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Study of Presence of Microplastic in Vicinity of Kuntbhyog Lake, Rewalsar Lake and Suketi River Which is A Tributary of Beas River, Mandi. Himachal Pradesh, India

[1] Kapil Dev, [2] Dr. M. R. Sharma, [3] Dr. Madhu Sharma, [4] Surabhi, [5] Prashant Thakur

[1],[2] Department of Civil Engineering, Carrier Point University, Hamirpur, Himachal Pradesh, India.
[1],[3],[4],[5] Department of Civil Engineering, Jawaharlal Nehru Government Engineering College, Sundernagar, Mandi, Himachal Pradesh, India.
Corresponding Author Email: [1] kapildev14183@gmail.com, [2] mrsharma.cpuh@gmail.com, [3] gautamadhu@gmail.com, [4] sharma.surabhi07@gmail.com, [5] thakurprashant018@gmail.com

Abstract*— The analysis, prevention, and removal of microplastic (MP) pollution in water is identified as one of the major problems that the world is currently facing. Microplastics can be directly released into water when microplastics are formed by the degradation of bigger plastics. Based on the existing studies, the characterization of microplastics in water is still one of the remaining challenges because they can be easily confused with organic or other types of matter. So, this study was conducted to determine the presence of microplastics in surface water and soil in the vicinity of Kuntbhyog lake, Rewalsar lake, and Suketi river. The samples from the lakes and river were collected in the month of March, 2021. The microplastics were isolated from the surface water and soil samples by using various processes. Microplastics were sorted visually according to their shapes and colours after being examined under microscope. The most abundant particles found in the study were flakes and fragments. This study provides an insight into the types of microplastics found in water bodies as mentioned above and, therefore, further actions needed to be taken to curb the distribution of microplastics in the ecosystem from threatening the food chain of creatures below water and also human health.

Index Terms: Kuntbhyog lake, Microplastics, Rewalsar lake, Suketi river

I. INTRODUCTION

Plastics are basically synthetic organic polymers that are formed by the polymerization of monomers extracted from petroleum and other products. The different properties of plastic are durability, light weight, and inexpensive (M. Golden et al. 2019 [25]). Plastics have extensive application because it is easy to sculpture them into a variety of products. Plastics have become the most important packaging option since the development of commercially viable plastic in the 1950s (N. Saipolbahri et. al. 2020 [5]). Large plastic particles get degraded slowly into small pieces with sizes ranging from metres to micrometres (S. Kumar et al. 2020 [1]). Microplastics are small plastic pieces less than five millimetres long that can be harmful to the ocean and aquatic life. Plastic is a broad term used to describe synthetic polymers which are formed by a polymerization process (A. Oladejo 2017 [2]).

Plastics on the basis of size can be microplastics, nanoplastics, mesoplastics, and megaplastics depending upon their classification size. The size of microplastics is less than 5 mm and can range up to nanoparticles (E Danopoulos et. al. 2020 [8]). Nanoplastics are usually of the size of 10–9 m, mesoplastics are those whose size is greater than 5 mm, macroplastics are a few centimetres in size, and megaplastics are more than 1 metre in size (A. Oladejo 2017 [2]).

Microplastic is detected in marine water, waste water, fresh water, food, air, and drinking water, both bottled and tap water. Microplastic can enter into water in various ways, like surface runoff and waste water effluent, combined sewer outflows, industrial effluent, degraded plastic waste, and atmospheric deposition. Microplastic can enter the treatment and distribution systems of both tap and bottled water. Due to the lack of a standard method for sampling and analysing micro plastics, the comparisons between different studies are difficult, but some basic conclusions can be drawn (A. Oladejo 2017 [2]).

The presence of microplastics in treated tap and bottled water has been confirmed by several studies, which raises questions and concerns about the impact that microplastics in drinking water might have on human health (World Health Organization Repot, 2019 [10]). Microplastic consists of different chemical compositions, shapes, colours, sizes, and densities (J.S. Weis 2020 [13]). There is no scientifically agreed definition of micro plastic, but plastics less than 5 mm are generally considered micro plastic, although most definitions focus on size and composition (P.U. Iyare et al. 2020 [11]). Various polymers of plastic were found in various studies carried out in the past. The polymers that are most frequently found are polyethylene terephthalate (PET) and polypropylene. The detection of the smallest particles

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depends upon the size of the mesh used for sampling. The meshes used in drinking water and fresh water are of different sizes, so the sizes of particles obtained are also different (Lusher et al. [12]).

The use and production of plastic became extensive in the 1940s, and after that, it continued to expand. In the 1950s, the production of plastic was 1.7 million tonnes and it increased to in 2018, 360 million tonnes were produced. It is now the fastest growing urban waste and accounts for approximately 60-80% of all marine debris. There has been a fast increase in the amount of plastic over the past years. At present, the amount of plastic waste that enters annually into the oceans is between 0.48 and 1.27 million tons, and it is expected to be doubled in the next 10 years (Heloisa Westphalen et al. 2018 [7]). The production of plastic in Europe is approximately 49 million tonnes and in the world, it is 322 million tonnes. It is very difficult to quantify the amount of plastic due to the lack of proper sampling and analysis methods (Yolanda Pico et al. 2019 [6]).

Earlier, it was thought that the southern and northern poles were relatively free from the contamination of microplastics. However, recent studies have reported microplastics in the sea waters of the north and south poles (Waller et al. 2017 [22]).

The surface area of the Southern Ocean region of the polar front has a surface area of about 22 million km2, representing 5.4% of the world's oceans. This area is under increasing threat from fishing, the introduction of foreign materials, and pollution, which leads to the rise in sea temperature and ocean acidification (Aronson et al. 2011 [23]). Recent observations from the Arctic showed that remote polar regions were not beyond the reach of microplastic pollution (Lusher et al. 2015 [24]).

Microplastics in soil have increased in recent years, and they are harmful to water. In soil, microplastic is more abundant than in ocean water, and the world's agricultural soils alone could hold more microplastic mass than oceanic surface water (M.S. Helmberger et al. 2020 [18]). The average annual growth in plastic production is estimated to be 8.6% since the 1950s (Jinge Jie Guo et. al. 2020 [20]).

When dumped into the soil, microplastics affect the physical properties of soil such as water holding capacity (W.H.C.), the composition and performance of the soil microbial community, and the soil flora and fauna (de Souza Machado et al., 2018 [16], Lehmann et al., 2019 [17], Rillig et al., 2019 [19]). When petroleum-based consumer-based consumer products, such as fashion items made of synthetic fibers, first appeared on the market in the second half of the twentieth century. Despite the fact that the number of studies on microplastics concentrations in soil environments has increased over the last decade, there is still little knowledge on microplastic concentrations and their relationship to adverse effects (Buks et al. 2020 [9]).

Agricultural producers who use plastic mulch films might risk microplastic contamination by fragmentation of larger foil pieces unintentionally left in the field. Thus, agriculture can be seen as a victim of microplastic pollution on the one hand, but may also play a role as a polluter on the other hand.

Agricultural production is suspected to emit microplastics from soils into aquatic systems. Thus, negative effects might be transferred through agricultural soils to other ecosystems and economic sectors, e.g., fisheries (Henseler et al. 2019 [21]).

Microplastics have been found across the world in soil. They can negatively affect a range of soil organisms through several mechanisms, like other anthropogenic pollutants, and this depends upon particle size, shape, and polymer type (M.S. Helmberger et al. 2020 [18]).

II. POTENTIAL HUMAN HEALTH HAZARDS

The hazards that are associated with micro plastics come in three forms:

- **Particles:** - Particle toxicity depends on size, surface area, shape, and surface characteristics, as well as the chemical composition of microplastic particles.

Particles larger than 150 micrometres are not likely to be absorbed in the human body. There is limited uptake of smaller particles. (W.H.O. Report 2019 [10]).

- **Chemicals:** - Polymerization reactions do not complete during the production of plastic, which results in monomers like 1,3-butadiene, ethylene oxide, and vinyl chloride that can leach into the environment. Biodegradation and weathering of plastic also cause the residual monomers. The micro plastic has a hydrophobic nature and has the potential to accumulate hydrophobic persistent organic pollutants (POP). POPs like polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and organochlorine pesticides (W.H.O. Report 2019 [10]).
- **Biofilms:** - Microorganisms that can make a biofilm around these micro plastics When microorganisms grow on drinking water pipes and other surfaces, biofilms are formed in drinking water.

Most microorganisms in biofilms are considered non-pathogenic but can also be pathogenic, like Pseudomonas aeruginosa, Legionella spp., etc. Biofilm forming microorganisms are attracted more to hydrophobic non-polar surfaces than to hydrophilic surfaces. There is no evidence of harmful effects on the health of humans from these biofilms (W.H.O. Report 2019 [10]).

III. MICROPLASTICS: THEIR ORIGIN AND CHARACTERIZATION

Microplastics come from a variety of sources, including larger plastic debris that degrades into smaller and smaller pieces. Ordinary consumer products are the source of most of the ocean's microplastics, according to the study by the

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International Union for Conservation of Nature (IUCN). That includes textiles, city dust, tires, road markings, marine coatings, personal care products, and engineered plastic pellets (Boucher et.al. 2017 [14]).

Plastics are the most prevalent type of marine debris found in the ocean and great lakes, as per the National Oceanic and Atmospheric Administration (NOAA) of the US Department of Commerce (A. Ballent et al. 2016 [3]). About 0.48 to 1.27 million tonnes of plastic waste enter the ocean annually, and we are expected to see this number double in the next 10 years (Wu, W.M., Yang et al. 2017 [4]). There are various sources of microplastics as under:

- **Synthetic textiles:**

Synthetic textiles are the single greatest contributors to engineered microplastics in the water bodies and oceans, accounting for 35% of the total volume. Polyester, nylon, acrylic, and other synthetic fibres – each a form of plastic – make up 60 percent of the fabric content of our clothes.

Washing synthetic textiles frees engineered microplastics through abrasion and the shedding of fibres from the fabrics. That's due to the mechanical and chemical stresses that fabrics undergo during the washing process in a laundry machine. These fibres, too small for the plant to filter, are discharged with treated wastewater. The fibres eventually find their way to the oceans. Natural fabrics like cotton shed too. But while many natural fibres biodegrade, synthetics don't.

- **City Dust:**

City dust accounts for 24% of microplastics in the oceans and comes from a variety of sources. City dust includes losses from the abrasion of objects like synthetic soles of footwear and synthetic cooking utensils; the abrasion of infrastructure like household dust; artificial turf; harbours and marina building coatings. It also includes particles from the blasting of abrasives, the weathering of plastic materials and the use of detergents.

- **Road Markings:**

Road markings account for 7% of the primary microplastics in the bodies of water. The materials are either spread by wind or washed off the roads by rain before reaching surface waters and potentially the oceans.

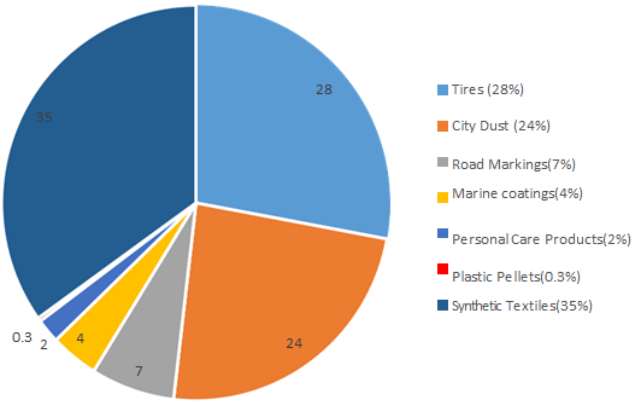

Figure 1: Origin Source of Microplastics [26]

- **Marine Coatings:**

Marine coatings account for 4% of all primary microplastics found in the ocean. Operators apply marine coatings to all parts of seagoing vessels for protection. That includes the hull, the superstructure and on-deck equipment. The materials involve solid coatings, anticorrosive paint, or antifouling paint. Weathering and spills during application, maintenance, and disposal of these coatings cause the release of primary microplastics.

- **Personal Care Products**

Many personal care and cosmetic products contain a type of engineered microplastic known as microbeads. The products include scrubbing agents, shower gels, and creams.

- **Plastic pellets:**

Manufacturers produce several plastics in the shape of pellets or powders, the primary form of plastic. These producers then transport the pellets to plastic transformers that make plastic products. Basically, there are two characterizations of microplastics based on how they are produced:

(a) Primary microplastics:

This class of microplastics includes plastic pellets, nurdles, and microplastic scrubbers, which are manufactured and used as cosmetics, abrasives, and exfoliating cleansers.

(b) Secondary Microplastics:

This category of microplastics includes plastics from wear and tear, abrasion degradation, and the breakdown of large plastic debris. Fragmentation of larger plastic materials results in the formation of secondary plastic debris (Cole M. et al. 2011 [15])

IV. SAMPLING SITE

Kuntbhyog lake, Rewalsar Lake and the Suketi River were chosen for analysis. Sampling was performed in the month of March 2021. A total of 12 samples were taken from Kuntbhyog lake, 6 from lake water and 6 from bank soil. Six

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samples were taken from Rewalsar lake, 3 from water and 3 from bank soil. Twenty Suketi river samples were collected from various locations, ten from the water and ten from the bank soil. The first sample was taken from the village of Thather, near the Poly Houses, and the last sample was taken from Mandi, where the Suketi Khad meets the Beas River.

Figure 2: Plastic waste Kuntbhyog Lake

V. METHODOLOGY

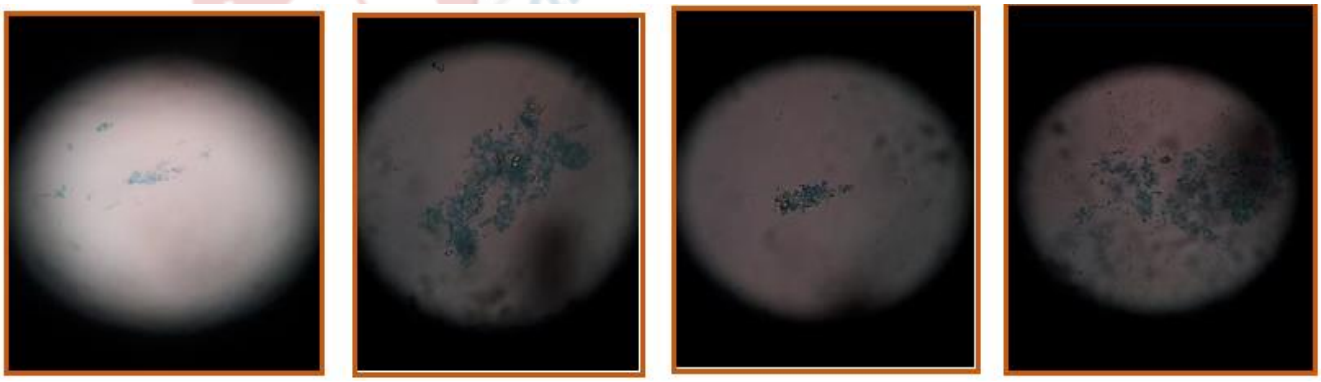
Microplastics were filtered out from the different water and soil samples using wet peroxide oxidation (WPO) and density separation methods. The residue collected on the filter paper was transferred to glass slide and observed under microscope with 40X and 60X magnification lens.

VI. RESULTS AND DISCUSSIONS

The images of microplastics observed under the microscope are shown in the Figure 3 below. From various research papers, it was observed that microplastics can be divided into various categories according to shape and size as they can have various shapes like fragments, fibres, pallets etc. and can be of various sizes ranging from 5mm to 1 micron. So, the microplastics are divided accordingly.

VII. CONCLUSION

In this research, microplastics were found in the surface water samples and sediment samples taken from the Suketi river from different sampling points. Moreover, no microplastics were found in samples of Kuntbhyog and Rewalsar lakes. Because most sampling points were chosen downstream from the adjacent garbage dumping and segregation site, plastics were mixed with Suketi river, which disintegrated over time and converted to fine fragments and fibres of plastic, also known as microplastics. The amount and size of microplastics depends on the depth of sampling. More the depth, smaller the size of microplastics that can be found depending upon the type of microplastics and their densities. Fragments and flakes were the most abundant types of identified microplastics at the sampling site. These microplastics are harmful to human health and also to aquatic life as they can eat the plastic, which they might think is food, and eventually die. Hence, this study will give knowledge about the major concern of microplastics, which need to be focused on and prevented before posing any severe threat to human health and can also cause the extinction of aquatic life, which in turn disrupts the food chain and may lead to hazardous bioaccumulation.



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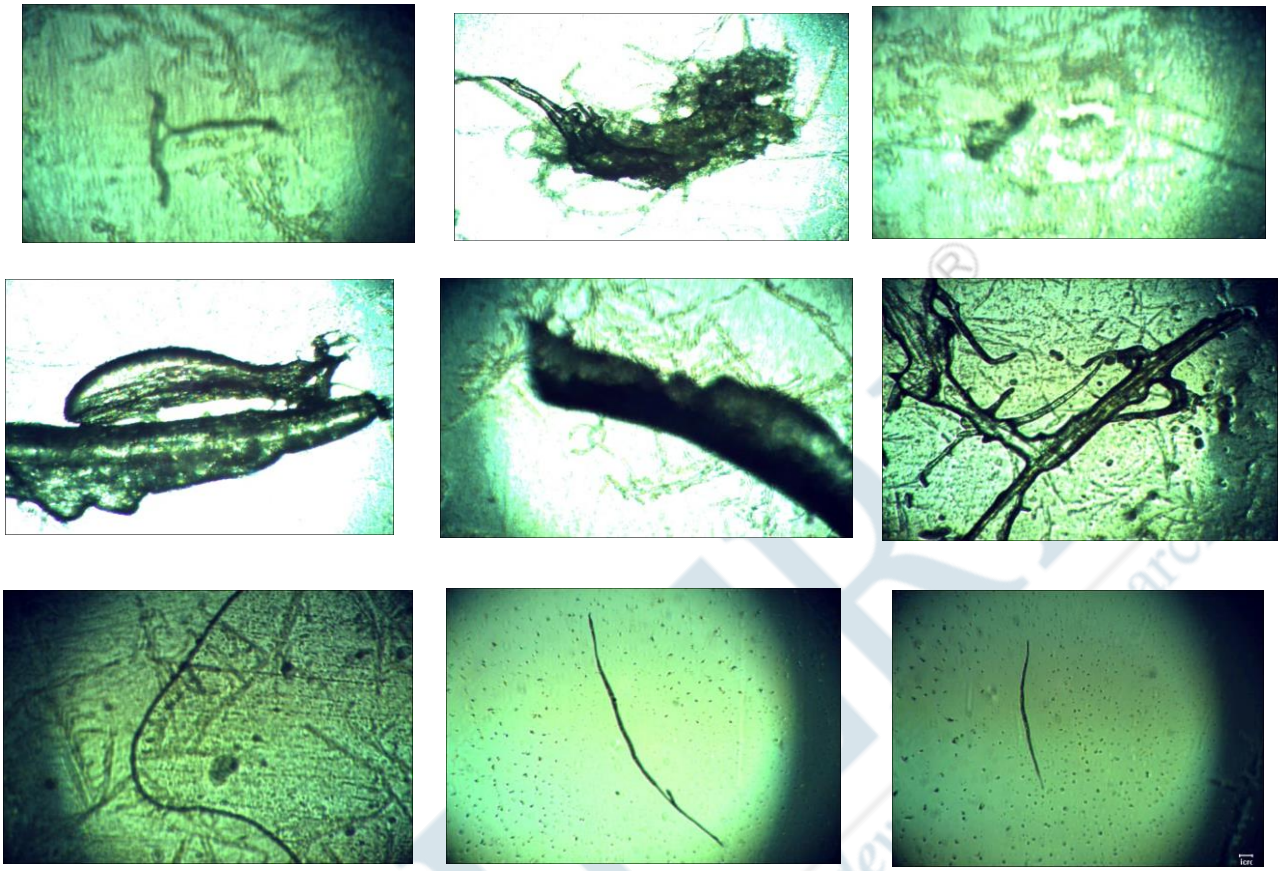

Figure 3: Microplastics in samples taken from Suketi river observed under microscope

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