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A Review on the Environmental Pollution of Langat River, Malaysia

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Abstract: Environmental pollution of the rivers in terms of floods, droughts and landslides are the outcomes of the uncertain rainfall pattern due to climate change and it also contributes to the chemical contamination of the rivers along with the anthropogenic activities. The Langat River can also be polluted by the trans-boundary floods and precipitation in terms of the air pollution both in Malaysia and in the neighbour countries. Therefore, the water resource management related government and non-government institutes, business sector and civil society should have an effective participation for the better management of the river. Moreover, a regional platform could be useful in order to mitigate the impacts of atmospheric pollution as well as trans-boundary floods through sharing information, knowledge and expertise.

Key words: Environmental, climate change, trans-boundary, water pollution, drinking water.

Introduction

The pollution of Malaysian rivers in terms of environmental issues along with the anthropogenic issues is a growing concern. Many studies reported that flood occurred in Malaysia because of heavy rainfall (Ching et al., 2013; DID, 2009; Hussaini, 2007) and it exaggerated because of the incidences of landslides along the river bank, lack of drainage network and high spring tide (DID, 2009; Tam et al., 2014). Therefore, flood is the most significant natural disaster in Malaysia because of its frequency and extent in the 189 river basins including Peninsular, Sabah and Sarawak (Hussaini, 2007). Flooding has severe impact on the 9% land of the country (i.e. 29,720 km^2) and 21% population (i.e. 4.915 million) that cost around RM 915 million a year with the additional economic sequential cost of RM 1.83 billion (DID, 2009). According to Department of Irrigation and Drainage (DID) there were several major floods in the history of Malaysia such as the flood incidences of 1886, 1926, 1931, 1947, 1954, 1957, 1963, 1965, 1967, 1969, 1971, 1973, 1979, 1983, 1988, 1993, 1998, 2001, 2003, 2004, 2006 and 2007 (BEM, 2004; DID, 2009). However, the intensity and frequency of floods have increased significantly in Malaysia because of changes in climate and rainfall pattern (IPCC, 2014). Therefore, these floods compelled Malaysian government to concern about urban flood management by the Department of Irrigation and Drainage (DID) along with the formation of the National Disaster and Relief Committee under the National Security Council. A special Flood Control Commission

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was also formed which is chaired by the Minister of Natural Resources and Environment Ministry (BEM, 2004; DID, 2009). Similarly, air pollution is also a large contributor of chemical pollution of the surface water in terms of precipitation and Department of Environment (DOE), Malaysia has identified more than 140,011 industries as the major sources of air pollution (DOE, 2013). Therefore, this review explored the environmental reasons in polluting the Langat River in order to suggest better management of the river.

Study Area

The main course of Langat river is 141 kilometres originating in the hills of Hulu Langat and falls in the Strait of Malacca. Moreover, the river runs through the different constituencies of Selangor (78%), Negeri Sembilan (19%) and the Federal Territories of Kuala Lumpur and Putrajaya (3%) (Lim et al., 2012). Therefore, literature was reviewed from the secondary sources in order to explore the impacts of environmental reasons in polluting the Langat river as well as to suggest recommendations for the better management of the river.

Impact of Climate Change on Langat River Basin

The impacts of climate change such as the uncertain rainfall pattern, floods, landslides, etc. are also responsible for the pollution of Langat river (IPCC, 2013, 2014; Krishnan, 2009; Mohd et al., 2012; Rapport et al., 2010; SPAN, 2012). It was reported that climate change has significantly contributed to the non-point sources of pollution such as agricultural activities, rubber cultivation, forest clearing, rapid urbanization, etc. in the Langat river basin (Ali et al., 2012; Rapport et al., 2010). The langat river Basin is situated on the equator and the amount of annual rainfall in the basin varies from 1500 to 2900 mm (Lim et al., 2012). However, the rainfall is highly influenced by the maritime continent monsoon in the basin including the Peninsular Malaysia (IPCC, 2013, 2014). The average temperature in the basin is around 32°C and the annual average relative temperature is 80% (Lim et al., 2012). A monthly rainfall study during 2000-2009 on the Langat river basin indicated that the basin experienced increasing average annual rainfall (Figure 2). Lim et al. (2012) also reported the increasing average annual temperature and humidity in the basin.

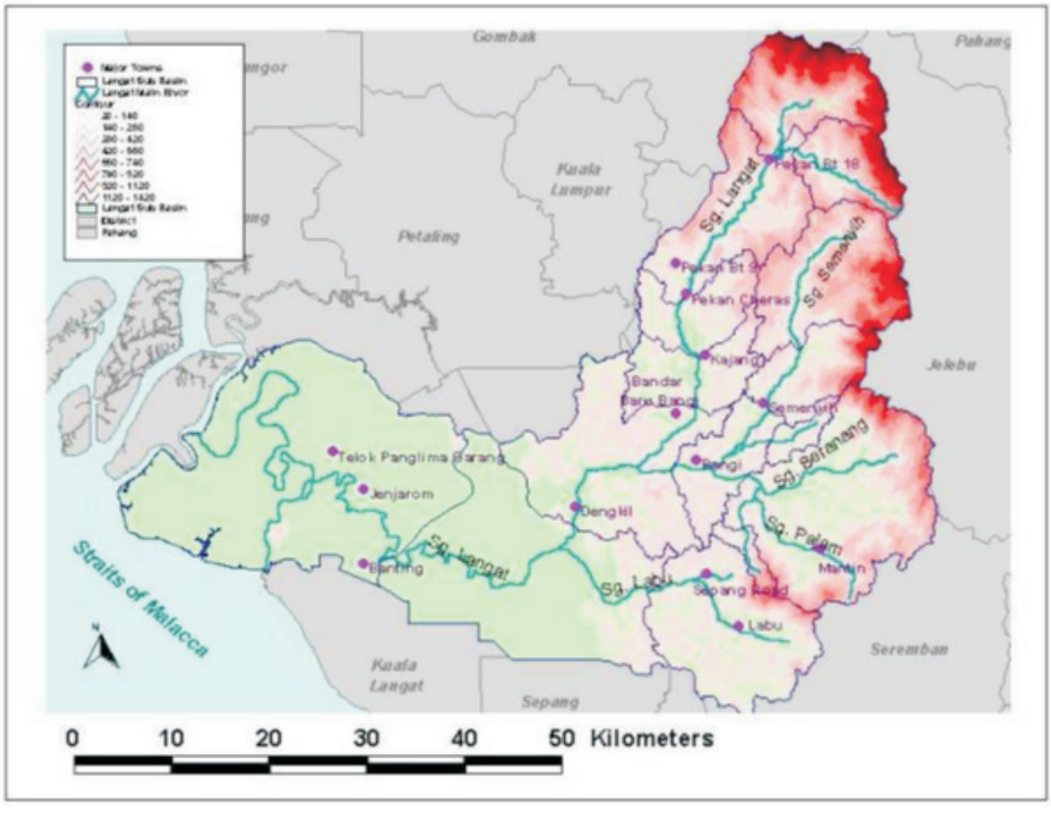

Figure 1: Langat river and its tributaries within the river basin.
(*Source:* Juahir, 2009)

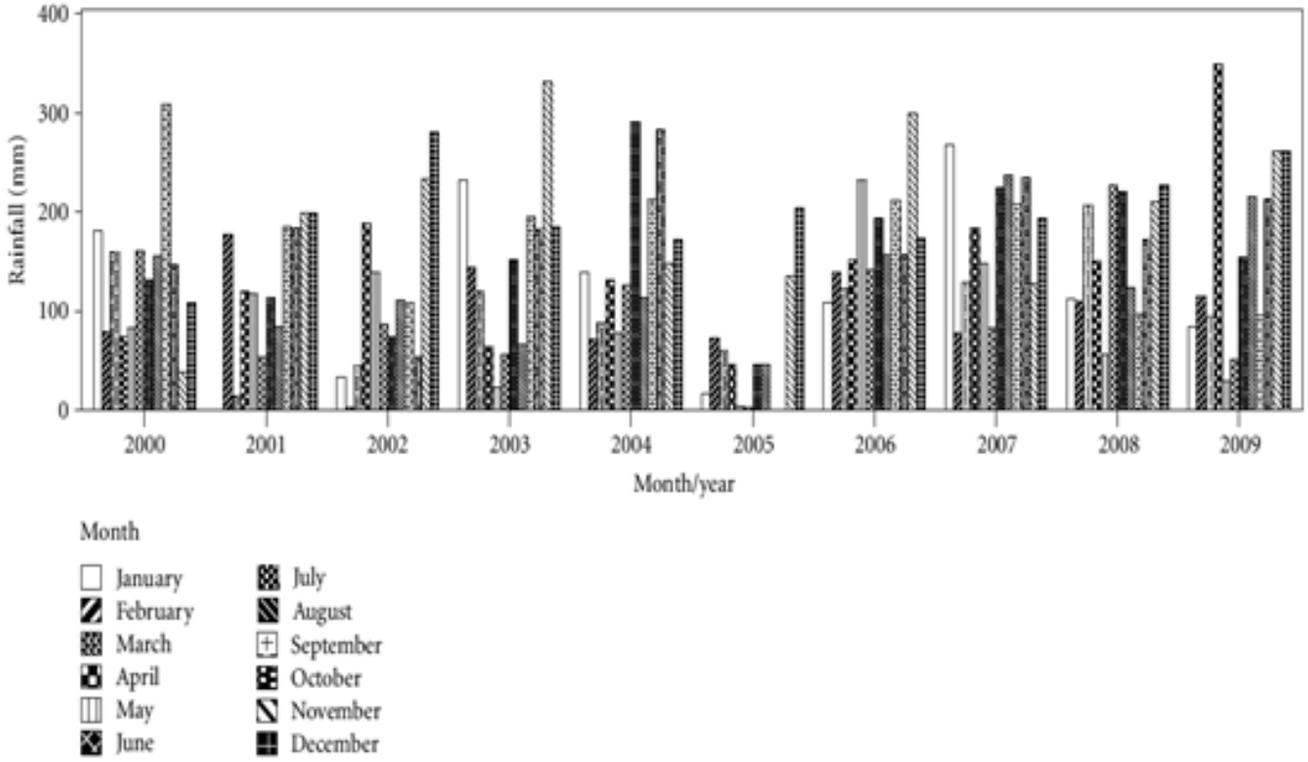

Figure 2: Monthly average rainfall in Langat river basin from 2000 to 2009.
(*Source:* Lim et al., 2012)

According to the Malaysian Metrological Department (MMD), the west coast of Peninsular Malaysia observed a 6-10% increase in the total rainfall during the period of 2000-2007 compared to 1990-1999 (MMD, 2009). The highest rainfall exceeds 5000 mm and the lowest is about 1750 mm. The average annual rainfall is 2820 mm in Peninsular Malaysia, but there is considerable temporal and spatial variation (Juahir, 2009). Similarly, the frequency of uncertain and intensified rainfall have increased evidently in the Peninsular Malaysia that was alike to the scenario of rainfall pattern in Southeast Asia (IPCC, 2014). In the report of IPCC (2014) it was also predicted that the fresh water resources and drinking water quality would be degraded because of uncertainty in rainfall pattern.

Heavy rainfall usually turned into floods in the Peninsular Malaysia (DID, 2009; IPCC, 2014). The impact of climate change was clearly evident in the Langat river basin through the incidents of heavy and less rainfall that usually turned into floods and continuous dry days respectively. There were several incidents of landslide along the Langat river bank while raining heavily in the basin. Moreover, the mudflow increased in the river during floods when there was much runoff. As a result, the WTPs (Water Treatment Plants) were unable to treat the water for drinking purpose. On the other hand, when there were drought situations, there was also less flow of water in the river and the concentration of the chemical in the river increased significantly (Rapport et al., 2010). In that case, the WTPs were also unable to treat the river water for drinking purpose and the WTPs got shutdowns (Rapport et al., 2010). The Prime Minister of Malaysia also addressed that there were serious prolonged drought incidents due to less rainfall in the middle of 2014 in Malaysia which led to serious drinking water crisis (Bernama, 2015). Moreover, drought (i.e. decrease in total precipitation) along with the increased number of pollution sources were considered as the reasons for contamination of the rivers in Malaysia (GOM, 2010).

Juahir et al. (2010) reported that the flood augmented the pollution concentration in the Langat river through increase in the direct runoff from the vast urban areas of the basin (Juahir et al., 2010). Toriman (2008) also reported that the average monthly mean discharge of 35 cumecs in the Langat river at Dengkil gauging station exceeded 50% of the time during 1974-1990, while 20% of the time would have an estimated mean discharge of 48 cumecs. It was further reported that the highest discharge in the river was recorded in November and

December during 1974-1990 when there was the onset north-east monsoon (Toriman, 2008). However, the lowest flow was recorded in August which was also the driest month in the year during 1974-1990. Memarian et al. (2012) reported that the upward trend in the river discharge at Hulu Langat sub-basin has a significant correlation with the rainfall pattern.

Department of Environment (DOE) also reported that the increased incidences of the landslides in Langat river basin were significantly linked to the heavy rainfall (Rapport et al., 2010). Indeed the landslide incidents along the bank of Langat river increased the sediment flow in the river and it was one of the reasons for the shutdowns of WTPs in the basin (Alkimia, 2014; Suhaini, 2015). Toriman (2008) based on the USLE (Universal Soil Loss Erosion) model also pointed out that in the Langat basin the average lowest soil erosion rate was 76.4 ton/ha/year in the palm oil estates; however, the highest was 382.5 ton/ha/year in urban areas (Table 1). Moreover, the maximum sediment concentration was recorded in the main course of Langat river 89,574 mg/l whereas the minimum concentration of sediment was recorded at the Semenyih river 49,530 mg/l which is a branch of Langat (Toriman, 2008). The higher upward trend in sediment concentration at Semenyih sub-basin was recorded in 2012 mainly because of heavy rainfall and flood than the sediment concentration at Lui and Hulu Langat sub-basin (Memarian et al., 2012).

Landslide incident in the Langat River Basin is one of the major natural disasters and it was recorded that Kuala Lumpur (19.2%) and Selangor (16.6%) were the most vulnerable zone in terms of landslide, followed by Perak (13.4%) in Malaysia (Rahman, 2014). The incidents of landslides were positively associated with the duration of heavy rainfall i.e. short duration (<3 hours), heavy rainfall (>70 mm) or with continuous rainfall (>1 day) (Ibrahim and Rainis, 2004; Rahman, 2014). The Prime Minister of Malaysia also addressed that landslide incidents in Malaysia were linked to the heavy rainfall, flood, land clearing and land encroachment activities (Bernama, 2015). For instance, the Hulu Langat Landslide incident in 2011 was considered as one of the major natural disasters in the history of Malaysia (Table 2). Ibrahim and Rainis (2004) identified that there were 70 sites in the Langat river basin which were prone to the incidents of landslides.

Table 1: Soil erosion and sediment flow in the Langat river based on USLE model

Land use	*No. of grid square*	*Average soil erosion (ton/ha/year)*
Mixed cultivation	87	96.7
Palm oil estate	28	76.4
Rubber estate	40	122.6
Urban	71	382.5
Forest	31	38.86

Source: Toriman, 2008

Regional Contribution to Pollute Langat River

Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are being used not only in Malaysia

Table 2: Some of the landslide incidents in Selangor and Federal territories

Year	*Location*	*Type and nature of landslide/slope failure*
May, 99	Bukit Antarabangsa, Ulu Kelang, Selangor	Massive landslide
Nov, 02	Hillview, Ulu Kelang, Selangor	Debris flow. Sliding/ flowing of debris soil during heavy rain – toppled a bungalow at the toe of the hill
Nov, 03	Bukit Lanjan, North Klang Valley Expressway, Selangor	Rock fall/rock debris
Nov, 04	Taman Harmonis,Gombak, Selangor	Debris flow. Sliding/ flowing of debris soil from uphill bungalow project – toppled the backportion of neighbouring down slope bungalow after weeklong continuous rain
May, 06	Ulu Klang, Selangor	Landslide due to collapse of retaining wall and retrogressive slope failures. Buried three blocks of longhouses.
Nov, 06	Bukit Serdang, Selangor	Landslide at Taman Bukit Serdang
Mar, 07	Precint 9, Putrajaya	Landslide
2011	Hulu Langat, Selangor	Landslide

Source: Rahman, 2014

(UNEP, 2013; Zainuddin et al., 2012) but also in the neighbouring countries such as Singapore, Thailand, etc. (Hu et al., 2011; Kunacheva et al., 2011a) largely for the last five decades in the STPs (Sewerage Treatment Plants), food packaging, fire-fighting foams, leather, surface coatings for carpets, furniture, and paper products without any regulation and monitoring (Kunacheva et al., 2011b; Shivakoti et al., 2010). However, these PFOA and PFOS are considered as perfluorinated compounds (PFCs) which are bio-accumulative and toxic.

These PFCs are found in the air, surface water as well as in the rainwater (Zainuddin et al., 2012). Similarly, trans-boundary hazy pollution due to wild forest fire both in the Malaysia specially in Selangor as well as in the neighbour countries (e.g. Indonesia) resulted into increased air pollutants such as PM (Particulate Matters), SO_2, etc. (Ahmad and Hashim, 2000; MMD, 2009; WRI, 2014). Therefore, the Langat river can also be polluted from the PFCs as well as PM through precipitation in the basin. Hence, the pollution of Langat river should also be studied from the regional perspective as the air pollution through PFCs, PM and PAHs (Tahir et al., 2009) can contaminate the Langat river through precipitation.

For instance, about 20.8% stationary pollution sources were identified in the Selangor State which was the highest among the States of Malaysia in 2013 (DOE, 2013). Moreover, there were increased emissions of 0.06% (i.e. 1,874,836 metric tons) CO and 0.2% (i.e. 198,920 metric tons) SO_2 in 2013 compared to the year 2012 due to the use of coal in the industries as fuel. Similarly, PM (Particulate Matter) also increased significantly due to the burning of huge fossil fuel in the power plants (DOE, 2013). Accordingly, mercury can also reach waterways through anthropogenic activities e.g. combustion of fuel for energy production (53%) and incineration of waste (34%). Moreover, mercury is released into atmosphere as vapour when dental amalgam (i.e. alloy consist of mercury, silver, tin, copper and zinc) is incinerated and eventually the vapour collects into the waterways (MOH, 2010).

It was also reported that the intensity of floods in Malaysia including the Langat river basin has increased significantly over a few decades and sometimes these floods were also called trans-boundary floods because of their extent. For instance, if there was a flood in Thailand and Singapore then the contaminated flood water may also cross the border and can pollute the rivers in Malaysia. As Langat river has many tributaries, there might be possibilities of getting pollution of the river by the contaminated trans-boundary floods' water (Chan, 2015).

Management of Langat River

Department of Irrigation and Drainage (DID), Malaysia is responsible for the structural (e.g. engineering) and non-structural (e.g. research) activities in the Langat river basin in order to reduce the pollution of Langat river from flood. Moreover, the quality of river water is monitored by the Ministry of Health (MOH), Malaysia and Department of Environment (DOE), Malaysia. However, Selangor Water Management Authority (LUAS) in Selangor and BKSA in Negeri Sembilan are the state's authority in terms of management of Langat river. Rivers are the main sources of drinking water in Malaysia and Langat river is also providing drinking water to the 50% populations in the state of Selangor (Farid et al., 2016). Accordingly, in the 10th Malaysia Plan it was decided that the National Water Services Commission or Suruhanjaya Perkhidmatan Air Negara (SPAN) would be responsible for the activities of the water operators including licensing in all the states of Malaysia (GOM, 2010).

In Selangor as well as in the Federal Territories of Kuala Lumpur and Putrajaya, SYABAS (Syarikat Bekalan Air Selangor Sdn Bhd) is the only water distributor of treated water at household level. As there are many GO-NGOs and private institutes for the management of the Langat river, the participation of all the stakeholders need to be effective. Unfortunately, the participation of all the stakeholders is still not adequate to manage the river particularly in terms of pollutions (Mokhtar et al., 2010). Moreover, the Environmental Quality Act 1974 and the Water Service Industry Act 2006 should be reviewed specifically in terms of stakeholders' meaningful participation for the better management of the river (Farid et al., 2016). Similarly, power plants, motor vehicles, and open burning activities should comply with the Environmental Quality (Clean Air) Regulation, 1978 because of severe air pollution in Malaysia (DOE, 2013). Hence, air pollution or polluted atmosphere in terms of various chemicals can also contaminate the river through precipitation.

Recommendation and Conclusion

The pollution of Langat river is very critical because of its extensive use for drinking purpose. Although the government has taken several steps through its

ministries, departments and agencies to improve the quality of the river, yet a few further initiatives are required to minimize the contamination of the river.

- There should be scientific as well as engineering researches i.e. dam building, drainage networks, etc. in order to reduce the impact of flood. Therefore, there will be less run off in the river as well as less pollution of the Langat river.
- There should be a regional platform along with implementable policies to avoid the water pollution from trans-boundary flood and haze/air pollution.
- There should be also knowledge, information and technology sharing among the neighbouring countries as well as among institutes (i.e. government, private and civil societies) within the country to raise awareness of all the stakeholders to reduce water pollution.
- There should be plantation along the bank of Langat river to reduce the rate of landslide incidents, and the land and forest clearance activities should be controlled.
- There should be strict monitoring on the industrial emission into the atmosphere.

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