

# Microplastics in sediment from Skudai and Tebrau river, Malaysia: a preliminary study

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**Abstract.** Plastic debris floating on surface water has now become an environmental issues concerning its abundance and fate. Generally, plastic debris that are fragmented into less than 5 mm in size is known as microplastics (MP). To date, discovery on the occurrence and impacts of MP in marine environments have been reported by many studies. However, less investigation has been carried out in freshwater environments. The occurrence of MP in Malaysia is also unknown. Thus, the present study has characterised the abundance of MP between Skudai and Tebrau River. The quantification of MP levels in these channels are pertinent since both rivers are listed among polluted rivers in Malaysia with high amount of rubbish. Surface sediments were collected with a box corer and MP were extracted via density separation. The inspection of particles was carried out under microscope and were categorized based on shape, colour, and size. Preliminary results showed that the concentration of MP was much higher in Tebrau than of Skudai River. The study demonstrates that the abundance of MPs in both urban rivers may possibly be affected by weathering breakdown of large plastic materials since these locations are well-known for fishing and industrial areas.

## 1 Introduction

To date, only a few studies have reported the occurrence of microplastics in freshwater as compared to marine environment [1, 2]. However, different patterns of these studies can be perceived, particularly in rivers, where the research scopes depend on the obtainability of the environmental or biological matrices in a particular location, its seasonality (temporally) and also spatial distributions. To indicate this, [3] have recently reported on the abundance of microplastics in surface sediment based on two seasonality. Meanwhile, another study investigated on the spatial occurrence of microplastics along the river and its tributaries [4].

This includes the occurrence of microplastics from the upstream area down the river mouth [5]. Notwithstanding the strategies for investigation varies, the comprehensive database on its occurrence (i.e. distributions, category, types of polymer) in freshwater environment is still scarce [6]. The fact that the high population density in urban area has

given a significant impact to the environment is undeniable and the most notable matter is plastic materials [7]. As is generally known, their route into aquatic biome mostly originated from the improper disposal by human. This includes the directly disposal of plastic materials down to the river system by reckless user. Nevertheless, up till now, comprehensive understanding on the source as well as deposition and decomposition of different plastic polymers in the environment are still poor [8].

In 2010, Department of Statistics, Malaysia [9] has reported that Johor is the fifth largest state in Malaysia with 3.35 million population distribution of which makes it as the second most populous state after Selangor. The capital state of Johor, Johor Bharu has 1302/km<sup>2</sup> of population density making it as among the most densely populated city in Malaysia [9]. Both Skudai and Tebrau River are located within this region and well-known for fishing and leisure activities (public recreational park). It is worth noting that these rivers have also been reported as the most polluted rivers in Peninsular Malaysia with high amount of rubbish [10], where the predominant trash is plastics as evidently observed to this day.

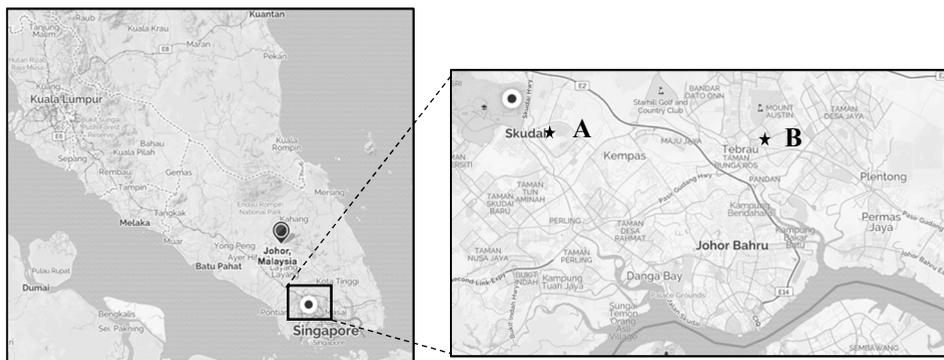
## **2 Materials and Methods**

### **2.1 Sampling site and contamination precautions**

Surface sediments were collected from Skudai and Tebrau River in December 2017. A box corer (Wildco) was used to collect the sediment at sampling sites. In each river (as shown in Figure 1), three subsites sediments were collected between 2 m then mixed together into a stainless-steel tray as one sample [6, 11]. The sample then was preserved in sediment bottles prior to further analysis in the laboratory. Aluminium foil was used to cover sediment samples as to minimise air-borne plastic particle contamination during sampling activities [12]. To prevent plastic contamination, all equipment and glassware were rinsed thoroughly with ultrapure water (PURELAB® Flex, Elga) thrice before use [13, 14]. All glassware containing sample matrices in the laboratory were sealed with aluminium foil as to minimise air-borne plastic particle contamination [12]. Preparation of chemical solutions in the method description were carried out in the fume hood as to prevent plastics particle contamination from surrounding. Ultrapure water (PURELAB® Flex, Elga) was used to prepare chemical reagents throughout the experiments.

### **2.1 Digestion of biogenic materials and density separation**

The collected sediments were oven dried at 50°C for 3 days or until completely dried. Density separations were performed in three replicates. An amount of 50 g dried sediment was weighed in a glass beaker and 150 ml of 30% hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) was added. The reaction was then left to stand for one week in order to digest biogenic materials in the sediment samples [15]. The remainder H<sub>2</sub>O<sub>2</sub> solution from the sediment was then filtered through a 53 µm stainless steel sieve (Endecotts Ltd, London, England). Clear visible particles that are larger than 200 µm on the sieve were then transferred to a clean petri dish. The sediment that remained in the glass beaker was allowed to oven dry at 50°C overnight.



**Fig. 1.** Two sampling points at Skudai (A: 1.528506, 103.672485) and Tebrau River (B: 1.524672, 103.672485) in Johor Bharu district.

## 2.2 Density separation

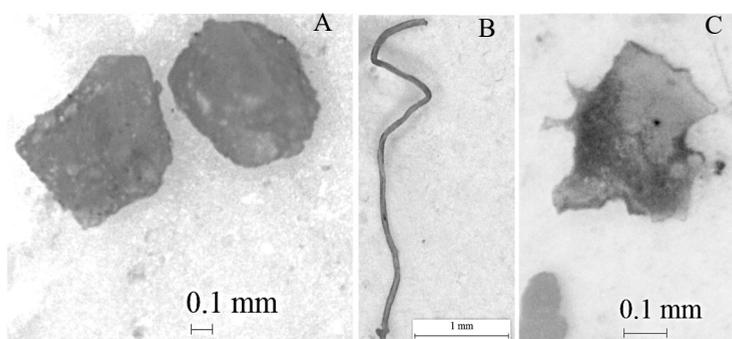
Density separation method by [16] was followed in order to determine the abundance of microplastics in sediment. Saturated sodium chloride (NaCl) with density of  $1.2 \text{ gcm}^{-3}$  was used to separate particles. An amount of 450 ml of NaCl was added to dried sediment and the mixture was stirred for 3 minutes. Then, salt water was added up to 0.5 cm from the flask mouth. After the mixture was left standing overnight, the buoyant particles were isolated by pouring 50 ml NaCl. The supernatant then was passed through a  $1.2 \mu\text{m}$  pore size glass microfiber filter (Whatman GF/C) using a vacuum pump (Gast Manufacturing Inc., USA) [6]. The filtered items were washed several times with ultrapure water as to remove NaCl solution residues and undigested organic materials (i.e. shells) was also discarded. One control sample was carried out by filtering 200 ml of NaCl solution through filter paper. The filter paper was then was dried at  $30^\circ\text{C}$  for 24 hours. All filtered particles were further identified in subsequent analysis.

## 2.3 Identification of microplastic particles

Microplastics were inspected and photographed under microscope (HSZ-600) with  $40\times - 45\times$  magnification. The observation of microplastics under microscope were carried out in accordance to the described procedure in [11]. The microscope stage was moved in a “zigzag” pattern from left to right position. The particles were carefully identified and measured where the particle under inspection cannot be torn apart and crushed by a tweezer. The measurement was conducted by using *i-solution* premium (IMT Cam3) software with a resolution of  $1200\times 800$  pixels. Meanwhile, particles that possess organic structure was carefully identified and discarded from the analysis. Inspected microplastic particles were assessed based on shape, colour and size. Category of shape of particles (fibre/line, fragment, film, foam, bead/pellet) were evaluated in accordance to the definition described in [17]. Meanwhile, colour appearance was divided into six different categories: blue, black, yellow, transparent, white and red [11]. In this study, particles that exceeded 5 mm (mesoplastics) and smaller than  $1 \mu\text{m}$  (nanoplastics) were excluded from analysis. The length size of the identified items were also recorded according to the size class:  $0-100 \mu\text{m}$ ;  $101-500 \mu\text{m}$ ;  $501-1000 \mu\text{m}$ ;  $1001-5000 \mu\text{m}$  [18]. Concentration of microplastics was expressed as number of particles per unit mass of the sample matrix, where the unit was standardised as particle per kg dry weight [19].

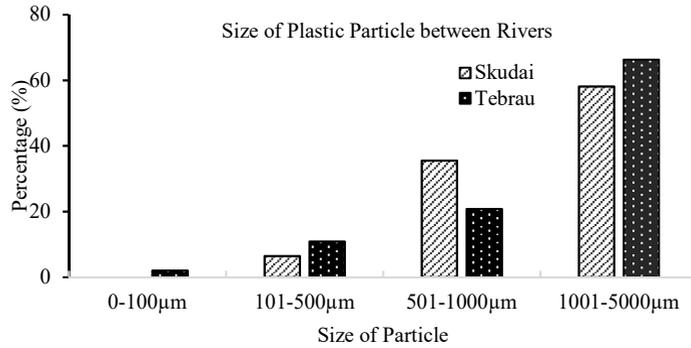
### 3 Results and Discussion

In this preliminary study, microplastics were detected in both rivers in December 2017 (Figure 2). The average concentrations in Skudai and Tebrau River were  $200 \pm 80$  and  $680 \pm 140$  particles per kg, respectively. Meanwhile, the dominant size detected in both rivers was 1000 to 5000  $\mu\text{m}$ , occupied more than 60% of total particles (Figure 3). Previous study had reported that microplastics size ranging from 500 to 5000  $\mu\text{m}$  may lead to high chances of ingestion incidence by aquatic animals [20]. Only sank microplastics on surface sediment were enumerated in this work since sediment samples were demonstrated as a good representation for long-term microplastics accumulation than in water column [6]. Hence, this may cause a prolong effect to benthopelagic species in the channel. Meanwhile, the most abundant shape found in Skudai and Tebrau River was film (Figure 4). Similar finding were also reported from sediment on four different sites in River Thames [21].

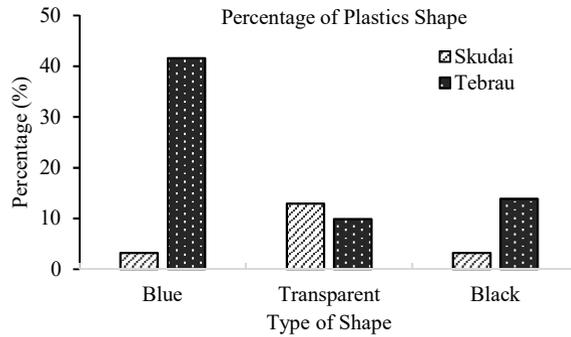


**Fig. 2.** Different shape category of microplastic particles (A: fragment, B: line/fibre, and C: film) found in Skudai and Tebrau River.

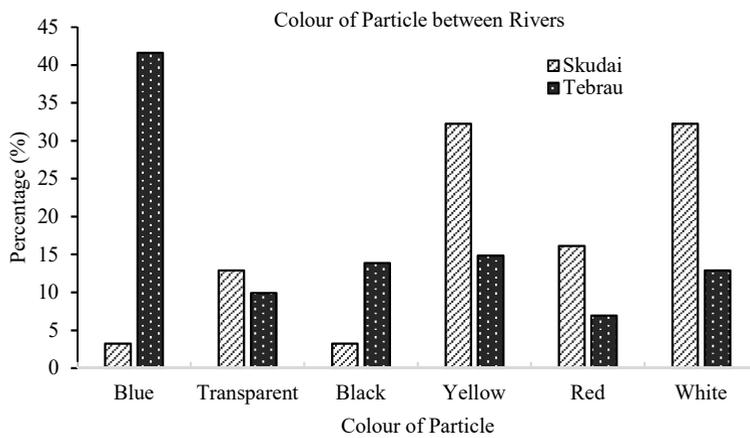
As well as, microplastics obtained from both rivers were mostly colored particles. This showed a consistent result with previous studies on the microplastics abundance worldwide [20]. Here, blue was the most dominant colour in Tebrau River (Figure 5). In contrast, yellow and white were equally dominant colours observed in Skudai River. The evaluation on the variation of microplastics colours in environment is significant since colours may also increase the chances of aquatic organisms to ingest plastic particles by mistaking them for food [22, 23]. Where possible, the ingestion incident may affects the growth rate, hatchability, and food ingestion of the aquatic organisms [24]. Besides that, Choi et al. [25] reported that microplastics with different shapes have also caused intestinal distention to shipshhead minnow, *Cyprinodon variegatus* under controlled laboratory condition.



**Fig. 3.** Different size category of microplastic particles found in Skudai and Tebrau River.



**Fig. 4.** Comparison on the abundance of plastic particle shapes between Skudai and Tebrau River.



**Fig. 5.** Different category of plastic colour particles found in Skudai and Tebrau River.

Our preliminary results showed a distinctly difference in abundance of microplastics between Skudai and Tebrau River. Possible reason for this might be due to the constant input of plastic waste, as evidently observe in these rivers to this day. Thus, most of the plastic trashes will eventually sink and covered with sediment before degradation takes place [11]. In fact, concentration of microplastics found in this study are greater than from sediment in Ottawa River, Canada [4], Beijiang River, China [6] and comparable with those found from sediment in Antuã River, Portugal [22] as well as in River Thames, UK for microplastics abundance between size range of 1000 and 5000  $\mu\text{m}$  [21]. In contrast, the abundance of microplastics found in the present study were smaller than have been reported in Scheldt River, Belgium [26] and Rhine-Main River, Germany [27].

Meanwhile, Castañeda et al. [28] demonstrated that freshwater sediment could act as a sink for microplastics where the similar concentration was found in marine sediment. As well as, Rodrigues et al. [22] have also reported the similar pattern of microplastics abundance found in Antuã River, Portugal sediment and from various studies in marine environment. In this preliminary monitoring work, no bead or spherules were found in the sediment from both rivers although local plastic manufacturer and sewage treatment plant are located near to the sampling points in Tebrau and Skudai River, respectively. Nevertheless, high concentration of spherules were recorded by several studies, for instance in River Danube [29] and St. Lawrence River [28]. To the best of our knowledge, this study is the first to report on the occurrence of microplastics in river sediment with microplastics observed between the most polluted urban rivers in Peninsular Malaysia.

All microplastics obtained are derived from the fragmented and weathered of larger plastic items where this type of plastic particles is usually categorised as secondary sources of microplastics [30]. According to Eerkes-Medrano et al. [2], secondary sources of microplastics are typically associated with high population density areas, of which based on the level of local human activities. Besides that, wastewater treatment plant as well as industrial pressure also contribute to the high abundance of microplastics near to the river [15, 22, 31]. Meanwhile, Nor et al. [23] found that the sampling sites that have low level of human activities showed low microplastics concentration in Singapore's estuaries.

Our preliminary study identified Skudai and Tebrau River could also act as a water route to transport used plastic materials and may significantly increase the plastic debris problem in the river floor as well as surface water. Certainly, this incident may also contribute to the accumulation of plastic particles in river mouth as well as along the Tebrau Straits. In fact, this particle has been previously reported to contaminate estuary ecosystem worldwide. For instance, Fok and Cheung [32] have found the potential of Pearl River as a source of microplastics in contaminating Hong Kong estuary. Meanwhile Peng et al. [6] have indicated that urban river input was the major factor for the abundance of microplastics in Changjiang Estuary.

## 4 Conclusion

Based on the preliminary analysis, sediment from both urban rivers are polluted with microplastics, where the high concentration can explicitly be observed in Tebrau River. This preliminary work represents the baseline database for monitoring microplastic concentration in the most polluted rivers in Peninsular Malaysia. The findings also showed the importance of regulation of plastics materials and recycling plan as to prevent the increasing of this threat in the aquatic environment. Furthermore, the findings may provide a foundation to gain insight into the source as well as the associated impact with this pollutant to environment and possible affect to aquatic biota health through microplastics ingestion.

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