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Session I: Preventive Measures of Plastic Pollution

Use of Recycled Plastic Materials in Roads and their Potential for Microplastics Release

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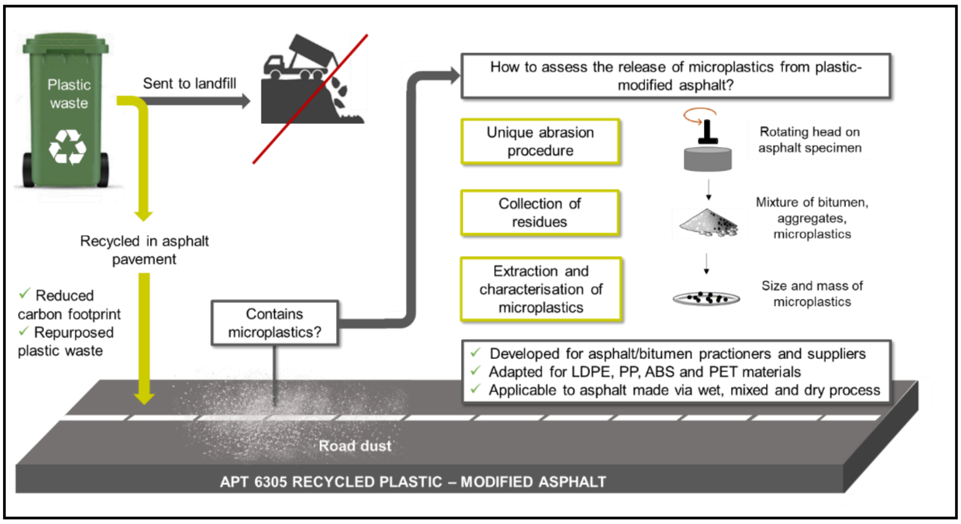
Keywords: asphalt roads; bitumen; recycled plastics; microplastics

Graphical Abstract



Abstract

A total of 3.5 million tonnes of plastics were consumed in Australia for the 2018-19 financial year. 11.5% of the consumed plastics were recycled (locally and exported) while the rest were sent to land fill. With the national ban on plastic exports, alternative methods to deal with waste plastics must be implemented for a sustainable future. In this context the Transport and Infrastructure Council of Australia, which bring together Australian and New Zealand transport ministers, has funded a large research project on recycled plastics in asphalt roads (Austroads Project APT6305). The project is investigating the benefits, methodologies, testing frameworks, and performance-based specifications for incorporating recycled plastics into asphalt.

All around the world, road authorities are trying to incorporate recycled materials in roads; but

more stringent environmental requirements are coming into place that ask scientists to also evaluate new aspects of these technologies. In fact, although fostering recycling in roads can be seen as an effective measure to reduce the infrastructure's carbon footprint, there are many aspects that have never been studied before. In the case of recycled plastics, for instance, there are concerns around the possible generation of microplastic particles due to weathering and trafficking. The analysis of the composition of road dust has just started to be evaluated by some research studies and no standards or universal testing frameworks are available yet.

In particular, the release of microplastics from plastic-modified asphalt has not been investigated although constituting a potential threat for the environment due to the known toxicity of microplastics. A unique abrasion procedure has therefore been developed for practitioners and suppliers to benchmark the release of microplastics from different types of plastic-modified bituminous materials. The abrasion conditions of an asphalt sample submerged in water were optimised based on the test duration, system temperature and water pH to yield a measurable amount of microplastics and ensure the accuracy and reproducibility of the test. Optimum conditions were obtained for a test duration of 20 min, a temperature of 5 °C and a water pH of 7. The suitability of the hose material generating abrasion by rotating on the asphalt sample was also assessed and a stainless-steel hose was selected at the expense of a rubber hose, which was quickly damaged during the test. The extraction of microplastics from the mixture of bitumen, aggregates and plastics generated by the abrasion test was performed by dissolving the bitumen in toluene and separating the microplastics from the aggregates via density separation in dichloromethane. The collected microplastics were then fractionated through four filters into 0.45 – 3 µm, 3 – 38 µm, 38 – 368 µm and > 368 µm size range. Up to 4.5 g of residues were collected after the abrasion of 800 g LDPE-modified asphalt sample, among which 12 mg was made of microplastic, most of which falling within the 3 – 38 µm and > 368 µm size range. The extracted microplastics were finally analysed via staining and fluorescence microscopy, which confirmed the efficiency of the extraction procedure to separate microplastics from bitumen and aggregates.

Biography

Associate Professor Filippo Giustozzi is an expert in road and airport pavement materials. He completed his second Ph.D. at Virginia Tech University (USA) and is now the Chair of the Technical Committee on Sustainable and Resilient Pavements at the Transportation Research Board of the National Academies of Sciences and Engineering in the USA. He has participated in several major road and airport construction projects since 2008. Dr. Giustozzi is the Lead Investigator of the national Austroads project APT6305 on Road-grade recycled plastics for sustainable asphalt pavements, approved by the Transport and Infrastructure Council that brings together Commonwealth, State, Territory and New Zealand Ministers. He also collaborates with several industry associations and contractors on a variety of research and field projects, mainly on polymer-modified bitumen and recycled materials for road applications. At RMIT University, he is leading the Intelligent Materials for Road and Airport Pavements research group and has developed the only university-based fully equipped asphalt and bitumen laboratory in Australia, which currently employs more than 20 researchers.

Dr Marie Enfrin has been a Postdoctoral Research Fellow at RMIT from January 2021. She completed her PhD in chemistry and chemical engineering at the University of Surrey, UK, and Deakin University, Australia. Her research interests lie in the field of microplastic pollution, from their generation to their release and impact on aquatic and terrestrial ecosystems. She is currently a member of A/Prof. Filippo Giustozzi's research group where she is investigating the environmental impact of using recycled plastic waste in sustainable asphalt pavements.

Microplastics in the agroecosystem: An emerging threat to the plant and soil health

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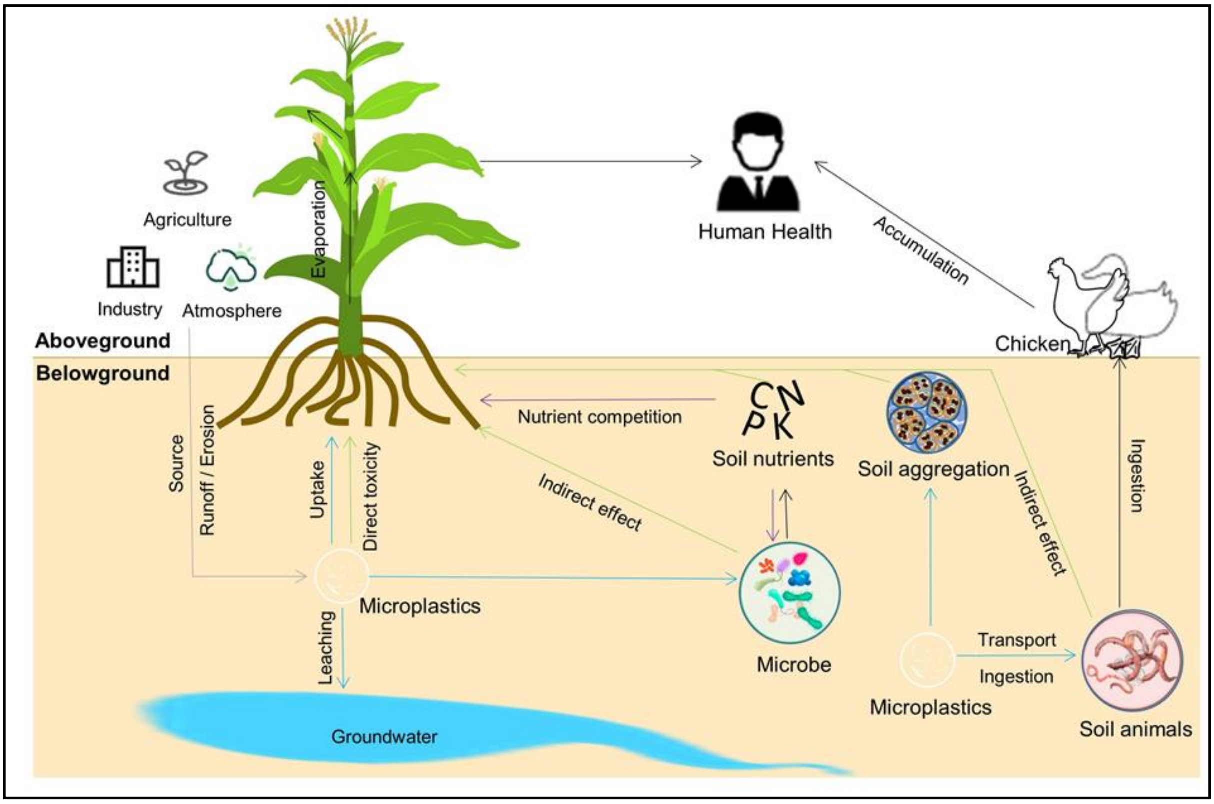
Keywords: Microplastics, plant growth, soil carbon storage, nutrient cycling, greenhouse gas emissions, biodegradable plastics, agroecosystem

Graphical Abstract



Abstract

Thin plastic mulch films (4–8 μm thick) are widely used in agroecosystems to improve crop growth and water use efficiency. Although extremely effective, after crop harvest they are notoriously difficult to recover from soil and are rarely recycled and fragmented consequently by tillage and UV radiation. Of these, microplastics (MPs; particles <5 mm in diameter), typically formed from the disintegration of larger plastic debris, are thought to be the most environmentally damaging. Due to our poor understanding of MPs behavior in soils, it is currently not possible to make informed decisions on future policies relating to the use and disposal of agricultural plastics. Based on current evidence, we aim to evaluate whether MPs represent an emerging threat to plant-soil health in agroecosystems. We assess the ecological risks to plant-microbe-soil interactions associated with MPs and discuss the consequences of MPs on soil carbon (C), nutrient cycling, as well as greenhouse gas emissions in agroecosystems. We also identify knowledge gaps and give suggestions for future research. We conclude that MPs can alter a range of key soil biogeochemical processes by changing its

properties, forming specific microbial hotspots, resulting in multiple effects on microbial activities and functions. Because of the diverse nature of MPs found in soils, in terms of polymer type, shape and size, we also see differing effects on soil organic matter (SOM) decomposition, nutrient cycling, and greenhouse gases production. Importantly, increased bioavailable C from the decomposition of biodegradable MPs, which enhances microbial and enzymatic activities, potentially accelerates SOM mineralization, and increases nutrient competition between plant and microbes. Thus, biodegradable MPs appear to pose a greater risk to plant growth compared to petroleum-based MPs. Although MPs may confer some benefits in agroecosystems (e.g. enhanced soil structure, aeration), it is thought that these will be far outweighed by the potential disbenefits.

Biography

Huadong Zang works as an associate professor at China Agricultural University (CAU) since 2018. Before joining CAU, he obtained PhD at the University of Goettingen and works as a PostDoc at Bangor University. He has wide experience in agronomy and soil science, and extensive experience in ^{13}C natural abundance techniques and multiple stable/radioactive isotope (^{13}C, ^{14}C, ^{15}N, ^{18}O) labeling approaches. His past research focused on N and C cycles in the plant-soil system, specifically, how N fertilization, temperature, and crop management influence C sequestration, organic matter stabilization, turnover, and priming effects in the agroecosystem. His current research interests in investigating C and nutrients cycling, as well as the plant-plant and plant-microbial-soil interactions in diversified cropping systems and agroecology. In his work he uses a combination of methods including on-station and on-farm experiments, isotopic labeling, zymography, and molecular techniques.

Removal of Microplastics by Advanced Nanomaterials

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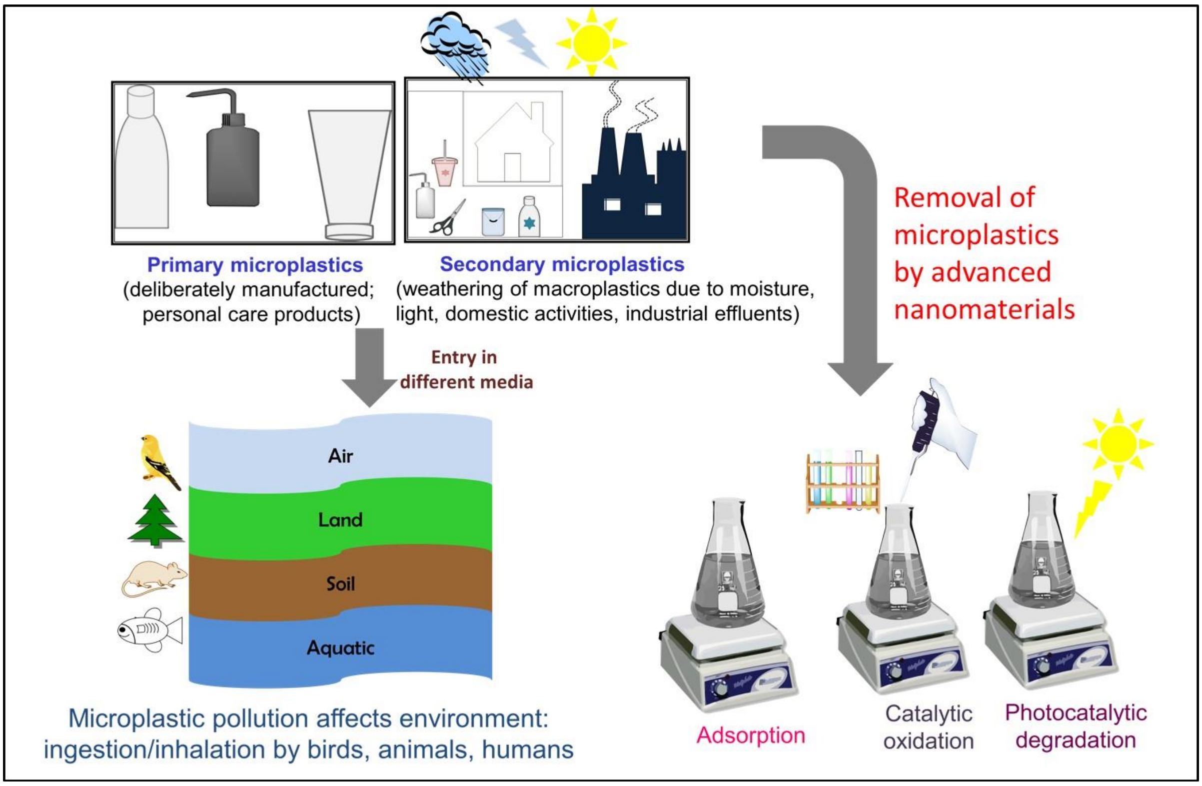
Keywords: Microplastics; environment; adsorption; photocatalytic degradation; catalytic oxidation.

Graphical Abstract



Abstract

Microplastics (MPs) are light-weight plastic particles (size < 5mm), that are ubiquitous in the environment having various compositions, shapes, morphologies, and textures. The adsorption of several deadly contaminants occurs on the surface of MPs because of their hydrophobic nature and large surface area/volume ratio. The ingestion of micron-sized MPs is hazardous to living beings especially marine species, birds, animals, and soil creatures. Human exposure to MPs is also unquestionable because of their presence in the air, indoor dust, food items, etc. Understanding the gravity of the situation, it is imperative to take severe steps against the menace of MPs. Removal methods like adsorption, catalytic and photocatalytic degradation are the techniques that utilize advanced nanomaterials for the eradication of MPs. The change (reduction) in polymer weight implies the degradation of the polymer and additionally FTIR and SEM analysis are the characterization techniques, used to identify the changes in the structural and morphological features of MPs after the disintegration. Adsorption technique

employing magnetic adsorbent promises to remove ~100% MPs whereas biodegradable catalysts can eliminate ~70-100% of MPs. Catalytic degradation through advanced oxidation facilitated by $SO_4^{\bullet-}$ or $OH^{\bullet}$ radicals (generated by peroxymonosulfate or sodium sulfate) is also an effective system for the elimination of MPs. Photocatalytic degradation using diverse materials like TiO_2 based catalysts like ZnO-based catalysts, nitrogen-doped, carbon-doped TiO_2, Au@Ni@TiO_2, etc., has also been widely reported in the literature. The thorough analyses of removal efficiency, advantages, and disadvantages of the contemporary nanomaterials for the removal of MPs can be beneficial in this regard for fabricating much more efficient materials as well as for advancements in the technologies to achieve complete elimination of MPs. Largely, the reusability and cost factor of nanomaterial to be utilized as adsorbent/catalyst determine the commercial viability. The economical, as well as environmentally benign synthesis approaches, should be targeted to achieve a versatile catalyst. Relentless efforts concerning plastic regulation are crucial to completely clear out this problem from the environment.

Biography

Dr. Soumen Basu was born in West Bengal, India in 1980. He received the B.Sc. degree (Chemistry Hons.) from Vidyasagar University, India in 2001, the M.Sc. degree (Inorganic Chemistry) from the same university in 2003 and the Ph.D degree from Indian Institute of Technology, Kharagpur, India in 2008. He did his first postdoctoral research from University of Alabama, USA (from 2008-2009), and second postdoctoral research from Australian Institute for Bioengineering and Nanotechnology (AIBN), University of Queensland, Australia (from 2009-2011). He is currently working as Associate Professor, Thapar Institute of Engineering and Technology, India in the field of environmental sustainability (water splitting/wastewater treatment/toxic pollutant degradation) by advanced functionalized nanomaterials. He is also actively involved in developing chemical-sensors/nanobiosensors and porous adsorbents for carbon capture and storage (CCS) technology. He has published more than 140 research articles in reputed international journals with an h-index of 37 and citations of 6500.

Microplastics Pollution: Integrated Approaches and Solutions

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Key Words: Microplastics; Strategies, Solutions, Pollution, Waste Management

Abstract
The National Oceanic and Atmospheric Administration (AOAA) defines microplastics as tiny plastic particles of less than 5 millimetres long. There exists a range of processes that contribute to formation of microplastics. For example, due to the breakdown of microplastics during the weathering process, microplastics are formed. Raw materials used in the production of plastics (resin pellets) also continue to contribute to the amount of existing microplastics. In 2014, it was estimated that, 51 trillion pieces of microplastics exist in the ocean (4Ocean Team, 2020). This amount exceeds the amount of stars in the Milky Way by 500 times. In comparison to macroplastics, microplastics are also carriers of persistent organic pollutants (POPs) and bacteria. Chemicals such dioxins and pesticides are found in micoplastics and these are hazardous to animal and human health. Other than the impact caused by microplastics in the aquatic communities, land ecosystems are also affected through the introduction plastic debris that affect organism behaviour, pollute food sources and contaminate ground water. To reduce the impact of microplastics on the environment, priority should be given through global multidisciplinary collaborative approaches. A literature review is conducted to establish the current best practices that can improve waste management of plastics for the purpose of enhancing environmental and health impacts caused by microplastics. Studies focusing microplastics pollution AND/OR strategies are reviewed. Through a critical analysis of the findings from these studies, the study recommends the following strategies and solutions for reducing mircoplastics pollution; utilization of biogradebale or bio-based plastics; enforcement of extended producer responsibility; advancement and improvement of waste collection systems; enforcement of recycling; plastic production and consumption regulation; improvement of recycled plastic supply-chains; design of reverse logistics systems, promotion of reusing plastics; and utilization of alternative transportation. The recommendations are applicable in all contexts but the implementation is what may differ. Therefore, this study is a drive towards achieving sustainable management of microplastics using collaborative approaches.

Biography
Bupe G Mwanza has a PhD in Engineering Management with academic and research experience in manufacturing systems, operations management, quality assurance in higher education and solid waste management. She is currently a senior lecturer at the University of Zambia in the Graduate School of Business. Bupe is currently serving as Review Editor on the Editorial Board of Waste Management (specialty section of Frontiers in Sustainability). International Peer review journal panels include; Journal of Cleaner Production; Total Quality Management; and Inderscience. International conference peer review panels include, Industrial Engineering and Operation Management; and Industrial Engineering and Engineering Management. She has presented in countries such as Zambia, Zimbabwe, South Africa, Ghana, Colombia, Singapore, Malaysia, Indonesia, Macao, Thailand and India. Bupe has won best paper awards in Zambia, Zimbabwe, South Africa and Malaysia. Bupe was awarded Distinguished Woman in Industry and Academia Award at the 2020 Industrial Engineering and

Membrane fouling by nano/micro plastics: challenges and potential mitigation strategies

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Abstract

The concern for the increase in microplastics in the environment has dominated recent news headlines. These microplastics can further erode and fragment into nanosized plastics, which further raises serious concerns and challenges as they are difficult to separate, characterise and quantify. The nano/microplastic contaminants in either water systems or wastewaters poses a challenge to water and wastewater treatment plants as these treatment plants are dealing with large volumes of water and wastewater, and could allow large amount of microplastics to pass through[1]. This has serious implications, both for water treatment plants that provide drinking water for people and for wastewater treatment plants where effluents are being either discharged into the environment or used as agriculture fertiliser or irrigation. Most water and wastewater treatment plants would have membrane filtration units within the processing plant and the presence of particulates such as microplastics can significantly foul membranes, causing a decrease in filtration performance[1]. A better understanding on the impact and mitigation of nano/microplastics fouling on membrane filtration units would be important for improving operation of treatment plants and separation of nano/microplastic separation using membranes. This presentation will show using microplastics sourced from a commercial facial scrub (i) how microplastics can easily fragment into nanoplastics[2] (ii) fouling of ultrafiltration membranes by nano/microplastics[3] and (iii) possible mitigation of the fouling via chemical surface treatment of membranes using plasma technology [4] coupled with physical air scouring [5].

References

[1] M. Enfrin, L.F. Dumée, J. Lee, Nano/microplastics in water and wastewater treatment processes–origin, impact and potential solutions, Water Res., 161 (2019) 621-638.
[2] M. Enfrin, J. Lee, Y. Gibert, F. Basheer, L. Kong, L.F. Dumée, Release of hazardous nanoplastic contaminants due to microplastics fragmentation under shear stress forces, J. Hazard. Mater., 384 (2020) 121393.
[3] M. Enfrin, J. Lee, P. Le-Clech, L.F. Dumée, Kinetic and mechanistic aspects of ultrafiltration membrane fouling by nano-and microplastics, J. Membr. Sci., 601 (2020) 117890.
[4] M. Enfrin, J. Wang, A. Merenda, L.F. Dumée, J. Lee, Mitigation of membrane fouling by nano/microplastics via surface chemistry control, J. Membr. Sci., 633 (2021) 119379.
[5] M. Enfrin, J. Lee, A.G. Fane, L.F. Dumée, Mitigation of membrane particulate fouling by nano/microplastics via physical cleaning strategies, Sci. Total Environ., 788 (2021) 147689.

Biography

Dr. Judy Lee received her double degree in B.Eng. (Chemical Engineering) and B.Sc (Physics) in 2002 and her PhD in 2006, both from The University of Melbourne, Australia. In 2007 She was awarded the JSPS Fellowship to spend two years in Japan at the National Institute of Advanced Industrial Science and Technology (AIST). She then returned to the Chemical Engineering Department at the University of Melbourne in 2010 as a postdoc for further two years before being awarded the DECRA (Discovery Early Career Researcher Award) by the Australian Research Council in 2012. In 2015 she took up an academic post at the University of Surrey as a Senior Lecturer, and is currently a Reader and Director of Learning and Teaching for the department. Her research group at Surrey is interested in both fundamental work and applied aspects of ultrasound processing and membrane filtration systems, with a particular interest in wastewater treatment.

Qualitative Identification of Microplastics: A Preliminary Study Using Fourier-transform infrared (FTIR) spectroscopy

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Keywords: Microplastics, FTIR, Analytical procedure, Qualitative analysis

Abstract

The prevailing of microplastics draws a great deal of concern due to their negative impacts to the environment. The environmental microplastics usually consist of several chemical constituents, and classifying these constituents is import for subsequent pollution control and risk management. In the literature the environmental microplastics were often analyzed as a whole by measuring their total weight and particle number. In contrast, this study employed Fourier-transform infrared (FTIR) spectroscopy to identify the polymer constituents of the tested microplastics, using polyethylene terephthalate (PET), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) and nylon (NY) as the model plastic polymers. Mixtures containing different tested microplastics were analyzed. For a given tested plastic in a plastic mixture, its apparent signals may be interefered or masked by the reflection of another coexisting plastics. Therefore, uniqueness in FTIR signal for each tested plastic becomes critical if each plastic constituent shall be identified. By comparing the FTIR signals from the plastic sample containing multi-component polymers, the characteristic wave number of each test sample was established according to its obtained FTIR spectrum. The FTIR spectra enabled the identification of their respective plastic constituents. In addition, real samples obtained from a selected industry and the ambience were employed to examine the applicability of the proposed identification procedure. This study demonstrated the FTIR application to identifying microplastic constituents by proposing a systematic operating procedure.

Biography

Dr. Chihhao Fan is a professor of the Department of Bioenvironmental Systems Engineering, National Taiwan University. He received his Ph. D. in Civil Engineering from Purdue University in 1997. He was a postdoctoral fellow at the Hydrotech Research Institute of National Taiwan University right after receiving his Ph. D. degree. After working one year with Nation Taiwan University, he decided to work with the Taiwan Environmental Protection Administration as an environmental engineer. In 2000, Dr. Fan joined Ming Chi University of Technology as a faculty member, and he transferred to National Taiwan University in 2015. Dr. Fan's main research areas include watershed management, water/wastewater treatment, environmental chemistry, water resource management. He conducted more than 60 projects in these related areas, and currently, he has been serving as a board member of several government committees. He currently also serves as the managing editor of Paddy and Water Environment.

Microplastics Research Trends and Future Challenges in the Korean Environmental Fields

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Recently, environmental pollution caused by microplastics has emerged as an important environmental problem worldwide. Modern society entered the plastic age in earnest when DuPont started selling nylon invented by American chemist Wallace Hume Carothers in the early 1900s, which is thought to be a change that surpasses the Bronze Age and Iron Age. Plastics have been used in large quantities due to their convenience, but management in consideration of environmental impacts is insufficient. With an increasing use of plastic, considerable plastic waste is generated, threatening the environment and public health. In particular, changes in living patterns in urban areas have significantly impacted the rate at which plastic waste increases every year. Thus, governments in many developed countries have implemented numerous policies to reduce plastic waste generation.

In particular, in April 2018, there was a problem with the collection of plastic waste in Korea, which resulted in many changes in plastic-related policies and research fields. The Ministry of Environment is promoting research on integrated life cycle of microplastics generation, behavior, risk assessment and management. First, the generation status and material flow of waste plastics generated as waste are analyzed, and the source of their generation is investigated by identifying the route through which they are exposed to the environment. In addition, the Korean government is preparing the analytical method for microplastics and is conducting research on the behavior and risk by investigation the contamination status. In this presentation, we would like to introduce the research projects and contents being promoted in the environmental field. In addition, I would like to briefly introduce the research on the development of integrated microplastics management technology to be promoted in 2022.

Biography
Dr. Sun Kyoung Shin is currently a director at the National Institute of Environmental Research. Dr. Shin received her PhD in chemical engineering at New Mexico State University. Following her PhD, she served as a senior researcher at the Ministry of Environment. She has expertise in hazardous waste management and environmental pollutant analysis, with a particular focus on waste recycling and waste to energy.

Session II: Risk Assessment and Analysis of Plastics

Effects of Micro- and Nano-plastics Wastes on Human Health

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Keywords: Plastics; Micro- and nanoplastics; Toxicity; Health impacts; Environmental pollution

Abstract
Every element of daily life, such as technology, health and therapeutics, as well as household items, is impacted by the plastics. After its single use, most of the people discard the majority of these used plastics, which would cause serious major environmental threat. The breakdown of these plastics in such a large number from micro-to-nanosizes has raised much concern about how hazardous these plastics are to the environment and the individuals. Although a number of researchers have been published extensively on the environmental implications of micro and nano-plastics, there has been little research on their effects on human health at the sub-cellular or molecular level. This chapter deals with the manufacturing of plastics, their behaviour, degradation, levels of toxicity and pollution in the environment, and the possible health impacts on humans, especially in the days of Covid-19 and provide possible solutions to this ever increasing plastics wastes mitigation. We will discuss on the impact of these micro- and nano-plastics on human health such as central nervous system, kidney, digestive and excretory system; respiratory system; placental barrier; skin, etc. This chapter will also discuss about the plastics wastes generated from the pandemic that the world is facing today.

Biography
Dr. Tejraj M. Aminabhavi is presently the Emeritus Professor, Department of Chemistry Karnatak University, Dharwad, India continuing his research activities in Pharmaceutical Engineering Department. He completed his PhD from the University of Texas at Austin in 1979 in the field of polymer science and was a post doctoral associate at Clarkson University, Potsdam, New York during 1980-1982. He taught polymer science for 37 years at Karnatak University, Dharwad, India in addition to being the founder director of center of excellence in polymer science (2002-2007). During 2007-20012, he worked as a scientific advisor to Reliance Life Sciences in Mumbai, India. Dr. Aminabhavi has a distinct career of having published 850 research papers, 70 review articles, a text book published by Wiley in 2002, an edited book by Elsevier in 2020 and 3 US Patents in membrane science area applied to water purification. His research interests are in the area of pharmaceutics, nanoparticulate drug delivery systems, and hydrogels in drug delivery. He has done research in brain delivery applications of polymeric nanoparticles, hydrogels for insulin therapy, and anticancer drug delivery systems. Professor Aminabhavi is the recipient of two international awards one from Iran (2009), QIA Laureate from the President of Iran and Nikkei Asia Award from Japan (2013). His research publications received high citations up to 43,000 with an h-index of 100. Aminabhavi has been the visiting scientist to University of Texas at Dallas, Lamar University, Texas, UT Southwestern Medical Center at Dallas, Texas State University, San Marcos, and Cambridge University (UK) in addition to many other universities in China, France, Taiwan and Korea. He is serving as the editor in Chemical Engineering Journal (membrane section), Editor in chief of Materials Science for Energy Technologies and Sensors International.

Plastic detection using a multi-method approach: Comparative case studies from coastal tourism sites

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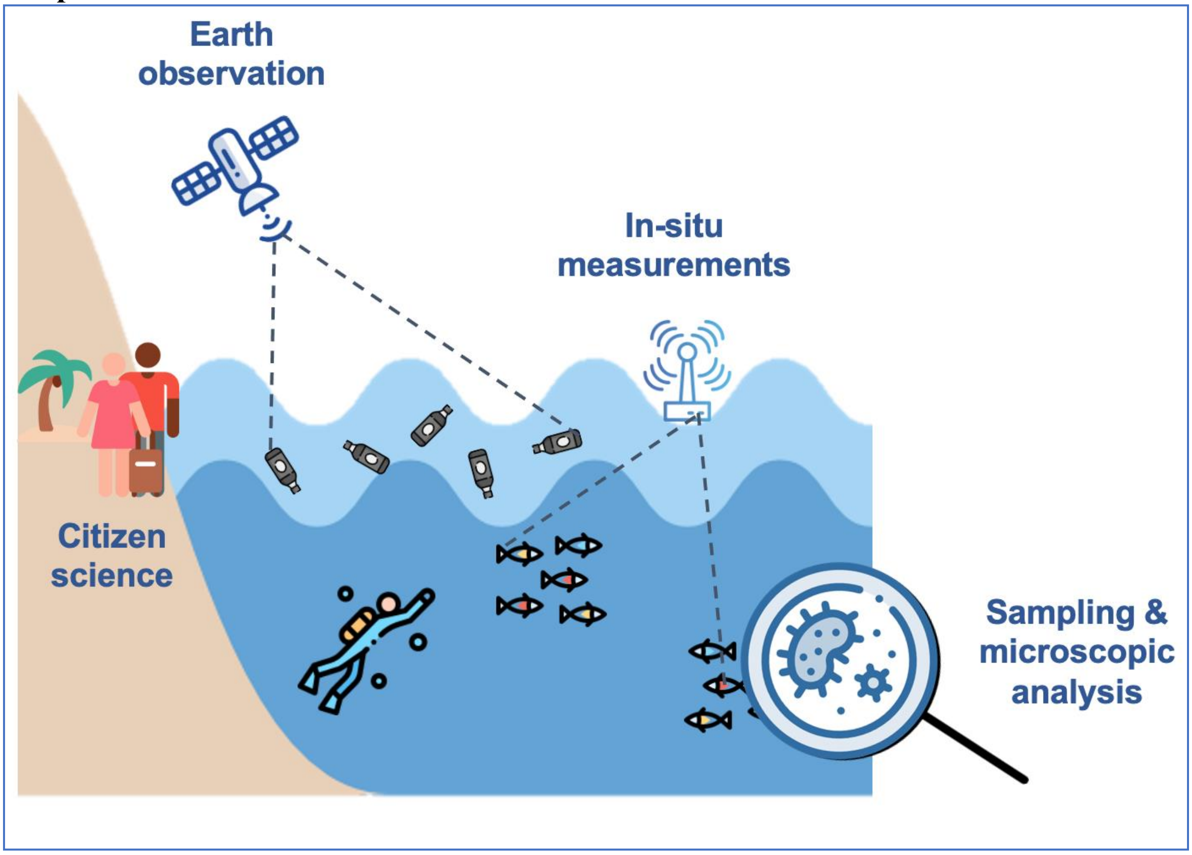
Keywords: Plastic; Plastic waste; Marine pollution; Coastal sites; Multi-method approach

Graphical abstract



Abstract

Floating plastic particles have been documented in water bodies around the world (Derraik, 2002). The effects of marine litter, and especially microplastics, on natural ecosystems have been well documented and range from passive ingestion, to entanglement, or chemical contamination of marine organisms, posing serious risks of species survival (Cózar et al. 2014). Despite a growing body of literature addressing the impacts of marine plastic pollution, the magnitude, distribution, and spatio-temporal variability of plastic accumulations remain open questions (UNEP, 2018, 2019a, 2019b). In particular, detecting the sources and pathways of marine plastic has proven problematic due to the uncertainty and limited traceability of plastic

flows in natural ecosystems (Veiga et al., 2016). Furthermore, plastic can enter bodies of water and subsequently be transported via wind or tide (Jambeck et al., 2015), dislocating the problem of plastic pollution from its source. Ocean and current models have proven successful in tracing the pathways and transfer of micro-plastic particles in bodies of water, as well as delivering reliable data on the magnitude of marine plastic pollution. However, existing constraints affect the paucity of real-time, harmonized information on the extent and distribution of plastic entering our seas. To supplement this knowledge gap, the study proposes a multi-model approach that combines a number of data acquisition techniques to advance knowledge of the effects of anthropogenic human activities on the marine environment in the African and America context, attempting to unveil possible sources of plastic and microplastic pollution.

This study offers a comprehensive, harmonized model for detecting and quantifying marine plastic on coastal sites and coastal waters, leveraging experiences from southern California (USA) and Zanzibar (Tanzania) (Maione, 2019, 2021; Maione et al., 2021). Selected sites present different features related to geography, presence and/or conditions of urban infrastructure and waste management systems, beach uses and users, local economies, and socio-cultural characteristics, that can contribute to plastic pollution policies and be accounted for when building marine pollution models. Data acquisition entails a combination of satellite-based earth observations with in-situ measurements using sensor data, existing water quality analyses, beach litter inventories, and water/specimen sampling among others. Observations are recorded into a database (geographic coordinates of transects and observations, photographic evidence, specimen description, count/weight/size, morphological and chemical characteristics) and processed using lab equipment.

Findings show plastic as the most dominant litter type, at all surveyed sites, with beverage bottles, shopping bags, wrappings, and single-use tableware being the most common litter items. Waste characterization serves the dual purpose of supplementing the existing paucity of data on plastic waste material flows, and, depending on the degradation status of collected items, advance recommendations on their potential recovery. Subsequently, litter information was crossed-validated via interviews with local stakeholders (from the waste and tourism sectors) to evaluate sources and pathways of coastal pollution. This study provides recommendations on plastic pollution monitoring and reporting via the integration of qualitative (e.g., interviews, citizen science) and quantitative data (e.g., observations, sampling, material flow inventories) on beach and marine litter. Finally, the study provides implications for beach users and facilities located along the shoreline to mitigate and prevent plastic material lost at sea.

References

[1] Cózar, A., Echevarría, F., González-Gordillo, J. I., Irigoien, X., Úbeda, B., Hernández-León, S., Palma, A. T., Navarro, S., García-de-Lomas, J., Ruiz, A., Fernández-de-Puelles, M. L. and Duarte, M. D., 2014. Plastic debris in the open ocean. *Proceedings of the National Academy of Sciences*, *111*(28), pp.10239-10244.

[2] Derraik, J. G., 2002. The pollution of the marine environment by plastic debris: a review. *Marine pollution bulletin*, 44(9), pp.842-852.

[3] Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Ramani, N., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, *347*(6223), 768-771.

[4] Maione, C., 2019. *Emergence of plastic pollution on tourism beaches in Zanzibar, Tanzania*
[5] Maione, C., 2021. Quantifying plastics waste accumulations on coastal tourism sites in Zanzibar, Tanzania. *Marine Pollution Bulletin, 168,* p.112418.
[6] Maione, C., Fernandez, G. and Vito, D., 2021. Plastic detection using a multi-model approach: The case of Southern California-Baja California. ASITA 2021.
[7] UNEP, 2018. Report of the first meeting of the ad hoc open-ended expert group on marine litter and microplastics. Nairobi: UN Environment Programme.
[8] UNEP, 2019a. Report of the second meeting of the ad hoc open-ended expert group on marine litter and microplastics. Geneva: UN Environment Programme.
[9] UNEP, 2019b. Report of the third meeting of the ad hoc open-ended expert group on marine litter and microplastics. Bangkok: UN Environment Programme.
[10] Veiga, J. M., Fleet, D., Kinsey, S., Nilsson, P., Vlachogianni, T., Werner, S., Galgani, F., Thompson, R. C., Dagevos, J., Gago, J., Sobral, P. and Cronin, R., 2016. Identifying sources of marine litter. MSFD GES TG Marine Litter Thematic Report, JRC Technical Report, EUR 28309.

Biography

Maione is a natural scientist, currently pursuing her doctoral degree in Industrial Engineering. Her doctoral research is focused on monitoring material flows and pollution cycles across the plastic industry-environment-society nexus, and investigating the role of technology in the transition to a circular economy for plastics. Previous works encompass exploration of plastic pollution in the African seas and related impacts on human communities and marine ecosystems, and quantitative analysis of microplastic accumulations in pelagic biota and their effects on species survival. Research interests include marine pollution, microplastics, earth observation, material flow analysis, ocean and coastal management.

Dr. Gabriela Fernandez is an Adjunct Faculty in the Department of Geography, Principal-Investigator at the Center for Human Dynamics in the Mobile Age, and Graduate Advisor of the Big Data Analytics Master of Science Program at San Diego State University. She received a Ph.D. in Urban Planning, Design, & Policy from the Department of Architecture and Urban Studies at the Politecnico di Milano. Her research interests include urban metabolism ideologies and material flow analysis of metropolitan cities. Identifying urban typologies and socioeconomic indicators in the urban context while promoting public policy, smart cities, UN-SDGs, and vulnerable-populations. She serves as the UNEP delegate of the Major Group for Children & Youth, Marine Litter-&-Micro-Plastics Working-Group. She is Co-Founder & Researcher at the Metabolism of Cities, a NPO with data, tools, & publications related to urban metabolism studies & Director of the Metabolism of Cities Living Lab-at-SDSU working to localize the UN-SDGs in southern-California.

Index Models for Environmental Micro- and Nano- Sized Plastics

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Keywords: Carcinogenic, Chemometrics, Estimated daily intake, Health risks, Modeling, Plastic pollution, Policy makers, Toxicity

Abstract
The definition of environmental indexes is one of the most widely used methods and methodologies for the study of exposure to polluting agents, and it is a highly helpful instrument for describing the quality of the environment in a simple and straightforward manner. In this study, index models were presented and described that can be used in evaluating the contamination, pollution and health risks of environmental micro (MPs) and nanoplastics (NPs) to ecosystems and humans. Index models such as plastic contamination factors (pCf) and pollution load index (pPLI), plastic- bioconcentration or accumulation factors (pBCf or pBAf), plastic-biota-sediment accumulation factor (pBSAf), biota accumulation load index (BALI), polymer risks indices (pRi), polymer ecological risks index (pERI) while plastic estimated daily intake (pEDI) and plastic carcinogenic risks (pCR) were described for oral, dermal and inhalation pathways. All index modeled were further described based on polymer types of MPs/NPs. The final value is represented by a quantity that measures a weighted combination of sub-indices and defined by an appropriate mathematical function. The central concept is to present an indicator that can describe, in a clear and concise manner, the level of MPs/NPs in the environment, thereby indicating where it would be necessary to intervene and where it would not in order to improve overall environmental conditions.

Biography
Christian Ebere Enyoh is currently a Research Fellow at the Department of Chemistry, Imo State University, Nigeria. He holds a Master of Science degree in Analytical Chemistry from the same University. His research is currently focused on micro and nano plastics and other emerging pollutants, including their monitoring and remediation. He led a research project which provided for the first time the impact of macro and micro plastics in soil on phytochemicals in plant in Nigeria. Christian received the Japanese MEXT scholarship for Ph.D in environmental science with focus on microplastics at the Saitama University. He is a member of the Chemical Society of Nigeria and has over 100 publications to his credit.

Disposable face masks - Analysis of the release of synthetic micro and nano particles an dchemical contaminants - linked to the COVID-19 pandemic

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Abstract
With the increase on the manufacturing and use of disposable face mask (DPFs) due to the C ovid- 19 pandemic, the inappropriate and unregulated disposal of these items is a concerning cause of the intensification of plastic as an environmental problem nowadays. This study focu ses on the emission of different contaminants from 7 DPFs brands (a total of 9 batches) that were immersed in deionised water in order to emulate environmental conditions once these DP Fs are discarded and released into the environment. 7 different brands of DPFs (a total of 9 ba tches) were purchased from several manufacturers and suppliers and pollutants were filtered and deposited in membranes. These results have been published (https://doi.org/10.1016/j.wat res.2021.117033).

Methodology:

Leaching and filtration of particles.

10 face masks for each batch were submerged in 1.5 L deionised water for 4 hours and gently agitated by stirring every hour to ensure complete coverage and contact of DPFs with water. Post submersion, the eluent (leachate) was then filtered under vacuum through a 0.1 µm Al_2O_3 membrane filter.

Microscopy and FTIR

To determine the coverage of the contamination by particles, light microscopy was put in plac e. For scanning electronic microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) analysis, samples were mounted on carbon tape and placed in vacuu ms chamber. Fourier transform infraredspectroscopy (FTIR) was used for quick solid sample analysis and surface characterisation.

ICP-MS elemental analysis and LC-UV and LC-MS accurate mass of leachate

DPFs were submerged in 250 mL of deionised water for a period of 24 hours. To check the b ackground interference, a procedural blank was run with samples. To check for carryover, bla nks were run after every sample and after highest calibration. A subsample of the leachate was analysed for polar organic compounds by direct injection (5 µL) on LC-UV for initial sample contamination screening and LC-MS for compound identification. Procedural blanks were run pre and post samples.

Results

Face mask and Filtrate characterisation: Microscopy and FTIR analysis

9 separate batches of DPFs (from 7 brands) were tested for their potential capacities of releasi ng pollutants in water. All 9 batches of DPFs emitted fibres (believed to be made of polypropyl ene) and crystalline fragments (believed to be of siliceous composition).

Light microscopy forsome DFMs presented many different coloured fibres, suggesting that, in the manufacturing process, some of them are stained with dying agent that seems to tarnish also the membranes during the filtration process.

Polypropylene was confirmed as the primarily material use on the manufacturing of the face
masksby FTIR analysis, with some additional functionalisation seen in some dyed brands par
ticularly on the coloured sides. The use of SEM-
EDX demonstrated that the size of the particles deposited on the membranes are in the micro
(<1 mm) and nano (submicron particle size 0.1-
1 µm) range. All DFMs in the study released also a significant amount of grain sized particles
measured between 360 nm- 500 µm on SEM. The analysis with EDX suggested the elementa
l composition of particles. A high percentage of carbon was found on fibrous particles, most li
kely derived from polypropylene. High percentages of silicon and oxygen were found in the
majority of the grains, more likely to be compositions of silica. Associated with these particle
s, there was often presence of heavy metals associated, especially in the coloured face masks.
Some heavy metals were located on grain particles of children DPFs. These heavy metals (suc
h as such as Pb, Cd, Sb and Cu) are common chemical additives added during plastic manufa
cture.
Leachable metals and organic compounds: ICP-MS and LC-MS analysis.
ICP-
MS analysis demonstrated the presence of heavy metals released from the DPFs into the leac
hate, showing disconcerting levels of Sb on some DFMs (ranging from 111-
393 µg/L). All face masks appeared to release Cu with levels ranging from 0.85 µg/L to high
est levels of 4.17 µg/L. PB was also observed in some samples, the highest value being of 6.7
9 µg/L.

Sample	Cd (µg/L)	Co (µg/L)	Cu (µg/L)	Pb (µg/L)	Sb (µg/L)	Ti (µg/L)
Procedural Blank	N.D*	N.D	N.D	N.D	N.D	N.D
Face mask 2 (Leachate)	N.D	N.D	4.17	0.01	1.06	0.64
Face mask 4 (Leachate)	0.01	0.54	1.87	0.62	N.D	0.27
Face mask 4 (Leachate) repeat	0.04	0.59	1.22	0.89	N.D	N.D
Face mask 5 (Leachate)	N.D	N.D	0.85	0.75	3.07	N.D
Face mask 6 (Leachate)	1.92	N.D	1.80	6.79	N.D	N.D
Face mask 7 a (Leachate)	0.53	N.D	2.06	1.62	111	N.D
Face mask 7 b (Leachate)	N.D	N.D	2.31	N.D	393	0.12

Face mask 7 c (Leachate)	N.D	N.D	4.00	N.D	147	0.06

References

[1] Bartošová, A., Blinová, L., Sirotiak, M., Michalíková, A., 2017. Usage of FTIR-ATR as non-destructiveanalysis of selected toxic dyes 25, 103–111.
[2] Charles, J., Ramkumaar, G.R., Azhagiri, S., Gunasekaran, S., 2009. FTIR and thermal studies onnylon-66 and 30% glass fibre reinforced nylon-66. E-Journal Chem. 6, 23–33. https://doi.org/10.1155/2009/909017
[3] Coates, J., 2006. Interpretation of Infrared Spectra, A Practical Approach. Encycl. Anal. Chem. 1–23. https://doi.org/10.1002/9780470027318.a5606
[4] Hahladakis, J.N., Velis, C.A., Weber, R., Iacovidou, E., Purnell, P., 2018. An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during theiruse, disposal and recycling. J. Hazard. Mater. 344, 179–199. https://doi.org/10.1016/j.jhazmat.2017.10.014
[5] Keller, A.A., Adeleye, A.S., Conway, J.R., Garner, K.L., Zhao, L., Cherr, G.N., Hong, J., Gardea- Torresdey, J.L., Godwin, H.A., Hanna, S., Ji, Z., Kaweeteerawat, C., Lin, S., Lenihan, H.S., Miller,R.J., Nel, A.E., Peralta-Videa, J.R., Walker, S.L., Taylor, A.A., Torres-Duarte, C., Zink, J.I., Zuverza-Mena, N., 2017. Comparative environmental fate and toxicity of copper nanomaterials. NanoImpact 7, 28–40. https://doi.org/10.1016/j.impact.2017.05.003
[6] Jung, S., Lee, S., Dou, X., Kwon, E.E., 2021. Valorization of disposable COVID-19 mask through thethermo-chemical process. Chem. Eng. J. 126658.
[7] Rehman, M., Liu, L., Wang, Q., Saleem, M.H., Bashir, S., Ullah, S., Peng, D., 2019. Copper environmental toxicology, recent advances, and future outlook: a review. Environ. Sci. Pollut.Res. 26, 18003–18016. https://doi.org/10.1007/s11356-019-05073-6
[8] Sullivan, G.L., Gallardo, J.D., Jones, E.W., Hollliman, P.J., Watson, T.M., Sarp, S., 2020. Detection oftrace sub-micron (nano) plastics in water samples using pyrolysis-gas chromatography time of flight mass spectrometry (PY-GCToF). Chemosphere 249, 126179. https://doi.org/10.1016/j.chemosphere.2020.126179

Biography

Dr. Sarper Sarp (Co-PI), is a Lecturer in Chemical Engineering at Swansea University (SU). He has 17 years of experience in water quality, advanced water monitoring of micro-pollutants and water treatment systems. He has authored 40 papers in international peer-reviewed journals (h-index: 18, Citations: 1,766), has five intellectual property documents, and currently serves as Editorial Board Member for the leading environmental and water quality journals *ES&T Water and Desalination*. In 2020, his research team published a novel analytical sample preparation and analysis method that is capable of identifying and semi-quantifying nano-size plastics in water sources (https://www.sciencedirect.com/science/article/abs/pii/S0045653520303726) His team later used the same method to identify micro and nano particle release from disposable face masks when littered in the environment (https://www.sciencedirect.com/science/article/abs/pii/S0043135421002311)

Impact of microplastic contaminants on marine environment and its life

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Key words: Surface water; sediments; marine organisms; Toxicity

Abstract _
Microplastics are the smallest plastic materials formed by the disintegration of larger plastics. Some microplastics are made directly and used as raw materials for cosmetics. Currently, these contaminants are found almost in the entire marine environment. The complexity in the chemical composition of the plastic reduces its biodegradability and the negligence in disposal makes way for them to enter and accumulate in the aquatic environment. Presently, this is a growing scientific concern since these tiny particles are easily accessible to a wide verity of aquatic biota owing to their small size and are eventually transferred via the marine food web. As a result, toxic contents accumulate in marine organisms and cause toxicity to tissues. In addition, these microplastic particles also act as a carrier for other toxic pollutants. Because, it will absorb the other toxic contaminants such as heavy metals, pesticides and hydrocarbons and boost the toxicity. The chronic biological effects on marine organisms are due to the accumulation of microplastics and its chemical components in their cells and tissues. Thus, it is necessary to recognize the possible impact of microplastics on the marine ecosystem. It will help to find out the preventive measures. But, the toxicity study on microplastics on marine environment and the biological organisms is very limited. Since, it is the need of the hour to find out possible impact of microplastis on marine environment and its organisms. There is an urgent need to control the overuse of plastic and related materials and to enforce certain laws and policies to manage plastic waste. This study depicts the sources, fate and impact of seafood, especially on the food chain, and discusses some of the environmentally mitigation measures to control the impact of microplastic toxicity on the marine ecosystem.

Biography

Dr. A. Sundaramanickam is an Associate professor at the Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, India where he has been a faculty member since 2005. Specifically, his research focuses on the following areas: (1) Marine pollution and Bioremediation 2) Microplastics Pollution and its impact (3) Waste water treatment (4) Water quality management and (5) Biopolymer production. He has operated the Seawater Quality Monitoring project funded by Ministry of Earth Sciences, Government of India, as Principal Investigator. He has published several book chapters and more than 65 papers in scientific journals such as Environmental Pollution, Marine Pollution Bulletin, Environmental Management, Environmental Science and Pollution Research, Critical Reviews in Environmental Science and Technology, Enzymes and Microbial Technology, Journal of the Mechanical Behavior of Biomedical Materials etc. Dr. A. Sundaramanickam also reviewed numerous manuscripts for more than 25 journals. Currently he serves academic editor for PLoSOne. He has also reviewed research proposal for many financial agencies and also he has served as a technical committee members and chaired session in National and International conferences. He has received several research awards for his accomplishments.

Ingestion of microplastics in fish

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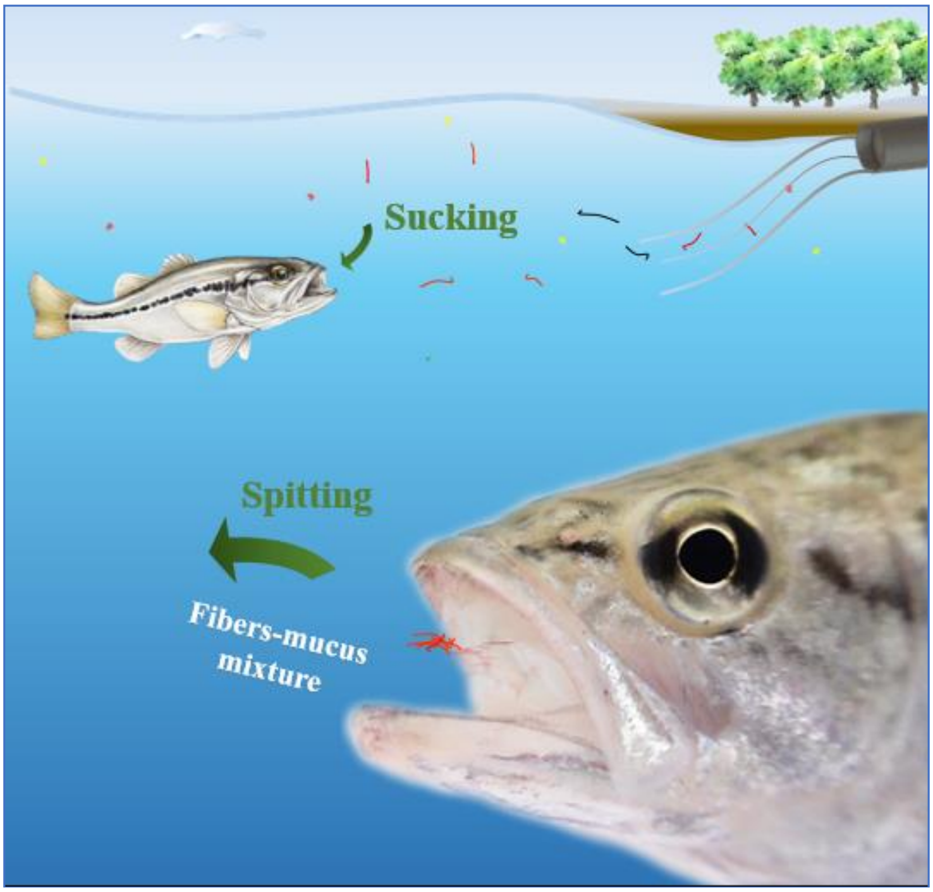
Key words: fish, ingestion, microplastic, microfiber, feeding behavior

Graphic abstract



Abstract
Microplastics (size of plastic debris < 5 mm) occur in various environments worldwide these days and cause detrimental effects on biota. Up to date, about 1000 fish species have been reported to contain microplastics in their bodies in field investigations. Fish is also one of the most common species used for toxicity study of microplastic in the laboratory. However, the ingestion behavioral responses of fish to microplastics in feeding processes as well as their link to the occurrence of microplastics in field are not well understood. In this presentation, we introduced our work in recent years about the ingestion of microplastics in fish. We investigated microplastic pollution in freshwater and seawater fish in the field; we also studied the accumulation of microplastics in the body of fish and the behavioral response of fish to plastic pellets and fibers in the laboratory. In the field, we found that low abundances of microplastics occurred in all collected fish species, but little fragments or pellets existed in the body of fish.

No evidences suggest that microplastics larger than 20 μm were able to enter muscle or liver of fish. In the laboratory, we developed internal persistent fluorescent fibers to track microplastics and found that fish usually ingested and cleared microplastics quickly, e.g., within one hour. In feeding experiments with four fish species, swallowing-feeding fish ingested more pellets than filtering- and sucking-feeding fish. With high-definition and high-speed observational experiments, we found that all species did not actively capture microfibers; instead, they passively sucked in microfibers while breathing. Surprisingly, fish showed a rejective behavior which was spontaneously coughing up microfibers mixed with mucus. Nevertheless, some of microfibers were still found in the gastrointestinal tracts and gills of fish, while abundances of ingested microfibers were increased in the presence of food. Our findings reveal a common phenomenon that fish ingest microplastics inadvertently rather than intentionally. We provide a reasonable explanation for the low abundances of microplastics and no special types of microplastics (i.e., raw pellets) in fish in the field. We also provide insights into the pathways via which microplastics enter fish and potential strategies to assess future ecological risk and food safety related to microplastics.

References:

[1] Li BW, Liang WWH, Liu QX, et al., 2021. Fish ingest microplastics unintentionally. Environ. Sci. & Technol. 55(15), 10471–10479.
[2] Ma CZ, Li LY, Chen QQ, et al., 2020. Application of internal persistent fluorescent fibers in tracking microplastics in vivo processes in aquatic organisms. J. Hazardous Mater. 401:123336.
[3] Su L, Deng H, Li BW, et al., 2019. The occurrence of microplastic in specific organs in commercially caught fishes from coast and estuary area of east China. J. Hazardous Mater. 365, 716-724.

Biography

Huahong Shi is a professor of Environmental Sciences at East China Normal University and an associ ate editor of Marine Pollution Bulletin (2020-). He got his Ph.D. degree of Aquatic Biology in Jina n University of China in 2003. He is interested in studying microplastic pollution in aquatic environments and endocrine disrupting chemicals in aquatic organisms. He has ever studied impo sex in snails, thyroid disrupting effects of chemicals on amphibian and teratogenicity of chemi cals to vertebrate embryos for 20 years. In recent 8 years, Huahong is focusing on microplast ic and nanoplastic pollution including analytical methods, fate, toxicological effects and risks t o human health. He has been listed as one of the “Highly Cited Researchers” by Clarivate A nalytics for 2020.

Microplastics in edible salts and their removal strategy

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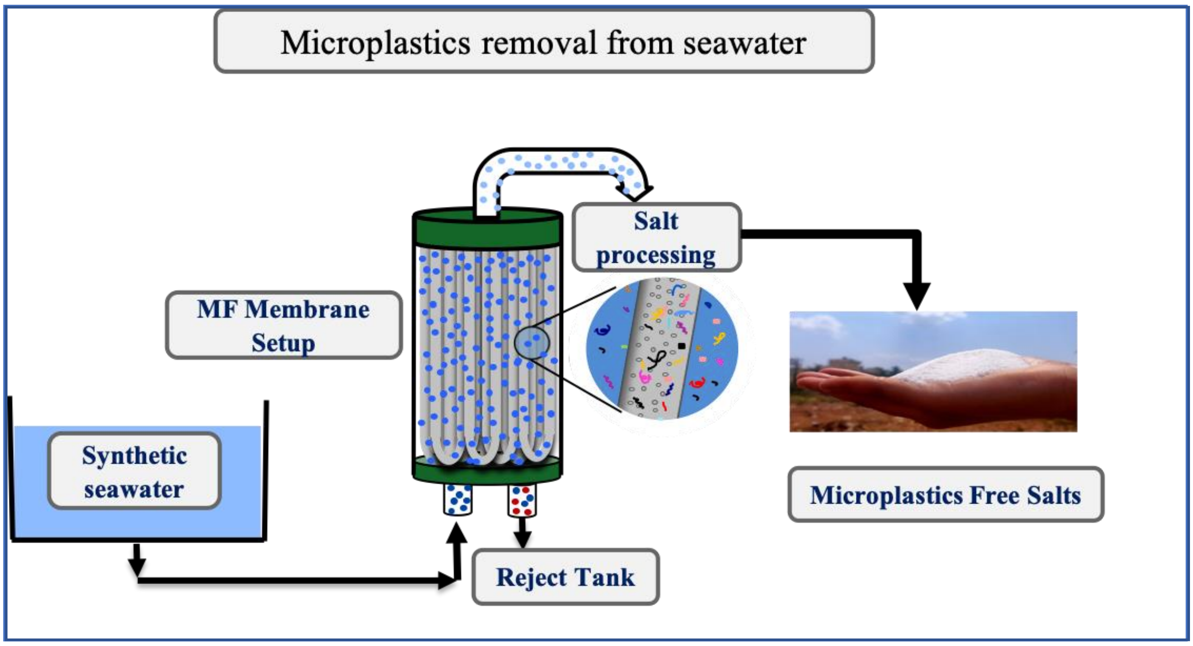
Keywords: Marine pollution; Salt; Seawater; Microplastics; Membrane technology

Graphical Abstract



Abstract

As emerging contaminants, microplastics have attracted attention around the world. The poor degradability allows the plastic waste to stay in the water for a long time and it breaks into smaller and smaller pieces of plastic over time. The findings indicate that human ingestion of microplastics through sea salt is closely linked to the contamination of plastic particles in seawater. Microplastics present in salt may create a potential health hazard for humans. In this work, we have developed an innovative approach for the removal of microplastics from synthetic seawater with the help of membrane technology, which has the potential to avoid the transfer of microplastic particles into salts. The visual evaluation was performed using optical and fluorescence microscopy to classify the shape, size, number, and colour of microplastic particles. A wide range of MPs were found: 1400 - 1900 particles/kg in refined sea salt, 1900 - 2300/kg in unrefined sea salts. The composition of the microplastics were analysed by Raman spectroscopy. The most common MPs were polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), nylon, and polystyrene (PS). This is the first study, to the best of our knowledge, where we successfully removed microplastics from seawater, which can be used further in the large-scale industry.

Biography

Prof. Kaustubha Mohanty has obtained his PhD degree in Chemical Engineering from Indian Institute

Technology Kharagpur and is currently working as a Professor of Chemical Engineering at Indian Institute Technology Guwahati. His key research areas are biofuels, biological wastewater treatment, microplastics, membrane technology, microalgae biorefinery and biomass pyrolysis. He has published more than 160 research papers in peer-reviewed journals and edited one book on Membrane Technology & Applications (Taylor & Francis, USA). He is an Associate Editor of Journal of Chemistry; Associate Editor of The Journal of Institution of Engineers (India) Series: E; Associate Editor of Research Journal of Environmental Sciences; Review Editor of Frontiers in Bioenergy and Biofuel and Editorial board member of Renewable Energy (Elsevier). He is a Fellow of Royal Society of Chemistry, UK and Fellow of Institution of Engineers (India) and Life Member of Indian Institute of Chemical Engineers. Currently, he is holding the post of Head, School of Energy Science & Engineering at IIT Guwahati.

A preliminary analysis on the separation of ultrafine plastics particles from water.

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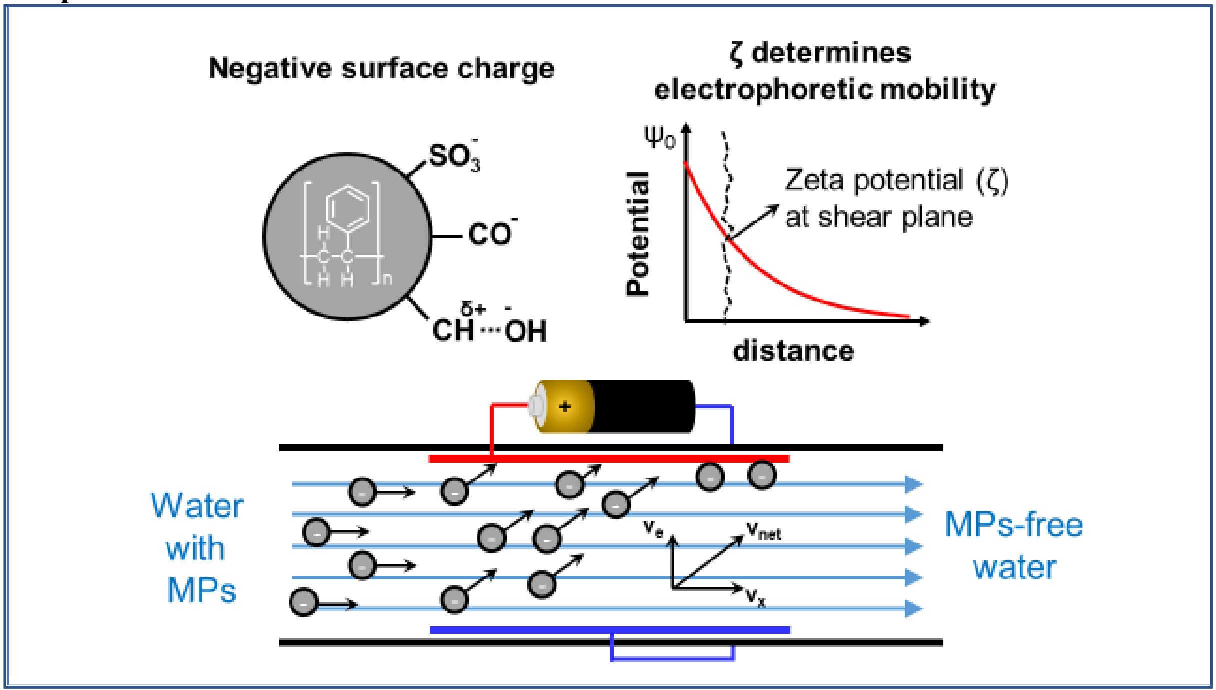
Keywords: electrophoresis, ultrafine plastics, surface charge, critical applied voltage, continuous-flow electrically assisted separator

Graphical Abstract



Abstract
The presence of plastics particles, especially in the size range between nano and micrometer, i.e. the ultrafine class, is expected to be severe ecological and human health risks. The separation of ultrafine plastics from aquatic environment is crucial to the characterization and control of plastic materials in water. While plastics appear to be intrinsically inert, nonetheless,

three mechanisms can be visualized to contribute charge to plastics surface. First, defects, both edge and bulk, created during synthesis, are the most accessible sites for initiating surface charges through ion adsorption. These edge and bulk defects also provide opportunity for reaction with water molecule, i.e., hydration reaction. Finally dipole-dipole interaction between water molecules and surface electro-rich atoms such as N, Cl, O and S readily create hydroxo groups. Together, these reactions generate Bronsted acidity on plastics surface.

Electrophoresis is applied to analyze the surface charge (or zeta potential) of selected plastics particles, such as polystyrene (PS) and *polymethyl methacrylate* (PMMA) latex in simple electrolyte ($NaClO_4$) as a function of pH, particle size and particle number concentration. Results clearly indicated that the electrophoretic mobility (or zeta potential) was affected by particle size and particle number concentration, in addition to ionic strength and pH. For example, the electrophoretic mobility increased from -2.25 to -1.0 μm-cm/V-s when the ionic strength was increased from 0.05 to 0.3 M in $NaClO_4$ electrolyte at PMMA concentration of 50 mg/L and pH 8.5. The electrophoretic mobility decreased from -2 to -4.5 (μm-cm/V-s) when the preliminary particle size was increased from 30 nm to 2000 μm. The variation of surface charge as affected by particle size and number concentration particularly was interpreted on the principle of electrical double layer.

Several forces govern the movement (and transport) of ultrafine particles including plastics in aquatic environment, gravity, friction and electrostatic. The terminal velocity of micro-plastics particles (particle size between 1 to 10 μm) is controlled by electrostatic and gravity forces, whereas electrostatic force alone is the dominant factor controlling the transport of nano-plastic particles. Preliminary simulation on the separation efficiency of ultrafine plastics particles was conducted using continuous-flow reactor. Preliminary results showed that at applied DC voltage, E_{app}, equal or greater than the critical separation potential, E_c, it is possible to achieve 95% separation of nano-plastics particles within 60 min from an electrostatic separator having a retention time of 20 min for plastic particles of the size of 5 mm and density of 1.2 g/cm^3 under E_c of 30 V/cm.

In conclusion, electrophoresis is feasible for the collection of ultrafine plastics particles from dilute surface water.

Biography

Prof. Chin Pao (C. P.) Huang is the Donald C. Phillips Professor and the Francis Alison Professor at the University of Delaware in Newark, Delaware, USA. Prof. Huang received his BS degree in civil engineering from National Taiwan University, Taipei, Taiwan, in 1995. He then earned his MS degree in environmental engineering and Ph. D. degree in aquatic chemistry from Harvard University, Cambridge, Massachusetts, USA, in 1967 and 1971, respectively. Prof. Huang has advised the thesis research of over 50 Ph. D. and 70 MSs, and mentored a dozen of post doctors. Prof. Huang's research expertise is in thermodynamics and kinetics of chemical reactions at the solid-water interfaces. His recent research interests are advanced oxidation processes, environmental electrochemistry, and environmental nanotechnology. Prof. Huang has published over 300 refereed journal articles in addition to editor of six bookts. His current h-index is 86 with 27441 total citations according to Google Scholar. Among his many honors and award, Prof. Huang was a recipient of the Gordon Maskew Fair Medal of Water Environment Federation and Gordon Maskew Fair Award of American Academics of Environmental Engineers and Scientists. Prof. Huang was also the awardee of the Life-time Achievement Award of Asian-Americans Engineers of the Year.

Characterization and analysis of microplastics and nanoplastics in water

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Keywords: Microplastics, Nanoplastics, Raman Micro Spectroscopy, Fourier Transform Infrared Spectroscopy, Drinking Water

Abstract
The global increase in plastic waste has received world-wide attention recently, especially during the COVID-19 pandemic. Lots of consumer products that are used daily contain plastic components and living without plastics is somewhat unimaginable. There should, therefore, be methods to mitigate plastic waste or to recycle used plastics. However, challenges persist in the detection and analysis of plastic particles in the environmental media, especially in drinking water, due to the presence of nanoscale plastic particles. Such challenges include, but are not limited to, a lack of standardization of sampling, inconsistent pretreatment standards, and a lack of standardization of analytical methods of microplastics and nanoplastics. Such issues may be overcome through accurate validation of analysis data and by producing standards for identifying and quantifying microplastics and nanoplastics. Few studies have been carried out for the identification and quantification of microplastics and nanoplastics in drinking water, including tap water and bottled water. A systematic approach, ranging from sample preparation, purification, and analysis to QA/QC, is suggested for accurate analysis of microplastics and nanoplastics in water. Furthermore, consistent protocol from international standardization is recommended in all steps involved in the characterization and analysis of plastic particles, including sampling, pretreatment, and characterization and analysis. In this presentation, characterization and analysis methods for microplastics and nanoplastics from different types of water are presented, along with the gaps in research identified through the characterization and analysis of microplastics and nanoplastics in water.

Biography
Dr. Ingyu Lee received his Ph.D. in environmental engineering at the University of Seoul, under the supervision of Prof. Hyunook Kim. Following his Ph.D. degree, he served as a research associate at Argonne National Laboratory. He has three years of research experience since his Ph.D., in wastewater treatment technologies, water quality control systems, and waste treatment, with a particular focus on anaerobic digestion.

Effect of Plastic and Micro-plastic on Climate Change

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Keywords: Climate change, Global Environment, Micro-plastic, Environmental pollution

Abstract
More than one million seabirds and over 100,000 sea animals are killed each year by plastics. Microplastics arise from a range of sources, including bigger, smaller and smaller plastic trash. Moreover, microbeads are extremely few components of produced plastic polyethene, incorporated into health and beauty goods like certain cleaners and toothpaste as exfoliants. These tiny particles are easily transported through water filters and end up in the ocean and the Greater Lakes, posing a risk to water life. The difficulty with microplastics is that they don't dissolve into harmless molecules like plastics of any size. It can take hundreds of miles of years for plastics to break down — and the environment to be devastated meanwhile. Microplastics are evident on beaches as tiny colorful, sandy particles of plastic.Marine creatures regularly eat, resulting in microplastic contamination. In addition to their mechanical effects, free-floating pollutants, such as polychlorinated biphenyls, polycyclic aromatic hydrocarbons (PAH), and heavy metals tend to stick to their surfaces. Microplastics are in two categories: primary and secondary. Primary microplastic consists of small, commercially-designed particles such as cosmetics, as well as clothes and other textiles that are microfibers, such as fishing nets. Secondary microplastic is part of the degradation of more extensive plastic components, such as bottles of water. This decomposition is due to exposure to external elements, namely sunlight and ocean waves. Pollution from plastic is a risk to the safety and quality of food, healthy human beings, coastal tourism, and climate change. Study shows that when exposed to sun energy plastics produce greenhouse gases; studies reveal that microalgae are polluted by pollution from microplastics, which reduces the capacity of those plants to photosynthesize carbon in trapping them. The findings show that pollution from micro-plastics may interfere with the sequestration system for natural carbon in the ocean. Sunlight and heat contribute to potent greenhouse gases released by plastic which lead to an alarming feedback circuit. As climate changes, the globe is hotter, more methane and ethylene are produced from plastic, which increases the rate of change and perpetuates the cycle. The utilization of existing international, legally binding agreements to combat marine plastics pollution is urgently needed. To avoid and decrease plastic pollution, recycling and reuse of plastic items and funding for research and innovation are essential to developing new products to replace plastics.

Biography
Dr Nirban Laskar is Assistant Professor in the Department of Civil Engineering at Mizoram University, Aizawl, India. He has more than three years of teaching experience and he has expertise in Water Resource and Environment Engineering.

Monitoring, Control and Assessment of Plastic Wastes:
A Life-Cycle Thinking for Circularity

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Abstract
Plastic wastes in the natural environment have aroused significant attentions around the world due to its severe impacts to ecosystem and human health. In particular, microplastics (or nanoplastics) in combination with toxic contaminants would be transferred through the food chain via bioaccumulation, thereby potentially affecting food safety and human health. In this research, we will provide an overview on the current situations of global plastic wastes. Then, we will discuss the key elements in monitoring, control and assessment of plastic wastes from a life-cycle thinking. For instance, in the case of monitoring, we will illustrate the methodology of thermal analyses, such as thermogravimetric analysis, for quantifying the microplastics in real waterbodies. We will also discuss the reuse and recycle of plastic wastes from both theoretical considerations and practical applications, thereby realizing circular economy system. Lastly, we will point out the priority research directions for microplastics monitoring, control and assessment, including (i) development of standardized and robust methods for sampling, characterization and quantification of microplastics in water, sediments and biological tissues, (ii) development to effective strategies and technologies for control and removal of microplastics, (iii) evaluation of occurrence, behaviors and fate of microplastics at global scale concerning their long-terms effects to ecosystems, and (iv) thorough assessment of health and ecological risks in different environmental matrices. This study will provide an insight into the green research on renewable alternatives and/or alternative waste management strategies for plastic wastes.

Biography
Shu-Yuan Pan is currently an assistant professor at Department of Bioenvironmental Systems Engineering, National Taiwan University. He received his PhD degree in Environmental Engineering from National Taiwan University. He was included in the list of "World's Top 2% Scientists" in the field of Earth & Environmental Sciences (2020); and was awarded the "Young Scholars Fellowship (the Einstein Program)" by the Ministry of Science and Technology, Taiwan (2019); the "Honorary Member" by the Phi Tau Phi Scholastic Honor Society (2016); the "Green Talents Fellow" by BMBF, Germany (2013). His current research group focuses on the GREAT (Green Research for Environmental and Agricultural Technologies) work. He has published more than 80 SCI-index Journal articles with a total citation of >3700 times and an h-index of 32 (Data on September 2021 from Google Scholar). He holds 7 issued patents and 4 pending patents.

Stormwater treatment systems – a long-term sink or source of microplastics?

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Keywords: Microplastics, stormwater, urban pollution, green infrastructure, biofilters.

Abstract
Stormwater, particularly urban runoff, conveys of high concentration of microplastics from their sources to terrestrial water bodies such as ponds, lakes, and rivers. In urban areas, stormwater treatment systems such as biofilters are typically used to reduce over-land flow, increase infiltration or groundwater recharge, and treat stormwater for reuse in water-stressed areas. Microplastics could accumulate in these systems, which may later serve as a net source of microplastics. Yet, the fate of microplastics in these systems is unknown. Furthermore, it is unclear to what extent microplastics may migrate deeper into the subsurface and whether they could pose any risk to groundwater pollution. The overall objective of the proposed study is to examine the accumulation and transport of microplastics in stormwater treatment systems. We analyzed the subsurface distribution of microplastics in and outside the boundaries of fourteen stormwater infrastructures including bioretention system, bioswales, and biofilters in Los Angeles, and compared the distribution above and below ground in the bioswale to compare the relative contribution of wind and stormwater that carry microplastics to bioswales. The concentration of microplastics exponentially decreased with subsurface depth, indicating the accumulation of microplastics within the top 5 cm of subsurface soil and groundwater pollution risk from the accumulated microplastics is low. Outside the treatment system boundary, the subsurface retardation coefficient decreases with increases in soil grain size (D50), indicating filtration or straining of microplastics. Inside the boundary of the treatment system, however, the retardation coefficient was independent of soil grain size, indicating compost or mulch used in the filter layer may have been contaminated with microplastics. The retardation coefficient appears to be independent of land use. Surprisingly, the concentration of microplastics within stormwater infrastructures is not different ($p>0.5$) from the concentration outside stormwater infrastructures boundary, indicating atmospheric deposition is a significant factor in the deposition and accumulation of microplastics on the surface of stormwater infrastructures. The high concentration of microplastics on leaves of vegetation in stormwater infrastructures confirmed that atmospheric deposition can be a dominant pathway of delivering microplastics to stormwater infrastructures in addition to stormwater. Overall, these results improve the understanding of how and where microplastics may accumulate in stormwater infrastructures in urban areas.

Biography
Dr. Sanjay Mohanty is an assistant professor at the Department of Civil and Environmental Engineering at the University of California Los Angeles (UCLA). He directs the Subsurface Engineering and Analysis Laboratory at UCLA. His research group examines how fundamental physical and biochemical processes in subsurface soil are shifted under natural and anthropogenic stressors such as compaction, excess pollutant loading, wildfire, drying, freezing, and flooding. His research applies these fundamental concepts to engineering the subsurface soil for different purposes: treat stormwater from a wide range of pollutants, improve bioremediation methods, and alleviate deterioration of soil

and water quality during climate change.

Systematic Meta-analysis of Microplastic Concentrations in Aqueous Ecosystems

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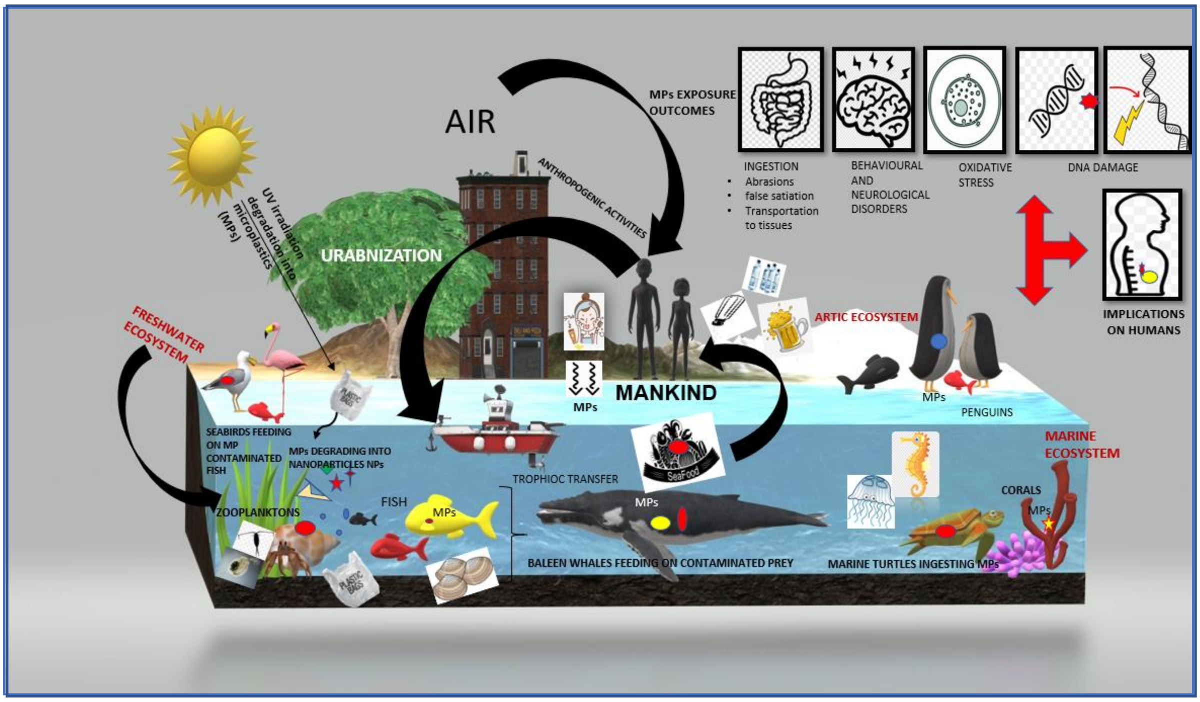
Graphical Abstract



Abstract
Background
Micro- and nano- sized plastic particles have given rise to a newfound curiosity among researchers as they are gathering steam in terms of its potential human and environment health hazards. The discovery of plastic particles of the micro-scale sizes, in the ‘pivot of change era’ of the early 1970s, led to the genesis of the term ‘Microplastics (MPs)’ which was hypothesized to contribute towards the emerging threats of environment and human health. Apart from the reports of around 690 marine species being contaminated by MPs up till now, there are also recent records of MPs presence in table salts (> 100 brands), drinking water (both tap and bottled), branded milk, beer, seafood, canned sardines, tea bags, meat packaging, take-away food containers, market cooked rice and inevitably in air with an estimated human body burden of (0–3.0) $\times 10^7$, (0–7.3)$\times 10^4$ and (0–4.7)$\times 10^3$ items per person per year through inhalation, consumption of table salt and drinking water respectively. With such an interminable,

quinquagenarian surge of MPs now, we have managed to score 8.3 billion metric tons of the world-wide volume of plastics. The infiltration of MPs in the water systems is majorly the result of anthropogenic activities of mankind at individual as well as community level. The domestic runoff in the form of fibers, microbeads, and differential fragments of MPs from cosmetic and other household consumer products, becomes the main cause of aquatic exposure in the present times. Besides, the uncontrollable degradation of the larger plastic items, releases from the manufacturing industries (pellets and resin powders from air-blasting) severe the menace. Fishing, tourism, recreational activities also contribute significant primary pathways of exposure leading to marine and freshwater organism's susceptibility to MPs. However, the studies have been reporting toxicities of MPs at unrealistic concentrations which are not likely in near future based on the analysis of the current reported MPs concentrations from across the world in surface water, sediments as well as the organisms.

Objective

We carried out a systematic meta-analysis to analyse the concentrations of microplastic from environmentally occurring field samples (like water, sediment and organisms) and the concentrations employed under laboratory settings in order to have a comparative interpretation among the severity of exposure and resultant toxic effects among the organisms.

Methodology

In this work, a total of 201 data points including environmentally occurring MPs and concentrations of MPs in laboratory settings have been analysed towards constructing a severity Index based on the concentrations of MPs and thereby clearing the risk picture associated with it. The reported environment and laboratory concentrations have been compared to interpret the reality behind the MP pollution and the hazard it poses to the environment.

Key Findings

Among the 100 incidences of MPs concentration in laboratory, 22 points had concentrations lying below the highest reported environmental concentration i.e., 1.54E+08 MPs/m3. An in-depth search of the MPs related available literature lead us into formulating a Hypothesis as: The severity of the MP toxicity increases with increasing number of particles and decreasing size. The lowest environmentally occurring concentration of MPs was found to be reported in the Gulf of Maine in the United States by Law et al., (2010), with an abundance of arou nd 0.001particles/m^3 while the highest environmental concentration of the MPs was in the European snow (1.54E+08 MPs/m^3) comprising mainly of varnish, rubber, PE, and PA which was calculated to be about 4.42E+11 fold lesser than the highest reported laboratory concentration of about 6.80E+19 MPs/m^3 that has been used to assess MPs toxicity in prim ary producers using *Skeletonema costatum* model system. Most of the lab experiments were conducted at approximately 4.17E+11-fold higher MPs concentrations compared to environmentally relevant concentrations. Among the total of 100 studies done under laboratory settings, only 22.0% lie under the reported field concentration. The average reported concentrations from field studies and laboratory exposure studies were found to be 1.90E+06 MPs/m^3 ± 1.54E+07 MPs/m^3 and 7.92E+17 MPs/m^3 ± 6.82E+18 MPs/m^3 respectively. Around 1.54E+08 MPs/m3 and 2.00E-03 MPs/m3 was the maximum and minimum reported MPs concentration from the selected data points in the present investigation. However, there are still some voids in the environmental MPs data in terms of the spatial concentrations in a given time, as many areas are still unexplored for their MPs loads. Based on the analysis, we made MPs concentration index scale to have toxicity criteria noticed among the organisms under *in situ* and lab conditions.

Conclusion &Recommendations

Microplastics have been found to be present in the natural environments and are notorious of their harmful lingering effects on the biota. Scientific communities have targeted and identified MPs and have demonstrated their detrimental effects on a range of organisms both from the aquatic and terrestrial ecosystems. However, the concentrations of the MPs used in such extrapolatory studies was found to be many folds higher than what has been reported from the environmental matrices leading to a confused status of MP adversities. There is hence a huge need for the standardization of the exposure units and concentrations as well as the adoption of guidelines for regulated experiments on MPs, as the cumulative number of laboratory trials might pose as another pathway for MPs exposure to the untargeted populations through inadvertent disposal practice. Hence it is recommended to consider the future work based on reported concentrations in the environment for assessing the risk associated with MPs. This will provide a sustainable development goal for the developing countries in tackling the MPs menace and precise risk assessment strategy in regulatory point of view.

Biography

Dr. Anbumani Sadasivam is a senior scientist in the Division of Ecotoxicology at CSIR-Indian Institute of Toxicology Research (Government of India).