



UNIVERSITI PUTRA MALAYSIA

***HEALTH RISK ASSESSMENT OF NITRATE EXPOSURE IN GROUND
WATER AMONG RESIDENTS AT THREE VILLAGES IN
TANAH MERAH, KELANTAN***

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HEALTH RISK ASSESSMENT OF NITRATE EXPOSURE IN GROUND WATER

AMONG RESIDENTS AT THREE VILLAGES IN

TANAH MERAH, KELANTAN

BY

MOHAMAD HILMI BIN MUSTAPHA

**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

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**KAJIAN PENILAIAN RISIKO KESIHATAN TERHADAP TAHAP NITRAT DI
DALAM AIR PERIGI DI TIGA KAMPUNG DI TANAH MERAH, KELANTAN**

MOHAMAD HILMI MUSTAPHA

Pengenalan: Pendedahan nitrat dalam air perigi di kawasan pertanian merupakan isu penting dalam aspek kesihatan. Pendedahan manusia kepada nitrat membawa kepada banyak risiko kesihatan termasuk penyakit methaemoglobinemia. **Objektif:** Objektif kaji selidik ini adalah bagi mengkaji pendedahan nitrat dalam air perigi dan menjalankan penilaian risiko di tiga buah kampung di daerah Tanah Merah, Kelantan. **Methodology:** Sejumlah 80 orang responden telah dipilih berdasarkan kriteria yang telah ditetapkan. Manakala, sampel air perigi diambil dari setiap rumah responden dan analisis sampel dijalankan menggunakan YSI Professional Plus. Borang kaji selidik digunakan untuk mendapatkan maklumat sosio-demografik, maklumat perigi dan pengambilan air minuman harian responden. Berat badan responden diukur menggunakan penimbang berat Seca. Penilaian risiko kesihatan dijalankan melalui pengiraan rumus yang sedia ada. **Keputusan:** Nilai kepekatan nitrat dalam sampel air adalah di bawah piawaian kualiti air Malaysia (10mg/L). Nilai min \pm SP adalah di kawasan Kampung Padang Siam iaitu nilai min \pm SP (1.07 \pm 1.11 mg/L) diikuti Kampung Bechah Kelubi (1.05 \pm 1.15 mg/L) dan Kampung Chawas (0.58 \pm 0.53 mg/L). Ujian hubungkait Kruskal-Wallis menunjukkan tiada hubungkait antara kepekatan nitrat dengan jenis kampung ($p > 0.05$). Manakala ujian hubungkait antara nilai kepekatan dengan setiap lokasi pengambilan sampel menunjukkan ada hubungkait ($p < 0.05$). Nilai min \pm SP bagi pengambilan kronik harian ialah 0.021 \pm 0.024 manakala bagi indeks hazad pula ialah 0.134 \pm 0.146. **Kesimpulan:** Merujuk kepada pendedahan nitrat air bawah tanah yang dikaji tidak akan menyebabkan masalah kesihatan kepada mereka yang menggunakannya.

Kata Kunci: Nitrat, air perigi, piawaian kualiti air Malaysia, pengambilan kronik harian, indeks hazad, Tanah Merah

HEALTH RISK ASSESSMENT OF NITRATE EXPOSURE IN GROUNDWATER AMONG RESIDENTS AT THREE VILLAGES IN TANAH MERAH, KELANTAN

MOHAMAD HILMI MUSTAPHA

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 Tanah Merah, 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:** Eighty (80) respondents were selected in this study based in the inclusive and exclusive criteria. The groundwater samples were taken from each respondent's well, and were analyzed with a YSI Professional Plus 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 levels in this study was below the Maximum Concentration Limit of National Standard for Drinking Water Quality of Malaysia (NSDWQ) (<10mg/L). The value of mean \pm SD for nitrate levels in all water samples were 0.91 ± 1.00 mg/L. The highest mean \pm S.D of nitrate levels (mg/L) was done Kampung Padang Siam which was $(1.07 \pm 1.11$ mg/L) followed by Kampung Bechah Kelubi $(1.05 \pm 1.15$ mg/L) and the mean \pm S.D (mg/L) for Kampung Chawas was $(0.58 \pm 0.53$ mg/L). There was a significant difference in nitrate levels between each location ($p < 0.05$), and Kruskal-Wallis test showed no significant difference in nitrate levels between these villages ($p > 0.05$). The mean \pm S.D for Chronic Daily Intake (CDI) and Hazard Index (HI) was 0.021 ± 0.024 and 0.134 ± 0.146 respectively. **Conclusion:** As far as nitrate exposures are concern, the groundwater would not cause detrimental health effect to those who use it for daily purpose.

Keywords: Nitrate, groundwater, maximum concentration limit, chronic daily intake, hazard index, Tanah Merah

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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
CEPA	California 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 is very important to the Malaysian economy. There has been a rapid growth in agricultural activities. These developments of agriculture have also resulted in increasing of chemicals usage such as fertilizers, herbicides and insecticides. (Kamil et al., 1990).

Exposure to nitrate results in multiple health effects, and it particularly affects human health. In rural areas, groundwater contamination is frequently associated with agricultural activities such paddy plant. Fertilizers that are spread on fields or stored can actually leach into an aquifer and contaminate drinking water when nitrate that originates from these fertilizers reach a well. Nitrate is a common contaminant that can be critical to human health when its levels exceed 45 mg NO₃/L (USEPA, 1991).

Consumption of water containing nitrate at levels higher than 49 mg NO₃/L could lead to methaemoglobinemia in infants (WHO, 2007) and, in the long term, could be potentially carcinogenic to humans (INSPQ, 2003). The US EPA suggests a threshold for nitrate in drinking water between 50 and 90 mg NO₃/L and points out that no risk for human health has been observed for infants consuming water containing less than 45 mg NO₃/L (USEPA, 1991). 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, government authorities must protect public health by ensuring adequate drinking water quality from well water.

Nitrate in the environment accumulating from both natural and anthropogenic sources. Naturally, soil mineralization and atmospheric deposition of nitrogen are major contributors of nitrate existence. Meanwhile, the examples of anthropogenic sources are from agricultural, industrial residue and septic tanks. Yet, agricultural activities are more important sources of nitrate to the environment (Weyer, 2001).

Today, the 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 the major nitrate pollution in groundwater (Reyes, 2007).

1.2 Problem Statement

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

According to Kamil et al. (1990), 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.

Moreover, nitrate is one of the most common contaminants in groundwater that come from either fertilizer or sewage that leads to nitrate contamination of groundwater (CWC, 2011). In addition, the increasing contamination of groundwater and surface water supplies by nitrate, primarily from commercial fertilizers usage has been documented (Weyer, 2001).

The problem to be highlight was whether the level of nitrate in well water is safe for drinking. Some parts of rural Kelantan are equipped with the rural water supply system, in which some residents are still using as a main water source.

1.3 Study Justification

This study was carried out in order to assess nitrate concentration level in groundwater at Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi in Tanah Merah, Kelantan since majority of the people in Tanah Merah practice agriculture activities. The common crops are paddy, tobacco, watermelon and vegetables. Their agricultural practices are expected to cause high application of urea and Nitrogen, Phosphorus and Kalium (NPK) fertilizer to support plant growth. Many studies showed relationship between which fertilizers usage in the agricultural field.

In Kelantan, groundwater plays a very important role in the public water supply system. Approximately 70% of the total water supply in the state including Tanah Merah is derived from groundwater (Azwan et al., 2010). Tanah Merah is one of the districts in Kelantan and it is also labelled as an agricultural area. Kamil et al. (1990) reported that nitrate levels in groundwater located in agricultural areas are significantly different from urban and forested areas. The increasing usages of fertilizers result in increased nitrate content in the groundwater source.

Nitrate in well water still exists especially near paddy field, thus getting data for occurrence is essential to plan further measures in overcoming this problem because it is greatly related to health. The study was also conducted to compare nitrate concentration in well water with the National Standard for Drinking Water Quality (NDSWQ) Malaysia.

1.4 Conceptual framework

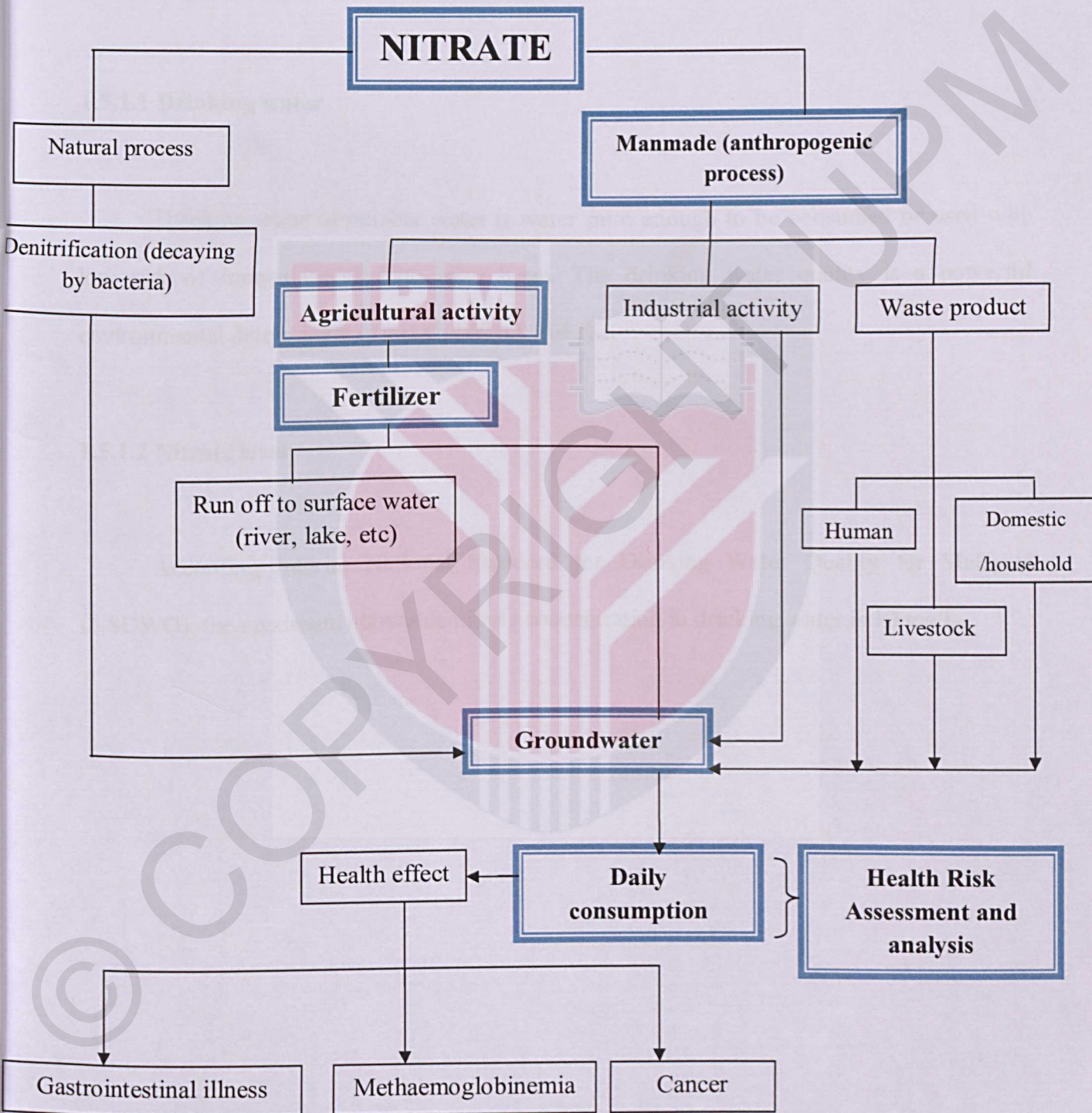


Figure 1.1: Conceptual framework (CWC, 2011 ; Rosen and Kropf 2009).

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 four 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 was read in-situ three times and the average reading was obtained collected directly from each respondent's groundwater source.

1.5.2.2 Nitrate level

Nitrate in groundwater samples is analysed using YSI Professional Plus multimeter and the results were obtained directly on site.

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.

$$CDI = \frac{C \times DI}{BW}$$

Where,

DCI = 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).

1.6 Objective

1.6.1 General Objective

To determine the level of nitrate in groundwater and to perform health risk assessment among respondents in Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi in Tanah Merah, Kelantan.

1.6.2 Specific objective

1. To determine nitrate level in groundwater
2. To compare nitrate level between each study location/ wells water
3. To compare nitrate level between the three villages
4. To compare nitrate level of groundwater with national standard
5. To determine the $HI=CDI/RfD$

Where, HI= Hazard Index,

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

RfD=Reference dose (mg/kg/day)

1.7 Research Hypothesis

1. There is a significant difference of nitrate level in groundwater among each study location
2. There is a significant difference of nitrate level in groundwater between the three villages studied
3. Nitrate concentration in groundwater in Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi is higher than the NSDWQ, Malaysia
4. Hazard Index of the respondents < 1

CHAPTER 2

LITERATURE REVIEW

2.1 Nitrates in Environment

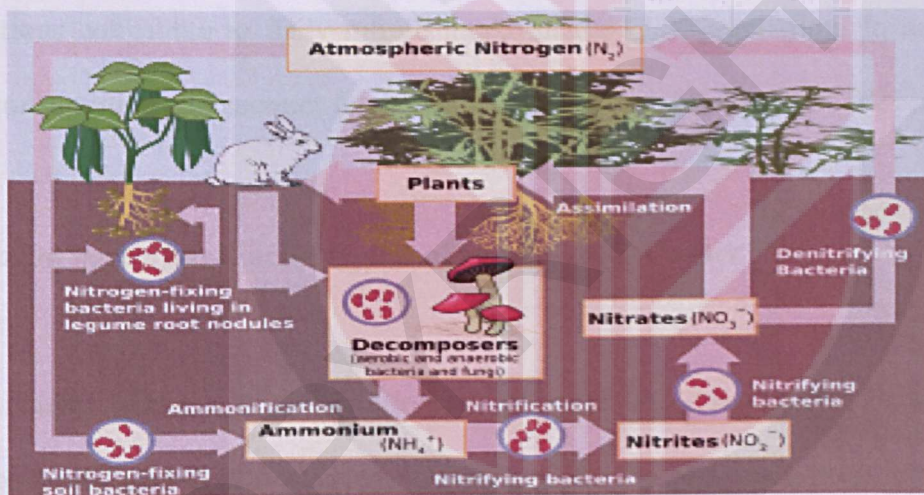
The majority of Earth's atmosphere, approximately 78% is nitrogen, making it as the largest pool and occurs in many different gaseous forms such as elemental nitrogen, nitrate, nitrite and ammonia (Absolute Astronomy, 2011). Natural reactions of atmospheric forms of nitrogen with rainwater result in the formation of nitrate and ammonium ions. 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 (Astronomy Absolute, 2011).



(Source: Wikipedia, 2013)

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

Nitrate is an inorganic compound produced when nitrogen is introduced into the environment. Although nitrate occurs naturally at low levels, human activities including the usage or improper disposal of fertilizers for agriculture, animal manure, or human waste, can elevate levels of nitrates in sources of drinking water (CWC, 2011).

Some vegetables (lettuce, spinach, celery, greens, etc), cigarette smoking, and certain medications contribute to daily nitrate intake in the U.S. population. In addition, drinking water consumption can account for a substantial portion of that intake (Weyer, 2001).

2.4 Issue of agricultural activity and nitrate in groundwater

Nitrate is also a common nitrogenous compound due to natural nitrogen cycle and anthropogenic (man-made) sources which have greatly increased the nitrate concentration level particularly in groundwater (Haller et al., 2010).

As mentioned by Walter (2009) and Tredoux et al. (2009), groundwater can be a significant source of nitrate which can come from runoff and leach down of fertilizer residue.

The high agricultural activities are achieved by using plant nutrients such as nitrogen fertilizers. When nutrients are applied in excess of plant needs, they have a potential to pollute surface and groundwater (Mahvi et al., 2005).

2.5 Exposure and risk assessment

2.5.1 Exposure to nitrates can cause immediate or acute health problems. Exposure over long periods of time can lead to many other dangerous health conditions (CWC, 2011).

Risk assessment method can also be used to estimate the risk of adverse ecological effects due to pollutant in the environment which are consist of four steps; hazard identification, dose-response assessment, exposure assessment and risk characterization (Boguski, 2010).

2.6 Health Effects

2.6.1 Methaemoglobin or “Blue Baby Syndrome”

Methaemoglobinemia disturbs the blood cells ability to carry oxygen (Haller et al.; CWC, 2011). Excessive nitrates or nitrites can alter the iron in haemoglobin to the ferric state. Nitrite oxidizes easily into nitrate. Thus, nitrate will form methaemoglobin; an abnormal form of haemoglobin (ATSDR, 2011).

Greer et al. (2005) mentioned that infants for whom formula may be prepared with well water containing high levels of nitrate can lead to nitrate poisoning and the methaemoglobinemia in infants. Therefore, clinical reports reinforces the need for testing of groundwater for nitrate content.

2.6.2 Gastrointestinal (GIT) complications

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).

2.6.3 Carcinogenic diseases and problems

Peter Weyer who holds a 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).

Nitrate can be reduced endogenously within the human body to nitrite through bacterial and other reactions. Nitrite can be further reduced to N-nitroso compounds (NOCs). NOCs are some of the strongest known carcinogens and can act systemically where it has been found to induce cancer in a variety of organs (Weyer, 2001; Rao, 2006).

2.6.4 Others health related problem

The scientific and medical studies have linked nitrates to multiple digestive tract impairment, dyspepsia, depression, headaches and weaknesses (CWC, 2011).

Besides that, miscarriage, stillbirths or premature birth and Sudden Infant Death Syndrome (SIDS) can occur. It also can cause the mutagenicity (DNA damage), teratogenicity and also impaired growth of foetuses in utero, which by leading toneural tube disabilities and other birth-related disabilities (Kevin et al., 2005).

2.7 Extra information about nitrate

Nitrosamines and nitrosamides are two groups of chemicals that comprise N-nitroso compounds. N-nitroso compounds are formed by the reaction of a nitrite compound with amines or amides. This process is known as N-nitrosation of nitrates and nitrites. Both of them are known to be precursors to N-nitroso compound formation in the presence of amines or amides under normal gastric conditions. Approximately 5% of ingested nitrates in food and water are converted to nitrite in the saliva, further promoting endogenous nitrosamine

formation. N-nitrosocompounds are known to be potent carcinogens and are also known to cause congenital malformations (Griesenbeck, 2009).

Residents in Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi around 10 000 people. Half of the population used the well water for domestic use and they lived near to the agricultural area. Wastes generated by the three villages were collected by the local authorities which is Majlis Daerah Tanah Merah.



METHODOLOGY

3.1 Introduction

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

3.2 Study Design

A cross-sectional study design was used. The equipment used in this study was a YSI Professional Plus Multimeter. The method used in this research was by doing sample analysis with instruments. A YSI Professional Plus multimeter was used to determine nitrate levels in water samples. Data collected for water analysis was questionnaire for respondents. SPSS V19 was used to analyse the data obtained.

3.3 Study location

Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi in Tanah Merah, Kelantan were chosen as the study locations. These locations were chosen due to its agricultural activities as the main economic activity and most of the residents still rely on groundwater for daily needs. Main fertilizers used at this study area were NPK fertilizers. This was believed to consist of nitrate 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. Please refer to diagram.



Figure 3.1: Map of study locations

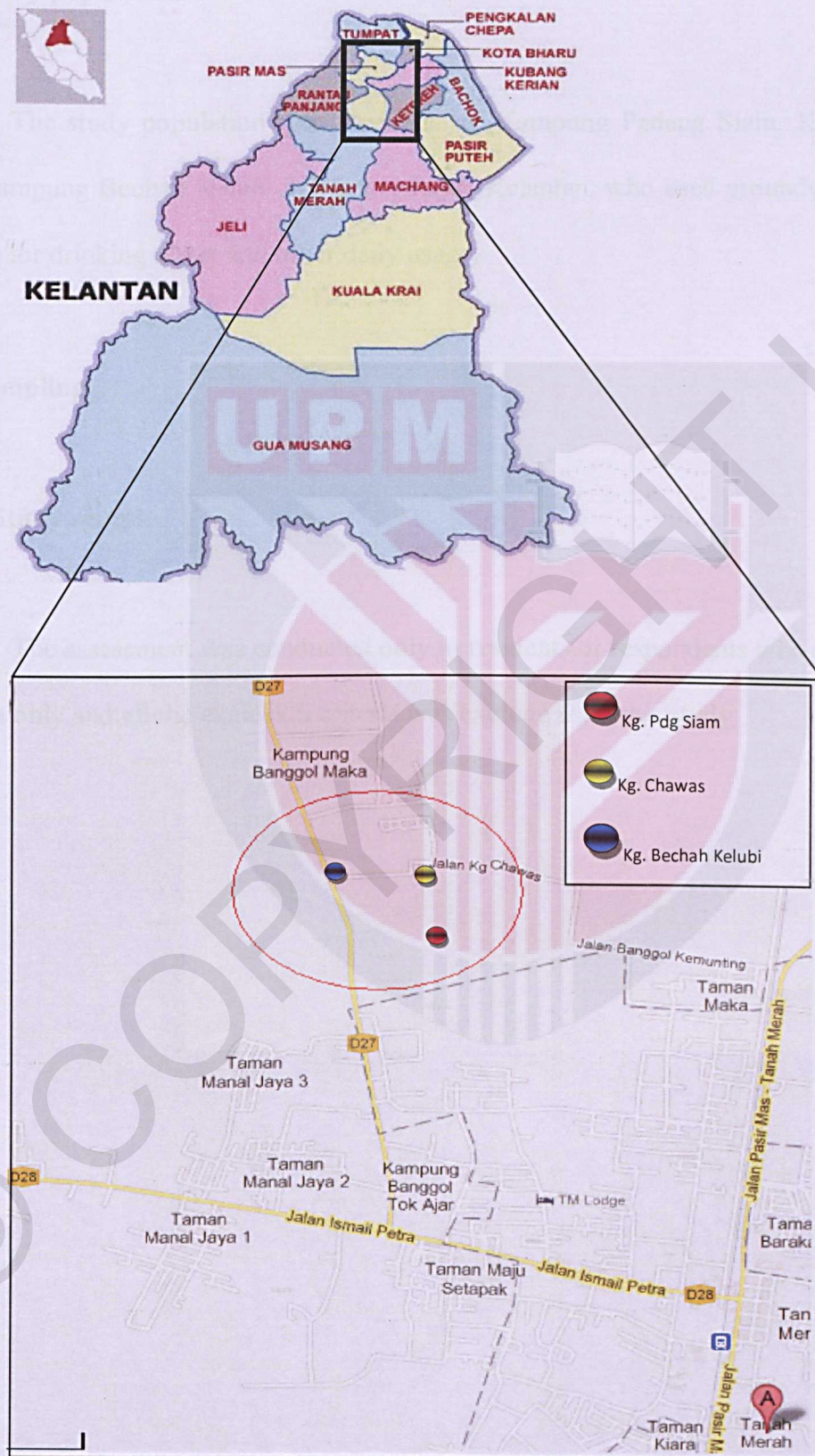


Figure 3.1 : Map of study locations

3.4 Study population

The study population were residents of Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi in Tanah Merah, Kelantan, who used groundwater as the main source for drinking water and other daily usage.

3.5 Sampling

3.5.1 Study sample

The assessment was conducted only to residents or respondents who met the inclusion criteria only and all the exclusion criteria was exclude from this study.

3.5.2 Sample Size

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

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

Where, N= sample size

P=Prevalence

e=Probability error

According to Reyes (2007), the prevalence of nitrate level of groundwater from wells sampled which was above of 50mg/L is 30% (0.3). So the sample size was calculated as below.

$$N = \frac{0.3(1-0.3)}{0.05^2}$$
$$= 84$$

Based on the calculation above, the value of 84 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 added 20% from actual sample size. So the sample final sample size was 100.

3.5.3 Sampling method

Purposive sampling was used as the sampling method. The respondents were selected based on a few inclusive and exclusive criteria.

3.5.4 Sampling unit

For this study, resident living in Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi, who fulfilled the inclusive criteria were used as the sampling unit.

Inclusive criteria:

- I. Age 18 years old and above which is considered as adult.
- II. The respondent is a lifelong resident of Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi in Tanah Merah, Kelantan.
- III. The respondent used groundwater as his/her main source of water supply for his/her daily usage.

Exclusive criteria:

- I. Respondents who used water filter systems.

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 contained questions regarding the socio-demographic information, Part B contained 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 weight of the respondents was measured using a Seca Weight scale. The readings were taken three times and then averaged. The unit was in kilogram (kg).

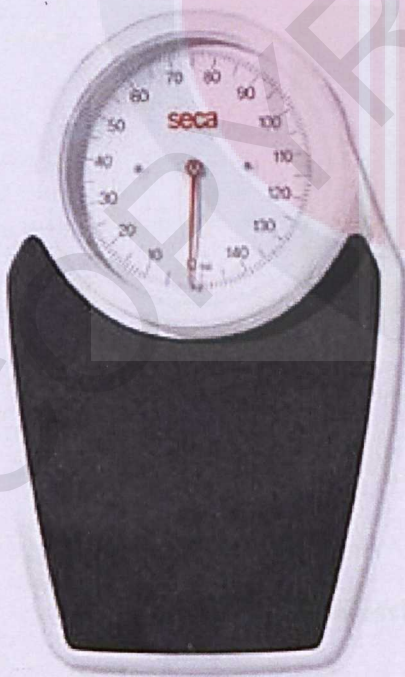


Figure 3.2 Seca weight scale

3.6.3 Drinking water daily intake

The daily intake rate of water among respondents was measured by using a standard cup of 200 ml, and every respondents 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 : YSI Professional Plus Multimeter

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,

DCI = 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 19.

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 sure 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 only 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 Tanah Merah.
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.

CHAPTER 4

RESULTS

4.1 Background of respondent

4.1.1 Socio-demographic of respondent

The data collection was carried out from January to February 2013 at the respective areas.

The total number of respondents who participated in this study was 80 (Table 4.1). All of the respondents were Malays (100%). There were more male (46 -57.5%) compared to females (34 -42.5%) respondents. (Table 4.2).

The mean and standard deviation for age of respondents was 60.75 ± 10.34 . The median was 62 years old. Age ranged from 21 to 89 years old.

This study was conducted in three villages, namely Kampung Padang Siam (28 respondents-35%), Kampung Chawas (25 respondents-31.3%) and Kampung Bechah Kelubi (27 respondents-33.8%).(Table 4.3).

Table 4.1 Number of respondents

Statistics			
Valid	80		80
Missing	0		0

Table 4.2 Comparison between male and female respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
F	34	42.5	42.0	42.0
M	46	57.5	56.8	100.0
Total	80	100.0	100.0	

F=Female
M=Male

Table 4.3 Table of resident number between three villages.

	Number	Percent	Valid Percent	Cumulative Percent
Bechah	27	33.3	33.3	33.3
Kelubi				
Chawas	25	30.9	30.9	64.2
Pdg Siam	28	34.6	34.6	98.8
Total	80	100.0	100.0	

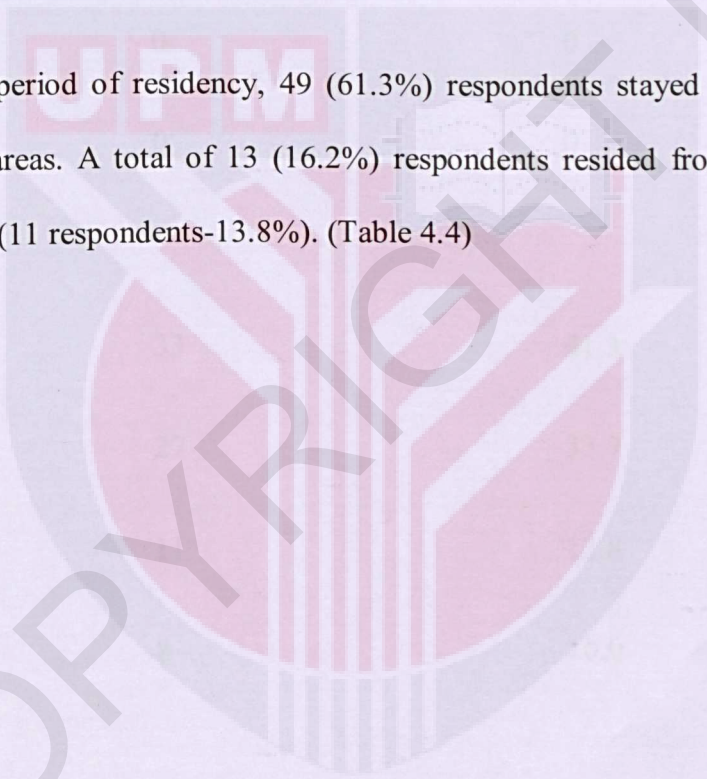
For information on education level, the highest percentage was respondent who had never attended school (19 respondents-23.8%), followed by primary school level (15 respondents-18.8%), Penilaian Menengah Rendah (PMR) which was 17 (21.3%) respondents and Sijil Pelajaran Malaysia (SPM) which also 17 (21.3%) respondents. For Sijil Tinggi Persekolahan Malaysia (STPM), there were only 7 (8.7%) respondents. Lastly only 5 (6.2%) respondents had higher education (diploma and degree).

With regards to information on occupation of respondents, the highest was farmers (33 respondents- 41.3%), followed by the unemployed (27 respondents-33.7%), other jobs and self-employment which was 11 respondents (13.8%) and 8 respondents (10.0%) respondents, respectively.

Table 4.4 Socio-demographic information

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, 49 (61.3%) respondents stayed more than 20 years at the respective areas. A total of 13 (16.2%) respondents resided from 1-10 years, followed by 11-20 years (11 respondents-13.8%). (Table 4.4)



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Table 4.4 Socio-demographic information

Variable	No. of Respondents	%
Race:		
Malay	80	100
Chinese	0	0
Indian	0	0
Other	0	0
Occupation:		
Farmer	33	41.3
Unemployed	27	33.7
Self-employment	11	13.8
Others	8	10.0
Income (RM):		
<500	33	41.3
500-1000	35	43.7
1001-1500	8	10.0
1501-2000	1	0.8
>2000	3	3.8

Table 4.5 Well information

Period of Residency:

Period of Residency	No. of Respondents	%
>20 years	49	61.3
11-20 years	11	13.8
1-10 years	13	16.2
>1 year	8	10.0

4.1.2 Well Information

Table 4.5 showed 75 respondents (93.7%) at Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi used electric pumps. Only five (5) respondents used manual hand pump.

For age of well, 51 (63.7%) wells were more than 15 years old. There were 9 (11.3%) wells which were less than 1 year and within 11-15 years old, respectively. Please refer to Table 4.5.

Table 4.5 Well information

Variable	No. of Respondents	%
Type of well:		
Pump well	75	93.7
Manual well	5	11.3
Age of Well :		
<1 year	9	11.3
1-5 years	6	7.5
6-10 years	5	6.2
11-15 years	9	11.3
>15 years	51	63.7

4.1.3 Drinking Water Information

All 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 1.51 ± 0.26 . While median was 1.6 L/day. The range was between 1.0 – 2.0 L/day.

Furthermore, only 27 (33.8%) respondents complained about the colour and odour change of groundwater (Table 4.6)

Table 4.6 Drinking Water information

Variable	No. of respondent	%	Mean \pm S.D (L/day)	Median (IQR) (L/day)	Range (L/day)
Daily water drink (L/day)			1.51 ± 0.26	1.6	1.0 – 2.0
Colour and odour change:					
Yes	27	33.8			
No	53	52.2			

N=80

4.2 Nitrate level in groundwater

Table 4.7 shows the mean \pm S.D for nitrate levels mg/L was 0.91 ± 1.00 . The range was from 0.00 to 5.01 mg/L.

Table 4.7 Nitrate level in groundwater samples

Variable	Mean \pm S.D (mg/L)	Range (mg/L)
Nitrate level (mg/L)	0.91 \pm 1.00	0.00 to 5.01

N=80

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 0.91 \pm 1.00. 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 \pm S.D (mg/L)	Range (mg/L)	p-value
Nitrate level (mg/L)	0.91 \pm 1.00	0.00 to 5.01	0.00

4.4 Comparison of nitrate levels between villages

Kruskal-Wallis test was used to compare nitrate levels between the three villages studied. The highest mean \pm S.D of nitrate levels (mg/L) was Kampung Padang Siam which was 1.07 ± 1.11 . The mean \pm S.D (mg/L) for Kampung Chawas was 0.58 ± 0.53 . Lastly, the mean S.D (mg/L) for Kampung Bechah Kelubi was 1.05 ± 1.15 .

According to p-value (0.140), 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 respondents	Mean \pm S.D (mg/L)	Range (mg/L)	p-value
Kg. Pdg Siam	28	1.07 ± 1.11	0.08-4.31	0.140
Kg. Chawas	25	0.58 ± 0.53	0.11-2.68	
Kg. B. Kelubi	27	1.05 ± 1.15	0.08-5.01	

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, 2012). Figure 4.1 indicated that nitrate levels from all sampling sites (80 houses) were below 10mg/L, which was the maximum limit of NSDWQ.

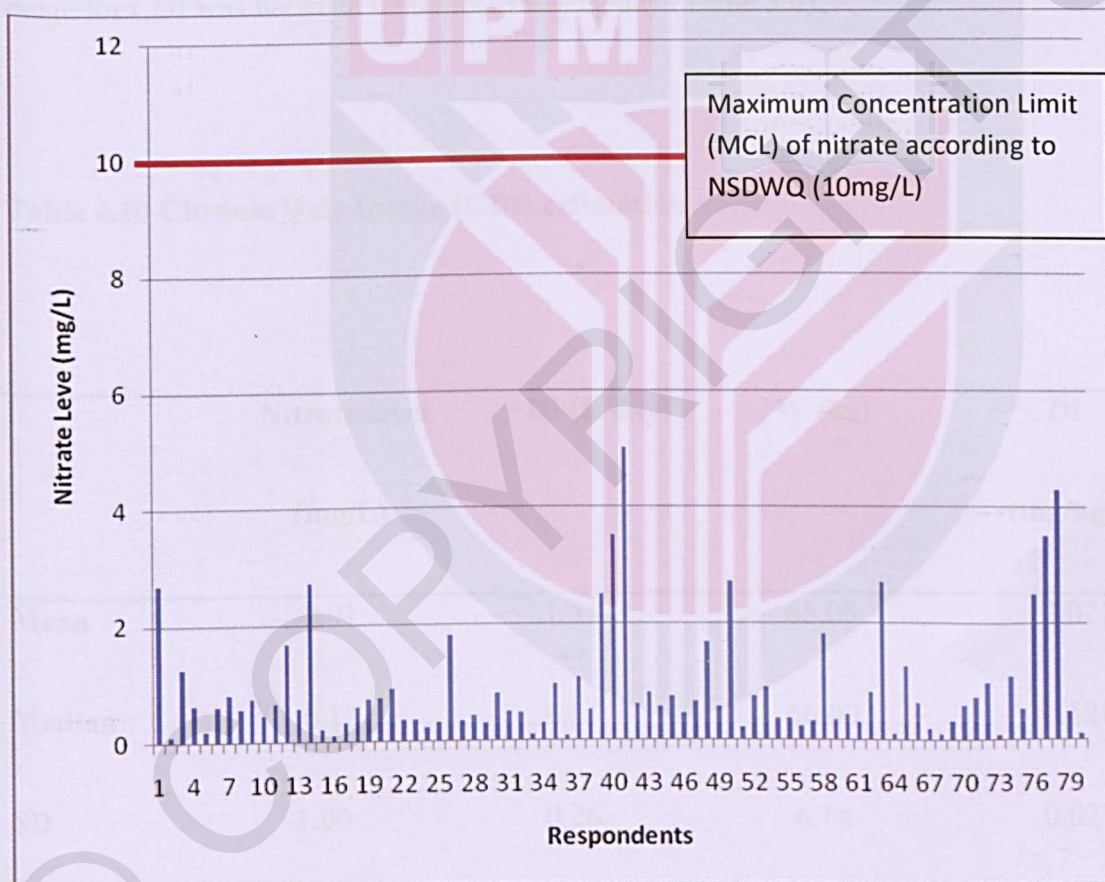


Figure 4.1 : Comparison of nitrate level among study locations with national standard

4.6 Exposure information (Chronic Daily Intake)

Table 4.10 shows the mean \pm S.D for respondent's body weight as 66.05 ± 6.14 kg.

The range for respondent's body weight was between 51 – 80 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 0.021 ± 0.024 . The range for CDI was between 0.00 – 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/
Mean	0.91	1.51	65.05	0.021
Median	0.13	1.6	66.00	0.129
SD	1.00	0.26	6.14	0.023
Range	0.00-5.01	1.0-2.0	51-80	0.00-0.13

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 0.00-0.08. The mean \pm S.D was 0.134 ± 0.146 . As shown in Table 5.1, HI value for all respondents was less than 1 (80 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	80	100	0.134 ± 0.146	0.00-0.08
HI>1	0	0		

Chapter 5

Discussion, Conclusion and Recommendation

5.1 Discussion

5.1.1 Social Demographic Data

For this study, all respondents were Malay. Based on table 4.2, the study comprised of 34 female (42.5%) and 46 male (57.5%), aged between 21 to 89 years old. The mean \pm S.D for respondent age was 60.75 ± 10.34 . The majority of respondent were more than 55 years old. This study was conducted in three villages, namely Kampung Padang Siam (28 respondents-35%), Kampung Chawas (25 respondents-31.3%) and Kampung Bechah Kelubi (27 respondents-33.8%).

The majority of respondent never had formal education (19 respondents). Most respondents worked as agriculture workers (33 respondents). Most respondents' income were less than RM1000. The majority of respondents lived in the study areas for more than 20 years and used electrical-pump well. Majority of wells were more than 15 years old (51 wells – 63.8%).

5.1.2 Nitrate Level in groundwater

The mean \pm S.D for nitrate levels mg/L was 0.91 ± 1.00 . The range was from 0.00 to 5.01 mg/L. This was considered as normal, as indicated by WHO (2007); the normal concentration of nitrate in surface water is between 0-18 mg/L. However, nitrate can reach high levels as a result of agriculture run-off, refuse dump run-off, or contamination of human and animal waste. A study by Grover (2006) also indicated that nitrate was found at levels greater than 1 mg/L in groundwater. A study by Mahmoud et al. (2009) indicated that the mean nitrate levels in drinking water networks in Tabas, Iran ranged from 2.9 to 3.25 mg/L, which was slightly higher than this study.

In addition, results of nitrate analysis in Sumas-Blaine aquifer, USA for the period of 1990 to 2000 showed a mean of 5.7mg/L (Mohammad and Kaluarachchi, 2004). Environment Canada (2003) also reported the nitrate concentration in groundwater often exceeding the Canadian Drinking Water Quality of 10mg/L.

Low levels of nitrate determined in this study were probably influenced by the rainfall event; as sampling was conducted after rainy season in January and early February 2013. According to Environment Canada (2003) and Ahmad et al. (1992), rainfall influence the concentration of nitrate, as it enters the groundwater at a high rate at the beginning of rainy season and remain at constant low levels during dry season. During the rainy season, water table rises and nitrate in unsaturated zones such as soil become mobilized into groundwater.

Therefore, nitrate level is high at the condition. In contrast, nitrate will accumulate in soil during the dry season, decrease of mobilization into stream and groundwater, thus resulted to lower nitrate concentration in the groundwater.

Nitrate concentration in groundwater also was depending on crop system. Randall et al. (1997) indicated that different cropping systems caused different concentration of nitrate in groundwater. The continuous crop system increased the tendency for nitrate to leach downwards compared to mixed crop system. Farmers in this study practiced mixed crop system that may caused low levels of nitrate in groundwater studied.

Another factor that may cause low nitrate levels in this study could be due to sampling time. Water sample were collected after rainy season where it was also pre-fertilisation period, where applications of fertilizer to the crops has not yet started and thus, no excessive fertilizer leaching to groundwater have occurred.

5.1.3 Comparison of nitrate level between each study location

5.1.4 Nitrate levels between villages

Result in this study indicated a significant difference of nitrate levels between each study location. p-value for this comparison was $p < 0.05$. This was consistent with a study by Rajmohan and Elango, (2005) whom indicated that nitrate levels of groundwater were varied between each sampling location. The difference in well depth may cause the significant difference in nitrate levels between each location. A survey of Ontario domestic well illustrated that nitrate in groundwater typically decreases with the increase of well depth (Environment Canada, 2003).

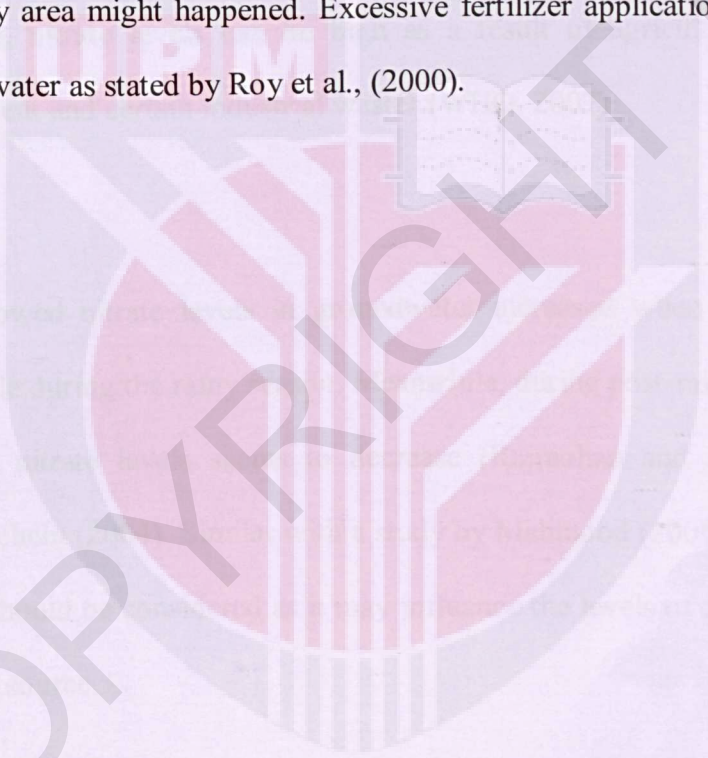
The distance of agriculture land to the well also plays an important role in determining the nitrate levels in groundwater. Many studies have shown agriculture activities contribute to high nitrate levels in groundwater (Wan Ruslan et al., 2004; Weyer, 2001).

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 Nitrate levels between villages

Results in this study did not exceeded the maximum concentration limit (MCL) yet

The highest mean \pm S.D of nitrate levels (mg/L) was Kampung Padang Siam (1.07 ± 1.11 mg/L) followed by Kampung Bechah Kelubi (1.05 ± 1.15 mg/L) and Kampung Chawas was (0.58 ± 0.53 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).



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5.1.5 Comparison of nitrate level to the national standard

Results in this study did not exceeded 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).

In most countries, nitrate levels in drinking water normally do not exceeded 10mg/L. However, in some areas, nitrate levels can be high as a result of agriculture activities, discharge of sewage effluent and certain industrial wastes (WHO, 2007).

Many studies showed nitrate levels in groundwater increased when there was an increase in the water table during the rainy season. Meanwhile, during post-raining or during dry and warm weather, nitrate levels seems to decrease (Rajmohan and Elango, 2005; Mohammad and Kaluarachchi (2004). Similar with a study by Mahmood (2009) which stated that weather conditions should be considered as it may influence the levels of chemicals such as nitrate in groundwater source.

A previous study in Kelantan also indicated nitrate contamination was found to be prominent and persistent in groundwater. On average, 15% of groundwater samples were found nitrate levels above the MCL of 10mg/L with the highest concentration levels of 30mg/L (Aminuddin et al., 1994).

Besides that, the uptake of nitrate as a nutrient by crops is responsible for the nitrate levels in water source. Low levels of nitrate possibly due to quantity of nitrate fertilizer application to crops was reasonable or insufficient, in turn which reduces the leaching of excess nitrate into water streams or aquifers. In addition, sampling was conducted after raining season, thus this study may disrupt nitrate levels. Chemical concentration such as nitrate in groundwater is primarily linked to the bedrock sources within the aquifer and also influenced by hydrological factors such as the frequency of rainfall and duration of rainfall. (Neal et al., 2000; Grover, 2006).

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 0.021 ± 0.024 . The range for CDI was between 0.00 – 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 0.00-0.08. The mean \pm S.D for HI was 0.134 ± 0.146 . 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 a critical resource which life depends on. Loading of contamination to drinking water sources occurs through many paths, natural and anthropogenic including via agriculture activities. Water contamination also can cause many health problems. Thus, quality of water source including groundwater should be of grave concern.

This study also showed a strong significant difference ($p < 0.05$) of nitrate levels between each location where p value is 0.00, as nitrate levels may differ according to different location and geological areas.

However, this study showed there was no significant difference ($P < 0.05$) of nitrate levels between Kampung Padang Siam, Kampung Chawas and Kampung Bechah Kelubi as p value was 0.140. Thus, the second hypothesis was rejected.

Based on this study, the quality of groundwater in these three villages in Tanah Merah was considered safe since the nitrate levels of sampling site was below the national and international standard and Hazard Index (HI) was below 1, which indicates no adverse effect due to nitrate exposure. In short, the third hypothesis was rejected.

The Hazard Index (HI) value for all respondents were less than 1 which indicates that the nitrate pollution in groundwater in Kampung Padang Siam, Kampung Chawas, and Bechah Kelubi is negligible. Thus, the fourth hypothesis failed to be rejected.

Although there was no nitrate levels which exceeded the MCL, there should be concern in order to minimize any further exposure of nitrate towards humans as well as the ecosystem and the environment.

5.3 Recommendation

Since this was cross-sectional study, the data was collected at one point of time only and this cannot conclude the causal relationship between the variables. It is recommended that a further study is conducted where the data can be collected at different point of time.

Human health risk is required to be studied further. Furthermore, monitoring programmes should be in place in areas where drinking water has a high probability of nitrate contamination such as agricultural areas.

Since this study only focused on three villages, the result may not represent the whole district or state. Additional further 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.

The wells are required to be regularly tested for nitrate to ensure that the water being supplied meets all the drinking water standards for public water supply systems. If water quality problems do exist, the water should be treated before it is consumed. Besides that, people should be recommended to use suitable water filter systems in order to minimize contamination of nitrate.

In order to build new tube wells, the drilling must be done deep enough to extend past the water table into the groundwater aquifer below, this is due to nitrate concentration in the groundwater decreases as depth of well increases.

Moreover, as many local factors influence groundwater, it is important that local governments realize the role they have in managing this resource for the future. The emphasis of groundwater management should be placed on conservation and prevention, not recommendation after groundwater becomes contaminated.

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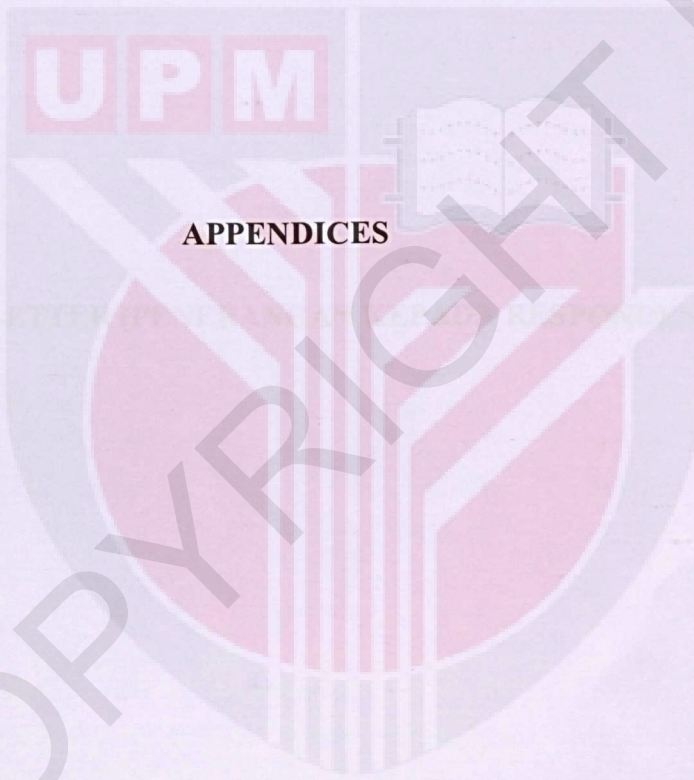
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APPENDICES

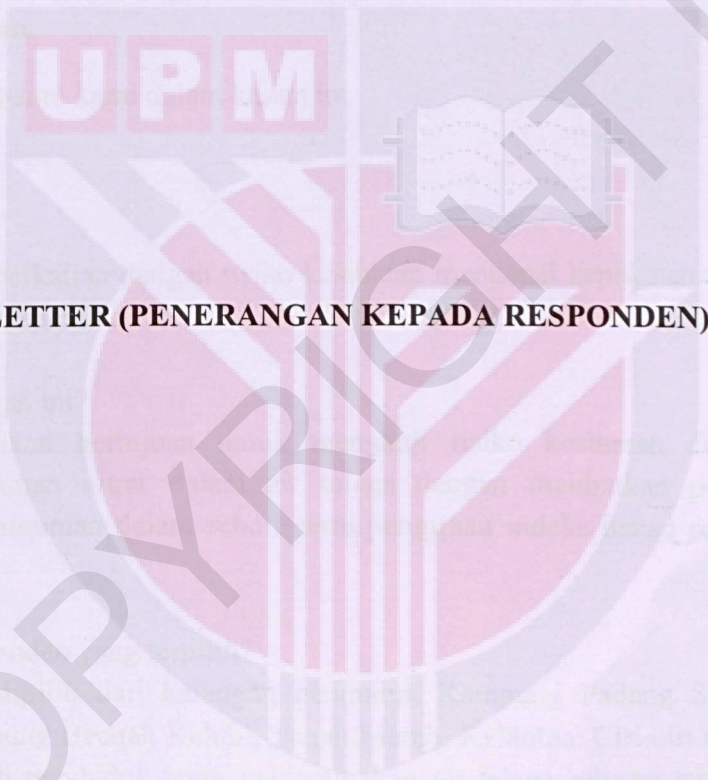
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PENERANGAN KEPADA RESPONDEN

NUK KAHANI

COVER LETTER (PENERANGAN KEPADA RESPONDEN)



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FAKULTI PERUBATAN DAN SAINS KESIHATAN
FAKULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

PENERANGAN KEPADA PESERTA

TAJUK KAJIAN:

Kajian risiko kesihatan mengenai kepekatan nitrat dalam air telaga di kawasan pertanian di Tanah Merah, Kelantan.

Terima kasih kerana membantu kami dalam kajian ini.

1. Apakah kajian ini?

Kajian ini adalah berkaitan dengan risiko kesihatan mengenai kepekatan nitrat dalam air telaga di kawasan responden.

2. Apakah tujuan kajian ini?

Kajian ini dijalankan bertujuan untuk mengkaji risiko kesihatan disebabkan oleh pendedahan kepekatan nitrat dalam air telaga dengan melibatkan pengiraan kadar pengambilan air minuman dalam sehari serta pengiraan indeks hazard setiap responden yang terlibat.

3. Berapa ramai responden yang terpilih?

Responden akan dipilih dari kalangan penduduk Kampung Padang Siam, Kampung Chawas dan Kampung Bechah Kelubi, Tanah Merah, Kelantan. Ciri-ciri responden yang akan dipilih adalah penduduk yang menggunakan air telaga sebagai sumber air utama untuk kegunaan harian seramai 100 orang responden akan dipilih untuk terlibat dalam penyelidikan ini.

4. Apakah jenis ujian yang akan dijalankan?

Semua responden akan diberikan boring soal selidik untuk diisi sendiri oleh responden. Selain itu, berat setiap responden akan ditimbang menggunakan penimbang tanta dalam unit kilogram (kg).



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SELANGOR, MALAYSIA

BORANG PERSETUJUAN RESPONDEN

RESEARCH TITLE:

Kajian Risiko Kesihatan Terhadap Pendedahan Nitrat dalam Air Telaga di Kawasan Pertanian di Tanah Merah, Kelantan.

RESEARCHER: MOHAMAD HILMI BIN MUSTAPHA

Saya..... No.K/P.....

Alamat.....

bersetuju untuk menyertai kajian bertajuk seperti di atas.

Saya telah membaca dan memahami isi kandungan kajian berdasarkan apa yang telah dinyatakan di dalam 'PENERANGAN KEPADA PESERTA' yang telah dilampirkan bersama surat kebenaran ini dan penerangan tambahan daripada penyelidik.

Saya faham bahawa kajian ini dijalankan untuk mengenal pasti pendedahan berkaitan nitrat dalam air telaga di kalangan penduduk di Kampung Padang Siam, Tanah Merah, Kelantan.

Saya juga faham bahawa segala maklumat dan segala keputusan yang diberikan dan segala keputusan yang saya perolehi adalah sulit dan hanya akan digunakan untuk tujuan penyelidikan dan rujukan penyelidik.

Saya juga faham bahawa maklumat ini boleh digunakan untuk penyelidikan tetapi setiap individu tidak akan dinyatakan identitinya.

Saya faham bahawa saya mempunyai hak untuk menarik diri dan juga mempunyai hak untuk menarik semula keizinan pada bila-bila masa sekiranya perlu apabila merasa tidak selesa pada mana-mana ujian atau aktiviti yang dijalankan oleh penyelidik semasa kajian dijalankan dan tiada sebarang tindakan ke atas saya atas tindakan tersebut.

Tandatangan.....
(Responden)

Tandatangan.....
(Saksi)

Tarikh :

Nama :

No.K/P :

Saya mengesahkan bahawa saya telah menjelaskan kepada responden sifat dan tujuan penyelidikan klinikal yang tersebut di atas.

Tarikh Tandatangan

(Penyelidik)



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Semua maklumat adalah untuk kegunaan kajian sahaja dan maklumat ini akan disimpan
rahasia. Sila jawab semua soalan pada bahagian yang disediakan

BAHAGIAN A (MAKLUMAT RESPONDEN)

Nama: _____

Alamat: _____

Umur: _____

Jantina: Laki-laki Perempuan

Race: _____

Melayu Cina

India Etnik Lain (Nyatakan): _____

Adakah anda budimasti? Ya Tidak



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)

Nama: _____

Alamat: _____

1. Umur: _____

2. Jantina:

P	L
---	---

3. Bangsa:

Melayu

Cina

India

Lain-lain (Nyatakan): _____

4. Berapakah berat badan anda?

5. Tahap pendidikan tertinggi anda?

<input type="checkbox"/> Tidak bersekolah	<input type="checkbox"/> Sekolah rendah	<input type="checkbox"/> SPR/PMR
<input type="checkbox"/> SPM	<input type="checkbox"/> STPM/ Diploma	<input type="checkbox"/> Lain-lain: _____

(Nyatakan)

6. Apakah pekerjaan anda?

<input type="checkbox"/> Tidak bekerja	<input type="checkbox"/> Peniaga
<input type="checkbox"/> Petani	<input type="checkbox"/> 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:

Bandar Separa Bandar/ Pekan Luar Bandar

10. Adakah kawasan pertanian anda berdekatan dengan tempat kediaman anda?

Ya Tidak

11. Berapakah jarak kawasan pertanian dengan kediaman anda?

12. Apakah jenis telaga yang digunakan?

Telaga pam Telaga gelung
 Telaga tanah 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 ait 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



Ref: UPSR/RSK/106-06-01/2013/001/001
Date: 14 December 2013

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

RESEARCH PROJECT:

HEALTH RISK OF AMBIENT CENTRATE EXPOSURE TO
WATER AMONG KEMANTAN

RESEARCHER:
SUPERVISOR:



ETHIC CONSENT LETTER

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