



## Use of plastic during covid-19 pandemic: Protector or polluter

Neha Kumawat<sup>1</sup>, Pooja Meena<sup>1</sup>, Ramesh Prajapat<sup>1</sup>, Vinod Kumari<sup>2</sup>, Shashi Meena<sup>3\*</sup>

<sup>1</sup> Research Scholar, Department of Zoology, University of Rajasthan, Jaipur, Rajasthan, India

<sup>2</sup> Associate Professor, Department of Zoology, University of Rajasthan, Jaipur, Rajasthan, India

<sup>3</sup> Assistant Professor Department of Zoology, University of Rajasthan, Jaipur, Rajasthan, India

### Abstract

The Covid-19 pandemic remained both beneficial and adverse consequences for the ecosystem around the world. People used hand gloves, face masks, personal protective equipment (PPE) kits, as well as other protective equipment during the crisis, which contributed to a significant rise in the consumption of plastics and the production of biomedical waste. Fresh food in single-use plastic containers has also increased as a result of safety concerns in grocers and supermarkets. More than 8 million tons of pandemic-related plastic garbage has been produced worldwide, with more than 25,000 tons ending up in the ocean. Therefore, this improper plastic dumping in the atmosphere and aquatic resources could contribute as potential infection vectors. Marine organisms such as turtles, fishes, whales, beach seabirds, and other marine mammals might be at risk of entrapment and unintentional, deliberate, or indirect ingestion of latex gloves which may cause fatal damage and death. In addition, human health hazards are also posed by minute particulate size plastics in seafood, which is a popular source of protein for many people throughout the world. In this review, we have explored how plastic production increased during Covid-19 and how this would contribute to short and long-term environmental repercussions.

**Keywords:** covid-19, plastic waste, aquatic habitat, pollution, environment

### Introduction

Covid-19 has grown to be the most popular and contested object on the entire planet and the cause for this has been the rapid infection and death of mankind. In India, the first instance of the disease was seen in a student on 30th January 2020, in the Thrissur region of Kerala. Given the rapid rate of the virus in the nation and the ensuing catastrophe, a "total lockdown" of 21 days in India has been proclaimed on 24th March 2020. As of the magnificence of Covid cases in India, the time length of the lockdown was prolonged in stages (Chen *et al.*, 2020) [24]. Due to the constant lockdown and various laws and regulations set by the Indian Government, several human activities, including industrial projects, vehicle movement, construction projects, tourism, and other common transportation, experienced a "Never Before" immobility phase. Aside from mandatory governmental actions, the public has been instructed to maintain social distance and to use masks and sanitizers as essential protective equipment. Since the Covid period, people are still wearing face masks, hand gloves, personal protective equipment (PPE) kits, and use other safety equipment such as hand sanitizer to protect them from corona pandemic, which results in a sharp increase in the use of plastics and adds to the amount of healthcare waste. Plastics are indispensable in the medical industry, where they are used in single-use surgical instruments, packaging, and other equipment, as well as in certain medical procedures and transplantation (Chen *et al.*, 2020) [24]. During the lockdown, besides increasing the use of medical equipment, plastic packaging of foods and groceries for home deliveries was also enhanced (Scaraboto *et al.*, 2020; Vanapalli *et al.*, 2020) [6, 7].

Massive manufacture and widespread consumption of plastic since the pandemic period resulted in a deluge of trash mishandling and environmental issues (Silva *et al.*, 2021) [2]. This rise is linked to the pollution of a wide range of ecosystems and habitats, from far lakes and beaches to the deepest oceans, changes in water quality and specie distribution, higher mortality, and organism entanglement (Welden, 2020; Yunus *et al.*, 2020) [26, 28]. In India, after lockdown N-95 surgical and fabric masks, as well as other biomedical debris, were discovered floating in the bottom in an underwater clean-up programme at various beaches. From September 16 to September 27, 2020, the divers collected almost 1,500 kg of garbage in three rounds. In November 2020, 17,000 kilograms of plastic from Rushikonda beach in Visakhapatnam was removed over 57 days. Single-use plastic safety equipment is posing a new challenge to marine life. Marine species have declined by 70% over the years, with many being listed as endangered on the Red List of the International Union for Conservation of Nature. Microplastics have a negative impact on people also in addition to organisms (Silva *et al.*, 2019; 2021) [2, 3]. The mechanisms of plastic toxicity in humans and other animals include metabolic problems, oxidative stress, and inflammatory reactions (Chang *et al.*, 2020; Silva *et al.*, 2021) [2]. The Covid-19 epidemic has brought this issue

to the forefront of environmental study due to a surge in single-use plastics and a decrease in solid waste recycling and reuse, including its haphazard disposal (Nghiem *et al.*, 2020; Singh *et al.*, 2020a) <sup>[12, 18]</sup>.

This article provided a detailed account of the potential impact of Covid-19 on human health and the environment, including the outcome of public behaviour and policies aimed at promoting single-use plastic use. It covers the sources, types, and distribution of plastic products, with a possible focus on plastic waste management measurements. In this review, we look at how plastic trash is mismanaged and littered, posing a risk of viral transmission as well as being a pollution source in terrestrial and marine ecosystems, with long-term consequences.

### Plastic Waste Production during Covid-19

The Covid-19's global extension outside the primary epicenter has stringent for far extensively distributed and well-functioning medical facilities. It has also been determined that traditional production lines were unable to meet the potential demand in the event of a pandemic. Furthermore, people must remain disease-free in order to restrict the pandemic. Personal protective equipment, including as a gloves, a face shield, and facemask, is therefore critical for the safety of health-care workers, patients, and for every person throughout the pandemic and future disease outbreaks (Prata *et al.*, 2020) <sup>[19]</sup>. In recent months, there has been a massive increase in the usage of single-use plastic, which has wreaked havoc on the environment (Prata *et al.*, 2020; Saadat *et al.*, 2020; Zambrano-Monserrate *et al.*, 2020) <sup>[19, 23, 29]</sup>. Microplasticfibres have been found in plastic-based safety devices in the environment (Fadare and Okoffo, 2020) <sup>[20]</sup>. Polypropylene is commonly used in N-95 masks, whereas Tyvek is commonly used in gloves, medical face shields, and protective suits, all of which can endure a long time and leak dioxin and other dangerous compounds into the environment (Singh *et al.*, 2020b) <sup>[19]</sup>. According to the World Wildlife Fund (WWF), it is assuming that if just 1% of mask trash are inappropriately disseminated in environment, the ecosystem will be polluted by nearly 10 million masks every month (Italy WWF, 2020) <sup>[8]</sup>.



**Fig 1:** Types of plastic usage during Covid-19 pandemic

### Categories of Plastic Waste during Covid -19

#### Plastic Packaging Materials

People were ordered to stay indoors throughout public lockdown and home quarantine to prevent the virus from spreading. As a result of this circumstance, People have panicked and purchased large quantities of supplies, particularly from online grocery stores (Scaraboto *et al.* 2020; Sharma *et al.*, 2020) <sup>[6, 7]</sup>. During the lockout, the dependence on online purchasing to employ home delivery services for crucial and commercial supplies has resulted in a growing demand for single-use plastic bags, such as HDPE, PET, PP, and PS, resulting in a massive increase in plastic packaging trash generation (Bengali 2020; Sim *et al.* 2020; Singh *et al.* 2020b; Sharma *et al.* 2020) <sup>[22, 10, 19, 14]</sup>. India had a 250 percent spike in non-organic purchasing app downloads after the country eased lockout prohibitions in May, as revealed mobile marketing estimates by the State of E-commerce platform advertising 2020. This shows that e-commerce, or online shopping, is becoming more popular. The amount of plastic wrapping trash has also surged. Furthermore, concern about the coronavirus has led to excessive and abrupt storage of consumable products or other foodstuffs, which has resulted in an unwanted rise in demand for packaging materials all over the world. The increased demand for online food delivery services has a substantial impact on restaurant consumers' consumption patterns, accelerating the use of single-use plastics. As a result, the amount of garbage generated by single-use product packaging and pouches enhanced. Regrettably, this results in a larger environmental footprint (Sharma *et al.*, 2020) <sup>[7, 14]</sup>.

#### ▪ Single use Plastic and Online Food Delivery

Plastic can be manufactured using organic polymer but for industrial purposes plastic is manufactured using petrochemicals. The commonly used polymers—Thermosetting and thermoplastics—are used as additives in

plastic production to give the product different qualities. The online food delivery service (OFDS) has ushered in an alternative revenue stream for restaurants. In this business model, restaurants register with the digital platform wherein consumers can order food via an app. The food will be picked up by delivery riders at the restaurant and be delivered to the consumer. In a study published in *Nature Human Behavior*, the researchers found that office employees are to use food delivery services. This, in turn, increases the waste produced from single-use food packaging and bags. As people were forced to remain indoors in order to curb the spread of the virus, demand for online food delivery service has surged. The growing demand for this type of food service is predicted to significantly alter the consumption pattern of restaurant patrons, which may accelerate the consumption of single-use plastics. The lockdowns, however, may have accelerated the adoption of this new mode of transaction for both the consumers and the restaurants, as reflected by the forecasted 11% OFDS revenue increase for 2020. Shifting the restaurant operations to focus more on food delivery requires greater utilization of takeout containers and packaging. Unfortunately, this also leads to a greater environmental footprint.

#### ▪ **Single use Plastics in Online Shopping**

The Coronavirus pandemic promoted an unprecedented change in consumption habits, especially as lockdowns contributed to the increase in online shopping and in delivery services. One of the consequences is the substantial amounts of plastic waste produced, which can undermine the efforts to reduce plastic pollution. The lockdowns, the increase in online shopping and in delivery services have also contributed to change in consumption of plastic products in households. In this context, this commentary focused on exploring the impacts of pandemic in relation to single-use plastic waste in households. According to the State of Shopping App Marketing 2020's mobile marketing analytics, India witnessed a 250 per cent spike in non-organic shopping app installs as the country began lifting lockdown restrictions in May. This shows that e-commerce, or online shopping, has increased. And so has packaging waste. This plastic crisis is not new to us. Plastindia Foundation — India's leading plastic industry body — has estimated an annual consumption of 16.5 million tonnes, of which almost half is plastic manufactured for single-use packaging material that immediately becomes a waste. This non-biodegradable waste breaks down into smaller fragments and contaminates soil and water, leading to severe health problems and harming marine life. When burnt, it leads to high air pollution and is linked with emission of cancer-causing pollutants. Around 59% of the respondents indicated both re-using plastic bags and using cloth/fabric bag for shopping, followed by 52% of responses stating intention to avoid the use of plastic straws. Other responses included using stainless steel cutlery (39%), buying drinks in glass bottles instead of plastic bottles (33%) and using glass or steel containers for shopping (33%).

#### **Biomedical Waste**

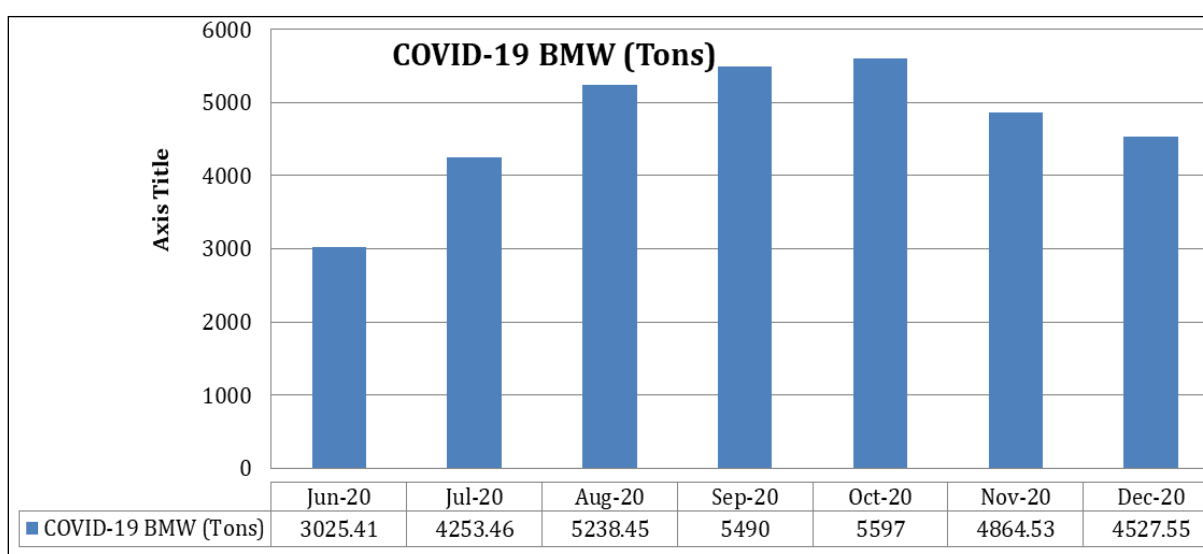
Medical waste creation has surged all across the world since the outbreak of the coronavirus, which posing a huge hazard to the atmosphere and human health. The collection of suspicious patients, testing and therapy of a significant number of sufferers, and finally decontamination has resulted in a huge number of contagious clinical trashes, the majority of which are composed of plastic (Somani *et al.* 2020; Varbanov *et al.* 2020; Zambrano-Monserrate *et al.* 2020) <sup>[14, 21, 29]</sup>. Following the introduction of the Covid-19, hospitals have experienced a significant increase in the usage of gloves, masks, hand sanitizer bottles, protective medical suits, and, particularly, syringes, all of which are leading to an unanticipated problem. In addition, catheters, syringes, tubes, respirators, saline solution packing, and thermometers, all of them are substantially composed of plastic, add to the plastic pollution. During the handling and collecting of biomedical waste, regular personnel were obliged to use sanitization and suitable personal protective equipment, like as three-layer masks, nitrile gloves, gumboots, splash-proof gowns/aprons, and safety goggles.

However, BMW manufacturing will increase significantly as a result of this. The proportion of pharmaceutical waste produced in Ahmedabad, India, surged from approximately 550-600 kilogram/day to roughly 1000 kilogram/day during the first period of the lockdown (Somani *et al.*, 2020) <sup>[14]</sup>. In India, only 225 captive incinerators and 198 Common Bio-Medical Waste Treatment Facilities (CBMWTFs) process about 550 tonnes of bio-medical trash each year (Singh *et al.* 2019; Yadav *et al.* 2020) <sup>[1, 27]</sup>. In India, 2.5 million PPEs were demanded every day in 2020, and the Ministry of Health and Family Welfare provided 4.6 million N95 masks in June of that year. sMedical waste disposal and management in Indian towns is based on a defective system that mostly relies on landfilling and local burning techniques. Head caps, used masks, and shoe covers should be cremated, as should Covid-19 plastic trash such as hazmat suits, nitrile gloves, and goggles.

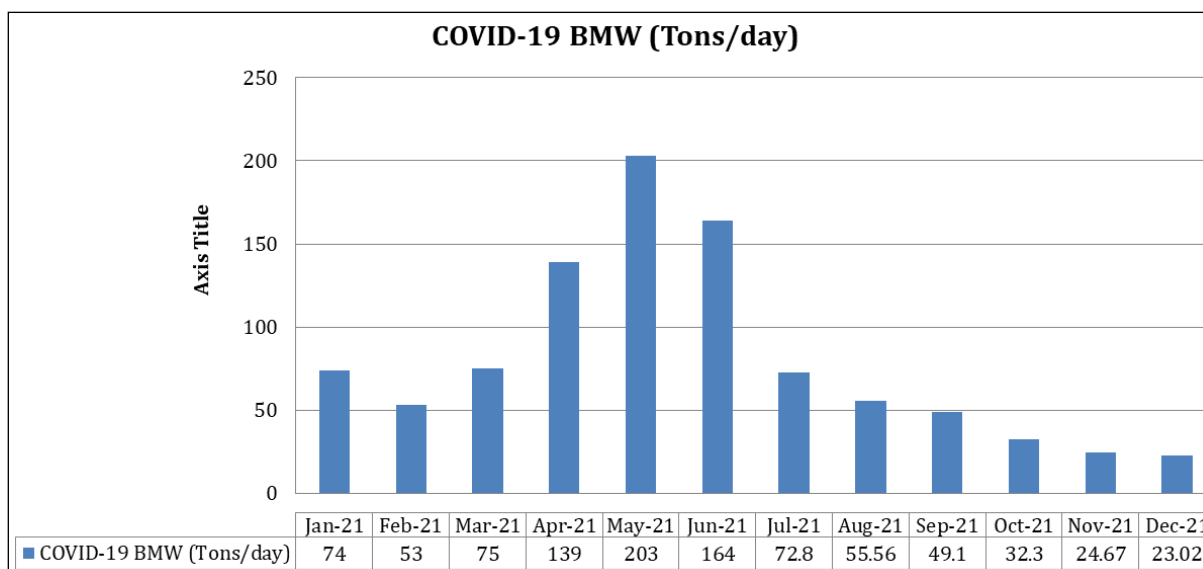
#### ▪ **Safety Equipment use and Haphazard Disposal**

Single-use plastic has surged dramatically in recent months, wreaking havoc on the ecosystem (Pata 2020; Zambrano-Monserrate *et al.* 2020; Saadat *et al.* 2020) <sup>[29, 23]</sup>. People are currently wearing face masks, hand gloves, personal protective equipment (PPE) kits, and use other safety equipment such as hand sanitizer to protect themselves from corona pandemic, which results in a sharp increase in the use of plastics and adds to the amount of healthcare waste. If the masks make it to the oceans, they could endanger marine life. Although latex rubber gloves are natural items, there are concerns that they are not necessarily environmentally friendly. Chemicals employed in their production are hazardous to the environment, and disposing of such wastewater is another issue (Kumar *et al.* 2020). The amount of biomedical waste (BMW) produced by COVID-19 patients is increasing all around the world. Only 198 Common Bio-Medical Waste Treatment Facilities (CBMWTFs) and

225 captive incinerators treat roughly 550 tonnes of biomedical waste (BMW) per year in India (Singh *et al.* 2019; Yadav *et al.* 2020) <sup>[1, 27]</sup>. Regular worker sanitization and appropriate personal protection equipment, such as three-layer masks, splash-proof aprons/gowns, nitrile gloves, gumboots, and safety goggles, should be required when handling and collecting biomedical waste. However, this will result in a significant rise in BMW production. During the first phase of the lockdown, the amount of medical waste generated in Ahmedabad, India, increased from 550-600 kg/day to around 1000 kg/day (Somani *et al.*, 2020) <sup>[14]</sup>. The local waste management authorities have been faced with a huge issue as a result of the unexpected increase in hazardous trash and its correct management. Most people, however, dump them (e.g., face masks, hand gloves, etc.) in open places and in certain cases with domestic garbage due to a lack of information regarding infectious waste management (Rahman *et al.*, 2020) <sup>[15]</sup>. The careless dumping of these wastes clogs waterways and worsens pollution in the environment (Singh *et al.*, 2020; Zambrano-Monserrate *et al.*, 2020) <sup>[29]</sup>. Face masks and other plastic-based protection equipment have been identified as a potential source of microplastic fibres in the environment (Fadare and Okoffo, 2020) <sup>[20]</sup>. N-95 masks are usually made of Polypropylene, while Tyvek is used for protective suits, gloves, and medical face shields, both of which can last a long time and leak dioxin and harmful substances into the environment (Singh *et al.*, 2020). Though experts and responsible authorities recommend that domestic organic waste and plastic-based protective equipment (hazardous medical waste) be properly disposed of and segregated, mixing these wastes increases the danger of disease transmission and waste workers' exposure to the virus (Ma *et al.*, 2020; Somani *et al.*, 2020; Singh *et al.*, 2020) <sup>[25, 14]</sup>.



**Fig 2:** Production of biomedical waste during June 2020- December 2020 in India (Source: CPCB, 2020)



**Fig 3:** Production of biomedical waste during the year 2021 in India Source (CPCB, 2021)

#### ▪ Duties of the Authorities and People Involved in the BMW Handling During the COVID 19

The duties of the persons and authorities involved in BMW's handling and management are clearly described in BMW rules 2016 and amendment rule 2018. All the healthcare facilities should strictly comply with the roles designated by the CPCB. The authorities should give the utmost priority to the management of BMW to prevent

virus transmission. The current setup might lack the information and resources for the safe handling of BMW, similar to quarantine centers.

Therefore, an excellent team who are trained, prepared and informed on the updated guidelines should be in charge of the handling and processing of biomedical waste in these centers.

#### **Duties of quarantine facility authorities**

- Providing all the legal authority for the establishment and allocation of resources for of the BMW storage area.
- Arranging authorized vehicles for the transportation of BMW to the hospital or disposal facilities.
- Conducting induction, orientation programs and training the personnel involved in the handling and management of BMW.
- Monitoring the processes and ensuring its compliance with SOPs that have been laid down.
- Issuing the authorized identity card to the person entering the quarantine facilities.
- Handing over the generated BMW to the authorized collectors.
- Maintaining accurate documentation and reporting the same to the higher authorities.

#### **Duties of Biomedical waste Management Company, Hospital or CBMWDF**

- Timely collection of BMW from the quarantine centers (at least twice a day).
- Providing all the personal protective equipment to the persons involved in the transportation and disposal of BMW.
- Regular sanitization of the BMW workers.
- Encouraging the strict adherence to the guidelines during the transportation and disposal of waste.
- Providing the information regarding the reception of BMW to the generating facilities.
- Handing over the disinfected or sterile waste to the respective agency for recycling.
- Providing updated information to the BMW handlers.
- Assist healthcare facilities and quarantine centers during the training.
- Maintaining proper records and documents for at least five years.
- Auditing the records with the generating facilities.
- Any injury or accident case should be reported to the quarantine facility in charge or the sanctioned authority.
- Continuous education, training, monitoring and supervision of BMW handling processes (daily basis).

#### **Duties of State Pollution Control Board**

- They should ensure the compliance of healthcare facilities and other BMW generating centers to the BMW rules 2016.
- They can allow the CBMWF for additional hours of work, but it should be monitored and recorded accurately.
- They should make sure that the minimum documentation for the authorization of quarantine centers is received and maintained.
- They shall monitor and supervise the BMW handling activity of all the facilities regularly and document the same.
- Remote quarantine centers beyond the reach of CBMWFs should be permitted for the deep burial of BMW.
- The state control board should assist CBMWFs with any required resource collection and disposal during the pandemic.
- In case the amount of BMW exceeds the capacity of CBMWFs, the hospital or healthcare setting can be permitted for incineration within the health care setting
- State pollution control should download and use the COVID19BWM app and stay updated with the uploaded data regularly.

#### **Plastic Boom and Environmental Pollution during a Pandemic**

The *Plastindia Foundation*, India's major plastic industry association, estimates that the country consumes 16.5 million tonnes of plastic each year, about half of which is produced for single-use packing that is thrown away. As a result of the unanticipated surge in hazardous rubbish and its improper handling during the pandemic, local waste management authorities were confronted with a major problem. Due to a shortage of knowledge about contagious waste disposal, most people discard face masks, hand gloves, and other personal protective equipment in public locations and in some cases alongside household garbage (Rahman *et al.*, 2020) <sup>[15]</sup>. Unsafe depositing of these trash clogs streams and contributes to environmental damage (Singh *et al.*, 2020a; Zambrano-Monserrate *et al.*, 2020) <sup>[18, 29]</sup>.

**Microplasticfibres** have been discovered in the ecosystem from face masks as well as other plastic-based protective devices (Fadare and Okoffo, 2020) <sup>[20]</sup>. Polypropylene is commonly used in N-95 masks, while Tyvek is frequently used in protective suits, gloves, and medical face shields. Both materials can remain a long period and leak toxic compounds (Singh *et al.*, 2020b) <sup>[19]</sup>. GHG emissions, as well as other extremely harmful

substances such as PCBs, furans, dioxins, and heavy metals, have increased as a consequence of the shortage of efficient waste treatment systems and unregulated burning, posing substantial atmospheric challenges. Despite the fact that latex rubber gloves are biological, but there are worries that they're not environmentally friendly. Chemicals used in their manufacture are harmful to the environment, and disposing of effluent is another issue (Heidari *et al.*, 2019) <sup>[13]</sup>. Despite the fact that specialists and relevant authorities advise that home organic matter and plastic-based safety gear (harmful clinical trash) be carefully discarded of and separated, merging such materials enhances the spread of infectious diseases and workers' constant exposure to contamination (Ma *et al.*, 2020; Somani *et al.*, 2020; Singh *et al.*, 2020a) <sup>[25, 14, 18]</sup>.

As per the WHO, the globe requires 1.6 million safety glasses and 89 million plastic clinical masks each month. These masks and glasses are manufactured of polypropylene that can take up to 500 years to deteriorate in the ocean. If these materials end up in the oceans, they may pose harm to aquatic life. Discarded fishing traps are also toxic to aquatic organisms and are responsible for the overwhelming plastic contamination in the waterways. The "Decade of Ocean Science for Sustainable Development" has been declared by the United Nations for the years 2021-2030. In 2018, India agreed to support the UN Environment's "Clean Seas Campaign." "The initial approach in achieving this target was to develop a "National Marine Litter Policy" by researching marine contamination along the nation's 7,500-kilometer coastline. Once trash enters the water, it has the potential to affect the entire ecology. During monsoons, plastic and biological waste clog river mouths, this is swept through the waterways and ultimately ended up in marine beds. Though it is harmful to oceanic life, it ultimately turns aquatic food unhealthy since micro plastics may be hazardous in the long range if they infiltrate the human food chain (Ravichandran, 2020a) <sup>[16]</sup>. Asian rivers are thought to be responsible for 86 percent of all worldwide plastic pollution in the ocean. A UN Environment Programme initiative is currently investigating plastic wastes infiltrating the Ganga River, with a second stage surveying the sorts of single-use plastics that have expanded as a result of Covid-19. But because of the lockdown, work on drafting the policy was halted. "The National Green Tribunal" had taken "suomoto action" against uncontrolled disposal of hazardous waste.

Early in 2020, pharmaceutical waste was discovered in water sources in Karnataka and Tamil Nadu. Syringes, masks, testing equipment, and blood bags were discovered thrown along the seashore on Thiruchinakuppam route in Tiruvottiyur, Chennai. The Manivakkam and Anakaputhur lakes in Chennai have also been found to possess biomedical waste. Medical supplies had always been dumped in the water bodies of OtteriNalla, Maduravoyal, Puzhal, Vandalur, Porur, and Muttukadu (Ravichandran, 2020b) <sup>[17]</sup>. N-95 clinical and fabric masks, as well as other biological debris, were discovered floating in the bottom after lockout at Rushikonda beach in Visakhapatnam as part of an underwater clean-up campaign. During 16<sup>th</sup> September to September 27<sup>th</sup>, 2020, the divers retrieved almost 1,500 kg of garbage in three rounds. In November 2020, 17,000 kilograms of wet plastic was removed over the course of 57 days. During clean-up drives on Mumbai's Juhu beach from May to August 2020, they discovered 1,050 gloves, 10,000 masks, and PPE kits disposed along the coast (Ravichandran, 2020 a) <sup>[16]</sup>.

#### ▪ Plastic and Water Ecosystem

Single-use plastic safety equipment's are posing a new danger to the marine organisms. Marine species have dropped by 70% over the decades, with several being classified as endangered in Red List by the "International Union for Conservation of Nature". Four turtles were trapped in traps and had their limbs removed because of suffocation; one of them also had a huge particle of plastic in it. Plastic consumption can harm their vital organs, and because they are incapable to eat, they die in discomfort and hunger. Oceans cover three-quarters of the earth's area, produce half of the oxygen human's use, and serve as a major carbon sink. The safeguarding of the aquatic habitats must begin with resolving the problems of shoreline populations, evolving aquatic tourism regulations, financing marine species exploration, reviving coastal environments, and halting port advancements that manage toxic containers in biodiversity-rich regions that are habitat to crucial marine organisms such as cetaceans, sea turtles, corals, and other sea creatures. To handle the rising burden of marine debris, strategies to regulate at site should be implemented, such as expanding biomedical waste processing facilities and enhancing the collecting system. Governors should seek to create an appropriate plastic waste disposal programme, and more stringent legislation and rules regulating the production, consumption, and consumption of plastic products (includes recycling and altering incentives) (Ravichandran, 2020b) <sup>[17]</sup>.

#### Conclusion

Plastics have a wide range of traits and properties that have substantially improved our quality of life, making a plastic-free industry and living difficult to envision. The Covid-19 outbreak, according to estimations, has resulted in an unforeseen spike in the quantity of plastic and pharmaceutical waste, notably for healthcare and self protection products around the globe. Huge quantities of plastic garbage (including medical disposal) are produced on a worldwide scale, with the vast majority being landfilled or burned (which both have severe environmental repercussions) and only a minor part being recycled. To reduce the ecological burden of garbage, the United Nations Development Program (UNDP) in India established a Plastic Garbage Management Programme (2018-2024). By 2024, the UNDP wants to nearly treble its plastic waste management in India to 100 cities. However, during the Covid-19 pandemic, which resulted in a large rise in garbage, particularly medical plastic waste, the programme suffered a major setback, affecting the livelihoods of workers who often work in dangerous situations. Inadequate plastic garbage handling and improper disposal will have short - term

and long time effects on public health and environment during the pandemic. Plastic waste is causing havoc on both aquatic and terrestrial environments. People need to understand the long-term repercussions of their plastic consumption and dumping. There is a requirement of better methods in plastic waste handling with regards of enforcing plastic consumption restrictions and educating individuals on plastic trash minimization, reusing, cycling, and handling. Bio-based plastics may be a solution at this time, but scaling up innovation is vital to assure its environmental friendliness and inclusion in the circular economy. In addition, plastic waste management strategy of India is built on a defective healthcare waste disposal process that mainly depends on landfilling and local incineration efforts. As a result, government policy, human accountability, and organizations are all important in keeping us from falling from one disaster to another.

## References

1. Singh A, Unnikrishnan S, Dongre S. Biomedical waste management in India: awareness and novel approaches. *Biomed J Sci Tech Res*,2019;13(04):10089-10091.
2. Silva ALP, Prata JC, Walker TR, Duarte AC, Ouyang W, Barcelò D *et al.* Increased plastic pollution due to COVID-19 pandemic: Challenges and recommendations. *Chemical Engineering Journal*,2021;405:126683.
3. Silva CJM, Silva ALP, Gravato C, Pestana JLT. Ingestion of small-sized and irregularly shaped polyethylene microplastics affect *Chironomus riparius* life-history traits, *Sci. Total Environ*,2019;672:862-868. 10.1016/j.scitotenv.2019.04.017
4. CPCB Generation of COVID-19 related biomedical waste in states/UTs, 2021.
5. CPCB Generation of COVID-19 related biomedical waste in states/UTs, 2020. <https://cpcb.nic.in/covid-waste-management/>
6. Scaraboto D, Joubert AM, Gonzalez-Arcos C. Using lots of plastic packaging during the coronavirus crisis? You're not alone. *The Conversation*,2020;668:1077-1093.
7. Sharma HB, Vanapalli KR, Cheela VS, Ranjan VP, Jaglan AK, Dubey B *et al.* Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling*,2020;162:105052.
8. Italy WWF. In the disposal of masks and gloves, responsibility is required WWF International. *Retrieved*, 2020.
9. Prata JC, Silva AL, Walker TR, Duarte AC, Rocha-Santos T. COVID-19 pandemic repercussions on the use and management of plastics. *Environmental Science & Technology*,2020;54(13):7760-7765.
10. Sim K, Chua HC, Vieta E, Fernandez G. The anatomy of panic buying related to the current COVID-19 pandemic. *Psychiatry Research*,2020;288:113015.
11. 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. *Science of The Total Environment*,2021;750:141514.
12. Nghiem LD, Morgan B, Donner E, Short MD. The COVID-19 pandemic: considerations for the waste and wastewater services sector. *Case Studies in Chemical and Environmental Engineering*,2020;1:100006.
13. Heidari M, Garnaik PP, Dutta A. The Valorization of Plastic Via Thermal Means: Industrial Scale Combustion Methods. *Plastics to Energy*, 2019, 295-312.
14. Somani M, Srivastava AN, Gummadivalli SK, Sharma A. A. Indirect implications of COVID-19 towards sustainable environment: an investigation in Indian context. *Bioresource Technology Reports*,2020;11:100491.
15. Rahman MM, Bodrud-Doza M, Griffiths MD, Mamun MA. Biomedical waste amid COVID-19: perspectives from Bangladesh. *The Lancet.Global Health*,2020;8(10):e1262.
16. Ravichandran N. Discarded single-use plastic masks and gloves are choking ocean beds. *Mongabay*, 2020a. <https://india.mongabay.com/2020/10/discarded-single-use-plastic-masks-and-gloves-are-choking-ocean-beds/>
17. Ravichandran N. Used plastic masks and gloves are making their way into water bodies across India, 2020b. *Scroll.in*. <https://scroll.in/article/977217/used-plastic-masks-and-gloves-are-making-their-way-into-water-bodies-across-india>
18. Singh N, Tang Y, Ogunseitan OA. Environmentally sustainable management of used personal protective equipment. *Environmental science & technology*,2020a;54(14):8500-8502.
19. Singh N, Tang Y, Zhang Z, Zheng C. COVID-19 waste management: effective and successful measures in Wuhan, China. *Resources, Conservation, and Recycling*,2020b;163:105071.
20. Fadare OO, Okoffo ED. Covid-19 face masks: A potential source of microplastic fibers in the environment. *The Science of the total environment*,2020;737:140279.
21. Varbanov PS. Recent research directions: missing pieces of the puzzle. *Clean Technologies and Environmental Policy*, 2020, 1-2.
22. Bengali S. The COVID-19 pandemic is unleashing a tidal wave of plastic waste. *The Los Angeles Times*, 2020.
23. Saadat S, Rawtani D, Hussain CM. Environmental perspective of COVID-19. *Science of the Total Environment*,2020;728:138870.
24. Chen WQ, Ciacci L, Sun NN, Yoshioka T. Sustainable cycles and management of plastics: A brief review of RCR publications in 2019 and early 2020. *Resources, Conservation and Recycling*,2020;159:104822.

25. Ma Y, Lin X, Wu A, Huang Q, Li X, Yan J. Suggested guidelines for emergency treatment of medical waste during COVID-19: Chinese experience. *Waste Disposal & Sustainable Energy*,2020:2:81-84.
26. Welden NA. The environmental impacts of plastic pollution. In *Plastic Waste and Recycling* (pp. 195-222). Academic Press, 2020.
27. Yadav SK, Chakraborty I, Banerjee S. Bio-medical waste management in India: contemporary approaches and way forward. *EPRA Int J Multidiscip Res*, 2020.
28. Yunus AP, Masago Y, Hijioka Y. COVID-19 and surface water quality: Improved lake water quality during the lockdown. *Science of the Total Environment*,2020:731:139012.
29. Zambrano-Monserrate MA, Ruano MA, Sanchez-Alcalde L. Indirect effects of COVID-19 on the environment. *Sci Total Environ*,2020:1:728:138813. doi: 10.1016/j.scitotenv.2020.138813. Epub 2020 Apr 20. PMID: 32334159; PMCID: PMC7169883.