SciMedCentral Chemical Engineering & Process Techniques

Review Article

Emerging Threats to Aquatic Environments Due to the Essential Add-on for COVID 19 Pandemic- Waste Management as a Proxy

Manikanda Bharath K[1]*, Usha Natesan[1], Judith D Silva[2] and Sathya Velusamy[3]

[1]National Institute of Technical Teachers' Training and Research, Chennai, India
[2]Tamil Nadu Irrigated Agriculture Modernization Project, Public Works Department, Government of Tamil Nadu, India
[3]Department of Environmental Sciences, Anna University Taramani Campus, India

***Corresponding author**

Manikanda Bharath K, National Institute of Technical Teachers' Training and Research, Chennai, Tamil Nadu - 600113, India, Email: krmanibharath93@gmail.com

Submitted: 19 May 2022

Accepted: 16 June 2022

Published: 17 June 2022

ISSN: 2333-6633

Keywords

- Covid-19
- Face masks
- Medical waste management
- Advanced technologies
- Environmental monitoring

Abstract

In the present situation of the COVID 19 pandemic, the essential use of face masks, medical gloves, and other things is wielded as personal protection equipment for human health and to minimize further disease infections. Increased usage of face masks, medical gloves, and other essential materials to grow in plastic pollution threaten the aquatic organisms in environments.

According to current research, microplastic contamination should be a major concern due to its massive impact on aquatic biota and the overall ecosystem. The purpose of this research is to look at the environmental impact of face mask wastage and to find sustainable techniques to decrease this waste and help them sustain the environment. In the current situation, to tackle the global COVID 19 pandemic and minimize plastic pollution, many countries enact policies and strict rules on the usage and alternatives of plastics. As a result, it is critical to take the required actions, such as collection, segregation, storage, and recycling, to safely dispose of face masks and to use alternative technologies to improve resource recovery.

INTRODUCTION

As the COVID-19 (SARS-Cov-2) track has been very active since 2019, December in China and then globally, making people vibrant and alert all through their routine activities with no hope for future commitments marks a strong footprint insisting on their usage of Personal Protective Equipment (PPE) [1]. This PPE is ultimately made of non-recyclable plastic, which again challenges Mother Nature, already affected by multifarious burdens. In the vein of reducing plastic waste, rapidly increasing PPE exposure has become challenging, threatening the livelihood on this affected planet earth.

As per Laura Parker, National Geographic, April 15, 2021, 65 billion gloves per Month are used globally, with a tally of face masks reaching 129 billion per Month with approximately twice the usage compared to gloves [2]. This calculation accounts for 3 million face masks/per minute. The National Geographic also highlights the disposal of 3.4 billion face masks or face shields being discarded every day, with Asia holding the top position of all the continents globally with the removal of 1.8 billion face masks every day [3]. There is a global say "Disposable" for many synthetic products, but actually, they are not getting off whereas occupying the globe in alternative forms imparting multiple taints and shortcomings with no proven records [4].

Moreover, the composition of PPE kits is mostly plastic fibers, especially polypropylene which takes centuries for fragmentation into micro and nano plastics, ultimately polluting the environment with the release of 173,000 microfibers/per mask/per day as per the study of Environmental Advances [5]. Compared to developed nations, developing countries pay less attention to nature, thinking it is not their responsibility to protect it [6]. This, on the other hand, results and affects very tremendously with loss of population, economy, livelihood, increased poverty, elevated crime rate, etc. People's ignorance and laziness in discarding the used PPE also mark various problems for six sense human beings and five sense other living creatures. The improper disposal of used face masks/face shields, gloves, etc., increases the percentage of this ongoing COVID-19 trauma; the innocent cattle and birds get entangled with the straps of the carelessly discarded masks [7]. The outbreak of this ongoing pandemic is also of global concern as it threatens the international scientist's crisis of curbing plastic pollution with no solid solution. Apart from the PPE used for self-protection against the ongoing COVID-19, the circulation of plastics in other forms for packaging and takeaway has increased to a much more drastic range without control. This has happened because the policymakers and general public control the contagious pandemic rather than curbing the usage and circulation of plastic products. In India as part or whole, there is no separate strategy adopted for disposal of the used mask. However, awareness is created to disinfect/segregate the used PPE separately before discarding or handing it over to the concerned solid waste management system adapted in their locality. Inappropriate disposal of used PPE affects both health and the environment [5,8,9].

Liebsch [10] warns of global warming because of the tremendous usage of face masks or face shield. The by-products used in producing N95 masks and sewing for cloth mask production enhance the emission of CO_2 into the atmosphere, thereby resulting in global warming. Accordingly, Klemme Š et al. [11] in their study on “The energy and environmental footprints of COVID-19 fighting measures -PPE, disinfection, supply chains” reveals the increase in CO_2 released during the production process, which are 50 g CO_2 -eq/N95 Masks, 59 g CO_2 -eq/ Surgical Mask and 60 g CO_2 -eq/Cloth Mask respectively. The accounted CO_2 emission is only for a single piece, and imagination of this scenario on a global scale which is actively in practice imparting a significant role as a warrior for the ongoing pandemic of Covid is shocking with no appropriate solution. Though there are no permanent solutions available for the disposal of plastic-related waste, different management and assessment approaches like incineration, landfilling, etc., have been used [12]. Though there are streamlined technologies available for treating hospital waste like pyrolysis, microwave, etc.[13,14], there is a dramatic rise in PPE waste in the ongoing COVID-19 as people are instructed for mandatory wearing of the lifesaver "Masks" [15]. Sarawut Sangkham [5] in his study on "Face mask and medical waste disposal during the novel COVID-19 pandemic in Asia" has appropriated 381,179,657 pieces of total daily face mask usage, accounting for 80% of the acceptance rate with 6,491.49 (tons/day) of medical waste for India considering 1,381,085,714 population on an appropriate. The face mask is being utilized as personal protection equipment for human health and stopping ram the spread of the virus in the ongoing COVID 19 pandemic. Plastics or other by-products of plastics are used in most face masks. Increased use of face masks leads to increased plastic pollution, which endangers aquatic creatures in the ecosystem. There are several approaches and methods for treating microplastic-contaminated soil and water, but they are all in their early phases. Environmentalists have warned that the epidemic has intensified existing plastic waste issues by contributing to increased ocean pollution. The purpose of this study is to investigate the environmental impact of face mask waste and to develop sustainable techniques to decrease this waste. According to current research, microplastic contamination should be a major concern due to its massive impact on aquatic biota and the overall ecosystem.

Face masks, medical gloves, and other waste a threat to oceans

While exposed to ultraviolet (UV), radiation, becoming brittle and fragmenting into microplastic particles. The high temperature, better aeration, and extended daylight are the most appropriate conditions for repeated fragmentation of plastics into micro or nano level. The aquatic conditions such as anaerobic and low temperature result in slow degradation [3]. Figure 1 shows that photographs of face masks, medical gloves, and other waste threaten oceans.

Environmentalists have cautioned that the pandemic has exacerbated the ongoing plastic waste problems by contributing to an increase in ocean contamination [2]. Aside from forming microplastics, improperly dumped face masks can cause respiratory and gastrointestinal blockages and death by malnutrition in wildlife.

Plastics or secondary products derived from plastic materials are found in most face masks. As a result, increased use of face masks, particularly single-use masks, may lead to increased plastic pollution, endangering marine and aquatic environments. Increased use of face masks, surgical gloves, and other essential materials to grow in plastic pollution impacts negatively aquatic life. As a result, the irresponsible disposal of used facemasks into the environment, as well as the mishandling of the waste they generate, may pose a significant pollution load on the region's aquatic ecosystems. In addition to generating microplastics, improperly discarded face masks can induce gastrointestinal and respiratory blockages, as well as death through malnutrition in animals.

Landfill treats and solid waste management

Furthermore, micro and nano plastics from face masks endanger wildlife and pollute our waterways. Studies suggest disposable masks may potentially release harmful contaminants such as heavy metals and toxic dyes [1]. To prevent the spread of the fatal virus, all kinds of safety procedures are being taken during waste disposal. Gloves, PPE kits, masks, and other necessary materials are being made accessible to Safai Sainiks, healthcare workers (HCWs), and other frontline employees (FLWs) [5]. Figure 2 shows the plastic debris, face masks, and medical gloves disposable on the roadside.

New academic studies and environmental policies are considering the rising issues in solid waste management to identify strategies to mitigate the hazard [3]. It is essential to prepare and examine numerous solutions to reduce plastic pollution, namely collection, segregation, and storage strategies for recycling and appropriate methods for safely disposing of face masks and medical waste. Table 1 is given to induce the impact of face mask-i risk of microplastic pollution.

Our effort against waste and devotion to the phrase "reduce, reuse, recycle" helps decrease excessive usage of commodities, and it's the prime importance for humanity. The governing body of different nations uses several global conventions to mitigate plastic pollution. Moreover, reusing and recycling face mask trash and creating materials for building construction from this waste (e.g., artificial aggregates, lightweight plastic blocks, and ecological mortar) might be a feasible option shortly to utilize plastic waste for other purposes and decrease pollution and hygienic issues [4].

Figure 1 Photographs of face masks, medical gloves, and other waste are a threat to oceans.

Figure 2 Roadside disposable face masks and medical gloves.

Current Practices available in India and Tamil Nadu

In India, Cities like Chennai have already framed protocols and rules to handle and dispose of COVID 19-related biomedical wastes its details are given in Table 2. Initiatives such as segregating the waste in yellow-colored bags, disinfecting the wastes before disposal, and other such guidelines are given by both State and central pollution control boards of India [6]. A 16-member group would monitor Chennai's biomedical waste disposal every Month. The committee, led by the Chennai district collector, is charged with drafting the District Environment Plan and reporting to the Chief Secretary on the efficient execution of the Bio-Medical Waste Management Rules, 2016. The Officers from various government agencies, including revenue, Chennai Corporation, PWD, fisheries, rural health services, and animal husbandry, served on the board. The Tamil Nadu

Table 1: The Potential impacts of face mask based microplastic pollution.

Category	Issue	Consequences	Ref.
Environmental	• Occurrence of plastic in the aquatic environment. • Improper disposal of facemask reaching water bodies. • Microplastics create a new microbial niche.	• Enter the major food web to human existence. • Bioaccumulation of toxins. • Act as a medium for further outbreaking of COVID-19 since the particles tend to proliferate microbes and disseminate in the food chain and/or direct attacks. • Affect microbial habits and the environmental processes in aquatic ecosystems.	(Haque et al., 2021) [14]
Social	• Pollution of aquatic environment or shore with plastics or plastic particles.	• Reduces aesthetic and recreational value thus, impacts to human social and mental stability.	(Yang et al., 2020) [16]
Economical	• Environmental and social impacts of plastic and plastic particles.	• The clean-up activities and lifesaving activities of the aquatic bodies are expensive. • Tourism industry experiences a significant loss.	(Zheng et al., 2019) [17]

Figure 3 Coastal clean-up pro for Chennai Beach at International Coastal Clean-up Day.

Pollution Control Board (TNPCB), will publish monthly progress updates. This follows a July 15 ruling from the National Green Tribunal's Principal Bench, which told all states two months to organize district-level committees and establish an assessment of healthcare institutions and bio-medical waste generation, as well as put up a website. Regulations are being approved to form district-level observation committees around the State, according to official sources in the TNPCB. The Centre Pollution Control Board (CPCB), recently presented a report to the National Green Tribunal (NGT), that discovered various flaws in the execution of Bio-Medical Waste Management rules in Tamil Nadu and recommended the suspension of health care facilities for ongoing violations [6]. In April, the TNPCB reported that 4,307 healthcare establishments generated 17,226 tonnes of bio-medical waste each year. However, according to the most recent submission, there are 7,651 healthcare institutions.

Tamil Nadu, Pollution Control Board issued a Public Notice for Urgent Attention

Responsibilities of Health Care Establishments (HCFs), and all healthcare services /Quarantine camps or Residences care facilities/Testing labs and Common Bio-Medical Waste Treatment Facilities (CBMWTFs), are compelled to share the specific treatment/guidelines relating to the management, collection, transportation, and dumping of biomedical waste produced after treating COVID-19 affected persons as outlined

Table 2: Current practices for infectious waste separation, storage, transportation, and disposal in India.

Country	Practices for COVID-19 Waste Generated from Healthcare Facilities	COVID-19 Waste Treatment and Disposal
India	• Use dedicated trolleys and collection bins in COVID-19 isolation wards, laboratories, and test centers. Used masks are discarded and collected in separate 'yellow color-coded plastic bags' (suitable for biomedical waste collection) labelled 'COVID-19 waste.' • Disinfect inner and outer surfaces of containers, trolleys, and bins with 1% NaClO solution daily. • Depute dedicated sanitation workers for biomedical and general solid waste collection and timely transfer to temporary storage. • Use vehicles with GPS and barcoding systems for containers containing HCW for waste tracking. Label vehicles with 'Biohazard' sign.	• Common biomedical waste treatment facility (CBWTF). • Disposal permitted by deep burial only in rural or remote areas without CBTWF facilities. • Large volume of yellow color-coded (incinerable) COVID-19 waste beyond the capacity of existing CBWTFs and BMW incinerators, usage at existing treatment, storage, and disposal facilities (TSDFs) or captive industrial incinerators if any exist in the state/union territory. In such cases, ensure separate arrangements for handling and waste feeding.

below: Maintain proper waste segregation in hospitals by using different color-coded dumbing bins or containers, as per BMWM Rules, 2016 as amended, and CPCB instructions for BMW Management Rules implementation. To ensure appropriate durability and no leakage, waste from COVID-19 treatment must be collected in double-layered bags (using two bags). Before handing across the same CBMWTF, collect and store biological waste in a specified area. COVID-19 debris should be stored in a particular collecting receptacle labelled "COVID-19 waste" and segregated in a temporary storage area until delivered to CBWTF approved workers. Hospital waste is collected in COVID-19 treatment wards can be transported straight from the ward to the CBMWTF collection vehicle. COVID-19 Waste should always be marked on bags/containers used to collect hazardous wastes from COVID-19 wards.

Keep a distinct document's path record of the waste generated in COVID-19 treatment wards. In COVID-19 treatment wards, utilize specialized carts and collecting containers. These goods should be labelled as "COVID-19 Waste." Daily disinfection of the (in and out), surfaces of dumping bins used for COVID-19 dumping sites must be done with a 1% sodium hypochlorite solution. Separately assign sanitation employees to handle COVID-19 biomedical waste and ordinary solid waste.

Some advanced treatment technologies

Bioreactors: Bioreactor-based wastewater treatment technologies are considered eco-friendly and sustainable technologies. The bioreactor is mainly devised with microbes immobilized on a dynamic bed of biofilm or membrane of biofilm.

Mechanical separators and separators usually carry out the process of separating liquid water from biosolids in bioreactors joined with sequential tanks. The aerators meant for air circulation also fasten up the biochemical function of microbes in the bioreactor. The biochemical reactions between the wastewater and microbes in the bioreactors lead to the degradation of contaminants into less toxic or non-toxic. If the wastewater contains heavy metals, sulfate-reducing bacteria may be inoculated, producing hydrogen sulfide and paving the way for the precipitation of soluble metals as metal sulfides. Thus, they can be recovered as a value-added product.

Biofiltration: Biofiltration is the process of specific bacterial or microbial species grown on a biofilter to form a biofilm. Then the wastewater should be passed through this biofilm via up-flow or downflow way. The degradation of organic matter and other pollutants present in the wastewater will be degraded by immobilized microbes faster. Factors such as the activity of microbes, time, amount of oxygen, heat, and water composition are significant in the action of the biofilm, and then the quality of treated wastewater is also dependent on the above factors. This green treatment type is appropriate for domestic wastewater and industrial water treatment.

Bioremediation: Bioremediation is the process of utilizing microbes for the removal or transformation of contaminants from wastewater into less toxic or non-toxic forms. There are two types of bioremediations such as in-situ and ex-situ. Practically, using microorganisms in contaminated sites has certain limitations. Hence, it is impossible to remove or clean up all the contaminants using bioremediation or biofiltration technologies. Thus, other advanced green technologies like electrowinning and electrocoagulation were successfully developed and employed in wastewater treatment.

Electrowinning: Electricity is passed between cathode and anode engrossed in an electrolyte solution called electrowinning. Metals are extracted electrically from dissolved cations and embedded in the cathode. Thus, electrowinning can recover metals and metalloids from wastewater. Unlike conventional electrowinning, where electrolytes are circulated slowly or stagnant, green treatment technologies 'emew electrowinning' use a strong electrolyte circulation flow. It significantly enhances the diffusion of metal species into the cathode and deposits faster and can also recover the metals even at low concentrations.

Electro Coagulation: Electrocoagulation is a process of introducing coagulants electrochemically and removing suspended and colloidal forms of pollutants from wastewaters. This process is generally used to remove pesticides, radionuclides, other contaminants, and even microbes from wastewaters.

(1) hydrated cations are generated at an iron or aluminum anode by applying electric current

(2) the charges of pollutants are neutralized by the cations, and the unstable particles become micro-flocculants;

(3) these micro-flocculants can be removed from the water quickly. The complete mechanism of these green treatments technologies is a combination of ionization, electrolysis, hydrolysis, and free-radical formation. It changes both the physical and chemical properties of wastewater, removes the pollutants, and finally results in the treated wastewater suitable for discharge.

Coastal clean-up and management of face masks during the COVID-19 pandemic

Public-private partnerships in research, infrastructure, and marketing, would aid in bringing about the improvements mentioned earlier. Individual responsibility, business action, and government policy are required to prevent us from moving from one tragedy to the next. Therefore, this extensive usage of COVID-19 essential add-ons such as face mask gloves generates a vast amount of plastic waste in a shorter period. Every year the Coastal clean-up prog was implemented in Ram Chennai Marina beach on International Coastal Clean-up Day shown in Figure 3.

Large plastic items and their degraded fragments can be transported through wind, eroded soil, and surface runoff into the aquatic ecosystem. The conducive environmental conditions such as heat, sunlight, and a well-aerated environment led to the generation of microplastics through repetitive fragmentation of the plastics. At the same time, the other conditions, such as cold and oxygen-free aquatic environments and sediments, will pave the way for the temporal degradation of plastic materials over a significant period at a slow phase.

CONCLUSIONS

As a result, comprehensive tests and analyses should be carried out to check the conclusion of each method's efficiency and appropriateness. The 4Rs method should be used to control any plastic waste. While various ways are simple to implement and efficient, there is a risk of additional contamination from the chemicals used in those processes. As a result, we may choose appropriate physical or biological approaches for the sustainable treatment of microplastics. Effective waste management regulations and policies may pave the path for scientific treatment and disposal of plastic waste, reducing the growing microplastic pollution from various sources and reducing plastic pollution by encouraging sustainable plastic waste management technologies by focusing our policies to inculcate individual behavioural, societal, and institutional improvements. These increasing problems in solid waste management during and after the epidemic have been explored in light of new research and environmental legislation. Thus, it is essential to plan and consider separation, storage, and collection for recycling and disposing of face masks and medical waste to decrease plastic waste and facilitate alternative waste technologies. To promote and encourage the use of natural plant fiber face masks and limit the risk of the pandemic spreading to the environment from hospitals and communities, standardization processes and rigorous medical waste management standards must be developed and carefully implemented. Technologies to assess and reduce the number of plastic debris entering water bodies should be established. Governments, for example, may develop innovative solutions and take the lead on appropriate disposal to address the issue of plastic pollution from Covid waste. Implementing some, if not all, of these recommendations in India, should help to guarantee that the impact of COVID-19 does not generate a legacy of microplastic pollution in the aquatic environment.

REFERENCES

1. Du S, Zhu R, Cai Y, Xu N, Yap PS, Zhang Y, et al. Environmental fate and impacts of microplastics in aquatic ecosystems: a review. RSC Adv. 2021; 11, 15762-11784.
2. Temitope D, Oyedotun T, Kasim OF, Famewo A, Oyedotun TD, Moonsammy S, et al. Municipal waste management in the era of COVID-19: Perceptions, practices, and potentials for research in developing countries, Research in Globalization. 2020; 2: 100033.
3. Tripathi A, Tyagi VK, Vivekanand V, Bose P, Suthar S. Challenges, opportunities, and progress in solid waste management during COVID-19 pandemic, CSCEE. 2020; 2: 100060.
4. Nzediegwu C, Chang SX. Improper solid waste management increase potential for COVID-19 spread in developing countries. Resour Conserv Recycl. 2020; 161: 104947.
5. Sangkham S. Face mask and medical waste disposal during the novel COVID-19 pandemic in Asia. CSCEE. 2020; 2: 100052.
6. Ramteke S, Sahu BL. Novel coronavirus disease 2019 (COVID-19) pandemic: Considerations for the biomedical waste sector in India. CSCEE. 2020; 2: 100029.
7. Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature . 2020; 579: 270-273.
8. de Sousa FDB. Pros and Cons of Plastic during the COVID-19 Pandemic. Recycling. 2020; 5: 27.
9. Parashar N, Hait S. Plastics in the time of COVID-19 pandemic: protector or polluter? Sci Total Environ. 2021; 759: 144274.
10. Liebsch T. The Rise of the Face Mask: What's the Environmental Impact of 17 Million N95 Masks? 2020.
11. Klemeš JJ, Fan YV, Jiang P. The energy and environmental footprints of COVID-19 fighting measures -PPE, disinfection, supply chains. Energy (Oxf). 2020; 211: 118701.
12. Vanapalli KR, Sharma HB, Ranjan VP, Samal B, Bhattacharya J, Dubey BK, et al. Challenges and strategies for effective plastic waste management during and post COVID-19 pandemic. Sci. Total Environ. 2021; 750:141514.
13. Ilyas S, Srivastava RR, Kim H. Disinfection technology and strategies for COVID-19 hospital and bio-medical waste management. Sci. Total Environ. 2020; 749: 141652.
14. Haque MS, Uddin S, Sayem SM, Mohib KM. Coronavirus disease 2019 (COVID-19) induced waste scenario: a short overview. J. Environ. Chem. Eng. 2021; 9: 104660.
15. Silva ALP, Prata JC, Walker TR, Campos D, Duarte AC, Soares ACDAMVM, et al. Rethinking and optimizing plastic waste management under the COVID-19 pandemic: policy solutions to redesign and reduce single-use plastics and personal protective equipment. Sci Total Environ. 2020; 742: 140565.
16. Yang Y, Liu W, Zhang Z, Grossart HP, Gadd GM. Microplastics provide new microbial niches in aquatic environments. Appl Microbiol Biotechnol. 2020; 104: 6501-6511.
17. Zheng K, Fan Y, Zhu Z, Chen G, Tang C, Peng X. Occurrence and species-

specific distribution of plastic debris in wild freshwater fish from the pearl river catchment. Environ Toxicol Chem. 2019; 38: 1504-1513.

18. Khan MM, Parab SR. Simple Economical Solution for Personal Protection Equipment (Face Mask/Shield) for Health Care Staff During COVID 19. Indian J Otolaryngol Head Neck Surg. 2020; 1-5.

19. Selvaranjan K, Navaratnam S, Rajeev P, Ravintherakumaran N. Environmental challenges induced by extensive use of face masks during COVID-19: A review and potential solutions. Environmental Challenges. 2021; 3: 100039

20. Chaabna K, Doraiswamy S, Mamtani R, Cheema S. Facemask uses in community settings to prevent respiratory infection transmission: A rapid review and meta-analysis, Int J Infect Dis. 2020; 104: 198-206.

21. Tamil Nadu Pollution Control Board Public Notice.

22. How to stop discarded face masks from polluting the planet.

23. Guidelines for disposal of masks, gloves soon in Andhra Pradesh.

24. India's 'Recycle Man' makes bricks from discarded face masks.

25. Safe disposal of used face masks: VST's BIN-19 proves up to the task.

Cite this article

Manikanda Bharath K, Usha N, Silva JD, Sathya V (2022) Emerging Threats to Aquatic Environments Due to the Essential Add-on for COVID 19 Pandemic- Waste Management as a Proxy. Chem Eng Process Tech 7(2): 1068.