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QUANTITATIVE ANALYSIS OF PLASTIC POLYMERIC POLLUTION AT THE SHORE OF THE SHATT AL-ARAB RIVER IN SOUTHERN IRAQ

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ABSTRACT

Five stations (Al-Fao, Al-Seeba, Abu-Al-Kasieb, Basrah Center, Garmatt-Ali) along the Shatt Al-Arab River were selected for analysis of mesoplastics debris and macroplastics debris. The average density of shoreline plastic debris of the Shatt Al-Arab River was 170.552 g/m^3 at the shore. Al-Seeba station represents the least polluted shoreline (107.93 g/m^3), while the Basrah Center station (242.53 g/m^3) was higher in pollution. The quantitative of plastic items found in Garmatt-Ali station was (116.46 g/m^3), Abu-Al-Kasieb (164.98 g/m^3), and Al-Faw (220.71 g/m^3) stations. The shoreline mesoplastic debris items were composed of bags (film) Pieces (35%), Single-use plastic or polystyrene cups (20%), Pieces of drinking Bottles (15%), fishing lines (19.64g, 5%), Female sanitary protection (2.5%), takeaway or food container (1.5%), cigarettes filters (1.5%), bottles covers (2%), plastic straws (,0.5%) and other types of polymers (17%). The shoreline macroplastic debris was classified into seven types; Plastic bottles of all types (40.51%) as larges, Single-use plastic carrier bag (35.46%), polystyrene takeaway or food container (6%), Single-use plastic or polystyrene cups(3%), Female sanitary protection, nappies and wet wipes (1.39%), Smoking-related packaging makes (2%), plastic straws, stirrers, and cutlery make (1%) and other types of polymers (11%). Also the shoreline plastic debris was classified depending on the type of polymers in to: polyethylene Terephthalate (40.51%), high-density and low-density polyethylene (35.46%), polystyrene (6.53%), polystyrene (9.94%), polypropylene (3.34%), dry polyamide (5.22%) and other types of polymers (5.53%). The salinity of tap water is considered the main reason for use of small and medium-sized water plastic bottles significantly is the main contributor to plastic pollution in the Shatt al-Arab River, in addition to the presence of restaurants and tourist areas that throw the plastic waste in the Shatt al-Arab in addition to fishing activities.

KEY WORDS : Polymer, Plastic pollution, Shatt Al-Arab river, Water pollution.

INTRODUCTION

Plastic is one of the types of high-molecular-weight organic polymers prepared from petrochemical raw materials. Plastics are mostly non-degradable materials or they decompose very slowly. The global demand is increasing day by day for all types of polymers causing problems and risks to the environment due to the slow degradation of this organic polymer (Tripathi *et al.,* 2016).

Plastic pollution is an important environmental problem for the United Nations environment Program, In addition to climate change, it affects biological diversity and human health. The spatial distribution, species, and characteristics of macro-, meso-, and micro-plastic fragments in shoreline sediments of a freshwater lake. Food wrappers (polypropylene andpolystyrene), bags (high- and low-density polyethylene), bottles (polyethylene terephthalate and disposable Styrofoam), food containers (expanded polystyrene) were the dominant macroplastics recorded in this study. An average of 25 mesoplastics (mainly expanded polystyrene) and 704 microplastic particles (diverse resins) were recordedper square meter insandy sediments (Blettler *et al.,* 2017).

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Plastic has been observed in large quantities since the mid-twentieth century, as a material element of modern life and as a pollutant of the environment on a large scale. And plastics have become widespread in the marine and river environment, with different shapes and sizes, and the quantities of plastic are likely to increase over the next few years (Zalasiewicz *et al.,* 2016). For decades, plastic waste has been dumped in seas, rivers, and lakes, which leads to pollution of beaches and waters (Faure *et al.,* 2015).

Plastic materials have unique properties and advantages such as lightweight, strength, durability, and cheapness (Laist, 1987). These characteristics and characteristics make them suitable for the production and manufacture of a very wide range of products, and they are the characteristics that make plastic pose a great danger to the environment (Pruter, 1987).

There are a lot of large-scale research efforts on plastic pollution, but they have focused on examining plastics in the oceans only, and there are very few studies done on freshwater systems of rivers, and therefore, there is a relative lack of knowledge about the presence of plastic waste in rivers water and sediments throughout The world, and data on the existence, sources and fate of that waste are almost scarce (Eerkes-Medrano *et al.,* 2015).

The presence of plastic debris in seas, rivers, and beaches causes great harm to marine organisms through entanglement and ingestion, and more than 260 species of organism's have recorded accidents of ingestion or entanglement with plastic debris. Plastic waste has the potential to cause damage to the benthic ecosystem. Since they are also buoyant, they travel long distances, and finally, settle in sediments, and they may persist for centuries. The risk of plastics to the aquatic environment has been neglected for a long time, and its risk was only recently recognized (Laist, 1987).

The Shatt al-Arab River is one of the most important rivers in the Republic of Iraq and the main source of fresh and surface water in Basra Governorate, southern Iraq. Its water is used for many purposes, including drinking, irrigation, fisheries, navigation and industry. The Shatt al-Arab River forms in Qurna where the Tigris and Euphrates rivers meet together in the north of Basra Governorate, and it is a link between the freshwater from Iraq to the saltwater in the Arabian Gulf [8] (Abdullah *et al.*, 2015). About 5 x 109 m^3 of its nutrient-rich water is discharged from the Shatt al-Arab River into the Arabian Gulf every year [10]. TheShatt al-Arab river's area of 969059 square kilometers is occupied by trees and aquatic weeds on a large scale, and contains unique collections of fauna and water plants that represent a diverse, delicate, and balanced ecosystem (Douabul and Al-Saad, 1985). The Shatt al-Arab River, as part of the city of Basra in southern Iraq, is vulnerable to plastic accumulation from land sources due to population concentration along its shores, and intense fishing and recreational water activities in its waters, especially in the summer months.

Plastic Riverine pollution in the coastline of the Shatt al-Arab River is not yet documented, and therefore the objectives of this work are: assessing and determining the state of river pollution with plastic, estimating and measuring the accumulated plastic in the Shatt al-Arab coast in addition to identifying the types of plastic debris in terms of use and identifying the types of polymers that make up these Plastics.

MATERIALS AND METHODS

Five stations throughout the shoreline of Shatt Al-Arab River were sampled during the Summer of 2019 for analysis of mesoplasticdebris (5 mm to 2.5 cm) and macroplasticdebris (2.5cm to 1m) debris, which are Al-Faw (29°58′28.6″ N - 48°29′09.5″ E), Al-Seeba (30°20′16.5″ N - 48°15;34.5″ E), Abu Al-Khasib (30°27′44.5″ N - 48°00′06.0″ E), Basrah Center (30°33′00.0″ N - 47°47′10.0″ E) and Garmat-Ali (30°48′10.6″ N - 47°45′03.8″ E).

The selection of sampling stations was based on easy to reach site access and suitability for sampling and the different human activities to which they are thought to be exposed. On each station, three transects were selected at random on the bank of the river, each transect was 5 meters in length.

Within each transects, an individual quadrat of one square meter (1 m × 1 m) were chosen randomly for waste plastic sampling, so, a total of 15 samples (three per each station) were collected from the different station. Each sample has consisted of soil scooped with a small shovel from the selected 1 m^2 quadrat to a depth of approximately ten cm to fill a fifteen-liter pail.

The plastic waste was separated and isolated from the soil manually, collected in a labeled plastic bag, and transported to the laboratory for an accurate analysis then, in the lab, the plastic waste samples were washed with distilled, hot water three times to remove soil finally.

The samples were then air-dried at room temperature. The different types of plastic items were placed into separate containers, marked by the name of the station and type of plastic.

samples were then weighed by a digital balance with to 0.01 g precision, and their density (mass of debris items/m^3 of the soil) was calculated as follows:-

$$(d) = (m) / [(a) \times (h)]$$

where

d = density of debris items (g/m^3

m = mass of debris items for one meter cubic (g)

a = area sampled = 1 m^2

h = depth of sample = 10 cm = 0.1 m

Each size class was then separated by type of plastic as Plastic bottles, Single-use plastic carrier bag, polystyrene takeaway or food container, Single-use plastic or polystyrene cups (4%), Female sanitary protection, Smoking-related packaging makes and plastic straws, stirrers, and cutlery makecups (4%), Female sanitary protection, smoking-related packaging makes and plastic straws, stirrers, and cutlery make.

Plastic wastes were also classified into six classes depending on the type of polymers which are made of by depending on the markings on it, the type of use, and the external appearance, in addition to measuring the density of all polymers that make up that plastic waste and calculation the percentage of each polymer (the plastic coastal waste) according to the following equation:

$$\text{polymer\%} = \frac{\text{mass of polymer}}{\text{The total mass of all polymers in all station}} \times 100\%$$

The density of polymers was measured to determine the types of polymers according to their density by the method of buoyancy - Archimedes' principle in practice, which states that an object partially or completely submerged in liquids experiences a buoyancy force that affects it upwards. The volume of this force is equivalent to the weight of the fluid displaced by the action of the object.Polymers (plastic waste) are weighed in air (A) and then again (B) in water with a density by using digital accurate balance . The polymer density ñ can be calculated as follows:

$$\rho = \frac{A}{A - B}(\rho o - \rho L) + \rho L$$

ρ = Density of the polymer, A = Weight of the polymer in air, B = Weight of the polymer inthe water, ρ0 = distilled water density, and ρL= Density of air, at room temperature 25 °C. The temperature of distilled water must be taken into account as this can cause density changes of 0.001 to 0.1 per degree Celsius.

RESULTS AND DISCUSSION

In total, 852.61g of debris was found on the five surveyed stations along the side of a stream Shatt Al-Arab River (15 quadrats, each of 1m^2, Random sampling) during the survey period, which represents an average of 170.522 g/m^3. Figure 1a and 1b show the plastic pollution in the Basrah

Fig. 1a. Plastic pollution in the Basrah Center station.

Fig. 1b. Plastic pollution in the Garmatt-Ali station

Center station and the Garmatt-Ali station.

Table 1 and Figure 2 show the average density of plastic debris per quadrat in the different stations. In general, the highest density of plastic items was found in Basrah Center station and al-faw station. In others shoreline (Al- Garmatt-Ali and Abu-Al-Kasieb stations) a lower degree of pollution was observed and Al-Seeba was represented the least polluted station.

The shores of the Seba and Garmatt Ali stations are characterized by a low density of plastic debris due to the limited access of the public to them, because of the presence of a small number of users to these beaches and a low level of public use such as fishing, swimming and picnic. The low level of general use leads to a decrease in the density of plastic debris found on these beaches.

Figure 3 show the total mass of debris collected in all location of shoreline where the total mass of the mesoplastic riverine debris were 392.82 g/m^3 and the total mass of Macroplastic riverine debris were 459.74 g/m^3.

The highest quantitative of mseoplastic riverine debris was found in Al-Fao station (133.57 g/m^3), perhaps because of the breakage of some large-sized plastic waste into smaller parts during running in the water or colliding with the coasts of the river or ships and the rest of the solid materials, as it moves this riverine debris gradually reaches the end of the Shatt Al-Arab River and reaches its last station, which is Al-Faw Station. At the Garamatt Ali station, the smallest quantity of mseoplastic riverine debris was found (40.82 g / m^3).

Table 1. Average quantitative of plastic debris in five shore stations

N	Location	Density (g/m^3)
1	Garmatt-Ali station	116.46
2	Basrah Center station	242.53
3	Abu-Al-Kasieb station	164.98
4	Al-Seeba station	107.93
5	Al-Fao station	220.71

The highest quantity of Macroplastic marine debris was found in Basrah Center station accounting for (139.02 g/m^3). The least it was quantity found in Al-Seeba station where only 62.62 g/m^3.

In qualitative analysis, Figure 4 shows the shoreline mesoplastic debris items were composed of bags Pieces (137.50g, 35%), Single-use plastic or polystyrene cups (78.57 g, 20%), Pieces of drinking Bottles (58.93g. 15%), fishing lines (19.64g, 5%), Female sanitary protection (9.82g, 2.5%), takeaway or food container (5.89g, 1.5%), cigarettes filters (5.89g, 1.5%), bottles covers (7.85g, 2%), plastic straws (1.96g, 0.5%) and other types of polymers (66.87g,17%).

Figure 5 show the shoreline macroplastic debris was classified into seven types; Plastic bottles of all types (186.24g,40.51%) as larges, Single-use plastic carrier bag (163.02g, 35.46%), polystyrene takeaway or food container(27.58g,6%), Single-use plastic or polystyrene cups(13.79g,3%), Female sanitary protection, nappies and wet wipes (6.39g, 1.39%), Smoking-related packaging makes (9.19g, 2%), plastic straws, stirrers, and cutlery make 4.59g, 1%) and other types of polymers (50.57g, 11%).

The bags (film) fragments was the high density debris in meso-plastic, while in macro- plastic, the plastic bottles of all types was the high density debris (Figures 4 and 5).

In general, the most dominant debris were water bottles, bags (film) and plastic cups. This was particularly the case were found near the shore access points. This type of debris appeared to be derived from shore users as they were concentrated at tourism and restaurant locations and were found throughout the shore. In addition, of interesting note was the increase of fishing related type of debris, which was prominent near locations of boat launch sites and areas of popular beach fishing sites. A majority of debris appeared to be of terrestrial origin but transported to the shore from the river.

Tourism, Fishing and the presence of informal settlements on the Shatt al-Arab coast is likely to be main the source of plastic debris as indicator items tracing back to tourism were generally found in high quantities. Some people, mostly from the local Shatt Al-Arab river region community spend vacations on its shore. The shoreline was partly observed to be more polluted with debris (e.g. plastic bottle and bag (film). The percentages of each group, calculated using the occurrence of the respective indicator items (Figure 6).

The shoreline plastic debris was classified depending on the type of polymers in to: polyethylene Terephthalate (40.51%), high-density and low-density polyethylene (35.46%), polystyrene (6.53%), polystyrene (9.94%), polypropylene (3.34%), dry polyamide (5.22%)and other types of polymers (5.53%).

The polymer most commonly used was polyethylene Terephthalate (41%) used in the manufacture of drinking water bottles, followed by high-density polyethylene and low-density polyethylene (35%) used in the manufacture of packaging materials, packaging and the manufacture of bags and film (Figure 7).

The density of polymers was measured to determine the types of its according to their density by the method of buoyancy - Archimedes' principle

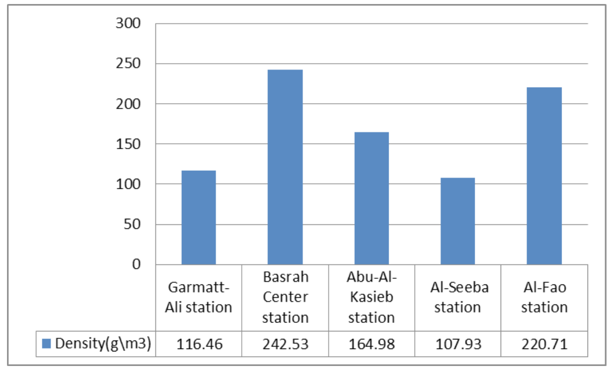

Fig. 2. Average quantitative (density) of plastic debris in five shoreline stations

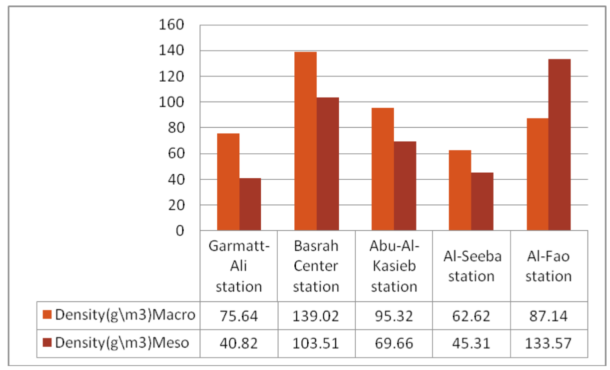

Fig. 3. Debris density (g/m^3) found in shoreline samples (Meso and Macro sizes)

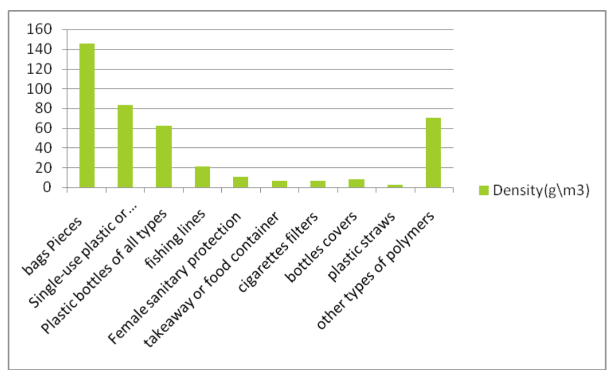

Fig. 4. Density and type of Mesoplastic debris in shoreline debris

Table 2. The density measurements of plastic polymer (debris).

Polymer name	Density (g/cm^3) in literature [12] Min.	Density (g/cm^3) in literature [12] Max.	Density (g/cm^3) mesured In labortary
Polyethylene terephthalate (PET)	1.37	1.45	1.41
Polyethylene (PE)	0.91	0.97	0.91
Polystyrene (PS)	1.01	1.04	1.02
Expanded polystyrene (EPS)	0.016	0.640	0.02
Polyamide (nylon) (PA)	1.02	1.05	1.02
Polypropylene (PP)	0.9	0.91	0.91

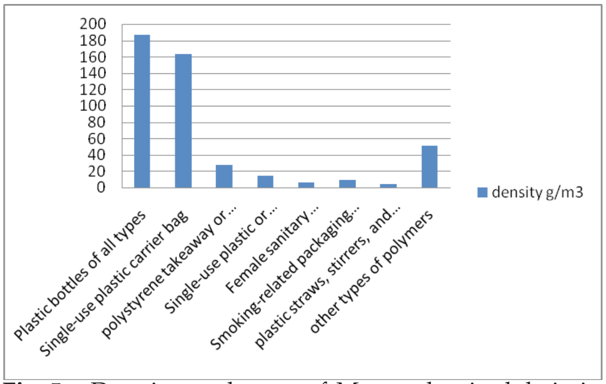

Fig. 5. Density and type of Macroplastic debris in shoreline debris.

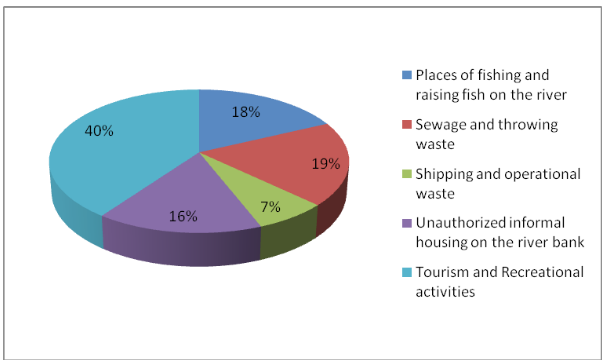

Fig. 6. The sources of plastic polymeric pollution.

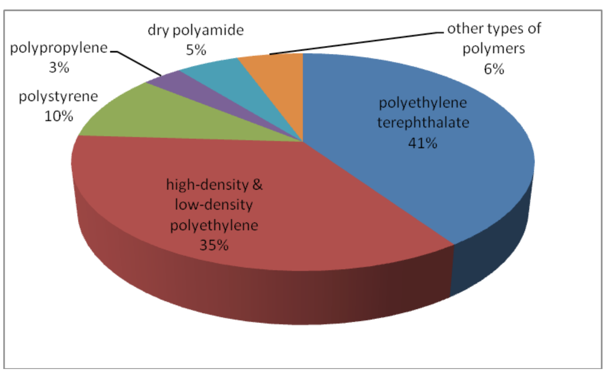

Fig. 7. The type of polymer from which the riverine plastic waste is made.

in practice. The measured density values were compared with those found in the literature and found to be identical (Table 2).

CONCLUSION

The average density of shoreline plastic debris of the Shatt Al-Arab River was 170.552 g/m^3. the higher pollution density was in Basrah Center station, while Al-Seeba station was represented the least polluted shorelines. The bags (film) fragments was the high density debris in meso-plastic, while in macro-plastic, the plastic bottles of all types was the high density debris, the polymer most commonly used was polyethylene terephthalate(41%) used in the manufacture of drinking water bottles.

The study shows that the main reasons for plastic pollution in the Shatt Al-Arab coast is the tourism, fishing, and the presence of informal settlements.

Quantities of water debris in the Shatt Al-Arab River are less than the amounts found in other international rivers. The Shatt Al-Arab River an active economic corridor for commercial and cruise ships, industrial practices, tourism, and fishing, making it a source of plastic pollution.

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