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Microplastics in ecosystems and health

Microplásticos en los ecosistemas y la salud

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Abstract

Microplastics are very small plastic particles, less than 5mm in diameter. These materials may originate from the degradation of larger plastic products, such as bottles and bags, or may be intentionally manufactured for use in cosmetics. Microplastics are a significant environmental problem because they can be ingested by marine animals and other living things, causing them significant damage. Furthermore, these materials can act as toxic contaminants. The objective of this study is to know and understand the negative effects of microplastics on ecosystems, and on human health, and to know the technologies that are being used to reduce this type of contamination through recycling and the development of alternatives to plastic, as well as knowing the policies that are being developed to address this problem. This study seeks to create greater public awareness of the problem, improve understanding of the effects on ecosystems, and identify the sources and routes of entry of microplastics into the environment. In summary, research on microplastics is essential to address the problem of plastic pollution and to find effective solutions to protect our environment and health.

Microplastics, Pollution, Ecosystems, Health

Resumen

Los microplásticos son partículas de plástico muy pequeñas, inferiores a 5mm de diámetro. Estos materiales pueden ser originados por la degradación de productos de plástico más grandes, como botellas y bolsas, o pueden ser fabricados intencionalmente para su uso en cosméticos, Los microplásticos son un problema ambiental importante porque pueden ser ingeridos por animales marinos y otros seres vivos, causándoles un daño significativo. Además, estos materiales pueden actuar como contaminantes tóxicos. El objetivo del presente estudio es conocer y entender los efectos negativos de los microplásticos en los ecosistemas, y en la salud humana, y conocer las tecnológicas que se están utilizando para reducir este tipo de contaminación a través del reciclaje y el desarrollo de alternativas al plástico, así como conocer las políticas que se están desarrollando para abordar esta problemática. Con este estudio se busca crear mayor conciencia pública sobre el problema, mejorar la comprensión de los efectos en los ecosistemas e identificar las fuentes y las rutas de entrada de los microplásticos en el medio ambiente. En resumen, la investigación sobre los microplásticos es esencial para abordar el problema de la contaminación por plásticos y para encontrar soluciones efectivas para proteger nuestro medio ambiente y salud.

Microplásticos, Contaminación, Ecosistemas, Salud

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Introduction

As mentioned above, microplastics are small plastic particles, usually less than 5 millimetres in size, that have become a major environmental concern worldwide. These microplastics are found in a variety of sources, such as personal hygiene products, synthetic clothing, packaging and plastic waste that decomposes over time.

Microplastics can have negative effects on the environment, including pollution of the oceans, disruption of marine and terrestrial ecosystems, and possible ingestion of microplastics by wildlife and humans. In addition, microplastics can also release toxic chemicals that can be harmful to health.

The magnitude of the microplastics problem is increasingly being recognised by governments, businesses and the general public, and measures are being taken to address the problem. Some of these measures include banning microplastics in personal care products, promoting proper waste management, developing alternatives to plastic and research into new technologies to reduce microplastics in the environment.

This topic is important because in addition to the effects already mentioned, microplastics can also disrupt natural biological and ecological processes.

They are also important to study because they are a form of environmental pollution and can persist in the environment for hundreds of years, which can have long-term consequences for the environment. However, microplastics are a global challenge that requires governments, businesses and the general public to work together and collaborate to effectively address the problem.

One way to address the problem of microplastics is through techniques that help reduce the source of these materials. This may include the elimination of certain products containing microplastics, such as personal hygiene products, plastic microbeads, or the promotion of sustainable alternatives to plastic.

One of the techniques used to address this problem is the use of innovative advanced recycling technologies, which are being developed to separate and recover microplastics from plastic waste and, in turn, reduce the amount of microplastics released into the environment.

Such innovative technologies include cleaning with fishing nets and collecting microplastics through flotation and filtration technology. The implementation of monitoring and assessment programs can help to better understand the magnitude of the problem and its impact on the environment. The results of these studies can inform the policies and regulations needed to address this problem.

Last but not least, public education and awareness are critical to addressing this problem. By increasing public awareness of the effects of microplastics on the environment and human health, a change in behavior and consumption of plastic products can be encouraged.

In summary, a variety of techniques are being used to address the microplastics problem, and a comprehensive and collaborative approach will be needed to reduce the amount of microplastics in the environment and protect our health and the planet.

General objective

The main objective of the article is to study the options available and present a proposal for improvement towards the environmental and health problems that have become the disposal of plastics and microplastics, as well as to understand the negative effects of microplastics on ecosystems, from biodiversity to biogeochemical processes, and to understand the effects of microplastics on human health, through the ingestion of contaminated food or the inhalation of particles in the air.

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Theoretical framework

Since humans first appeared on Earth, they have used five main materials to make tools and objects: wood, stone, bone, horn and skin. Others were added to these materials during the Neolithic revolution: clay, wool, vegetable fibers and some metals, and it was not until the beginning of the 20th century that these materials of natural origin began to be massively replaced by artificial or synthetic materials, created by human hands; these materials are called polymers, which are a macromolecule composed of long chains in which a smaller unit called monomer is repeated.

Polymers can be classified according to their origin (natural or synthetic), according to their physical properties (elastomers, plastics and duroplastics), and according to their response to temperature (thermoplastics and thermosets).

The raw material of polymers is petroleum, which is subjected to a fractional distillation and cracking process (chemical process by which the original compound is divided into simpler and smaller compounds) for the separation of its components. (Figure 1),

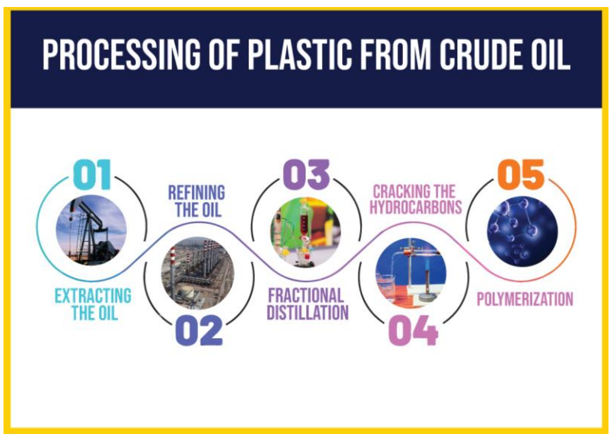

Figure 1 Plastic processing from crude oil
Source: Plastic collectors save the word

History of plastics

The history of plastics dates back to the 19th century, when synthetic materials began to be developed from petroleum chemistry. The first plastics were hard and brittle, but over time new, more flexible and resistant plastic materials were developed.

One of the first synthetic plastics was celluloid, developed in the 1860s from cellulose and initially used in the manufacture of billiard balls, buttons and combs. In 1907, Belgian chemist Leo Hendrik Baekeland invented Bakelite, the first synthetic plastic completely synthesized from phenol and formaldehyde. Bakelite was widely used in the manufacture of electronic products, such as switches and plugs.

In the 1930s, new types of plastics were developed, such as polyethylene and PVC (polyvinyl chloride). During World War II, plastics became an essential material for the production of military products such as parachutes, helmets and airplanes.

In the 1950s, new types of plastics, such as polypropylene and polystyrene, were developed and began to be used in the manufacture of packaging and consumer products. The production of plastics expanded rapidly during the 1950s and 1960s, and they became a ubiquitous material in everyday life. The resulting rapid growth in plastics production is extraordinary, outpacing most other man-made materials. Notable exceptions are materials that are widely used in the construction sector, such as steel and cement.

Plastic production

The manufacture of plastics begins with small molecules, called monomers, which are repeated thousands or millions of times and assembled into long chains, called polymers (Figure 2). Almost all plastics are made from fossil fuels, especially petroleum and natural gas.

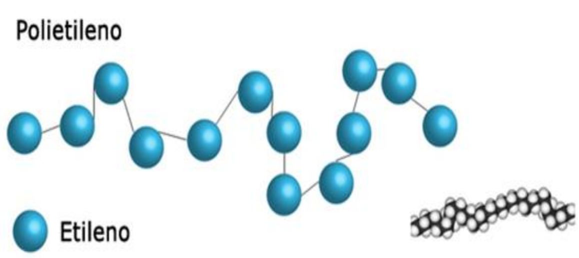

Figure 2 Polymer molecule chain
Source: Ecoplas

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Plastics are produced by adding an initiator with free radicals and modifying substances to the monomer (basic structural unit of the polymer) (Figure 3). Plastics are increasingly used in the industrial and consumer sectors, in packaging, containers, insulating materials, construction and a multitude of other objects.

Figure 3 Plastic manufacturing. Free of hormonal
Source: contaminants.org.

Use of plastic

The global production of plastics has grown relentlessly in recent decades. Plastics help us preserve food through packaging, insulate buildings, use electronics, make vehicles more fuel efficient, manufacture bags, clothing and more. However, the largest market for plastics is packaging, an application whose growth was accelerated by a global shift from reusable to single-use packaging.

The magnitude of plastics consumption in our societies results in a high carbon footprint related to the production of large volumes of waste, persistent pollution, and damage to wildlife and the ecosystem.

As a result, the share of plastics in municipal solid waste (in mass) increased from less than 1 % in 1960 to more than 10 % in 2005 in middle- and high-income countries. In addition, global solid waste generation, which is strongly correlated with gross national income per capita, has grown steadily over the past five decades.

In 2015, about 146 tons of plastic containers and packaging were produced, with an average use of less than 6 months (Figure 4).

Figure 4 Plastic packaging waste
Source: National Geographic

For consumer products, the plastic used in 2015 amounted to more than 42 million tons. These types of products are used on average only 3 years before being discarded. Figure 5.

Figure 5 Consumer products
Source: National Geographic

Plastic is also in our clothes. Around 59 million tons were used in the textile industry in 2015. The average life of textile products is 5 years, after which they usually end up polluting the environment. (Figure 6)

Figure 6 Textile industry
Source: Coats.com

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In the electrical sector, 18 million tons are used annually in all types of cables and electronic devices for their electrical current insulating properties. Most of these components move on to a better life 8 years after their manufacture. (Figure 7)

Figure 7 Electricity sector
Source: Eludesa.com

In 2015 alone, some 3 million tons of plastic were used in different types of industrial machinery. Their average service life will be 20 years in this case. (Figure 8)

Figure 8 Industrial sector
Source: Nacional Geographic

Plastic used in construction is estimated to have an average life span of 35 years, during 2015 alone it amounted to 65 million tons. (Figure 9)

Figure 9 Plastic in construction
Source: Ecoplas.org

47 million tons of plastic were used in 2015 in other types of activities, including healthcare and agriculture. After 5 years, most of these materials will have become waste. (Figure 10)

Figure 10 Plastic in construction
Source: Ecoplas.org

The increasing production of plastics has brought with it pollution, and health problems, which has generated growing awareness of the issue, guiding public opinion and paving the way for stronger policy intervention on this front. The OECD Global Plastics Outlook reports seek to inform and support these efforts.

Fate and toxicity of plastics

By the end of 2015, all plastic waste generated from primary plastics had reached 5800 metric tons (Mt), of which 700 Mt were PP&A fibers. There are essentially three different destinations for plastic waste. First, it can be recycled or reprocessed into a secondary material.

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Recycling delays, rather than avoids final disposal, it would reduce future plastic waste generation only if it displaces primary plastic production; however, due to its counterfactual nature, this displacement is extremely difficult to establish. In addition, contamination and mixing of polymer types generates secondary plastics of limited or low technical and economic value. Second, plastics can be thermally destroyed. While there are emerging technologies, such as pyrolysis, that extract fuel from plastic waste, to date, virtually all thermal destruction has been by incineration, with or without energy recovery.

The environmental and health impacts of waste incinerators depend largely on the emission control technology, as well as the design and operation of the incinerator. Ultimately, plastics can be disposed of and contained in a managed system, such as landfills, or left uncontained in open dumps or in the natural environment.

Between 1950 and 2015, the cumulative generation of primary and secondary (recycled) plastic waste amounted to 6300 MT. Of this, approximately 800 Mt (12 %) of plastics have been incinerated and 600 Mt (9 %) have been recycled, only 10 % of which have been recycled more than once. About 4900 Mt, 60 % of all plastics produced, were discarded and are accumulating in landfills or in the natural environment. Fig. 11

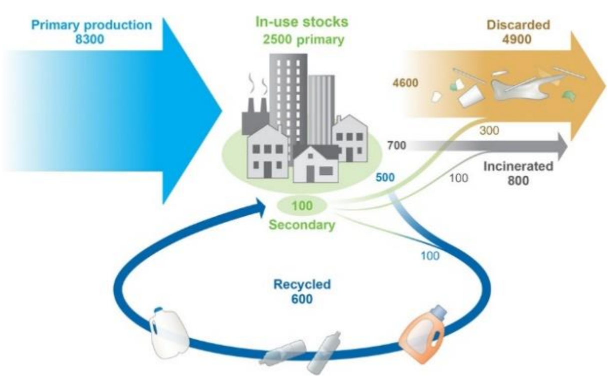

Figure 11 World production, use and destination of polymer resins, synthetic fibers and additives (1950 to 2015; in millions of metric tons)
Source: Science.org

None of the mass-produced plastics biodegrade to any significant extent; however, sunlight weakens the materials, causing fragmentation into particles known to reach millimeter or micrometer size. Research on the environmental impacts of these "microplastics" in marine and freshwater environments has accelerated in recent years, but little is known about the impacts of plastic debris on terrestrial ecosystems.

Although plastic is most visible in its final form as consumer products, packaging or other useful items, all plastics are made of complex mixtures of chemicals.

It is the properties of these chemicals (monomers), and in particular the additives, which are not usually linked to the plastic material itself, that cause serious health problems. These additives are added to make the plastic have different characteristics, such as being softer or softer. A typical example of additives are phthalates. Additives are not part of the polymer structure, so they can be released from the plastic in response to energy from the sun or microwaves and contaminate the air, water or food.

Many of the largest and most dangerous carcinogenic and hormone-disrupting chemical families are directly associated with the production of plastics, compared to other materials such as heavy metals, flame retardants, aphthalates, bisphenols or fluorinated compounds.

The toxic effects produced by microplastics and their associated substances include the production of reactive oxygen species, increased oxidative stress indicators, alterations in gene transcription and expression, DNA damage, endocrine disruption alterations and even effects on population parameters, such as the probability of survival and low fertility rates, which has generated great public health concern.

Classification codes for plastics

Some plastics have numerical codes found on the bottom of most plastics. These codes indicate the type of plastic used, so that each item can be sorted and processed for proper recycling; however, many other types of plastics do not carry a code and are generally not recyclable.

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Table 1 shows the classification of these plastics, examples of common use, their monomers and the hazard of exposure to these monomers.

		POLYMER	COMMON EXAMPLES	MONOMER	MONOMER HAZARD?
1	**PET PETE**	Polyethylene Terephthalate (Polyester)	Soft drink bottle, yogurt cup, vegetable tray, shampoo bottle, plastic tea bags, polar fleece textile fabric	Terephthalic acid + ethylene glycol	
2	**HDPE**	High-Density Polyethylene	Drinking water pipes, cutting board, refillable drinking bottle, yogurt drink bottle, trash bag / bin liner, shower gel bottle	Ethylene	
3	**PVC**	Polyvinyl Chloride	Artificial leather, bath tub squirt toys, inflatable bathing ring, tablecloth, drinking water pipes, flooring, cling wrap, pond liner	Vinyl chloride	Carcinogen
4	**LDPE**	Low-Density Polyethylene	Cling wrap, trash bag / bin liner, lemon juice bottle, plastic wrap, freezer bag, hair conditioner bottle	Ethylene	
5	**PP**	Polypropylene	Foldable water container, thermal undergarments, ground water pipes, refillable drinking bottle, yogurt cup, gummy candy packaging	Propylene	
6	**PS**	Polystyrene	Styrofoam cup, yogurt cup, fruit and vegetable tray	Styrene	Probable carcinogen; suspected reproductive toxicant
7	**OTHER**	Other			
*	**PC**	Polycarbonate	Baby bottles, electronics enclosures, compact discs	Bisphenol A Bisphenol S	Endocrine disruptor Endocrine disruptor
*	**PUR**	Polyurethane	Artificial leather, foam mattress, scouring pad, kids bath sponge, shower slippers	Isocyanate + polyol	Isocycanates: inhalation hazard
*	**PTFE**	Polytetrafluoroethylene (Teflon) Polyamide (Nylon)	Nonstick baking sheet liner; nonstick cookware; some breathable water-repellent materials like Gore-Tex “Plastic” tea bags clothing	Tetrafluoroethylene (Various)	Probably carcinogen
*	**ABS**	Acrylonitrile butadiene styrene	Drinking water pipes, electronics enclosures, 3d-printed objects	Acrylonitrile, butadiene, styrene	Acrylonitrile: possible carcincogen; butadiene: known carcinogen; styrene: suspected carcinogen
*	**PLA**	Polylactide	Yogurt cup, coffee cup lid, shampoo bottle, vegetable tray, 3d-printed objects	Lactic acid	
*	**NITRILE**	Acrylonitrile butadiene rubber	Non-latex gloves	Acrylonitrile, butadiene	Acrylonitrile: possible carcincogen; butadiene: known carcinogen
***May be numbered “7 OTHER”, but often not numbered for recycling**					

Table 1 Common plastic polymers and their associated monomers
Source: Heal. Health and enviroment alliance

As previously mentioned, plastics are largely composed of polymers, large chemical molecules consisting of chains of smaller repeating units known as monomers, plus many. Additives that are often found in finished products. During and after use, polymers can break down into smaller components or their constituent monomers, which happens when a plastic bottle of water is exposed to sunlight.

However, despite these inherent concerns about their use, polymers are exempt from registration in both Europe and the United States. This means that companies are not required to provide information on the health and environmental hazards associated with exposure to these polymers.

Table 2 shows the classification of plastics in commonly used products.

PRODUCT	TYPICAL PLASTICS	PRODUCT	TYPICAL PLASTICS
Acoustic foam	PUR	lemon juice bottle	LDPE
Artificial leather	PUR, PVC	nonstick baking sheet liner	PTFE
Baby bottles	PC	oven bag	PET
Bath tub squirt toys	PVC	place mat	PVC
Bib	PE	plastic cup	PS
Cling wrap	PVC, LDPE	plastic tea bags	Nylon, PET
Coffee cup lid	PLA	polar fleece textile fabric	Recycled PET
Compact disc	PC	pond liner	PVC
Crisps packaging	PP+PE layes	pool noodles	PE
Cutting board	HDPE	rain pant	PE
Drinking water pipes	PVC, HDPE, ABS	refillable drinking bottle	PP, HDPE
Flooring	PVC	scouring pad	PUR
Foam mattress	PUR	shampoo bottle	PET
Foldable water container	PE, PP	shower gel bottle	PS
Freezer bag	LDPE	shower slippers	PVC
Fruit tray	PS	soft drink bottle	PP
Furniture foam	PUR	styrofoam cup	LDPE, HDPE
Ground water pipes	PP, PVC	tablecloth	PS, PET, PLA
Gummy candy packaging	PP	thermal undergarments	PET
Hair conditioner bottle	LDPE	trash bag / bin liner	LDPE, HDPE
Handkerchief packaging	PP	vegetable tray	PS, PET, PLA
Inflatable bathing ring	PVC	water bottle (not reusable)	PET
Inflatable pool toys	PVC	yogurt cup	PS, PP, PET, PLA
Kids bath sponge	PUR	yogurt drink bottle	HDPE

Table 2 Typical plastics used in commonly used products
Source: Heal. Health and enviroment alliance

Global problem

In 2022, a study by the Organization for Economic Cooperation and Development (OECD) estimates that 22% of the world's plastic waste will be wasted and only 9% will be successfully recycled. Figure 12

The OECD indicates that, globally, twice as much plastic waste is being produced as two decades ago, and that almost half of all plastic waste is generated in the organization's member countries, according to the OECD Global Plastics Forecast.

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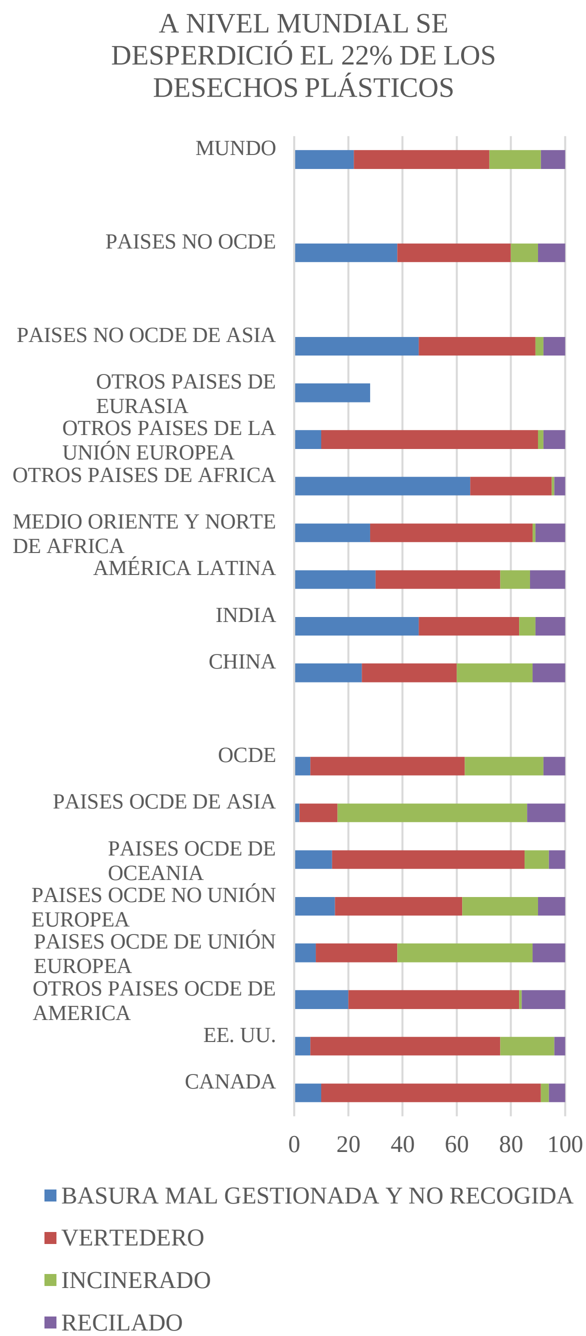

Graphic 1 Disposal of plastic waste
Source: OCDE/Gráfico: LR-LM

According to the study, plastic waste generated annually per person varies from 221 kilograms in the United States and 114 kilograms in the European countries that belong to the OECD, to 69 kg, on average, in countries such as Japan and South Korea.

In addition, most plastic pollution is due to poor collection and disposal of the larger plastic waste known as macroplastics.

However, leakage of microplastics, i.e., synthetic polymers less than 5 millimeters in diameter, from items such as industrial plastic granules, synthetic textiles, road markings and tire wear, is also a serious problem of great concern to the organization.

According to the study, OECD countries are responsible for 14% of total plastic leakage, accounting for 11% of macroplastic leakage and 35% of microplastic leakage.

The COVID-19 crisis led to a 2.2% decline in plastic use in 2020 as economic activity slowed, but led to an increase in litter, such as takeaway food packaging and plastic medical equipment such as face masks. However, as economic activity resumed in 2021, plastic consumption also rebounded and intensified the problem.

Consumption has quadrupled

According to the OECD, consumption of plastic materials is four times higher today than it was 30 years ago, driven by growth in emerging markets. Global production reaches 460 million tons and accounts for 3.4% of global greenhouse gas emissions. Global plastic waste generation more than doubled between 2000 and 2019 to 353 million tons and almost two-thirds of plastic waste has a useful life of less than five years: 40% is packaging; 12% consumer goods and 11% garments.

Sources of exposure to Microplastics

Human exposure to microplastics is manifold, including through the air we breathe, the food we eat or the products we use. Many consumer products now incorporate "microplastics," tiny particles ranging in size from a few millimeters to microscopic "nanoplastics" the size of bacteria.

Microplastics are often deliberately added to certain products such as exfoliants and toothpastes to improve their function, and plastic "microbeads" are used to make sunscreen spread more evenly.

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However, it is surprising to learn that most of the microplastics (35%) come from the clothes we wear, as more and more synthetic textiles (such as nylon) are used to make them cheaper, but each wash releases thousands of fibers that end up in waste water. Another important source of microplastics is car tires (30%) and city dust (25%).

Road signs and paints, as well as cleaning and personal hygiene products represent 5%, respectively. It should be noted that plastic products are made with different chemical compounds and therefore have different densities. For example, plastic bags, made of polyethylene, are less dense than seawater, so they will float; other plastics are heavier and will sink to the bottom of the ocean. This implies an obvious contamination of the marine habitat; but, in addition, microplastics have the capacity to accumulate hundreds of toxic substances, including insecticides, herbicides, fertilizers and persistent organic pollutants that are carcinogenic and endocrine disruptors.

These particles are also colonized by bacteria that can act as accumulators of other pollutants. Thus, the microplastics present in ocean water enter the food chain through plankton and from there pass to fish larvae, mollusks and crustaceans; from there to larger fish, until they reach our plates.

It has been proven that the plastic ingested by the creatures varied from 50 to 100 percent in the Mariana Trench, the deepest trench in the world, and that all the organisms that inhabit it have ingested plastic or semi-synthetic fibers. Figure 12.

Figure 12 Plastics in marine life. Journal of the Mexican Academy of Science

Figure 13 shows the persistent cycle of plastic toxins in the environment and thus in humans.

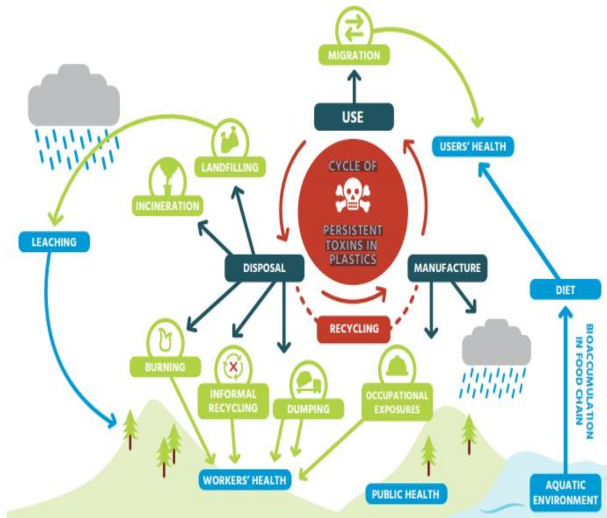

Figure 13 Persistent cycle of plastic toxins
Source: Health and enviroment alliance

Microplastics now constitute "a major potential threat to global aquatic ecosystems" on an almost unimaginable scale. A study by researchers at the University of Newcastle, Australia, suggested that people may be ingesting 5 grams of microplastics each week, roughly the amount of plastic on a credit card.

In 2013, scientists estimated that already more than five trillion plastics and their particles are floating in our oceans, most of them microplastics.

Scientists from the University of Ghent, Belgium, recently discovered that on average the European seafood consumer ingests 6400 grams of microplastics per year.

In addition, the presence of microplastics has also been reported in the stomach contents of freshwater fish globally. This is due to confusion by fish with their natural prey, such as plankton. Therefore, studies have been conducted to evaluate the ingestion of PM fragments according to color (red, green, yellow, white, black and blue), observing that zebrafish in particular preferred to consume the blue fragments, while avoiding green and white fragments. Although it is not yet clear how plastic coloration is related to selectivity and consumption in freshwater fish, the visual abilities of fish may explain why certain colors are attractive to a particular fish species.

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A 2018 investigation of bottled drinking water, analyzing more than 250 samples from nine countries, found that 90% was contaminated by plastics: primarily polypropylene (54%), nylon (16%) and polyethylene or PET (6%). These results prompted the World Health Organization (WHO) to initiate a review of the risks of microplastics in drinking water. Following this first review, WHO highlighted the need for more research on the health effects of microplastics and has called for strong action against plastic pollution.

In January 2019, the European Chemicals Agency (ECHA) proposed a restriction on adding microplastics to certain products, which is expected to prevent the release of 500,000 tons of microplastics over the next 20 years.

An estimated 8 to 12 million tons of plastic are released into the world's oceans each year, and it is expected that by the year 2050 there will be more plastic than fish in the ocean if no action is taken to address the problem. Figure 14.

Figure 14 Impact of plastic
Source: Iberdrola

Recommendations

There are several recommendations and actions that should be taken to address the microplastics problem:

1. Reduce the overall consumption of plastics in our daily lives. This includes avoiding the use of disposable plastic products, opting for sustainable and reusable alternatives, such as cloth bags instead of plastic bags, reusable bottles instead of single-use plastic bottles, and avoiding products with plastic microbeads in their composition.

2. Implement and improve waste management systems to prevent plastics and microplastics from ending up in the environment. This involves encouraging proper recycling of plastics, litter collection and promoting waste reduction in general.

3. Research and track the presence and effects of microplastics in different environments, such as oceans, freshwater bodies, soils and air. This will help to better understand the extent of the problem and to take appropriate measures to address it.

4. Implement effective regulations and policies to address the production and use of microplastics. This may include banning or restricting certain products containing microplastics, promoting sustainable alternatives, and setting quality standards for the proper management of plastics and waste.

5. Create public awareness programs to promote behavioral changes and sustainable habits. Awareness of the environmental and health effects of microplastics should be raised, and clear guidelines should be provided on how to reduce their impact.

Addressing the microplastics problem requires a combination of individual actions, government regulations, ongoing research and public education. A comprehensive and collaborative approach is needed to minimize the release of microplastics into the environment and protect our health and ecosystems.

Conclusion

Plastic waste is now so ubiquitous, i.e. it is present everywhere in the environment that it has been suggested as a geological indicator of the proposed Anthropocene era, a term that has been created to designate the impact on climate and biodiversity of both the rapid accumulation of greenhouse gases and the irreversible damage caused by excessive consumption of natural resources. Microplastics are considered to constitute one of the main sources of anthropogenic pollution in the world, due to inadequate or non-existent urban and industrial waste collection, recycling and disposal systems (World Bank, 2016). Therefore, the almost permanent contamination of the natural environment with plastic waste is a growing concern. Therefore, it is necessary to create more and better awareness programs, involve governments to create policies that control the manufacture, disposal and recycling of plastics, and create fines for plastic producing companies that use toxic and harmful substances to humans, and do not inform about the dangers of their use.

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