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MICROPLASTIC AND HEAVY METAL CONTAMINATION IN FRESHWATER ECOSYSTEMS WITH GLOBAL EVIDENCE AND LOCAL INSIGHTS FROM MANGLA LAKE, PAKISTAN

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By

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Abstract

Heavy metals and heavy microplastics presence in lake contaminate all the compartments of Mangla Lake. These are highly toxic for the aquatic animals, plants, water and sediments and their quality decreases. The aimed of the study is to determine the concentration of heavy metals and microplastics, its types in the environmental compartments of Mangla Lake, Azaad and Jammu Kashmir. The other purpose of this study is to evaluate the human health risk due to the consumption of the fish from Mangla Lake. Samples collected from the Mangla Lake and digest in acid and then analyzed by Atomic Absorption Spectrophotometer(AAS) and Flame Photometer for heavy metal detection. The concentration of these metals is in the range between Zn (0.22 to 0.996) mg/Kg, Cr (0.15 to 0.882) mg/Kg, Cd (0.05 to 0.385) mg/Kg, Ni (0.01 to 0.558) mg/Kg, Pb (0.1 to 0.32) mg/Kg are detected in AAS and Na (57.2 to 168) mg/Kg, K (10.4 to 32) mg/Kg, Ca (0.3 to 802) mg/Kg is detected using flame photometer. Samples are filtered in a Vacuum Filtration Assembly and dried in oven then microplastics are identified with the electron microscope. The FTIR test is apply to check the type of polymer and its nature. Filaments, fragments, films and fiber checked with electron microscope. 19% filaments, 8% fragments, 5% films and 68% fiber. HDPE and LDPE, PET, PP, PVC, PVA and Nylon category detected in FTIR. These results show high contamination in the water of Mangla Lake. Which affects the plants and aquatic life. This is also a threat to humans when they consume fish of Mangla lake.

Key words

Microplastic, Heavy metals, Pollution, Aquatic ecosystem, Environmental health risks, Mangla lake.

Introduction

1.1 Mangla Lake

Mangla lake is the 12th-largest manmade freshwater reservoir in Pakistan (Ahmad et al., 2023). The five pockets that make up the Mangla reservoir are Mangla, Khad, Jari, Poonch, and Kannsi, it is connected to many wastewater systems release the dangerous toxins in it (Khalid et al., 2024). The Mangla water reservoir's water quality is therefore under risk. Toxin heavy metals and microplastics are being introduced into the Mangla water reservoir because of the disposal of household, industrial wastewater and tourism (Khan et al., 2023). The harmful impacts from this metal and microplastics pollution on aquatic ecosystems'

fauna and flora, human health, water quality, soil quality, and agriculture become more (Mehmood et al., 2024). Thus, researchers all over the world are concentrating on quantitative analysis of heavy metals and microplastics in aquatic ecosystems. In aquatic habitats, a range of physicochemical characteristics (pH, conductivity, ions, and so on) as well as biological aspects influence the availability of metal to entities (Rahim et al., 2023).

1.2 Microplastics

The scientific community paid little attention to the earliest reports of plastic debris in the oceans in the early 1970s (An et al., 2024). According to common perception, not all plastics behave similarly in the environment because of differences in composition (Cheng et al., 2024). The multifaceted challenge of identifying microplastics in the environment remains unsolved. The physical form, size, texture, shape, and chemical composition of plastics are different and also these qualities change both during and after use (Arat, 2024). Plastics have densities that differ from water's based on their composition. The majority of the earliest reports on plastics concentrated on macro debris washed up on shorelines or floating at the water's surface (Maddison et al., 2023). Among them are low-density polymers like polyethylene and polypropylene, which are utilized in single-use containers (Sharma et al., 2023). However since many other polymers are denser than water, they should sink, such as polyethylene terephthalate, polycarbonate, and polyvinyl chloride. Plastic qualities, including as color, flexibility, flame retardancy, and ultraviolet (UV) resistance, can be altered by adding organic or inorganic additives (Wang et al., 2023).

1.3 Plastics used in the Marine Environment

The every year demand for plastics worldwide has been increasing gradually in recent years, reaching a current level of over 245 million tons (Ahmad et al., 2020). Plastics are versatile, strong, lightweight, and potentially transparent materials that can be used in a wide range of applications (Koelmans et al., 2022). They are ideal packaging materials due to their inexpensive cost, superior oxygen/moisture barrier qualities, bio inertness, and lightweight (Thushari & Senevirathna, 2020). Traditional materials like paper, metal, and glass are being replaced with more affordable plastic packaging with better or equal design (Adam et al., 2020). Therefore, about one-third of the plastic resin produced is turned into consumer packaging material, such as single-use, throwaway goods that are frequently found among beach litter (Imogen Ellen Napper & Thompson, 2020). Microplastics are not as easily visible as bigger fragments; even resin pellets, or meso-plastics, combined with sand make them difficult to see with the naked eye (Lu et al., 2021).

1.4 Heavy metals

Air and water pollution, two detrimental effects of human activities near coastlines and they are increasing day by day (Mok et al., 2023). Because they are nondegradable and persist in the environment for extended periods of time, heavy metals constitute significant hazards (Raeeszadeh et al., 2023). The substantial

impact that heavy metals place on marine creatures at the local, regional, and global levels is shown in a review of current researches (Muhammad & Ahmad, 2020). Therefore, it is essential to comprehend the effects of heavy metal concentration in the marine environment and how it affects the ecology. Many man-made and natural processes, including weathering of rocks and soil, volcanic eruptions, mining, metal processing, industrial and urban effluents, ports and harbor operations, and mining, introduce heavy metals into the aquatic system (Zhang & Wang, 2020). Heavy metals that naturally occur in the environment are referred to as the "background level." Anytime the ambient environment's background values of heavy metals are exceeded, the marine environment becomes contaminated (Wong et al., 2022). Metals fall into the water, float around, and get absorbed into silt particles (Aziz et al., 2023).

Dissolved metals are directly harmful to marine life, and the majority of them concentrate in aquatic species, which leads to biomagnification (Xue et al., 2022). Metals like iron, zinc, and copper are essential to a living thing's metabolic processes and are only harmful in comparatively high amounts even at extremely low quantities, heavy metals like cadmium, lead, mercury, and chromium can be harmful (Bharti & Sharma, 2022). Phytoplankton growth, density, and morphological alterations can all be impacted by heavy metals (Szymańska-Walkiewicz et al., 2022). Furthermore, algae's lack of photosynthesis is impacted by elevated heavy metal concentrations in the marine environment (Ismanto et al., 2024). The phrase "heavy metals" refers to a class of metals and metalloids with an atomic density greater than 4,000 kg/m3 (Jin et al., 2020). Almost all heavy metals are toxic to humans, even at low metal ion concentration Copper, cadmium, zinc, chromium, arsenic, boron, cobalt, titanium, strontium, tin, vanadium, nickel, molybdenum, mercury, lead, etc. are a few examples of heavy metals (Fu & Xi, 2020). Heavy metals such as copper, zinc, nickel, boron, iron, and molybdenum are essential for plant growth, but when concentrations of these metals exceed allowable limits, they become toxic to both animals and plants (Ghuge et al., 2023). Lead, mercury, cadmium, and arsenic are among the other few heavy metals that are not necessary for the growth of plants and animals (Jeong et al., 2023).

Due to the entry of industrial wastewater, sewage sludge, fertilizers, the use of treated wastewater for land application, and the weathering of soil minerals, the soil becomes contaminated with heavy metals (Ahmed et al., 2022). The majority of heavy metals, such as zinc, cadmium, and copper, are typically linked to hazardous problems and pollution, particularly when they are present in dissolved form (Garai et al., 2021). Due to their harmfulness and mobility, any of these heavy metals present in extremely high concentrations pose a threat to human health and can interfere with many of the earth's functions (Nyiramigisha, 2021). Furthermore, it is more difficult to remove these heavy metals as they are not biodegradable. Therefore, it's critical to quantify, understand, and manage the contamination caused by heavy metals in nature (Mukherjee et al., 2023).

1.5 Rationale for the Study

Plastic degradation is a commonly employed process in developed nations. Microplastic pollution is a serious issue because it is present in aquatic environments and poses serious toxicological and physical risks. Degradation of plastic polymers through physical, chemical, and biological processes is a dependable method. Pakistan is a developing country that faces negative health and environmental effects from the buildup of different types of plastic polymers deposited in water, plants, sediments, and fish species. Pakistan is vulnerable to the degradation of the environmental compartments (i.e., water, sediment, plants, and fish) due to anthropogenic activities. This study can help in quantifying the microplastic and heavy metals in various environment compartments. This research provide literature about the heavy metals and microplastic contamination in Mangla lake. The figure 1 describes the step wise heavy metal and microplastic and human health risk assessment.

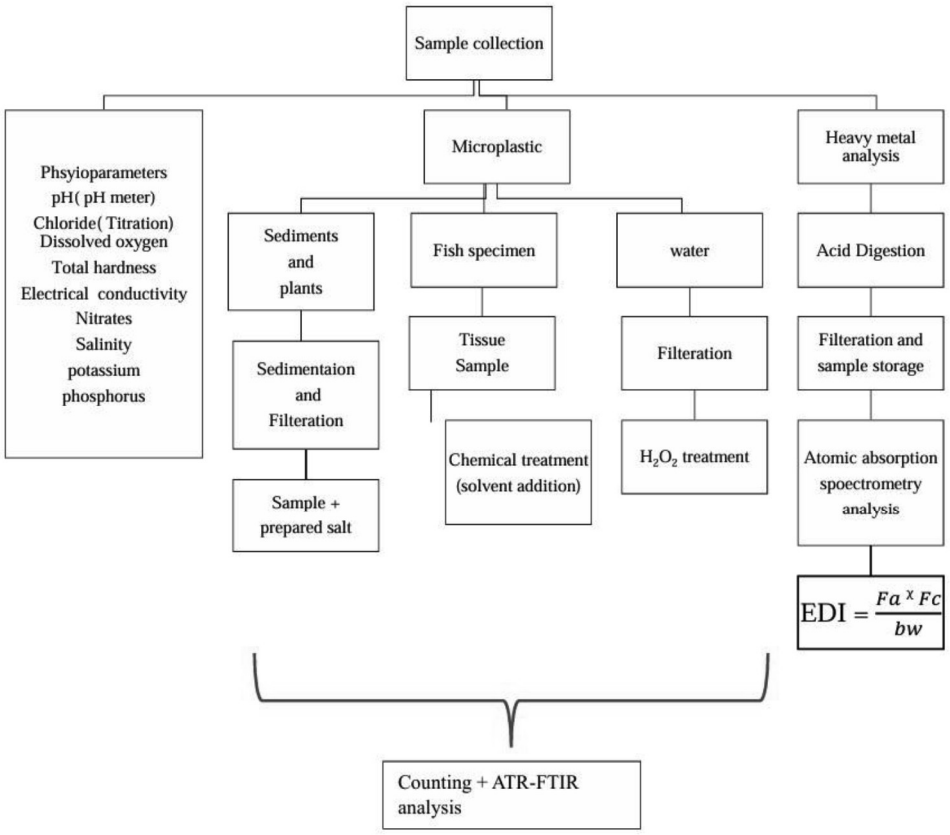


Figure-1: Flow diagram of heavy metal and microplastic analysis and human health risk assessment

1.6 Freshwater microplastic pollution worldwide

Microplastics contamination in the Flathead Lake, USA. Water samples were taken to check MPs. Different shapes of MPs are identified i.e., fibers, line, fragments and sheets. Polymer characterization of these MPs are PET, PVC, and PP. Both dry and wet season variations were checked. In dry season 4-140 particles/m2/day and in wet season 0.006-0.050/ml MPs abundance are shown. The slow process of decomposition and rate of production increases lead to the accumulation of microplastics in water which has adverse effects on aquatic ecosystem (Xiong et al., 2022).

A study investigates the MPs contamination in the Haikou Bay, Northern South China Sea. Water samples are collected to identify the MPs. Fibers, foams, fragments and films shapes of MPs are detected. Which have different colours black, red, white, green, purple and blue. The polymer characterization of these MPs are rayon, PEST, PVC, PU, Nylon. MPs abundance is 0.26-0.85 items/m3. Once the plastic enters the water it remains for thousands of years and becomes nanomaterial and microplastics (Qi et al., 2020).

Study conduct to determined the microplastics contamination in the Yulin River. Water samples were taken to check MPs abundance and polymer types. Foams and fibers are identified in these samples. The polymer characterization of these MPs is PE, PS ,PP. Bay, mainstream and tributary was check. The MPs abundance shows in 3.60×10-1 items/L in Bay, 1.30×10-2 in mainstream and 1.95×10-1 in tributary. . Plastics are of different types of polyester (PE), polythene, polyvinylchloride and polypropylene which are known as the organic polymers that emanate from petroleum out of which PE hold first position and PP hold second position in the global market (Mao et al., 2020).

The study conduct to check the MPs contamination rate at Baikal Lake, Siberia. Fragments and fibers are detected in the water samples. PP was detected and its abundance is 291±252 m-3. PH control the lowering and raising the chemical leach rate from the surface which alter the chemical balance of microplastics (Mao et al., 2020).

According to this study Surgu Dam reservoir, Turkey was highly contaminated with MPs. The shapes of MPs are fiber, film, fragments and foam are identified in the water samples of Surgu Dam. The MPs have different colours i.e. blue, white, green, gray, yellow, red and white. The abundance of these MPs are 760-1440/m2. PET and PP are the polymer characterizations of these MPs (Turhan, 2021). A study conduct to determined the MPs rate in Koshi River, crossing China to Nepal. The abundance of the MPs are 202±100 items/m3 which has shape of fibers which is detected in the water samples of this river. Polymer characterization of these MPs are PE, PP, PET. Polyamide and PS. In the atmosphere the average size of plastic appears to dwindle which results in a surge in perfusion (Turhan, 2021). The study in Thailand show the MPs contamination in the Tapi- Phumduang River. The abundance of MPs is 1.77±0.28 items/L. The shape of MPs which are detect

in the water samples of river is fibers and fragments. PE, PET, Nylon, Rayon are polymer characterization of these samples (Chinfak et al., 2021).

A study conducted on the Defeng River, China which shows the microplastics contamination in the Defeng river. Water samples were taken to check MPs. Different shapes of MPs are identified i.e., fibers, film, fragments and foam. Polymer characterization of these MPs are PU, PP, PS, POM, PET, PE, Nylon and Rayon. Samples were taken in July and December. In July MPs abundance is 4×10-5 - 9×10-4 items/L and in December MPs abundance is 3×10-4 – 2.5× 10-3 items/L. In the virgin microplastic certain additives are added because of the demand of the products which results the additional property of the adsorption of pollutants present in the water (Jiang et al., 2020).

According to this study at Kavery River, India has high contamination rate of MPs in the sediments. Samples of sediments were taken from the river and analysis for the MPs apply. Polymer characterization was shown in these samples are PET, PA, PS, PP, PEF. These MPs have shapes of films, foams, fibers and fragments. Colour of these MPs are shown orange, green, red, white and transparent. The abundance of these MPs is 386±84.5 items/kg .(Maheswaran et al., 2022) This study show the MPs pollution in the Liangfeng River, China. Sediments samples were taken from the river and analyzed. The abundance of the MPs is shown 3177±1970 items/kg these samples. The shape of these MPs are films, fibers and fragments (Xia et al., 2023).

This study was conducted at Netravathi River, India. Sediments samples were collected and analyzed to check the MPs pollution. 96 pieces/kg are found in the samples of sediments. Polymer characterization of these MPs are PP, PE and PET. The colours shown of these MPs are blue, green, white, red, brown and yellow (Amrutha & Warrier, 2020). According to this study Brisbane River, Australia is highly contaminated with MPs. Sediments samples were taken to analyze the rate of MPs. PET, PE, PA, PP are the polymers which are detected in these samples. These MPs are of multiple colours. The abundance of these samples was shown is 10-520 items/kg. The shape of MPs are fibers, films and fragments. This study determined the MPs concentration in West River, China. Sediments samples were taken for the analysis. The abundance of MPs in sediment samples is 2560-10,240 items/kg. These MPs have different shapes i.e. pallets, fibers, films and fragments. Polymer characterization of these MPs is PET, PVC, PP, PS, PP (He et al., 2020).

This study investigates the MPs concentration in the fish of Defeng River, China. Digestive track and tissue samples of fish were taken and analyzed the MPs concentrations and its types and check how it effects the fish life. Fragments, foam, film and fiber are the shapes of MPs were shown in the fish samples. These MPs have white, yellow, blue, black, red and green colours. 2.0±1.6 items/individual abundance of MPs shown in the digestive track and 2.2 × 103 ± 1.6 × 103 items/kg abundance of MPs are shown in the tissue samples. PP, Olefin, POM, Rayon, PU, PET are the characterization of these polymers (Jiang et al., 2020).

Microplastics which has floatable and incessant characteristics are prevalent as a marine contaminant in the aquatic environment, which transfer pollutants to organisms which present in the water by acting as a carrier. A wide range of aquatic species uptake the small size of microplastic which results the disturbance in their physiological functions. Microplastics block the gastrointestinal system of organisms. Microplastics are now detected in all types and phases of food chain of marine ecosystem. Many aquatic animals consume microplastics because their food and microplastic size are similar. Recent studies shows that almost all aquatic animals ingest microplastics (Senathirajah et al., 2021).

This study determined the MPs concentration in the fish of Tapi-Phumduang River, Thailand. Missel tissue samples were taken from the different sites of river. Fragments and fibers are found in these samples. 0-1.85 items/g MPs abundance are shown in these samples. PE. PP and PET are the polymer types found in these samples. Biomagnification is not obtained because of the rapidly uptake and excreted by marine species. However, behavioral development disorders are result in marine species because of the increasing in the uptake of MPs and reduction in food uptake. Polybrominated diphenyl ethers and DDT are organic pollutants that is release and accrue readily by microplastics (Jiang et al., 2020).

The study was conducted on the fish of Finish Lake, Finland. Vendance and Perch fish samples were taken. Two shapes of MPs are found these samples i.e. fibers and fragments. PET, PP, PS, PET are the polymer types shown in the results of these samples analysis. The elevation of potential harm of microplastic reverberates by the reduction of its particle size. Aquatic organisms are not chemically hazardous by additive-free microplastic, but their physical conditions are disturbed by it such as bowel obstruction. Certain materials play a role in biotic degradation. It can be bacteria and fungi. Certain species play role in biotic degradation. It can be bacteria and fungi (Pankkonen, 2020).

Studies looking at the presence of microplastics in the marine environment have significantly grown recently (Osman et al., 2023). Study states that there is always fresh data about the fate of microplastic trash from laboratory and field study (Curren & Leong, 2024). Study demonstrate that trash in all aquatic environments Microplastics are often investigated in connection with plankton samples, muddy and sandy sediments, ingestion by vertebrates and invertebrates and interactions between chemical pollutants (Lee et al., 2023).

Based on the information that is currently accessible, every category of marine creature is highly likely to come into contact with microplastics. Numerous publications on other pertinent topics (such as polymer degradation at sea, novel laboratory and sampling techniques, developing sources, and externalities) were also examined and addressed. For the first time, the consequences of microplastics on the marine ecosystem are thoroughly examined in this research (M. Ahmad et al., 2020). According to this study microplastic are present in all the compartments of environment We eat microplastic in food, breath from the air (Li et al., 2023).

According to this study the major question rising from microplastic is how much it effect the human health. The effect of microplastics depend upon the concentration (Angraini et al., 2024). The study states that there are two common sources of microplastics primary and secondary. They have different shapes and sizes. Sewage sludge, paints, microbeads, artificial turfs are different sources of primary microplastics. Fishing waste, municipal debris, any large size plastic waste, plastic bottles and bags are the sources of secondary plastics (Nyaga et al., 2024).

A study tells the major source of microplastics is the increase in vehicles tires wear. Rubber particles present in the environment are very dangerous and scary. The more dominant type of microplastic are secondary because the large plastic take hundreds of years to convert into microplastic as compare to secondary type (Muthulakshmi et al., 2023). This tells that microplastics are now add in the food chain. The size of microplastic is 5 mm which become from the large particle of plastic (Emenike et al., 2023). According to the study microplastic are detected in the aquatic environment, food chain and drinking water for the consumption of human which has adverse effect on the health of human. So now microplastics is the major concerns worldwide which is gaining public attention (Prata, 2023).

A state that the mismanagement of plastic waste lead to the microplastic accumulation. Because of their connections to other persistent organic pollutants in the environment, heavy metals, pesticides, medicines, and additives, microplastics are sometimes referred to as a cocktail of contaminants (Al Mamun et al., 2023). This study tells these contaminants are lead to the severe illness of the human health like diabetes, cancer, reproductive and cardiovascular problems which shows that the exposure impact on the health of human by acting as a physical stressors of contaminants of the environment and can enter into a circulatory, digestive and respiratory system (Senathirajah et al., 2021).

A states that Microplastics are contaminants that are present in every environmental compartment on the planet, including aquatic environments (Nyaga et al., 2024). A states that numerous reports have been made about the ingestion and trophic transfer of microplastics by aquatic organisms (Ali et al., 2024). This study demonstrate that Microplastics which has floatable and incessant characteristics are prevalent as a marine contaminant in the aquatic environment, which transfer pollutants to organisms which present in the water by acting as a carrier. A wide range of aquatic species uptake the small size of microplastic which results the disturbance in their physiological functions by additive-free microplastic but their physical conditions are disturb by it such as bowel obstruction. Certain materials play role in biotic degradation. It can be bacteria and fungi. Certain species play role in biotic degradation. It can be bacteria and fungi. Microplastics block the gastrointestinal system of organisms. Microplastics are now detected in all types and phases of food chain of marine ecosystem. Many aquatic animals consume microplastics because their food and microplastic size are similar. Recent studies shows that almost all aquatic animals ingest microplastics (Jia et al., 2021).

1.7 Ecotoxicity and tropic transfer of heavy metals in water

This study tells complicated processes, such as adsorption-desorption, precipitation dissolution, diffusion induced by chemical variations (salinity, dissolved oxygen (DO), pH, temperature, etc.), and benthic bioturbation (resuspension), influence the behaviour and cycling of heavy metals between the surface sediments and the overlying water. Prior research has demonstrated that these mechanisms have a rather significant impact on the behaviour of heavy metals (Saidon et al., 2024). This study tells the Heavy metals are naturally released into soils and surface waters via volcanic eruptions, chemical weathering, and physical weathering. Anthropogenic contaminants are derived from industrial and municipal trash, which significantly alters and increases their contributions. The cuticles of amphipods, fish gills, and other delicate aquatic organs then absorb them. The main points of the identification, potential, and likely causes of trophic transfer and biomagnification of environmental pollutants. The concentration of arsenic is generally found to be diluted from lower trophic levels (from producer to bottom level of consumer, secondary, and finally to tertiary consumer (forage fish)), but it is bio-diminished across food webs in freshwater ecosystems, while it is biomagnified in marine ecosystems of higher trophic level (tertiary consumer of predatory fish (Azhar et al., 2022).

According to this study the quality of water is determine by the chemical, physical and biological components in every aquatic system. The physiochemical characteristics directly effect by aquatic biota which is present in any aquatic habitat. For the determination of trophic status in any of aquatic ecosystem physiochemical characteristics will check. It is an essential tool to check the water quality. To check the water pollution fish is an important animal in any aquatic environment. Because it easily damage from the contaminants in water bodies. Biodiversity and habitat biodegradation are two main long term effect which is caused by trace elements. Heavy metals disturbs organisms at cellular, physiological and molecular level which have negative effects on the community population level.Study tells that many diseases caused by heavy metals are considered most hazardous contaminants because of their negative effects on all living things. Some elements also play biological functions in aquatic plants and animals life known as trace elements (Zaynab et al., 2022).

According to this study these elements are Fe, Zn, and Cu. People, plants, soil and animals are effected badly because of the large amount of trace elements. They are deadly if they ingest in large amount. Trace elements sink and accumulate in soil and remains in it for a long time (Hołtra & Zamorska-Wojdyła, 2020).A study states that trace elements have lengthy biological half-life and are non-biodegradable. Because of these characteristics trace elements become very toxic. Eco-toxicity and amount of heavy metals accumulate by soil and remain in it for a very long period of time because chemical and microbial deterioration cannot break heavy metals (J. Xu et al., 2021). According to this study heavy metals are known as trace elements because of their presence in environment matrix. Trace Ultra is (1 kg/ kg) and trace is (10 mg kg-1) . Artificial and organic sources both

cause heavy metals contamination. Poisoning of heavy metals in water, soil, air is the one of the biggest ecological issue (Masindi et al., 2021).

The study demonstrates that food chain is the main source of contamination and exposure of heavy metals in animals and humans. Many heavy metals play important physiological role at some range but too much quantity of these heavy metals can cause harmful effects. These are known as cobalt. Zinc and iron (Kour et al., 2021). A study tells the carcinogenic and toxic effect are caused by heavy metals.(Co, Cu, Ni, Cr) effects the kidneys and central neurological system. (Cu, Pb, Cd) effects the skin, bones and liver. (Cr, Ni, Cd, Cu) effects the teeth (Kour et al., 2021). Variety of techniques is used to determine heavy metals i.e. Flame photometer, X-rays and AAS. The pollution of the aquatic environment by both organic and inorganic pollutants poses a severe threat to the life of aquatic animals, particularly fish significant concentrations of inorganic (Uddin et al., 2021). The study demonstrates that how industrialization causes heavy metals contamination in the Calabar Metropolis Cross river state water. The concentration of Chromium was checked which is 27.68±0.34 ppm (Operacz et al., 2022). According to this study soil of Poland was highly polluted with the HM because of the industrial activities. Fe, Zn, Rb, Sr, Zr, Ti, Mn, Co, Cu, Pb are the HM which are detect in the soil samples of Poland. The concentration of these samples are Fe(27133.83), Zn(147.72), Rb(16.30), Sr(95.95), Zr(307.11), Ti(466-3.66), Mn(289.85), Co(418.54), Cu(44.97), Pb(112.88)mg/kg (Pham et al., 2024).

The study identifies the HM contamination in the soil Bidoup Nui Ba National Park (Southern Vietnam)of because of the increase in industrialization. Total 28 HM were detect in these soil samples. These are Zn, Pb, Cr, Cu, Hg, Cd, As (Pugazhendhi et al., 2024). According to this study root and shoot biomass of Magnesite mine tailings were highly contaminated because of the HM. The abundance of HM shown in samples of root and shoot samples i.e. Cd(83.3±1.2), Cu(45.8±1.5),Zn(134.8±1.7), Pb(92.4±2.2), Ni(78.95±1.4) mgkg-1 because of the unprocessed dumping waste of industries (Pugazhendhi et al., 2024).

1.8 Mangla Lake Case Study

In March 2024, samples of the lake sediments, plants, fish, and surface water were taken from different sampling sites to check the presence of heavy metals and microplastics. Every sample shows an abundance of microplastics which are collected from the Mangla Lake. All the water sites of Mangla Lake are contaminated because of the water resort at the Mangla Lake and sewage waste. Due to the increase in tourism at the resort pollution also increased. There are many sources of pollution at the Mangla Lake. Different types of microplastics are identified according to their shape and color, which is 19% filaments, 8% fragments, 5% films and 68% fiber. Different types of plastics are found in these samples which were detected in the FTIR which are HDPE and LDPE, PET, PP, PVC and Nylon category detected in water samples. In fish 16% filaments, 27% fragments, 10% films and 47% fiber detected.

The results show the large amount of heavy metals in Mangla Lake which affected the plants, water, fish, and soil. Heavy metals are detected in fish, sediments, plants, and water. Pb, Cr, Cd, Ni and Zn are detected with AAS. Ca, K and Na are detected with flame photometer. In water samples, Zn is determined in high amount which is 0.461SS. The amount of Pb in water sample 1 is 0.021 and in samples 2 is 0.34. The amount of Cr in sample 1 is 0.007 and in sample 2 is 0.15. The amount of Cd in sample 1 is 0.05 and in sample 2 is 0.77. The amount of Ni in sample 1 is 0.06 and in sample 2 is 0.048. The amount of Zn in sample 1 is 0.058 and sample 2 0.461. The amount of K is in the range of 10.4 to 18.7 measured. The amount of Ca is in the range of 0.30 to 139. The amount of Na is in the range of 57.2 to 105 detected. In fish sample 2, Cr is determined in high amount which is 0.481. The amount of Pb in water sample 1 is 0.280 and in samples 2 is 0.32. The amount of Cr in sample 1 is 0.287 and in sample 2 is 0.481. The amount of Cd in sample 1 is 0.125 and in sample 2 is 0.120. The amount of Ni in sample 1 is 0.01 and in sample 2 0.006. The amount of Zn in sample 1 is 0.058 and in sample 2 is 0.419. The amount of K is in the range of 5.7 to 39.2. The amount of Ca is in the range of 3.0 to 15.6. The amount of Na is in the range of 128 to 198.

Human health risk assessment is calculated with the formula of EDI. The HQ value of Pb (0.003), Cr (0.003), Cd (0.0030), Ni (0.03), Zn (0.003), K (0.0003), Ca (0.003) and Na (0.003) was detected. This shows the hazard risk of these metals to humans when they consumed this contaminated fish.

Conclusion

This review paper is highlighting the issue of microplastic as well as heavy metals in aquatic environment and their impact, mainly focusing on Mangla Lake. Many global studies describe that microplastic and heavy metals both cause posses severe human and ecological health risks.

Microplastic arise from primary and secondary sources like synthetic fibers, microbeads, plastic debris that are now dispersed in freshwater systems, biota, sediments and also effecting human through drinkable water and consuming fish. Due to small size of microplastic they have ability to absorb other toxic substances like pesticides, heavy metals and also their persistent ability make them more hazardous. These microplastics enter in the food chain through ingestion of contaminated water fish that may lead to immune disruption, oxidative stress and bowel disruption. Microplastic act as a carrier of contaminants that cast negative impact on aquatic biota as well as on human.

Heavy metals like Fe, Cu, Zn even though these are micronutrient but become toxic when present in excessive amount. Accumulation of heavy metals in the environment due to anthropogenic activities like mining, improper waste disposal practices and industrialization leads to comination of water bodies. The heavy metals like Cr, Pb, Hg, Cd can cause reproductive, carcinogenic and neurotoxic effects. The biomagnifications of heavy metals across the globe is due to their long biological life and non-biodegradable nature.

The findings show that Mangla lake like other globally freshwater ecosystem also effected from both microplastics and heavy metals. These contamination is not only harming aquatic life but also human health through contaminated water and fish consumption. Their behavior in the ecosystem, simultaneously as physical particles or chemical stressors, contributes to the formation of a `cocktail of contaminants' and aggravates ecosystem destruction. This study describes that increase of human activities near Mangla Lake cause the increase of pollution in Lake. One of the major contributors of pollution to the Mangla Lake is Mangla water resort. Microplastics and heavy metals are non-biodegradable and are highly toxic. Which cause a major life threat to the aquatic life, reduces their food consumption because if the consumption of plastic. Spectrophotometer(AAS) and Flame Photometer are used for heavy metal detection. Electron microscope and FTIR test is taken to check microplastic and its types. Extremely limited research is done on the Mangla Lake. . Zn, Cr, Cd, Ni, Cd ,Na, K, Ca value shows the negative potential effects on the aquatic life, plants and sediments of Mangla lake. Also, when fish consume by human it effects human health. HDPE and LDPE, PET, PP, PVC, PVA and Nylon category shows the high contamination rate of microplastic and their potential effects on aquatic life, plants and sediments. How it can be transfer to humans when they consume fish if Mangla Lake.

To alleviate these hazards, the following steps ought to be taken:

- Develop and implement policies for the controlled disposal of plastic and industrial waste.
- Conduct regular surveillance of microplastic (MP) and heavy metal (HM) concentrations in water, sediment, and biota.
- Effect administrative actions for public education campaigns about pollution control.
- Challenge the scientific community to map out biodegradation pathways, contaminant interactions, and ecotoxicological effects particular to Mangla Lake.

Restricting access to, and monitoring the environment is accompanied by active promotion of supporting policies with community-driven solutions for the healthier protection of the public as well as the high importance freshwater ecosystems from the additional threats posed by microplastics and heavy metal pollution demonstrates the need for an integrated, multi-faceted approach.

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