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A Review on the Chemical Pollution of Langat River, Malaysia

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Abstract: Langat River, which is a very important source of drinking water, as well as development in the Langat Basin, needs special care to reduce the pollution. Environmental Quality Report of Department of Environment since 1997 to the latest 2013 addressed that the river possessed the status of class III which required extensive treatment before drinking. However, more than one of the nine water treatment plants in the basin had to remain closed several times during 2012-2015 due to high concentration of chemical pollution in the river. Therefore, the review of secondary literature found out the reasons of chemical pollution in Langat River. The hazardous chemical pollution in the river was mainly due to the anthropogenic activities as well as there was lack of enforcement of policies to reduce the pollution. Hence, a proper and up-to-date chemical using guideline is required for the basin in reducing the water pollution which would be applicable for all the basins in Malaysia.

Key words: Anthropogenic, chemical pollution, water treatment plant, drinking water.

Introduction

Langat River is the prime source of drinking water in the basin and the pollution of the river is one of the major threats to the local population (Alsalahi et al., 2014; Juahir et al., 2011). The water of this river is used for drinking, domestic and agricultural activities (Santhi and Mustafa, 2013), as well as for the industrial activities. There are both point and non-point sources of pollution along the river (Al-Mamun and Zainuddin, 2013; Juahir et al., 2010). On one hand, the point sources are sewage disposal, industrial discharge, etc. (Al-Odaini et al., 2013). On the contrary, the rapid urbanization in the basin along with land clearing and agricultural activities is considered as the non-point sources of pollution (Juahir et al., 2011). Chemicals from the agricultural activities and urbanization highly contributed to the Bisphenol A (Santhi et al., 2012) and asbestos pollution respectively in the Langat River (Safitri et al., 2013).

It was also reported that several Water Treatment Plants (WTPs) in the basin had to remain closed several times due to high chemical concentration (Mohd et al., 2012; SPAN, 2012). As a result, the human beings are at risk of chemically contaminated drinking water (Gong et al., 2009). Even the radioactive and hazardous chemicals in drinking water can lead to cancer (Ahmad et al., 2014; Almayahi et al., 2012). Hence, the pollution of drinking water sources has been very much critical as the demand of the total domestic water requirement for Langat catchment will exceed the demand of 335 MLD (million litres per day) in 2025, whereas in 2010 the total demand of domestic water was around 208 MLD

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(Toriman, 2008). Moreover, the degradation of Langat River will be continued with the process of development (Fulazzaky et al., 2010). Therefore, the review explored the point and non-point sources of chemical pollution of the Langat River in order to recommend better quality of the river.

Contamination of Drinking Water Sources in Malaysia

Inland river systems provide almost 95% to 98% water resources in Malaysia (Leong et al., 2007; Santhi et al., 2012), but the surface water was contaminated with chemical due to heavy industrialization (Muyibi et al., 2008). Department of Environment (DOE) reported that about 2292 industries were the significant water polluters in Peninsular Malaysia and among the industries 928 food and beverage industries were the highest (40%) polluters followed by the 324 rubber industries (14.1%). Similarly, the locations of maximum polluter industries i.e. 414 were in Selangor, followed by Johor i.e. 384 industries in Peninsular Malaysia (Muyibi et al., 2008). Therefore, the surface water of the rivers in the Peninsula was contaminated with heavy metals (Alina et al., 2012), radioactive elements (Almayahi et al., 2012; Hamzah et al., 2010; Hamzah et al., 2014) as well as biological contaminants (Al-Badaii and Shuhaimi-Othman, 2014). Moreover, the pollution of the river also enhanced because of less focus on the highly efficient and economic treatment of industrial discharges (Ho et al., 2012).

DOE (2013) mainly monitored the point sources of pollution of the rivers in Malaysia (Table 1) and identified that the manufacturing industries (i.e. 23.85% and 44.57% in 1997 and 2010 respectively) and sewage treatment plants (i.e. 49.27% and 86.49% in 2010 and 2013 respectively) were the highest sources of pollution in the rivers. It was specified that the high concentration of ammoniacal nitrogen in the rivers was mainly from the STPs 78.4% (Table 2) while industries contributed 3.5% (i.e. food services establishments 3% and manufacturing 0.5%). However, Environmental Quality Report 2013 indicated that the STPs including the IST (Individual Septic Tank) and CST (Communal Septic Tank) were responsible for more than 86% pollution of the rivers in Malaysia (DOE, 2013).

Pollution of Langat River

Langat River Basin is considered as one of the four major river basins in Selangor which covers three States of Malaysia namely, Selangor (78%), Negeri Sembilan

Table 1: Point sources of pollution in the rivers of Malaysia

Point sources of pollution	*Overall pollution number in 1997*	*Overall pollution number in 2010*	*Overall pollution number in 2013*
Manufacturing industries	57 (23.85%)	9,069 (44.57%)	4,595 (0.31%)
Sewage treatment plants	47 (19.67%)	10,025 (49.27)	1276,150 (86.49%)
Animal farms	15 (6.28%)	754 (3.70%)	602 (0.04%)
Agro-based industries	24 (10.04%)	500 (2.46%)	508 (0.03%)
Food service establishment	17 (7.11%)	-	192,710 (13.06%)
Non-industrial/Wet markets	79 (33.05%)	-	879 (0.06%)

Source: (DOE, 1997, 2010, 2013).

Table 2: Point sources of pollution load in the river of Malaysia (ton/day)

Point sources of pollution	*BOD ton/day*	*NH_3-N ton/day*	*Suspended solid ton/day*
Manufacturing industries	31 (4.0%)	1.30 (0.50%)	66 (5.50%)
Sewage treatment plants	289 (38.1%)	208 (78.4%)	401.8 (33.0%)
Animal farms	191 (25.2%)	25 (9.4%)	397 (32.7%)
Agro-based industries	41 (5.4%)	22.7 (8.6%)	100.8 (8.3%)
Food service establishment	200 (26.4%)	8 (3.00%)	239 (19.80%)
Non-industrial/Wet markets	6 (0.90%)	0.30 (0.10%)	8 (0.70%)

Source: DOE, 2013.

(19%) and Federal Territories of Putrajaya and Kuala Lumpur (3%) (DOE, 2003). The river also supplies water to the 50% population of Selangor (Lim et al., 2013a). However, in 1997 and 2013 the Langat River was reported as slightly polluted though the status was class III which required extensive treatment before drinking (DOE, 1997, 2013). The studies on the water quality of Langat River revealed that the water was not suitable for drinking without treatment and the physico-chemical parameters for EC, TDS, Cl, HCO_3, SO_4, Na, Mg, Al, Fe and Se did not comply with the Malaysian National Drinking Water Quality Standard (NDWQS) (Adnan et al., 2012; Lim et al., 2013a; Lim et al., 2013b; Lim et al., 2013c; Osman et al., 2012). Therefore, the review of the secondary literature explored the chemical pollution in Langat River along with the recommendations to reduce pollution of the river.

Although industrial discharges reduced to 9.09% in the Langat River in 2013 compared to 84.09% in 2002, it is still a potential source of chemical pollution in the river (Table 3). Moreover, food service establishment was the highest i.e. 79% source of pollution at Langat River in 2013 which also possesses the additive chemicals.

Comparison between point and non-point sources of pollution in Langat River (Table 4) highlighted NH_3-N pollution load in the river which was mainly from

Figure 1: Langat River Basin in Peninsular Malaysia.
Source: **Juahir, 2009.**

Table 3: Comparison of point sources of pollution (sectorwise) in Langat River

Source of pollution	*Pollution in 2013[1](%)*	*Pollution in 2006[2](%)*	*Pollution in 2002[3](%)*
Industrial discharges	9.09	58.00	84.09
Sewage discharges	10.80	28.00	7.78
Sand mining/Quarry	0.24	-	4.16
Wet markets	0.60	-	2.35
Landfill	0.18	-	0.90
Pig farm	0.09	2.00	0.36
Workshop	-	-	0.36
Construction sites	-	12.00	-
Food service establishment	79.00	-	-

Source: [1]DOE, 2013; [2]Lee et al., 2006; [3]Juahir et al., 2011.

Table 4: Point and non-point sources of pollution load in Langat River (ton/day)

Pollution sources	*COD*	*BOD*	*TSS*	*TM*	*NH_3-N*
Industry	22.65	5.536	14.414	0.2440	1.513
Wet market	1.07	0.384	0.409	0.0050	0.056
Pig farm	1.02	0.201	0.460	0.0056	0.725
Public sewage treatment plants	20.68	5.047	5.692	0.0890	3.071
Private sewage treatment plants	4.34	1.060	1.200	0.0200	0.640
Individual sewage treatment plants	17.26	7.140	8.354	0.0000	2.784
Landfill	5.65	1.048	8.149	0.0310	0.664
Sand mining	20.88	0.820	206.670	2.7780	0.057
Total point source	93.55	21.240	245.350	3.1700	9.510
Total non-point source (ton/day)	614.95	132.690	2791.030	15.2500	12.670
% Point sources	13.2	13.8	8.0	17.2	42.8
% Non-point aources	86.8	86.2	92.0	82.8	57.2

Source: Juahir et al., 2011.

sewage discharges i.e. about 6.495 ton/day. Moreover, point and non-point NH_3-N pollution load were 42.8% and 57.2% respectively in river. On the other hand, sand mining was the vital reason of TSS (Total Suspend Solid) load i.e. 206.670 ton/day in Langat River.

SPAN (National Water Services Commission) reported that the discharges of industrial effluent, wastes of the poultry farm, and sand mining (Krishnan, 2009) in the river were contributing seriously to increase the level of pollution especially ammonia (Bernama, 2014; Mohd, 2012; SPAN, 2012). The Selangor Water Management Authority (LUAS) also reported that there was high level of ammonia concentration (>7.0 mg/l) in the Langat River from STPs and urban runoff during 2012-2015 which stopped the operations of Water Treatment Plants (WTPs) such as Semenyih, Cheras Mile 11, Bukit Tampoi, and Salak Tinggi several times (Alkimia, 2014; Isnin, 2015).

Metal-processing and petroleum industries discharges e-waste/effluent in Langat River including high level of Zn, Cu, Ni, Fe, Al, Pb, Mn, Cr and Sn (Aris et al., 2015; Zulkifli et al., 2010). Moreover, the animal feed contaminated the river water with the elevated Cu (Lee et al., 2006). Similarly, the mining activities significantly increase the prevalence of Cu, Sn, Fe, Au, etc. in the surface water of the river (Aris et al., 2015). Moreover, there are total 86 extraction sites of sand and gravel among 198 extraction sites in the Sate Selangor (81) and Negeri Sembilan (5) were the highest in the Langat River Basin (Table 5).

Langat River degraded with Bisphenol A mainly through the industrial discharges, urban runoff, rural

Table 5: Mineral extraction sites in the Langat River Basin

Mineral	*Selangor*	*Langat catchment (north)*	*Negeri Sembilan*	*Langat catchment (south)*	*Langat catchment (total)*
Granite quarries	24	10	18	11	21
Clat pits	13	3	18	0	2
Earth material	133	24	64	19	43
Kaolin pits	1	1	0	0	1
Limestone	1	0	0	0	0
Sand and gravel	140	81	58	5	86

Source: Juahir, 2009.

sewage and domestic wastewater (Al-Badaii and Shuhaimi-Othman, 2014; Santhi et al., 2012) while Sewerage Treatment Plants (STPs) were one of the potential sources of toxic perfluorinated compounds (PFCs). The concentration of PFOA (Perfluorooctanoic acid) was the highest i.e. 5.94 ng/mL in Langat River where there were leaches from the landfills (Zainuddin et al., 2012). Similarly, the increased discharges of toxic Polycyclic Aromatic Hydrocarbon (PAHs) such as ammoniacal nitrogen (NH_3-N) in river generally leaches from landfills and open dumping sites (Tahir et al., 2009). However, there is no standard of PAHs both in the raw and drinking water in the NDWQS of Malaysia (MOH, 2004) and no policies to use or monitor these PFCs (Adnan et al., 2012). Moreover, the industrial sector extensively using asbestos in construction (Safitri et al., 2013) though in public sector the use of asbestos has been banned since 2005 due to its toxic characteristics (DOWS, 2014; Li et al., 2014; Safitri et al., 2013). The river was also exposed to many untreated hazardous pharmaceuticals such as cytotoxic, antiviral, hormones, and certain bioengineered drugs (Santhi et al., 2012) and it can be carcinogenic (MOH, 2010).

Management of Water Quality

River Pollution Prevention and Water Quality Improvement Programme by DOE started in 2001 through the 8th Malaysia Plan (DOE, 2010) and the programme is still continued through the 10th Malaysia Plan (GOM, 2010). Ministry of Health along with LUAS in Selangor and BKSA (Badan Kawal Selia Air) in Negeri Sembilan are also monitoring the water quality of the river. However, NDWQS need to be updated as the standard of toxic chemicals such as PAHs, PFCs, etc. have not yet set in the NDWQS. Moreover, the enforcement of Environmental Quality Act (EQA) 1974 and the Water Service Industry Act 2006 should be strengthened so that there should be minimum pollution of the river. However, it is also observed from the EQA 1974 along with its amendment through Environmental Quality (Industrial Effluent) Regulations 2009 that there is no guideline regarding the discharge of chemicals into environment.

Recommendation and Conclusion

Sewerage Treatment Plants (STPs) followed by the industrial sector are considered as the main sources of chemical pollution in the Langat River. Some water quality parameters e.g. Pb, Al, Cr, Cd, Cu, etc. are crossing the level set in Malaysian NDWQS, although it is the main source of drinking water in Selangor. Moreover, there is also lack of policies on the PFCs and PAHs along with scientific research on it. Therefore, the following issues should be considered for the better quality of Langat River:

- Scientific as well as social researches are very urgent requirements to know the prevalence of carcinogenic and hazardous chemicals in the Langat River as well as in the drinking water to examine the health status of the populations.
- A proper, up-to-date and fixed chemical using guideline along the river basin should be formulated to reduce the contamination of the river along with awareness raising activities.
- The National Standard for Drinking Water Quality (NSDWQ) should be updated with a standard range of all the chemicals found in river and drinking water.
- There should be strict monitoring on the industrial and sewage discharges into the river to control the discharges without treatment as sources are in different states.

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Calendar of Events

2nd International Conference on Environment and Bio-Engineering (ICEBE 2016)
12th to 14th January 2016
Penang, Malaysia
Website: http://www.icebe.org/
Contact person: Ms Mickie Gong
Organized by: CBEES

1st Journal Conference on Environmental Science and Development (JCESD 2016 1st)
12th and 13th January 2016
Penang, Malaysia
Website: http://www.ijesd.org/jcesd/1st/
Contact person: JCESD
Organized by: CBEES

6th International Conference on Future Environment and Energy (ICFEE 2016)
23rd and 24th January 2016
Pattaya, Thailand
Website: http://www.icfee.org/
Contact person: Mr Issac Lee
Organized by: CBEES

7th International Conference on Environmental Science and Development – ICESD
1st to 3rd February 2016
Rome, Italy
Website: http://www.icesd.org/
Contact person: Mr. Issac Lee
Organized by: CBEES

ASIA 2016: Water Resources and Hydropower Development in Asia
1st to 4th March 2016
National Convention Centre, Road 13, Vientiane, Lao Peoples Democratic Republic
Website: http://atnd.it/28498-0
Contact person: Melanie Ganz
Organized by: Aqua-Media International

Ajman 4th International Environment Conference 2016: Smart Cities and Green Innovation
2nd and 3rd March 2016
Ajman, United Arab Emirates
Website: http://www.aiec2016.org/
Contact person: W.A. Eldin
Organized by: Municipality and Planning Department - Ajman Government

Water Demand Side Management GCC
7th and 8th March 2016
Dubai, United Arab Emirates
Website: http://www.waterdemandsidemanagementgcc.com/
Contact person: Lara Makdessi

International Conference on Civil, Environment and Waste Management (CEWM-16) Mauritius
20th and 21st March 2016
Mauritius
Website: http://caeer.org/conference.php?slug=CEWM-16&sid=3&catDid=105
Contact person: Ms. Lipsa Zheng
Organized by: International Association of Civil, Agricultural & Environmental Engineering Researchers

International Conference on Sustainable Waste Management - ICSWM
26th to 28th March 2016
Hong Kong
Website: http://icswm.org/
Contact person: Ms. Frannie Lee
Organized by: SCIEI

International Conference on Air, Water, and Soil Pollution and Treatment (AWSPT'16)
30th and 31st March 2016
Prague, Czech Republic
Website: http://awspt.com/
Contact person: International ASET Inc