

# Environmental Impact of Selecting Disposable Medical Masks and Cloth Masks during COVID-19

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**Abstract:** With the outbreak of COVID-19, masks have become daily protective articles that everyone needs. Because masks can block the spread of the virus and reduce the risk of infection. The use of many disposable medical masks has brought great pressure to the environment. Therefore, this study will compare the environmental impact of disposable medical masks and cloth masks. From the point of view of material and manufacturing technology, which kind of mask is more friendly to the environment is analyzed. Firstly, the composition and characteristics of disposable masks and cloth masks with replaceable filter elements are described. Secondly, it describes the impact of disposable medical masks and cloth masks on the environment, including the impact on animals, plants, soil, and the ocean. Finally, it is concluded that the use of naturally degradable cloth masks is more environmentally friendly than disposable medical masks. It is recommended that people minimize the use of disposable medical masks during the COVID-19. This study fills a gap in how to solve the problem of mask pollution. We can reduce the harm of masks to the environment from the perspective of finding alternative products, to achieve the long-term goal of sustainable development.

## 1 INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a virus that broke out in Wuhan in December 2019. The common clinical symptoms of infected people include fever, dry cough, fatigue, muscle and body pain, headache, loss of taste and smell, sore throat, stuffy nose, runny nose, bad heart, vomiting, and diarrhea (CDC 2021). COVID-19 is transmitted through droplets containing viruses and very small particles exhaled by infected people. These droplets and particles may be inhaled by others from the nasal cavity or fall into their eyes, mouth, and nose. In some cases, the virus may contaminate the contact surface. Less than 6 feet away from the infected person is the most likely to be infected (CDC 2021). The World Health Organization (WHO) announced the virus outbreak on January 30, 2020, and issued an alert to all countries (Rahmani, Mirmahaleh 2021). Disposable medical masks can usually block virus nanoparticles with a diameter of about 100 nm (Babaahmadi, Amid, Naeimirad, Ramakrishna 2021). Therefore, experts say that masks are an effective tool to prevent the spread of viruses. People use a lot of masks for self-protection because they are cheap and efficient enough to be

used once and then thrown away (PARKER 2021). Since the outbreak of covid-19, 3 million masks have been used worldwide every minute. In Asia, people throw away 1.8 billion masks every day. China, the world's most populous country, discards nearly 702 million masks every day (PARKER 2021). If each disposable mask weighs 3 grams, about 4.1 million tons of plastic waste will be generated worldwide every year. At the same time, we are shocked that 80% of such wastes enters our marine environment. Unfortunately, these mask wastes have entered our water flow system (Babaahmadi, Amid, Naeimirad, Ramakrishna 2021). The wide use of disposable surgical mask materials poses a serious threat to our environment.

Some studies have reported that contaminated masks can be disinfected and reused (Robert Dennis, 2020). However, this theory cannot be accepted by the public at present. At present, the treatment methods of disposable medical masks are mainly disinfection, landfill, and incineration. Disposable medical masks become harmless after being treated in an incinerator. By burning at a temperature above 850 °C, the mask not only becomes harmless but also generates a lot of energy while burning. The calorific

value of polypropylene, the main component of the mask, is 44 MJ/kg. If all masks produced in 2020 are burned, 2.68% will be generated  $2.68 \times 10^{10}$  MJ energy, equivalent to  $5.9 \times 10^5$  T diesel,  $5.86 \times 10^5$  tons of gasoline,  $5.01 \times 10^5$  tons of natural gas. Although the incineration of disposable medical masks produces a lot of energy, the CO<sub>2</sub> produced in the incineration process cannot be ignored. If all masks produced in 2020 are burned, will be released  $1.43 \times 10^9$  kg carbon dioxide (Tabatabaei, Hosseinzadeh-Bandbafha, Yang, Aghbashlo, Lam, Montgomery, Peng 2021). However, due to the excessive number of masks, incinerators in various countries may not be able to handle such a large number of second-hand masks. Therefore, most medical masks may be sent to landfills or directly discarded in the environment. However, there are also some environmental problems in landfill sites. Generally, the degradation cycle of disposable medical masks buried in the land usually takes more than 300-500 years. Most of the existing literature contributes to the treatment of disposable medical masks, rather than thinking from the perspective of replacing disposable medical masks.

This paper will first describe the main components of disposable medical masks and cloth masks. Secondly, the impact of disposable masks and cloth masks on the environment is discussed. Finally, some reasonable suggestions and disposal measures are given.

## 2 COMPOSITION AND CHARACTERISTICS OF THE MASK

### 2.1 Composition and Characteristics of Disposable Medical Mask

Most of the disposable medical mask wastes contain polypropylene, polyethylene, polyurethane, polystyrene, polycarbonate, and polyacrylonitrile, which will cause plastic or microplastic pollution to the environment (Akber Abbasi, Khalil, Arslan 2020). Generally, disposable medical masks have three layers (Fig. 1). The inner and outer layers are spun-bound polypropylene, and the filter layer is melt-blown polypropylene (Stringking 2021). Aluminum wire is nose strips to fix the shape (Pandit, Maity, Singha, Annu, Uzun, Shekh, Ahmed 2021). Cotton and rubber form an elastic band that is ear

loops.

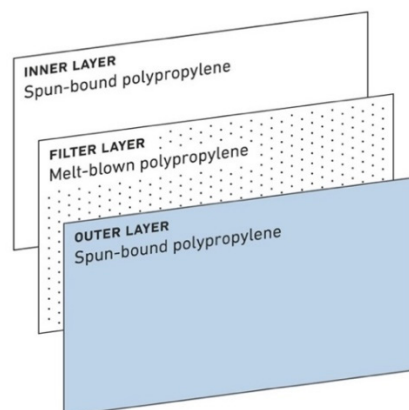


Figure 1: Layers layout of the disposable medical mask (Stringking 2021).

The main components of the disposable medical mask are polypropylene, either 20 or 25 grams per square meter (gsm) in density (Henneberry 2021). Polypropylene is a polymer whose monomer is propylene (an organic hydrocarbon with the chemical formula C<sub>3</sub>H<sub>6</sub>). The chemical formula of polypropylene is (C<sub>3</sub>H<sub>6</sub>)<sub>n</sub>. The main characteristics of polypropylene are toughness and flexibility, large thermal expansion, resistance to organic solvents, and resistance to weak oxidizing agents (Byjus 2021). These characteristics also become the reason why polypropylene is selected as the main material for disposable masks. In addition, disposable masks are widely used because the price of polypropylene is low, and the manufacturing process is simple. This is also the reason why the price of disposable medical masks is relatively low. Over time, these polypropylenes will enter the environment in the form of microplastics (Selvaranjan, Navaratnam, Rajeev, Ravintherakumaran 2021).

A very important reason why people prefer disposable medical masks during COVID-19 is convenience. Because disposable medical masks can be easily purchased at a lower price.

### 2.2 Composition and Characteristics of Cloth Mask

The cloth mask also has three layers. An inner layer of absorbent material, like cotton, a middle layer to act like a filter or barrier (replaceable filter element), made of non-woven material like polypropylene, an outer layer of a non-absorbent material, like polyester or a polyester blend (Miller 2020).

However, the main component of the cloth mask with a replaceable filter element is cotton. Both quilt and cotton 600 TPI material can meet the requirements of blocking covid-19 transmission in terms of air permeability and filtration efficiency (Hartanto, Mayasari 2021). Because cotton is a low-carbon and reusable substitute material, it is highly preferred as an alternative raw material for mask production (Patricio Silva, Prata, Walker, Campos, Duarte, Soares, Barcelo, Rocha-Santos 2020). In addition, the incineration of cloth produces biological carbon dioxide, but the incineration of disposable medical masks will produce fossil carbon dioxide from polypropylene (Tabatabaei, Hosseinzadeh-Bandbafha, Yang, Aghbashlo, Lam, Montgomery, Peng 2021). Therefore, the reusable cloth mask with a replaceable filter element shows a very important advantage in terms of environmental burden (Núria Boix Rodríguez, Claudio Favi, Marco Marconi 2021).

### 3 EFFECT OF DISPOSABLE MEDICAL MASKS ON ENVIRONMENT

Since the outbreak of COVID-19, the extensive use of disposable medical masks has led to their frequent appearance in the environment. As people do not follow the appropriate treatment methods of disposable medical masks, mask waste is increasing all over the world (Selvaranjan, Navaratnam, Rajeev, Ravintherakumaran 2021). Therefore, the abandoned disposable medical mask has brought great challenges to the environment. Disposable medical masks are usually made of a thin polypropylene layer and are not easy to decompose. However, over time, they gradually degrade into microplastics, and then these microparticles enter the environment and the risk of food chain pollution increases (Tabatabaei, Hosseinzadeh-Bandbafha, Yang, Aghbashlo, Lam, Montgomery, Peng 2021). Fig. 2 shows the process after disposable medical masks are discarded at will.

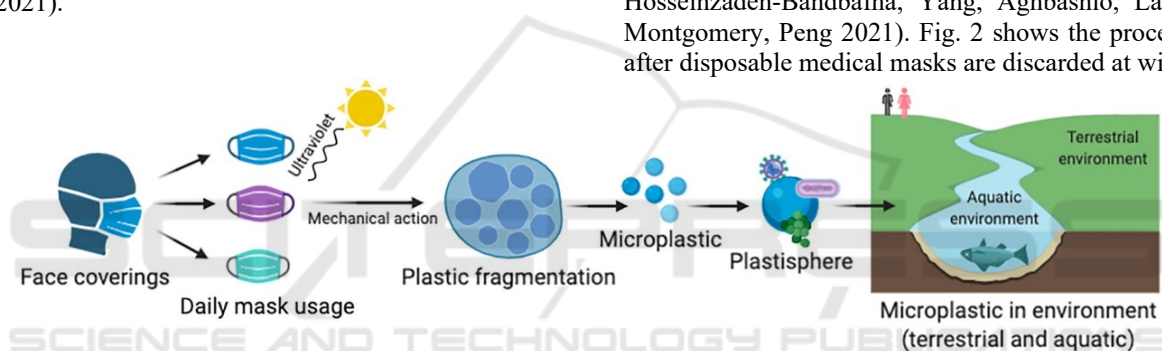


Figure 2: A general description of the fate of microplastic in the environment originating from the face masks (Akber Abbasi, Khalil, Arslan 2020).

#### 3.1 Effects of Disposable Medical Masks on Animals

First, disposable medical masks have a direct impact on animals. For example, disposable medical masks randomly discarded in the soil may affect the activities of animals, resulting in entanglement and death (Fig. 3) (Selvaranjan, Navaratnam, Rajeev, Ravintherakumaran 2021). The disposable medical mask can directly affect animals and the environment like more than 200 species, including marine mammals, turtles, and seabirds, are entangled, or ingested by masks (Patricio Silva, Prata, Mouneyrac, Barcelo, Duarte, Rocha-Santos 2021). According to reports in Colombia, a bird was entangled in a disposable medical mask discarded from a tree. Then he died after the mask wrapped his body and beak (Steiner 2020). In addition, disposable medical masks are easy to be mistaken for food by animals. Because they are very common and can fill their stomachs, to

reduce food intake and lead to starvation and death of animals. It may also poison marine animals that eat plastic (Selvaranjan, Navaratnam, Rajeev, Ravintherakumaran 2021). For example, it is reported that the death of an adult Magellanic Penguin (*Spheniscus Magellanicus*) found in Juquehy Beach in São Sebastião, Brazil may be related to the intake of disposable medical masks. This mask appears in the stomach of penguins, which may limit the feeding activities of organisms and lead to hunger (Brandao, Braga, Luque 2011). The ingestion of microplastics will interfere with the reproduction, growth, and development of animal larvae (Klemes, Fan, Tan, Jiang 2020).



Figure 3: Vets were able to cut the mask off and the bird is now recovering (Williams 2020).

### 3.2 Effects of Disposable Medical Masks on Soil and Plants

Disposable medical masks are degraded by chemical or biological processes in an open environment, such as light irradiation, weathering, corrosion, and water immersion, to form microplastics. Toxic chemicals that release plastics (Selvaranjan, Navaratnam, Rajeev, Ravintherakumaran 2021). Mineral extraction of this toxic chemical will penetrate the soil. Toxins in soil accumulate in organisms and affect the growth of vegetation. For example, the microplastic decomposed from the mask will lead to the death of trees and soil erosion. Soil erosion will lead to further environmental deterioration and degradation and affect climate change. According to the research, the production of disposable medical masks will bring problems such as land occupation, water acidification, nonrenewable energy, and mineral extraction (Lee, Neo, Khoo, Yeo, Tan, Chng, Yan, Lok, Low 2021).

### 3.3 Effect of Disposable Medical Masks on Ocean

Disposable medical masks are blown into rivers and streams and taken to the sea. Scientists recorded their records on beaches in South America, river outlets in the Gulf of Jakarta, the coast of Bangladesh, the coast of Kenya, and Hong Kong (PARKER 2021). Over time, the plastic in the mask will decompose into smaller fragments, and finally into microplastics and

nano plastics (Shen, Zeng, Song, Yi, Hu, Zhang, Zeng, Xiao 2021). Because the ocean contains a large amount of plastic waste, the ocean will absorb toxins and organic pollutants in these wastes (Selvaranjan, Navaratnam, Rajeev, Ravintherakumaran 2021). The total amount of microplastic fibers released from disposable medical masks discarded in the environment increased by about 25000 times over time (Shen, Zeng, Song, Yi, Hu, Zhang, Zeng, Xiao 2021). Therefore, more and more harmful substances will enter the ocean. This will affect the habits of microorganisms in the marine ecosystem, resulting in the chaos of the marine ecosystem. In addition, the appearance of many disposable masks on the beach will reduce the aesthetic and beach entertainment value.

## 4 EFFECT OF CLOTH MASK ON ENVIRONMENT

Natural cellulose fibers such as cotton and flax have good mechanical strength, hydrophilicity, and biocompatibility, and can resist protein adsorption and biological pollution. Therefore, they are widely used in virus filters, such as cloth masks (Junter, Lebrun 2017). The three-layer cellulose cloth mask is the best choice to replace the medical mask made of the synthetic polymer (Pandit, Maity, Singha, Annu, Uzun, Shekh, Ahmed 2021). Because the cotton mask is natural, non-toxic, washable, and reusable (Ho, Lin, Weng, Chuang 2020). Cotton is naturally produced, so the cloth mask made of cotton can be biodegradable. Cotton can be biodegraded by anaerobic and aerobic methods. In addition, the degradation rate of cotton is also related to environmental conditions, such as oxygen content, water content, temperature, pH value, fabric structure, weight, fiber tightness, etc. (Fibers 2017). Therefore, the use of cloth masks can protect humans and our environment (Babaahmadi, Amid, Naeimirad, Ramakrishna 2021).

### 4.1 Effects of Cloth Masks on Animals

The composition of cloth masks will not have a great impact on animals, because cotton, the main component of cloth masks, is a material that can be naturally degraded and will not cause harm to animals (Morgana, Casentini, Amalfitano 2021). Cloth masks can also cause entanglement of animals in the environment, but because cloth masks are easy to decompose, they will not cause permanent and fatal damage (Wu, Li, Lu, Tang, Cai 2021). However, the

production and planting of cotton, the main component of cloth masks, will have some bad effects on animals. First, a large number of pesticides need to be used in the process of planting, which will cause some animals to die eating pesticides by mistake. Secondly, these pesticides will penetrate into the soil and follow rivers and streams into lakes, resulting in the accumulation of toxins in aquatic animals. Biologists estimate that millions of birds in the United States die each year from the effects of pesticides sprayed on cotton and other crops. When the runoff from farmland contains high concentrations of pesticides, it will kill fish in nearby rivers and streams. In a well-documented case in Alabama in 1995, at least 240000 fish were killed by water (Cubie 2006). Therefore, the use of cloth masks will have some indirect effects on animals.

#### 4.2 Effects of Cloth Masks on Plants and Soil

Because of their biodegradable properties, cloth masks will not have a negative impact on plants and soil. However, the main component of cloth masks will affect plants and soil during the planting of cotton. Firstly, many pesticides, especially pesticides, need to be used in cotton planting, which will cause potential harm to the ecological chain and affect the normal growth and development of plants. In addition, a large number of pesticides will also remain in the soil, resulting in the decline of soil quality. Secondly, cotton planting will lead to serious degradation of soil quality. Although the areas devoted to cotton cultivation in the world have remained unchanged in the past 70 years, the growth process of cotton has led to land fertility depletion and serious soil degradation in many areas (W.W. Fund, Cotton Industries, WWF. (2021).

#### 4.3 Effect of Cloth Mask on Ocean

Cloth masks discarded in the ocean can entangle animals and cause death. Moreover, many cloth masks appear on the beach, which will affect the beauty and the development of tourism. It is optimistic that the cloth mask will quickly separate and reduce its impact on the ocean under the corrosion of seawater and the illumination environment. In addition, so many pesticides need to be used in the cotton planting process, which is the main component of the cloth mask. These pesticides will eventually enter the ocean with the surface water. For a long time, marine biodiversity and marine ecological chain will be seriously affected.

## 5 DISPOSAL MEASURES

For many disposable medical masks that already exist in the environment, people should take them to a suitable disposal position when they see them, so as not to cause greater harm to animals and the environment. Secondly, while enjoying the convenience brought by disposable medical masks, we should pay attention to protecting the environment. According to regulations, discarded masks shall be collected and disposed of innocuously. Second, people should stop using disposable medical masks in daily life and use cloth masks with replaceable filter elements for daily protection. For the government, it should be strengthened.

## 6 CONCLUSIONS

Since covid-19, the use of many disposable medical masks has caused serious environmental pollution. These disposable medical masks, which are discarded at random, affect the health of animals, plants, soil, and oceans. The investigation shows that disposable medical masks and cloth masks will have different degrees of impact on the environment in different stages. However, the cloth mask is more friendly to the environment both in terms of material and structure. The environmental pollution of disposable medical masks will exist from raw materials to manufacturing and then use. The use of cloth masks will reduce a lot of medical waste and will have a small impact on the environment in addition to the planting of raw cotton, but traditional cotton planting can be replaced by organic cotton planting. Therefore, we should stop using disposable medical masks and use cloth masks with replaceable filter elements instead, because cloth masks are more environmentally friendly than disposable medical masks. This article from a new perspective gives people some new methods to solve the problem of mask pollution.

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