

1 **Integrated analysis of microplastics and heavy metals in the urban aquatic environment**

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Abstract

20 Microplastics (MPs) are ubiquitous primarily in aquatic environment where they travel freely
21 from one place to another. Higher surface area with strong hydrophobicity made them a perfect
22 candidate to sorb different pollutants in aquatic ecosystem. This study investigates occurrence
23 and distribution of MPs in Qasimpur canal running in Multan city and carry large quantity of
24 sewage waste and industrial effluents. Twenty-five surface water samples were taken and
25 examined regarding the abundance of microplastic, morphology, color distribution, and related
26 heavy metals (As, Cd, Pb) and microbial contamination (total coliform and E. coli). Findings
27 exhibit that MPs concentration is between 25 and 6 MPs L⁻¹. Relative distribution of MPs shows
28 that fibers (32.01%) were prevalent in water sample followed by fragment (20.39%) while sheet
29 and pellet were least among water samples. Weight distribution of MPs types also exhibit that
30 fibers were dominated in water. MPs were also distributed on the basis of color where blue and
31 white is dominant colors among all. Heavy metals were detected to be in concentrations that are

32 much higher than permitted concentrations of heavy metals in WHO standards and heavy metal
33 pollution index (HPI) estimates that pollution level was dangerous. Accuracy of methods used to
34 analyze was ± 3 , which proves the validity of the received results. Synergistic relationship
35 between MPs and heavy metals implies that microplastics are vectors in transportation of
36 contaminants, which is dangerous to ecology and human health. Findings from current work
37 provide insight in accumulation, distribution and abundance of microplastics with in flowing
38 water. Results offer a scientific foundation of pollution control and environmental management
39 measures in urban water bodies.

40 **Key words:** Microplastics, Fibers, Water contaminants, Aquatic ecosystem, Surface water
41 pollution, Environmental impact categories

42 **Introduction**

43 Plastics are lightweight, durable, inert and resistance free pollutants which persist in nature for
44 long time. These properties are further reinforced by various factors such as additives, retardants,
45 fillers and stabilizers etc (Amenábar et al., 2024). Fast pace plastic pollution all over the world is
46 major cause of concern for marine and terrestrial ecosystem. According to a report by United
47 Nations Environmental Protection (UNEP) that every year 19 to 23 million tons of plastic waste
48 made its way to aquatic ecosystem including rivers, canals, lakes and ocean (UNEP, 2024).
49 Plastic pollution affects natural process and habitat of locals which have negative impact on
50 socio-economic well-being of people. Microplastics (MPs) are small fragments of plastics
51 usually less than < 5 mm in size and invisible to naked eye (Banik et al., 2024).

52 Primary plastic particles less than 5 mm in size is intentionally produced and used in various skin
53 care products while secondary microplastic originate from primary microplastic's weathering,
54 chemical/environmental abrasions by UV photo degradation, biodegradation, hydrolysis and
55 change in temperature (Ahmed et al., 2023). UV photo degradation of microplastics breakdown
56 the chemical bonding of plastics called fragmentation (Casillas et al., 2023). MPs with micro to
57 nano size present in water bodies adsorb organic matter, heavy metals and toxic compounds.
58 Microplastics also provides conducive environment for the growth of microorganisms, microbial
59 interaction with heavy metals, toxic compounds and wit MPs itself. Biofilm formation and
60 propagation of pathogenic microbes is also important in this environment. Distribution of MPs in

61 different water bodies is due to the presence of nearby landfill site, sewage line or waste water
62 treatment plant. Rivers and streams contain fresh water but are the sink source of MPs (Nath et
63 al., 2023).

64 Microplastics have lethal effect towards zooplankton, which is taken up by fishes as a source of
65 food. Engulfing MPs by fishes not only become part of their body but also adds into food web.
66 Aquatic organisms taken up large quantity of MPs have effect on human beings as estimated in a
67 study that 55000 MPs were ingested by people by consuming animals affected with MPs
68 exposure (Danopoulos et al., 2020). MPs on soil is harmful for terrestrial animals as it travel with
69 air and scatter over large area on land. Most MPs degrade under UV radiations from the sun from
70 where carbon is released back to the atmosphere. Extremely small sized MPs were inhaled by
71 animals and human beings which retain in body organ through blood circulation and causes
72 mutagenic effects (Gabisa and Gheewala, 2022). MPs taken up by human beings through
73 drinking water is a potential health hazard. World Health Organization (WHO) recommends
74 toxicological level of MPs daily taken up by drinking water is $3 \mu\text{gkg}^{-1} \text{day}^{-1}$ of total body weight
75 (Marsden et al., 2019). Phytoremediation, biochar application, composting and green removal are
76 some of the most prominent solution to remove MPs (Tran et al., 2022).

77 Presence of microplastic is a great public discussion because it persists in the aquatic
78 environment and become part of food chain. As of 2019, 8000 plastic products were made in
79 Pakistan with 0.8 million tons of plastic which contributed to 0.6 million tons of plastic waste
80 makes its way into aquatic ecosystem (Dawn, 2019). According to a study by Irfan et al. (2020)
81 12-35 MPs per cubic meter were detected in the river Ravi. A descriptive microplastic and
82 heavy-metal measurements of the urban canal system can be used to leverage state-of-the-art
83 IoT-based measurements to improve the time resolution and data integrity as discussed by
84 Mohandas et al. (2025). In another work by Mohandas et al. (2025), highlights how sensor-cloud
85 structures are necessary in evaluating coupled pollutants (microplastics and heavy metals) in
86 urban water bodies, and this implies that related sensor-network models can enhance subsequent
87 monitoring of microplastic-related pollution. Since study contributes to quantify the abundance
88 and morphology of MPs in an urban canal system along with associated heavy metals and
89 microbial concentration to establish a relationship between HMs, MPs and microbes in a

90 synergistic way therefore, this research work is designed to highlight the abundance and nature
91 of microplastics in Qasimpur canal Multan.

92 **Material and methods**

93 **Sampling sites**

94 Multan is an ancient city situated along river Ravi in southern Punjab with population of 2.2
95 million. Qasimpur canal is the major tributary of Ravi river having many discharge points and
96 move across residential and industrial area of Multan city. A sampling point within the urban
97 area provides insights into the impact of human activities, pollution, and infrastructure on water
98 quality. Twenty four water samples (three samples per selected site) from different locations
99 were collected based on discharge drains from Multan city and addition of effluents into canal
100 from nearby industries. In total eight sites were distinguish from where water samples were
101 collected before monsoon season in May 2024. Mean annual temperature of Multan is 25 °C and
102 annual precipitation is 175 mm. Canal also carry sewage water directed towards it from Multan
103 residential area. Deposition of microplastics from canal water is not done because of lining of
104 canal and fast flow of water. Therefore concentration of MPs in canal water is expected to be
105 higher than normal.

106 **Surface water sampling**

107 One liter of surface water was collected from each sampling point and transferred to clean glass
108 jar previously rinsed with deionized water. Collected water samples were sieved through
109 stainless steel sieve having mesh size of 25, 100 and 350. Filters containing filtrate was then
110 placed in glass beaker which is in direct contact of 33% H₂O₂ at 50 °C for 24 hours to degrade
111 organic matter and to avert the growth of microbes. After 24 hours the leftover in sieve was
112 washed with deionized water thrice to remove residual H₂O₂ (Gies et al., 2018). Samples were
113 again washed with deionized water and filter it through filter paper to remove impurities.
114 Washed sample was then dried at room temperature by placing in petri plates and preserve it for
115 further use.

116 **Sample processing**

117 Samples were processed by using flotation technique having different densities as described by
118 Zhang et al, (2018). Flotation technique is done by making two extraction solutions with one is
119 DI water and other is sodium iodide solution. Higher density microplastics sample were settle
120 down while lower density MPs remain suspended in the extraction solution. MPs were separated
121 on the basis of heavy and light density plastic particles. Suspended MPs were separated in 50 ml
122 glass funnel and rotate at 120 rpm for 2 hours by adding 40 ml deionized water. Side and cap of
123 tubes were rinsed with DI water and centrifuged at 3000 rpm for 10 minutes to help settled down
124 suspended MPs. Supernatant was filtered through whatman filter paper 91 having pore size 11
125 μm . filter paper was dried at room temperature and stored in sealed petri plate for further use.
126 Repeat the step thrice until no floating material was observed in solution. Heavy density MPs
127 were also separated by the method by using 600 g L^{-1} sodium iodide solution.

128 **Observation, identification and quantification of microplastics**

129 Dry filter paper containing MPs was placed under microscope and evenly distributed on glass
130 slide with brush to avoid overlapping of MPs. After distribution a high resolution photo was
131 taken to identify the number and type of microplastic on glass slide. Glass slide was then placed
132 in oven for 3-5 seconds at $130 \text{ }^\circ\text{C}$ and subsequently second photo was taken. MPs heating at such
133 temperature change its structure to shiny, transparent and circular while impurities like organic
134 matter, organic fibers and silicate particles remain unchanged. A visible difference was observed
135 by comparing both photos as first one is a reference for size, number and shape of microplastics
136 while second is set reference to determine any organic component in MPs. Microplastics were
137 separated on the basis if they are organic in nature, thickness of fiber maintained throughout its
138 entire length as well as color of MPs is homogenous throughout its length. All possibly identified
139 MPs were separated, measured, counted and categorized into different types on the basis of
140 morphology, weight and color according to the protocol developed by Hidalgo-Ruz et al, (2012).

141 **Heavy metal determination and pollution index**

142 All collected ground water samples were determined for the presence of heavy metals. For this
143 water samples filtered through stainless steel sieve was used. Arsenic (As) was determined by
144 molybdenum blue method As (V) in UV visible spectrophotometer at wavelength 870 nm.
145 Cadmium (Cd) and lead (Pb) was determined by running on atomic adsorption

146 spectrophotometer (ASA) at 228 nm and 217 nm wavelength respectively. To obtain accuracy in
147 results AAS was calibrated with reference standard prior to analysis. Duplicate sampling and
148 triplicate measurement was recorded to minimize error. Results from As, Cd & Pb was subjected
149 to following formula to determine heavy metal pollution index of collected water samples;

$$150 \quad \text{HPI} = \frac{\sum_{i=1}^n W_i Q_i}{\sum_{i=1}^n W_i} \quad (1)$$

151 In equation; n is the total number of samples, sub-index of ith parameter is Q_i , ith unit parameter
152 weight is W_i . Value for ith parameter is calculated by using following equation;

$$153 \quad Q_i = \sum_{i=1}^n \frac{M_i - L_i}{S_i - L_i} \times 100 \quad (2)$$

154 In equation; concentration of ith metal in water sample is M_i while S_i is the maximum value for
155 ith parameter. L_i is the ideal value.

156 **Microbial activity in water samples**

157 To quantify microbial activity 100 ml of sample was collected and filtered through having
158 membrane having mesh size of 0.45 μm and incubate it in petri dish for 48 hours at 37 $^{\circ}\text{C}$.
159 Colonies for total coliform and E.coli were counted under colony counter and expressed as
160 colony per 100 ml of water as suggested by Forbes et al, (2007).

161 **Results**

162 **Concentration and morphology of microplastics in water**

163 Microplastics particles retrieved from eight water samples collected from Qasimpur canal,
164 Multan were categorized quantitatively. MPs recovery rate (95-98%) during spiking, observation
165 and quantification stage reinforce analytical results validity. Six types of MPs were observed in
166 the water samples i.e., fiber, fragment, foam, granule, sheet and pellet. Among all collected
167 samples fiber ranges between 25 ± 6.0 and 14 ± 5.5 followed by fragment with average of 19 ± 2.0
168 and 11 ± 2.6 . Table 1 indicates that concentration of foam also ranges between 14 ± 6.2 and 6 ± 2.6 .
169 A significant difference was observed between all MPs types which indicate presence of
170 secondary MPs in canal water. Granule, sheet and pellet altogether were within the similar range
171 however their concentration is less in canal water then fiber and fragment.

172 **Abundance and distribution of microplastics**

173 Microplastics abundance in canal water was also recorded as given in figure 2. Fibers were high
174 in concentration with 32% in Disposal Khad factory, 29% in Chawan Pul and 27% in Vehari
175 chowk and Al-Khalid associates. 20% fragment was also recorded in Al-Khalid associates,
176 NGPS, Peeran Ghaib and Naubahar bridge. Foam was ranged between 17-9% while granule was
177 recorded between 21-11%. Sheet was ranged between 17-10% while pellet was recorded
178 between 16 and 10%.

179 **Microplastics distribution by weight**

180 Microplastics weight was given in table 2 indicating its concentration by weight in water sample.
181 Among all categories fiber ranges between 5.1 mg L⁻¹ and 2.4 mg L⁻¹. Fragment also was in the
182 similar range with small variations. Foam, granule, sheet and pellet give highest weight by 3.4
183 mg L⁻¹, 3.3 mg L⁻¹, 3.3 mg L⁻¹ and 3.8 mg L⁻¹ respectively. It was noted that MPs size were in
184 correlation with the numbers of MPs identified in water samples.

185 **Microplastics distribution by color**

186 Identified microplastics were also distributed into various colors as given in figure 3. Among all
187 blue is the abundant color with 52.75% in pellet and 27.08% in sheet. Similarly, white is also
188 dominant color among all with 54.65% in foam as well as 31.25% in sheet. Red and grey colors
189 are also abundant where fiber exhibit 26.04% red color while 31.4% and 31.86% grey color was
190 exhibited by foam and granule respectively. Among all identified MPs fiber, granule and sheet
191 also gives transparent color by 12.43%, 10.62% and 7.29%, respectively. Green and yellow
192 colors are also given by different MPs but in smaller concentration. Off-white and light blue
193 colors are least among all with 8.14% light blue exhibited by foam and 6.59% off-white color is
194 given by pellet.

195 **Heavy metal concentration and pollution index (HPI) of canal water**

196 Water samples collected from Qasimpur canal also contain arsenic, cadmium and lead in greater
197 concentration as indicated in figure 4a. Arsenic was recorded between 0.085 mg L⁻¹ and 0.062
198 mg L⁻¹. Cadmium concentration was also recorded between 0.1 and 0.064 mg L⁻¹. Lead was
199 recorded between 0.3 and 0.049 mg L⁻¹. Results indicate that all metals were highly toxic to

200 biotic factors at such concentration. According to World Health Organization (WHO)
201 concentration of As, Cd & Pb were limited in 0.01 mg L⁻¹, 0.003 mg L⁻¹ and 0.01 mg L⁻¹,
202 respectively. Heavy metal pollution index indicates cumulative effect of all heavy. Figure 4b
203 clearly depicts HPI is hazardous.

204 **Microbial concentration of canal water**

205 Water having high bacterial activity of total coliform and E.coli is considered as contaminated
206 water due to pathogenic attributes of both microbes. According to WHO both microbial
207 communities must be 0 colony forming unit (CFU) in 100 ml of water. As canal water contains
208 organic matter and heavy metals thus it becomes the active source for the growth of pathogens
209 like coliform and E. coli. Highest total coliform concentration was reported in water sample
210 collected from Naubahar bridge (2290 CFU). Disposal Khad factory and NGPS, Peeran Ghaib
211 also have highest total coliform concentration. On the other hand E. coli concentration in canal
212 water was also similar but with a slight decline compared to coliform concentration. Highest
213 E.coli was noted in NGPS, Peeran Ghaib (1971 CFU) along with Vehari chowk and Naubahar
214 bridge as depicted in figure 5.

215 **Discussion**

216 Pervasive distribution of microplastics (MPs) with increasing concentration of heavy metal
217 becomes a major challenge for aquatic biodiversity as well as for mankind. Multan is a major
218 industrial city diversified with residential area. With the population of 2.2 million anthropogenic
219 activities greatly impacted Qasimpur canal Multan, contain sewage load from residential area
220 and effluents from industrial area while flowing all across Multan. Along with it canal also carry
221 water from non-point source (agriculture runoff). MPs abundance relies on recovery rate as
222 isolation of MPs is a lengthy process involve sieving and centrifugation for couple of time.
223 Moreover microplastics have more resemblance to organic matter as in case of fiber which might
224 be organic fiber instead of polymeric fiber. Microplastics might also discard away during
225 transportation; sieving and centrifugation by sticking with the walls of glass wear or adhere to
226 the sieve. All mentioned scenarios and hurdles were described by Stolte et al. (2015) indicating
227 positive correlation to current work. According to Imhof et al. (2012) all above-mentioned
228 described method only gives recovery rate of 81-99%. To improve MPs recovery rate spiking

229 must be done which alternatively improves extraction of MPs during the process as discussed by
230 Simon et al. (2018).

231 Current study is not sensor-design-oriented, but the principle of enhancing precision of
232 measurements is the same as increasing the accuracy of quantifying microplastic particles and
233 related concentrations of the heavy-metal as in future studies, similar signal-processing or
234 sensor-calibration techniques can be applied to microplastic imaging or detection (Palani et al.,
235 2023). Counting of microplastics after separating it from canal water by using different sieves of
236 various mesh sizes is an important task. Usually in sieving there might be a risk of contamination
237 from external environment as it is a long process. Micro and nano fibers present in lab
238 environment might get mixed up with the MPs present in the sieves. According to Rochman et al.
239 (2015) strict monitoring is applied while conducting the procedure. This involves avoiding of
240 suspected MPs from lab environment. On the day of experiment suspected MPs were separated
241 from lab environment on the basis of color and visual appearance. MPs from lab coat or lab
242 wears were separated from the collected samples. Number of MPs after each crucial step i.e.,
243 collection, transportation, storage, centrifugation and filtration will be reduced (Talvitie et al.,
244 2015). Loss of fiber of any length is a major drawback to study MPs. Similar was happen in the
245 current case where number of MPs after each crucial step reduces making it harder to quantify
246 MPs in canal water sample. At the end of procedure the number of fibers in canal water sample
247 varies between 14 and 25 MPs L⁻¹. Flotation method used in current work followed by
248 centrifugation is widely accepted method to quantify MPs from water. Current MPs separation
249 technique is also superior in case of flotation where higher density MPs settles down leaving
250 behind only less density MPs suspended in the solution as describes by Hernandez et al. (2017).
251 MPs extraction using oil-water emulsion was given by Crichton et al. (2017) but was not
252 applicable as emulsion remains up lift MPs due to which sedimentation and separation on the
253 basis of densities is not possible. Another drawback in the technique is loss of MPs by sticking
254 with sieve.

255 MPs concentration in surface water is directly attributed to population density and urbanization
256 (Kataoka et al., 2019). Similar situation was described by Irfan et al. (2020) where MPs in water
257 samples of river Ravi was largely from municipal and industrial waste. Different types of MPs
258 were isolated from canal water including fiber, foam, granule, sheet, fragment and pellet. Present

259 study describes fiber as most pronounced morphotype in all sampled water collected from
260 various locations of Qasimpur canal, Multan but same was not happened in every case as MPs
261 distribution is based on lab environment and usage pattern (Mason et al., 2016). Microplastics
262 type is also relies on retention in the solution on the basis of density. In some cases MPs was
263 sorbed into bigger plastic particle and was not able to detect (Michielssen et al., 2016). MPs
264 distribution on the basis of color suggests inherent color of MPs or it might be changed due to
265 weathering or adsorption of chemicals when exposed to contaminants present in waste water.
266 Discoloration of MPs also happened due to sorption of various pollutants. Predominant blue
267 color in fibers, high percentage of white foam and red dominance in pellet is in consistence with
268 prior studies. According to a study by Jendanklang et al. (2023) almost 45% blue fiber, white
269 fiber and pellet with most of them red in color were isolated from Chao Phraya River in
270 Thailand. Similarly sludge from waste water treatment plant in Lithuania reports black, white
271 and transparent color in higher frequency while green and red were in minor proportion (Uoginte
272 et al., 2022).

273 Tail risk contagion and multiscale spillovers as given by Zeng et al. (2025) is an effective
274 analogy to the dynamics of environmental pollution. Just as banks running on shocks in a
275 financial market, sharp increases in microplastic or heavy metal loads may spread across related
276 aquatic systems, producing the effect of multiscale contamination. Such spillover or contagion
277 frameworks may be useful in determining the transmission of risks of pollution among sites and
278 periods in time to aid in predictive management of urban water quality. Similarly, the
279 heterogeneity of interaction between microplastics, heavy metals, and microbes in the water
280 bodies also exhibits varying responses to varied contamination loads. The implementation of
281 quantile based analysis frameworks may thus enhance the determination of ecological risk along
282 the different pollution gradients (Zeng et al., 2025). Industrialization and urbanization in
283 combination degrade environment. Waste water having high density heavy metal is hazardous to
284 all type of life. A negative imbalance was developed with the increase in waste water compared
285 to fresh water (Hussain et al., 2019). Highest concentration of arsenic, cadmium and lead was
286 observed in water samples collected from Qasimpur canal. In Pakistan canal water is the major
287 source which is polluted by industries and sewage water while farmers are forced to apply water
288 for irrigation purpose. Heavy metal concentration is dependent to environmental condition. As
289 water samples for current study is collected between January and July therefore varied

290 concentration was observed. MPs have potential to sorb HMs but might take decades or even
291 years to complete the process. Lead is not sorbed in MPs and persists in environment for long
292 time. Heavy metal pollution index is determined for all collecting points' reveals that water is
293 hazardous for all kind of activities. Local factors like sunlight, flow of water and presence of
294 organic content also impacted the presence of HMs in water thereby affect rate of HPI (Zhou et
295 al., 2019). Pathogenic microbes such as Coliform and E. coli were determined in water sample of
296 Qasimpur canal. According to Ashbolt et al. (2001) the most probable reason behind
297 concentration of these two microbes is the presence of feces in water samples. It has also been
298 suggested that estimation of these microbes is necessary to indicate its presence in waste water
299 (Sanders et al., 2013). It has also been reported that estimation of coliform is an easy task due to
300 its interaction with the ecosystem to produce hazardous result as estimated by Khan et al. (2019).
301 Microbe oxidation and membrane separation are predominate technique in microbial separation.
302 Current study reveals that high microbes were noted in water samples collected from NGPS,
303 Peeran Ghaib, Disposal Khad factory and Vehari Chowk.

304 **Conclusion**

305 Current study was framed to get distribution, concentration and types of microplastics in the
306 water samples of Qasimpur canal, Multan along with adapted separation technique. Flotation
307 technique proved to work best in terms of separating MPs in water samples. It was noted that
308 MPs near urban centers and industries were high in concentration. Detection method for MPs
309 helps separate organic and polymeric micro particles in water sample. Among all isolated MPs,
310 fibers were prevalent to all water samples while pellet were least in water samples. Heavy metals
311 (As, Cd & Pb) were detected in water samples giving varying concentration. Heavy metal
312 pollution index was calculated giving hazardous nature of water for all collected water samples.
313 Due to surface water microbial concentration is highest largely came from sewage water
314 containing fecal components. Results suggest that MPs might act as vector in transferring heavy
315 metals over the large area along with movement of water in canal. Synergistic pollution of MPs
316 and heavy metals poses ecological risk and potential harmful effect to aquatic organisms. The
317 number of sampling season used in study was restricted to one canal and one season which might
318 not reflect the changes with time in contamination. To enhance accuracy, future studies must
319 cover a multi-seasonal period, have a larger area of coverage and utilize advanced spectroscopic

320 or Internet of Things-based methods of detection. The inclusion of predictive modeling might
321 also help improve the knowledge about microplastic/heavy metal interactions and their
322 ecological effects in the long run.

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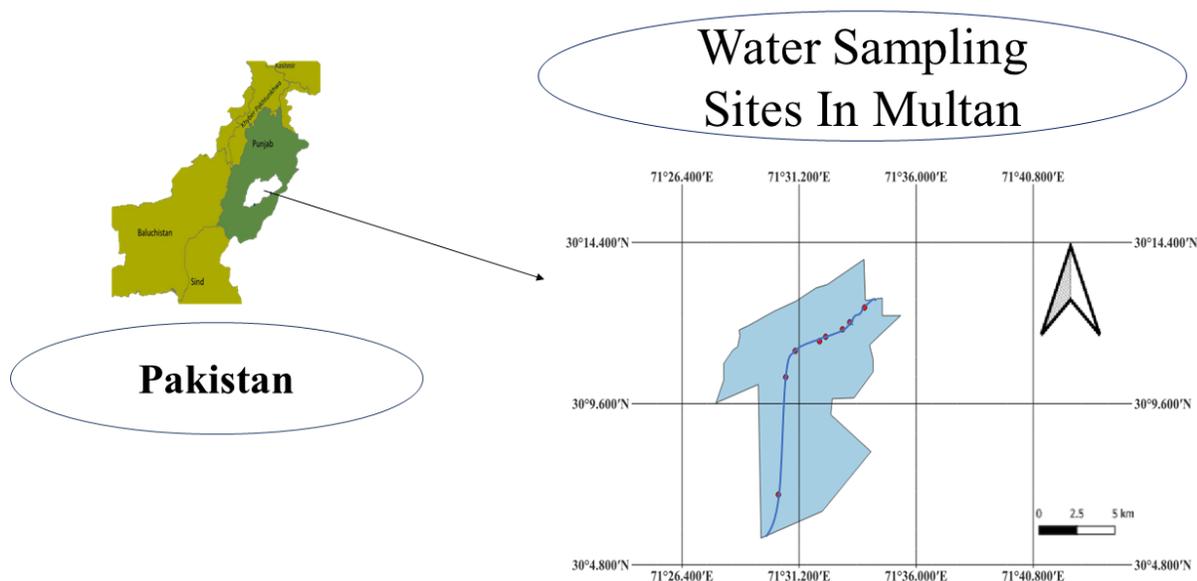
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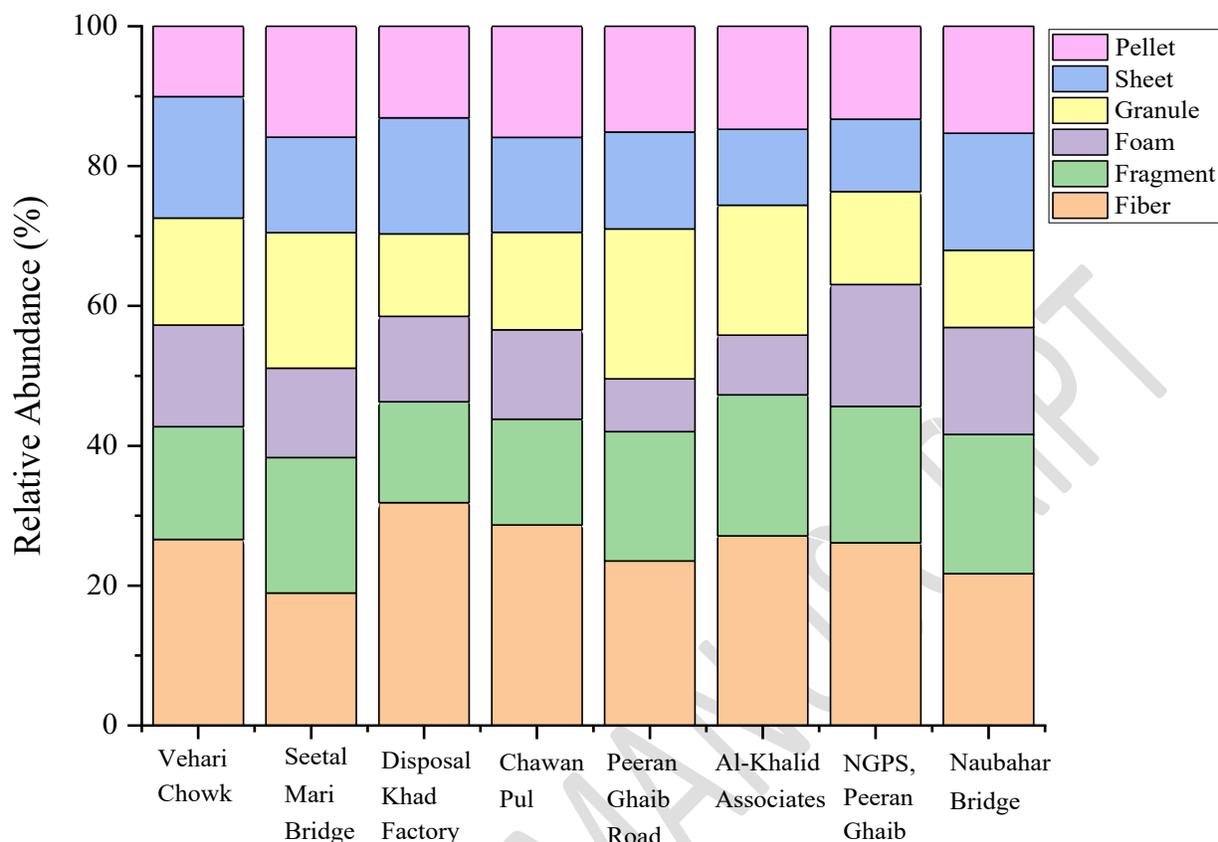
425 **Figure 1** indicates water sampling sites from Qasimpur canal

426 **Table 1** indicates number of microplastics (mean & standard deviation) detected in 1 liter of

427 collected water samples from Qasimpur canal, Multan

Sampling Site	Fiber	Fragment	Foam	Granule	Sheet	Pellet
Vehari chowk	22±10.5	13±4.5	12±4.3	13±5.5	14±4.0	8±5.1
Seetel Mari bridge	14±5.5	15±4.7	10±2.0	15±4.5	10±5.0	12±4.5
Disposal Khad factory	24±3.2	11±2.6	9±3.0	9±3.6	13±5.6	10±3.0
Chawan Pul	25±6.0	13±2.6	11±7.2	12±4.5	12±3.5	14±5.8
Peeran Ghaib road	19±4.0	15±3.7	6±2.6	17±5.2	11±2.0	12±4.3
Al-Khalid Associates	23±13.0	17±8.5	7±2.0	16±5.5	9±2.0	13±5.6
NGPS, Peeran Ghaib	21±6.0	16±6.0	14±6.2	11±7.0	8±3.2	11±7.7
Naubahar bridge	20±5.5	19±2.0	14±3.7	10±3.2	16±1.5	14±3.0

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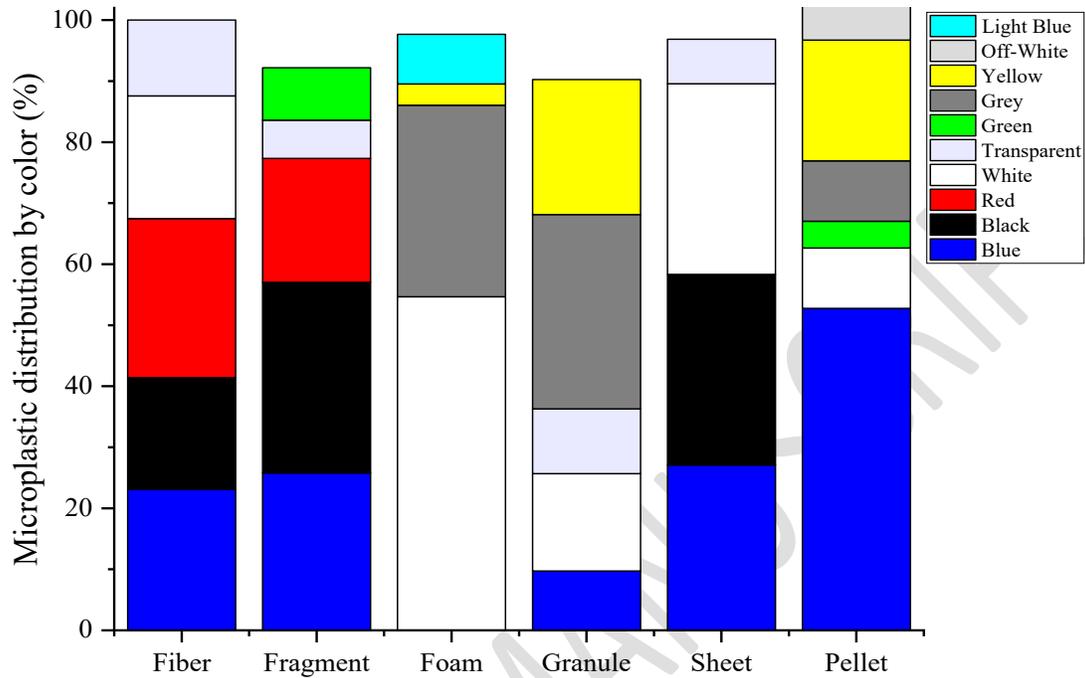


429
 430 **Figure 2** Relative abundance of microplastics (pellet, sheet, granule, foam, fragment, fiber)
 431 identified in collected water samples from Qasimpur canal, Multan

432 **Table 2** indicates microplastics weight (mean & standard deviation) detected in 1 liter of
 433 collected water samples from Qasimpur canal, Multan

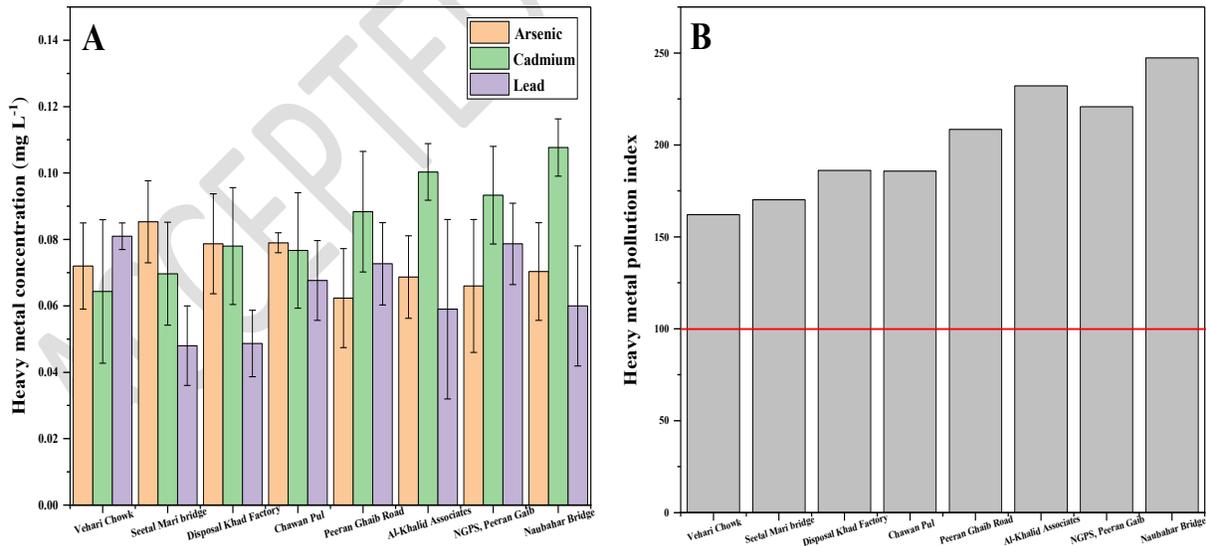
Sampling Site	Fiber (mg L ⁻¹)	Fragment (mg L ⁻¹)	Foam (mg L ⁻¹)	Granule (mg L ⁻¹)	Sheet (mg L ⁻¹)	Pellet (mg L ⁻¹)
Vehari chowk	2.4±1.4	1.5±2.5	2±0.5	2.1±1.1	1.8±0.6	3.8±1.2
Seetel Mari bridge	3.8±0.3	4.8±0.8	2.7±1.1	2.5±1.3	2.3±0.5	3±0.7
Disposal Khad factory	4.9±1.5	2.4±1.4	1.5±0.4	1.9±0.4	3±0.6	2.6±0.5
Chawan Pul	5.1±2.0	4.7±1.2	0.7±0.5	1.8±1.2	1.7±0.4	1.8±0.1
Peeran Ghaib road	4.2±2.0	3.1±2.2	1.6±1.4	1.1±0.3	2.2±0.3	2.1±0.5
Al-Khalid Associates	3.3±0.5	5.5±1.3	2.8±0.9	3.3±1.4	1.9±0.2	3.4±1.2
NGPS, Peeran Ghaib	2.7±2.2	2±2.0	3.4±1.6	2.4±0.6	3.3±1.1	1.7±1.0

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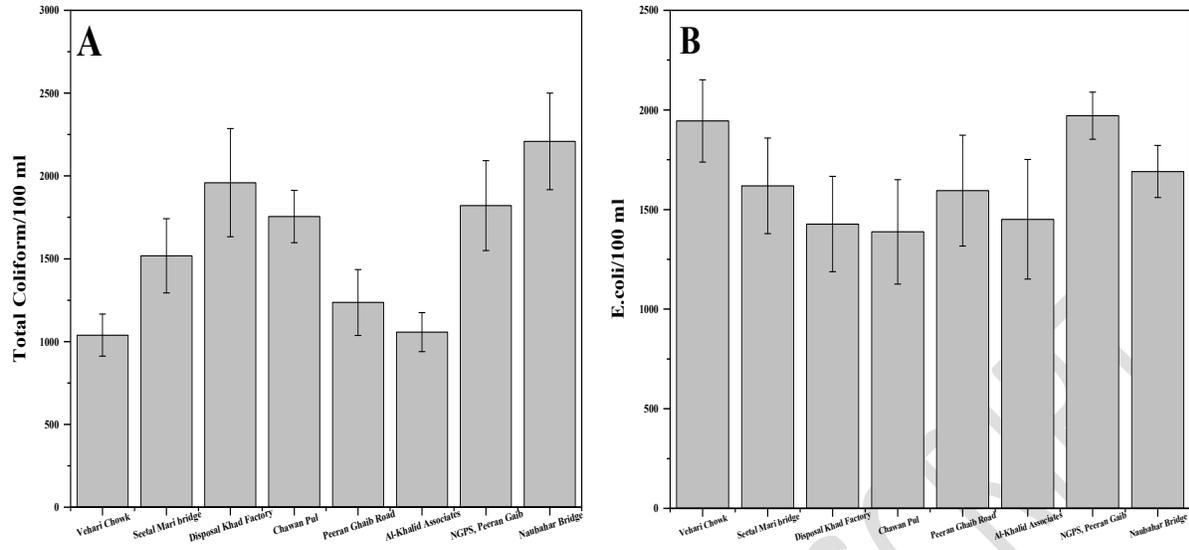
435

436 **Figure 3** exhibit microplastics distribution by color



437

438 **Figure 4** indicates a) heavy metal concentration and b) pollution index of collected water
 439 samples from Qasimpur canal, Multan



440

441 **Figure 5** indicates microbial concentration (a) Total coliform & b) E.coli) of collected water
 442 samples from Qasimpur canal, Multan]

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