Indian Journal of Ecology (2024) 51(4): 926-932
DOI: https://doi.org/10.55362/IJE/2024/4332

Manuscript Number: 4332
NAAS Rating: 5.38

Impact of Pollutants on Water Quality and Distribution of Macrophytes in Tuikual River, Aizawl, Mizoram

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***Abstract*:** The current investigation was conducted in Aizawl, Mizoram, from upstream to downstream of the Tuikual river. It is a major tributary of the Tlawng river, which supplies water to Aizawl, Lunglei, and a number of neighbouring settlements. The primary goal of the research is to determine the influence of contaminants on the water quality and distribution of aquatic macrophytes in the Tuikual river. Site 1 is located near the river's source, and the river also obtains discharge from Aizawl Civil Hospital, the state's major hospital. Site 2 is in downstream of the river following the confluence of streams at Site 1 polluted by discharge of domestic trash from cities as well as discharges from Ebenezer Hospital. Site 3 is in downstream of Site 2 and includes overflow from sandstone rocks. Site 4 is downstream from Site 3 in the area where the river enters the Tlawng river The DO, turbidity, and phosphate-P levels were not within the limitations established by several organizations. Twenty-six macrophytes were recorded from 15 families. The aquatic plants with the highest importance value index (IVI) at Sites 1, 2, 3, and 4 were *Commelina benghalensis* (57.0), *Commelina benghalensis* (65.9), *Echinochloa stagnina* (50.1), and *Equisetum hyemale* (45.7), respectively. The Shannon-Weiner diversity index (H'), species evenness (J'), and species richness (D_{mg}) were highest (H'=2.548; J'=0.9; D_{mg}=2.46) at the least polluted site (Site 4), whereas Simpson dominance (D) was highest (D=0.186) at the most polluted site (Site 2). The polluted areas (Sites 1 and 2) had the highest similarity index (88%). The findings indicate that the values of macrophyte-based indices reflect water quality at different sample sites and may be used to measure river ecological health.

***Keywords*:** Tuikual river, Water quality, Parameters, Aquatic macrophytes, Quantitative

Water quality refers to its physical, chemical, and biological qualities (Spellman 2013) and water at high concentration render it unfit for human consumption. It compromises the long-term survival of marine ecosystems as well as water quality (Banadda et al 2009). Industrial waste and sewage discharges are the main causes of river contamination. Anthropogenic activities include urbanisation, industrial processes, agricultural practices, and a fast rising population (Akhtar et al 2021). Water quality has declined over the past few decades due to a number of factors, including the fast growing human population, an increase in anthropogenic activities, changes in land use, and the discharge of sewage and municipal garbage into water bodies (Rana et al 2016). Excess nutrients are released into the water system which greatly accelerates the growth of weeds before severely suffocating ecosystems (Sudhira and Kumar 2000).

Macrophyte are aquatic photosynthetic organism large enough to be visible with the naked eye, growing constantly or occasionally submerged beneath, floating on, or rising through the water surface. They spend at least part of their lives in water, either fully immersed or exposed. Aquatic macrophytes can help improve water quality by removing excess nutrients and pollutants like nitrogen and phosphorus from the water and are important components of aquatic ecosystems and serve critical roles in protecting the health and functionality of aquatic ecosystems. The diversity and quantity of macrophytes reflect the overall quality of an ecosystem. Macrophytic plants, which have a high capacity to bind toxins from sewage, are the best evidence of water pollution (Mishra and Tripathi 2004). The Tuikual river is becoming polluted as a result of the discharge of household and municipal waste from Aizawl's western areas, as well as biomedical discharges from Civil Hospital and Ebenezer Hospital. The river catchment region, which has a total population of 21694 and conveys sewage from roughly 5100 homes at a rate of 694192 liters per day, is located on the western side of Aizawl city. Because there is no adequate sewage treatment facility in the area, domestic waste continues to run untreated into the river. The objective is to determine the influence of contaminants on the water quality and distribution of aquatic macrophytes in the Tuikual river.

MATERIAL AND METHODS

Study area: The Tuikual river passes through the middle of Aizawl City and is located at 23˚ 43 ' 49.8" N Latitude and 92˚ 42 ' 26.6" E Longitude. It is a major tributary of the Tlawng river, which supplies water to Aizawl, Lunglei, and several nearby settlements. The research area, which is around 9.45 kilometers long. Four sample locations were evaluated based on the types of contaminants discharged into river water. The following are the features of the sampling sites:

Site 1: It is located near the river's source, and the river also obtains discharge from Aizawl Civil Hospital, the state's major hospital.

Site 2: Located downstream of the river following the confluence of streams at Site 1, it is distinguished by the discharge of domestic trash from cities as well as discharges from Ebenezer Hospital.

Site 3: It is located downstream of Site 2 and includes overflow from sandstone rocks.

Site 4: This site is located downstream from Site 3 in the area where the river enters the Tlawng river (also known as the Tuithum river).

Water sampling: The water samples were collected at the same time as the macrophyte survey for physical and chemical analysis using the procedures outlined in the "Standard Methods for Examination of Water and Wastewater" (APHA 2005). For measuring DO, water samples were instantly fixed in BOD bottles. The other water samples were collected using an opaque plastic bottle. The water samples were carefully collected and labelled before being delivered to the laboratory within 24 hours for measurement of dissolved oxygen, turbidity, acidity, nitrite-N, phosphate-P, nitrate-N, and sulphate. Titration was used to determine dissolved oxygen (DO) and acidity, while a nephelometer was used to measure turbidity. Nitrite-N (NO_2^-), phosphate-P (PO_4^{3-}), nitrate-N (NO_3^-), and sulphate (SO_4^{2-}) concentrations were determined using spectrophotometric methods.

Aquatic macrophytes sampling: During the vegetative season (rainy season), the distribution of aquatic macrophytes was examined along the river. The rainy season appears to be the most advantageous season for emerging macrophytes buried seed germination (Rai and Munshi 1982). The quadrat (1m x 1m in size) was randomly used to observe the spread of aquatic macrophytes (30 at each sampling site). The standard methods described by Misra (1968) and Mueller-Dombois and Ellenberg (1974) were used for the field investigation. Field observations were carried out to collect, count, and identify the aquatic macrophytes identified in each quadrat to the species level. It was further researched with the assistance of professionals from the Botanical Survey of India, Eastern Circle, Shillong, and checked using reference material (Cook 1996).

Analysis of phytosociological characteristics: Several quantitative parameters were thoroughly investigated, including frequency, density, abundance, abundance frequency ratio (A/F), relative frequency, relative density, relative abundance, and important value index (IVI). The frequency, density, and abundance of each species were calculated separately (Misra 1968, Ambasht 1969). These are then used to express the diversity and dispersal of the community.

RESULTS AND DISCUSSION

Water Quality Assessment

Dissolved Oxygen: The DO content of the water ranged from 4.57 mgL^{-1} (Site 2) to 6.72 mgL^{-1} (Site 4). DO levels were low at Sites 1 and 2 due to the significant discharge of organic waste that was decomposed by microorganisms (Table 1). Compared to the upstream, the downstream had a slightly higher DO level (Souilmi and Tahraoui 2021). During the decomposition process, microbes consume a significant amount of DO, reducing the amount of DO in the water body (Kataria et al 2006). Many fish and invertebrates require DO for health and reproduction; nevertheless, chronic exposure to low DO levels causes stress, diseases, and, in some cases, organismal death (Ali et al 2022). The DO levels at Sites 1 and 2 were lower than the BIS/ICMR acceptable limit.

Turbidity: The turbidity of the water ranged from 11.4 NTU (Site 3) to 28 NTU(Site 2). The turbidity of water samples was found to be highest at Site 2 (Table 1), which could be attributed to heavy rainfall that carries sediment, organic and inorganic material, suspended particles, and other contaminants into the water body from the catchment area (Jehamalar et al 2010). Suspended debris can clog or harm fish gills, reducing disease resistance, growth rates, egg and larval maturation, and the effectiveness of fish capture methods (Tarras-Wahlberg et al 2003). The turbidity values were above the USPH/WHO permitted limit.

Acidity: The acidity content of the water ranged from 26.5 mgL^{-1} (Site 4) to 87.2 mgL^{-1} (Site 2). Water acidity was found to be higher at Sites 1 and 2 (Table 1), which could be attributed to an increase in organic content, which encourages microbial breakdown and releases carbon dioxide (Singh et al 2010). Carbonic acid is generated as a result of the respiratory processes of biological organisms that emit carbon dioxide.

Table 1. Physicochemical parameters of water samples in Tuikual river

Parameters	Site 1	Site 2	Site 3	Site 4
DO (mg L^{-1})	4.87	4.57	6.47	6.72
Turbidity (NTU)	25.8	28.0	11.4	12.7
Acidity (mg L^{-1})	83.2	87.2	32.5	26.5
Nitrite-N (mg L^{-1})	0.44	0.42	0.33	0.17
Phosphate-P (mg L^{-1})	0.34	0.37	0.21	0.16
Nitrate-N (mg L^{-1})	0.35	0.37	0.287	0.28
Sulphate (mg L^{-1})	3.78	4.20	2.79	2.60

Nitrite-N: The nitrite-N content of the water ranged from 0.17 mgL^{-1} (Site 4) to 0.44 mgL^{-1} (Site 1). NO_2^- levels were high throughout Sites 1 and 2 as a result of excessive runoff from fertilisers, sewage, septic systems, industrial chemicals, and nitrite-containing food preservatives (Table 1).

Phosphate-P: The phosphate-P content of the water ranged from 0.16 mgL^{-1} (Site 4) to 0.37 mgL^{-1} (Site 2). Phosphate-P readings were high at Sites 1 and 2 (Table 1), which might have been caused by agricultural runoff containing phosphate fertilisers brought on by heavy rain as well as sewage influx because sewage generally raises phosphate-P levels in water. Phosphorus-P causes eutrophication when mixed with nitrate-N (Lalchhingpuii 2011). The phosphate-P was higher than the USPH permitted level at all sites.

Nitrate-N: The nitrate-N content of the water ranged from 0.28 mgL^{-1} (Site 4) to 0.37 mgL^{-1} (Site 2). The nitrate-N level was at its highest at Sites 1 and 2 due to runoff from fertilised agricultural regions and septic tank leakage entering the water body (Table 1). The amount of nitrate in the water is increased by sewage discharge into the open water and soil erosion. When there is too much nitrate in surface water, algae can bloom quickly, and the water's quality suffers.

Sulphate: The sulphate content of the water ranged from 2.60 mgL^{-1} (Site 4) to 4.20 mgL^{-1} (Site 2). Increased agricultural land and sewage runoff containing sulphate minerals, which is brought into the water body by heavy precipitation, could be the cause of higher sulphate content during the rainy season at Sites 1 and 2 (Table 1) (Rizvi et al 2015).

Impact of pollutants on the water quality of the Tuikual river: The vast majority of water pollutants are chemicals that remain dissolved or suspended in water and have a negative impact on the ecosystem. Upstream sites 1 and 2 had high parameter values due to the catchment area's high pollution load. Due to domestic sewage, runoff from agricultural fields, washed fertiliser from agricultural fields, and other pollutants entering the river's water body from the catchment area, the river was severely contaminated. Continuous industry monitoring and awareness are essential for improving public health in this area (Deoli and Nauni 2021). The unplanned and direct release of trash from multiple sources has significantly deteriorated water quality at all research sites.

Diversity and distribution of aquatic macrophytes: Twenty-six 26 macrophytes belonging to 15 families were identified at the four study sites (Table 2). Site 2 was the most polluted study site, with only 11 species represented, followed by Site 1, Site 3 and Site 4. The Poaceae family had the highest number of macrophytes (Fig. 1). The aquatic macrophytes found in the Tuikual river were all emergent. *Alternanthera philoxeroides, Brachiaria mutica, Canna indica*, *Colocasia esculenta, Ipomoea aquatica, and Polygonum glabrum* were present only at Sites 1 and 2. All stands contain *Drymaria cordata, Polygonum barbatum, and Polygonum hydropiper. Neptunia oleracea* and *Juncus effusus* were found only at the least polluted site (Site 4).

Diversity Indices: The Shannon-Weiner diversity index (H'), species evenness (J'), and species richness (D_{mg}), were highest (H'=2.548; J'=0.9; D_{mg}=2.46) at Site 4, whereas Simpson dominance (D) was highest (D=0.186) at Site 2 (Table 3). The polluted sites (Sites 1 and 2) were more similar, with a similarity index of 88%, followed by Sites 3 and 4, with a similarity index of 78.7%. Site 2, on the other hand, has the least similarity to Sites 3 and 4, with a similarity index of 29% (Table 4).

Phytosociological Characteristics of Aquatic Macrophytes

Frequency: *Commelina benghalensis* had the highest frequency at Sites 1 (77%) and 2 (100%) and *Echinochloa stagnina* highest frequency at Site 3 (100%) and *Pogonatherum crinitum* at Site 4 (100%) (Tables 6-9).

Density: *Commelina benghalensis* had the highest density values at Sites 1 (3.7 plants/m^2) and 2 (3.5 plants/m^2), *Echinochloa stagnina* (4.1 plants/m^2) at Site 3, and *Equisetum hyemale* (4.8 plants/m^2) at Site 4.

Abundance: *Drymaria cordata* (4.9 plants/m^2) had the highest abundance value at Sites 1 and 2. *Echinochloa stagnina* had the highest abundance value at Site 3 (4.1 plants/m^2) and *Equisetum hyemale* had the highest abundance value at Site 4 (7.5 plants/m^2).

Importance Value Index (IVI): Depending on the ratios, the distribution may be a regular (<0.025), random (0.025–0.05), or contagious (>0.05) distribution (Curtis and Cottam, 1956). *Commelina benghalensis* had the highest Importance Value Index at Sites 1 (57) and 2 (65.9). *Echinochloa stagnina* at Site 3 (50.1) and *Equisetum hyemale* at Site 4 (45.7) .

Abundance to frequency ratio (A/F): *Alternanthera sessilis* exhibits the highest abundance to frequency ratio at Sites 1 (0.097) and 3 (0.075). *Colocasia esculenta* (0.151) at Site 2 and *Drymaria cordata* (0.301) at Site 4. The abundance to

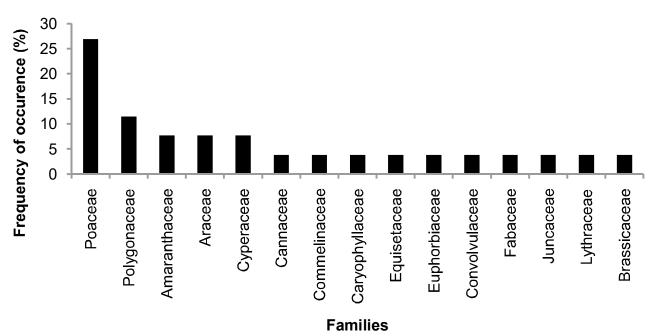

Fig. 1. Family-wise percent distribution of macrophytes

frequency ratio revealed that a regular (<0.025) distribution of macrophytes occurs only at Sites 3 and 4, while a random (0.025–0.05) and contagious (>0.05) distribution of macrophytes occurs at all sites. The majority of the analysed aquatic macrophyte species had a random distribution pattern at all sites.

Impact of pollutants on the distribution of macrophytes: *Alternanthera philoxeroides, Brachiaria mutica, Canna indica*, *Colocasia esculenta, Ipomoea aquatica,* and

Table 4. Aquatic macrophytes similarity index at selected study sites (Per cent)

Sites	4	3	2	1
1	38	40	88	1
2	29	29	1	
3	78.7	1		
4	1			

Table 2. Aquatic Macrophytes recorded during the study period from Tuikual river

Scientific names	Family	Common name	Site 1	Site 2	Site 3	Site 4
Alternanthera philoxeroides (Mart) Griseb	Amaranthaceae	Aligator weed	+	+	-	-
Alternanthera sessilis (L.)	Amaranthaceae	Sessile joyweed	+	-	+	+
Brachiaria mutica (Forsk). Stapf.	Poaceae	Water grass	+	+	-	-
Canna indica L.	Cannaceae	Indian shot	+	+	-	-
Colocasia affinis Schott.	Araceae	Dwarf elephant ear	-	-	+	+
C. esculenta (L.) Schott	Araceae	Elephant ear plant	+	+	-	-
Commelina benghalensis Linn.	Commelinaceae	Bengal day flower	+	+	-	+
Cuphea carthagenesis J.F.Macbr.	Lythraceae	Colombian waxweed	-	-	+	-
Cynodon dactylon (L.) Pers	Poaceae	Bermuda grass	-	-	+	+
Cyperus scariosus R.BR.	Cyperaceae	Umbrella-sedges	+	-	-	+
Drymaria cordata Linn.	Caryophyllaceae	Tropical chickweed	+	+	+	+
Echinochloa stagnina (Retz.) P.Beauv.	Poaceae	Hippo grass	-	-	+	+
Equisetum hyemale L. var. affine (Engelm.)	Equisetaceae	Rough horsetail	-	-	+	+
Homonia riparia Lour.	Euphorbiaceae	Willow leaved water croton	-	-	+	+
Hygroyza aristata (Retz.) Nees.	Poaceae	Asian watergrass	-	-	+	+
Hymenachne pseudointerrupta C. Muell.	Poaceae	Marsh grass	+	-	+	-
Ipomoea aquatica Forssk.	Convolvulaceae	Water spinach	+	+	-	-
Juncus effuses L.	Juncaceae	Soft rush	-	-	-	+
Kyllinga tenuifolia Steud.	Cyperaceae	Low spikesedge	-	-	+	+
Neptunia oleracea	Fabaceae	Water mimosa	-	-	-	+
Phragmites karka (Retz.) Trin. Ex Stand	Poaceae	Tall reed	-	-	+	+
Pogonatherum crinitum (Thunb.) Kunth	Poaceae	Bamboo grass	-	-	+	+
Polygonum barbatum L.	Polygonaceae	Knotweed	+	+	+	+
P. glabrum Willd.	Polygonaceae	Dense flower knotweed	+	+	-	-
P. hydropiper L.	Polygonaceae	Water pepper	+	+	+	+
Rorippa laciniata (F. Muell.)	Brassicaceae	Jagged bitter-cress	+	+	+	-

Symbols: + for "present" and - for "absent"

Table 3. Aquatic macrophytes diversity-dominance indices at selected study sites

Diversity indices	Site 1	Site 2	Site 3	Site 4
Shannon-Weiner diversity index	2.089	1.904	2.472	2.548
Simpson dominance index	0.176	0.186	0.106	0.101
Species evenness	0.790	0.790	0.890	0.900
Species richness	2.140	1.690	2.400	2.460

Table 5. Phytosociological characteristics of aquatic macrophytes at Site 1

Name of the species	Freq (%)	Density	Abundance	Relative Freq	Relative density	Relative abundance	IVI	A/F ratio
Alternanthera philoxeroides	23.3	0.23	1	4.4	1.6	3.5	9.6	0.042
Alternanthera sessilis	13.3	0.2	1.3	2.5	1.2	4.4	8.1	0.097
Brachiaria mutica	40	0.5	1.3	7.5	3.5	4.4	15.4	0.032
Canna indica	23	0.3	1.1	4.4	1.9	4.1	10.3	0.047
Colocasia esculenta	16.6	0.2	1	3.1	1.2	3.5	7.8	0.06
Commelina benghalensis	77	3.7	4.8	14.4	25.8	16.9	57	0.062
Cuphea carthagenesis	20	0.23	1.2	3.8	1.6	4.1	9.5	0.06
Drymaria cordata	70	3.4	4.9	13	23.9	17.2	54.2	0.07
Hymenachne pseudointerrupta	37	0.6	1.6	6.9	4	5.5	16	0.043
Ipomoea aquatica	16.6	0.2	1	3.1	1.2	3.5	7.8	0.06
Polygonum barbatum	57	1.7	3.1	10.6	12.2	10.8	33.6	0.054
Polygonum glabrum	46.6	0.6	1.2	8.8	4	4.3	17	0.025
Polygonum hydropiper	30	0.5	1.8	5.6	3.7	6.3	15.6	0.06
Rorippa laciniata	63.3	2	3.2	11.8	14.1	11.2	37.1	0.05
Total	533.7	14.3	28.5	100	100	100	300	

Table 6. Phytosociological characteristics of aquatic macrophytes at Site 2

Name of the species	Freq (%)	Density	Abundance	Relative Freq	Relative density	Relative abundance	IVI	A/F ratio
Alternanthera philoxeroides	26.6	0.3	1.1	5.9	2.5	4.8	13.2	0.041
Brachiaria mutica	36.6	0.6	1.5	8.2	4.6	6.6	19.4	0.04
Canna indica	20	0.2	1	4.4	1.6	4.3	10.4	0.05
Colocasia esculenta	6.6	0.1	1	1.5	0.5	4.3	6.3	0.151
Commelina benghalensis	100	3.5	3.5	22.2	28.7	15	65.9	0.035
Drymaria cordata	63	3.1	4.9	14.1	25.7	21.2	61	0.077
Ipomoea aquatica	10	0.1	1.3	2.2	1.1	5.7	9	0.13
Polygonum barbatum	56.6	1.7	3.1	12.6	14.2	13.1	39.9	0.054
Polygonum glabrum	43.3	0.6	1.3	9.6	4.6	5.6	19.9	0.03
Polygonum hydropiper	40	0.6	1.6	8.9	5.2	6.8	20.9	0.04
Rorippa laciniata	46.6	1.4	2.9	10.4	11.2	12.6	34.1	0.062
Total	499.3	12.2	23.2	100	100	100	300	

Polygonum glabrum were found only at Sites 1 and 2 (polluted sites) and have a high ecological amplitude. Despite the fact that all of the study sites were polluted, species from the worst water quality sites (Sites 1 and 2) may be considered highly pollution-tolerant due to their high tolerance to extremely polluted water. *Drymaria cordata, Polygonum barbatum,* and *Polygonum hydropiper* were present in all stands, indicating high stress tolerance and being suggested for extracting contaminants from polluted water. Pollution-sensitive species may include *Neptunia oleracea* and *Juncus effusus*, which were found only at the least polluted site (Site 4). Pollutants and unwanted compounds collect in many areas of plants, and the removal tendency of a species depends on the nature of the substance, which varies from species to species. Pollution-tolerant species such as *Drymaria cordata*, *Polygonum barbatum*, and *Polygonum hydropiper* are suggested for removing pollutants from polluted water.

CONCLUSION

The severely disturbed regions (Sites 1 and 2) were polluted by significant anthropogenic systems such as dumping sewage, detergents, rubbish, faulty drainage systems, waste disposal, bathing, and clothes washing directly into water sources. The worst water quality was observed at Sites 2 and 1, followed by Sites 3 and 4. The intensity of pollutants has a significant impact on the diversity and distribution of species. The findings suggest management of the drainage system, diversion of sewer to the sewage treatment plant, and proper treatment of river

Table 7. Phytosociological characteristics of aquatic macrophytes at Site 3

Name of the species	Freq (%)	Density	Abundance	Relative Freq	Relative density	Relative abundance	IVI	A/F ratio
Alternanthera sessilis	13.3	0.1	1	1.5	0.8	3.8	6	0.075
Colocasia affinis	66.6	0.8	1.3	7.3	4.9	4.8	16.8	0.019
Cynodon dactylon	50	0.6	1.1	5.4	3.3	4.3	13.1	0.022
Cyperus scariosus	40	0.4	1.2	4.4	2.7	4.5	11.5	0.03
Drymaria cordata	63.3	0.9	1.4	6.9	5.1	5.2	17.1	0.022
Echinochloa stagnina	100	4.1	4.1	10.9	23.7	15.5	50.1	0.041
Equisetum hyemale	53.3	1.1	2	5.8	6.2	7.6	19.6	0.037
Homonia riparia	90	1.5	1.7	9.8	8.7	6.4	24.8	0.018
Hygroyza aristata	36.6	0.4	1.2	4	2.5	4.5	11	0.032
Hymenachne pseudointerrupta	83.3	1.5	1.8	9.1	8.5	6.7	24.3	0.021
Kyllinga tenuifolia	70	1.2	1.6	7.6	6.8	6.4	20.7	0.022
Phragmites karka	76.6	1.7	2.3	8.3	10.1	8.6	27.1	0.03
Pogonatherum crinitum	73.3	1.4	2	8	8.5	7.6	24.1	0.027
Polygonum barbatum	16.6	0.2	1	1.8	1	3.8	6.6	0.06
Polygonum hydropiper	23.3	0.3	1.1	2.5	1.6	4.4	8.5	0.047
Rorippa laciniata	63.3	1	1.5	6.8	5.6	5.8	18.3	0.023
Total	919	17.2	26.3	100	100	100	300	

Table 8. Phytosociological characteristics of aquatic macrophytes at Site 4

Name of the species	Freq (%)	Density	Abundance	Relative Freq	Relative density	Relative abundance	IVI	A/F ratio
Alternanthera sessilis	40	1.1	2.6	5.4	4.9	5.5	15.7	0.065
Colocasia affinis	50	2	4	6.7	9.1	8.2	24	0.08
Commelina benghalensis	36.6	1	2.8	4.9	4.7	5.8	15.4	0.076
Cyperus scariosus	43.3	1.8	4.1	5.8	8.1	8.3	22.2	0.094
Cuphea carthagenesis	26.6	0.4	1.4	3.6	1.7	2.8	8.1	0.052
Drymaria cordata	16.6	0.8	5	2.2	3.8	10.2	16.3	0.301
Echinochloa stagnina	56.6	0.7	1.2	7.6	3	2.4	13	0.021
Equisetum hyemale	63.3	4.8	7.5	8.5	21.8	15.4	45.7	0.118
Homonia riparia	70	1.6	2.3	9.4	7.3	4.7	21.3	0.032
Hygroyza aristata	50	0.9	1.8	6.7	4.1	3.7	14.5	0.036
Juncus effuses	30	0.5	1.8	4	2.4	3.6	10.1	0.06
Kyllinga tenuifolia	23.3	0.6	2.5	3.1	2.7	5.3	11.1	0.107
Neptunia oleracea	33.3	0.4	1.2	4.5	1.8	2.5	8.7	0.036
Phragmites karka	20	0.9	4.5	2.7	4.1	9.2	16	0.225
Pogonatherum crinitum	100	3.1	3.1	13.4	14.3	6.4	34.1	0.031
Polygonum barbatum	46.6	0.7	1.5	6.3	3.4	3.2	12.8	0.032
Polygonum hydropiper	40	0.5	1.4	5.4	2.6	2.9	10.9	0.035
Total	746	21.8	48.7	100	100	100	300	

water before supply for drinking purposes. Moreover, hospital discharge needs to be checked, as it has a severe health impact on people consuming river water. This research could lead to more in-depth water resource studies as well as the development and execution of effective water management plans. Pollution-tolerant plants can be effectively employed to extract various sorts of contaminants from waste water. Environmental mass awareness campaigns and public involvement should be implemented, and particularly in watershed areas, to educate people about the adverse impacts of water pollution on human health. To prevent future degradation of monitoring river water should be regulated.

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Received 18 February, 2024; Accepted 20 June, 2024