The Issue of Plastic and Microplastic Pollution in Soil

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Soil pollution with plastics represents a great threat to plants, animals, but especially to humans, as a very small quantity of the plastic which is discarded daily is recycled or incinerated in waste facilities, much of it reaching landfills where their decomposition lasts up to 1000 years and during this time the toxic substances penetrate the soil and the water. If, initially, the pollution with plastics has been identified and recognized in the aquatic environment, recent studies show that plastics residues exist in huge quantities in the soil. The present study focuses on the analysis of factors that pollute soil, so the various studies that have been carried out claim that soil pollution with plastic is much higher and increases in an aggressive manner, being estimated to be 4 to 23 times higher than water pollution with plastics, and the accumulation of microplastics in the soil has a negative impact on soil biota. Thus, once the plastic material accumulates in the soil, it is assimilated to organic matter and the mineral substitutes of the soil and persists for several hundred years.

Keywords: plastic pollution, soil, plastic waste, microplastic, sludge, plastic mulching film

Since its appearance in the early 1950s, the plastics industry has grown significantly and today is one of the most important economic sectors for our society [7]. Despite their multiple benefits, plastics are associated with high levels of waste and leakage into the environment.

Taking into account that the evolution of life takes place under conditions of uncertainty, we have to pay attention on the protection of human health [16] and also on the environment health [13].

We live in a *plastic age*, with over 240 million tons of plastic used annually, mostly disposable [21]. Soil, an essential component of the terrestrial ecosystem, suffers strong pollution pressures due to the limited recovery of discarded materials, because plastic accumulates in the environment [19].

Microplastic soil contamination has consequences on both biodiversity and soil function, and plastic fragments are present all over the world, with multiple adverse effects.

One third of the plastic waste reach the ground, [4] most of it disintegrating into small particles, known as microplastic which disintegrate too into nanoparticles and then, ends up in the food chain [6]. This is possible because, when plastic particles decompose, they acquire new physical and chemical properties, increasing the risk of having a toxic effects on human body.

Accumulation of plastics in the environment is a global problem that will continue to grow [22] if current waste production, consumption and management practices remain unchanged. It is estimated that about 12,000 million tonnes of plastic waste will accumulate in landfills or the environment by 2050 if no action is taken [7].

The sewerage network is the main method of distribution of microplastics. Concerned is the fact that sewage sludge is often applied to the fields as fertilizer, which results in thousands tons of microplastics reaching the soil annually [24].

Experimental part

The presence of plastics in the environment, either as macroplastic residues or as microplastic residues, has been widely recognized as a global problem. This is one of the most challenging anthropogenic phenomena affecting the planet and is one of the main threats to biodiversity.

While pollution with plastics and microplastics in the aquatic environment has particularly attracted attention, the problem of soil pollution with plastics has somehow been unexplored [9].

Interesting is the fact that, more than 80% of the plastics found in the aquatic environment were produced, used and stored on land. Therefore, plastic pollution is a major problem of both contamination and deterioration of the terrestrial environment and of the transfer to the aquatic environment.

Lately, the action of soil biota, especially animals, has been examined as a microplastic soil incorporation engine. [18] Thus, Huerta Lwanga et al. (2016), through their experiments, demonstrated that worms help to incorporate the microplastic granules into the soil [10] and Rillig et al. (2017) demonstrated in the laboratory that the worms can influence the microplastic granule movement at surface down the soil profile [17].

Results and discussions

Terrestrial emissions are also a predominant source of microplastics, predominantly from car tires, household waste, textiles, [2] industrial processes such as sandblasting and deflagration of plastics, and the deterioration of surfaces made or covered with plastics such as grass artificial paint or polymer paint. Clearly, most of these emissions occur in urban and residential areas [11].

Even geophagic fauna, such worms, colemboles or mites, contributes to soil pollution with microplastics, as they fragment fragile plastic debris and eat them, favoring the incorporation of plastic fragments into the soil. Also, digestive mammals, such as gophers and moles, contribute to the incorporation of microplastics into the soil [19].

Agricultural land has a high potential for sewage sludge as a result of wastewater treatment. It is obvious that organic matter and nutrients are beneficial to crop growth and development, but at the same time there are concerns about the possible negative effects of long-term sludge application [14].

Using sludge from sewage treatment channels as a fertilizer is a very convenient practice for farmers [12], which is common in many developed regions. For example, in Europe, about 50% of sewage sludge is processed for agricultural use [15].

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In 2015, according to data provided by Eurostat, 967,744 thousand tons of sludge were used at EU-28 level. [23] Germany used about 50% of the total, distributing on land 427,736 thousand tons of sludge. Poland in turn distributed 107.5 thousand tons, followed by the Czech Republic with 101.64 thousand tons. The rest of the EU countries have distributed sludge on land in quantities ranging from 0.936 thousand tons to 87.6 thousand tons (Fig.1).

If we continue to refer to agriculture, rapid population growth has been a challenge for agriculture [8], and this has to face these pressures, also taking into account the limited availability of arable land [20].

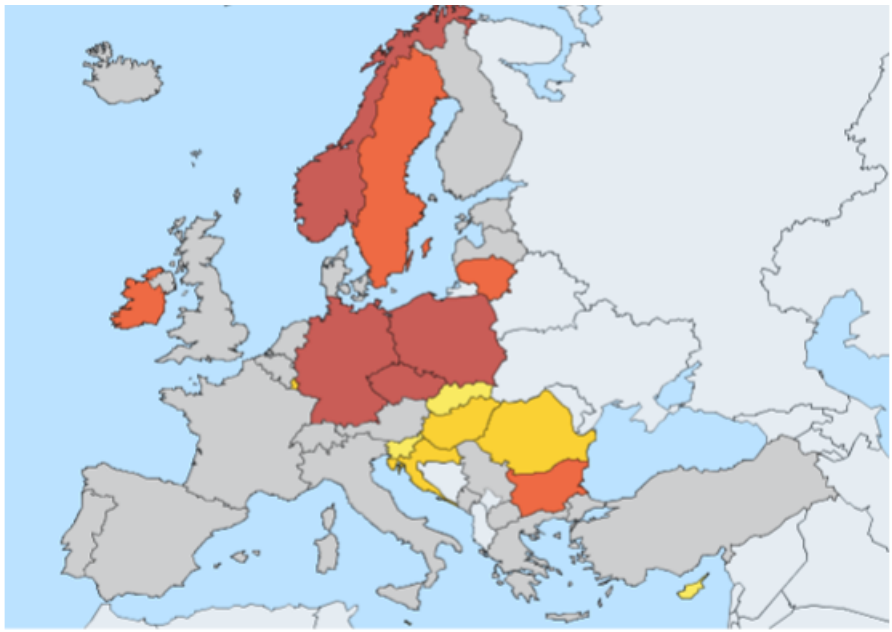
Thus, plastic wrapping has become a very common practice in the world, thanks to the increased productivity, earlier and richer crops, and controlled water consumption.

But as any advantage brings a disadvantage, this long-term mulching method can have negative implications for soil and ecosystem quality [5].

The negative effects of excessive use of hardly degradable polyethylenes may result from additives present in plastic, from pesticide leakages, and from plastic debris that breaks down into microplastics, remain intact, without decomposing, accumulating year after year, and being absorbed into the soil [1] (Fig. 2).

Chae and An (2018), illustrated the flow diagram of waste plastics and their distribution in soil across different paths. Thus, plastic waste penetrates the surface of the soil reaching deeper layers of soil either through the plants or through the feeding activities of the living creatures [3] (Fig. 3).

Plastic is very resistant to degradation, and once it has penetrated into the soil, plastic particles persist for a very long time and accumulates, reaching levels that affect soil biodiversity.

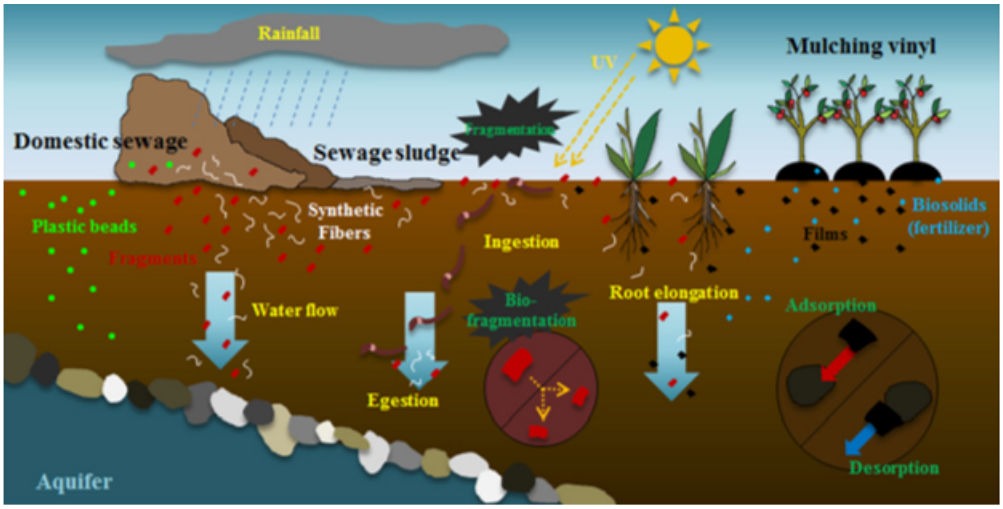


Source: Eurostat, 2019. [22]

Fig. 1. Sludge disposal for agriculture use in 2015 in European Union

Source: http://www.world-agriculture.net/article/the-benefits-and-challenge-of-plastic-film-mulching-in-china

Fig. 2. Crop residue after plastic mulching



Source: Chae, Y, An J., Environmental Pollution, vol. 240 (2018) 387-395 [3]

Fig. 3. The flow of plastic wastes in the soil environment

Conclusions

Even though there are no so many information on soil pollution with plastics and microplastics, various studies have identified the main sources of soil pollution, giving an wake-up call on this type of pollution, as harmful as aquatic pollution.

The purpose of this study was to identify the factors that contribute to soil pollution, how these factors operate and which are the consequences that arise.

Regarding agriculture, even if the purpose of farmers is other than polluting soil, soil amendments such as mud from waste water treatment channels are one of the main sources of pollution. Sewage treatment plants receive huge amounts of microplastics from households, industries, or surface leaks present in urban areas, which accumulate in the sludge left behind by application and which farmers choose to use, due to much lower costs.

The use of plastic mulching film has gained a lot of notoriety, due to its beneficial effects on crop quality, higher and early production, and the maintenance of soil temperaments. However, with the intensive use of this mulching method, the problem of soil pollution arose because of the plastic that remains on the soil after the removal of these films.

If since now, attention has been focused on aquatic pollution, research shows that the presence of these plastics on the soil surface has effects with a very negative impact.

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