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Towards zero pollution in Europe

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Contents

Editorial

Hans Bruyninckx
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Towards zero pollution in Europe

Last spring, a coronavirus reshaped the world in a matter of weeks. Many of the things that we had taken for granted were suddenly not available to us anymore. The pandemic caught the world by surprise, but, if you had asked a scientist working in a field related to infectious diseases, this was only a matter of time.

One cannot help drawing parallels between the pandemic, the climate crisis and the biodiversity crisis. Scientists had warned us about a pandemic — there were rather accurate scenarios — but nobody knew exactly how it would unfold.

We cannot paint an exact picture of a world that is two or four degrees warmer. We do not know exactly what the tipping points will be for entire ecosystems. What we do know is that, unless we take decisive action and aim for systemic transitions, the outlook is not positive and time is running out. A pandemic can, we hope, be controlled in a relatively short period of time. It might prove to be much more difficult to reverse any damage caused by reaching a tipping point in climate change or in the degradation of nature.

The links between these fast- and slow-moving crises and pollution are clear. Cutting air pollution and reducing greenhouse gas emissions almost always go hand in hand. Curbing water and soil pollution would benefit nature. Reducing resource use and moving to a circular economy would also reduce pollution.

Many health authorities have warned that citizens with certain pre-existing conditions may be more vulnerable to COVID-19. These pre-existing conditions include respiratory illnesses, which are, in some cases, a consequence of, or exacerbated by, poor air quality.

As a result of the harsh lockdown measures, the concentrations of some key air pollutants dropped dramatically in many European cities. These shocks were not wanted — they are not a model for a well-managed transition — but they showed that air quality in cities can be improved dramatically by reducing car traffic and changing our current mobility patterns.

Human beings and the institutions we have built are wired to deal efficiently with clear and present danger. Unclear, invisible or slow-moving catastrophes are harder for us to comprehend and tackle. Pollution is one such challenge.

In most places in Europe, air does not look, feel, smell or taste dirty. Yet, every year, poor air quality causes the premature death of nearly half a million Europeans. Tap water in Europe is generally safe to drink. We can enjoy fishing and swimming in many of our rivers, lakes and coastal areas. Yet, many of Europe's water bodies are not in good condition. Europe's soils still suffer from pollution that was released decades or centuries ago.

The problems are clear but we should also remember that actions and policies to tackle pollution have made a difference. The number of Europeans dying prematurely as a result of poor air quality is less than half of early 1990s levels. Europe's industry is becoming cleaner, with fewer emissions to air and water. Advanced waste water treatment covers more and more communities. Our agricultural practices are slowly evolving.

Yet, we can and should do much more. This will require the better implementation of existing policies and also ambitious targets that show a path towards climate neutrality, zero pollution, circular economy, healthy nature, and social justice in this fundamental sustainability transition.

Ursula von der Leyen, President of the European Commission, has set an ambitious agenda for her team's political priorities for the next 5 years. The European Green Deal and its zero pollution ambition outline actions that reflect European citizens' demand for addressing the climate and biodiversity crises, while ensuring a just transition where people are not left behind. This is an agenda that could have a lasting legacy in Europe.

The European Environment Agency's (EEA) work has shown that our unsustainable systems of production and consumption — especially those related to food, mobility and energy — are at the core of our sustainability challenges, including pollution. These systems are deeply integrated into our way of life and cannot be changed overnight but we must move in the right direction and our ambition needs to match our capabilities.

For the first time in modern history, we have the means to aspire to generating heat and electricity, moving around and growing food without harmful pollution. We no longer need to accept pollution that affects people and the environment as an inevitable side product of progress.

Europe has shown that we can make progress with strong and binding legislation. When harmful technologies are banned, we find better ways of doing things. Increasing knowledge and putting a steep enough price tag on pollution has proven to work. There are many policy instruments to choose from and, as long as the ambition is right, people will find ways to move in the right direction.

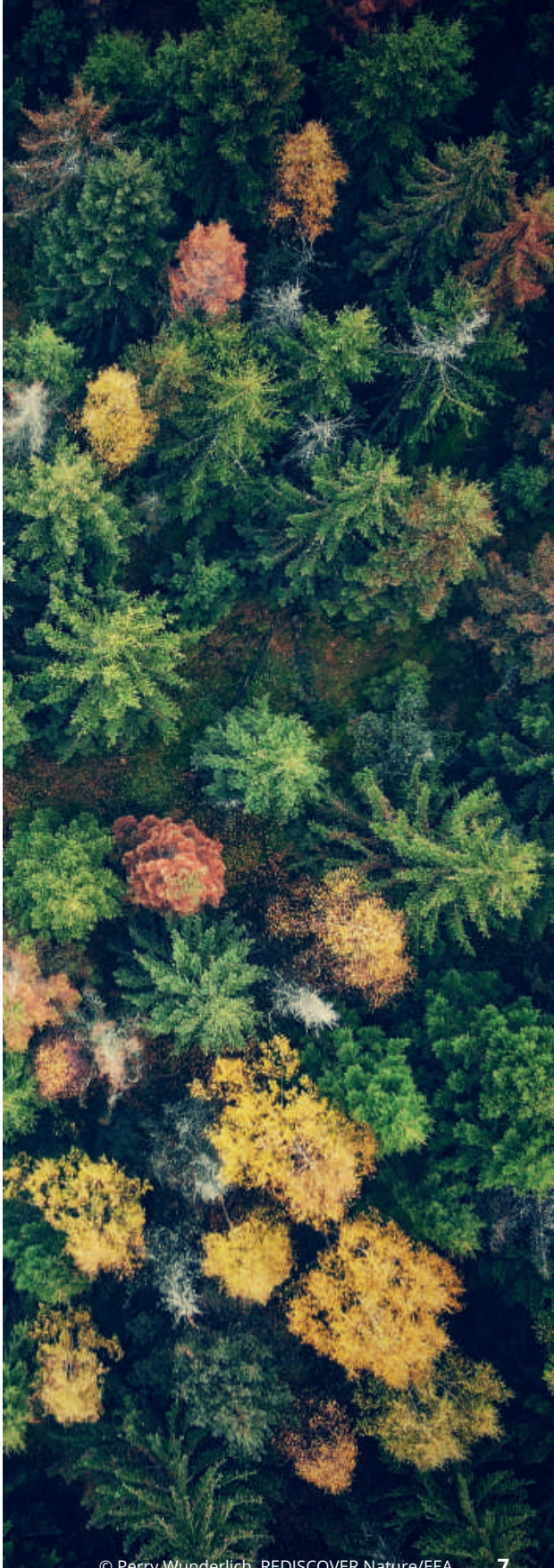
The EEA has a lot of knowledge and expertise to offer on pollution and other environmental challenges as well as solutions for them. EEA Signals 2020 provides a glimpse of the issues we seek to address.

'Never again…' is a phrase that human kind has had to say to itself too often. Yet, this conviction of not repeating past mistakes and not allowing the same tragedies to unfold has also led to movements and institutions, including the European Union, that have protected individuals and made our societies stronger.

The 'Next Generation EU' recovery package aims to repair the economic and social damage brought by the coronavirus pandemic. The package is about next generations, our future, and about reinventing our economy and society in a way that respects the limits of our planet and ensures people's long-term well-being.

Despite progress over past decades, the EEA's landmark assessment 'The European environment — state and outlook 2020' clearly showed that Europe now faces environmental challenges of unprecedented scale and urgency. We must take urgent action over the next 10 years to protect the environment, the climate and people.

Hans Bruyninckx
EEA Executive Director



What is pollution?

Pollution changes a medium such as air, water or soil in a way that can make it harmful to people or nature. Different types of pollutants include chemicals, dust, noise and radiation. These pollutants have many different sources. Some of those sources are diffuse, such as transport or agriculture, whereas others are linked to a specific place, such as a factory or power plant.

Transport is responsible for around **45 %** of Europe's emissions of nitrogen oxides (NO_x) and a significant proportion of the total emissions of other key pollutants.

Road traffic is the most widespread source of environmental noise, with more than

100 million

people affected by harmful levels in Europe.

Energy production and distribution are the main source of sulphur oxides (SO_x) emissions and a major source of NO_x emissions.

Sources: NEDC data viewer[1] and LRTAP data viewer[2], EEA report - The European environment — state and outlook 2020[3], EEA indicator - Exposure of Europe's population to environmental noise[4].

Pollutants released at one point can cause local harm but can also travel long distances. EEA Signals 2020 looks at pollution through different lenses related to the Agency's work and EU legislation.

Unsustainable farming practices lead to pollution of soil, water, air and food, overexploitation of natural resources, and biodiversity loss and ecosystem degradation.

The **agricultural sector** is responsible for more than **90 %** of Europe's ammonia emissions and almost 20 % of emissions of non-methane volatile organic compounds (NMVOCs), such as benzene and ethanol.

Domestic heating is an important source of dust pollution. Commercial, institutional and residential buildings account for **53 %** of fine particulate matter ($PM_{2.5}$) emissions. Households are also a source of pollution discharges to water.

Waste production and poor waste management contribute to air pollution and affect ecosystems. Dump sites, illegal disposal and littering create further risks, including soil pollution and marine litter.

The European Commission's zero pollution ambition

The zero-pollution ambition for Europe was announced in the European Green Deal, part of the European Commission's strategy to implement the United Nations Sustainable Development Goals agenda. Its key aim is to protect citizens and ecosystems by better monitoring, reporting, preventing and remedying pollution.

The zero-pollution ambition can help the EU further decouple prosperity from harmful levels of pollution, while enhancing EU resilience and strategic autonomy. This can also support a sustainable post-COVID-19 recovery by, for instance: helping to mainstream the zero-pollution ambition in recovery efforts; promoting adequate and timely information on the health and economic benefits of acting on pollution; and exploring further development of business practices that reduce pollution, create job opportunities and reduce social inequalities, as pollution disproportionately affects the most vulnerable people.

As part of the wider zero-pollution ambition, the European Commission has already announced actions to reduce pollution in several Green Deal initiatives, in particular the Circular Economy Action Plan, the Biodiversity Strategy and the Farm to Fork Strategy.

Foreseen to be published in 2020 and 2021, the Chemicals Strategy for Sustainability and the Zero-Pollution Action Plan will help boost cleaner products and technologies across all relevant economic sectors, prioritising pollution prevention over remediation. Following an open public consultation, the Zero-Pollution Action Plan is foreseen for the first half of 2021.

The Zero-Pollution Action Plan will, amongst other priorities, focus on enhancing implementation of existing and new legislation, revising key pollution control instruments, addressing pollutants of emerging concern, and setting up an integrated zero-pollution monitoring and outlook framework. The European Environment Agency will be a key partner in these activities.

Improving air quality improves people's health and productivity

Europe's air quality has improved significantly over recent decades but pollutants still harm our health and the environment. Measures to limit pollution would improve our quality of life, save money in healthcare, boost workers' productivity and protect the environment.

Europe's air is a lot cleaner than it was when the European Union (EU) and its Member States started introducing air quality and pollution prevention and control policies about half a century ago. European and national policies and local actions have been able to curb pollution from transport, industry and the energy sector.

Despite this progress, the EEA's annual Air quality in Europe[5] assessments consistently show that air pollution still poses a danger to human health and the environment. Air pollution levels in many of Europe's cities still exceed both the EU's legal limits and the World Health Organization's (WHO's) guidelines for the protection of human health. The tragic consequence of this is that, according to the EEA's estimates, every year about 400 000 Europeans die prematurely because of poor air quality.

Air pollution is the number one cause of premature deaths from environmental factors in Europe but it also has considerable economic impacts. It increases medical costs and reduces economic productivity due to the ill health of workers. Air pollution also harms soil, crops, forests, lakes and rivers. Pollutants even damage our houses, bridges and other built infrastructure.

Moreover, the negative impacts of poor air quality are not equally distributed across society. A recent EEA report[6] showed that air pollution, as well as extreme temperatures and noise, disproportionately affect Europe's most vulnerable citizens, especially in Europe's eastern and southern regions. In addition to overall improvements, targeted action is needed to better protect vulnerable groups.

COVID-19 and air pollution

A decrease in many societal and economic activities during the pandemic led to a decrease in emissions and subsequent levels of certain air pollutants. For example, the use of vehicles declined during lockdowns and this led to lower nitrogen dioxide concentrations in many cities across Europe[7].

Exposure to air pollution is associated with cardiovascular and respiratory diseases — both health conditions known to increase susceptibility to COVID-19 and negatively influence prognosis. Some non-peer-reviewed articles have suggested links between air pollution and high COVID-19 mortality rates, for example in Italy and the United States, but further epidemiological research is required to clarify possible causal associations.

Find out more: www.eea.europa.eu/post-corona-planet/explore[8].

Deeply rooted, systemic problems

Particulate matter (PM), nitrogen dioxide (NO_2) and ground-level ozone (O_3) are the pollutants that cause the greatest harm to human health and the environment in Europe. The main sources of these pollutants are road transport, domestic heating, agriculture and industry.

In cities, where about three out of four Europeans live, road transport is often the main source of air pollution, especially because cars emit pollutants at the ground level, close to people. In parts of Europe, domestic heating with wood and coal is the most important source of harmful pollutants. Unfortunately, these emissions also increase during winter months when weather conditions often prevent pollutants from dispersing.

What is common to the sources of air pollutants is that they are deeply rooted in our societies' core systems of mobility, energy and food production and consumption. These same systems are not only the main sources of air pollutants, but also the root causes of the climate crisis and the rapid loss of biodiversity.

How we move people and goods around, how we generate heat and electricity, and how we produce and consume our food are, in many ways, the foundations of our current way of life. This is why changing these systems is not easy. In many cases, it requires us to reconsider the way we have built our societies and the way in which we live our lives.

Win-win solutions for cleaner air

The EEA has worked together with a number of European cities in a pilot project[9] to better understand the challenges to improving air quality at the local level. The 10 cities that participated in the pilot project have, for example, expanded district heating, promoted cycling, lowered speed limits and issued congestion charges to improve local air quality. Other successful initiatives include relocating industrial facilities, modernising

household stoves and boilers, using cleaner fuels for heating, switching to cleaner buses and trams, and introducing low-emission transport zones.

These measures reduce local air pollution and often noise, and they improve residents' quality of life. Moreover, the same actions cut greenhouse gas emissions and, in many cases, save money. Still, the same cities also reported important challenges, especially in engaging with citizens and making the political case for measures to improve air quality.

For best results, local and regional actions go along with effective national and EU policies that often offer substantial co-benefits in reducing greenhouse gas emissions and air pollution at the same time. These co-benefits can be achieved by, for example, improving energy efficiency and greening the mobility system.

People demand clean air

A recent report by the European Court of Auditors[10] noted that citizens can play a key role in pushing for better air quality. To inform citizens, the EEA gives access to near-real time data and statistics about air quality. The EEA and the European Commission have also built an online tool, the European Air Quality Index[11], which allows citizens across Europe to check current air quality where they live, work or travel. The index is calculated with hourly data from more than 2 000 air quality monitoring stations across Europe and also provides health-related information and recommendations.

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People are increasingly interested in the quality of the air they breathe, with some citizens taking steps to measure their local air quality themselves through citizen science[12]. The EEA is working together with the European Network of the Heads of Environmental Protection Agencies (EPA Network) on a project called CleanAir@School[13], which involves having children, parents and teachers measure pollutant concentrations around schools.

The schools that participate in the project measure nitrogen dioxide concentrations with simple low-cost devices, placing one sampler beside the road in front of the school and one in a less polluted area, such as the grounds behind the school. The project aims to raise awareness of traffic as a source of air pollution and encourage parents to shift away from bringing their children to school by car.

Towards zero air pollution

Local-, regional-, national- and EU-level actions and policies with binding targets have improved air quality in Europe for the benefit of its citizens and the environment. More and more people across the world are demanding similar progress. Reducing the number of deaths and illnesses from air pollution is one of the targets of the Sustainable Development Goals that aim to ensure healthy lives and promote well-being. A similar target is included for sustainable cities and communities. Like the other goals, achieving this would bring massive global benefits, including increased productivity and reduced medical costs.

The actions that are necessary to cut air pollution, both in Europe and globally, are largely the same actions that are necessary to address the climate crisis and stop the degradation of nature. We need to fundamentally change and decarbonise our systems of production and consumption, especially those related to mobility, energy and food.

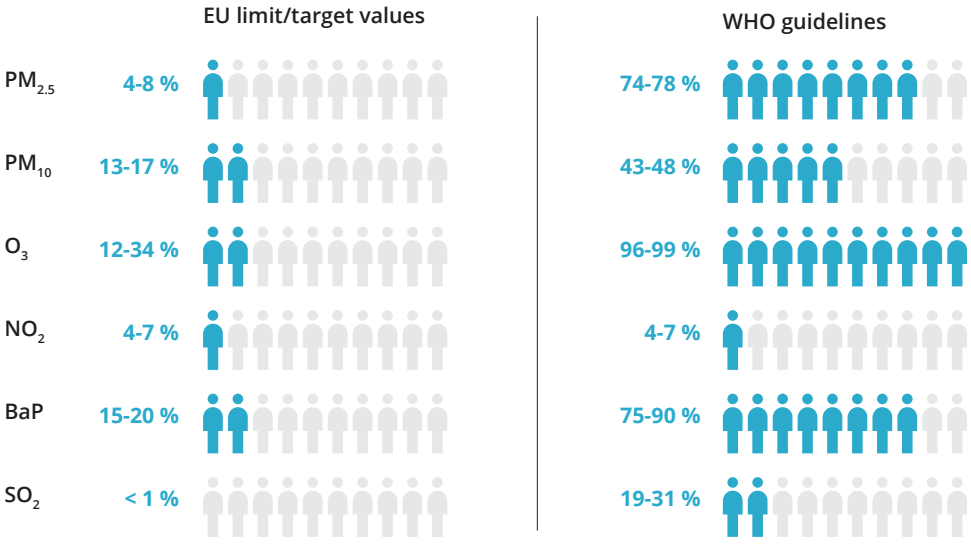
Find out more

- Air pollution: www.eea.europa.eu/themes/air
- SOER 2020, Chapter 8 on air pollution: www.eea.europa.eu/publications/soer-2020/chapter-08_soer2020-air-pollution/view
- European Air Quality Index: www.eea.europa.eu/themes/air/air-quality-index

Air quality problems in Europe's cities

Almost all Europeans who live in cities are exposed to air pollution that exceeds the levels set in the World Health Organization's (WHO's) guidelines for clean air. Air pollution is the greatest environmental health hazard in Europe and globally.

Share of the EU urban population exposed to air pollutant concentrations above EU and WHO reference values in 2016-2018



Main air pollutants and their effects on human health

Particulate matter (PM) is emitted from many sources and is one of the most harmful pollutants to human health. It penetrates sensitive regions of the respiratory system and can cause or aggravate cardiovascular and lung diseases as well as cancers.

Ground-level ozone (O_3) is an air pollutant that affects human health, vegetation and materials. Ozone is formed when other pollutants react with sunlight.

Nitrogen oxides (NO_x) and sulphur oxides **(SO_x)** are emitted from fuel combustion, such as from power plants and other industrial facilities. They contribute to acidification and eutrophication of waters and soils. In the air, they can cause health problems, such as airway inflammation and reduced lung function.

Organic pollutants, such as **Benzo(a)pyrene (BaP),** are emitted from fuel and waste combustion, industrial processes and solvent use. Substances such as hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) can have a range of harmful effects on human health and ecosystems.

Heavy metals, such as lead and mercury, are toxic to ecosystems. They are mainly emitted from combustion processes and industrial activities. As well as polluting the air, they can build up in soils and sediments, and bio-accumulate in food chains.

Ammonia (NH_3) is emitted mainly from agriculture and contributes to both eutrophication and acidification of waters and soils.

Source: EEA report - Healthy environment, healthy lives[14].

Ensuring clean waters for people and nature

Water covers more than 70 % of the Earth's surface and is essential to all life on our planet. Of all the Earth's water, 96.5 % is contained within the oceans as salt water, whereas the remaining 3.5 % is freshwater — lakes, rivers, groundwater and ice. Good management of this limited and precious resource is indispensable for the well-being of people and nature.

Throughout history, people have settled close to rivers, lakes and coastlines. Rivers and streams brought clean water and took away waste. As human settlements grew, so did their use of clean water and discharge of polluted water. From the 18th century onwards, Europe's water bodies also started receiving pollutants from industry.

With sewage systems, waste water treatment facilities and the regulation of pollutants from industry and agriculture, Europe has come a long way in reducing emissions to water bodies. Nevertheless, water pollution continues to be a problem, with over-exploitation, physical alterations and climate change continuing to affect the quality and the availability of water.

A mixed picture — the state of Europe's water bodies

About 88 % of Europe's freshwater use comes from rivers and groundwater. The rest comes from reservoirs (about 10 %) and lakes (less than 2 %). Like any other vital resource or living organism, water can come under pressure. This can happen when demand for water exceeds its supply or when pollution reduces its quality.

Waste water treatment and reductions in nitrogen and phosphorus losses from agriculture have led to significant improvements in water quality. However, according to the EEA's most recent data[15], only 44 % of surface waters in Europe achieve good or high ecological status, partly because of pollution. The situation of Europe's groundwater is somewhat better. About 75 % of Europe's groundwater areas has a 'good chemical status'[16].

Marine environment under threat

The current condition of Europe's seas — from the Baltic to the Mediterranean — is generally poor, according to the EEA's Marine messages II[17] assessment. Despite some positive developments achieved through regional cooperation, a range of pressures from historic and current human activities could cause irreversible damage to marine ecosystems.

Moreover, the EEA's report on contaminants in Europe's seas[18] showed that all four regional seas in Europe have a large-scale contamination problem, ranging from 96 % of the assessed area

in the Baltic Sea and 91 % in the Black Sea to 87 % in the Mediterranean Sea and 75 % in the North-East Atlantic Ocean. The contamination problem is mainly caused by synthetic chemicals and heavy metals originating from human activities both on land and at sea.

Similarly, the EEA's report on nutrient enrichment and eutrophication in Europe's seas[19] showed that eutrophication as a consequence of nutrient losses, mainly from agriculture, is another large-scale problem, especially in the Baltic Sea and the Black Sea.

Coastal and maritime activities, such as fishing, shipping, tourism, aquaculture and the extraction of oil and gas, cause multiple pressures on the marine environment, including pollution. Marine litter is present in all marine ecosystems, with plastics, metals, cardboard and other waste accumulating on shorelines, the seabed and surface waters. Ships and offshore activities also cause underwater noise pollution, which can negatively affect marine life.

Tackling water pollution — waste water and diffuse pollution

Much has been done across Europe to enable the collection and treatment of urban waste water. According to EEA data[20], most European countries were collecting and treating sewage at the tertiary level from most of their population by 2017. Still, in a number of European countries less than 80 % of the population was connected to public urban waste water treatment systems.

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Meanwhile, existing infrastructure requires maintenance and new pressures require substantial investments, including adapting to climate change, providing improved waste water facilities and tackling new concerns, such as medicines or the so-called mobile chemicals in waste water.

In addition to point source pollution from industry and waste water treatment plants, water bodies also suffer from diffuse pollution, for example from transport, agriculture, forestry and rural dwellings. Pollutants that are first released to air and soil often also end up in water bodies.

Intensive agriculture

Intensive agriculture relies on fertilisers to increase crop yields. These fertilisers often work by introducing nitrogen, phosphorus and other chemicals into the soil. Nitrogen is a chemical element abundant in nature and is essential for plant growth.

However, some of the nitrogen intended for crops is not taken up by plants. The amount of fertiliser applied may be more than the plant can absorb or it may not be applied during the plant's growing period. This excess nitrogen finds its way into water bodies and there it boosts the growth of certain water plants and algae in a process known as eutrophication. This extra growth depletes the oxygen in the water, rendering it uninhabitable for other animal and plant species.

Pesticides used in agriculture aim to protect crops from invasive pests, ensuring crop growth. However, these effects can occur beyond the intended target, harming other species and reducing biodiversity. Often, these chemicals end up in water bodies.

COVID-19 and water pollution

Lower economic activity during lockdowns is likely to lead to lower emissions to water from industry, while emissions from schools and workplaces are likely to shift towards households. There may be less water stress in specific areas in Europe, depending on the impacts on agriculture and energy production. Reduced tourism is also likely to lead to lower emissions to water along European coasts and in other tourist destinations.

Find out more: www.eea.europa.eu/post-corona-planet/explore[21].

Plastics in the water — size matters

Plastics have become integral to almost every aspect of our lives, and the issue of plastics entering our waterways, lakes and seas is dramatic and well documented.

Clearing visible plastic litter from rivers, beaches and even the sea might still be possible but, with time and exposure to sunlight, plastic waste fragments into ever-smaller pieces, known as micro- and nanoplastics. Waste water treatment plants can filter out most of these tiny particles but the remaining sludge is often spread on land, with plastic particles sometimes being washed into water bodies by rainfall. These smallest particles are hardly visible to the eye and their impacts on nature and our health are still poorly understood.

Many plastics are also highly adsorbent, attracting other contaminants. As noted in the EEA report on the state of Europe's seas[22], concentrations of contaminants in pieces of microplastic can be thousands of times greater than in ambient seawater. This exposes marine life to harmful chemicals, which, in turn, can end up on our plates.

Towards zero water pollution

In the past decades, Europe has made significant efforts to improve water quality, treat waste water and protect marine and freshwater habitats and species. Today, EU policies address a wide range of issues affecting water, such as drinking water, urban waste water, bathing water quality, single-use plastics, industrial emissions

and hazardous chemicals. Overarching programmes and legislation, such as the Water Framework Directive[23] and the Marine Strategy Framework Directive[24], strengthen these specific pieces of EU legislation.

However, efforts to move towards zero pollution will require a major focus on water as part of the European Green Deal's zero pollution action plan, including aiming to restore the natural functions of groundwater, surface water, marine and coastal waters, tackling pollution from urban runoff, and addressing new concerns, such as microplastics and chemicals.

As one of the key components of the European Green Deal, the farm to fork strategy aims to significantly reduce the agricultural use and risk of chemical pesticides[25], the use of antibiotics[26] and fertiliser losses to the environment, for example through integrated pest management and an integrated nutrient management action plan. The EU 2030 biodiversity strategy also supports similar objectives.

To help tackle the plastics problem, the EU has already proposed a plastics strategy[27] that aims to 'transform the way products are designed, produced, used, and recycled in the EU'. Meanwhile, consumer attitudes are changing and innovations mean that some items previously made from plastics can now be produced from cellulose sourced from recycled paper, textiles, plants or algae.

Find out more

- Water and marine environment: www.eea.europa.eu/themes/water
- SOER 2020, Chapter 4 on freshwater: www.eea.europa.eu/publications/soer-2020/chapter-04_soer2020-freshwater/view
- SOER 2020, Chapter 6 on the marine environment: www.eea.europa.eu/publications/soer-2020/chapter-06_soer2020-marine-environment/view
- EEA Signals 2018 — Water is life: www.eea.europa.eu/signals/signals-2018-content-list

State of water in Europe

Waste water treatment and reductions in nutrient losses from agriculture have led to significant improvements in water quality in Europe. However, many of Europe's freshwater bodies are still not doing well and the condition of Europe's seas is generally poor, partly because of pollution.

Groundwater

75 %

of groundwater areas have good chemical status

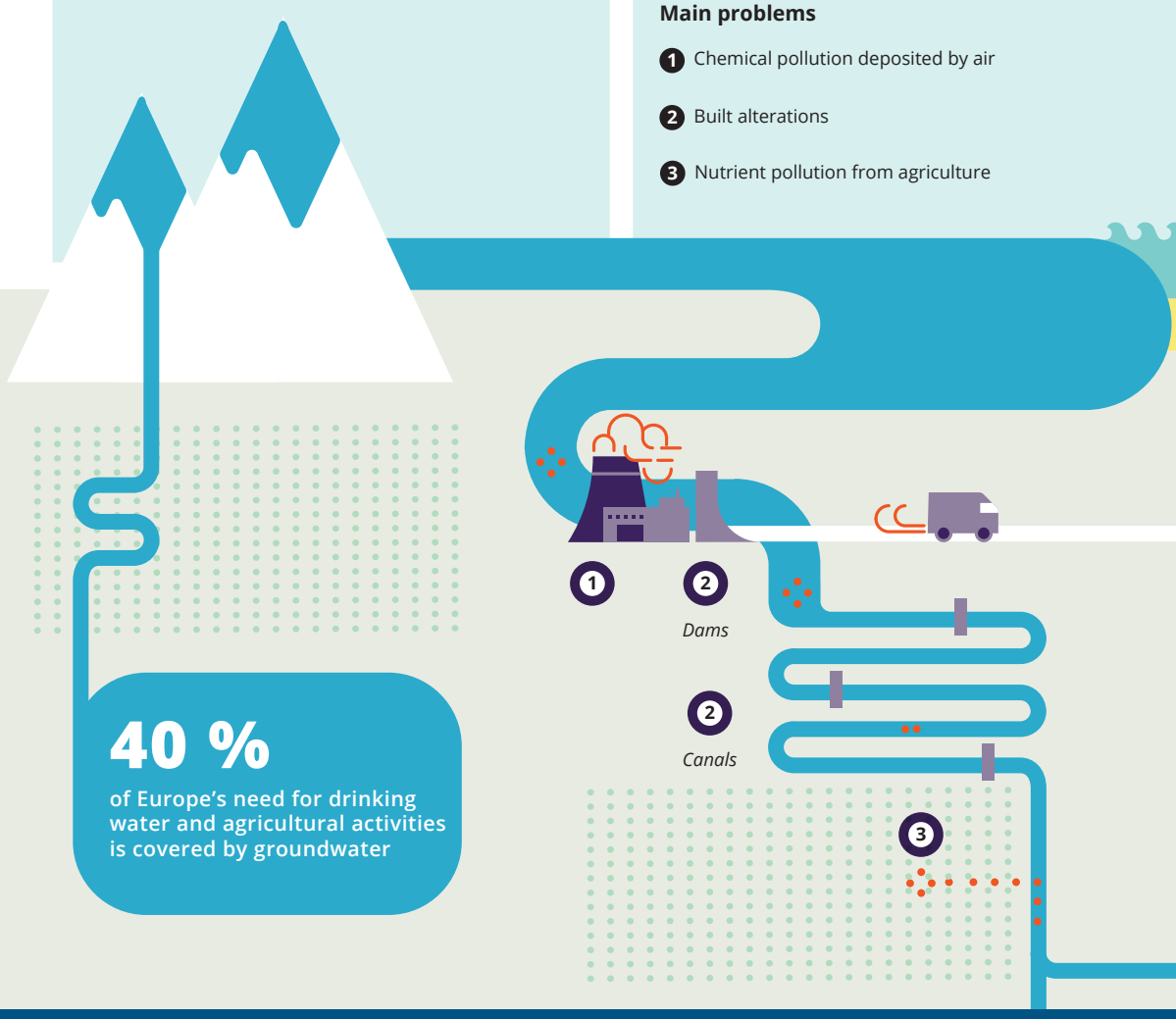
Surface waters
(rivers, lakes and transitional waters)

44 %

have good or high ecological status

Main problems

1. Chemical pollution deposited by air
2. Built alterations
3. Nutrient pollution from agriculture



40 %

of Europe's need for drinking water and agricultural activities is covered by groundwater

Sources: EEA 2018 water assessment; EEA report - Marine messages II; EEA report - State of Europe's seas[28].

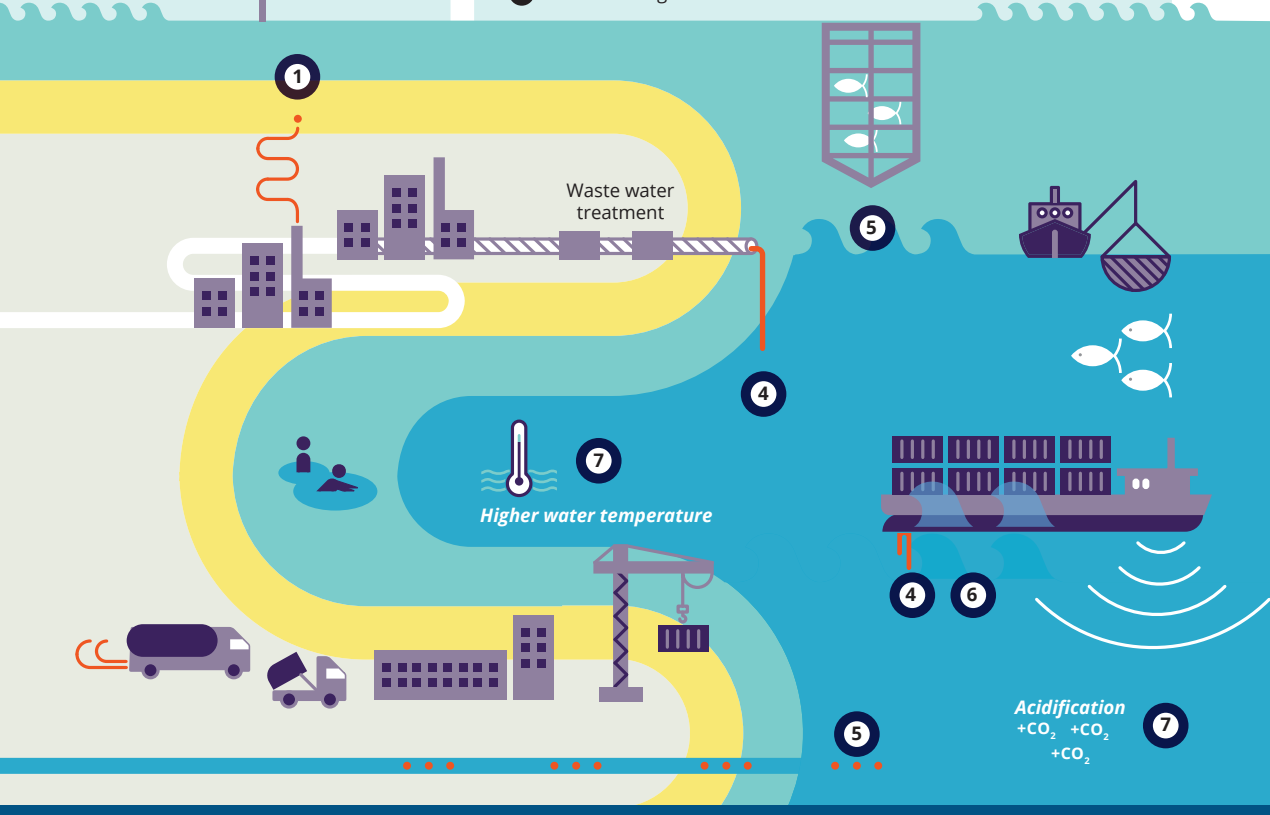
Sea

75-96 %

of assessed areas in Europe's seas have a contamination problem

Main problems

4. Chemical pollution
5. Nutrient enrichment and eutrophication
6. Pressures from coastal and maritime activities, including marine litter and underwater noise
7. Climate change



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Land and soil pollution — widespread, harmful and growing

What do many vineyards scattered across idyllic landscapes, industrial sites and landfills have in common? The presence of chemicals might be the answer. From heavy metals to organic pollutants and microplastics, the soil in which we grow our food and the land on which we build our homes might be contaminated with different pollutants. Contaminants are widespread and are accumulating in Europe's land and soils. How can we tackle this problem?

The ground below our feet is much more than rocks, soil and silt. Every square metre can be unique in terms of its composition, its structure and the life that it contains and supports. Some contain more rocks rich in certain minerals; others are rich in plant residues with pockets of air and water.

Soil is often a neglected domain of biodiversity but even a small patch can teem with life, ranging from tiny organisms to fungi and earthworms, all playing a vital role in the functioning of the soil ecosystem. It is also in this space that nutrients are turned into forms that plants can take up, allowing biomass to form and store carbon. It is also here that our prospective drinking water starts its natural purification journey towards groundwater.

A local problem?

The way we use land often introduces additional substances to these unique ecosystems in order to protect selected crops or add nutrients. Pollutants released from industry, transport and other economic activities can also travel long distances and reach soils, where they become diluted and are temporarily stored. Soil, a component of land, is considered polluted when contaminants adversely affect human health or the environment.

With every step we take, we could be standing on top of a very different mix and concentration of contaminants in the ground. The large variation of contaminants, soils, and climatic and land use conditions makes it costly to monitor and assess the full extent of land and soil pollution. What we know is mostly based on field samples scattered across countries.

Metals, fertilisers and pesticides

We need agriculture to grow our food but some unsustainable farming practices continue to contaminate soils.

Plants need, among other things, nutrients to grow and intensive agriculture can deplete nutrients in the soil faster than nature replenishes them. Fertilisers work by compensating this deficit by introducing

extra nutrients. Unfortunately, the whole amount is often not taken up by the plants and the surplus that is initially in soil, sooner or later, enters lakes and rivers. Once in water, surplus nitrogen often leads to excessive growth of plants and algae, the decomposition of which can severely reduce oxygen levels in water, harming animal and plant species in that ecosystem.

Copper has been used extensively as a fungicide in vineyards and orchards for decades. A recent large-scale study[29] showed that copper concentrations in vineyards were three times higher than the average in European soils. Copper is also added to animal feed and is introduced to the environment when manure is spread over grasslands and other agricultural lands.

Cadmium is another highly toxic metal found in mineral phosphorus fertilisers. Some 'organic fertilisers', such as sewage sludges, manure, compost and bio-waste, can also introduce a broad mix of heavy metals and organic pollutants if they are not well regulated.

Chemicals from the long-term use of pesticides are also found in soil samples from across Europe. Over 80 % of soils tested in one study[30] contained pesticide residues, with 58 % containing two or more types of residue.

Waste management, industry and beyond the borders

Agricultural practices are far from being the only source of land and soil pollution. Poorly managed waste — both municipal and industrial waste — is responsible for more than one third of local contaminations, followed by industrial activities. Of the several millions of sites estimated to carry out potentially polluting activities in the EU, detailed public information exists for only a fraction[31].

Land and soil pollution is also a global problem. Air and water can transport pollutants, including nitrogen compounds and tiny plastic fragments, across the globe and deposit them on land surfaces. Pollutants are found even on the highest peaks and the most remote beaches.

Forever they remain and accumulate

Some pollutants break down in soil over time but others remain forever. In many cases, land and its soils are the final destination where various pollutants end up and accumulate over time. The full risks of these chemicals and various mixes of them are not fully known. However, based on sampled sites, we know that land and soil pollution can have significant impacts on human health as well as soil biodiversity and ecosystem health. These pollutants can affect soil organisms and possibly contaminate our food and drinking water.

Remediating contaminated land is difficult and expensive, but necessary to clean up past pollution. However, local authorities often lack the means and tools to manage remediation. More than 65 000 sites have been remediated in the EU; however, by far, most potentially contaminated sites are still left untouched[32].

Best solution — prevention

Prevention remains the most effective and cheapest way to ensure healthy soils — and cleaner water and air — in the long term. Any initiative aimed at preventing and reducing pollution — from product design, better recycling, waste management, crop rotation, precision farming and reduced pesticide and fertiliser use to cleaner transport and industry — and at supporting authorities to implement effective measures will contribute to alleviating pressures on these vital ecosystems.

Many existing and upcoming policy initiatives under the European Green Deal — the circular economy, the farm to fork strategy, the biodiversity strategy, the chemicals strategy, the new soil strategy and the zero pollution action plan — provide a European framework and support national authorities and land users to protect land and soils from pollution. Additional support to local authorities and a more coherent EU policy framework on soil would further reinforce these efforts. After all, pollution is only one of the many threats that soils and land face.

Find out more

- Soil: www.eea.europa.eu/themes/soil
- SOER 2020, Chapter 5 on land and soil: www.eea.europa.eu/publications/soer-2020/chapter-05_soer2020-land-and-soil/view
- EEA Signals 2019 — Land and soil in Europe: www.eea.europa.eu/signals/signals-2019

Pollution and other impacts of agriculture on the environment

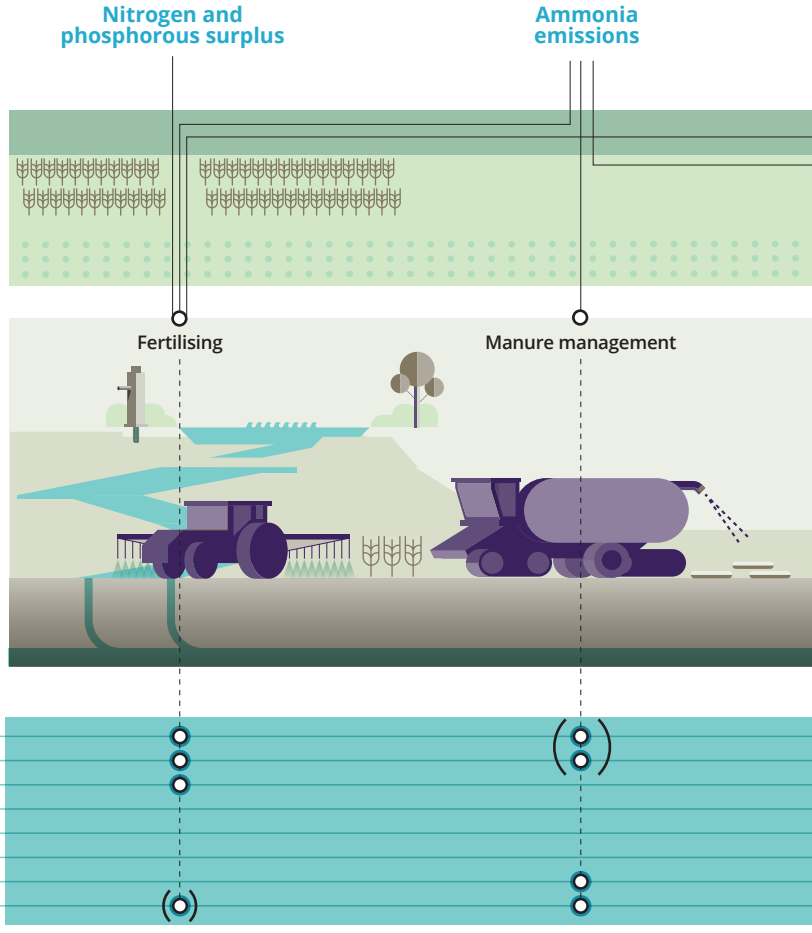
Agriculture has multiple impacts on the environment, climate and human health. Unsustainable farming practices lead to pollution of soil, water, air and food and over-exploitation of natural resources.

Pressures

Main sources and activities

Impacts

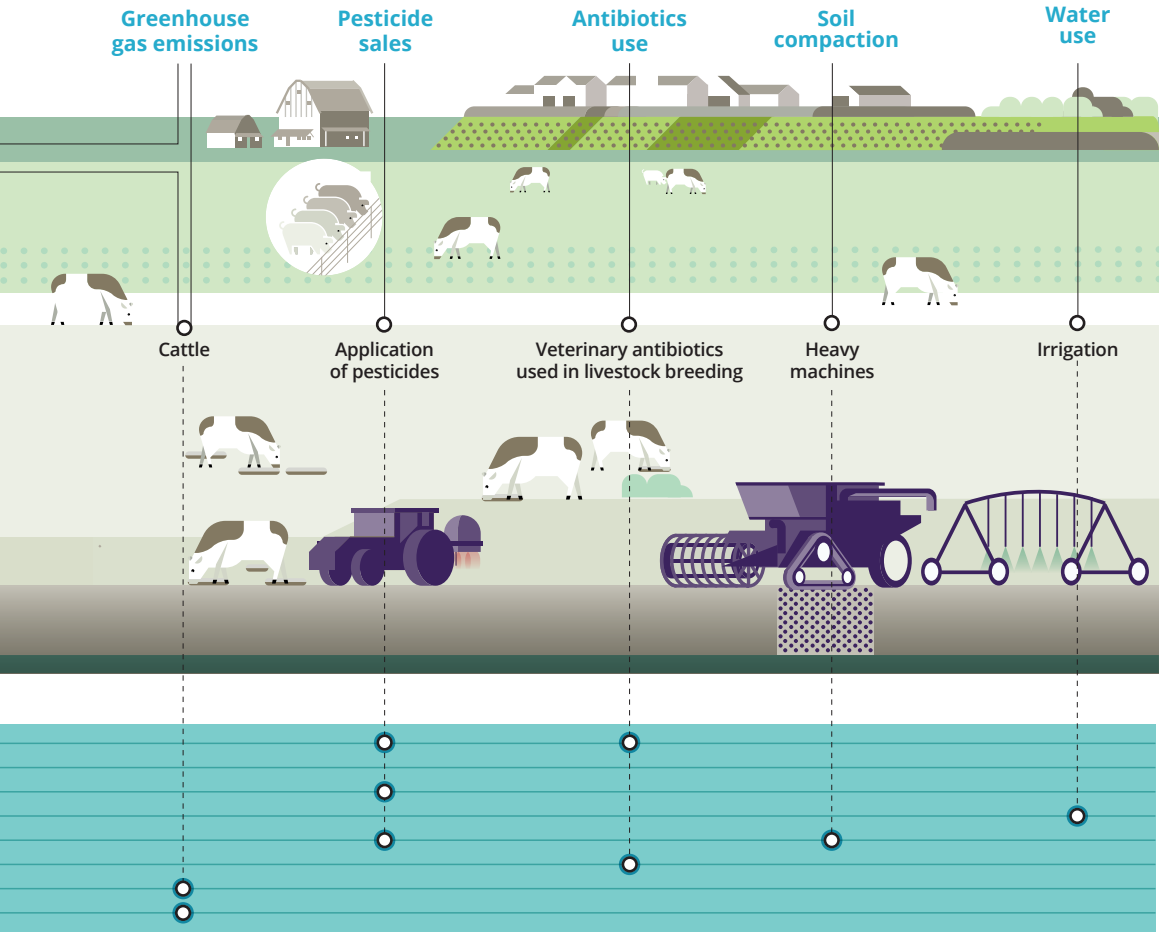
- Pollution of water bodies
- Eutrophication
- Biodiversity loss
- Overexploitation of water resources
- Loss of soil fertility/quality
- Antimicrobial resistance (AMR)
- Climate change
- Air pollution



Over-use of **nitrogen** fertilisers causes eutrophication of aquatic and terrestrial ecosystems.
If more **phosphorus** fertiliser is applied than taken up by plants, it may result in pollution of e.g. ground and freshwater and cause eutrophication.

Ammonia emissions from e.g. manure management result in air pollution and can bring harm to sensitive ecosystems.

Source: EEA report - The European environment — state and outlook 2020[33].



Greenhouse gas emissions from e.g. livestock farming, agricultural land, fertilizer use and enteric fermentation contribute to climate change.

Agriculture is the main user of **pesticides** in most countries. Pesticides have been linked to impacts on biodiversity and human health.

Sold veterinary **antibiotics** are mainly used in animal breeding. Over use and untailored use may cause Antimicrobial resistance (AMR).

Soil compaction may cause loss of soil fertility and reduce the capacity of soils to retain water and store carbon.

Agriculture is a main user of freshwater resources. **Overexploitation** may lead to decreasing groundwater levels, salt water intrusion and loss of wetlands.

Living healthily in a chemical world

We can categorise pollution by where we find it — in soil, water or air — or we can look at different pollution types, such as chemicals. Synthetic chemicals are all around us. Some of them, however, can also be very harmful to our health and the environment. How can we limit the negative effects of chemicals that have become a part of our current way of life?

Every day, we are surrounded by hundreds or thousands of synthetic chemicals. They are in our food, clothes, tools, furniture, toys, cosmetics and medicines. Our society would not be the same without these substances. However, despite their usefulness, we know many of these substances can have negative impacts on our health and the environment.

According to some estimates, about 6 % of the world's disease burden — including chronic diseases, cancers, neurological and developmental disorders — and 8 % of deaths can be attributed to chemicals. Moreover, these numbers could be growing and they take into consideration only a small number of chemicals whose effect on health is well established[34].

Dangerous cocktails and 'forever chemicals'

More than 300 million tonnes of chemicals were consumed in the EU in 2018 and more than two thirds of this amount were chemicals that are classified as hazardous to health, according to Eurostat[35]. Over 20 000 individual chemicals have been registered in the EU under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation[36].

As these numbers keep growing, it is increasingly difficult to assess all the effects that chemicals have on our health and the environment case by case. Most studies so far have investigated the effects of only single chemicals and their safe thresholds but people are constantly exposed to a mixture of chemicals. This combined exposure can lead to health effects, even if single substances in the mixture do not exceed safe levels.

Moreover, persistent chemicals can accumulate in human tissues, causing negative health effects after long-term exposure. For example, per- and polyfluorinated alkyl substances (PFAS)[37] are a group of almost 5 000 widely used chemicals that can accumulate over time in humans and in the environment. They are an example of persistent organic pollutants — the so-called forever chemicals.

People are mainly exposed to PFAS through drinking water, food and food packaging, dust, cosmetics, PFAS-coated textiles and other consumer products. The effects of human exposure to PFAS include kidney cancer, testicular cancer, thyroid disease, liver damage and a series of developmental effects affecting fetuses.

Using PFAS-free products and cooking materials helps to reduce exposure. General and specific guidance on how to find PFAS-free alternatives is often provided by consumer organisations and national institutions working on the environment, health or chemicals.

The precautionary principle

The 'precautionary principle' could be translated into everyday words as 'better safe than sorry'. It means that, when scientific evidence about something is uncertain, and there are reasonable grounds for concern about harm, decision-makers should err on the side of caution and avoid risks. With chemicals, the development of new substances outpaces research on their negative impacts. This is why it is important to proceed with caution.

Read more about the precautionary principle:

- Communication from the Commission on the precautionary principle[38].
- EEA's Late lessons from early warnings II[39].

Endocrine disruptors

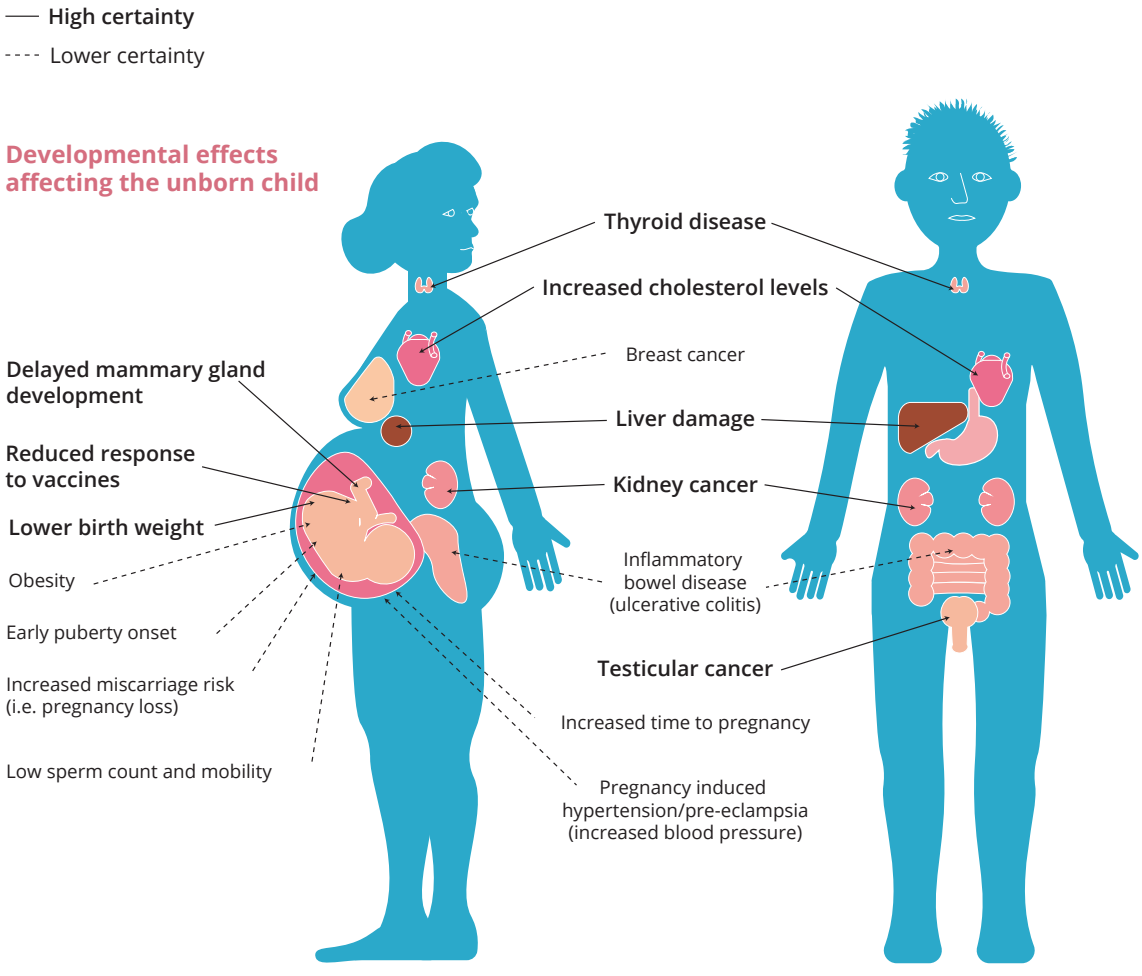
Some chemicals interfere with the functioning of the body's hormone system. Exposure to these so-called endocrine disruptors can cause a wide variety of health problems, ranging from developmental disorders, obesity and diabetes to infertility in men and mortality associated with reduced testosterone levels. Fetuses, small children and teenagers are especially vulnerable to endocrine disruptors[40].

Approximately 800 substances are known or suspected to be endocrine disruptors and many of them are present in everyday products, such as metal food cans, plastics, pesticides, food and cosmetics.

Endocrine disruptors include bisphenol A (BPA), dioxins, polychlorinated biphenyls (PCBs) and certain types of phthalates. Phthalates, for example, are used to soften plastic for use in a wide range of consumer goods, such as vinyl flooring, adhesives, detergents, air fresheners, lubricating oils, food packaging, clothing, personal care products and toys.

Effects of PFAS on human health

Per- and polyfluorinated alkyl substances (PFAS) are a group of extremely persistent chemicals that are used in many consumer products. PFAS are used in products because they can, for example, increase oil and water repellence or resist high temperatures. Currently, there are more than 4 700 different PFAS that accumulate in people and the environment.



Sources: US National Toxicology Program (2016); C8 Health Project Reports (2012); WHO IARC (2017); Barry et al. (2013); Fenton et al. (2009); and White et al. (2011) apud Emerging chemical risks in Europe — 'PFAS'[41].

Consuming food and drinks from containers that include phthalates is one way to become exposed. Inhaling indoor dust contaminated with phthalates that are released from plastic products or polyvinyl chloride (PVC) furnishings is another. (This is one of the reasons why airing our rooms regularly is important.) Children playing with toys that contain these substances are also at risk and, since phthalates can also be found in consumer products, such as soaps and suntan lotions, exposure can also occur through the skin.

The EU has put in place measures to reduce people's exposure to phthalates by banning the use of some of these substances and restricting the use of others in toys, cosmetics and food containers. However, older products and furnishings may contain phthalates that are now banned, so they are still present in our everyday environment.

Moreover, a recent inspection project by the European Chemicals Agency (ECHA)[42] showed that products imported from non-EU countries can still contain phthalates. China has in recent years put in place restrictions on certain phthalates in toys and food contact materials but restricted phthalates are still found in many products imported to the EU from China and other, sometimes unknown, origins.

Concerted efforts have reduced the presence of persistent organic pollutants, such as dioxins, PCBs and atrazine, in Europe's environment since the 1970s, but their persistence and the fact that they accumulate in the food chain, notably in animal fat, continues to cause concerns[43]. Another concern is that some substances have been substituted for other, equally toxic chemicals.

Regrettable substitutions

Chemicals found to be dangerous have sometimes been replaced by other substances, with a similar structure, only later proven to be just as toxic. These cases are called 'regrettable substitutions', such as in the case of substituting bisphenol-A, a chemical formerly used in many plastic items and in thermal printing paper, with bisphenol-S and bisphenol-F[44].

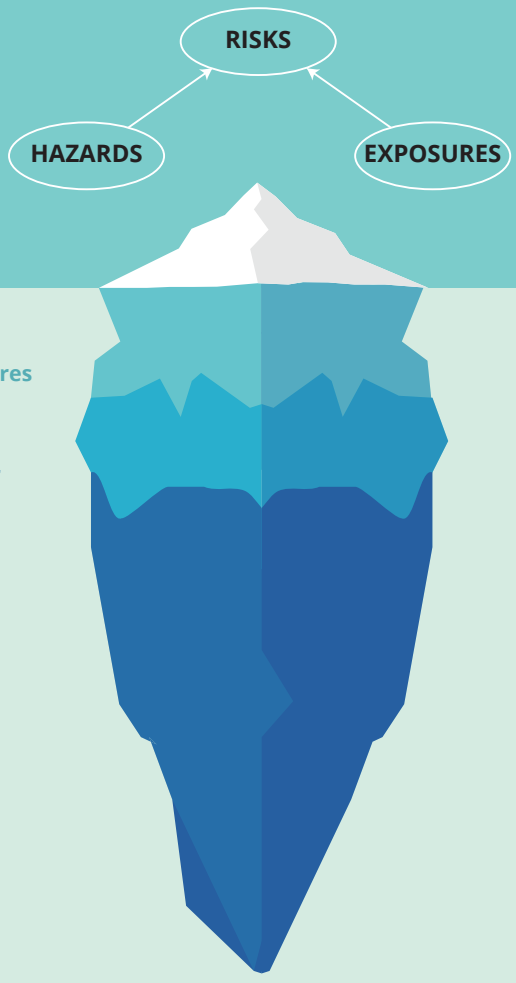
The unknown territory of chemical risks

There are many chemicals on the market and only a small fraction of these have been extensively studied for their risks. Designing safe products with a smaller number of different chemicals is one way of reducing potential risks.

~ 100 000 chemicals
on the market

~ 22 600 chemicals
with a use over 1 tonne per year

~ 4 700 chemicals
with a use over 100 tonnes per year prioritised in hazard characterisation and evaluation



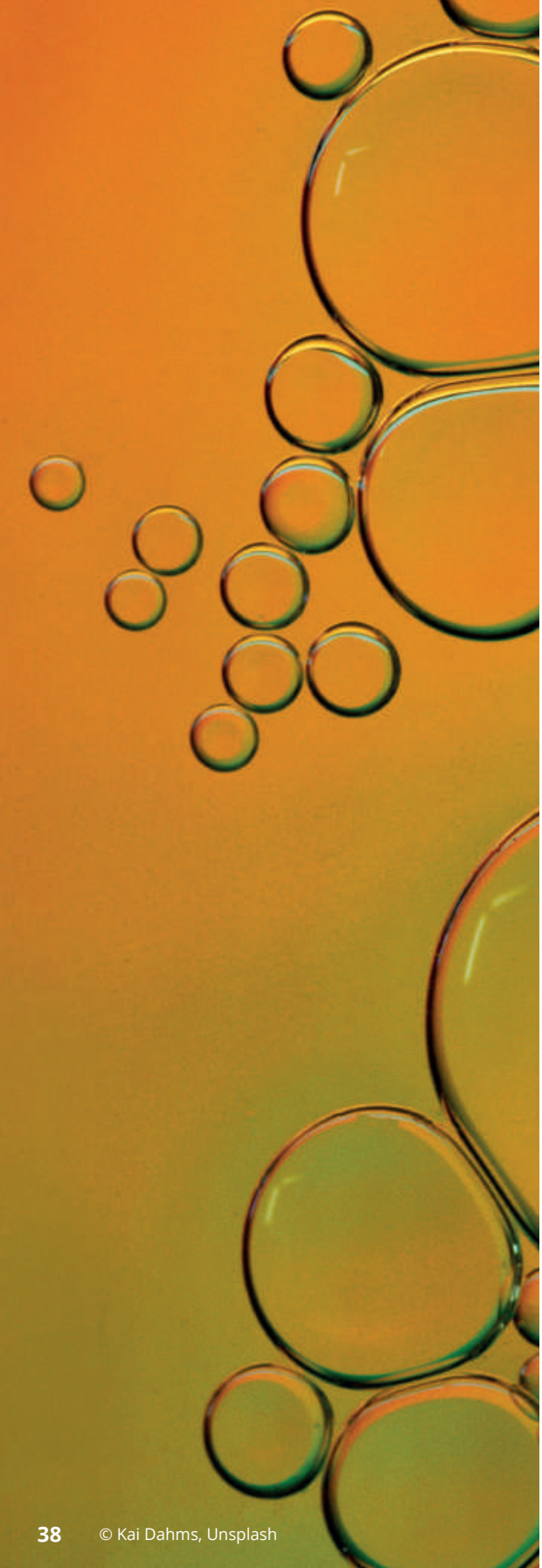
~ 500 chemicals
extensively characterised for their hazards and exposures

~ 10 000 chemicals
fairly well characterised for a subset of their hazards and exposures

~ 20 000 chemicals
with limited characterisation for their hazards and exposures

~ 70 000 chemicals
with poor characterisation for their hazards and exposures

Source: EEA report - The European environment — state and outlook 2020[45].



The chemicals we eat

Pesticides are another group of chemicals that can harm our health, mostly as a result of the consumption of vegetables and fruit that have been in contact with them. Children are especially vulnerable, partly because they eat proportionally more food per kilogram of body weight than adults do. Eating organic produce can decrease this pesticide burden but not everyone can afford that.

The EU regulates pesticides under the Regulation on Plant Protection Products and sets safe limits for pesticide residues in food and feed. The latest information from the European Food Safety Authority (EFSA)[46] shows that 95.5 % of food samples collected across the EU in 2018 were within legal limits. Table grapes and bell peppers were among the food products that most frequently exceeded the legal levels of residue. Still, based on the samples analysed, containing both regular and organic produce, the probability of European citizens being exposed to dangerous levels of pesticide residue is considered low.

Not all chemical substances harmful to our health are new. For example, mercury is naturally present in the environment and has been released in air and water by human activity for centuries. However, today we know that ingesting mercury can affect the nervous system, kidneys and lungs, and exposure during pregnancy can affect the development of the fetus.

People are exposed to mercury mainly through eating large predatory fish, such as tuna, shark, swordfish, pike, zander, eel and marlin. This also means that exposure can be limited by dietary choices, which is important especially for vulnerable groups, such as expectant mothers and young children.

For a more complete picture of human exposure to chemicals, there is a need for data on what is in our bodies. This includes chemicals that we eat as well as those that enter through other exposure pathways. These types of human biomonitoring data can be used to improve chemical risk assessments by providing information on actual human exposure through multiple exposure pathways.

Human biomonitoring — measuring our exposure to chemicals

Human biomonitoring measures people's exposure to chemicals by analysing the substances themselves, their metabolites or markers of subsequent health effects in urine, blood, hair or tissue. Information on human exposure can be linked to data on sources and epidemiological surveys, in order to inform research on the exposure-response relationships in humans.

The European human biomonitoring initiative, HBM4EU[47], launched in 2017 and co-funded under Horizon 2020, is a joint effort of 30 countries, the EEA and the European Commission.

The main aim of the initiative is to coordinate and advance human biomonitoring in Europe. HBM4EU will provide better evidence of the actual exposure of citizens to chemicals and the possible health effects to support policymaking. The project has also set up focus groups to understand EU citizen's perspectives on chemical exposure and human biomonitoring.

Under HBM4EU, efforts are under way to generate robust and coherent data sets on the exposure of the European population to chemicals of concern. This includes producing exposure data on 16 substance groups, mixtures of chemicals and emerging chemicals, as well as exploring exposure pathways and linking exposure to health effects.

Visit: www.hbm4eu.eu

Chemical effects on nature

Synthetic chemicals released into nature can affect plants and animals. For example, neonicotinoids are a type of insecticide used in agriculture to control pests that pose risks to bees, as bees are important pollinators supporting food production. Pesticides can also affect fish and bird populations and entire food chains. In 2013, the European Commission severely restricted[48] the use of plant protection products and treated seeds containing certain neonicotinoids to protect honeybees[49].

Towards a safer chemical environment

The EU has the strictest and most advanced rules in the world when it comes to chemicals. The REACH Regulation is the key piece of legislation that aims to protect human health and the environment, and the EU has put in place rules for the classification, labelling and packaging of chemicals[50].

The EU has a body of legislation to regulate chemicals in detergents, biocides, plant protection products and pharmaceuticals. Policies limit the use of hazardous chemicals in personal care products, cosmetics, textiles, electronic equipment and food contact materials. Limits are also in place for chemicals in the air, food and drinking water. Legislation addresses point source emissions from industrial installations and from urban waste water treatment plants.

Still, there is room for improvement to create a less toxic environment, and the European Green Deal aims to further protect citizens against dangerous chemicals with a new chemicals strategy and by moving the EU towards the zero pollution ambition.

Find out more

- Chemicals: www.eea.europa.eu/themes/human/chemicals
- SOER 2020, Chapter 10 on chemical pollution: www.eea.europa.eu/publications/soer-2020/chapter-10_soer2020-chemical-pollution/view

Professor Geert Van Calster
University of Leuven

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Does the polluter pay?

A simple but powerful idea lies at the heart of environmental laws in the EU: the 'polluter pays' principle. This principle has been applied in the form of taxes, fines and other measures, such as quotas for pollutant emissions and the Environmental Liability Directive. We talked to Professor Geert Van Calster about this principle, its benefits and shortcomings.

What is the 'polluter pays' principle about?

The 'polluter pays' principle is a simple principle based on common sense: the polluter — and this could be the actors or the activity causing the pollution — should pay to right the wrong. This could entail cleaning up the polluted area or covering the health costs of the people affected.

Historically, it has been a very powerful concept to mitigate the negative impacts of pollution. It provided a moral and legal imperative to take action. In pressing cases, it helped formulate policies and measures, which allowed for decisive action to identify pollution sources and their liability, reduce pollution levels and provide some compensation to those affected. For example, some economic activities known to release pollutants had to install filters to reduce pollutant emissions or establish sector-wide compensation funds.

But even in simple cases, where the polluter can be identified, implementation can be difficult. The 'culprit' may be unable to pay and the mother corporation or shareholders cannot always be held liable for the activities of a subsidiary. Not every country has a well-established legal framework to handle these cases. Even if they do, a legal process is often very lengthy and costly.

Moreover, with time, the principle has been applied to more complex cases of persistent and prevalent pollution, such as air pollution resulting from diffuse sources, where attributing responsibility and implementation get even more difficult.

How can we define who needs to pay whom?

In diffuse pollution cases, it is not easy to track and identify the polluter and connect it with the people affected. Air pollution can be caused by pollutants released from different sources and different locations, some of which may lie across international borders. We also need to think about the positive outcomes and benefits of these polluting activities. These are products and services, such as food, clothes, transport, which benefit us individually and the society as a whole.

For example, polluting activities outside the EU could be affecting local communities but the mother holding could be based in the EU and European consumers could be enjoying

the products. It is difficult to hold only the operator accountable in these cases. The wider society often bears the costs.

But the costs or the harm and the benefits are not distributed equally. Lower income communities or more vulnerable groups like single parent families tend to live closer to roads and be more exposed to pollutants from road transport.

Are there any good examples of effective measures?

There are two different types of approaches. The first aims at helping those affected and there are many good examples in Europe. The noise abatement panels or similar structures built along motorways can reduce noise levels significantly and hence the harm to those living there.

The second type aims at limiting or preventing pollution or harmful activities in the first place. These could consist of imposing taxes, pollution quotas or certain technological solutions. For example, Europe is introducing cleaner fuels or is gradually decreasing carbon emissions from new cars. For some sectors, emissions allowances are capped and can be traded. Some of these measures aim at adjusting the price in such a way as to influence consumption behaviour. Similarly, many Member States now charge by the quantity extracted or used instead of the number of taps, which has changed how we use water substantially.

Are there any shortcomings in the way we apply the 'polluter pays' principle?

Unfortunately, the current system can be seen and used as a 'licence to pollute': as long as you can pay — meaning if you can afford it, you are allowed to pollute. This is closely linked to the unequal distribution of benefits and costs of these polluting activities. The inequality issue also lies at the heart of global climate negotiations, both in terms of historic emissions (the amount each country has emitted so far) and current emissions per person. In an ideal world, everyone would be given an equal amount of carbon credit.

The second main shortcoming is that the 'payment' hardly ever covers all the 'costs'. The contaminated land in old industrial sites might be cleaned up to allow for people to live there. It is a very costly operation but it does not necessarily undo the harm done to the water bodies or to the people and animals dependent on that water. Costs are often limited to operational costs and do not reflect the real value of the benefits we get from nature.

Can we design a system that covers the full value?

We need a coherent and global approach that addresses all the challenges we face — environmental degradation, climate change, resource use and inequalities — in the same way that the Sustainable Development Goals do. The European Green Deal aims to bring some of this thinking into European policies.

To cover the real value, we would need a much more ambitious taxation system, both for corporate and personal tax, designed to induce a more sustainable behaviour. And, costs need to be integrated not only downstream on the consumption side but also upstream on the production side. As consumption and production systems are connected globally, integration requires an approach that extends beyond sovereign states' rules and regulations.

To be effective, this approach needs to be backed by a governance system with regulators that can ensure and enforce a level playing field with well-defined rules. On the ground, in addition to ambitious taxes and common standards, measures like anti-dumping duties and carbon border taxes as well as a common approach towards environmentally harmful subsidies will be necessary.

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The challenge of reducing industrial pollution

Industrial pollution in Europe is decreasing, thanks to a blend of regulation, developments in manufacturing and environmental initiatives. However, industry continues to pollute and moving towards zero pollution in this sector is an ambitious challenge.

We can categorise pollution by where we find it — in air, water or soil — or we can look at different pollution types, such as chemicals, noise or light. Another way to look at pollution is to go to its sources. Some pollution sources are spread out, such as cars, agriculture and buildings, but others can be better assessed as individual emission points. Many of these point sources are large installations, such as factories and power plants.

Industry is a key component of Europe's economy. According to Eurostat, in 2018, it accounted for 17.6 % of gross domestic product (GDP) and directly employed 36 million people. At the same time, industry also accounts for more than half of the total emissions of some key air pollutants and greenhouse gases, as well as other important environmental impacts, including the release of pollutants to water and soil, the generation of waste and energy consumption.

Air pollution is often associated with the burning of fossil fuels. This obviously applies to power plants but also to many other industrial activities that may have their own onsite electricity or heat production, such as iron and steel manufacturing or cement production. Some activities generate dust that contributes to particulate matter concentrations in the air, whereas solvent use, for example in metal processing or chemical production, may lead to emissions of polluting organic compounds.

Industrial air emission trends

Air emissions from industry in Europe have decreased over recent years. Between 2007 and 2017, overall emissions of sulphur oxides (SO_x) declined by 54 %, nitrogen oxides (NO_x) by more than one third and greenhouse gases from industry, including power plants, by 12 %[51].

These improvements in environmental performance by European industry have occurred for a number of reasons, including stricter environmental regulation, improvements in energy efficiency, a move towards less polluting types of manufacturing processes and voluntary schemes to reduce environmental impact.

For many years, environmental regulation has limited the adverse impacts of industrial activities on human health and the environment. Key EU measures targeting industrial emissions include the Industrial Emissions Directive, which covers about 52 000 of the largest industrial plants, and the Medium Combustion Plants Directive.

The EU Emissions Trading System (EU ETS), meanwhile, limits greenhouse gas emissions from more than 12 000 power generation and manufacturing installations in 31 countries. The EU ETS covers around 45 % of the EU's greenhouse gas emissions.

However, despite these improvements, industry is still responsible for a significant burden on our environment in terms of pollution and waste generation.

Public accountability — the E-PRTR and transparency of industrial emissions data

The European Pollutant Release and Transfer Register (E-PRTR) was set up in 2006 to enhance public access to environmental information.

In essence, the E-PRTR enables citizens and stakeholders to learn about pollution in all corners of Europe, who the top polluters are and whether or not pollutant emission trends are improving.

The E-PRTR covers more than 34 000 facilities across 33 European countries. E-PRTR data show, for each facility and year, information concerning the amount of pollutants released to air, water and land, as well as off-site transfers of waste and pollutants in waste water. E-PRTR data are freely available on a dedicated, interactive website[52]. The website archives historical data on releases and transfers of 91 pollutants across 65 economic activities.

Moreover, the E-PRTR is now integrated with wider reporting under the Industrial Emissions Directive, including further information for large combustion plants[53]. Together with the European Commission, the EEA is currently working on a new website to improve access to these data and information.

Counting the costs of industrial air pollution

In order to account for the external costs of air pollution, an individual pollutant's adverse impacts on human health and the environment are expressed in a common metric, a monetary value, which has been developed through cooperation between different scientific and economic disciplines.

Damage cost estimates are just that — estimates. However, when considered alongside other sources of information, they can support decisions by drawing attention to the implicit trade-offs in decision-making, such as the cost-benefit analyses used to inform impact assessments and subsequent legislation.

The EEA estimated in 2014 that the aggregated cost of damage over the 5-year period 2008-2012 caused by emissions from E-PRTR industrial facilities was at least EUR 329 billion (2005 value) and rising[54]. What is perhaps even more striking in this analysis is that about half of the damage costs occurred as a result of emissions from only 147, or 1 %, of the 14 000 facilities in the data set.

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The majority of the quantified damage costs is caused by emissions of the main air pollutants and carbon dioxide. Although damage cost estimates associated with heavy metal and organic pollutant emissions are significantly lower, they still cause hundreds of millions of euros in harm to health and the environment and can cause significant adverse impacts on the local scale. The EEA is currently working on a new study that will update these figures.

Reducing industrial pollution — assessment, legislation and implementation

The EEA regularly assesses trends in industrial pollution in Europe[55] based on E-PRTR and other data. These assessments show that industrial pollution has decreased over the past decade for emissions to both air and water. Existing and incoming EU policy instruments are expected to further reduce industrial emissions, but pollution is likely to continue to have adverse impacts on human health and the environment in the future.

A strong, growing, low-carbon industry based on circular material flows is part of the EU industrial policy strategy[56]. The goal is to create a growing industrial sector that draws less and less on natural resources, reduces pollutant emissions to air, water and land, and generates decreasing amounts of waste.

Meanwhile, other EU legislation sets more concrete air emission reduction targets, such as the National Emission Ceilings Directive[57] and the Industrial Emissions Directive[58], which aim to achieve the ambitious prevention and reduction of emissions, in particular through the continuous uptake of so-called best available techniques (BATs).

According to a recent EEA analysis[59], using best available techniques and implementing the more ambitious targets of the Industrial Emissions Directive would result in substantial emission reductions: 91 % for sulphur dioxide, 82 % for particulate matter and 79 % for nitrogen oxides. According to another analysis[60] on best available techniques, the more ambitious limits are, in the majority of cases, the more technically and economically achievable they are.

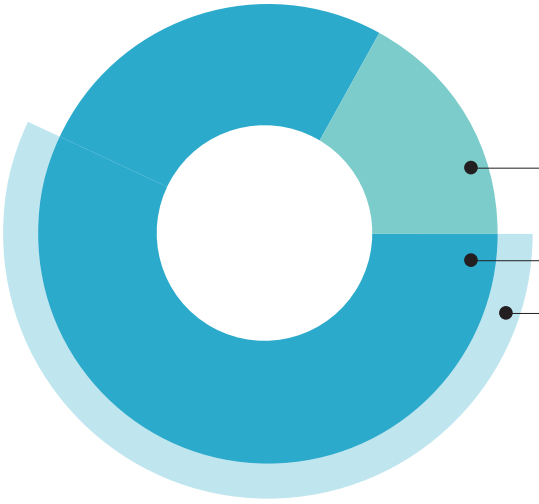
Fully implementing these directives would help the EU achieve environmental objectives, such as those on air and water quality. However, the emission-related directives often act independently and there is clear scope for further integration of the environmental objectives into the EU's industrial policy. Moving towards zero pollution will require even more robust legislation, implementation and monitoring to ensure that the industries of tomorrow are both clean and sustainable.

Find out more

- Industry: www.eea.europa.eu/themes/industry
- SOER 2020, Chapter 12 on industrial pollution: www.eea.europa.eu/publications/soer-2020/chapter-12_soer2020-industrial-pollution/view

Plastic pollution

Plastics have brought many benefits to our daily lives but the problem is that these products never truly disappear. Therefore, we should perhaps think about plastics as a type of pollutant from the point of their production and prevent plastic products and waste from leaking into the environment.



30 Million tonnes (Mt)
of waste generated in EU (2015)

17 %
collected for reuse or recycling (5 Mt)

83 %
lost (25 Mt)

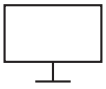
57 %
loss through landfilling and energy recovery

Types of plastic waste

16.3 Mt
plastic packaging waste

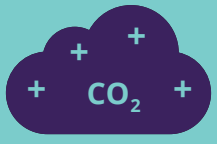
1-1.5 Mt
plastic waste from construction and demolition

1.2 Mt
plastic waste from end-of-life vehicles

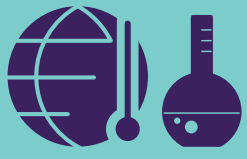


2.4 Mt
plastic waste from e-waste

Process losses in recycling



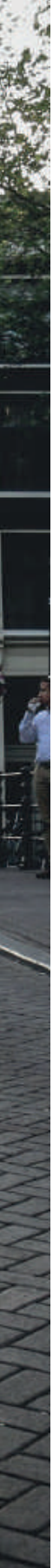
1 tonne of plastics results in 2.5 tonnes of CO_2 emissions from production and 2.7 tonnes of CO_2 emissions if incinerated.



Many other adverse environmental consequences are associated to the loss of plastic materials, such as release of microplastics into the environment.

Source: Reducing loss of resources from waste management is key to strengthening the circular economy in Europe[61].

 © Sabina Fratila on Unsplash



Noise pollution is still widespread across Europe, but there are ways to reduce the volume

Many of us are increasingly confronted by noise in our daily lives. Loud cars on the street, a low-flying plane overhead or a nearby train often bring with them annoyance and frustration. However, their impact on our health and environment could be a lot worse than you think.

We often think about pollution in terms of where it can be detected: pollution of air, water or soil. However, there are also some very specific types of pollution that harm people and wildlife.

At least one in five Europeans is currently exposed to road traffic noise levels considered harmful to their health. This number is even higher in urban areas and the problem is widespread across most cities in Europe. Road traffic is by far the top source of noise pollution in Europe, according to a recent EEA noise report[62] that looked at noise from roads, railways, airports and industry. These sources are in line with the Environmental Noise Directive, which does not cover noise from, for example, domestic activities or neighbours, or noise in workplaces.

Noise can be bad for your health

An estimated 113 million Europeans are affected by long-term exposure to day-evening-night traffic noise levels of at least 55 decibels. In addition, 22 million Europeans are exposed to high levels of noise from railways, 4 million to high levels of aircraft noise and fewer than 1 million to high levels of noise caused by industries.

What many people may not know is that long-term exposure to noise, even at the levels we are used to in urban areas, has significant health impacts. In most European countries, more than 50 % of people living in urban areas are exposed to road noise levels of 55 decibels or higher during the measured day-evening-night period. Long-term exposure to this level, according to the World Health Organization (WHO), is likely to have negative impacts on health.

The EEA estimates that long-term exposure to environmental noise causes 12 000 premature deaths and contributes to 48 000 new cases of ischaemic heart disease every year across Europe. It is also estimated that 22 million people suffer chronic high annoyance and 6.5 million people suffer chronic high sleep disturbance.

According to WHO evidence, these health impacts start to occur even below the 55 decibel noise level for the day-evening-night period and the 50 decibel noise level for the night period, which are the reporting thresholds set out by the EU's Environmental Noise Directive[63].

Therefore, these numbers are likely to be underestimated. Furthermore, the information provided by countries under EU law do not cover all urban areas, roads, railways and airports, nor do they cover all sources of noise.

What the EU is doing to reduce noise pollution

People's exposure to noise is monitored under the Environmental Noise Directive against two reporting thresholds: an indicator for the day-evening-night period (Lden), which measures exposure to noise levels associated with 'annoyance', and an indicator for the night period (Lnight), which is designed to assess sleep disturbance. These reporting thresholds are higher than the World Health Organization-recommended values and currently there is no mechanism in place for tracking progress against the latter lower values.

Wildlife is affected too

Noise also has a negative impact on wildlife, both on land and in the water. Noise pollution can cause a range of physical and behavioural effects on animals and increase their stress.

For instance, road traffic noise can make it difficult for frogs and songbirds to communicate with each other, especially during mating season. This can reduce their ability to reproduce or force them to flee their habitats.

Underwater noise from shipping, energy production, construction and other activities is another concern. For example, research has found hearing damage in whales, which can harm their ability to communicate with each other and find food.

Shh! Quiet please!

European countries have taken a number of measures to reduce and manage noise levels. However, it has been difficult to evaluate their benefits in terms of positive health outcomes, according to the EEA's noise report.

Examples of the most popular measures to reduce noise levels in cities include replacing older paved roads with smoother asphalt, better management of traffic flows and reducing speed limits to 30 kilometres per hour. Some cities have also implemented projects aimed at masking traffic noise by placing more pleasant-to-the-ear noises, such as running waterfalls, in city centres. There are also measures aimed at raising awareness and changing people's behaviour in using less-noisy modes of transport, such as cycling, walking and electric vehicles.

A number of cities and regions have also put in place so-called quiet areas, most of which are parks and other green spaces, where people can go to escape city noise. These areas, the creation and designation and protection of which are encouraged by EU rules, can bring significant environmental and health benefits, according to a 2016 EEA report on quiet areas in Europe[64].

However, EEA research found issues related to the availability of and access to these sites, especially in noisier city centres, where quiet green spaces are hard to find and not reachable within a 10-minute walk from people's homes.

COVID-19 and noise

Noise pollution from transport sources, such as road, rail or air traffic, is linked to economic activity. Therefore, a significant short-term reduction in transportation noise levels can be expected as a result of COVID-19-related lockdowns. However, environmental noise levels are reported over a prolonged period, as health effects appear when exposure is long term. As such, a short-term reduction in noise levels would not significantly reduce the annual noise level indicator used to measure the effects of noise.

Find out more: https://www.eea.europa.eu/post-corona-planet/explore[65].

Turn down the volume

It is clear that we cannot live without sound or noise and reducing noise pollution to 'zero' is unrealistic. However, the EU is working to make sure that noise levels are reduced so they do less harm to our environment and health. This is a big task.

It is already clear that the EU's 2020 objective on reducing noise pollution, as defined by the EU's 7th Environment Action Programme[66] of decreasing noise pollution and moving towards WHO-recommended levels for noise exposure, will not be met.

Many EU Member States will need to do more to take the steps needed to address noise pollution, especially in implementing the EU's Environmental Noise Directive.

Find out more

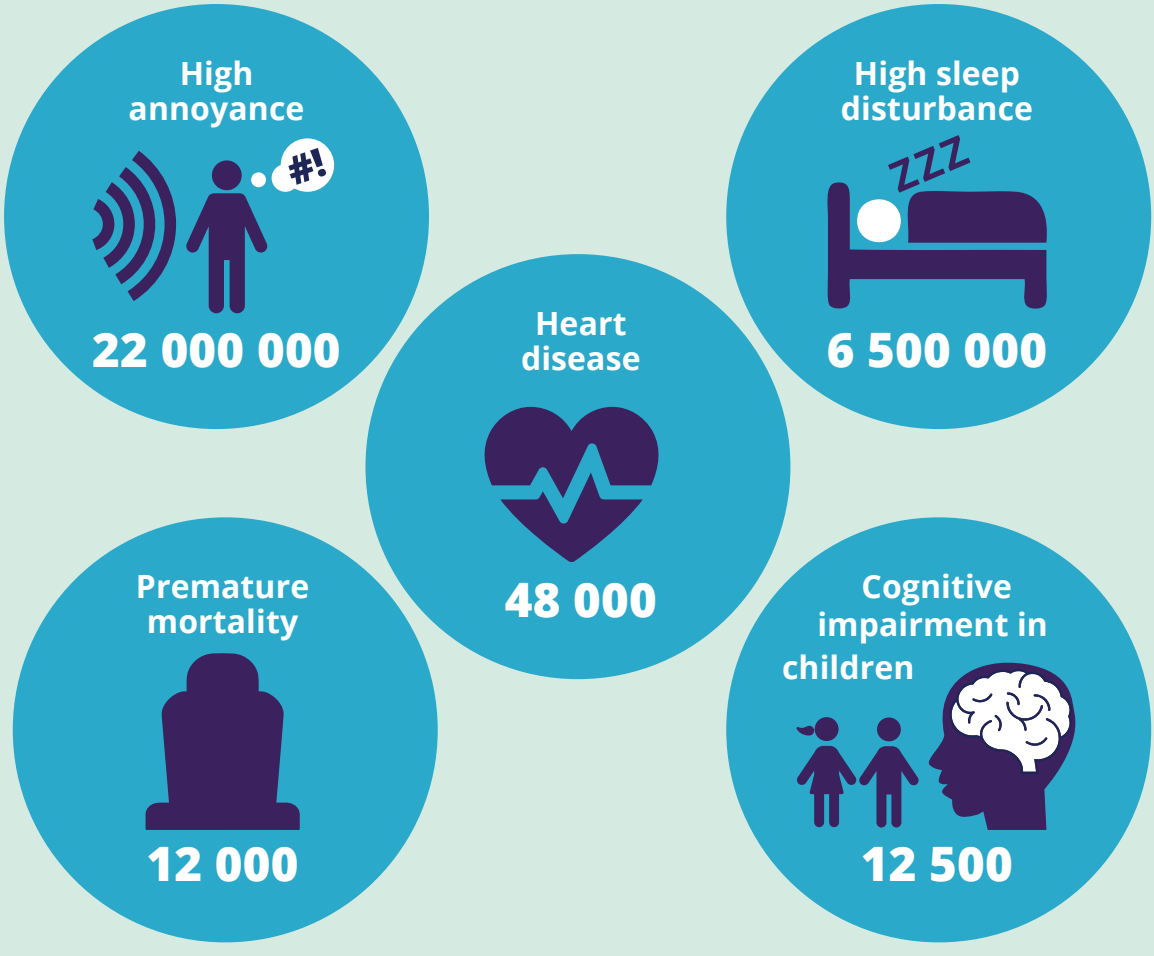
- Noise: www.eea.europa.eu/themes/human/noise
- SOER 2020, Chapter 11 on environmental noise: www.eea.europa.eu/publications/soer-2020/chapter-11_soer2020-environmental-noise/view

Noise pollution

Noise pollution is a growing environmental concern. Noise disturbs sleep and makes it harder to learn in school. It can also cause or aggravate many health problems. The most important source of environmental noise in Europe is road traffic.

20 % of the EU population — one in five people — live in areas where noise levels are considered harmful to health.

Impacts of environmental noise in Europe



Source: EEA report - Noise in Europe 2020[67].

Francesca Racioppi
WHO European Centre for Environment and Health

Addressing environmental risks to health

According to the World Health Organization (WHO), pollution accounts for 1.4 million preventable deaths per year in Europe but the situation is improving and the European Green Deal might be the opportunity to leapfrog towards sustainability. We talked about pollution and health with Francesca Racioppi, Head of the WHO European Centre for Environment and Health.

What are the most dangerous kinds of pollution and their health impacts affecting Europeans and their health impacts?

In Europe (meaning the 53 Member States of the WHO Regional Office for Europe — more than 900 million people), environmental risk factors still account for 1.4 million deaths per year and these deaths are to a large extent preventable. More than a third of these deaths are attributable to air pollution, which is the single most important environmental risk factor for our health. Another big proportion of pollution harm comes from hazardous chemicals. And, unfortunately, every day seven people, mostly children, die from diarrhoeal-related diseases so even water quality remains a problem. Even within the EU, in some rural areas, we have not yet achieved 100 % access to clean water and sanitation.

We still have a long way to go with environment and health but we can also be very clever in the way we join different agendas. For example, addressing air quality can mean addressing climate change emissions at the same time.

How did the effects of pollution on health change in Europe in the past decades?

In Europe, the situation has improved significantly. I was young at the time when the first legislations were brought into place to fight the acid rains and the eutrophication of lakes and seawater. We were perhaps the first in some industrial developments that were very problematic and we were also the first to be confronted with massive pollution and we had to deal with that. We have learned that you need common rules to deal with pollution because it knows no borders.

Of course, now we live in a globalised world and we have to acknowledge that pollution does not respect continental borders either. We have seen some issues moving from Europe to other regions where some dangerous industrial practices are still allowed, so we have a responsibility that goes beyond Europe, a responsibility for global health and that our policies support cleaner production.

Does air pollution influence the evolution of the COVID-19 pandemic?

There are still many unanswered questions regarding the relation between air quality and COVID-19 and it is a topic of current scientific investigation. However, there are some statements that we can already make. Improving air quality would never be wrong because we know that air pollution is an important risk factor for and cause of respiratory and cardiovascular diseases. People who have these underlying conditions have shown increased vulnerability to COVID-19 and are at a higher risk of reporting severe symptoms.

In the short term, we have seen an important reduction of air pollution across cities. This reduction is more prominent in the case of nitrogen oxides, a pollutant very much related to traffic, which is one of the activities most affected by the lockdown measures. There is a lot of research that is going on around this as we are speaking and from which we will learn and benefit in the future. COVID-19 is an unfolding tragedy but, at the same time, it has given us a glimpse at unprecedented data that could perhaps help us rethink the way to a 'new normal' that can deliver environmental and health benefits.

Can this crisis be a push towards a sustainable economy?

It is excellent that the European Commission has been working on the European Green Deal because it is a very strong commitment that can give a huge leverage to frame the recovery in a sustainable manner. There is an unprecedented opportunity for this 'new normal' to be a leap towards sustainable economic development and we are looking forward to working towards that in collaboration with the Commission.

What would be the easiest methods to decrease pollution?

If we focus on the example of air pollution, we need to address the sectors where it originates — the energy sector, transport, agriculture, waste management and many industries — working from local to global scales. A lot has been done over the past decades, but we still see that globally, 90 % of people are living in cities that do not meet WHO's air quality guideline values. This means that we still have a significant way to go that requires working with the different sectors to see how we can promote cleaner and safer transportation systems, for example. For all sectors there are positive ways forward.

I think it is also important to acknowledge that the effects of pollution in general, and of air pollution in particular, are not equally distributed. People who live in more deprived areas, very often live close to contaminated sites or in areas where there is a very high flow of traffic. The differences can be large, not only between countries, but also within countries.

What is WHO Europe doing in the field of environment and pollution?

For more than 30 years, our core mission, as WHO, is to work with our Member States and within countries to support them in

addressing their environment and health priorities. This came up very clearly at the last European Ministerial Conference on Environment and Health that took place in Ostrava in 2017. All 53 Member States came together and agreed to develop national portfolios for action on environment and health. We are at their side, supporting them in identifying the national priorities, and then supporting the work in that direction.

Also, we are continuing the normative work of the WHO: our Centre is coordinating the update of the WHO global air quality guidelines. Last year we launched the WHO environmental noise guidelines, providing public health-oriented recommendations to support legislation and policymaking for standards in our Member States and at the European level.

Do you expect the new WHO guidelines regarding noise and the forthcoming update on air pollution to be adopted by the EU as well?

I hope so. The WHO guidelines provide robust recommendations based on the most updated scientific evidence of what we know of the relationship between health and air pollution or environmental noise. From that point it is a political decision whether to refer to those guideline values when setting standards. We know that the European Commission refers frequently to WHO guidelines. For example, the EU Drinking Water Directive was revised based on the health-based recommendations and guideline values in the latest edition of the WHO guidelines for drinking-water quality. Environmental noise guidelines for the European region are considered in the revision of the Environmental Noise Directive. The debate remains open when it comes to the forthcoming update of the global air quality guidelines on how they will be reflected in European Union policies. We have to respect the political process and the deliberations of the EU and its Member States but we hope that those policies will promote and protect health, and we are here to support them.

Francesca Racioppi
Head of the WHO European Centre for Environment and Health

The future of monitoring pollution?

New technology and tools are opening up new possibilities for environmental monitoring and analysis. For example, citizen science, satellite observations, big data and artificial intelligence present opportunities for improving the timeliness, comparability, granularity and integration of data.

Examples of applications

1

Citizen science is a powerful tool for public engagement, complementing official data, and for raising awareness on environmental issues and policies.

- monitoring **waste and litter**
- counting species such **butterflies** or **birds**
- low-cost **air quality sensors**

2

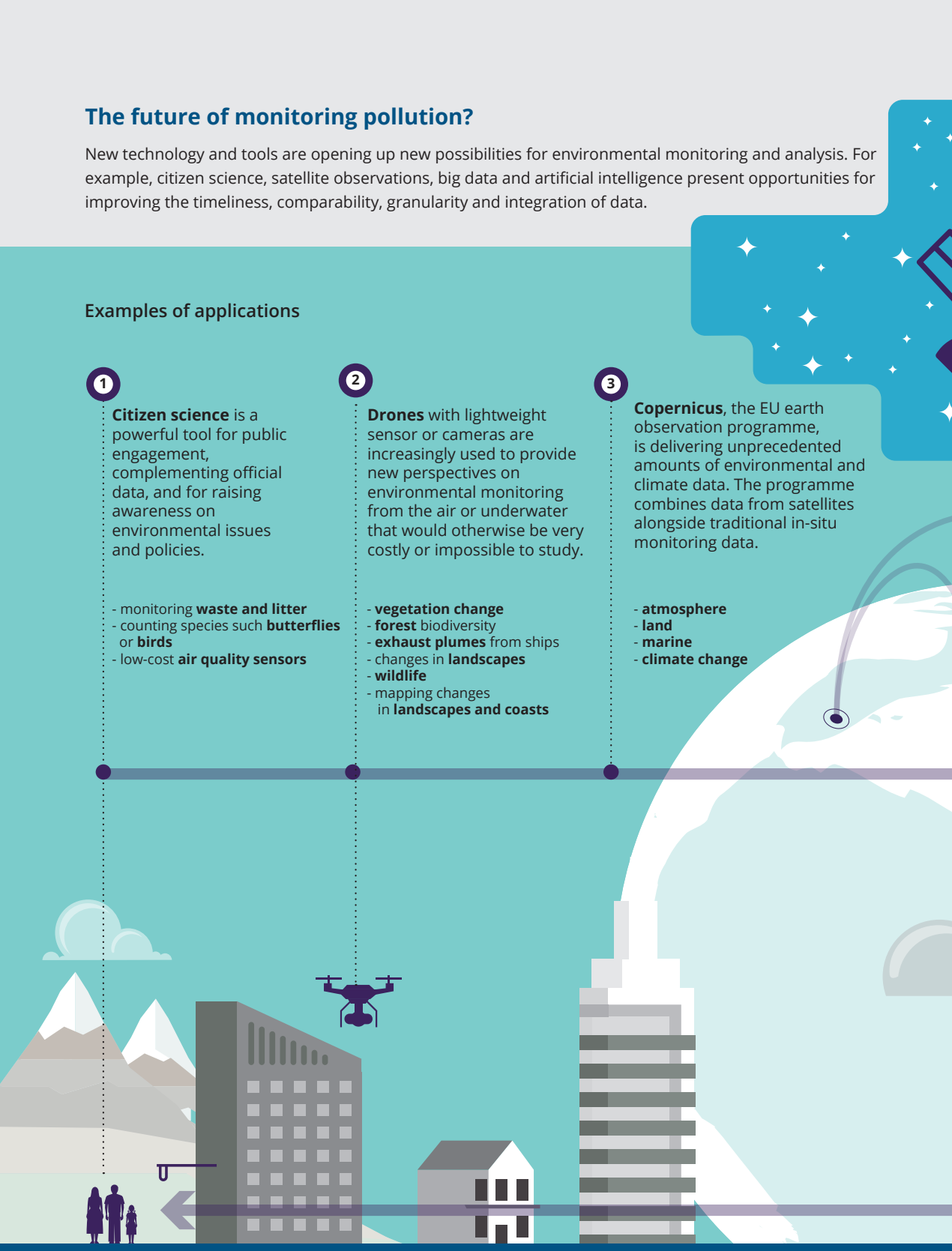
Drones with lightweight sensor or cameras are increasingly used to provide new perspectives on environmental monitoring from the air or underwater that would otherwise be very costly or impossible to study.

- **vegetation change**
- **forest** biodiversity
- **exhaust plumes** from ships
- changes in **landscapes**
- **wildlife**
- mapping changes in **landscapes and coasts**

3

Copernicus, the EU earth observation programme, is delivering unprecedented amounts of environmental and climate data. The programme combines data from satellites alongside traditional in-situ monitoring data.

- **atmosphere**
- **land**
- **marine**
- **climate change**



4

Near real-time data
The European **Air quality Index** uses air quality data reported every hour by countries across Europe. Such near real-time information is valuable in informing citizens of the current quality of the air where they live or work.

Similar systems could be valuable, for example, to monitor environmental noise, industrial pollution, water and soil quality, vehicle exhaust emission, or wildlife movements.

- **in-situ monitoring**

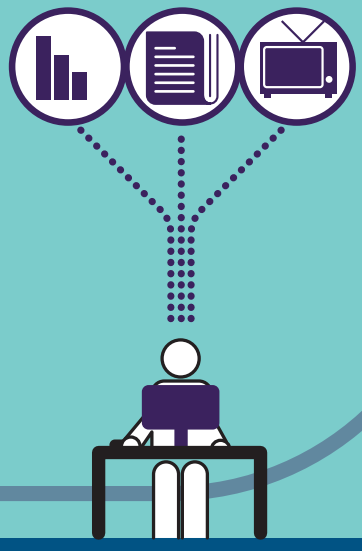
Artificial intelligence (AI)

The use of artificial intelligence coupled with big data is opening up new possibilities for environmental monitoring and analysis. Connecting different types of data, for example, on land use, traffic patterns, or buildings, with socio-economic variables, such as population data, allows new insights and predictions about environmental quality.

Digitalisation

Increasing computing power allows multiple data streams to be connected, for example, linking near-real time data from satellite and in-situ observations.

New opportunities in digitalisation offer better assessments, more geographic information, faster modelling and stronger connection to policy implementation.



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EEA Signals 2020

Towards zero pollution in Europe

What is pollution? Where does it come from? How does pollution affect the environment and how does it affect people's health? How can Europe move towards zero pollution, in line with the ambition of the European Green Deal? EEA Signals 2020 looks at pollution through different lenses related to the Agency's work and EU legislation.

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