Water quality monitoring along Kinta River in peninsular Malaysia

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Abstract. Rising trend of solid waste production particularly in town and city areas has caused numerous environmental pollutions. Population growth, economic and lifestyle patterns are the factors that lead to the alarming rate of solid waste production. Landfilling is widely used for disposal of wastes due to its low operation and maintenance costs. However, leachate discharged from landfill could be a problem to surface and groundwater if it is not adequately treated. So, the investigation of the transportation and transformation phenomena of micro pollutants along the river receiving discharge from landfill leachate is mandatory. This study is carried out to investigate the water quality as well as to detect the presence of endocrine disrupting compounds (EDCs) along Kinta river in Peninsular Malaysia. Water quality parameters i.e. biological oxygen demand, chemical oxygen demand, ammoniacal nitrogen, total suspended solids, dissolved oxygen and pH were recorded to calculate the water quality index (WQI). The identification of EDCs was carried out using gas chromatography–mass spectrometry analysis. Water quality index result showed that the status of the river in both months fall under good and medium status where it requires intensive/conventional treatment for consumable and drinking purposes. None of the EDCs was detected in any of the samples analysed in the present study. It is believed that the information gained are useful and beneficial for decision making authority.

1. Introduction

There is massive generation of by-products due to the economic development and change in lifestyle. It’s high time to address the problems related to generation of solid waste which ultimately ends up in landfills [1]. Landfills are the main alternatives used for disposal of solid wastes over the world including Malaysia. There are over 80% of landfills follow controlled tipping or open dumping practices because of the lower operating and maintenance costs compared to other conventional landfill system. Old and un-engineered landfill are unable to avoid contamination as the leeching of leachate may enter neighbouring soil and groundwater. Pollutants from toxic landfill leachate can accumulate and cause detrimental effect to ecosystem, food chains and human health. Generally, leachate from landfill is high in organic matter which include ammonia–nitrogen, heavy metals, and chlorinated organic and inorganic salts. According to Yiping et al. [2], these micro pollutants constitute a significant category of contaminants in landfill leachate although they present in minimum concentration of μg/L to ng/L when compared to the usual contaminates. The occurrence of micro pollutants from landfill leachate has
become growing concern of environmental concern worldwide [3]. Pradeep et al. [1] noted that micro pollutants namely emerging contaminants consisting of natural hormones, industrial chemicals, pesticides, Endocrine Disrupting Compounds (EDCs) and many other emerging compounds commonly present in waters at trace concentrations. However, in recent decades there have been growing numbers of different types of organic micro-pollutants detected and examined in aqueous environments [4]. The physical appearance of leachate is highly odorous black, yellow or orange-coloured muddy substance with a heavy pungent smell when it emerges from a typical landfill site. Landfill leachate contain micro-pollutants that are carcinogenic, persistence and bioactive compounds which potentially harm human health and environment and also effect the Water quality index (WQI) [5]. Discharged leachate from landfill are harmful to the surface water and groundwater if the leachate is not treated adequately before release into receiving river.

Water quality index is an index that commonly used in order to monitor and access the quality of a river [6]. WQI involves river grading into several rank that represent its suitability and uses. According to Patrick et al. [7] WQI is an equation used that computed all calculation into an index number that represent the whole water quality status. Department of Environmental (DOE), Malaysia has set national water quality standards for Malaysia. According to interim national water quality standards for Malaysia, the water class and water quality status are based on the WQI score as per tabulated in Table 1 [8].

| WQI   | Water Quality Status | Water Class |
|-------|----------------------|-------------|
| < 31.0| Very Bad             | V           |
| 31.0-51.9 | Bad            | IV          |
| 51.9-76.5 | Medium        | III         |
| 76.5-92.7 | Good          | II          |
| > 92.7 | Excellent          | I           |

Endocrine Disrupting Compounds (EDCs) are the chemicals which interact with endocrine and causes serious health problems. Studies have found that endocrine disrupting compounds (EDCs) are carcinogenic compounds that are commonly found in leachate and can give adverse impacts to humans and wildlife [9]. The contamination of EDCs in river or groundwater can be harmful as it poses a high endocrine disrupting risk to local resource users and the environment [8]. Some researchers have studied that the presence of EDCs from the leachate are extremely low in concentration that the conventional wastewater treatments are not able to remove EDCs effectively from the leachate [5]. Hence, the treated leachate from the landfills has a high possibility to flow into the river together with the presence of EDCs [10]. Thus, it is important to examine the water quality of the river from upstream to downstream to observe the quality of the water.

To date several studies have been conducted for the investigation of WQI and other micro pollutants presence in different rivers in Malaysia. To best of our knowledge no one has investigated the WQI and EDCs presence in Kinta river in Malaysia. Therefore, this study is carried out to monitor the water quality of a river in Peninsular Malaysia due to the leachate discharge, and to detect the presence of EDCs along the river. Water samples were analysed to calculate the WQI. Detection of EDCs was carried out by GC-MS using liquid-liquid extraction method.

2. Methodology

2.1. Study area

There were 9 sampling points throughout this research as shown in Figure 1. The sampling points were chosen as it covers the river network comprehensively and water quality of the whole river. The samples were taken at every 2 weeks for 4 times (batch 1, batch 2, batch 3 & batch 4) within February 2018 to March 2018. RL is the raw leachate sample before any treatment and TL is the treated leachate sample after it has been treated. Both RL and TL samples were collected inside the landfill. On the other hand,
UJ stands for upstream of the river. UJ is the point where the river water does not yet mix with any leachate effluent from the landfill. Moving on towards the downstream, DP stands for discharge point and this is the point where leachate effluent is being discharged and mixed with the water in the river. While point A, B, C, D and E are points at further downstream towards Kinta River.

Figure 1. Location of the sampling stations.

2.2. Sampling
The river water samples were taken in the middle of the river using a pail or a long water dipper. The samples were stored in High-density polyethylene (HDPE) bottles. Water quality parameters (TSS, BOD, COD, DO, pH and ammonia nitrogen) were recorded following the standard methods (APHA, 1992) with few modifications as described in our previous study [11].

2.3. Water quality index (WQI)
National water quality index was used to determine the water quality index (WQI). The data obtained from TSS, pH, BOD, COD, ammonia nitrogen and DO was multiplied with their sub-indices to calculate the WQI which is given by the following equation [6]:

\[
WQI = [0.22 \times SI_{DO}] + [0.19 \times SI_{BOD}] + [0.16 \times SI_{COD}] + [0.15 \times SI_{NH}] + [0.16 \times SI_{SS}] + [0.12 \times SI_{pH}]
\]  

(1)

Based on the value of WQI obtained from Equation (1), the status of the water quality can be identified according to interim national water quality standards for Malaysia.

2.4. Detection of endocrine disrupting compounds (EDCs) in water samples
EDCs were first extracted from the water samples for their identification using liquid-liquid extraction method. Dichloromethane (DCM) was used as a solvent for the extraction of EDCs. The extracted sample was then analysed by gas chromatography-mass spectrometry (GC-MS) to quantify the concentration of EDC in terms of parts per billion (ppb).

3. Results and discussion

3.1. Water quality index (WQI)
Water quality index (WQI) are often used to express the status of a river. It was classified into two categories which are good and medium with different usages, the status was given on the base of WQI values as shown in Table 1. According to Kaurish and Younos, et al. [12] WQI is an important index that utilize, monitor and follow up any incremental water quality improvement trends in order to determine the effectiveness of stream restoration efforts. Based on all the results obtained from the experiments, the WQI score for each point was calculated as shown in Table 2. Point UJ and A has an average score of more than 80. This indicates that the water at these points falls under ‘good’ status, where the water can be used for recreational purpose and only requires a conventional treatment [13]. The water at these points is also able to cater sensitive aquatic life. The water at discharge point DP and B is falling under ‘medium’ status with average WQI of 70-75. However, moving on further downstream towards point C, D and E, these points has an average score ranging from 61-70 where the water at these
points falls under ‘medium’ class. The water stream in this area is not suitable for sensitive aquatic life as well as recreational purpose and requires an extensive treatment and can only be used for common of economic value as well as livestock drinking [14]. This is because the point C, D and E are congested with development area such as residential area, commercial area as well as industrial area. The graphical representation of WQI is shown in Figure 2.

Table 2. Water quality status at sampling stations.

| Point | WQI average | Status | Class |
|-------|-------------|--------|-------|
| UJ    | 80.14       | Good   | II    |
| DP    | 75.05       | Medium | III   |
| A     | 80.00       | Good   | II    |
| B     | 70.45       | Medium | III   |
| C     | 64.73       | Medium | III   |
| D     | 65.69       | Medium | III   |
| E     | 61.94       | Medium | III   |

Figure 2. WQI of the water samples.

3.2. Detection of endocrine disrupting compounds (EDCs)
All the water samples were analysed for the detection of endocrine disrupting compounds. Interestingly, no EDCs were detected at all points as summarized in Table 3. This shows that the wastewater treatment plant in the landfill has successfully removed all the EDC content or the concentration of EDC in water samples is extremely low to be detected. EDC is hard to analyse as it has high action forces to be determined at a very low concentration [7]. The extraction of organic compounds in the present work was carried out for a sample of 100 ml. The extraction can be extended to 1000-10000 ml samples for further analysis.

Table 3. EDCs detection results.

| EDC class                        | Result |
|----------------------------------|--------|
| Polyhalogenated compound         | ND     |
| Phenolic Compounds               | ND     |
| Phthalates                       | ND     |
| Pesticides                       | ND     |
| Hormones                         | ND     |
| Pharmaceutical & Personal Care Products | ND     |
| Combustion by-product            | ND     |

*ND – Not Detected
4. Conclusion
This study had highlighted and achieved all the objectives. Water quality index and the presence of EDCs in a river in Peninsular Malaysia were monitored for a period of 2 months at 9 different points. Water quality index result showed that the status of the river in both months fall under good and medium status where it requires intensive/conventional treatment for consumable and drinking purposes. The river water at point UJ and A shall only require a conventional treatment and is able to cater sensitive aquatic species. At points DP and B, the water quality is medium. The water quality at point C, D and E decreases because the residential, commercial and industrial wastes are being discharged at these points. In terms of EDCs, none of the EDC compounds was detected in any of the samples. It is recommended that water of this river should be treated before drinking and monitored for possible EDCs contamination and treatment.

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