

**ASSESSMENT OF WATER QUALITY CHARACTERISTICS DURING  
BASE AND STORM FLOW EVENTS ON SUNGAI LANGAT BASIN**

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**UNIVERSITI TEKNOLOGI MALAYSIA**

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BASE AND STORM FLOW EVENTS ON SUNGAI LANGAT BASIN**

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**A project report submitted in partial fulfillment of the  
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## DEDICATION

*As this journey begun  
Passing through a long distance and difficult path  
A shine of guidance given to lead this dark trail  
To Dr. Noor Baharim Hashim as my supervisor to lead me patiently*

*Daddy and Mommy  
You are my supports that always embrace me  
You always have been there for me  
Through your prayers and love  
Both of you have been my eyes to lead this hopeful journey  
To both of you Charlie and Zaiton*

*My Siblings  
Companions where I can share my happiness and sadness  
As all of you always bringing me laughter and joy  
Presents of you all simply ease my journey  
To Kamal, Yunus and Jasmin*

*As this journey nearly end  
Where all my efforts, time, hard work gathered  
Finally, to You I lay my burden  
Hoping for the Best*

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## ABSTRACT

Rapid urbanization along the Sungai Langat plays an important role in the increase of point source (PS) and non-point source (NPS) pollutions. The water quality statistical analysis during the base and storm flow events outputs enables to identify the PS and NPS pollution impairing the river. Sungai Langat basin is deteriorated due to NPS pollution of BOD, COD, TSS, NH<sub>3</sub>-N, NO<sub>3</sub> and *E.Coli* from year 2004-2008. The utmost and less most water constituents polluting Sungai Langat basin were ranked using the violation analysis during base and storm flow events. The overall rank from the most to less impacting pollutants impairing Sungai Langat basin are *E.Coli* (NPS)> *E.Coli*(PS)> TSS(NPS)> COD(NPS)> NH<sub>3</sub>-N(NPS)> BOD(NPS)> COD(PS)> TSS(PS)> NH<sub>3</sub>-N(PS)> BOD(PS). The longitudinal profile analysis (year 2008), show the BOD, COD, TSS, NH<sub>3</sub>-N, NO<sub>3</sub> and *E.Coli* have similarity where the all of the studied water quality concentrations have increased at DOE station of 1L07 to 1L05 segment of river due to sewage. It also founded that the presence of *E.Coli* in Sungai Langat is at concerning level as the concentration of *E.Coli* can reach 44 times higher than limiting standard of 2000cfu/100mL. The presence of *E.Coli* in Sungai Langat is proved by the longitudinal concentration profiles illustrating the decreasing level of DO and pH at segment of 1L07 to 1L05. The strong concentrations of BOD and COD at the same segment of the Sungai Langat are related to anthropogenic pollution sources and are from sewage (PS) such as sewage treatment plants and industrial effluents. The GIS maps confirmed that there are numerous numbers of private and public sewage treatment plant, compare to other segments of the river. Another possibility is, the PS also suspected coming from the industry effluents which is responsible to the elevation of *E.Coli* in Sungai Langat basin. The failure of sewage treatment systems (overflow due to storm water) also may be the reason why the *E.Coli* level still high during storm flow events. Other sources (NPS) may be from municipal wastes, or animal husbandry of the segment of river.

## ABSTRAK

Peningkatan permodonenan di sepanjang Sungai Langat memainkan peranan penting dalam meningkatkan punca tetap pencemaran (PS) dan punca tidak tetap (NPS) pencemaran. Kualiti air statistik analisis semasa kejadian aliran dasar dan ribut digunakan untuk mengenalpasti punca pencemaran tidak tetap dan punca pencemaran tetap yang mencemarkan sungai. Didapati, lembangan Sungai Langat semakin tercemar akibat punca pencemaran tidak tetap oleh BOD, COD, TSS, NH<sub>3</sub>-N, NO<sub>3</sub> dan E. Coli dari tahun 2004-2008. Penyusunan bahan pecemar mengikut turutan dari paling cemar ke kurang cemar lembangan Sungai Langat dianalisis menggunakan analisis violasi semasa aliran dasar dan ribut. Kedudukan secara keseluruhan dari yang paling cemar ke kurang cemar lembangan Sungai Langat adalah E. Coli (NPS) > E. Coli (PS) > TSS (NPS) > COD (NPS) > NH<sub>3</sub>-N (NPS) > BOD (NPS) > COD (PS) > TSS (PS) > NH<sub>3</sub>-N (PS) > BOD (PS). Analisis Profil longitudinal (tahun 2008), menunjukkan BOD, COD, TSS, NH<sub>3</sub>-N, NO<sub>3</sub> dan E. Coli mempunyai persamaan dimana semua konsentrasi kualiti air telah meningkat di stesen DOE dari segmen sungai 1L05 dan 1L07 kerana untuk kumbahan. Ia didapati bahawa kehadiran E. Coli di Sungai Langat berada pada tahap tinggi kerana konsentrasi E. Coli boleh mencapai 44 kali lebih tinggi daripada standard, 2000cfu/100mL. Kewujudan E. Coli di Sungai Langat dibuktikan oleh profil konsentrasi longitudinal dimana tahap penurunan DO dan pH pada segmen 1L07 dan 1L05. Konsentrasi yang kuat BOD dan COD pada segmen Sungai Langat yang sama adalah berkaitan dengan sumber-sumber pencemaran antropogen dan berasal dari kumbahan (PS) seperti kilang rawatan kumbahan dan sisa industri. Peta GIS menegaskan bahawa terdapat banyak kilang rawatan kumbahan awam dan swasta, berbanding dengan segmen sungai lain. Kemungkinan lain adalah, PS juga dipercayai berasal dari efluent industri yang menjadi penyumbang kepada elevasi E. Coli dalam Sungai Langat. Kegagalan sistem pemprosesan kumbahan (limpahan kerana air hujan) juga boleh menjadi sebab tahap E. Coli masih tinggi semasa aliran ribut. Sumber-sumber lain (NPS) mungkin dari sisa kota, atau sisa dari ladang tanaman atau penternakan mengalir masuk ke segmen sungai tersebut.

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## LIST OF SYMBOLS

UTM	-	The Unversit Teknologi Malaysia
BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
TSS	-	Total Suspended Solid
E.Coli	-	Esheriachua Coli
NO <sub>3</sub>	-	Nitrate
NH <sub>3</sub> -N	-	Ammonia Nitrogen
WQI	-	Water Quality Index
SIBOD	-	Sub index Biochemical Oxygen Demand
SITSS	-	Sub-index Total Solid Demand
SINH <sub>3</sub> -N	-	Sub-index Ammonia Nitrogen
INWQS	-	Interim National Water Quality Standard
DOE	-	Department Of Environment
DID	-	Department of Drainage and Irrigation
GIS	-	Geographical Information System
PS	-	Point Sources
NPS	-	Non-Point Sources
STP	-	Sewage Treatment Plants
CST	-	Communal Septic Tank
DO	-	Dissolved Oxygen

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

The primary need for human survival is water can be listed after air as important necessity in human's daily life. The world history can prove us the importance of water whereby great civilization such as Nil civilization, Harappa and Mohenjo-Daro civilization or Cheng Ho civilization were born because of the great rivers as ultimate water resources which provide the community to civilized. The land near to river particularly river bank had been utilized by the community with varies activities such as bartering, agriculture, trading, farming taken place in order to them to survive. As the population increased by number, such activities were spread far out from the river bank simultaneously civilized the community, not only nationwide but worldwide.

Therefore, the early age of the simple and basic surviving activities has become complicated and complex industry, which developing country such as Malaysia, the wealth of the country depends based on the productivity of vast industry. In order the country to generate constant income, other activities such as modern farming and agricultural are encouraged by the Government, not only to

cover the needs of the citizens, but it became an international trading, to satisfy the demands from other country. The Government of Malaysia is very systematic in optimizing the available land, so that it fully utilized and benefits the government and also the citizens. Proper housing and residential area were located and being developed in order to give comfortable home to every citizen as the urbanization come along. Urbanization has always been main focus of the Government as act like mirror to reflect the development and the prosperity of a country.

Malaysia is very blissful as the country receives rainfall nearly 3000 millimeter per year which the natural renewing process of the environment especially the earth's natural resources such as water is essential in order to maintain a stable ecosystem on earth as well as to ensure a sustainable development of the nation. But, it need to clearly understood that, although 70% of the Earth's surface is covered by water, only 1% is accessible for direct human uses which are fresh water resources (Connell, 1974).

In such case, Malaysia is considered very luck because the country is very rich with fresh water resources such as lakes, rivers and groundwater. The rest of it is frozen in icecaps and the sea water which is too salty for human consumption, even though, there are technologies to convert the sea water to brackish water, yet it still new and expensive for general operation (Connell, 1974; Da Cunha, 1985; Klein, 1957). The demand for clean and fresh water is already rose and exceeding the supply in many parts of the world which is due to many factors including environmental factors such as pollution and climate change (Da Cunha, 1985).

As development and urbanization around the world is soaring high, developing country such as Malaysia should be aware of the consequent that it going to face due to development and urbanization of the country which is significant degrading of the level of the pollution. Urbanization has long been recognized as a principal contributory factor to many environmental problems, including flooding, biodiversity loss, deterioration of aquatic ecosystems and many others. These



impacts usually come with modification of the natural hydrologic condition, increase in runoff pollutant loadings and wastewater discharge or sewage, and decrease in river base flow during dry weather, as a result of land cover change and intensified human activity due to urbanization (Butler and Davies, 2004; Olivera and DeFee, 2007).

Rivers play a major role in assimilation or carrying off the municipal and industrial wastewater, run-off from agricultural land and other pollutant discharge. The municipal and industrial wastewater discharge constitutes the constant polluting source or sewage, whereas, the surface run-off is a seasonal phenomenon, largely affected by climate in the basin. Seasonal variations in precipitation, surface run-off, interflow, groundwater flow and pumped in and outflows have a strong effect on river discharge and subsequently on the concentration of pollutants in river water (Vega et al., 1998).

Water quality of river basin particularly in concern as the nature of the rivers in Malaysia is very long and the land use activities of the upper stream of the river will definitely affect the water quality of down stream of the river by pollutants discharge. The situation of river water quality in Malaysia is not getting any better. It began from the brooks and now the whole river basins are facing impairment of quality including the Sungai Langat basin located at the State of Selangor which is very vital river basin for Selangor citizen's health, economy and the environment.

As mentioned above, the ancient civilizations all begun based on the presence of the great rivers such as Nil, Mekong, Cheng Ho, and many more, however, in this era, many countries face river water pollution, mainly due to improper planning of land use activities along the civilization. Such as Selangor State which was lacked of proper land development planning in the 19<sup>th</sup> century despite of the civilization which took place way before, definitely gives adverse impact to quality of Sungai Langat basin particularly.

## 1.2 Problem Statement

Water is one of the primary needs of the human kind that need to be protected, well maintained the quality water and making sure it sustained for future concern. Fresh water resources such as rivers are now limited to be use due to the deterioration of the quality which making it unable to consume. The Sungai Langat basin, for example, provides water for its population for domestic as well as industrial and agricultural uses through its dams. There are two main dams built in Sungai Langat basin which are Langat and Semenyih Dam. Also, Sungai Langat feeds eight water treatment plants, most of which are located in serene village settings of Hulu Langat (The Star, 2006).

This proper treatments require to taking care of the quality of the drinking water which eventually will cost the price of clean water becomes higher, and the more pollute is the water resources, the more advance treatments are required and the more expensive is the clean water will become (Boopathy, 2000; Srinivasan and Murthy, 1999). Despites of population growth, rapid industrialization, urbanization and infrastructure development, will increases the usage of the water simultaneously increases the demand of water supply in domestic, agricultural and industrial areas is now in critical since the clean fresh water supply is depleting from natural sources due to pollution. Therefore, the sources of fresh water supply especially rivers like Sungai Langat need to make sure its clean for water supply and also well sustained from declining from the natural sources.

The river basin in Malaysia predominantly Sungai Langat basin need special attention as it is a major river basin adjacent to the Klang Valley, an urban conurbation that includes the capital city of Kuala Lumpur and other urban centers. Several large Federal Government projects, such as the Kuala Lumpur International Airport (KLIA) in Sepang, the new Federal Government administrative capital at Putrajaya and Malaysia's Cyber-City, Cyber City, are located within the basin. These development projects have spurred an influx of commerce and industry development

basin typifies, in general, the pattern of urban and industrial development in other parts of Malaysia and Southeast Asia. When new infrastructures, the most important being roads, highways and bridges, are put in place urban sprawl spreads from existing urban centers, in the case Kuala Lumpur, Petaling Jaya, Shah Alam and Puchong to the north of the basin, into areas that are less developed.

This leads to the conversion of agricultural land, and in some instances forest and other natural areas, into housing and industrial estates as well as business and commercial centers. Such urbanization leads to the establishment of new townships, which the coalesce with new growth, cause increased surface run-off carrying wastes called sewages entering river basin. This may caused an undesirable change in the water condition that decreases the river water quality occurred, it is described as river water pollution. Once the river assimilative capacity increases and violated the guidelines, it would classified as polluted river. The use of polluted water in human activities can affect human health and flora and fauna especially pollution in water intake such as rivers, lakes which is current scenario in Malaysia (Hallock, 2002).

There are also small riverside park, built by the Drainage and Irrigation Department (DID) has long been neglected and been turned to illegal dumping area which could contribute leachete, enters the river body and cause river pollution. A total of 30 industries estates, with more than 330 factories having 22 categories of industrial production, ranging from manufacture of agriculture end products to high tech products such as consumer electronics, are located in the basin. Most of the industries are medium scale. Electrical and electronic industries predominate, followed by manufacturing, industrial and engineering products, furniture, textile and fabrics, building materials and chemicals. Yet, the number of workshops, car wash centers and other business premises increased over the years is the most concerned as these shed-like shops that have contributed to the river's pollution, not the few planned industrial, housing and commercial areas with proper drainage and sewerage systems and treatment plants.

In 2006, the Department of Environment (DOE) Malaysia has announced the Sungai Langat basin as polluted river. This is due to industrialization taking place rapidly in area along the Sungai Langat basin that led to river pollution. There are houses and shops along a 20 km stretch from Cheras KM14.4 to the Sungai Langat dam. Further down at KM17.6, there are workshops and light industrial factories along the main road. According to The Star (2006), the drains from these premises lead to a larger drain and empties out into Sungai Langat. Moreover, the sewage from these premises is not channeled into any sewage treatment plant before the wastewater being released to Sungai Langat. The villagers claimed that, the Sungai Langat at few kilometers downstream from the Sungai Langat dam looks murky and putted the blame on the factories, warehouses and homes that been built along the river.

In 2007, nearly one million citizens in State of Selangor suffered as the main rivers Sungai Langat and Sungai Selisik which are main water supply intake points were polluted by ammonia due to industry activities along these two rivers. Pollution on these two rivers caused three of water treatment plants in Sungai Selisik, Batu 11 Cheras and Bukit Tampoi were forced to shut down temporarily due to high ammonia concentration containing in these rivers. The source of ammonia pollutant was from the pollutants which entered the river water body. The pollutants might be from the industry activities including quarry, cement factories, and wood treating industry along the river bank (Utusan, 2007). There was also illegal dumping along the river bank which also has the possibility of discharging leachate to the river water body.

Again in 2009, the mass media spread the news of the declaration of the Department of Environment, Malaysia announcing that Sungai Labu and Langat were polluted by ammonia and diesel oil which enforced the Pucak Niaga (M) Sdn Bhd to stop the operation of water treatment plant in Salak Tinggi temporarily. The ammonia concentration was twice of the allowed found in both rivers. At the same time, Sungai Labu which tributary of Sungai Langat basin was polluted by the diesel spillage which makes the river has diesel odor and turned in black in color causing

the fishes to die. It was believe that the sources of these pollutants were from the effluents of factories in Nilai Town, Negeri Sembilan. The Salak Tinggi water treatment plant was forced to shut down temporarily thirteen times since 2005 due to pollution of Sungai Labu (Berita Harian, 2009).

Recently in September 2010, the water treatment plant in Sungai Semenyih which is main tributary of Sungai Langat basin was closed. The raw water supply from Sungai Kembong, was polluted with the solid waste dumping in the nearby landfill area (Bernama, 2010). The solid wastes from dumping area generated leachate which flows to the main river and cause the ammonia level in the water supply elevated exceeding the standard stipulated by the Health Ministry. Shutting down the treatment plants temporarily has caused the water supply to 1.2 million citizens in Petaling, Hulu Langat, and Kuala Langat been cut for few weeks. In Berita Harian (2006), it been identified that there are fourteen cases that causing the impairment of Sungai Langat. The landfill nearby the Sungai Kembong was the major source of river water pollution which has the highest cases of six. There were three cases involved in polluting the river with discharging diesel, another pollutant sources was from Negeri Sembilan. There were two cases from cats and dog breeding centers that might discharge animal wastes to the rivers. The other two cases were from unknown sources.

According to Prabhakar (2000), the pollutant pollution also can result from natural runoff, dissolved chemicals in water that percolates thorough the soil and through land use activities, such as agricultural, mining, construction, industry, residential and businesses area. The time frame for the movement of some pollutants entering the water body is unpredictable depending on the features of particular pollutant. The land use activities carried out along the river basin is vitally essential to pinned the pollutant sources which could trigger pollutants that deteriorating the quality of the river basin. For example, excessive land application of manure can impair water quality by introducing pollutants including sediment and nutrients (USEPA, 2000). Since State of Selangor has undergoing rapid development, the population, also rising the human activities in utilizing the land along the river bank

gives a great adverse impact on the river basin. Truthfully, unfortunately, the Sungai Langat basin particularly Langat, Semenyih and Labu Rivers have been classified as slightly polluted/polluted river by the Government itself (DOE, 2007).

Therefore, it is very important to identify the pollutant sources through point source pollution based on the land use activities that took place around the Sungai Langat basin. Importantly, the non-point source pollutions is more concern than the point source solution due to difficulties to identify the sources specifically whereby the pollutants is hard to isolate and to control of impurities entering the surface-water body. Meanwhile the point sources where the pollution source comes from identified and specific source that goes into water-body which are easy to control and monitor compared to non-point source (Whipple and Hunter,1977; McCaull and Crossland, 1974). Thus, in order to make sure the river basin is clean of pollutants, the sources of pollutant discharge from the land use activities along the Sungai Langat basin must be identified and controlled.

The hydrology cycle and hydrological characteristics of Sungai Langat basin also affect the water quality of the river. The land use activities near the river bank definitely will disturb and change the hydrological characteristics of the rivers. The change of hydrological characteristics such as water level, width of the river, slope of the river bed will absolutely deteriorate the river water quality and also affect the living aquatic organisms. The hydrology cycle also had great influence of the water quality of river, mainly the rainfall, which highly depends on wet and dry season specifically in Malaysia. The dry and wet season influence also the affect the hydrological characteristics of a river such as flow rate, velocity, volume of a river, whereby, in dry season the flow rate, velocity also the volume of the river is very low, and flushing the accumulating pollutants will be impossible making the river become so dirty, and contradictory for the wet season. The tidal also affect the changes in river water quality (Nor Azman Kasan, 2006).

Definitely, the disturbances which make the changes in hydrology and hydrological characteristics is essential issue not to be ignored, the land use activities which mainly contribute the typical sources of pollutants such as agricultural, industry, residential, farming and others. It is also important to study the pollutant source integrating hydrology and hydrological of the river basin associating with the river water quality parameters in order to control the pollutant sources. Such study can be possible through implementation of computer database tools which has been a reliable enough in understanding, planning and management of water resources such as GIS (Yunus et al, 2004). Where, all spatial and temporal data such as river distribution maps, land use maps, pollutants sources coordination, can be developed to identify the source of pollutants which change of water quality characteristics of Sungai Langat basin in variable time frame.

### **1.3 Study Objectives**

The aim of the study is predominately to investigate the significances of pollutant to the river water quality of Sungai Langat basin. Therefore, the objectives of this study are:

- (i) To collect water quality, hydrological data, historical data, land use maps of and other required information of Sungai Langat basin from various government or private agencies, universities, journals, etc. and compile all spatial and temporal datasets using Geographical Information System (GIS).
- (ii) To perform comprehensive trend analyses; WQI trend, population trend and land use trend from 70's, 80's, 90's and 2000's to understand the past/present of Sg Langat basin scenario
- (iii) To carry out water quality statistical analysis during base and storm flow events to indicate the PS and NPS deteriorating Sg Langat basin

- (iv) To rank the PS and NPS from most and less pollutants impacting the Sg Langat basin through violation analysis during base and storm flow events
- (v) To execute longitudinal water quality concentration profile analysis in order to identify the precise sources of PS and NPS pollution along Sg Langat

#### **1.4 Scope of Study and Data Limitation**

The study is carried out within the Sungai Langat Basin which is drained by three major tributaries; Sungai Langat, Sungai Semenyih, and Sungai Labu. The main tributary, Sungai Langat, flows about 182 km from the main range (Banjaran Titiwangsa) at the Northeast of Hulu Langat District in south-southwest direction, and draining into the Straits of Malacca. Both Sungai Langat and Sungai Semenyih originate from the hilly and forested areas in the western slope of Banjaran Titiwangsa, northeast of Hulu Langat. The main reach of Sungai Semenyih can be considered to start from the Semenyih Dam flowing south southwest direction through the town of Semenyih, Bangi Lama and finally merges with Sungai Langat at about 4 km to the east of Bangi Lama town Sungai Semenyih is also supplemented by Sungai Beranang and Sungai Pajam.

The trend analysis of water quality index, population, land use and are covered from 1970's until 2008 expect for the public sewage treatment loading trend analysis is from 1994 to 2008 since the establishment of public sewage treatment plants begun in 1994 in Malaysia. However, its all depends on the availability of the data.

This study limits the water quality parameters to three parameters which consists of Biochemical Oxygen Demand (BOD), Ammonia Nitrogen (NH<sub>3</sub>-N) and



Total Suspended Solid (TSS) which have been used as input data for all DOE's stations in the Sungai Langat basin.

Meanwhile the hydrological data type that been considered are rainfall, river stage, discharge and suspended sediment for all DID's stations in Sungai Langat basin. Anyhow, the water quality and hydrological data has its limitation whereby government agency such as DID and DOE have constraints in providing data of water quality and hydrological data for all stations covering the whole Sungai Langat basin especially in early year of 1980's, 1990's. Therefore, the indexes published in DOE's reports will be utilized for this study.

Meanwhile, the historical data which are significantly important in order to analysis the source of PS and NPS entering Sungai Langat basin. Therefore, the historical data consists of land use maps, Geographical Information System (GIS) data, topographic maps covering the State of Selangor has been gathered. The hardcopy of land use maps for 1970s and 2000s, were simply purchased at the government agency of Town and Country Planning. Some of the maps which in hardcopy form were been transformed to softcopy form by digitizing process using available software.

It also been understood, that the importance of identification of point source (PS) and non-point source (NPS) for river basin is a must as it will determine the origin of the pollutant that give impact the Sungai Langat basin. Therefore, potential PS data such as longitude and latitude coordinates of Palm and Rubber Mills, Water Intake Points and Public Sewage Plant were obtained from DOE and IWK Sdn. Bhd respectively. Unfortunately, the obtained coordinates are available for year 2000's. The communal septic tank (CST) and septic treatment plants (STP) discharge concentrations of BOD, NH<sub>3</sub>-N and TSS also been obtained form IWK Sdn. Bhd.

### **1.5 Significance of Study**

This study will be beneficial not only to the Government of Selangor as well as the citizens of Selangor as this study helps the government to make decision on watershed management after identifying the sources of the problem that degrading the major rivers in the Sungai Langat basin. Further actions can be taken to cut the sources of pollution to already polluted rivers, and to prevent the river that been forecasted that will faced degrading of water quality. Beside that, the study will benefit the government to clean the critically polluted rivers which will result clean rivers that will definitely benefits the people's health, economy and the country. The study also has developed a digitalized database consist spatial and temporal data sets from 1970 until 2008 will certainly benefit others to further study the trends of land use-water quality of Sungai Langat basin.