

A WORLD OF PLASTIC



We created it, we depend on it, and now it's suffocating us.

5 billion bags every year, 25 million tons of waste every month, 1 million bottles every day around the world: plastic has reached all corners of the planet.

How is that possible?

And what are the consequences?



HOW IT IS POSSIBLE THAT SEAS AND OCEANS AROUND THE WORLD

RE FILLING WITH PLASTIC?

More than half of the plastic becomes waste in less than a year from production and most is not recycled or reused. Many of these wastes end their lives at sea. The causes of the problem are global and can be summarized in four fundamental areas: production, use, inadequate waste management, model of linear economy.

PRODUCTION: TOO MUCH!

Environmental pollution from plastics is a phenomenon of global scope, with astounding numbers. Although it is recognized as a global emergency and many states and institutions, including the European Union, are trying to make amends, **it is expected that in the next 30 years the production of plastic will still grow by 70%**, in line with a trend that has seen world production increase twenty-fold since the 1960s. In this context, Italy has a leading role: Italy is in fact the largest producer of plastic among the countries bordering the Mediterranean and is responsible for 2% of the world production of plastic products. In Lebanon, 219,800 tons of plastic waste are produced.

When you think about plastic, you shouldn't just imagine the packaged food or all plastic items that fill stores around the world. Even **cosmetics**, for example, often contain micro granules of plastic with abrasive function (e.g. scrub). Plastic is also widely used in the **textile industry**: many of the clothes we buy are, at least in part, of synthetic origin (e.g. acrylic, nylon, polyester, elastane, lycra). These fabrics, during washing, release small particles, invisible to the eyes and not entirely intercepted by water purification systems, which contribute to the increase of plastic in the environment.

USE: VERY SHORT!

The reasons for the rapid and extraordinary diffusion of this material are obvious: economical, versatile, safe, light. Also ideal for the production of disposable items, which represent in fact a large part of the plastic business. A significant fact shows: **almost half of all plastic produced in the world becomes a waste in less than three years**. It is mainly plastic that contains polyethylene, mainly present in packaging and disposable products. In fact, according to the European Union, there are 10 types of products that alone represent 70% of the plastic waste in the sea and for which there are already alternatives on the market: cotton-buds, cutlery, plates, straws, sticks to mix drinks, balloon sticks, food and beverage containers made of expanded polystyrene. Even in this case, the use of plastic in Italy is a record: just think **that we are the biggest consumers of bottled water in Europe and among the first in the world**. Not only that: about 80% of the plastic produced in Italy comes from the packaging industry and therefore has an extremely short life cycle.

GESTIONE: NON ADEGUATA!

Where does all this plastic go? It is largely dispersed in the environment. This is evidenced by numerous studies, which have shown the presence of plastic waste in the most remote places of the planet, from the seabed to the glaciers of the mountains, from rivers to the intestines of animals. Why is that? **Globally, about 37% of plastic waste is unmanaged or poorly managed, meaning it is not collected, dispersed in the wild, or dumped in illegal landfills**, polluting soil, freshwater and oceans with macro, micro and nanoplastics.

In Europe, a region that is virtuous compared to other parts of the world, approximately 25.8 million tonnes of plastic waste are produced each year. **Less than 30% of this waste is collected for recycling, many end up in landfill or incinerator** (respectively 31% and 39%) and a significant share leaves the European Union to be treated in third countries, where different environmental standards may be applied.

DID YOU KNOW THAT?



EVERYTHING FLOWS DOWNSTREAM: THE WATER CYCLE

It seems incredible that the wrapping of a candy dropped out of pocket during a trip to the mountains is just the same that we could see a few months later bathing at the sea: and yet it is just like that! The water of the whole planet is connected and circulates continuously.

The waste is dragged by the rain and the rivers down to the valley, reaching all the sea, and then remains there, while the water continues its path through evaporation (see teaching card "Everything flows downstream").

AN INDESTRUCTIBLE MATERIAL!

What happens to a plastic waste that does not end up in the garbage? One thing is certain: it does not disappear into thin air. Plastic deteriorates in the environment by breaking into smaller and smaller parts, which remain in the environment for a very long time. It is not yet clear how long the plastic is destroyed: a plastic bottle takes about 500 years to degrade, but we do not know if this degradation is complete or if it is nothing more than a breakdown into smaller fragments (macro, micro and nano plastics).

What about in Italy? Our waste management system includes **separate waste collection** made with the support of citizens, responsible for separating **paper, plastic, glass, metal and organic**, with the aim of facilitating recycling, albeit with a **strong regional gap, often linked to management problems and deficiencies in infrastructure in some areas of the country**.



But the system is not completely efficient: in 2017, **the plastic fraction from packaging not suitable for recycling was 38%** (more than 500 thousand tons), of this more than 80% was destined for energy recovery (incinerators or cement plants in Italy and abroad) and about 20% was sent to landfill. In some **regions of the South** (Sicily, Molise, Calabria and Puglia) less than 1/3 of the municipal waste is separated from consumers (private or industries) and properly managed. Even some large cities have difficulties in waste management. Naples, Rome and Genoa, for example, have a separate collection rate below the national average (53%). On average more than 60% of the total plastic waste collected ends up in landfill or incinerator: even if you throw the plastic in the correct container, does not mean that the material is actually recycled and placed back on the market in a circular economy.

Even in **Lebanon**, differentiated waste management has begun in **some areas**, but unfortunately the infrastructures are still lacking and the current situation does not facilitate this process.

Of course, waste that does not enter the separate collection system is more likely to end up dispersed in nature. No one can say exactly how much plastic ends up in the sea, **but it is estimated that, every year, between 5 and 13 million tons of plastic - from 1.5% to 4% of world production - ends up in the world's oceans** causing 80% of marine pollution. Following this trend, by 2025 the oceans will contain 1 ton of plastic per 3 tons of fish and by 2050 there will be, by weight, more plastic than fish. This waste for the **4/5 enter the sea driven by the wind or dragged by urban waste and rivers**: no matter if we live in a city far from the sea, our plastic in any case ends there.

DID YOU KNOW THAT?



"THE PLASTIC ISLAND"

The most known accumulation of plastic waste in recent years is definitely the **Great Pacific Garbage Patch**: a huge "island" of floating garbage, composed mainly of plastic, located more or less in the middle of the Pacific Ocean. Although the extent of the large patch is not precisely known, it is assumed to be between 700,000 square kilometers to over 10 million square kilometers (more than the surface of the United States). "The island" has existed since the early 1980s and was formed by the action of an ocean current that captures floating waste and aggregates it together.

Many plastic wastes have reached the most remote and inhospitable places on the planet, such as the Mariana Trench (11000 m deep), where the presence of plastic has been documented by the **Japan Agency for Marine-Earth Science and Technology (Jamstec)**.

SECONDARY MARKETS: INSUFFICIENT!

Recycling plastics is an expensive and complex business: this simple fact hinders the emergence of a circular economy model in the plastics supply chain. Not only that: the extraordinary characteristics of plastic mean that in many areas there is a shortage of environmentally friendly alternatives for consumers.



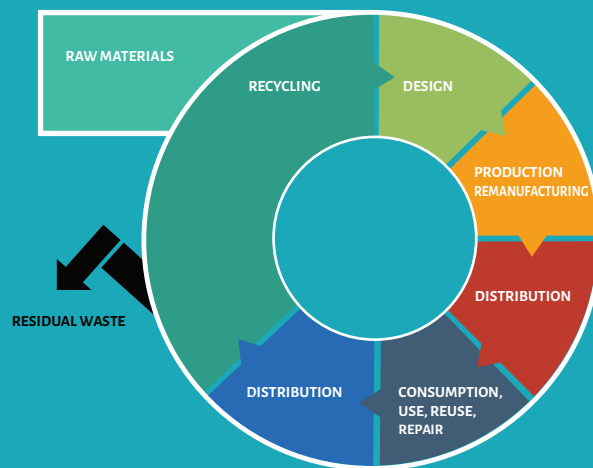
DID YOU KNOW THAT?

WHAT IS THE CIRCULAR ECONOMY?

An economy designed to regenerate itself, where the flows of materials are of two types: biological, able to be reintegrated into the biosphere, and technical, designed to be revalued without entering nature. It is an economical system designed to reuse materials in subsequent production cycles, minimizing waste.

Currently the prevailing economic model is linear ('take-make-throw') and has developed based on the availability of large amounts of resources and energy. But today we are many on this planet and resources are really starting to run out: this model is no longer sustainable.

A transition to a circular model has become necessary, which from design, production, consumption, to end-of-life destination knows how to do everything possible to limit the use of matter and energy "in input" and minimize waste and losses. This model also pays attention to the prevention of negative environmental externalities and the creation of social value



As we have seen, for several reasons, including the fact that in many countries much of the plastic cannot be recycled for health, safety or contamination reasons, **the percentage of plastic that is going to have a second life is very low**. But the recycled plastic collides with another criticality: most recycled plastics are of lower quality than virgin plastic and therefore are marketed at a lower price, this at a high cost of the whole process. The operational costs of recycling activities, in fact, are now prohibitive, both for the high costs related to the collection and differentiation of waste, and for the limited supply of recyclable plastics.

The possibility of giving second life to the plastic in a more profitable and efficient way is largely linked to the improvement of the quality of the recycled plastic, but also to the possibility of entering the "quality" plastic system.

Even collecting it all... we don't know where to put it!

The unsustainability of the current production and consumption model is made clear by the current difficulties in waste management. Not all the plastic that is collected in Italy and Europe is managed by our facilities. Until 2018, for example, it was largely sold to China, which recently changed the rules of the game, limiting the types of plastic imported from abroad: only quality plastic! The cause of this change of course is twofold: workers were underpaid and all that was worthless remained in China, eventually increasing the volume of local landfills. Having to balance environmental issues with their own resource needs, the Chinese have preferred to cut down on the types of products to enter their country, opting only for recyclable waste more easily and therefore at lower costs.

FOCUS ON PET: PLASTIC THAT NEVER DIES

PET is the second most widely used plastic globally, and therefore represents a large percentage of the plastic waste we produce. Water bottles, food packaging, containers of personal hygiene products and some technical fabrics are made of PET. PET waste collection and recycling is already an established market, especially in Europe, Japan and the United States, and is gaining ground in other emerging markets such as China. **The possibility of being divided into monomers without losing its properties makes PET a 100 % recyclable material.** It is therefore reusable repeatedly and, theoretically, infinite times. Recycling and reusing PET plastic multiple times reduces the need to produce more plastic material, which means that we can not only reduce the energy consumption used in the production of new plastic, but also to reduce the amount of solid waste going to landfill.

HOW IS PET PLASTIC RECYCLED?

Currently, PET is mechanically recycled through equipment that differentiates, shreds and rinses the plastic to recover the so-called "PET for food". In this process, however, only 20% of all plastic is reused, with the remaining waste material ending up in landfills and incinerators.

In 2011 a new process was patented that allows for the first time to chemically recycle PET objects. It is a process based on a new application of microwave technology that leads to the depolymerisation of the material, that is, to the division of the polymer chain into its "constituent rings".

If we compare the production of virgin PET from chemical recycling with that produced from oil and gas by studying the ecological impact of the whole life cycle (*Life Cycle Assessment*), from raw resources used to disposal, the former produces 60% less CO₂ emissions and consumes 68% less energy.



Recycle of PET (ITALIAN language)

Tutto ciò che c'è sul riciclaggio del PET - PET-Recycling (petrecycling.ch)

WHAT ARE THE CONSEQUENCES?

CLIMATE CHANGES

The **proliferation of disposable plastics** around the world is accelerating the climate crisis: **it contributes to greenhouse gas emissions at every stage of its life cycle**, from production to refining and how it is managed when it becomes a waste. To give an idea, it is estimated that, between production and incineration, the plastic cycle generates globally about 400 million tons of CO₂ per year. Recent studies show that by 2050 plastic will be responsible for 13% of the total "carbon balance" worldwide, equivalent to 615 coal-fired power plants.

Plastic production uses 4% of global oil and gas annually.

The continuous increases in the production volumes of plastic do not therefore facilitate the achievement of the Paris agreements.

DID YOU KNOW THAT?



WHAT IS THE PARIS AGREEMENT?

At the 2015 Paris Climate Conference (COP21), 195 countries adopted the first legally binding universal climate agreement. The agreement defines a global action plan to limit global warming well below 2°C, recognising the serious risks of continuing with the "*business as usual*".

AN ECOSYSTEM ESSENTIAL TO LIFE AT RISK: THE OCEAN

More often, disturbing images of whales with bellies full of plastic appear in the newspapers. These sad shows are nothing but the tip of the iceberg. The presence of plastic in the sea impacts many organisms in different ways.

1. Plastic in the food chain.

Plastics and microplastics at sea are transferred and accumulated along the food chain: an alarming phenomenon confirmed by recent studies, with effects still unknown on human health and the environment. Given the wide spread of small fragments of plastic (micro and nano plastics) in the seas and oceans around the world, it happens that these become part of the trophic network, up to our tables. How does this happen? A shrimp that feeds on plankton, together with it can ingest fragments of microplastics, for example 10 "bits of microplastics". A small fish, eating 500 shrimps, will then take 5,000 small plastic fragments. And so on, until you get to the top of the food chain, where, for example, a shark, preying in turn on fish that have eaten smaller fish, can accumulate in its stomach large quantities of plastic. The above **is an example of biomagnification**, that is a process whereby the accumulation of toxic substances in living beings (bioaccumulation) increases in concentration as it rises to the next trophic level.

Many animals, instead, eat the plastic directly: among the most involved species there are seabirds (shearwaters and seagulls), sea turtles, dolphins, jellyfish, sharks.

The ingestion of plastic causes death for two reasons: hunger, due to the fact that plastic fills the stomach without providing nutrients, and intoxication. In fact, the physical characteristics of plastic materials, such as porosity, are the basis of the risks of intoxication for those who ingest it: it easily retains pathogenic (bacteria, parasites) and toxic substances.

Man is also among the "victims" of plastic pollution: every year we ingest increasing quantities of nanoplastics through food and drinking water, with health effects still unknown.



2. Fishing nets, straws and other waste that kill directly.

The greatest risk for the inhabitants of the sea is actually constituted by some types of waste, in particular lines and other fishing equipment, very resistant, that twist around the animals seriously injuring or killing them. All these phenomena threaten, according to recent estimates, almost 700 species: 17% of these are included in the red lists of animals in danger of extinction, 92% are endangered by plastic and 10% have ingested microplastics.

This seriously damages the seas and oceans, ecosystems that are essential for life on Earth: they generate most of the oxygen we breathe, regulate the climate, provide us with food and provide ingredients for medicines.

Some examples of this:

- more than 3 billion people depend on marine and coastal biodiversity for their livelihood;
- globally, the estimated market value of marine and coastal resources and industries is about 5% of global GDP;
- the oceans represent the largest protein reserve in the world, with more than 3 billion people dependent on the oceans as a primary protein resource;
- the marine fishing industry employs more than 200 million people directly or indirectly.

DID YOU KNOW THAT?

MICROPLASTICS: WHERE DO THEY COME FROM?

Microplastics are divided into two types.

1. Primary microplastics, released directly into the environment in the form of small particles.

This category is estimated to represent 15-31% of microplastics in the ocean.

Sources:

- washing of synthetic clothes (35% of primary microplastics);
- tyre abrasion while driving,
- microplastics added to body care products.

2. Secondary microplastics, produced by the degradation of larger plastic objects, such as plastic bags, bottles or fishing nets. They represent about **68-81% of total microplastics**.

ECONOMIC DAMAGE: THE BLUE ECONOMY

It is estimated that the Italian "Blue Economy", the third largest in Europe, loses about 67 million euros a year due to plastic pollution. The *marine litter* ("marine garbage"), in fact, not only causes enormous damage to marine ecosystems (loss of biodiversity, endangered marine species, etc.), but has an extremely negative economic impact on important activities such as tourism and fishing.



UNEP (United Nations Environment Programme) estimates that plastics globally cause damage to marine ecosystems at a cost of USD 8 billion each year, with direct adverse effects on fisheries, maritime trade and tourism. The costs of plastic pollution do not weigh on all those actors who instead profit from it, both from production and use. Today, plastic manufacturers are not held responsible for the negative impacts of production, so much so that the market price of virgin plastics does not take into account the entire life cycle of plastics, that is, the costs for the environment and society.

SOURCES AND INSIGHTS



Report World Bank (English)

What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050 (worldbank.org)



Multimedia in –depth analysis of National Geographic (English)

We Depend on Plastic. Now We're Drowning in It. (nationalgeographic.com)



Section dedicated to plastic of the Ellen MacArthur Foundation (English)

Plastics in a Circular Economy | Ellen MacArthur Foundation



The water cycle explained to children (English)

The Water Cycle | The Dr. Binocs Show | Learn Videos For Kids - YouTube



Video European Union (English)

Microplastics: origins, effects and solutions

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