our daily uses must always clean and safe for drinking and cooking purposes. Contamination of water from nitrate or any other contaminants should be avoided. This is because contamination of water can cause many health problems.

Groundwater provides drinking water for more than one-half of the United States population (Solley and others, 1990), and is the sole source of drinking water for many rural communities and some large cities.

This study also showed a strong significant difference of nitrate levels between each location as nitrate levels may differ according to different location and geological areas. Thus, the first hypothesis failed to be rejected.

From this study, there was no significant different of nitrate level between the three villages which are Kampung Wakaf, Kampung Panggong and Kampung Batu Sebutir. Thus second hypothesis was rejected.

Highest reading of nitrate level in this study was 5.20mg/L and this level is considered safe because minimum level of nitrate which can cause adverse health effect is 10mg/L. Groundwater in these three villages are considered safe for drinking and cooking purpose. Hazard Index (HI) in this study was below 1 which indicates no adverse effect due to nitrate exposure. In short, the third hypothesis was rejected.

However, everyone should be concerned about the nitrate level because from day to day the use of fertilizer has increased in order to maximize the production of crops.

### **5.3 Recommendation**

This was only a cross-sectional study. The data was collected at one point of time only and this cannot conclude the causal relationship between the variables. Further studies are recommended where the data can be collected at different point of time.

Since this study only focuses on three villages, the result may not represent the whole district or state. Additional investigation should be done in a wider population and larger sample size so that the results of the study can be generalized to the population.

If people want to build a new well, they have to make sure it is deep enough. This is because to extend the past of water table into the groundwater aquifer. As we know nitrate concentration decreases as depth of well increases.

Local authorities should play their role in order to monitor the level of nitrate. Level of nitrate should be monitored from time to time especially at the risky areas such as near the agriculture area. Local authorities should practice proactive step so that contamination of nitrate in groundwater can be prevented.

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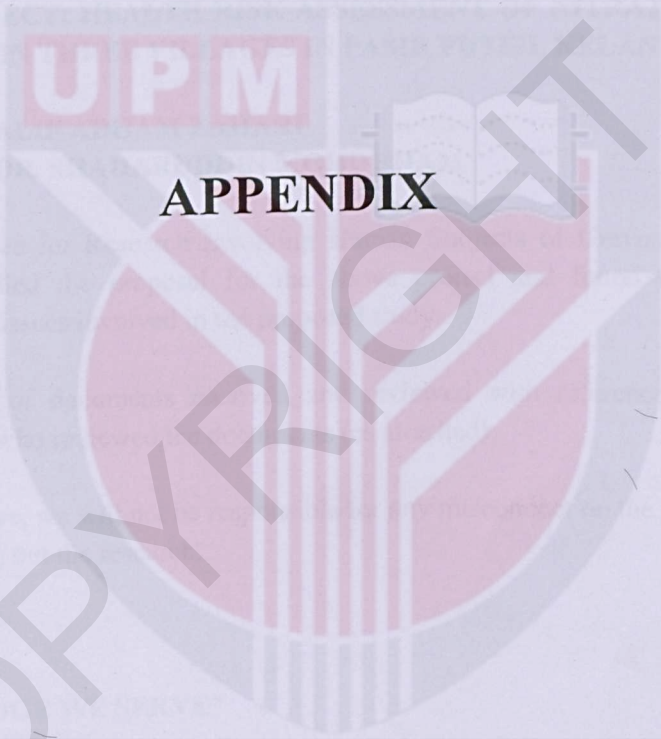
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OFFICE OF THE DEPUTY VICE CHANCELLOR (RESEARCH AND INNOVATION)  
R&I - UPANCAKTIAN METAFISIKAL (M/P2)  
Date: 17 May 2021

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Department of Environmental & Occupational Health,  
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Seremang, Negeri Sembang

Datuk,

RESEARCH FROM  
COPROWATER  
RESEARCHER  
SUPERVISOR



The  
(RESEARCH)  
The  
The  
The

Thank you

WITH AN APPRECIATION

Sincerely,



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- a) Members of the JKEUPM who reviewed the documents:  
- Prof. Dr. Johnson Stanslas
- b) Date of approval: 12/12/2013

Endorsed at JKEUPM Meeting on 6/6/2014, attended by:

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Prof. Dr. Elizabeth George	Pathologist, Dept of Pathology, Faculty of Medicine and Health Sciences	Female	
Prof. Dr. Lim Thiam Aun	Anesthesiologist, Dept of Surgery, Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Wan Omar Abdullah	Medical Parasitologist, Dept of Medical Microbiology and Parasitology, Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Patimah Ismail	Professor of Biomedicine, Dept of Biomedical Sciences, Faculty of Medicine and Health Sciences	Female	
Prof. Dr. Johnson Stanslas	Pharmacologist, Dept of Medicine, Faculty of Medicine and Health Sciences	Male	√
Assoc. Prof. Dr. Mansor Abu Talib	Assoc. Professor of Guidance and Counselling, Dept of Human Development and Family Studies, Faculty of Human Ecology	Male	
Assoc. Prof. Dr. Azmawani Abd. Rahman	Operations and Technology Management / Deputy Dean of Research and Graduate Studies	Female	√
Assoc. Prof. Dr. Noritah Omar (Lay Person)	Assoc. Professor of English Language, Dept of English Language, Faculty of Communication and Modern Languages	Female	√
Dr. Rojanah Kahar (Lay Person)	Senior Lecturer of Dept of Human Development and Family Studies, Faculty of Human Ecology	Female	√
Tan Sri Dato' Napsiah Omar (Independent Member)	Chairman, National Population and Family Development Board	Female	



**FORM B1: RESPONDENT'S INFORMATION SHEET AND CONSENT**

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

**1. STUDY TITLE :**

Health Risk Assessment of Nitrate Exposure Among Residents at Three Villages in Pasir Puteh, Kelantan

**2. INTRODUCTION:**

Agriculture activities in Malaysia have increased from time to time. Modern agriculture has been practiced by farmers to increase their productivity. exposure to nitrate results in multiple health effects, and it particularly affects human health. Groundwater contamination is frequently associated with agricultural activities such paddy plant. Fertilizers that are spread on the fields or stored can actually leach into an aquifer and contaminate drinking water when nitrate that originates from these fertilizers reach a well.

**3. WHAT WILL YOU HAVE TO DO?**

The respondent is required to answer the questionnaire to obtain the data information regarding on the study. 20 minutes will be given to complete the questionnaire.

**4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?**

Person below age of 18.

**5. WHAT WILL BE THE BENEFITS OF THE STUDY:**

**(a) TO YOU AS THE SUBJECT?**

It will helps the respondents to be aware about the quality water consumed

**TO THE INVESTIGATOR?**

It will help the investigator to identify level of nitrate that exceedd the standard.

**6. WHAT ARE THE POSSIBLE RISKS?**

There is no risks available in the study.

**7. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?**

The information and identity used in this study will remain confidential.

**8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?**

If you have any additional questions, you may contact to Dr. Shaharuddin bin Sham, Supervisor of the research at 012-3387305 or Alif Adham bin Zahari, the researcher at 013-6394107.



Please initial here if you have read and understood the contents of this page \_\_\_\_\_

**9. CONSENT**

I ..... Identity Card No.....  
address.....  
.....hereby voluntarily agree to take part in the research stated  
above \*(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I\* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

\* delete where necessary

Signature .....  
(Respondent)

Signature.....  
(Witness)

Date :.....

Name :.....

I/C No. :.....

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date .....

Signature .....  
(Researcher)

Sebelum menjawab adalah untuk mengetahui kajian mengenai...  
yang berkaitan dengan...  
yang berkaitan dengan...  
yang berkaitan dengan...

BAHAGIAN A (MATERI KESEKUTUPAN)

1. Nama: \_\_\_\_\_

2. No. ID: \_\_\_\_\_

3. Tarikh: \_\_\_\_\_

4. Lokasi: \_\_\_\_\_

5. Nama Pengerusi: \_\_\_\_\_

6. Nama Ahli: \_\_\_\_\_

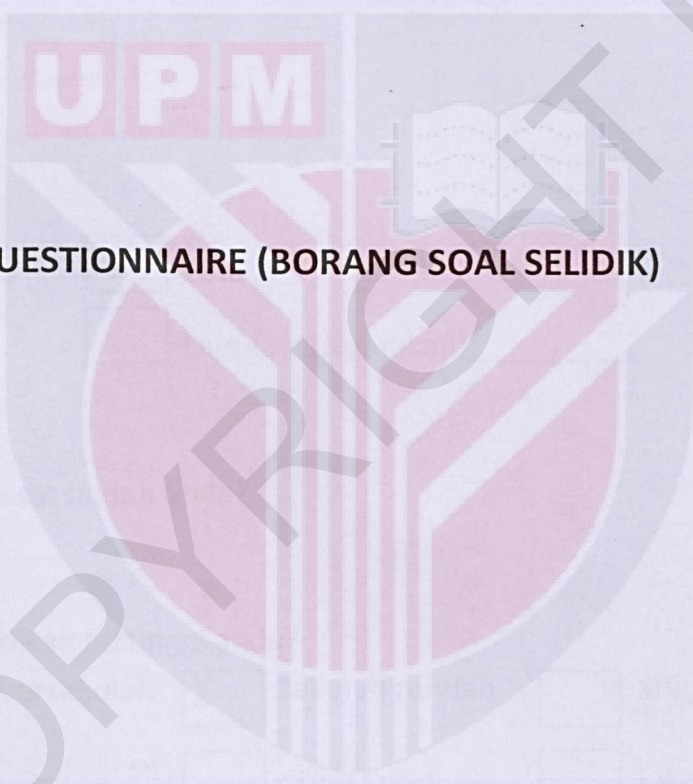
7. Nama Ahli: \_\_\_\_\_

8. Nama Ahli: \_\_\_\_\_

9. Nama Ahli: \_\_\_\_\_

10. Nama Ahli: \_\_\_\_\_

**QUESTIONNAIRE (BORANG SOAL SELIDIK)**



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Semua maklumat adalah untuk kegunaan kajian sahaja dan maklumat ini akan dianggap sulit. Arahan: Sila jawab semua soalan pada bahagian yang disediakan.

BAHAGIAN A (MAKLUMAT RESPONDEN)

1. Umur: \_\_\_\_\_

2. Jantina:  P  L

3. Bangsa:

Melayu

Cina

India

Lain-lain (Nyatakan): \_\_\_\_\_

4. Berapakah berat badan anda?

\_\_\_\_\_

5. Tahap pendidikan tertinggi anda?

Tidak bersekolah

Sekolah rendah

SPR/PMR

SPM

STPM/ Diploma

Lain-lain: \_\_\_\_\_

(Nyatakan)

6. Apakah pekerjaan anda?

Tidak bekerja

Peniaga

Petani

Lain-lain (Nyatakan): \_\_\_\_\_

7. Berapakah Jumlah pendapatan seisi rumah sebulan?

<input type="checkbox"/>	<RM500	<input type="checkbox"/>	RM501-1000	<input type="checkbox"/>	RM1001-1500
<input type="checkbox"/>	RM1501-2000	<input type="checkbox"/>	>RM2000		

8. Berapa lamakah tempoh anda tinggal di kawasan penempatan ini?

<input type="checkbox"/>	<1 Tahun	<input type="checkbox"/>	1-5 Tahun	<input type="checkbox"/>	6-10 Tahun
<input type="checkbox"/>	11-15 Tahun	<input type="checkbox"/>	16-20 Tahun	<input type="checkbox"/>	>20 Tahun

BAHAGIAN B (MAKLUMAT PERSEKITARAN)

9. Status kawasan perumahan:

<input type="checkbox"/>	Bandar	<input type="checkbox"/>	Separa Bandar/ Pekan	<input type="checkbox"/>	Luar Bandar
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10. Adakah kawasan pertanian anda berdekatan dengan tempat kediaman anda?

<input type="checkbox"/>	Ya	<input type="checkbox"/>	Tidak
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11. Berapakah jarak kawasan pertanian dengan kediaman anda?

\_\_\_\_\_

12. Apakah jenis telaga yang digunakan?

<input type="checkbox"/>	Telaga pam	<input type="checkbox"/>	Telaga gelung
<input type="checkbox"/>	Telaga tanah	<input type="checkbox"/>	Lain-lain (Nyatakan): _____

13. Berapa lamakah tempoh telaga ini digunakan?

< 1 tahun     1-5 tahun     6-10 tahun  
 10-15 tahun     >15 tahun ( Nyatakan ) : \_\_\_\_\_

14. Adakah air telaga ini dirawat?

Ya (Nyatakan: \_\_\_\_\_)     Tidak

15. Adakah telaga ini pernah diselenggara?

Tidak pernah     <1 tahun sekali  
 1-5 tahun sekali     >5 tahun sekali

BAHAGIAN C (MAKLUMAT PENDEDAHAN AIR MINUMAN)

16. Berapa gelaskah air yang diminum sehari?

<3 gelas     3-5 gelas  
 6-8 gelas     >8 gelas

17. Adakah air telaga dimasak terlebih dahulu sebelum diminum?

Ya     Tidak

18. Penggunaan air telaga untuk: \_\_\_\_\_

Air minum dan memasak

Mandi sahaja

Membasuh pakaian sahaja

Pertanian

19. Adakah anda berpuas hati dengan kualiti air telaga?

Ya

Tidak

Tidak Pasti

20. Pernahkah air telaga yang diturunkan keruh/berbau?

Ya

Tidak

21. Adakah anda pernah mengalami gejala sampingan selepas mengambil air minuman tersebut?

Ya

Tidak



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