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SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

Project Presentation On “Microplastics Analysis in River Water”

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Introduction

- ▶ Plastics an extremely versatile resource whose production levels have increased dramatically.
- ▶ The properties of plastic that make it such an attractive material during use also make it problematic when it becomes waste.
- ▶ The primary issue is that it is highly resistant to degradation.
- ▶ There is no technical standard that would require biodegradable plastic to degrade fully within a relevant time frame in the marine environment.

Microplastic

- ▶ Microplastics are tiny plastic particles that result from both commercial product development and the breakdown of larger plastics.
- ▶ As a pollutant, microplastics can be harmful to the environment and animal health.
- ▶ Microplastics, as the name implies, are tiny plastic particles they are defined as plastics less than 5 millimeters (0.2 inches) in diameter
- ▶ Microplastics are present in a variety of products, from cosmetics to synthetic clothing to plastic bags and bottles. Many of these products readily enter the environment in wastes.
- ▶ Microplastics consist of carbon and hydrogen atoms bound together in polymer chains.

Different Images of Microplastics



Sources of Microplastic

- ▶ Microplastics can either be manufactured (use in cosmetic scrubs, toothpastes, and cleaning products), or can result from the fragmentation of larger items of plastic debris.
- ▶ They are everywhere throughout the marine environment and have been found in river, lakes, coasts, sediments, the open ocean, deep seas.
- ▶ When pieces become small, fragmented and degraded they are almost impossible to trace to their original source.
- ▶ The three largest sources are thought to be fibres from textiles, microbeads and large pieces of plastic debris which will become microplastics as they fragment and degrade.

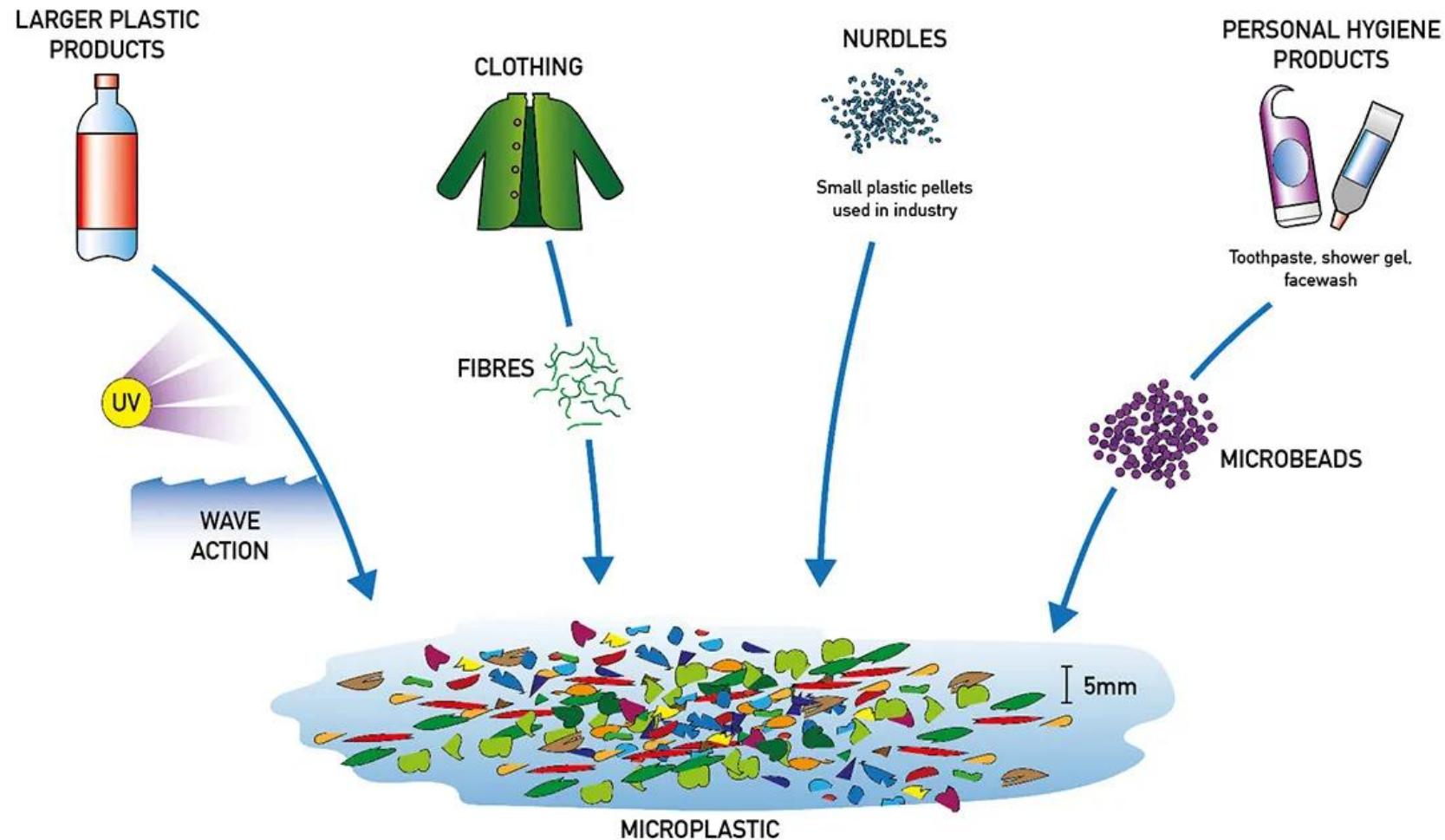


Fig : Formation Of MicroPlastics [2]

Categories of Microplastics:

1. Primary Microplastics
 2. Secondary Microplastics
- ▶ Primary microplastics are tiny particles designed for commercial use, such as cosmetics, as well as microfibers shed from clothing and other textiles, such as fishing nets.
 - ▶ Secondary microplastics are particles that result from the breakdown of larger plastic items, such as water bottles. This breakdown is caused by exposure to environmental factors, mainly the sun's radiation and ocean waves, wind abrasion.

Effects of Microplastics

- ▶ The reduced size of microplastic makes it easier for intake by aquatic organisms , disturbing their physiological functions.
- ▶ The presence of high concentrations of microplastics in beach sediments can change their permeability and heat absorbance
- ▶ Microplastics that are unintentionally ingested by humans can be subsequently transported into tissues.
- ▶ Human exposure to microplastics could lead to oxidative stress, DNA damage and inflammation.
- ▶ Pieces of microplastic can provide a surface on which marine insects can lay their eggs.

Literature Review

Sr. No	Author Name	Title of Paper	Year of Publication	Remarks
1	Surya Singh, Madhanraj Kalyanasundaram & Vishal Diwan.	Removal of microplastics from wastewater: available techniques and way forward	2021	Discussed the existing and upcoming treatment technologies for the removal of microplastics from wastewater
2	Kristina Borg Olesen & Stefan Anderberg	Microplastic Types in the Wastewater System—A Comparison of Material Flow-Based Source Estimates	2021	A Comparison of Material Flow- Based Source Estimates and the Measurement-Based Load to a Wastewater Treatment Plant

Literature Review

Sr. No	Author Name	Title of Paper	Year of Publication	Remarks
3	Thuhin K. Dey & Md. Elias Uddin & Mamun Jamal.	Detection and removal of microplastics in wastewater: evolution and impact	2021	A critical study on the effect of microplastics on aquatic organisms and human health is discussed
4	Rana Zeeshan Habib, Thies Thiemann	Microplastics and Wastewater Treatment Plants.	2020	In this research, Problems associated with the utilization of microplastic loaded sewage sludge

Literature Review

Sr. No	Author Name	Title of Paper	Year of Publication	Remarks
5	Mohammed S. M. Simone Kefer , Julia Reichel	Validation of Sample Preparation Methods for Microplastic Analysis in Wastewater Matrices— Reproducibility and Standardization	2020	This study was to develop a sample preparation method for wastewater samples, which removes natural organic matter without altering the properties of microplastics.
6	Jing Sun & Mark C.M.	Microplastics in wastewater treatment plants: Detection, occurrence and removal	2018	The up-to-date status on the detection, occurrence and removal of microplastics in WWTPs were comprehensively reviewed.

Literature Review

Sr. No	Author Name	Title of Paper	Year of Publication	Remarks
7	Abiola Oladejo	Analysis of microplastics and their removal from water.	2017	In this research, Removal of microplastics from water was studied using extraction with oil

Objectives

1. Identification of microplastics content in river water.
2. Identification of type of microplastics.
3. Identification of impacts of MPs on human health.
4. Suggestion of best possible method to treat microplastic in water

Methodology

- ▶ In order to conduct this Analysis, waste water sample is used to :
 1. Study methods of analysis and techniques to remove microplastic.
 2. Impacts of MPs on human health.
 3. Selection of source for water sample.
 4. Analysis of Sample Water.
 5. Analysis of Microplastic content.
 6. Results and Discussions.

Methods of Analysis

- **Visual Identification**
- Identification of large size range of microplastics also small plastics,
- Sorting
- Colourful plastic fragments
- Pre-production Resin Pellets(Size 2-5 mm)
- Identification of large microplastics offers an easy, simple and fast by Eye



Methods of Analysis

- **Microscopy**
- To view samples & objects that cannot be seen with the unaided eye
- Essential tool for measuring the physical characteristics of microplastics
- Provide detailed surface texture and structural information of objects
- Size range are usually identifiable particles of the sub-hundredmicron size range
($< 100 \mu\text{m}$) with no colour
- Biogenic materials from sediment also make microscopic observation difficult



Image : Microscopy Device

Methods of Analysis

- **FTIR**
- ▶ Fourier Transform Infrared (FTIR) spectroscopy
- ▶ Polymers are easily identified
- ▶ Well-established polymer spectrum library Presents
- ▶ Enables not only confirmation of plastics, but also identification of specific polymer types
- ▶ Non-destructive to plastics
- ▶ Fast and reliable
- ▶ Detection limit down to 20 μm
- ▶ Data on polymer composition

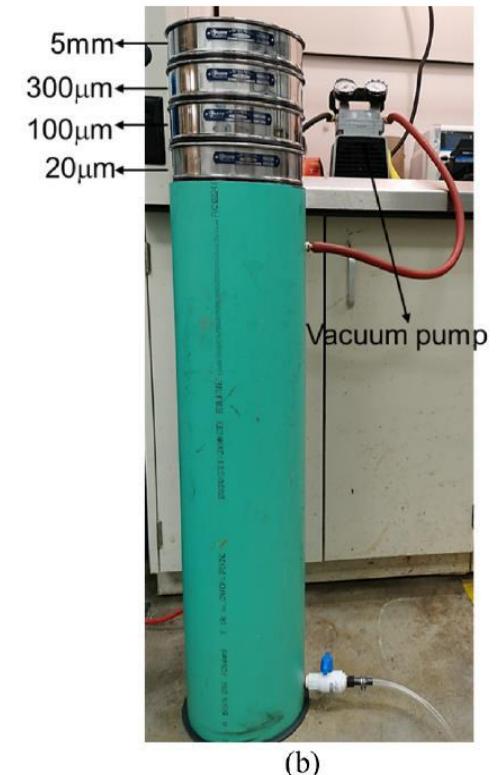


Image : FTIR Device

Techniques to Remove Microplastic...

➤ Vacuum Filtration

- ▶ Water could be filtered through a 20 µm sieve.
- ▶ Solubilization of non-MP particulate organics and the dissolved organics can be removed
- ▶ In this Removal technique,
- ▶ a) Solids and MPs recovered from water by stainless-steel sieves with pore sizes of 300 µm, 100 µm and 20 µm.
- ▶ b) Vacuum apparatus used to accelerate MP collection.



Techniques to Remove Microplastic...

- **Algal masses.**
- Sorption of microplastics on algae surface strongly depends on particles surface charge.
- Microalgae may offer a possibility for the removal of microplastics.
- Due to narrow channels in the algal cells, the movement of microplastics was restricted and thus the plastic particles were captured.
- Microalgae colonize microplastic particles
- Major mechanism for the sorption of microplastic particles onto algal Surface is electrostatic charge
- Positively charged particles sorb more onto algae due to presence of anionic polysaccharide substance in algal cell wall

Techniques to Remove Microplastic...

- **By magnetic extraction**
 - ▶ More likely to separate MPs from wastewater
 - ▶ Included magnetic seeds (Fe nanoparticles), oxalic acid (as Fe di-sorbent), and external magnetic attraction to separate MPs from seeds..
 - ▶ Almost 92% of PS and PE beads with a range of 10 to 20 μm can be removed.
 - ▶ MPs of a smaller size (less than 1 mm) have been removed up to 93%.
 - ▶ MPs were removed from the sediment and fresh water

Techniques to Remove Microplastic...

➤ By membrane filtration

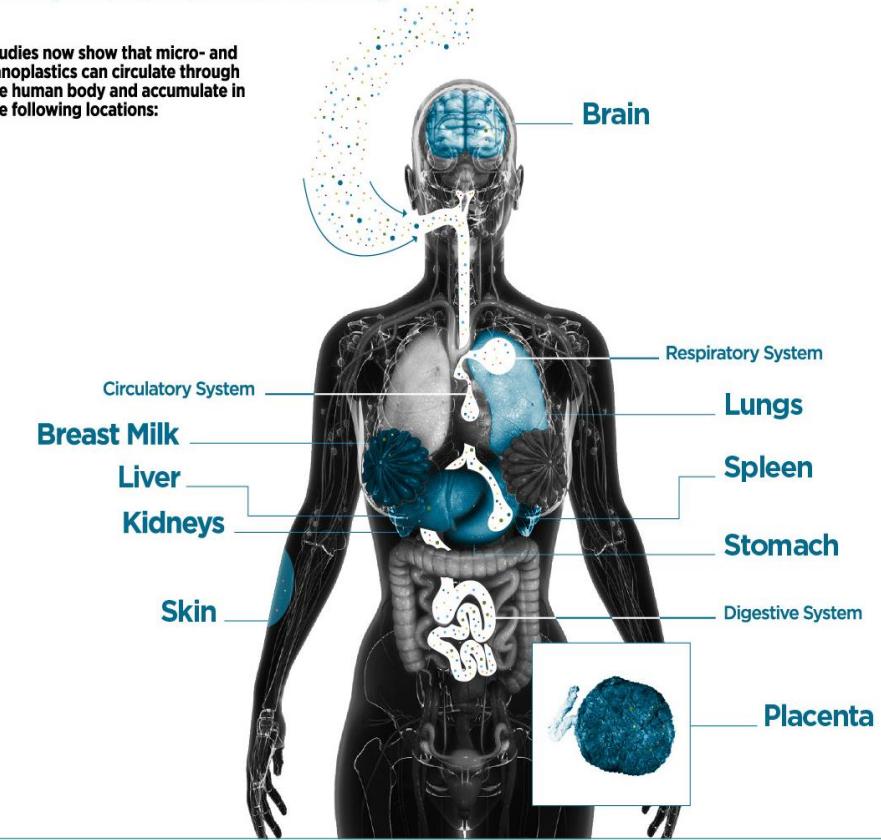
- ▶ Membranes with a uniform pore distribution have been widely applied during waste water treatment
- ▶ The electrostatic interactions between microplastics and ultrafiltration members were detrimental for the performance infiltration
- ▶ Microplastics particle size was larger than ultrafiltration membrane pore size
- ▶ Microplastics were adsorbed within and onto pore size or onto the membrane surface at high rate

Identification of impacts of MPs on human health

- ▶ Microplastics have been found in different foods such as fish and seafood, table salt, beer, honey and sugar, and tap water.
- ▶ The studies show that the human person eats at least 50,000 microplastic particles every year because of the infiltrated food chain, drinking water, and breathing air
- ▶ Microplastics could lead to Oxidative stress, DNA damage, Inflammation, Neurotoxicity, Reproductive toxicity, Disruption of immunity
- ▶ It is very important to reduce throwing of plastic waste on the ocean and landfill to avoid the effect of microplastic on the human health.

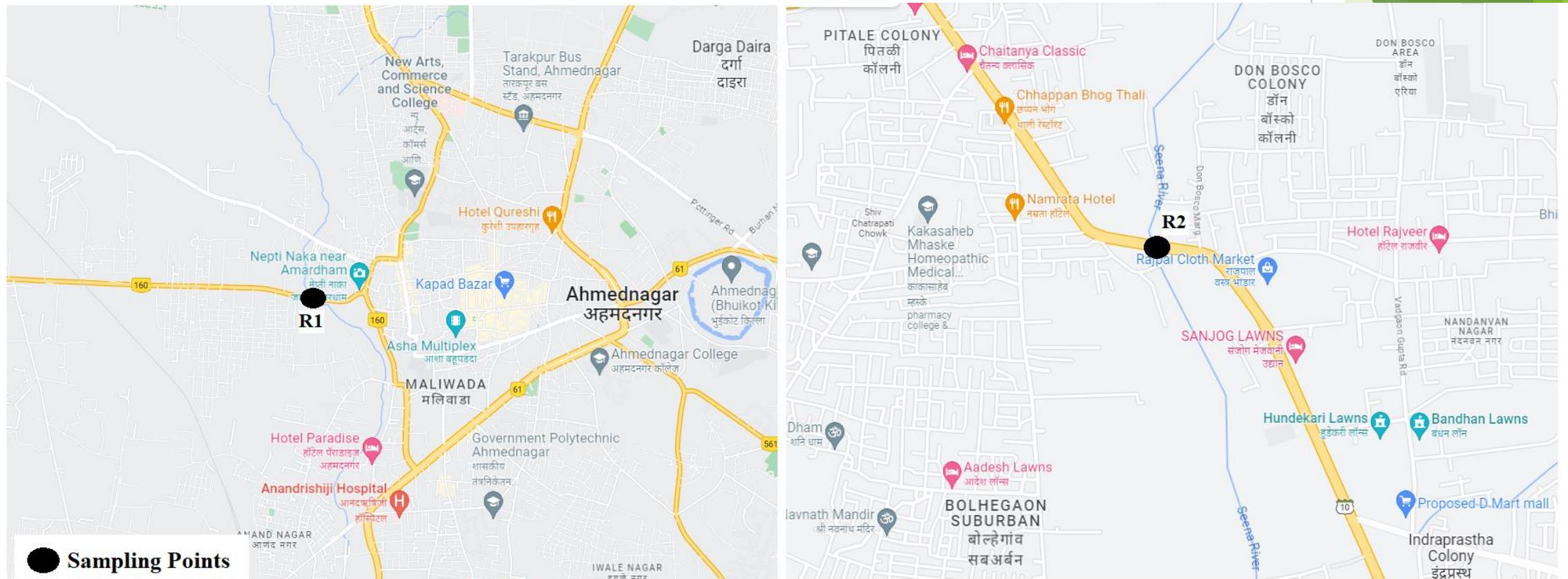
Microplastics in the Human Body

Studies now show that micro- and nanoplastics can circulate through the human body and accumulate in the following locations:



Selection of source for water sample

- ▶ Location 1 : Sina River (Near Nepti Naka, Ahmednagar)
- ▶ Web Co-ordinate : 19.0949769, 74.7265809



(Source: Google Map)

Selection of source for water sample

- ▶ **Location 2 :** Sina Dam, Karjat, Ahmednagar
- ▶ **Web Co-ordinate :** $18^{\circ} 49' 28.79''$ N, $74^{\circ} 56' 26.89''$ E



Source: Google Map

Sampling at Selected Location 1

- **Sina River** is a one of larger tributary of the Bhima River which originate near Ahmednagar city at Sasewadi.



Sampling at Selected Location 2

- ▶ Sina Dam, is an earthfill dam on Sina river near Karjat in Ahmednagar district in the state of Maharashtra in India.
- ▶ Due to Large area of dam we take 2 Samples from different locations of Dam



Analysis of Sample Water

- ▶ For analysis samples are collected from different location of Sina River.
- ▶ Various initial tests are taken to identify the different physical and chemical properties of sample.
- ▶ In tests, pH Value, Dissolved Oxygen, Turbidity.

Parameters	Standard	Outcomes				Remark
		R ₁	R ₂	D ₁	D ₂	
pH	7.5-8.5	10	9	8	8	Alkaline
DO	3-7.5 ppm	2	2	7.5	7.4	Flooding ,Even Death
Turbidity	<5 NTU	10	9	2	2	Difficult to Breathe

Table . Test Results with Standards

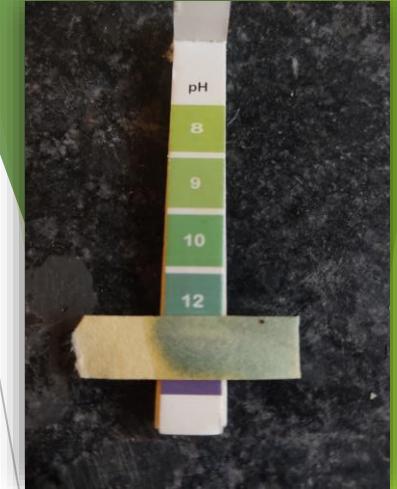


Image : Basic test on water sample at lab.

Analysis of Microplastics Content

- ▶ Provided samples were sieved through 5-mm sieve to eliminate larger particles and to retain particles of < 5 mm size
- ▶ The samples were treated with 5 ml of 30% H₂O₂ in order to degrade the organic matter.



Analysis of Microplastics Content

- ▶ The samples were allowed to settle for 24 h to achieve density separation. The clear supernatant was then filtered through 5 Micron Filter
- ▶ The filter were dried for 15 min before further examination
- ▶ The Partical were trapped in filter which are Collected by Using Distilled Water



Analysis of Microplastics Content

- ▶ Then this Sample is Placed In Sunlight Until sample not get dry. Proper Arrang ment is taken during evaporation for getting sample intact.The filter were dried for 15 min before further examination
- ▶ Collected Samples are Separate Out by their size, shape, colour Under Microscope
- ▶ The Collected Sample is Analysis under Fourier transform infrared (FTIR) spectroscopy for Identify and characterize unknown materials



Analysis of Microplastics Content

- ▶ For Analysis of Microplastic content we select a **Fourier Transform Infrared (FTIR) spectroscopy**
- ▶ Analysis is Done at Chemistry Department of SPPU



Best Possible Method to Treat Microplastic in Water

- ▶ There are different methods which are useful for remove microplastics. The following methods which are mostly used to treat microplastics for river water
- ▶ There are different methods which are useful for remove microplastics. The following methods which are mostly used to treat microplastics for river water

Sr No	Parameters	Methods of Removal			
		Vacuum filtration	Algal masses	Magnetic extraction	Membrane filtration
1	Efficiency(%)	98	94.5	93	95
2	Lowest size of microplastic particle removed(μm)	5	20	10-20	20-190

3	Speed of Removal	High	Low	Moderate	Medium
4	Maintenance	Less	NA	More	More
5	Installation cost	Moderate	less	low	Moderate
6	Lifespan	More	Less	Less	Moderate
7	Area Required	less	More	Moderate	More
8	Advantages	Separate out the microplastic with different sizes	No chemical, electrical,& mechanical operations	Remove small microplastic	Low filtration resistance

- ✓ After above study of different methods which are useful for removal of microplastic for river water, the vacuum filtration is one of the most effective and efficient method for treat Microplastic

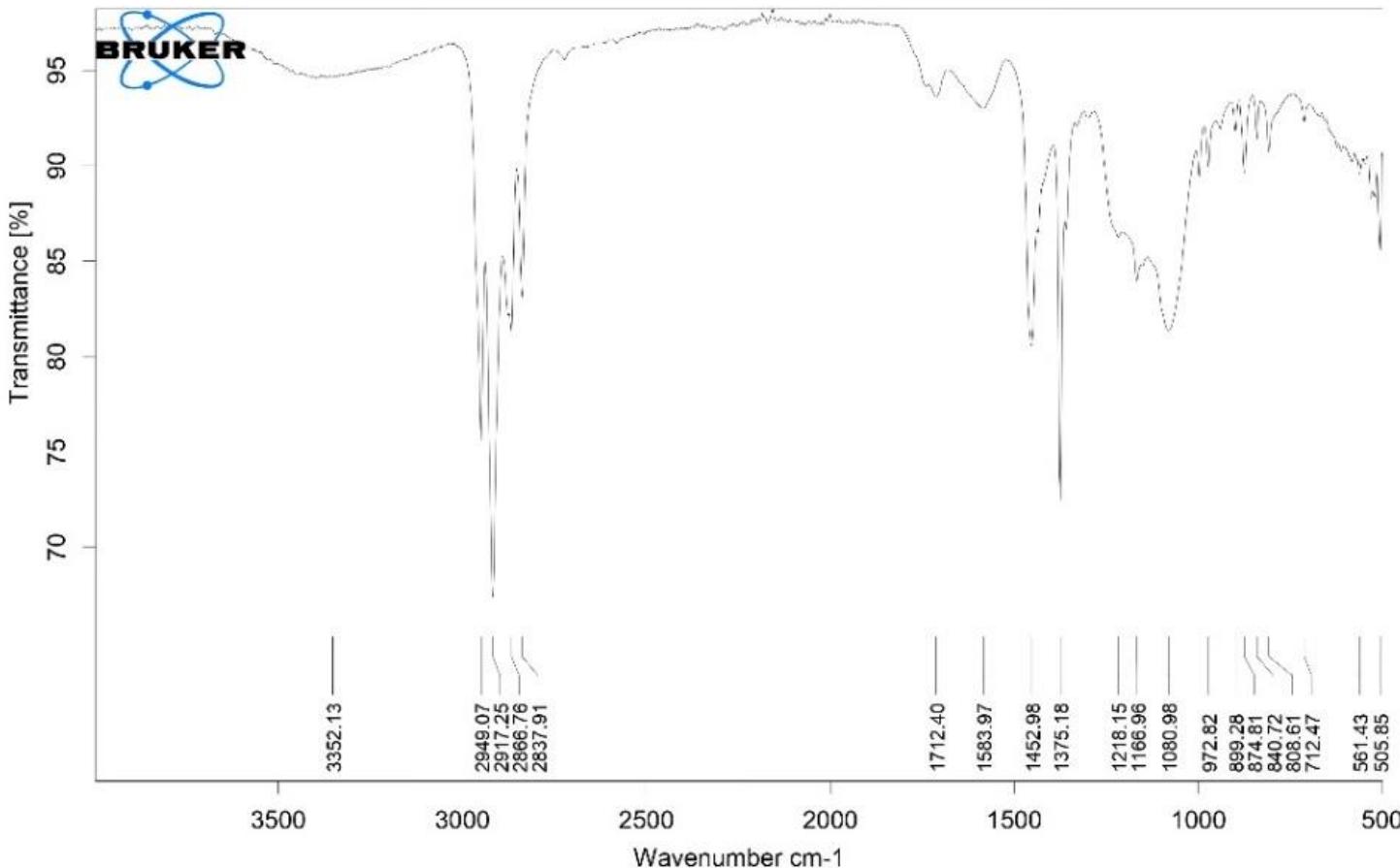
Results And Discussions

- ▶ Floating microplastics were present in all surface water of river and dam also present in surrounding of them.
- ▶ The average number and concentration of the microplastics for 4 stations as in average was 34.5 pieces per stations.
- ▶ The highest concentration of microplastics were found at R₁ with 43 pieces. The lowest concentration of microplastics found was as D₂ with 23 pieces.

Table - FTIR identification of selected microplastics (5 mm-300um)

Sr. No	Locations	Microplastic numbers			Total number
		5mm – 300um	300um – 100um	100um – 20um	
1	R ₁	15	20	8	43
2	R ₂	17	13	11	41
3	D ₁	5	17	9	31
4	D ₂	9	11	3	23

Graph -FTIR spectroscopy spectra of the microplastics (5 mm–300 um) collected in the river



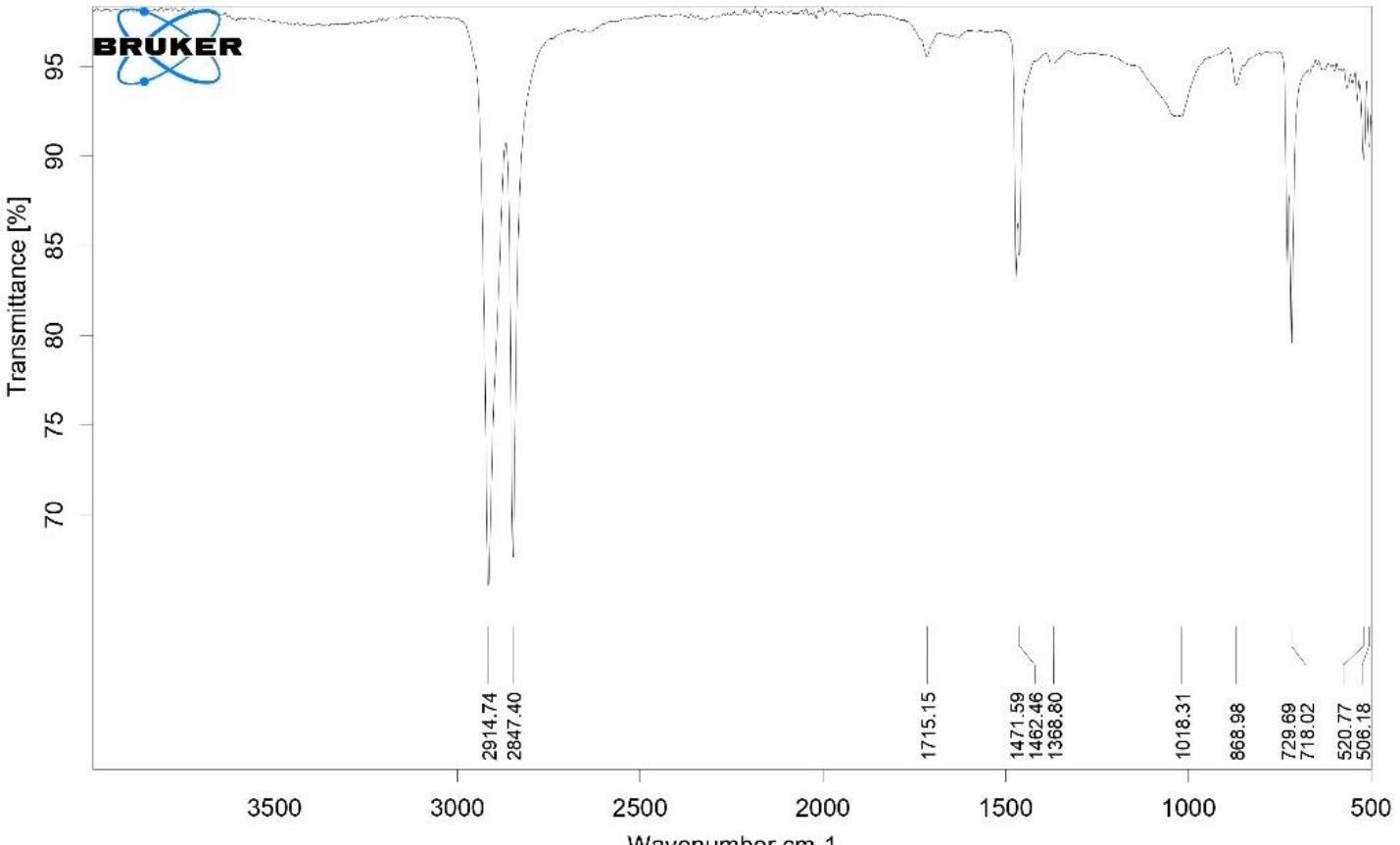
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Graph -FTIR spectroscopy spectra of the microplastics (5 mm–300 um) collected in the Dam



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Station	Polymer (% match)	Characteristic band (cm ⁻¹)
R ₁	PP (96), PE (97), LDPE (97)	PP: 2952, 2844, 2911, 1458, 1372,
R ₂	PP (96), PS (96), PE (97), LDPE (97)	PE, LDPE: 2911, 2847, 1467, 720
D ₁	PP (96), PE (97), LDPE (97)	
D ₂	PS (96), PP (96), PE (97), LDPE (97)	PS: 3022, 2911, 2844, 1647, 1502, 1439, 1024

- ▶ From observed pieces, most polymers found in the study area were Polypropylene (PP) and Polyethylene (PE), low density PE (LDPE), and Polystyrene (PS) were shared with equal percentage
- ▶ PP is indicated by the prominent presence of the 2949.07 cm⁻¹, 2837 cm⁻¹, and 2917 cm⁻¹ absorbing groups. The spectral assignments correspond to bands 1458 cm⁻¹ and 1372 cm⁻¹
- ▶ LDPE was characterized by high CH₃ methyl groups, shown by an intense 1375 cm⁻¹ peak. LDPE might be indicated by the presence of 1713 cm⁻¹, 1178 cm⁻¹ and 1631 cm⁻¹ bands that correspond to the carbonyl group

Conclusion

1. After the analysis of different water samples we found that there is presence of microplastic in Sina River as well as in Sina Dam.
2. After analysis of water some major types of microplastics are found in both Sina River as well as Sina Dam like Polypropylene (PP) and Polyethylene (PE), low density PE (LDPE), and Polystyrene (PS).
3. The occurrence of microplastics in river and their impacts on humans are important issues to be addressed. It was found from the literature survey that the human person eats at least 50,000 microplastic particles every year. Still, there is not enough data that help to know how microplastics affect humans. However, there are some solutions to eliminate the effect of microplastics on the humans and animals.
4. After the overall study of removal microplastic we conclude the till the date the vacuum filtration is best, easy and effective method to remove microplastic through water.

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THANK YOU...