The Analysis of Soil Contamination Related to Mask Production and Consumption during COVID-19 Pandemic

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Abstract. This paper focuses on the analysis of possible sources of soil contamination related to mask production, especially during the COVID-19 pandemic. The target of the study is to analyze two possible sources, mask production and mask consumption, to evaluate their contributions to soil contamination. Based on the analysis of current studies, one of the composites of surgical masks, polypropylene, is harmful to the environment. Considering that researching the universal situation of soil contamination can be too broad to investigate soil contamination, this paper proposes that China performs a good case study. Using statistics on mask production and particulate matter pollution led to the conclusion that only mask consumption and disposal result in contamination instead of the manufacturing process of masks in industries. At last, China's response to soil contamination is also examined. Therefore, this paper concludes and discusses several possible actions that could be adopted to combat soil contamination in China.

1 Introduction

In the past three years, the global epidemic of COVID-19 has induced many dramatic changes from different perspectives. In the field of environmental economics, many economists and environmentalists presented a series of predictions in terms of how the pandemic position affected it. Economists predicted a sharp decline in economic figures during the epidemic and a recovery following the end of COVID-19. Meanwhile, environmentalists may suggest a positive influence of COVID-19 on the environment since COVID-19 infected people and reduced their work capability so much that many industrial processes must be postponed, resulting in a sharp decline in industrial pollution. Such environmental problems before the global pandemic seemed to be alleviated, while some new invisible issues occurred during the pandemic.

When the amount of contaminants, such as nitrogen or phosphorous, is found in a certain zone of soil above a specific level, it is called soil contamination. Soil contamination could contribute to the loss of soil functions, for example, water cycle conservation and the ability to be cultivated for agricultural purposes. In addition, soil contamination could be characterized by the presence of synthetic substances or other modifications to the natural soil ecosystem. The frequency of this phenomenon is related to how heavily industrialized a region is and how heavily chemicals are used, both of which might cause leakage.

Due to the COVID-19 epidemic, there was a serious worldwide face mask shortage. Since there is a huge demand for masks to ensure people are not affected, there must be a skyrocketing trend in mask production. In China, almost all industries that can manufacture products related to cotton and gauze are engaged in mask production. With the help of engineers, designers, buyers, and people in manufacturing, the scale of mask production was enlarged to an unprecedented level. One facility could produce up to 50,000 masks each day, or roughly 1.5 million per month.

Unfortunately, most masks being manufactured are disposable and cannot be reused or recycled, and the period of use cannot last long. Therefore, people easily disposed of their masks, resulting in mass soil contamination around the world because of the harm of manufactured cotton and gauze. In this paper, the impact of such types of industrial production as mask production on the environment during COVID-19 will be examined. It is of great significance for the public to get an insight into this topic and realize its importance and impact on every person who may probably confront soil contamination from different perspectives.

2 Literature review

For a long time, scholars have been focusing on probable soil contamination brought on by the rapid growth of the industrial sector of the economy. In 2002, van Straalen suggested the methodology for assessing soil contamination. In this system of entire soil columns incubated in the lab under conditions that allow plant development and water drainage, measurements are done in a wide range of ecological domains [1]. This experimental suggestion provides valuable methodology for the further study of soil contamination. In 2015, according to the study, in such an

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industrializing and urbanizing country as China, potential issues of soil contamination had already been revealed. The statistics already showed that more than 15% of soil samples are confronting severe contamination [2]. Moreover, in recent studies, the damage caused by mismanagement of single-use of such personal protective equipment as masks and protective garments was precisely estimated. The results of such research demonstrate the facts that mismanagement in production and poor environmental awareness lead to plastic pollution [3]. To be more specific, there are several studies examining the significance of surgical masks for the environment. The great amount of microplastic pollution resulting from the random disposal of masks has been proven. According to statistics, one mask released 360 pieces of microplastic into the static water, and when the vibration rate increased, the release amount likewise climbed. This pointed out that the rapid growth of mask production and consumption and improper disposal are worrying [4].

In the context of COVID-19, this situation becomes more severe. The source of microplastic pollution consists of polymeric materials, which can be used to make surgical face masks. Not only the soil itself, but threats have also been posed to the cycle of ecology consisting of soil and water [5]. At the microscopic level, microfiber is a vital part of surgical masks that can finally result in microliters. Microfiber contamination by facial masks leads to an increase in the risk of large-scale contamination in many aspects, such as soil and marine biota [6]. For instance, the two smallest sizes of applied mask fragments caused different, concentration-dependent alterations in the lateral root numbers, whereas the larger polypropylene mask fragments at 1% concentration clearly restricted primary root length in soil [7]. In a conclusion, many studies suggested that mask and its specific composition matters can contribute to environmental problems such as soil contamination. Therefore, according to current soil environment and relevant studies, further investigations regarding the effects of plastic pollution on plant-soil interactions are urgently needed.

3 Analytical framework and discussion

For the analysis of soil contamination, it is undoubtedly true that many confounding variables should be eliminated. Among all countries and regions globally, it would be inaccurate to verify the condition of surgical masks and instruments in so many cases. Rather, selecting a certain region in which the soil composition shares uniqueness as a case study will give a more precise insight into the topic of mask and environmental soil contamination.

3.1 Current situation of soil contamination in China

As a country with high requirements for epidemic prevention, China's production and demand for protective equipment, such as masks, have reached a level that other countries cannot match. Given this context, China is certainly a perfect case study for studying the environmental impact of mask production and consumption—especially soil pollution. In this section, the current situation of mask production and soil pollution in parts of China will be questioned.

Considering soil contamination related to surgical masks, there are two possible forms. First, the contamination directly brought by mask production during industrial processes, such as extraction, refinery, and packaging. Contaminants resulting from industrial processes are likely to be pollutants similar to those present in the atmosphere. Instead, contamination in industrial processes is less likely to be heavy metals and composite materials derived from finished surgical masks. Second, the contamination indirectly brought about by the waste disposal of masks during the pandemic. When the disposable surgical masks that were used to protect people from exposure to viruses are improperly discarded, for example, by directly throwing surgical masks into places other than trash cans, the nearby environment could be contaminated.

Therefore, two hypotheses are proposed to suggest the possible effects of surgical masks on the environment: industrial pollution during mask production leads to soil contamination, and unregulated disposal of surgical masks leads to soil contamination. To confirm these hypotheses, an analysis of the source of contamination should be conducted.

3.2 Analysis of the source of contamination

Around the past two years of the global pandemic, the number of masks produced and the resource refineries in China as a domestic part of industrial production began to skyrocket. Nevertheless, not only have recent years witnessed a growth in industrial production of surgical masks, but the number of manufactured goods from industrial production of masks within China has risen more than ten years ago. The production of masks in China between 2011 and 2019 is shown in Figure 1.

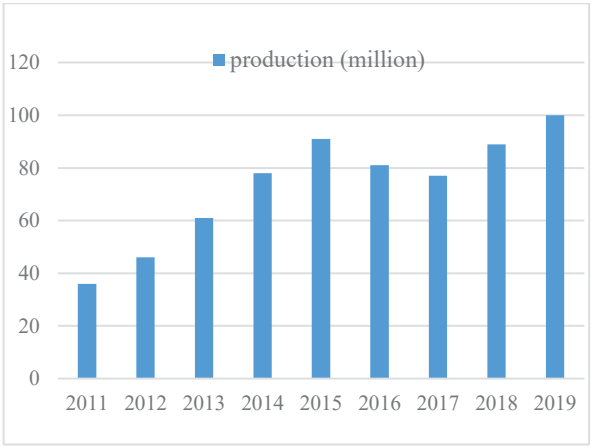

Fig. 1. China's masks production (Photo credit: Original).

However, the problems related to both surgical masks and soil contamination have not been proposed until the current epidemic. Previously, the issues of soil

pollution in China that were frequently discussed involved heavy metal pollution rather than microplastic and fibber contamination [8]. Therefore, stating that industrial processes lead to soil contamination is not legitimate and valid.

On the contrary, the vast amount of use of surgical masks indirectly leads to contamination of the soil and its ecosystems. In soil, the length of roots generally decreases as the concentration of polypropylene increases. A merely one percent concentration of polypropylene can prominently inhibit the growth of botanic roots used to extract nutrients to support the growth of the entire individual plant [7]. This can be proven by the comparison of data on particulate matter pollution between sources of industry and sources of life before and during the COVID-19 pandemic shown in Figure 2.

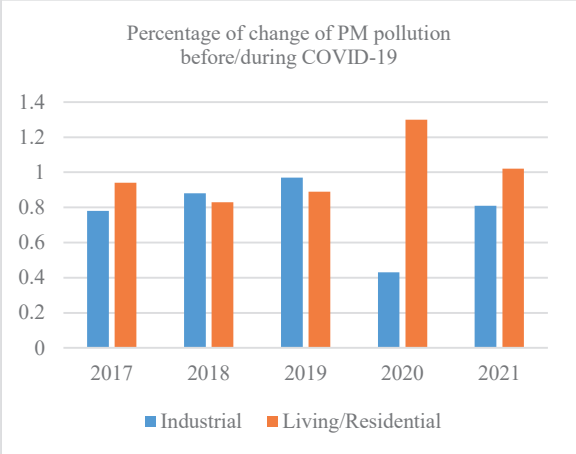

Fig. 2. Percentage of change of PM pollution in China. Source: http://www.cnemc.cn/jcbg/kqzlzkbg/

Given that the percentages of change in PM were less than 1 before the outbreak of the virus before 2020, there was a gradual trend of decline in both industrial and living/residential sources of PM pollution. However, considering whether the percentage change in the amount of pollution is greater than 1 or not, the amount of PM pollution due to living/residential sources began to increase since the outbreak of COVID-19, while the pollution due to industrial sources decreased during the pandemic.

By taking this perspective into discussion, the possible source of soil contamination can be defined as the consumption and easy discard of disposal masks out of the recycling process. Only if disposable masks are discarded with little or no attention to recycling processes can such contamination occur in the land environment.

3.3 Impacts on agricultural production

In studying the effects of masks on soil pollution, the impacts on agricultural activities, involving heavy usage of soil to cultivate such sources of food as cereal and grain, must be precisely examined. Previous research and investigations have already shown that toxic elements impose negative impacts on the environment. Furthermore, this process may eventually affect the health condition of humanity by gradually passing toxic elements from agent to agent.

Seeing the ecosystem as a whole, when people are aware of upcoming threats—COVID-19, they decide to purchase surgical masks to protect themselves from the lethal virus. Next, people discard the used masks once they affirm that their masks are no longer responsible for protection from the external virus. Parts of discarded masks are successfully recycled and then reused in other aspects, while the other parts are disposed of directly into soil and water, resulting in contaminated lands with polypropylene, which is classified as a substance that can restrain the expansion of soil [9]. Then, when humans consume plants grown on contaminated lands and animals feed on these plants, the unhealthy, toxic elements derived from discarded materials return to humans' bodies [10].

3.4 Impacts on water sources

For a country with such a large population as China, adequate and healthy water resources are necessary. Water quality, for example, imposes great challenges on countries that have a similar or even larger population than China, such as India. Discarded masks that pollute the environment have had a prominent and significant impact on water quality over the years since the outbreak of the COVID-19 pandemic. On a particulate level, masks are made of polypropylene or polyethylene glycol terephthalate. The former has similar properties to plastic, while the latter has very limited solubility in water. This combination of properties leads to waste masks contaminating water sources and aquatic ecosystems, as well as plastic materials.

What's more, plastic pollution in water does not merely affect the water itself. For the whole ecosystem that depends on water resources, pollution in one link contributes to the poisoning of a population of a certain species in the ecosystem, which serves as a potential threat to the overall health of the ecosystem. If this population of a certain species, such as fish or river shrimp, is an edible food resource for humans, there are also relevant issues in terms of human health.

3.5 China's response

In the current situation, the focus of the Chinese government is to ensure the safety and availability of the food supply instead of clearing soil contamination brought about by waste disposal. In recent years, given that China has nearly achieved 95% self-sufficiency in food supply—which has never been achieved by many developing countries in the world—China has decided to maintain the import of food instead of using domestic food production. This decision provides a promising future for sufficiency in the food supply. If there is a sudden decrease in either domestic production of food or external imports, despite a short-term increase in food prices, China and the market for the basic supply of food within China would be less likely to be affected by the

previous storage of food when domestic food production is sufficient.

However, the decision to increase imports to maintain food supply even if there is a shortage in domestic production to release the effects of agricultural contamination does not help reduce contamination. Contamination is derived from the direct decomposition of composite materials in a surgical mask. A higher percentage of food storage does not result in the elimination of contaminants. Despite the availability of food, the condition of agricultural lands is expected to deteriorate as long as there is little effort contributed to environmental protection.

Although China has little response to agricultural pollution, its efforts to protect water sanitation should not be ignored. In China, faced with water pollution, direct investment in building facilities to protect the environment is shown in Figure 3.

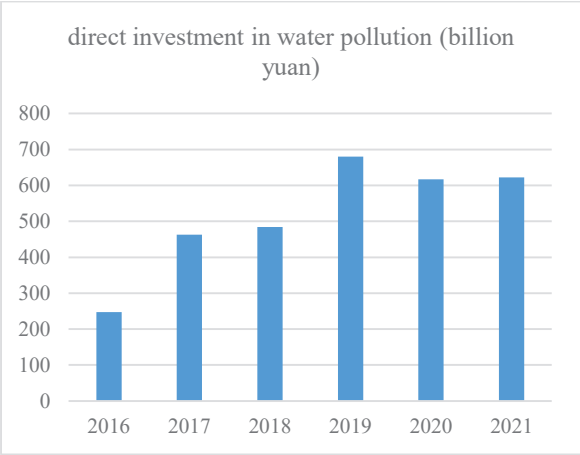

Fig. 3. Direct investment in water pollution in China. Source: http://www.cnemc.cn/jcbg/qgdbsszyb

It can be seen that China's direct investment in water pollution control increased year by year from 2016 to 2019. However, since 2019, the amount of direct investment has stabilized at around 100 million yuan, suggesting that China may have reached a balance between social benefits and social costs in water pollution control.

4 Conclusion

In conclusion, this paper thoroughly explains the current dilemma of mask consumption and its possibly related environmental problem—soil contamination. The reviewed literature reveals that such a problem has been proposed for years. To be specific, the case study of China's mask consumption, production, and soil contamination gives an overview of the answer. By taking a deeper analysis of the case, the consumption of masks and unregulated waste disposal of the masks, instead of mere industrial production, result in a higher risk to the soil. The response of China to such a grave issue was indirect. This may lead to some environmental issues in the future, such as severer soil contamination or health problems related to agricultural products made on contaminated plantations.

The case study in this paper did not use a large amount of data analysis because the statistical data available in terms of mask production and soil contamination in the three years since the outbreak of the COVID-19 pandemic was not enough to support it, resulting in a lack of intuitive data support. As for the future outlook, this paper expects environmental science research experts to cooperate in the future to complete a more detailed and precise report.

To prevent such contamination that could impose great threats to agricultural activities, a higher awareness of the pollution of surgical masks should be raised among the public. Currently, only a modest number of people realize the harm to the environment derived from the direct disposal of manufactured finished products, for example, surgical masks.

Not only China but also such developing countries as India and African countries facing similar problems due to the enormous amount of industrial production and consumption resulting from population expansion must consider soil contamination in terms of future developmental strategies.

Last but not least, the functions of masks, as one of the most portable and cheap equipment protecting people from external threats such as viruses and bacteria, should be acknowledged thoroughly in case abuse, misconception, and improper behavior during usage contributes to unprecedented negative impacts.

References

1. M.N. van Straalen, Biodegradation, Assessment of soil contamination - a functional perspective, **13**, 41-52 (2002)
2. F.J. Zhao, Y.B. Ma, Y.G. Zhu, et al, Environ. Sci. Technol., Soil contamination in China: current status and mitigation strategies**, 49**, 750-759 (2015)
3. G. Torres, E.D. Fernando, E. Gabriel, Sci. Total Environ., Face mask waste generation and management during the COVID-19 pandemic: An overview and the Peruvian case, **786** (2021)
4. M. Shen, Z.T. Zeng, B. Song, et al, Sci. Total Environ, Face mask waste generation and management during the COVID-19 pandemic: An overview and the Peruvian case**, 790** (2021)
5. T.A. Aragaw, Mar. Pollut. Bull., Face mask waste generation and management during the COVID-19 pandemic: An overview and the Peruvian case**, 159** (2020)
6. M. Torre, M.E. Kafritsa, A. Anastasopoulou, Mar. Pollut. Bull., Cross-contamination by COVID-19 mask microfibers during microliter analysis of marine biota, **181** (2022)
7. E. Mészáros, A. Bodor, A. Szierer, et al, J. Hazard. Mater., Indirect effects of COVID-19 on the environment: How plastic contamination from disposable surgical masks affect early development of plants, **436** (2022)

8. G. Qin, Z. Niu, J. Yu, et al, Chemosphere, Soil heavy metal pollution and food safety in China: Effects, sources and removing technology**, 267** (2021)
9. A.S. Soğanci, International Journal of Geological and Environmental Engineering, The effect of polypropylene fibber in the stabilization of expansive soils, **10**, 994-997 (2015)
10. S. Khan, M. Naushad, E.C. Lima, et al, J. Hazard. Mater., Global soil pollution by toxic elements: Current status and future perspectives on the risk assessment and remediation strategies–A review, **417** (2021)