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Applied GIS in Assessment Water Quality Modeling in the Malacca River. Case Study: Introduction to Research Study

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ABSTRACT

A research study documents the process of examination, using experimentation or investigation to discover and interpret on certain topic for the purpose of increasing the understanding of an issue. The main purposes of research study are to help people to understand and solve problems, communicate ideas and information to the public, help researchers to make decisions through data collection, and develop new knowledge for humankind. Research may be divided into the first stage (problem statement, research questions, hypothesis or objectives), second stage (literature review, research design, instrumentation, preliminary study), and third stage (data collection, data analysis or research findings, preparation of reports). The problem statement of this study involves river water pollution, while the objective of the study is to assess river water quality in the Malacca River, to determine major source and the factors contributing to river pollution, and to determine a spatial decision support system (SDSS) for minimizing water pollution in the Malacca River. The research design involves a quantitative approach (experimental methods), which collects primary data (water sample from Malacca River and GPS data information) and secondary data (water sample from government, GIS map-based data, and RS data). This data will be grouped together and undergo the analysis process of GIS and RS to develop SDSS. Information and results provided will become answers to the objective and determination of achievement of the research study. Therefore, this study provides new information for other researchers to perform more in depth research according to their field of study.

Keywords: Research study, water quality, GIS, RS, SDSS.

I. INTRODUCTION

A research study may be defined as 'gathering data, information and facts for the advancement of knowledge' [16]; 'a process to collect and analyze information in systematic steps with purposely to increase the understanding of an issue or topic' [4]. In more detail, a study is 'hard work in examination especially towards experimentation or investigation with the aimed to discover and interpret the facts, revision of accepted theories or laws in accordance to new facts, or practically application of new or revised theories or laws' [17]. The definition for a research study may be described by various definitions in accordance with the specific field of study, but the main purpose for carrying out a research study is to help people to understand and solve problems, communicate ideas and information to the public, help researchers to make decisions through data collection, and develop new knowledge for humankind. Conducting a research study should undergo in a systematic process, which may be divided into three stages namely first stage (problem statement, research questions, hypothesis or objectives), second stage (literature review, research design, instrumentation, preliminary study), and third stage (data collection, data analysis or research findings, preparation of reports). The probability of success for a research study can only be increased by following systematic methods such as the three phases stated previously.

According to the world statistics, a majority of developing countries (70 percent) are dumped the industrial wastes with untreated into water especially river and polluting the usable supply [14]. One of the

factors that causes these issues to occur is about 99 million pounds or 45 million kilograms of fertilizers and chemicals, and 2 million tons or 1.8 billion kilograms of human waste disposed into the waterways around the world every day [14]. The world's most polluted rivers are the Ganger River (India), Jian River (China), Jakarta River (Indonesia), Pasig River (Philippines), Tiete River (Brazil), and Yamuna River (India) [2]. River pollution is not exceptional to Malaysia. According to the report from Department of Environment in 2012, 41 percent or 195 rivers out of 278 are considered polluted, including the Malacca River in Malacca state. According to the report of Department of Environment [5], recorded 15,740 are water pollution that arises from variety of sources namely wastewater plants (63%), manufacturing industry (29%), animal farms (5%), and agricultural activities (3%). Hence, the problem of water pollution should be dealt as soon as possible by investigating the causes and contributing factors of pollution, and conducting a research study to find a solution for water pollution.

Malacca is a popular and well-known as World Heritage Site recognized by UNESCO in July 7, 2008 [6], leading the state become as a tourist destination based on historical tourism industry with the famous of A' Famosa City, Portuguese village, Bukit St John, Christ Church, Cheng Hoon Teng temple, etc. [12]. Apart from the historical value, the tourism industry is also focused on recreational activities such as the Melaka River Cruise, Zoo Melaka, Taman Buaya Melaka, Taming Sari Tower, Taman Botanikal Melaka, and so on [13]. The development of Malacca state is at an advanced stage and has provided job opportunities, services, and a comfortable life to the local residents while attracting the attention of various communities to concentrate in Malacca. Centralization or concentrated at Malacca city has affected the quality of environment such as water pollution in the Malacca River [15] [11] [7]. These issues and problems have had a negative impact on the local residents. An observation research had done by Hua & Kusin [10] stated that there are various human activities that carried out along the Malacca River such as agriculture, livestock, factories, commercial activities, and settlements. This situation does not only affect the tourism industry of Malacca state, but also brings harm to human and animals. Therefore, a research study should be carried out to solve this problem from continuously disrupting human life (for example daily activities and health) and harming animals (for example extinction or poisoning).

II. METHODS AND MATERIAL

The methodology used to carry out a research study involves the stages process, namely stage one, stage two, and stage three. These stages are further depicted in figure 1 and figure 2.

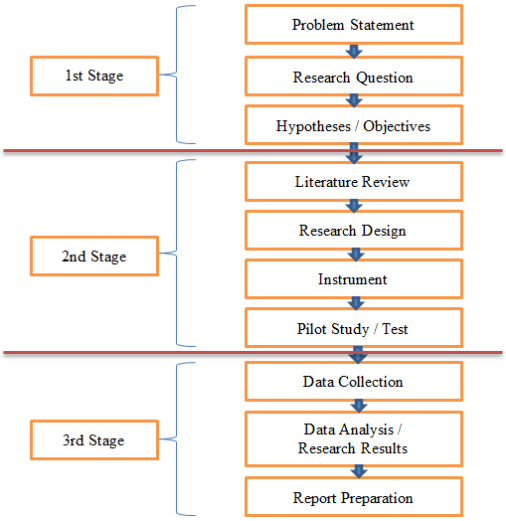

Figure 1: Stages process for research study.

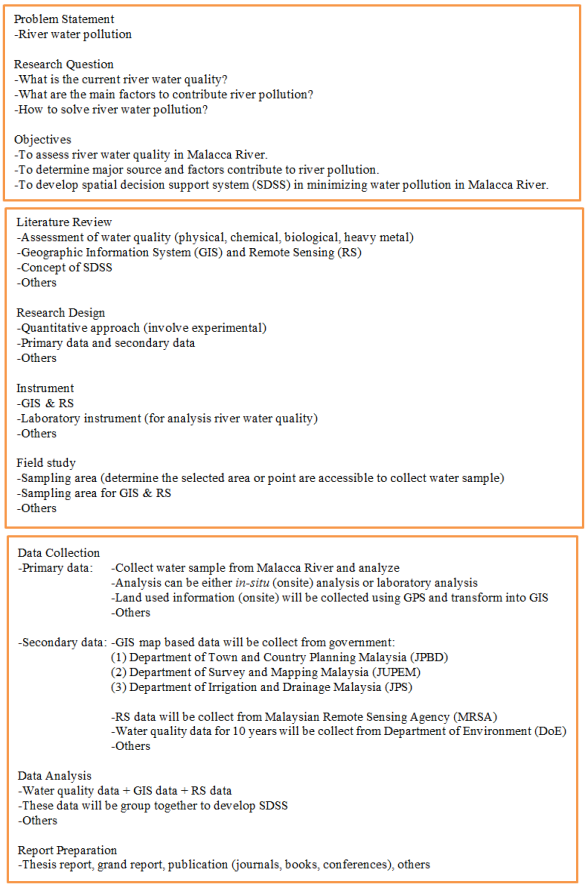

Figure 2: Stages of the process to assess water quality

III. RESULT AND DISCUSSION

Since water quality in the Malacca River is affected by water pollution due to certain activities, a research study should carried out to prevent and seeking solution to the river pollution from being continuously polluted. The problem statement in this research study is the river water pollution, which becomes the first step to be involved in the first stage. Since the researcher needs to find the answer for river water pollution, the first questions will be 'what is the current river water quality?' 'Is the water quality in river are slightly polluted or polluted?' 'What is the value used to determine water pollution?' 'Did the pollution value is based on physical parameters, chemical parameters, biological parameters, and heavy metal?' Next, the second questions that come to mind are 'what are the main factors to contribute river pollution?' 'Did river pollution happen naturally?' or 'Did the river pollution that happen has connection with human?' Lastly, researcher will apply critical thinking by asking 'How to solve the river water pollution?' 'Can humans stop the contributing factors of pollution?' and 'How much are the percentage of successful to implement the idea of reducing the river pollution?' Therefore, the objective of this research study is to assess river water quality (which involve physical parameters, chemical parameters, biological parameters, and heavy metals) in the Malacca River, to determine major source (refer to point source and non-point source pollution) and the factors (human activities, animals activities, natural activities) that contribute to river pollution, and to develop a spatial decision support system (SDSS) in minimizing water pollution in the Malacca River.

After the first stage is defined, the second stage will be carried out for the literature review, research design, instrument, and field study. Literature review can be explained as making references with critically and systematically on documents containing information, ideas, data and methods of obtaining information, which is relevant to the topic of research study [3]. In this research study, researcher will do refer to references of methods to assess water quality, which involve physical parameters, chemical parameters, biological parameters, and heavy metals. Generally, these four parameters will have different methods to analyze the raw water from river. For example, there are some physical parameters and chemical parameters can be analysed onsite or *in-situ*, while others will need to be analyzed in the laboratory. Next, since the researcher will use tools and computer systems like GIS to help analyze large quantity of data, the researcher should know the concepts, functions, and advantages of GIS before starting the next process. It is important for the researcher to be familiar with GIS to prevent any mistakes, errors, or carelessness in collect and analyzing data, and presenting the results. At the same time, the researcher is needs to pay attention on RS, where it is a tool to help in analyzes the data that exist in image form from satellite. There are slight differences between GIS and RS, especially in collecting data, as GIS data can be in primary (researcher collect data by its own) and secondary (researcher collect data from institution) data, while RS data is only available in secondary (researcher collect data from institution) data. Also, researchers should know and understand the concept of SDSS before applying it together by using GIS and RS to seek solution and answer for minimize the river pollution. So overall, a researcher needs to study more in the literature review, especially the methods of water quality assessment, GIS and RS, and the concept of SDSS, so that the results and information provided can help achieve the objective of research study.

Typically, literature reviews are related to the research design, where the process of collecting and gathering data will be decided. This research study is involved with an experimental process, which means the data that collected and analyzed will be quantitative approach. In other words, the water sample will be collected from the site and analyzed in laboratory with a selected process (which refer as the repeating process of analysis) to provide raw data. In some cases, the raw data from the laboratory analysis for certain parameters are not considered as complete and will need to undergo calculations to provide a result before further analysis. So, the research design will use a quantitative method to collect and gather the data, which exist in primary and secondary data. Secondary data will only be collected from government, privates, or other sectors, while primary data will require researcher to collect sample from the site and analyze it to provide result data. This data will exist in large quantities and require a tool to help synchronize the data systematically. Instruments involved in this research study are GIS and RS. GIS has the ability to convert any information from hardcopy (include spatial data, water quality data, humanities data)

into softcopy or digital data in the computer and represent it in the form of map-based information. If there are any changes such as land use, the GIS are able to discover and manage the data so that the information are updated for analyze and produce new information [8]. RS has the ability to observe information about ground surface and water surface by using satellite technology and interpret it into images or pictures using electromagnetic spectrum through electromagnetic radiation [9]. Therefore, RS can be used to help determine the current situation, factors, and impacts of water pollution that occurred in the Malacca River. Also, the researcher also needs to be concerned with the laboratory instrument that require analysis of river water quality. Basically, the standard procedure and instrument used to test the water quality is based on the American Public Health Association (APHA) – Standard methods for the examination of water and wastewater [1].

Once the research design and instruments are decided, researcher has to conduct a field studies in order to collect raw data, for example the Malacca River. The selected sampling area to collect water samples from the Malacca River should be accessible and will not bring any harm and dangerous situation to researcher. Information for land use near to Malacca River will also be collect using GPS (geographical coordinates, land use profile) and information will be keyed-in GIS as soft copy. When everything is ready, the researcher can start to collect data. Secondary data can be divided into two types, which is GIS, RS, and water quality. GIS map-based data can be collected from the government sector, involving with Department of Town and Country Planning (JPBD), Department of Survey and Mapping (JUPEM), and Department of Irrigation and Drainage (JPS). Meanwhile, RS data can be collected from Malaysian Remote Sensing Agency (MRSA), and water quality data for 10 years can be collected from Department of Environment (DoE). For primary data, researcher have to collect water sample from Malacca River and analyze the sample either onsite analysis or laboratory analysis. There is some information of land use that will be collected using GPS and transform into GIS for analysis. If the map-based that receive from government department are not up-to-date, then this will be a good opportunity to re-correct the information before undergo for analysis to provide new information. Basically, the application of GIS and RS in this research study is to determine the water quality status, the factors that contribute water pollution, impact of water pollution, and solution towards water pollution. So, the water quality data will be input into GIS and RS to assess and solve the river pollution problem. There are various analyses that can be used, for example GIS for buffering analysis, proximity analysis, overlay analysis, and reclassification analysis, and RS for spectral image analysis, decision tree image analysis, spatial image analysis, integrated image analysis, and so on. After the data are group together, the SDSS can be develop to form a new information and result, which become an answer to minimize the river pollution and achieve the research objective. The last step in third stage is to prepare the report, which can be a thesis report, grand reports, publications (in term of journals, books, and conference), and so. New information from this research study is important to other researchers to continue further research in advances for this particular field.

IV. CONCLUSION

A research study may be considered successful when the objective of the study is achieved with the aim to solve the problem statement. In order to achieve the objective of the study, the research should undergoes a systematic methods and steps to reduce mistake, incorrect, confusing, and carelessly, involving several stages namely first stage, second stage, and third stage. Basically, the first stage involves the problem statement, research question, and objective study; while the second stage involves the literature review, research design, instrument, and pilot study or pilot test. The third stage will involve data collection, data analysis or research results, and report preparation. It is important to conduct a pilot test or pilot study because this method will determine whether the whole process will either be correct or incorrect way to carry out the study. If there is any mistake in the process of the pilot test, changes can be made to reduce the mistakes so that they will not affect the analysis and results of the research study. Therefore, the research study entitled ‘Applied GIS in Assessment Water Quality Modeling in the Malacca River’ may be successful when the researchers follow the stages and processes systematically and answer all the objectives suggested. So, this study will become a starting point of new information for other researchers to do more deep-further research according to field of study.

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