Analysis of microplastic in surface water of Narmada River, Jabalpur, MP, India

Lal Krishna Kant Patel
Student
Jabalpur Engineering college, Jabalpur

Abstract: Microplastic particles are found in environmental compartments all over the world and receive a great attention, especially in the aquatic environment. Due to increasing anthropogenic activities, Portable water is the basic requirement in all over the world. The objective of this study is to investigate the abundance and types of microplastic particles (MPs) found in the Narmada River, 5th longest river and overall, longest west-flowing river in India. In this study, 4 sites in Jabalpur were selected along the length of the mainstream river to represent the whole length of the Narmada River across Jabalpur city. Four samples were collected after filtering the 240 liters of surface water of Narmada River. A total 57 microplastic particles were identified. 48 (84.3%) microplastic particles identified were less than 1mm and 9 (15.7%) microplastic particles were greater than 1mm. Finally, the paper also highlights the types of microplastic at different location. This study should be one of the first baseline studies for microplastic contamination in Narmada River stream. Data suggests contamination was at least coming from surface run-off, wastewater effluents and packaging or bottling materials.

Keywords: Microplastic; Narmada; fifth-longest river; Freshwater; Contamination.

Introduction
Microplastic (plastic with a diameter of less than 5 mm) has become one of the most significant pollutants in marine and river surface water. Because of its low production costs and availability, the use of plastic is becoming more comfortable and common. However, the waste generated as a result of the use of plastic products is a major source of concern for the environment and the water ecology (Li et al., 2018a).

In general, there are two types of microplastics: primary microplastics, which are created to serve specific purposes, like cosmetic microplastics and resin particles used as industrial raw materials, and secondary microplastics, which are created by fragmenting and reducing the volume of large plastic waste through physical, chemical, and biological processes (De Falco et al., 2019; Duis and Coors, 2016; Kole et al., 2017). Microplastics are small enough to be swallowed by a variety of marine organisms, from tiny zooplankton to huge vertebrate predators. (Botterell et al., 2019; Nelms et al., 2019).

Rivers are the primary mode of conveyance for microplastic in the ocean. Every year, 1.15 - 2.41 million tones of plastic debris enter the ocean via rivers all around the world. In the world's oceans, there are 5.25 trillion plastic fragments weighing over 250000 tonnes (Tsering et al., 2021)(Buwono et al., 2021). 67 percent of microplastic pollution in the ocean comes from the top 20 polluting rivers, and that are largely from Asia. Many studies on microplastic have been conducted on Indian rivers and sediment, and they have confirmed the presence of microplastic(Gupta et al., 2020). According to estimates, 70% of marine trash will sink and stay at the ocean's bottom whereas the vast majority (80%) comes from land sources(Lechthalier et al., 2021a).

There is limited research on microplastic pollution in the Narmada River and until now, there is no data on the microplastic pollution in surface water of Narmada. The aim this study is to check the presence of microplastic contamination in surface water of Narmada near Jabalpur city.

2. Methods
2.1 Study area
The Narmada River (5th longest river and overall, longest west-flowing river in India) originates from the Amarkantak Plateau in the Madhya Pradesh district of Anuppur at an elevation of 1048 m and runs westward across a distance of 1312 km before discharging into the Arabian Sea via the Gulf of Khambhat. The Narmada River was joined by several small and big tributaries. This river, which runs across Gujarat, Maharashtra, and Madhya Pradesh, is also known as the "Lifeline of Gujarat and Madhya Pradesh" because of the significant benefits it provides to these two states. The Narmada River has an average discharge of 1216 m³/s and a maximum discharge of 11246 m³/s during the monsoon season.
2.2 Site selection
4 locations in Jabalpur were chosen for this study along the Narmada river's main course to represent the river's whole length through Jabalpur city. From upstream to downstream of the river, the four locations were Jamtara (J), Gwarighat (G), Tilwara Ghat (T), and Bhedaghat (B). On a 80 kilometres length, the samples were taken around every 20 km.

2.3 Sampling method
Water samples of approx. 60 L were taken from 0.5 m below the river surface and immediately filtered through a 40 µm sieve and each filtered sample was transferred to a glass jar. The target microplastic size is greater than 40µm. At each sampling site, three samples of 20 L were taken at an interval of 1 km (0,0.5 and 1 km) from the centre of the river. Each sample was taken to the Chemistry department lab, JEC College Jabalpur (MP) for laboratory analysis.
2.4 Laboratory analysis

Laboratory analysis was done according to the manual provided by NOAA Marine Debris Program (National Oceanic Atmospheric Administration) (NOAA). According to the manual, filtered samples were oxidized with 30% hydrogen peroxide solution for 24 hours to oxidize the organic material present in the sample. After oxidation, density separation was done with zinc chloride solution (relative density of zinc chloride is 1.6-1.7) (Li et al., 2018b). After density separation, samples were filtered from 4.5 µm cellulose filter paper by using a suction pump. After filtration, each filter paper was put in a Petri dish and dried in a laboratory oven for 4 hours at 60-degree Celsius. Above figure show the process involved in laboratory analysis.
Dried samples were examined with a light microscope and shape (i.e. fragment, films, and spherical), dimension (length and dia), colour, and type of microplastic present in the sample was noted. Selected microplastics were sent to MANIT Bhopal for analysis with Fourier transform infrared spectroscopy (FT-IR) in transmission mode (IR-Affinity-1S Shimadzu, Japan). Every spectrum was recorded in the region of $4000-400 \text{ cm}^{-1}$ with 32 scans. The obtained spectra were matched with the microplastic spectrum.

2.5 Contamination control
All sampling equipment was non-plastic material. Equipment made up of steel, glass, and metallic was used. During the field sampling, all equipment was rinsed with river water (filtered to 40µm). The 40 µm sieve was also rinsed with filter water (filter to 40 µm) before collecting any sample. To control the airborne contamination, a filter paper of 4.5 µm (made of cellulose material) was put in a petri dish for the whole time during the samples were taken. During laboratory analysis, all steps were conducted in a clean lab and positive environment. All the equipment used in laboratory analysis was non-plastic.

3. Results
Four samples were collected after filtering of 240 litres of fresh water. A total of 57 microplastic particles were identified. 48 (84.3%) microplastic particles identified were less than 1mm and 9 (15.7%) microplastic particles were greater than 1mm. Table 1 shows the concentration of microplastic at each site according to their size. The average no. of microplastic identified was $0.2375 \pm 0.05 \text{ MP/L}$. Different types of microplastic were found like High-density polyethylene (HDPE), Poly (vinyl butyral) P(VB), Poly (vinyl formal) P(VF), Polypropylene (PP), etc.

<table>
<thead>
<tr>
<th>Size</th>
<th>&lt;1mm</th>
<th>&gt;1mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamtara</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Gwarighat</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Tilwara</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Bedaghat</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>48</td>
<td>9</td>
</tr>
</tbody>
</table>

84.21% 15.78%
Table: 2

<table>
<thead>
<tr>
<th>Location</th>
<th>P(VB)</th>
<th>HDPE</th>
<th>P(VF)</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamtara (J)</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Gwarighat (G)</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Tilwara (T)</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Bedaghat (B)</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>22</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Discussion

According to numerous reports, rivers transfer significant amounts of plastic from land-based sources into coastal oceans. (Eerkes-Medrano et al., 2015; Horton and Walton, 2017; Lebreton et al., 2017; Schmidt et al., 2017; Ding et al., 2019). However, there has been limited empirical data from rivers themselves and limited investigation into the Narmada microplastic composition.

In our study, average 0.2375 ± 0.05 MP/L microplastic particles were identified in the surface water of the Narmada river. In comparison to other Indian rivers, the research on the Ganga river system found lower average concentration of 0.038 MP/L and microfibers were prevalent; this was conducted with 30 L replicates of freshwater gravity filtered through a 330 mm mesh (Napper et al., 2021). Also studied microfibre contamination in the surface water in two rivers in the megacity of Chennai (Tamil Nadu), an average concentration of 0.4 microplastic particles/L was reported in the two rivers, whereas 0.2 microplastic particles/L was recorded in a rural river near Munnar (Kerala) (Lechthaler et al., 2021b). Where a Neuston net bag of dimensions, 0.147 m high, 0.294 m wide and an opening of A = 0.043 m², was employed for the data collection.

In our study, 48 (84.3%) microplastic particles identified were less than 1mm and 9 (15.7%) microplastic particles were greater than 1mm. Fragmented microplastics were most common shape in the rivers and they are originated from larger plastic debris. So, it can be concluded that the secondary sources and non-point sources are most significant sources of microplastics in the Narmada river at Jabalpur. Two third of the total microplastic were High-density polyethylene (HDPE), Poly (vinyl butyral) P(VB), and remaining were Poly (vinyl formal) P(VF), Polypropylene (PP), etc.

Conclusions

According to this study, the surface water of Narmada river at Jabalpur were contaminated with microplastics. Secondary microplastics, mainly originated from the degradation of larger plastics debris, were the most common types of microplastics in the studied. 48 (84.3%) microplastic particles identified were less than 1mm, this indicated that microplastics may degrade to nano sized and they may provide attachment sites to other pollutants in the studied river system. The study will also help provide a global context to plastic pollution in the Narmada when compared with similar studies in other rivers across the India. Also, it is the first study of microplastics abundance in the Narmada River in India. According to this study, it can be concluded that rivers are a key medium for accumulation and transportation of microplastics.

References


