© 2015 IJSRSET | Volume 1 | Issue 4 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Science

Introduction to Methodology Framework towards Water Quality Assessment Case Study: A Review of Malacca River

Ang Kean Hua, **Faradiella Mohd Kusin**
Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

ABSTRACT

Water is a basic resources required by organisms for survival. Various activities have caused water quality to remain contaminated. These problems are present in the Malacca River, Malacca state. This research study has been carried out based on methodology framework review towards water quality assessment in Malacca River. Methodology can be divided into three processes, namely the planning process, applying process, and analyzing process. The planning process includes the design to collect and gather, analyze, and present the data in result form, for example qualitative or quantitative analysis, and primary data or secondary data. Applying process refers to the methods used to collect and gather data for analysis; for example, primary data will require researcher to collect raw samples data from the site, and secondary data will require researcher to collect data from government departments and institutions, the private sector, non-governmental organizations (NGOs) and so on. Lastly, the analyzing process refers to the raw data undergoing analysis to provide result and information; for example, primary raw data and secondary raw data will need to be analyzed in a laboratory, in-situ analysis, GIS analysis, remote sensing analysis, other system analysis, and so on, depending on the objective of research study. If there were no mistakes or errors before, during and after collecting data, the results and information generated can determine the achievement of objectives or hypotheses of a research study.

Keywords: Methodology, planning process, applying process, analyzing process, water quality.

I. INTRODUCTION

Water is a basic resource required by organisms to continue surviving. Water is used to carry out several activities [1], such as drinking, bathing, washing, cooking, etc. According to the statistic, water covers 71% of Earth, which can be divided into oceans (96.5%), groundwater (1.7%), and glaciers and permanent snow (1.74%) [9]. For freshwater, only 2.5% exists in rivers, lakes, and atmosphere (with a percentage of less than 0.3%), while 98.8% is comprised of freshwater that exists in ice and groundwater [9]. In this situation, there is a smaller percentage (0.003%) that can be used by the organisms for certain activities [9]. Due to this, the easiest way to consume freshwater is through rivers and lakes. According a research from Gleick [9], the largest area of lakes that exist in the world includes Lakes Superior (82,680 km^2 in North America), Victoria (69,000 km^2 in Africa), Huron (59,800 km^2 in North America), Michigan (58,100 km^2 in North America), and Tanganyika (32,900 km^2 in Africa) (figure 1); meanwhile the longest rivers in the world include 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) (figure 2).

Until today, accessible of freshwater has been decreasing. This problem is caused by human activities that contaminate freshwater, and water pollution can be seen through river pollution. According to the Environmental Department of National Geographic [14], a majority of industrial companies in developing countries (at 70%) will dumped the untreated waste into waters, polluting the usable water supply. From the statistic shows that 99 million pounds (45 million kilograms) of fertilizers and chemicals are used each year, and 2 million tons (1.8 billion kilograms) of human

waste are disposed in waterways around the world everyday [14]. Human activities have caused river water pollution to occur all around the world, for example in the Ganges River (India), Jian River (China), the Jakarta River in Jakarta (Indonesia), Pasig River (Philippines), Tiete River (Brazil), and Yamuna River (India) [4]. River water pollution is also occurring in Malaysia, in which 161 (34%) rivers are slightly polluted and 34 (7%) rivers are polluted of the 473 rivers that being monitored [5]. Water pollution in the river can be attributed to human activities such as manufacturing industries (4,595 cases), animal farm especially the pig farming (754 cases), agro-based industries (508 cases), sewage treatment plant (1,462,897 cases), food services establishment (192,710 cases), and wet market (865 cases) [5]. Water pollution in rivers is no exception in the Malacca River in Malacca state [13], which was recognized as a historical and heritage site by UNESCO in July 2008 [7]. Therefore, these problems should be taken seriously in controlling and managing water pollution from continuously occurring in the river.

Table 1 : Large fresh lakes of the world
(with surface area greater than 5,000 km^2)

Lake	Area (km^2)	Volume (km^3)	Maximum depth (m)	Continent
Superior	82,680	11,600	406	North America
Victoria	69,000	2,700	92	Africa
Huron	59,800	3,580	299	North America
Michigan	58,100	4,680	281	North America
Tanganyika	32,900	18,900	1,435	Africa
Baikal	31,500	23,000	1,741	Asia
Nyasa	30,900	7,725	706	Africa
Great Bear	30,200	1,010	137	North America
Great Slave	27,200	1,070	156	North America
Erie	25,700	545	64	North America
Winnipeg	24,600	127	19	North America
Ontario	19,000	1,710	236	North America
Ladoga	17,700	908	230	Europe
Chad	16,600	44.4	12	Africa
Maracaibo	13,300	–	35	South America
Tonlé Sap	10,000	40	12	Asia
Onega	9,630	295	127	Europe
Rudolf	8,660	–	73	Africa
Nicaragua	8,430	108	70	North America
Titicaca	8,110	710	230	South America
Athabasca	7,900	110	60	North America
Reindeer	6,300	–	–	North America
Tung Ting	6,000	–	10	Asia
Vänern	5,550	180	100	Europe
Zaisan	5,510	53	8.5	Asia
Winnipegosis	5,470	16	12	North America
Albert	5,300	64	57	Africa
Mweru	5,100	32	15	Africa

Source: Retrieved from Gleick (1993, p14).

Water pollution in the river can be divided into several parameters, namely physical parameters, chemical parameters, and biological parameters. If river water pollution is at toxic levels (which causes death in aquatic animals), then experiments should be carried out to test the presence of heavy metals. Physical parameters include temperature, color, odor, taste, total suspended solid, total dissolved solid, transparency or turbidity, electrical conductivity, hardness, and salinity [5] [6]. Meanwhile, the chemical parameters will be tested in terms of ammoniacal nitrogen (NH_3-N), biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), and measurement of acid and base properties (pH) [5] [6]. The final water tests examine biological parameters, which may include fecal coliform, Escherichia coli (*E-coli*), and total coliform [5] [6]. Importantly, heavy metals will also be analyzed to detect the percentage of water poisoning, involving mercury (Hg), arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), and zinc (Zn) [5]. Basically, the standard procedure used to test the water quality is based on the American Public Health Association (APHA) [2] standard method for the examination of water and wastewater [3]. However, there are several institutions which have introduced other methods that are easier, faster, and have a lower low cost. These can be used to examine wastewater. Examples include the HACH company [10]; United States Environmental Protection Agency [8]; and the SASKATCHEWAN Research Council [16]. Analytical methods of testing wastewater are compulsory for academicians, researchers, and students to know in order to avoid any mistakes during the experimental process.

Table 2: Large rivers of the world
(with mean annual runoff greater than 200 km^3)

River	Average runoff (km^3/ yr)	Area of basin (10^3 km^2)	Length (km)	Continent
Amazon	6,930	6,915	6,280	South America
Congo	1,460	3,820	4,370	Africa
Ganges (with Brahmaputra	1,400	1,730	3,000	Asia
Yangzijiang	995	1,800	5,520	Asia
Orinoco	914	1,000	2,740	South America
Paraná	725	2,970	4,700	South America
Yenisei	610	2,580	3,490	Asia
Mississippi	580	3,220	5,985	North America
Lena	532	2,490	4,400	Asia
Mekong	510	810	4,500	Asia
Irrawaddy	486	410	2,300	Asia
St. Lawrence	439	1,290	3,060	North America
Ob	395	2,990	3,650	Asia
Chutsyan	363	437	2,130	Asia
Amur	355	1,855	2,820	Asia
Mackenzie	350	1,800	4,240	North America
Niger	320	2,090	4,160	Africa
Columbia	267	669	1,950	North America
Magdalena	260	260	1,530	South America
Volga	254	1,360	3,350	Europe
Indus	220	960	3,180	Asia
Danube	214	817	2,860	Europe
Salween	211	325	2,820	Asia
Yukon	207	852	3,000	North America
Nile	202	2,870	6,670	Africa

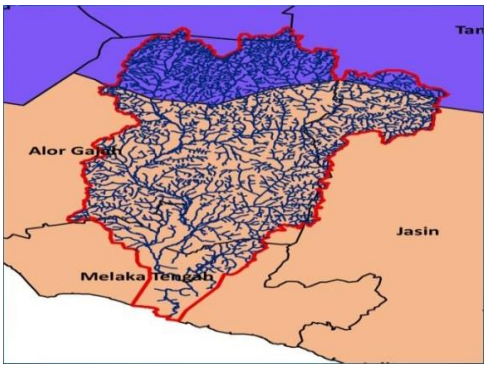
Source: Retrieved from Gleick (1993, p16).

II. METHODS AND MATERIAL

Research study will focused on the Malacca River in Malacca state. Malacca River runs across two districts (Alor Gajah and Melaka Central) with a length of 42 km [15]. If referring to the Malacca River basin, this covers a large area involved with three districts, namely Alor Gajah, Jasin, and Melaka Central (figure 3). Since land use plays a role in determining the quality of river water, human activities carried out within river basins will be considered as a factor that contributes to river pollution (figure 4). Hua and Kusin [11] have stated that the observation results from the map using remote sensing showing the human activities and the land used area can be divided into three categories, which is upstream area including farming activities, livestock activities and settlements activities; middle stream area including industrial activities, manufacturing activities and settlement activities; and downstream area including commercial activities, domestic activities and settlement activities. However, the results and information from remote sensing will be strengthened when there is more varied data (for example statistical data, questionnaire data, and so on) grouped together and analyzed to provide accurate results.

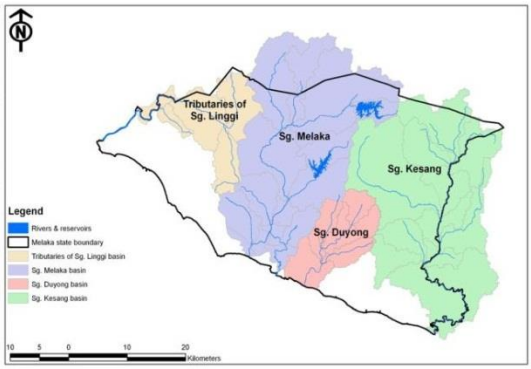
The process of collecting and analyzing data will involve *in situ* or on-site assessment (example analysis of physical parameters) and in the laboratory assessment (example analysis of chemical parameters, biological parameters, and heavy metals). Collecting the water samples for this research study may be divided into 3 categories (for between 10 and 15 stations of water samples), namely upstream river, middle stream river, and downstream river. The numbers of selected stations to collect the water sample do not depending on quantity, but rather are based on suitable area (for example, the meeting between two rivers to form main river), which creates larger river basins. Hence, the more human activities that are carried out in the basin area, the higher the percentage of water pollution in the river. There will be more stations concentrated in the middle stream area and downstream area (due to an increasing land use and human activities), while only some are located in the upstream area. The main reason to carry out an assessment is to prove the condition of river water quality is clean, slightly polluted, and polluted; this statistical analysis will increase the accuracy, authenticity and reliability of remote sensing results. At the same time, the results will help determine point source and non-point source pollution, which may be used to define the major factors contributing to water pollution in the river.

Figure 1: Malacca River Basin across three districts



Source: http://image2.slideserve.com/4405243/slide18-n.jpg

Figure 2: Malacca River basin covers the Malacca state



Source: http://image2.slideserve.com/4405243/main-river-basins-in-the-flood-mitigation-master-plan-for-melaka-n.jpg

III. RESULTS AND DISCUSSION

In achieving the objectives or hypotheses in solving the society issues, methods go through planning process, applying process, and analyzing process the data that had been collected and obtained from any sources (figure 1). In the planning process for collecting the data, the methodology concept will be involve qualitative and quantitative information. At the same time, the collected data are also needs to be determined in terms of whether the data will be primary data or secondary data. Both actions must be specifically defined so that there will be no mistaken or wrongly collected information in the applying process.

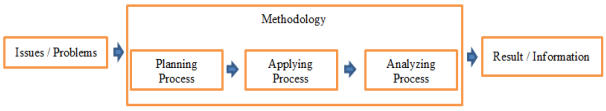


Figure 3: Methodology in a research study.

This research study will involve the quantitative method, which means it considers large amounts of data. For example, physical parameters, chemical parameters, biological parameters, and heavy metals, will be collected and analyzed in different categories. On the other hands, this research are also takes into account a number of years to determine the changes that have occurred in water quality in Malacca River, for example from 2001 to 2012 (depending on the permission and approval of DoE, Malaysia) and 2015. The collection data for this study will involve primary and secondary data. The researcher will collect water samples from Malacca River (primary data in 2015) and perform analysis of the raw samples in a laboratory. Meanwhile, the secondary data will be requested from the Department of Environment, Malaysia, from 2001 to 2012. However, the data for 2013 and 2014 will not be approved and released to the researcher due to factors of national security. The main purpose for collecting primary data is to make comparisons with secondary data in determining the factors that contribute to water pollution in Malacca River; and the primary data can also be used to prove the reliability of using secondary data to conduct this research study. Therefore, the planning process in methodology will be successful when the application process does not encounter any problems in collecting raw data.

Applying process refers to the methods used to collect and gather data for analysis. Since secondary data is referred to the data that have been collect by other researchers [12], the information for this research study will be collect directly from the government institution. However, primary data are derived from original sources or the first data [17]. In other words, the researcher has to collect the water sample from Malacca River and analyze the raw data in the laboratory. The water sample will be taken from the stations that have been specified for research via 'grab sampling', in which the researcher will go into the middle of river to take water samples or use a small bucket thrown into the middle of river (if the river is too deep and dangerous) (figure 4). The main purpose of using 'grab sampling' is that all of the test material is collected at a point (which refer to particular place) at one time, as the sample should be collected carefully and proper way to prevent mixing with foreign materials. If water is collected in a bucket, the sample will be placed in plastic bottle or glass bottle sample that have been devoted to water samples (figure 5). If the water sample will not be analyzed at the same time and day, the water sample will need to be preserved using acid to reduce the activeness rate of organic microorganisms in water samples, for example sulfuric acid (H_2SO_4) or nitric acid (HNO_3). This river water sample will be taken directly to the laboratory for analysis to obtain the results.

Figure 4: Grab sampling method used to collect water sample

Source:
(upper figure)
http://sustainability.psu.edu/sites/default/files/styles/site_content_header_image/public/images/SarahTzilkowski_0.jpg?itok=7FVJRih-
(lower figure)
http://www.joyeresearchgroup.uga.edu/sites/default/files/bucket-to-retrieve-oil_WS_web.jpg

Figure 5: Plastic bottle sample or glass bottle sample

Source:http://water.me.vccs.edu/courses/env211/changes/samplebottles.jpg

Once the river water samples are sent to the laboratory, an analysis will be conducted to obtain the results of river water quality. The analyzing process will involve two methods, namely *in-situ* analysis (on site or in position analysis) and laboratory analysis. Among the parameters that can be carried out for *in-situ* analysis are chemical parameters (DO and pH) and physical parameters, concerning temperature, color, odor, taste, total dissolved solid, transparency or turbidity, electrical conductivity, hardness, and salinity. This analysis on site can be conducted using meters for DO, pH, turbidity, conductivity and salinity, humidity temperature, total dissolved solids, and so on. Meanwhile, the laboratory analysis will determine the water samples such as physical parameter (total suspended solid), chemical parameters, biological parameters, and heavy metal. Among the machines involved to test the samples are vacuum pumps with glass microfiber filter, BOD meter, COD meters, ammoniacal nitrogen meters, MEL/MPN total coliform and E-coli laboratory with petrifilm plate, incubator, inductively coupled plasma mass spectrometry (ICP-MS) or an atomic absorption spectrometer (AAS) for heavy metal test. There are some parameters involved in laboratory analysis which will be extended to several days to determine the activeness of material in water samples. After analysis is conducted (if there are no mistake or error in methods of analysis), then the results will be obtained for each parameters and the next step can be carried out, including processing results, discussion, and conclusion of the research study. Therefore, the objective or hypothesis study can be presented to demonstrate the achievements of the research study.

IV. CONCLUSION

This study highlights the methodology used to collect data in Malacca River for this research study. Since the research study is involve with quantitative method, the data need to be collect in various, many, and large quantity for analysis, which involve with primary and secondary data. Primary data can be obtained through collection of raw sample data from river water and analysis on-site and in a laboratory, while secondary data will be collected from government departments and institutions or the private sector. Primary data will provide information demonstrating conditions of the Malacca River and factors (including the major factor) contributing to river water pollution. Since the secondary data have certain weaknesses, the primary data can be used to compared with the secondary data in determine the accuracy, relevance, and reliability before continue for further analysis. Secondary data is used to evaluate the start of contamination and the factors causing river water pollution based on the land use area. Rapid development may be considered to harm the river, but does not necessarily act as a factor contributing to river water pollution, depending on land use planning and management. Lastly, methodology is important to reach the objectives or hypotheses and determine the success of this research study.

V. REFERENCES

[1] Acreman, M.C. (1998). Principle of water management for people and the environment. In Water and population dynamics. Ed. A. de Shirbinin & V. Dompka, pp. 25-48. Washington, DC: American Association for the Advancement of Science.

[2] APHA Official Portal (2015). About APHA. Retrieved from https://www.apha.org/about-apha

[3] APHA Official Portal (2015). Standard methods for the examination of water and wastewater. Retrieved from http://www.mwa.co.th/download/file_upload/SMWW_1000-3000.pdf

[4] Bitrner, M. (July 4, 2013). The World's Most Polluted River. EHS Journal. Retrieved from http://ehsjournal.org/http:/ehsjournal.org/michael-bittner/the-worlds-most-pollutedrivers/2013/

[5] Department of Environment (2012). Malaysia Environmental Quality Report 2012.

[6] Department of Irrigation and Drainage (2009). Study on the river water quality trends and indexes in Peninsular Malaysia. Water Resources Publication, No. 2.

[7] Department of Town and Country Planning (2015). World Heritage City. Retrieved from http://www.jpbdmelaka.gov.my/bandarwarisan.html

[8] EPA Official Portal (2015). Water Quality Conditions. Retrieved from http://water.epa.gov/type/rsl/monitoring/vms50.cfm

[9] 1Gleick, P.H. (1993). Water in Crisis: A Guide to the World's Freshwater Resources. Oxford University Press, p.13.

[10] HACH Official Portal (2015). Application – Wastewater Discharge. Retrieved from http://sea.hach.com/wastewaterdischarge

[11] Hua, A.K. and Kusin, F.M. (2015). Remote Sensing towards Water Quality Study in Malacca River. Case Study: A Review Perspective. International Journal of Scientific Research in Science and Technology. 1 (2), 9-15.

[12] Marican, S. (2005). Social Science Research Methods. Prentice Hall/Pearson Malaysia.

[13] Nasbah, N.N. (January 23, 2010). Sungai Melaka tercemar. Utusan Online. Retrieved from http://ww1.utusan.com.my/utusan/info.asp?y=2010&dt=0123&sec=Selatan&pg=ws_01.tm

[14] National Geographic Official Portal (2015). Water Pollution. Retrieved from http://environment.nationalgeographic.com/environment/freshwater/pollution/

[15] River and Coastal Development Corporation Malacca Official Portal (2015). River Information. Retrieved from http://ppspm.gov.my/versionBI/index.php/muzium-perhutanan/informasi-sungai

[16] SASKATCHEWAN Research Council Official Portal (2015). Water Quality Testing. Retrieved from http://www.src.sk.ca/industries/environment/pages/water-quality-testing.aspx

[17] Yusof, R. (2003). Social Science Research. Pahang, Malaysia: PTS Publications & Distributors.

[18] URL : http://www.slideserve.com/ashby/jabatan-pengairan-dan- saliran-melaka