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Household's perception of water pollution and its economic impact on human health in Malaysia

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ABSTRACT

Environmental problems are a major global concern. In this global problem, water pollution is perhaps one of the more threatening causes of environmental problems. Water pollution significantly affects public health. Hence, this paper investigates household risk perception of water pollution and examines the demographic and socio-economic factors that influence their risk perception. The data was collected using a structured questionnaire and analysed by SPSS. The findings indicate that gender, age, education, income, AWN and ATT significantly affect household risk perception of water pollution. Upon discussing the water resource policies in Malaysia, we offer recommendations that will be helpful for policy-makers to improve river water quality in Malaysia.

Keywords: Water pollution; Households; Risk perception; Health impact; Economic impact, Malaysia

1. Introduction

Environmental problems are a major global concern. In this global problem, water pollution is perhaps one of the more threatening causes of environmental problems. Water is the most sensitive part of the environment, and a prerequisite for human and industrial development. The demand for fresh water continues to increase due to the population growth and access to clean water is becoming increasingly complex [1]. This valuable resource needs to be managed in a way that can establish a sustainable development of human population in an environment with limited resources. Water resources management is a great problem in many developing countries [2]. Regulatory management is weak and suffers from poor design and underfinancing. Collaborative

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decision-making is a strategic management approach mechanism for water resources [3].

Rapid urbanisation and industrialisation, the expansion of the mining industry and heavy use of chemicals in agricultural sectors threaten the water quality of many rivers. The sources of water pollution might be higher in river systems due to the revolutionary change in land-based activities. The government's urbanisation and industrial policy can increase the complexity in managing water resources. These policies focus on economic growth, such as the transformation of agricultural intense activity to heavy industry. Thus, changes in land-use activities such as industry and agriculture, deforestation and residential development have significantly affected the quality of water in many river systems. The Malaysian government and public are aware of the importance of rivers in Malaysia [4]. Fig. 1 shows the current water pollution problem of river basins in Malaysia.

Recently, the Malaysian government advised the public to protect the water in view of its importance for human survival and the health of the ecosystem. Hence, this study attempts to explore the household perception regarding water pollution, its causes and its impact on human health.

2. Impact of water pollution on human health in Malaysia

Staying healthy is vital for continued economic progression and sustainable growth. It is widely acknowledged that water pollution negatively affects human health [6]. General sources of water pollution include industrial wastes, sewage and rainwater. Such forms of polluted water are used by the agricultural sector. It was estimated that around 20 million hectares in more than 50 countries are treated with contaminated or partially treated contaminated water [7]. Polluted water has both advantages and disadvantages. There are numerous effects of using polluted waters. Some of the effects can be recognised instantaneously; others manifest themselves later.

When water is contaminated by toxins, often animals drink these toxins, which are then transferred to humans when they consume the flesh of that animal. This can harm human body in the form of typhoid and cholera, among others. Regular consumption of polluted water can damage the human heart and kidneys. Other diseases that can spread due to water pollution include poor blood circulation, vomiting,

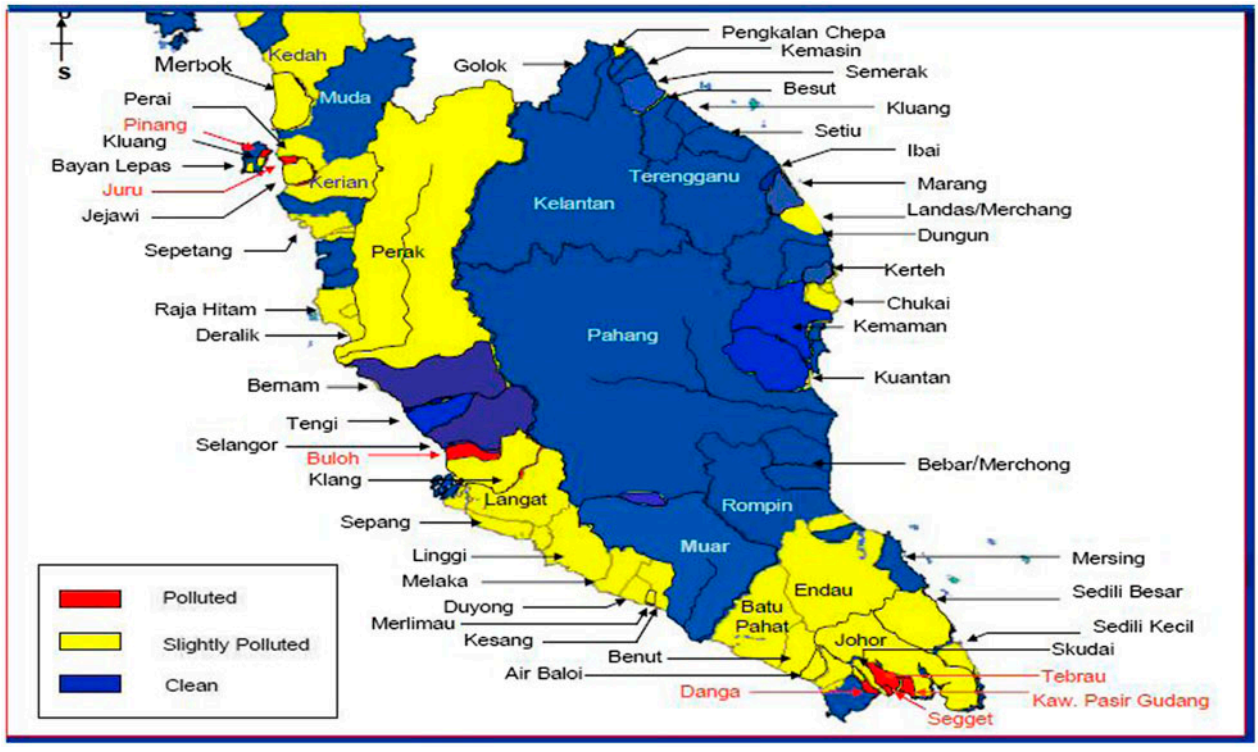

Fig. 1. Map of polluted river basins in Malaysia (Source: Afroz et al. [5]; www.ekovest.com.my).

skin lesions and damage to the nervous system. Water pollution is considered as the main cause of human death [8]. Moreover, mining effluent wastewater has elevated concentration of metal and metalloid that can be transported into ponds and rivers, and might eventually affect the health of locals [9].

In developing countries, research has shown that approximately more than 2 million children under five die each year from drinking contaminated water. Water pollution, hygiene and sanitation cause approximately 10% of global diseases [10]. A large number of population (nearly 900 million) lack access to safe water [11], while 2.5 million people do not have proper sanitation systems. According to IWMI [12], one-third of the world population experience moderate to high water stress. It was estimated that 0.5 million people die due to malaria and 1.4 million children die of diarrhoea annually [10]. Over 3.5 million people died in 2002 because of water pollution, sanitation and hygiene [10]. Approximately 4 million diarrhoea cases occur every year. For example, rotavirus gastroenteritis causes nearly half a million of children death under the age of five [13]. Diarrhoea is not only responsible for mortality but also can lead to malnutrition in children and make them more vulnerable to other diseases causing the death of 860,000 annually [10].

Eisakhani and Malakahmad [14] stated that the quality of water has dropped in the Bertam River due to vast growth in suspended solids, high concentrations of nitrogen and phosphorus compounds, including COD that cause a very significant enrichment and eutrophication, and the existence of "*Escherichia coli*" affecting severe microbiological infection. Their findings showed that all the parameters mentioned above are higher than those recommended by WHO. As suggested by Fewtrell et al. [15] and Zwane and Kremer [16], morbidity can be reduced by at least 25% through improving water supply, sanitation and hand washing with soap. Besides, high iron levels in drinking water damage the water quality [17], thus also have an impact on human health. In addition, there are many options or choices. But, all choices are not equally important. So, decisions regarding the most suitable solutions should consider the cost, reduce disease and improve overall health [18].

3. Materials and methods

3.1. Study site

This study was conducted among residents living along in the Gombak River. The Gombak River is located in the Gombak District of Selangor and its lower zone is situated in the Malaysian capital Kuala Lumpur. The catchment area within which the river passes has grown rapidly since the early 1970s and is expected to continue growing in the future. The topography of the watershed area is surrounded by hilly mountains. The Gombak River flows through Selangor and Kuala Lumpur as shown in Fig. 2. It is a tributary of the Klang River. The point where it meets the Klang River is where the name Kuala Lumpur originated. Gombak River used to be called Sungai Lumpur. Kuala Lumpur's name was taken as it was located in Sungai Lumpur's confluence or Kuala Lumpur.

3.2. Sampling method

The survey was conducted from April to June 2014. All of the respondents were Malaysian citizens. Our target respondent was the head of the household. The questionnaires were distributed and collected through face-to-face interviews. A purposive sampling method was used to select respondents. Participants for this study were head of the household aged above 18 years, and residents of Gombak using purposive sampling. This method is a non-probability sample that conforms to certain criteria [19]. This method was appropriate for our study since some criteria need to be met for a respondent to be selected. As such, valuable responses could be elicited from respondents who met these aforementioned criteria as it relates to the subject of the study. A total of 300 questionnaires were distributed to individual respondents out of which 255 were returned. The effective response rate is 85%, which is rather high. Seven respondents were excluded from further analysis due to non-conformity to the requirement to be used as samples and excessive missing data. The data in this instance was missing completely at random. Referring to Hoe [20], a sample size of 200 offers enough statistical strength for data analysis. The final sample size was 248.

3.3. Questionnaire design

In developing our questionnaire, many questions concerning the problem of water pollution were considered. The questionnaire had three sections. The first section consisted of the demographic information of the respondents, which included their gender, age, race, education, occupation and income. The second section included questions relating to water pollution and health issues and the third section included 18 items intended to measure their perception, awareness, knowledge, attitudes and behaviour towards water pollution and its impact on human health. In

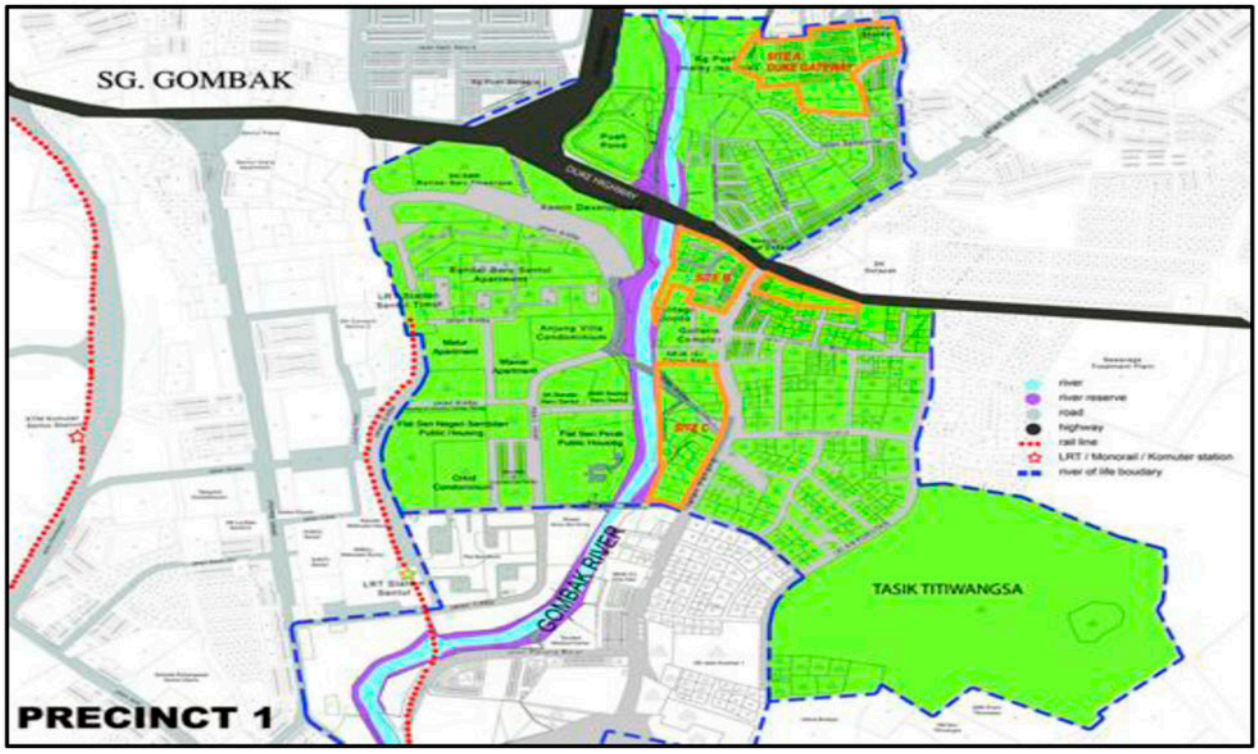

Fig. 2. Map of Gombak River.

section three, the respondents were asked to give their response based on a 5-point Likert scale. We used the scale of "1—strongly disagrees" to "5—strongly agree". This was to give the respondents flexibility when answering the questions. The questionnaire items were translated from English to Malay to make it accessible to all the respondents.

3.4. Specification of model

In order to estimate the effect of demographic and socio-economic variables on risk perception of water pollution, regression analysis was employed to test the following regression model:

$$\mathrm{RPOWP} = \alpha + \beta_1 \mathrm{Gen}_1 + \beta_1 \mathrm{Age}_2 + \beta_3 \mathrm{Edu}_3 + \beta_4 \mathrm{Inc}_4 + \beta_5 \mathrm{Att}_5 + \beta_6 \mathrm{Awn}_6 + \beta_7 \mathrm{Knw}_7 + \varepsilon \quad (1)$$

The following variables are used in the regression analysis as shown in Table 1.

4. Result and discussion

4.1. Respondents' profile

Analysis of the demographic characteristics of the respondents showed that more than half of the respondents were male (62 and 38% are male and female, respectively) (see Table 2). It also shows the age variation of respondents in the study area. The age of respondents ranged between 21 and over 51 years. Most of the respondents were young. The greatest number of respondents (52.0%) was aged between 21 and 30 years. The second largest group of respondents (26%) aged between 31 and 40 years. Only 3% aged 51 and above. The largest number of respondents was Malay (65%). Chinese, Indian and others were 17, 11 and 7%, respectively. The finding shows the educational background of the respondents as well. It is reported that 38.7% of the respondents had a degree, while 32.3, 22.6, 3.3 and 3.2% had higher secondary, diploma, postgraduate and primary degree, respectively. This study found that the highest percentage of the respondents (36.7%) had a monthly income of RM 2,000 and less than RM 2,000. The second highest percentage of the respondents (34.53%) had an income of RM 2,000 up to RM 4,000 per month, while 14.5%, 10.9%, of the respondents have income of RM 6,000 up to RM 8,000 and RM 4,000 up to RM 6,000, and respectively, per month. There were only 3.5% respondents with an income of more than RM 8,000 per month (Table 2).

Table 1
Variables used in the regression and their description

Variables	Description of the variable	Category
Gender	Male, Female	1 = Male 0 = Female
Age	Age of the respondents	1 = 21–30 years 2 = 31–40 years 3 = 41–50 years 4 = 51 and above years
Education	Education level	1 = Primary 2 = Higher secondary 3 = Graduate 4 = Postgraduate 5 = Diploma
Income	Household monthly income level	1 = RM 2,000 and less 2 = RM 2,001–4,000 3 = RM 4,001–6,000 4 = RM 6,001–8,000 5 = RM 8,001 and above
RPOWP	Refers to an individual's feeling of being affected by water pollution	Measured using five-point Likert scale from "strongly disagree" = 1 to "strongly agree" = 5
AWN	Awareness of water pollution	Measured using five-point Likert scale from "strongly disagree" = 1 to "strongly agree" = 5
KNW	Knowledge of water pollution	Measured using five-point Likert scale from "strongly disagree" = 1 to "strongly agree" = 5
ATT	Attitudes towards water pollution	Measured using five-point Likert scale from "strongly disagree" = 1 to "strongly agree" = 5

Table 2
Demographic information of the respondents (N = 248)

Basic information	Group	No. of households	Percentage
Gender	Male	153	62.0
	Female	95	38.0
Age	21–30	128	51.6
	31–40	64	25.8
	41–50	48	19.4
	51 and above	8	3.2
Race	Malay	160	64.5
	Indian	28	11.3
	Chinese	42	19.9
	Others	18	7.3
Education	Primary	8	3.2
Level	Higher secondary	80	32.3
	Postgraduate	96	38.7
	Graduate	8	3.3
	Diploma	56	22.6
Income of household (RM/month)	2,000 and less than 2,000	91	36.7
	2,000–4,000	85	34.3
	4,000–6,000	27	10.9
	6,000–8,000	36	14.5
	>8,000	9	3.5

Source: Field survey 2014.

4.2. Household perception of water pollution

Specific statements were designed to explore the general perception of households regarding water pollution, as shown in Table 3. The results revealed that 96.8% of the respondents are aware about causes of water pollution, 95.6% believed water pollution harms health and 72.2% stated that polluted water transmits various diseases. However, the findings showed that only 16.1% attended educational programmes on the health impact of polluted water and 19.4% mentioned that someone came to them to explain the water situation in their areas.

4.3. Sources of information about water pollution

The respondents were asked how they know about water pollution. Fig. 3 shows that 48% of respondents had obtained knowledge about water pollution from newspapers, 29.4% from TV, 6.9% from internet, 6% from friends, 6.5% from the community and 3.2% from advertisements.

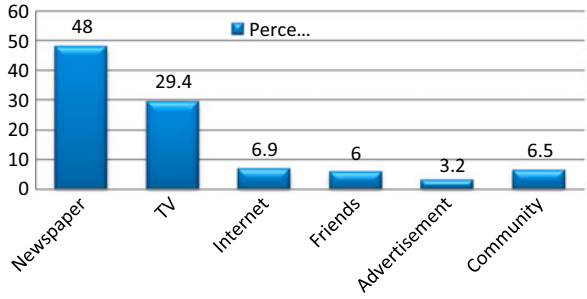

Fig. 3. Sources of information about water pollution.

4.4. The most serious disease caused by polluted water

The respondents were asked to rank the six specific diseases caused by water pollution in Gombak River. Fig. 4 shows that 45.2% of the respondents selected diarrhoea as the most serious disease. This is much higher than that for other types of diseases. Similar results were found for the Linggi River basin in Malaysia [21]. Dengue fever was ranked 13.3% and the second most serious disease. Only 2% of the households ranked hair diseases as being caused by water pollution.

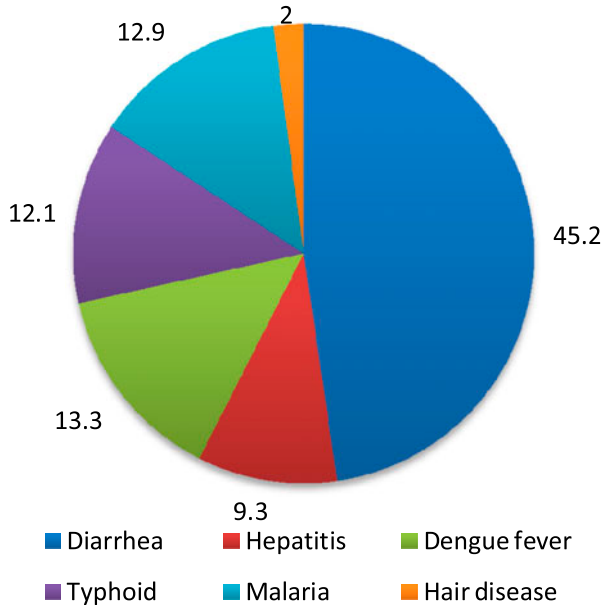

Fig. 4. Disease caused by water pollution.

4.5. Sources for drinking water

Respondents were asked where you got drinking water. There were various sources for drinking water. Forty per cent purchased their drinking water, city water (30%), individual well (16.0%), while only 5% of respondents do not know the source of their drinking water. The source of drinking water is shown in Fig. 5.

4.6. Storage of drinking water

During storage of drinking water, they did not use any precautions. About 68% stored water in plastic

Table 3
Household perception

Items	Yes (%)	No (%)
Do you aware about causes of water pollution?	96.8	3.2
Do you believe polluted water is harm for health?	95.6	4.4
Do you think that polluted water transmit diseases?	72.2	25.8
Have you been attended educational programmes on the health impact of polluted water?	16.1	83.9
Does anybody visit you to explain water situation in your area?	19.4	80.6

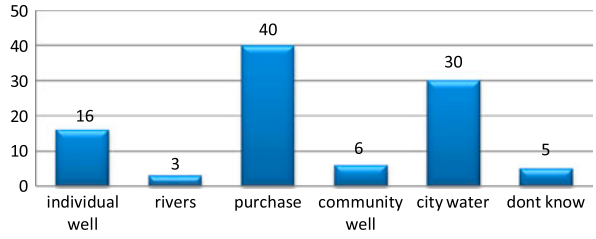

Fig. 5. Sources of drinking water.

buckets, 16% in earthen ware, 10% in stainless steel containers and 6% in others as indicated in Fig. 6. Most of them did not use a separate glass for taking water from the containers in which water was stored. Inhabitants of the village, especially children, did not use basic hygiene measures like washing hands before taking water from the storage container. Most of the villagers informed that they wash their water-storage utensil once a month, while some washed it once every two to three months. Most were unaware of the precautions to be taken before and after storing water to prevent waterborne diseases.

4.7. Vulnerable age to diarrhoea disease

The findings show that 58.9% of the children from 0 to 12 years are affected by diarrhoea in spite of demonstrating only a small fraction of the population. On the other hand, those who over 60 years of age consider form an unreasonably small percentage (2.4%) of diarrhoea, despite apparently having a high vulnerability to diarrhoea as shown Fig. 7. This might be due to frequent treatment or use of traditional medicines. Perhaps respondents felt that have developed a form of "immunity" to diarrhoea.

4.8. Factors influencing risk perception of water pollutions

In this study, the author(s) hypothesised that demographic and socio-economic variables have different significant effects on risk perception of water pollution. Based on Eq. (1), Table 4 shows that the value of adjusted-R^2 was 0.60, suggesting that approximately 60% of the disparity in the risk perception of water pollution (RPOWP) can be clarified by this model. The F-statistic value (16.373) signifies that the general significance of the model was comparatively high at 1%. The coefficients of regression prove the nature and greatness of the relationship among the variables. The positive coefficients of gender ($\beta = 0.102$), age ($\beta = 0.220$), education ($\beta = 0.080$), income ($\beta = 0.091$), AWNSS ($\beta = 0.124$), KWN ($\beta = 0.656$) and ATT ($\beta = 0.229$) indicate that the RPOWP has a positive relationship with the variables.

Nonetheless, the coefficient communicates merely the greatness. To test the significance of the coefficients a t-test was employed. The result of the t-test displayed seven variables, namely gender, age, education, income, AWN, KWN and ATT were significant at 1% with $p < 0.01$ while AWN was at 5% significant level and gender was at 10% significant level. From the statistics shown in Table 4 and the analysis presented above, it can be asserted that respondents that were more educated, had high income, aware of water pollution, have knowledge of water pollution and favourable attitudes have greater influence on risk perception of water pollution. This relationship was also expected from past studies and the model shows enough evidence in this regard. This results support the hypothesis that demographic and socio-economic factors have significant different effects on risk perception.

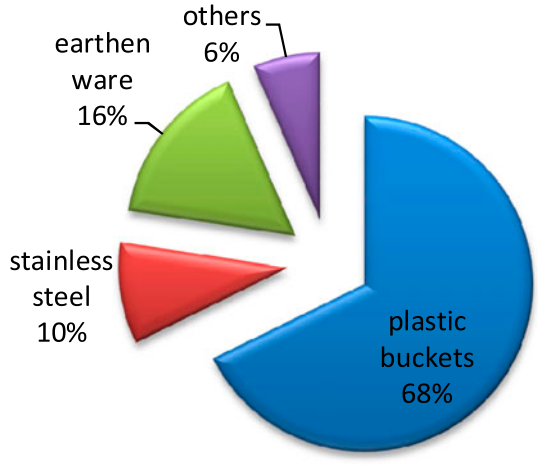

Fig. 6. Storage of drinking water.

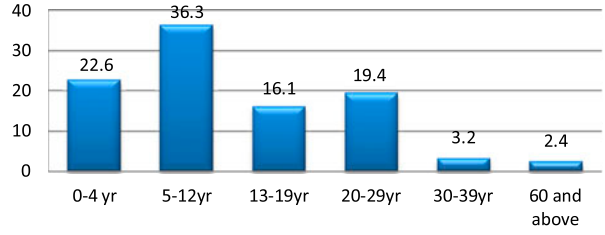

Fig. 7. Those mostly affected by diarrhoea.

Table 4
Factors influence risk perception of water pollution

	Coefficient	Std. error	*t*-value	Sig.
(Constant)	0.200	0.253	0.791	.430
Gender	0.102	0.054	1.881	.061
Age of the respondents	0.220	0.040	5.504	.000***
Education	0.080	0.028	2.882	.004**
Income	0.091	0.024	3.847	.000***
AWN	0.124	0.064	1.938	.054*
KNW	0.656	0.096	6.805	.000***
ATT	0.229	0.060	3.806	.000***
R^2	0.607			
Adjusted R^2	0.595			
DW	2.250			

***Significant at $\alpha = 1\%$.
**Significant at $\alpha = 5\%$.
*Significant at α = 10%, respectively.
Notes: AWN = Awareness of water pollution, KWN = Knowledge of water pollution, ATT = Attitudes towards water pollution and DW = Durbin Watson.

5. Conclusion

In the twenty-first century, rivers and their management will undoubtedly be a main issue as more than half of the rivers around the world are about to "die". Water becomes scarce as polluted rivers are increasing at an alarming rate. This situation is set to worsen. Water pollution is increasing rapidly in Malaysia and negatively affects the sustainability of water resources. According to a survey of 116 nationwide rivers in Malaysia conducted by the Department of Environment, 10% are heavily polluted (dead), 63% are polluted and only 27% are healthy. Kedah, a prominent rice farming area, suffered a severe poisoning of the air and water from a pesticide factory. The paddy together with bananas and coconuts became contaminated and lots of poultry died. After using the nearest stream for washing, the village dwellers had wounds on their bodies.

We also found based on literature reviews that the main causes of water pollution were due to low oxygen levels because oxygen levels have dropped dramatically because of sudden algae population explosions. Inadequate sewerage and drainage systems are similarly another issue for polluted water in Malaysia. Forestry, urbanisation and agricultural development have caused the contamination of most river systems, exaggerated the ecological dynamics and interrupted the natural food chains. Major sources of water pollution are produced by humans, although some of them are from natural sources. Based on the reports, a downward trend year by year shows that the water pollution problem is becoming more serious.

In our study, we found that there are three main sources of river pollution in Malaysia such as residential, agricultural and industrial wastes. One of the major impacts of water pollution is low water clarity, which decreases the amount of sunlight available for photosynthesis. Therefore, a suspended particle interferes with filter feeding and respiration through gills. Wastewater of industry, agricultural fertilizer and chemicals in surface water affect levels of dissolved oxygen in the water. The management of raw water from surface water for human consumption and industrial use has become more complex and more expensive because of water pollution. It is obvious that polluted water is dangerous for human health. The consumption of polluted water might seriously affect human heart and kidneys and cause poor blood circulation, skin lesions, vomiting and damage to the nervous system.

It is clear that in Malaysia, water has been the subject of national concern for some time now. Of all natural resources, water is the most severely threatened by pollution. A developing country like Malaysia, having sufficient water is pivotal to its overall economic growth. A tropical country like Malaysia will face a clean water shortage, something which can become a reality at the rate the rivers are being polluted these days. Therefore, the following subjects must be addressed to ensure sustainability of Malaysian water resources for now and in the future.

Firstly, the government should strengthen enforcement for protection of water resources and expedite industry restructuring, so that water operators will be financially assisted. Secondly, the government should invest in the installation of the technology and early

warning systems to detect pollution for water treatment and increase water operators' competency to deal with sudden pollution. Thirdly, the water services industry in Malaysia is undergoing major reforms. Effective and efficient water supply services depend on good water resource management. Quantity and quality of water sources are vital for continuous supply of safe and clean water. Therefore, water supply operations require continuous support from various agencies. Thus, co-operation of all stakeholders are required. Fourthly, the government should continue its "One State, One River" programme to rehabilitate one river in each state as per the Ninth Malaysia Plan planned by the Department of Irrigation and Drainage (DID) [22], Malaysia effectively.

Finally, personal consciousness is one of the most important recommendations to protect water from pollution. Therefore, an individual should not use any products that are harmful to the environment. They urge stores to abandon wasteful packaging and to use biodegradable materials. Besides, the authority should provide adequate sewage and drainage systems as well as formulate stringent pollution control regulations and educate the people of this city to develop an ecological conscience. Further, some awareness campaign is needed to change public attitudes, behaviours and expectations. Moreover, involvement with associations becomes necessary to support local and national groups that work to solve environmental problems on institutional, national and international levels. Every person must have sufficient information, participate in public hearings, serve on advisory committees and address review boards.

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