ORIGINAL ARTICLE

WATER RESOURCES DEVELOPMENT IN MALACCA RIVER

Ang Kean Hua [1]

[1]Faculty of Environmental Studies, Universiti Putra Malaysia, Malaysia
Email: angkeanhua@yahoo.com

Abstract

Water resources have decreased until today. Human activities have become the main factor causing water pollution in the Malacca River. This research study was conducted to determine water resources development in Malacca River. This study concentrated on a quantitative approach with a questionnaire in Likert scale form. The sampling area was Alor Gajah and Malacca Central, targeting 400 local residents as respondents. The analysis involved is descriptive analysis for demographic profile and factor analysis for water resources development in Malacca River. The reliability test based Cronbach's Alpha is 0.85 for 20 variables. Analysis showed that KMO test is 0.746 and Bartlett's test is 1457.022 ($p<0.05$), in which three factors are categorized, namely (1) policy, laws, and regulations for waste pollutants; (2) environmentally friendly programs for water resources; and (3) water pollution in an environmental ecosystem. Results have shown that laws and regulations in the short term will support policy to be successfully implemented by local residents; environmental friendly product will reduce pollutants contaminating the river; and success in achieving policy, law and regulation, and environmental friendly product will reduce water pollution and negative impacts to aquatic animals and ecosystem. In conclusion, moral and ethical values play an important role in supporting these three factors to reduce contamination in the water resources of the Malacca River.

Keywords: Water resources development; water pollution; environmental friendly; policy; law and regulation

Received 10th June 2018, revised 10th July 2018, accepted 25th July 2018

Introduction

Water is a necessary natural resource for living creatures after air, light, soil and minerals, and an ecosystem (National Geographic Official Portal, 2015)[1]. Water categorized in the hydrosphere consists of oceans (96.5%), groundwater (1.7%), and glaciers and permanent snow (1.74%) (Gleick, 1993)[2]. Freshwater are exist in rivers, lakes, and atmosphere (with less than 0.3%) to total only 2.5% can be used for drinking, bathing, washing, cooking, and other several daily activities (Gleick, 1993)[2]. Simultaneously, 98.8% of freshwater is contained in ice and groundwater (Gleick, 1993)[2] leaving a small percentage for uptake by living creatures to carry out daily activities. Therefore, the one and the only method to obtain freshwater for living is through lakes and rivers. For example, the largest lakes in the world include Lakes Superior (82,680 km^2 in North America), Victoria (69,000 km^2 in African), Huron (59,800 km^2 in North America), Michigan (58,100 km^2 in North America), and Tanganyika (32,900 km^2 in Africa), and the longest rivers are the Amazon (6,280 km in South America), Congo (4,370 km in Africa), Ganges (3,000 km in Asia), Yangzijiang (5,520 km in Asia), and Orinoco (2,740 km in South America) (Gleick, 1993)[2]. Nevertheless, most available freshwater can be taken directly and easily from rivers. Hence, these opportunities have given advantages to almost all animals to uptake water for activities.

Uncontrolled rapid development and extremely excessive land used have led to dangerous conditions for human and animals through various pollutions, especially water contamination in river (Hua, 2015)[3]. In other words, accessible of freshwater has been decreasing nowadays. In developing countries, 70 percent of industrial wastes are dumped with untreated into water, polluting the usable water supply (National Geographic Official Portal, 2015)[4]. Water pollution has increased, and more than 99 million pounds or 45 million kilograms of fertilizers and chemicals are used each year, and 2 million tons or 1.8 billion kilograms of human waste are disposed into waterways around the world every day (National Geographic Official Portal, 2015)[4]. As proof, these actions have caused destruction of water quality of rivers like the Ganges River (India), Jian River (China), Jakarta River (Indonesia), Pasig River (Philippines), Tiete River (Brazil), and Yamuna River (India) (Bittner, 2013)[5]. Disadvantages of river pollution affect ecological imbalances by stimulating plant growth and causing death to fish due to suffocation resulting from lack of oxygen (Hua and Marsuki, 2014)[6] (WWF Official Portal, 2015)[7]. Therefore, this issue should be taken seriously in handling the problem of river pollution before environmental destruction occurs.

River pollution activity still continues until this day due to an increasing demand for development and facilities for everyday life. A country like Malaysia is no exception - to grow as a developing country, is also involved in the contamination of rivers. In the latest report from Department of Environment Malaysia[8], about 41 percent or 195 rivers out of 278 are considered polluted. Contributions to river pollution have included manufacturing industries, agro-based industries, animal farms, sewage treatment plant, food services establishments, and wet market (Table 1). The contamination factors are also impact towards Malacca state, which refer to

Malacca River. Generally, Malacca is a historical tourism-based city recognized by UNESCO as world heritage site on July 07, 2008 (Bernama Official Portal, 2008)[9] (UNESCO Official Portal, 2015)[10]. The tourism industry generates secondary major economic value through arrival of tourists both local and international (Tourism Malaysia Official Corporate Website, 2015)[11]. Unfortunately, river contamination occurs when development involves various human activities (Nasbah, 2010)[12] (Jabar, 2010)[13] (Hua and Kusin, 2015)[14] . Nonetheless, continuous increasing in river pollution will not benefit to tourism industry, but providing disadvantages to society and environment. Therefore, river contamination due to human activities should be restricted, prohibited, and limited in order to conserve and preserve the environment, especially water quality in the Malacca River.

Table 1
Composition of Water Pollution Source

Types of Sources	Number of Sources
Manufacturing Industries	4,595
Agro-based Industries	
Rubber Mill	72
Palm Oil Mill	436
Animal Farm (Pig farming)	754
Sewage Treatment Plant	
Public	5,800
Private	4,083
Individual Septic Tank	1,449,383
Communal Septic Tank	3,631
Food Service Establishments	192,710
Wet Markets	865
Total	1,662,329

Source: Department of Environment Malaysia (2012)

Sustainable development can be defined as any development that meet the needs of current generations without compromising the ability of future generations to meet their needs and aspiration (WCED, 1987)[15], or development that improves human's life quality when living within carrying capacity of supporting ecosystems (IUCN, 1995)[16]. According to Hussain (1992)[17], development of economic growth should occur together with preservation of natural wealth like flora and fauna, as well as environmental cleanliness, so that future generations can enjoy their right to the environment. In other words, sustainable water resources not only involve ethical and moral values, but also renewability, resilience, and recoverability (Hua and Kusin, 2015)[18]. Renewability indicates that a source can be replaced, resilience signifies the ability to withstand stress for a long-term or any damage that unable to be restored, and recoverability is defined as a concept that concentrates on the rate or frequency of impact to have the possibility

for recovery (Clark and Gardiner, 1994)[19]. Xu *et al.* (2002)[20] designed a sustainability index (SI), the formula is as follows:

SI = (S – D) / S, where S > D; SI = 0, where S ≤ D *SI is Sustainability Index *D is demand *S is supply

When the SI value is bigger than 0.2 means there are no stress on water supply (where demand ≤ 80% of potential water supply), and when SI value is smaller than 0.2 means the water supply conditions is affected (where demand > 80% of potential water supply). For example, when SI = 0, the results show that water demand is higher than available water supply, and this is unsustainable for water resources. So, the *sustainable development* concept is suitable to apply in water resources in order to reduce contamination percentage from continuous rising. More precisely, *sustainable development* means treating on river pollution through controlling human activities in creating various negative impacts. Among the suitable methods in controlling human actions are included law and regulation, policy planning and environmental program, parents and community roles, and education. So, this research study has been conducted to determine water resources development in Malacca River through public perception to reduce water pollution and destruction of the natural environment.

Methodology

Since this study is concentrated on public perception, the research will involve a quantitative approach. In the other words, the questionnaire method will be used in collecting data. The questionnaire will be divided into two (2) categories, which are demographic profile and water resources development in Malacca River. The question set in demographic profile using nominal scale, while questions in sustainable development in Malacca River are set using an ordinal scale which can be used in advanced analysis such as a Likert scale. This Likert scale can be categorized into five (5) points (1-Strongly Disagree, 2-Disagree, 3-Normal, 4-Agree, 5-Strongly Agree). According to Figure 1, Malacca state can be divided into three districts, namely Alor Gajah, Jasin, and Melaka Tengah or Malacca Central. The total population for the three districts is 830,900 (Melaka State Government Official Portal, 2015)[21]. A research study done by Krejcie and Morgan (Krejcie and Morgan, 1970)[22] indicates that the selection of sample size can be determined using a formula (Figure 2) or tables (Figure 3). Nevertheless, researcher had made a target to achieve with at least 400 (Krejcie and Morgan, 1970)[22] local residents as respondents for sample size, which is the minimum number eligible for a research study, with random selection concentrated along the Malacca River.

Population Size Unknown;

Sample Size = $(\text{Range} / 2)^2 \div (\text{Accuracy Level} / \text{Confidence Level})^2$

Where;

Confidence Levels			**Accuracy Levels**
Level	**α**	**α/2**	Range X Desired Level of Accuracy (expressed as a proportion)
0.10	1.28	1.64	
0.05	1.64	1.96	
0.01	2.33	2.58	
0.001	3.09	3.29	

Population Size Known;

Size = $[X^2 NP\ (1\text{-}P)] \div [d^2\ (N\text{-}1) + X^2 P\ (1\text{-}P)]$

X^2 = table value of Chi-Square @ d.f. = 1 for desired confidence level

0.10 = 2.71 0.05 = 3.84 0.01 = 6.64 0.001 = 10.83

N = population size
P = population proportion (assumed to be 0.50)
d = degree of accuracy (expressed as a proportion)

Source: https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcRU0Ccc2pqn30piPV235tjemRBkmJxP4ar4h82y9nkP1oDyqbu-3w

Figure 1. Formula used to calculate sample size (known and unknown population size)

Table for Determining Sample Size for a Given Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size
"S" is sample size.

Source: Krejcie & Morgan, 1970

Source: http://www.kenpro.org/wp-content/uploads/2013/10/krejcie-and-morgan-table-of-determining-sample-size.png

Figure 2. Table used to defined sample size.

Since the Malacca River spans two districts, which are Alor Gajah and Malacca Central, so the sampling area will be concentrate at this two areas and along the Malacca River in Malacca state. The sampling area was divided into three categories, which are river, middle stream river, and downstream river. Upstream river only has 25% of the total target of respondents, and a majority of respondents that fulfill the target are from the middle stream river and downstream river. At the same time, various activities are carried out in the middle stream and downstream river areas, which can provide accurate and precise information for this research study. After the questionnaires are successfully collected and gathered, the information will be key-in into computer by using Statistical Package for Social Science or SPSS version 19 to perform data analysis. This data will be used to provide results through factor analysis.

Source: Malacca Town and Country Planning Department, 2012

Figure 3. Malacca state.

Result and Discussion

Analysis in this research study is based on descriptive analysis of the demographic profile and factor analysis of the water resources development in Malacca River as shown in Tables 2, 3, and 4.

Table 2
Demographic Profile

Category	Frequency (Percentage)
Gender	
Male	200 (50%)
Female	200 (50%)
Age	
< 20	1 (0.25%)
21 – 30	78 (19.5%)
31 – 40	183 (45.75%)
41 – 50	130 (32.5%)
≥ 51	8 (2%)
Number of Year live in Malacca	
1 – 10	40 (10%)
11 – 20	70 (17.5%)
21 – 30	130 (32.5%)
31 – 40	119 (29.75%)
41 – 50	40 (10%)
≥ 51	1 (0.25%)
Education Level	
Primary School	52 (13%)
Secondary School	166 (41.5%)
College	108 (27%)
University	74 (18.5%)
Employment	
Government	30 (7.5%)
Private	86 (21.5%)
Self-employed	131 (32.75%)
Retirees	78 (19.5%)
Student	74 (18.5%)
Others	1 (0.25%)

According to the analysis of the demographic profile, the number of respondents able to provide information was comprised of 200 men and 200 women. A majority of respondents that

took the time to complete the questionnaire were comprised of adults between ages 31 to 40 at 183 people (45.7%). Most of them are self-employed at 131 people (32.7%) with some that work in the private sector at 86 people (21.5%). In addition, the level of education of respondents indicated that most of them only studied until secondary school at 166 people (41.5%) as well as 52 people in primary school (13%), who settled in Malacca for a period of between 21 to 30 years is 130 people (32.5%). Following are adults, at 130 (32.5%) from ages 41 to 50 living in Malacca for 31 to 40 years (119 people or 29.7%) or 41 to 50 years (40 people or 10%) is working in the government sector (30 people or 7.5%), private sector (86 people or 21.5%), and a small number were in early pension (78 people or 19.5%). Most of respondents had an education up to university level at 74 people (18.5%) or at least until college level at 108 people (27%).

Lastly, respondents in the youth category from ages 21 to 30 consisted of 78 people (19.5%) and are mostly students pursuing colleges or universities level, and only settled in Malacca for short period between 1 to 10 years (40 people or 10%) or 11 to 20 years (70 people or 17.5%). There are also a number of respondents who work in government sector and private sector continue their studies at higher level such as master degree or doctor of philosophy degree. Respondents' perception in providing the information for the research on water resources development in Malacca River showed accurately, correctly, and precisely. This is because respondents have a higher exposure towards water resources in Malacca River. For example, majority respondents working as self-employed in businesses have settled down in Malacca for a period of time of at least 10 years. In other words, they were aware of changes in Malacca, particularly in uncontrolled exploration of land used development which causes destruction directly to environment. Meanwhile, respondents working in the government sector, private sector, as well as studying at university level, had deeper and critical thinking before taking any drastic action. For example, they realize that any exploration of extensive land used without unplanned development will 'spoil' the environment indirectly. So, they use their expertise to design and plan for development on paper before any building is constructed without approval. Therefore, the demographic profile of respondents is still important in determining the validity of information in water resources development in Malacca River.

Table 3
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.746
Bartlett's Test of Sphericity	Approx. Chi-Square df Sig.	1457.022 190 0.000

Table 4
Water Resources Development In Malacca River

Category	Component		
	1	**2**	**3**
Industrial waste and excretion waste will decrease water quality in river.	0.834		
Wastewater Action Plan.	0.730		
Toxic Reduction Plan.	0.724		
Habitat Protection Action Plan	0.707		
Water Acts 1920	0.692		
Sewage Service Act 1993	0.558		
Sewage and Industrial Effluents Act 1979	0.454		
Education Role.	0.385		
Water is habitat to aquatic animals.		0.793	
Green Technology Program Malaysia Malacca.		0.763	
Zero Plastic Program.		0.735	
River Program.		0.694	
Water Resource Program.		0.604	
Society or Community Role.		0.346	
Malacca River is polluted.			0.737
Surface water runoff increase water pollution.			0.716
Polluted water affect ecosystem.			0.688
Polluted water in river dangerous to aquatic animals.			0.658
River water pollution weakens the soil structure.			0.484
Parent role.			0.417
Eigenvalue	3.7	2.3	1.7
% of Variance	12.183	11.502	11.296
Cumulative % of Variance	12.183	23.684	34.981
Reliability Test	0.87	0.74	0.71
Number of Items (Total = 20)	8	6	6

Factor analysis is used to reduce the number of variables and to classify variables through detection structuring in the relationship between variables. Therefore, factor analysis has been applied on sustainable development in Malacca River, which involved 20 variables. Generally, factor analysis can only be performed when significant exist between the variables, which is based on the Bartlett's Test of Sphericity. Bartlett's Test of Sphericity is used to determine correlation between items (Chua, 2011)[23], where the value indicates 0.000 and it is less than 0.05 ($p<0.05$) (Table 3). So, the results have shown that it is significant between items and eligible to carry out factor analysis. Meanwhile, Kaiser-Meyer-Olkin or KMO test demonstrate *multicollinearity* (Chua, 2011)[23], where the same value of correlation between two or more items

and these items will determine the similarity aspect. In other words, KMO test will help the researcher to identify either the items can carry out with factor analysis, which is based on the absolute minimum value to be accepted is 0.5. In this case, the KMO value is 0.746 (KMO test>0.5) (Table 3) and these items are suitable for factor analysis.

Three factors have been identified for water resources development in Malacca River. The factors are policy, law and regulation for waste pollutants (F1), environmentally friendly program for water resources (F2), and water pollution in an environmental ecosystem (F3) (Table 4).

Factor 1: Policy, law and regulation for waste pollutants

The factor explains 12.183% of the variance in the data set, which included eight (8) variables in policy, law, and regulation of waste pollutants. As previously investigation stated that industrial waste and excretion waste become main issues to cause contamination and decrease the water quality in river (Hua and Kusin, 2015)[18]. This matter is supported by local residents and state government. Therefore, several policies like Wastewater Action Plan, Toxic Reduction Plan, and Habitat Protection Action Plan. together with laws and regulations like Water Acts 1920, Sewage Service Act 1993, and Sewage and Industrial Effluents Act 1979, are enforced by the state government. The Wastewater Action Plan has been suggested to increase wastewater treatment and disposal facilities together with operation and maintenance, while the Toxic Reduction Plan is applied to factories by reducing chemical waste products through recycled activity for reused purpose, and Habitat Protection Action Plan aims to save and protect endangered aquatic animals in river. Meanwhile, Water Acts 1920 is to avoid any foreign materials entering river without permission, Sewage Service Act 1993 is to increase sewage treatment and always maintained the quality service, and Sewage and Industrial Effluent Act 1979 is to regulate factories such that every wastes product should undergo for treatment before discharge onto land or into river. However, education plays an important role than policy law and regulation because it will mature and awaken a person before any actions taken recklessly without making plans, especially towards the environment. Concern and awareness for saving and protecting the environment is important and should be strengthened in the early stages like primary school level. In addition, moral and ethical value are compulsory be taught at this level (e.g. in primary school) so that they know about the environment that everyone will have the right to shared and used, and should not be greedy and selfish on environment which may cause damage to the environment. Therefore, education, policy, law, and regulation are all important to control and stop the waste pollutants from continuing to harm and destroy the environment.

Factor 2: Environmental friendly program for water resources

The second factor explains 11.5% of the variation in the data set. It consists of six (6) variables in environmental friendly programs for water resources. Water comprising H_2O element, which making it's very unique and required by all living creature. This condition is no exception to aquatic animals. Water is important to aquatic animals in terms of food source, shelter area, and habitat. Hence, polluting the Malacca River will cause poisoning, death, and extinction of aquatic animal's species. So, the state government introduced and promoted programs such as the Green Technology Program Malaysia Malacca, Zero Plastic Program, River Program, and Water Resource Program. Green Technology Program Malaysia Malacca has been suggested by state government to obligate local residents to use environmental friendly products to decrease river pollution, for example using eco-friendly shampoo when taking bath, using earth-friendly edible oils when cooking, and using bio-diesel when carry out an activity involving machines. The Zero Plastic Program is applied by using fewer plastic products to decrease chemical toxic waste production and increase recycle program to reduce plastic garbage waste that are hard to decomposes. The River Program highlighted by state government encourages local resident to participate in cleaning the river from garbage and increase promoting in loving the river. The Water Resource program is a minor factor by 'saving and recycling' the water by using rainwater collection program for outdoor activities like washing cars, gardening, and so on. Nevertheless, society and community also play an important role to success of these programs. Human beings are born to take care of each other, especially when there are other people making mistakes and need advice. Living in society and helping and advising each other in sustaining water resources in Malacca River will maintain the quality and quantity of the environment both directly and indirectly. Although nowadays is the modern era, attitudes of greed, arrogance, and selfishness should be removed in order to maintain an attitude of caring for each other that can be nurtured especially in protecting the environment. Therefore, applying environmental friendly programs and caring for each other in community or society will help to sustain the quality and quantity of water resources in Malacca River.

Factor 3: Water pollution for environmental-ecosystem

Last factor explain 11.296% of the variance in the data set with six (6) variables in water pollution towards environmental ecosystem. According to the report of DOE in 2012 stated Malacca River is polluted due to human activities, namely agricultural, livestock, factories, commercial, municipal, settlements, and open space. However, there are various factors to cause pollution in Malacca River, for example landslides and soil erosion, wastes of fallen trees, and air pollution. Basically, air pollution will indirectly cause water pollution in the river. This problem can occur when there are too many vehicles in urban area will lead to air pollution due to carbon monoxide. So, the carbon monoxide will mix with moisture to form a toxic moisture and cause acid rain to cool the Earth surface. Indirectly, rain water drops onto surface will create surface water runoff, where it's flows from high area to low area and ended in the river before it

flow into the sea. Hence, surface water runoff which consider as 'acid' will cause pollution to the Malacca River. At the same time, the fast water flow will have energy to transport foreign material such as liquid and solid form that have light weight to float on the water and entering the river. This situation will cause water quality in Malacca River to decrease by a certain percentage due to mixture of acid rain and foreign material. Not to forget, water flow on the surface will be absorbed into the soil to become groundwater, which is used for internal purposes (e.g. drinking, cooking). Since there are mixtures of acid rain and foreign material, when absorbed into soil, this situation will cause changing soil quality. For example, polluted water will affect soil nutrients and weaken the soil structure. This may result in erosion and sedimentation problems in the river. Not only that, the plant species will also be affected due to soil erosion and caused trees to fall into the river. Mixtures between acid rain, foreign material, soil sedimentation, and tree wastes lead to water pollution in Malacca River, which can cause danger to aquatic animals. When aquatic animals experience death and extinction, this will affect the whole ecosystem because submerged aquatic vegetation or seaweed is considered as one of the primary producers of the aquatic food chain. This is the reason why parental roles are important in shaping their children's' attitudes towards the environment. It is parent's responsibility to teach, advice, guide, and showing a good example especially in saving and protecting the environment. If parents fail in this responsibility, then the environment which people depend on to continue survive will vanish and be lost forever.

Conclusion

In conclusion, water resources in the Malacca River are in critical condition because the water quality status is changing from partially polluted into polluted. These results was proved through the perception of respondents, where they experience the significant changes in color and bad odor, the death of fish, garbage waste and chemical waste, and trees waste and soil sedimentation. Therefore, the state government is taking action by applying several approaches such as policy and law-regulation, environmental friendly program, and moral and ethical value. Although the policy will take a long term to be implemented, laws and regulations will serve in the short term to keep the process of policy successfully applied into local residents. Not only that, the awareness in using environmental friendly product also promoted by the state government in order to reduce pollutants contaminating the Malacca River. Indirectly, moral and ethical values can be implemented as minor support for reducing river pollution. The purpose for state government to take drastic action by applying several approaches such as to control the pollution factors like agricultural and livestock activities, factory activities, commercial activities, and so on, from continuing to contaminate the Malacca River. Since water quality needs a long period to recover to become clean, thus the approaches should be successfully implemented and applied by local residents to stop pollute the Malacca River. Therefore, local residents should collaborate with the state government to save, protect, and sustain the water resources in Malacca River from destruction and being lost forever.

References

1. National Geographic Official Portal (2015). *Conservation*. Retrieved from http://education.nationalgeographic.com/encyclopedia/conservation/
2. Gleick, P.H. (1993). Water in Crisis: A Guide to the World's Freshwater Resources. *Oxford University Press*, p.13.
3. Hua, A.K. (June 2015). An Indication of Policy Study towards Water Resource in Malacca State: A Case Study of Malacca River, Malaysia. *International Research Journal of Social Sciences*. 4(6), 15-20.
4. National Geographic Official Portal (2015). *Water pollution*. Retrieved from http://environment.nationalgeographic.com/environment/freshwater/pollution/
5. Bittner, M. (July 04, 2013). The World's Most Polluted River. *EHS Journal*. Retrieved from http://ehsjournal.org/http:/ehsjournal.org/michael-bittner/the-worlds-most-polluted-rivers/2013/
6. Hua, A.K. and Marsuki, M.Z. (2014). Public perception towards environmental awareness. Case study: Malacca River. *International Journal of Academic Research in Environmental and Geography*. 1(2), 53-61.
7. WWF Official Portal (2015). *Study the effect of pollution on an ecosystem*. Retrieved from http://wwf.panda.org/about_our_earth/teacher_resources/project_ideas/pollution/
8. Department of Environment Malaysia (2012). *Malaysia Environmental Quality Report 2012*.
9. Bernama Official Portal (November 22, 2008). *Pengiktirafan Tapak Warisan Dunia UNESCO Mampu Lonjak Ekonomi Negara*. Retrieved from http://www.bernama.com/bernama/v3/bm/news_lite.php?id=373739
10. UNESCO Official Portal (2015). *Melaka and George Town, Historic Cities of the Straits of Malacca*. Retrieved from http://whc.unesco.org/en/list/1223
11. Tourism Malaysia Official Corporate Website (2015). Facts & Figures. Retrieved from http://corporate.tourism.gov.my/research.asp?page=facts_figures
12. Nasbah, N.N. (January 23, 2010). *Sungai Melaka tercemar*. Utusan. Retrieved from http://www.utusan.com.my/utusan/info.asp?y=2010&dt=0123&sec=Selatan&pg=ws_01tm
13. Jabar, B.H. (August 09, 2010). Melaka: Longkang tercemar. *Berita Harian Online*. Retrieved from http://www.bharian.com.my/bharian/articles/Melaka_Longkantercemar/Article/.
14. Hua, A.K. and Kusin, F.M. (May 25, 2015). A Review of Applied GIS Based in Sustainable Water Resources Management in Malacca River. Case Study: An Observation Perspective. *International Journal of Scientific Research in Science, Engineering and Technology*. 1(3), 157-162.
15. WCED (World Commission on Environment and Development) (1987). *Our Common Future*, Oxford University Press, Oxford.
16. IUCN (World Conservation Union), UNEP (United Nations Environment Programme)

and WWF (World Wide Fund for Nature) (1991) *Caring for the Earth: A Strategy for Sustainable Living*, IUCN, Gland, Switzerland.

17. Hussain, A. (1992). *Working towards sustainable development*, Conference report. Southern Asian Institute, New York.
18. Hua, A.K. and Kusin, F.M. (June 16, 2015). Remote Sensing towards Water Quality Study in Malacca River. Case Study: A Review Perspective. *International Journal of Scientific Research in Science & Technology*. **1**(2), 9-15.
19. Clark, M.J. and Gardiner, J. (1994). Strategies for handling uncertainty in integrated river basin planning, *in Integrated River Basin Development*, edited by C. Kirby and W.P. White. John Wiley and Son, Chichester.
20. Xu, Z. X., Takeuchi, K., Ishidaira, H., & Zhang, X. W. (2002). Sustainability analysis for Yellow River water resources using the system dynamics approach. *Water Resources Management*, *16*(3), 239-261.
21. Melaka State Government Official Portal (2015). *Fact & Number*. Retrieved from http://www.melaka.gov.my/en/tentang-kami/fakta-nombor
22. Krejcie, R.V. and Morgan, D.W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*. **30**, 607-610.
23. Chua, Y.P. (2011). *Kaedah dan statistic penyelidikan: kaedah penyelidikan*. Mcgraw Hill Education.

Citation in English

Ang Kean Hua. (2018). Water Resources Development In Malacca River. *Muallim Journal of Social Sciences and Humanities*, 2(4), 251-264.