Investing in Europe's water health: from toxic to thriving

Investing to solve
global challenges

SUMMA EQUITY

Preface

Water is the foundation of life and society. It is essential to human well-being, ecosystems, economies, and public services. It sustains agriculture, powers industry, supports biodiversity, and underpins public health.

Recognizing its importance, the European Union declared water a shared heritage that must be protected and defended. Yet this essential resource is under growing pressure. Climate change, urbanization, industrial expansion, and geopolitical instability are pushing water systems toward a tipping point. From droughts and floods to contamination and conflict, water is increasingly manipulated, weaponized, or degraded, turning a source of life into a source of risk.

True resilience means safeguarding not just people, but the natural systems that sustain us. Healthy ecosystems provide irreplaceable services, filtering our water, storing carbon, and protecting against floods, ultimately reminding us that the health of these systems determines ours. Across Europe, pollution and mismanagement are eroding resilience at its core.

At Summa, we believe the future can look different: one where water bodies are protected, resilient, and inclusive, where access to clean water is not a privilege but a guarantee. Our portfolio reflects this commitment: NG Nordic is tackling depollution at the source, helping industries and municipalities remove contaminants before they reach ecosystems. Waterise is revolutionizing access to water through deep-sea desalination, offering scalable, energy-efficient solutions to scarcity. Nutris is demonstrating regenerative agriculture at scale, reducing reliance on synthetic inputs and cutting nutrient runoff. Summa is ready to go further, scaling up its investments to drive lasting impact across the water value chain.

Achieving European water health requires more than isolated fixes. It means investing to prevent pollution at its source, addressing it throughout the entire water and waste management cycle. It also entails remediating and regenerating the most affected ecosystems, especially those that supply and sustain communities. It requires collaboration across sectors, borders, and disciplines. Clean, safe water enables societies to prosper, while degraded water erodes ecosystems, economies, and public health.

Water is more than a resource; it is a strategic asset, a public good, and a shared responsibility. We hope this report inspires action, investment, and innovation to make water health the cornerstone of Europe's resilience.

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About this report

Thank you for reading Summa's report on investing in European water health. This report provides a comprehensive overview of how human production systems shape the water cycle and how diffuse pollution impacts health and ecosystems. It identifies key levers for action, emphasizing financing solutions, innovation, and broad stakeholder involvement. At its center is Summa's Water Health Scenario, developed to quantify and connect systemic challenges and market dynamics to high-impact investment opportunities. We hope that this report serves not only as an informative resource but also as a catalyst for action, encouraging discussion and collaboration among stakeholders to advance water health across Europe.

Six families of pollutants defining Europe's water health challenge

This report focuses on six pollutant families that together represent the most persistent, toxic, and widespread pressures on Europe's waters, ecosystems, and public health.

They were selected from twelve pollutant classes identified under EU and EEA frameworks, based on their resistance to natural degradation, tendency to accumulate in living organisms, and limited removal by conventional treatment systems.

Together, these six pollutants represent the core of Europe's water health challenge – driving both environmental degradation and risks to human health.

Per- and polyfluoroalkyl substances (PFAS)	Synthetic compounds used in industrial processes, coatings, and firefighting foams; among the most persistent contaminants known, often called "forever chemicals." Examples include Perfluorooctane sulfonate (PFOS) and Perfluorooctanoic acid (PFOA), both of which are now widespread in water, soils, and the human body.
Pesticides	Agricultural chemicals designed to protect crops; easily transported by rain and runoff, they contaminate rivers and groundwater and harm pollinators, wildlife, and food safety.
Nutrients (nitrates and phosphorus)	Essential for crops, yet when used in excess they wash into rivers and lakes, causing algal blooms, oxygen loss, and declining water quality.
Microplastics	Microscopic plastic fragments shed from tires, textiles, and packaging; they accumulate in soils, rivers, and marine environments, where they affect aquatic life and enter the food chain.
Pharmaceuticals and Personal Care Products (PPCPs)	Traces of medicines and cosmetics that pass through wastewater treatment and accumulate in rivers and lakes, affecting wildlife and promoting antibiotic resistance.
Heavy metals	Elements such as lead, mercury, and cadmium released from industry, mining, and legacy pollution; they persist indefinitely in soils and sediments and threaten both ecosystems and human health.

Thanks to

Roland Berger Water Team for their significant support in shaping the content of this report and Christopher Gasson (Publisher, Global Water Intelligence), Ingo Fetzer (PhD Researcher at Stockholm Resilience Center), Guillaume van Rijckevorsel (COO, Soil Capital), Philippe Mauguin (CEO and PDG, INRAE) and Bruno Pigott (Executive Director WateReuse Association) who shared their expertise along our journey.

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Executive summary: Europe’s water at a breaking point

Europe’s waters are deteriorating.

Only 40% of surface waters meet ecological standards, and fewer than 27% pass the test on good chemical status.[1] A combination of legacy pollutants such as nitrates, pesticides, and heavy metals has dominated Europe’s water challenges for the past decades, while emerging contaminants such as “forever chemicals” (PFAS), PPCPs, and microplastics are now adding to the burden. Together, these substances have created a toxic load that spreads across rivers, aquifers, lakes, and coasts.

This is not only an environmental crisis; it is a systemic risk to health, ecosystems, and economies. Ecosystems themselves are vital economic infrastructure. In evaluation of positive economic externalities, the European Commission estimates that the services they provide, from water purification and food provision to flood protection and carbon storage, are worth more than EUR 230 billion each year.[2] This is comparable to the entire economic output of agriculture and forestry. As water systems degrade, this natural capital is eroded, shrinking the very foundation of Europe’s water health.

The hidden toll on nature and human health

The damage is already tangible. Freshwater biodiversity is under threat, with fish and insect populations collapsing under chronic exposure to pesticides, nutrients, and microplastics. Persistent chemicals accumulate in soils, food chains, and human blood, contributing to cancer risks, endocrine disruption, reduced fertility, and antimicrobial resistance.

Often described as an invisible killer, water pollution rarely makes headlines causing sudden shocks. Instead, it works silently, building up in bodies and ecosystems over years until the damage is widespread and costly. As contamination deepens, what begins as an environmental issue becomes a critical public-health imperative.

Beyond single pollutants, the real risk lies in combined and continuous exposure to thousands of interacting substances. Scientists describe this as the exposome, the totality of environmental exposures that shape human biology throughout life.[3] People encounter this chemical mix daily by ingesting contaminated food and water, absorbing substances through the skin and breathing in air. These lifelong exposures accumulate from infancy to old age, altering metabolism, fertility, and immune resilience. Understanding and managing the exposome, the full chemical and biological burden on the body, is essential to protect both human health and the ecosystems that sustain it.

Why Europe is falling short

EU policy has made progress, but it is far too slow. While directives have reduced some emissions, regulation remains largely reactive with restrictions often coming after widespread contamination. Monitoring still only covers a small share of the chemicals in use. Just a few dozen substances are routinely tracked under EU law, leaving major gaps for emerging contaminants, and almost no evaluation of their combined “cocktail” effects. Implementation is equally weak: the European Commission has confirmed that full compliance with the Water Framework Directive’s 2027 targets is out of reach under current programs, and nearly half of all EU environmental infringement cases now relate to pollution – including water, air and chemical contamination.[4]

1.(European Commission, 2025) 2.(European Commission, 2025) 3.(Wild, 2005) 4.(European Commission, 2025)

The erosion of ecosystem services is a hidden cost of this implementation gap. Europe's wetlands, riparian corridors, and soils alone provide a water purification service worth an estimated EUR 60 billion annually in avoided treatment costs. This natural dividend is shrinking as nutrient loads exceed sustainable thresholds.[5] When ecosystems degrade, society must replace free services including purification or flood buffering with expensive infrastructure, shifting costs from nature to taxpayers and utilities.

This growing dependency on engineered solutions makes financing a central bottleneck. The European Commission estimates that current spending on environmental protection – including water, air, waste, and biodiversity – amounts to around 1.6% of EU GDP per year. To meet existing environmental objectives, this level would need to rise to about 2.4% of GDP, an increase of roughly 50%, corresponding to an additional EUR 122 billion per year. Falling short of this level leaves ageing infrastructure, legacy pollution, and emerging contaminants insufficiently addressed. The result is a mounting cost of inaction – at least EUR 180 billion annually in health impacts, ecosystem losses, and clean-up expenses.[6] Private capital has largely stayed away due to fragmentation, long payback periods, unpredictable cost-sharing, and lack of stable regulation.

Summa's blueprint for achieving European water health by 2040

Guided by our vision to invest in solving global challenges, we have developed the "Water Health Scenario" – a proprietary framework for systemic transformation across the pollution value chain. From farms and factories to consumer products, the scenario outlines how coordinated action can restore Europe's water systems and protect both humans and biodiversity from harmful exposure.

The transformation envisioned in the Water Health Scenario is driven by four key levers: **Reduce** (eliminate harmful substances through bans, phase-outs and substitution), **Capture** (intercept pollutants at their source or along their pathways), **Shield** (protect populations from pollutant exposure), and **Remediate & Regenerate** (restore ecosystems and clean up legacy pollution).

By 2040, these measures would cut pollutant emissions across all major contaminant groups by more than 50%, triggering a historic recovery in water quality and ecosystem health. As a result, around three-quarters of European water bodies would achieve compliance with EU Environmental Quality Standards. When nutrient and chemical toxicity drop below harmful levels, fish, invertebrates and pollinators could begin to recover. At the same time, cleaner sludge management, heavy-metal removal, and the expansion of organic farming to a quarter of EU cropland would help rebuild soil fertility and microbial diversity, reducing contamination risks for crops and grazing animals.

Human exposure would also fall sharply: by 2040, the share of Europeans exposed to drinking water above the safety line – defined in the Water Health Scenario as ≤ 2 ng/L for the sum of four PFAS - falls from up to 50% today to less than 5%. This bold target for PFAS, aligned with Danish best practice, sets the level of protection required to secure public health and would reinforce the EU's leadership on chemical safety.

Together, these actions would safeguard human health, regenerate ecosystems, and restore the natural resilience of Europe's waters, soils, and wildlife – laying the foundation for a cleaner, more resilient Europe.

The benefits of the Water Health Scenario are profound:

- **PFAS:** exposure shrinks from ~200 million people today to fewer than 5 million, with blood levels in affected areas dropping by 90%
- **Pesticides:** the number of people exposed to tap-water exceeding safety limits fall from 45 million to fewer than 8 million people
- **Nitrates:** pollutant levels in aquifers are cut in half, with no Europeans exposed above legal limits
- **PPCPs:** cut residue by 70%, with advanced wastewater treatment covering 80% of the population
- **Microplastics:** annual ingestion drops sixfold, from 20,000 to fewer than 3,000 particles per person
- **Heavy metals:** accelerated replacement of lead pipes and cleanup of legacy sites cut exposure by around 90%, leaving only a small share of Europeans above thresholds by 2040

This is more than compliance. It is a blueprint for resilience, protecting the water resources that underpin Europe's food, industry, energy systems, and human health.

Financing an accountable transition

The Water Health Scenario outlines a path to restore Europe's waterways by 2040, requiring EUR 226 billion of investment over the next 15 years. This would be on top of the investments already mandated by EU water directives. The investment is distributed across the four levers as follows:

5.(European Commission, 2025) 6.(European Commission, 2025)

- **Reduce:** EUR 28 billion to eliminate harmful substances through precision farming, combined with phase-out and substitution effort toward the most hazardous chemicals
- **Capture:** EUR 155 billion to intercept pollutants at their source or along their pathways, including advanced wastewater treatment, decentralized capture, and pollutant destruction
- **Shield:** EUR 31 billion to protect populations from polluted drinking water
- **Remediate & Regenerate:** EUR 12 billion to restore ecosystems and legacy pollution

This ambition builds on the strong momentum in the sector. According to the Global Water Intelligence (GWI), total planned investment in treatment over 2025–2040 already stands at EUR 420 billion. The Water Health Scenario would require around EUR 120 billion more, a ~30% increase in water treatment investment compared with the baseline.

The remaining EUR 106 billion represents additional initiatives beyond water treatment, spanning actions that prevent pollution at the source, capture contaminants before they enter the waterways and regenerate degraded ecosystems. This additional effort is within reach and economically justified, as the cost of inaction would be far greater.

Taken together, the EUR 226 billion in incremental investment would be part of enabling Europe's water-health transition. We estimate that water-health markets can reach around EUR 370 billion in annual revenues by 2040, driven by expanding demand for advanced treatment, resource recovery, and ecosystem restoration. In total, this transformation could unlock a EUR 1 trillion water-market opportunity by 2040, reflecting the full growth potential of Europe's water-health economy, underpinned by both the baseline and incremental investments identified in Summa's scenario.

Accountability must guide the transition. The "polluter pays" principle is regaining traction, ensuring that those responsible for contamination bear a share of the costs of prevention and remediation. France has introduced a PFAS levy, Swedish courts are holding industrial polluters liable for clean-up costs and from 2028, EU directives will require pharmaceutical and cosmetics producers to finance at least 80% of the costs of removing micropollutants from wastewater.[7] Applied more broadly, these mechanisms could finance a significant share of treatment and site restoration. They could cover more than 30% of the water treatment investments in the Water Health Scenario, easing the burden on households and public budgets.

Equally important are "beneficiary pays" models, particularly in agriculture and other sectors that depend on clean water. Organic farming already accounts for 10% of EU farmland,[8] with a target of 25% by 2030. Emerging initiatives are increasingly rewarding practices that deliver cleaner water, healthier soils, and restored biodiversity.[9] These models recognize farmers, land managers, and industries as stewards of water resources, while channeling value from supply chains and consumers toward sustainable production.

Public funding will remain critical, supporting initiatives that deliver long-term environmental and social benefits – such as nature-based solutions, agricultural transitions, and ecosystem restoration – that are often difficult to monetize through market mechanisms. Strategic use of EU and national funds can also help contain tariff increases by leveraging private capital and ensuring that efficiency gains translate into affordability. At the same time, closing the circular loop can generate new revenue streams and reduce costs. Recovering and monetizing valuable resources from wastewater and sludge such as nutrients for biofertilizers, biogas, and other forms of renewable energy, can turn pollution control into value creation rather than a cost burden. By internalizing these externalities, utilities and industries can recover part of their investment needs and help keep tariffs affordable, ensuring that price adjustments reflect real efficiency gains rather than additional costs for consumers.

Once polluter-pays and beneficiary-pays mechanisms are applied, and public funding supports non-market benefits, the remaining gap for water treatment investments can be closed through modest, phased tariff adjustments. These would remain affordable, with targeted support available to protect vulnerable households.

A call for stewardship

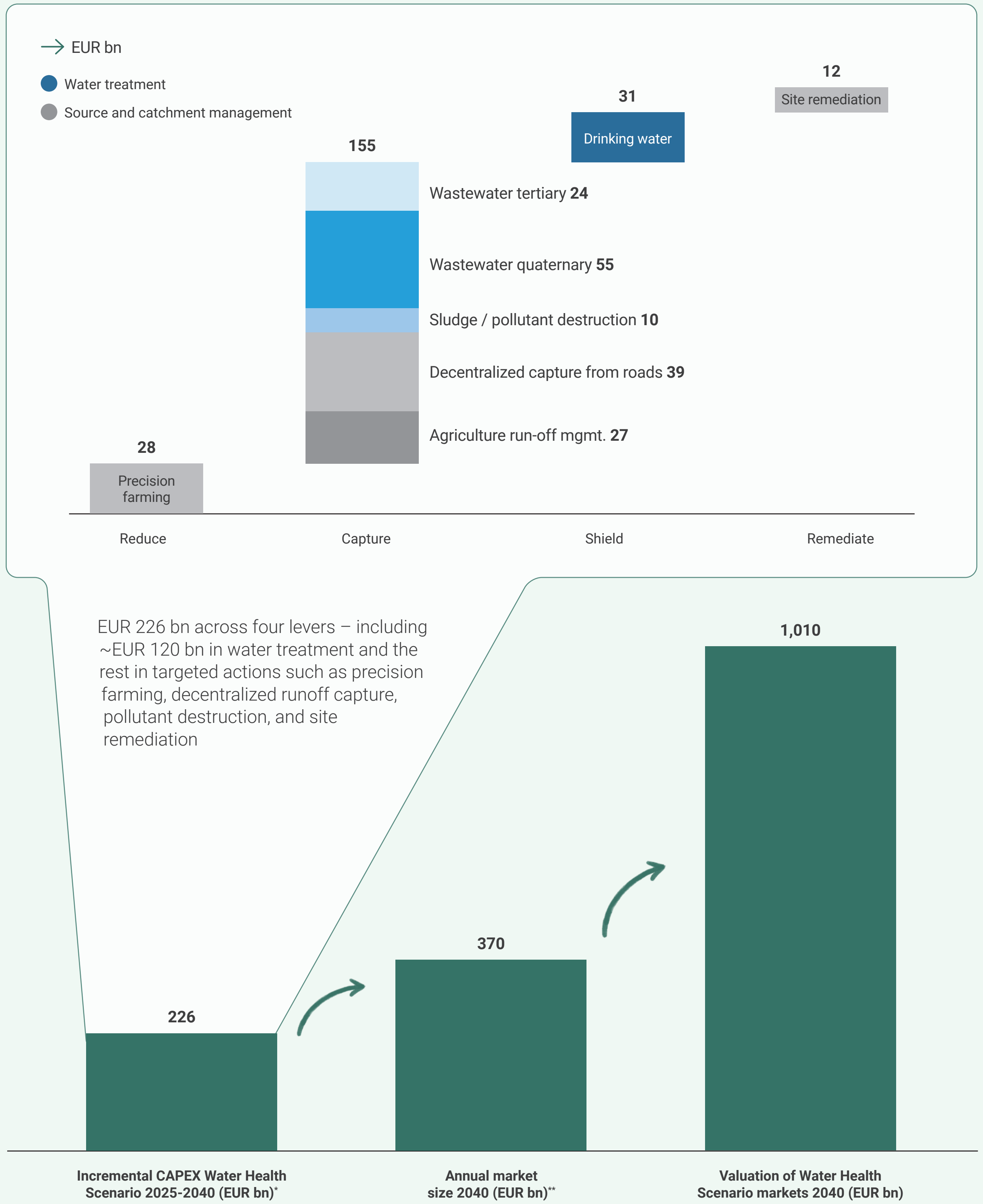
Summa is investing in solutions that address capability gaps and systemic barriers in the water sector, including fragmented governance, underfunded infrastructure, and low public awareness. We advocate for cross-sector collaboration, stronger pollutant regulation and monitoring, and more precise approaches to cultivating agriculture, designing consumer products, and managing water resources to better protect people and nature.

The Water Health Scenario shows that transformation is within reach. With bold investment and coordinated action, Europe can cut toxic exposures, prevent premature deaths, revive ecosystems, and avoid billions of health and environmental costs each year. This is not only about avoiding risks. It's about unlocking innovation, creating healthier communities, and building resilience for generations to come.

7.(Sweden Herald, 2025) 8.(IFOAM Organics Europe, 2025) 9.(European Commission, 2020)

Figure 01
Financing the Water Health Scenario

Investing EUR 226 bn in incremental CAPEX to unlock a EUR 1 tn water market opportunity by 2040



* Represents incremental CAPEX identified in the Water Health Scenario, on top of a baseline investment of EUR 570 bn projected under current regulatory and market trends over the next 15 years ** Calculated as annual turnover in 2040

Only

40%

of surface water meet EU ecological standards and fewer than 27% are considered to be in "good chemical status"

The burning platform: understanding Europe's water crisis

> – I would step back and treat water health as the overarching idea that unites those issues of water and climate change. Water is like our blood. It's the flow that makes civilization possible, and different forces now threaten the health of that circulation.
>
> **Christopher Gasson**
> Publisher, Global Water Intelligence

Water's silent strain: quantity, quality and continuity

Already in 2000, the European Union recognized water as a shared heritage, one that must be protected, defended, and treated with care.[10]

Yet this most vital resource is under growing pressure. Climate change, rapid urbanization, industrial expansion, population growth, and unsustainable consumption patterns are all intensifying demands on Europe's water systems. Geopolitical instability adds another layer of complexity, driving water security across the continent and toward a tipping point. The increasing use of water as a tool in conflict shows its vulnerability and its strategic value. Once protected even during wartime due to its essential role in sustaining life, water is now increasingly manipulated, weaponized, or contaminated to apply political pressure or deepen humanitarian crises. The destruction of Ukraine's Kakhovka Dam and the closure of the North Crimean Canal are stark examples. This is also seen in other high-tension regions, such as India–Pakistan or Israel–Gaza, where access to water is connected to political and territorial conflicts. This is not only cause for concern, but a powerful testament to water's central role in stability and peace.

Climate change demonstrates that water's quantity, quality, and reliability are deeply interconnected, and that managing them in isolation no longer works. As droughts intensify, rivers and reservoirs shrink, reducing available supply. This scarcity concentrates pollutants, raises temperatures, and accelerates algal blooms, rapidly degrading water quality and forcing utilities to ration or shut down services. Floods create a different but equally disruptive dynamic: they wash pollutants into treatment systems, overwhelm infrastructure, and trigger microbiological contamination, often leading to service interruptions and boil-water advisories.

10.(European Council, 2000)

These interlinked climate pressures are already visible across Europe today. In 2024, nearly 30% of river networks exceeded flood thresholds,[11] while around 20% of EU land faced chronic water stress.[12] These extremes are amplified by Europe's reliance on surface water: 74% of withdrawals come from rivers and lakes, which are highly sensitive to volatility. Groundwater has traditionally provided a more stable buffer, accounting for only about a quarter of water withdrawals but supplying 65% of Europe's drinking water.[13] Yet, even this resilience is weakening, as declining rainfall reduces aquifer recharge and increases volatility in once-reliable reserves. Drought-hit regions such as Spain and Greece have imposed water restrictions, while floods across Central Europe have disrupted treatment plants and damaged infrastructure. The pattern is clear: when quantity fails or quality collapses, continuity is the first to go.

Climate extremes are only part of the story; economic growth is deepening existing vulnerabilities. In 2022, the EU abstracted 197 billion m³ freshwater.[14] Cooling for electricity generation accounted for about 35% of this total, while public water supply – including households, tourism, and services – represented roughly 20%. Manufacturing and industry added another 15%, and agriculture around 30%. Although agriculture accounts for less than a third of abstraction, most irrigation water is consumed rather than returned, making it responsible for nearly 70% of Europe's net freshwater use.[15] Together, these demands place enormous strain on rivers and aquifers, especially during dry periods.

The impact is not just about volume. Discharges of heated or chemically treated water from industry degrade quality and increase pollution risk. At the same time, rising ambient water temperatures driven by climate change further reduce oxygen levels, stress ecosystems, and amplify the effects of contaminants.

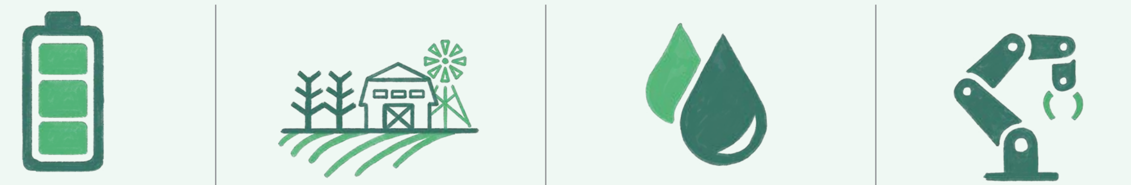
Heavy withdrawal and discharge patterns destabilize continuity, leaving downstream utilities vulnerable to supply interruptions, particularly during droughts or peak demand. These pressures reveal a stark reality: water quality is the cornerstone of resilience. While shortages or infrastructure failures are immediately visible, it is the invisible pollutants, from industrial chemicals, legacy agricultural runoff and emerging contaminants such as PFAS, that silently degrade ecosystems. Left unaddressed, this silent degradation undermines the very systems that sustain Europe's resilience.

The scale of the problem is clear: the European Commission's 2025 Environmental Implementation Review confirms that only 40% of Europe's surface waters are in good ecological status, and fewer than 27% meet good chemical status. None are in line with the Water Framework Directive's 2027 goals.[16] The same review highlights that nearly half of all EU environmental infringement cases concern water and pollution, out of a total of 309 open cases across the Union, with 18 Member States specifically facing formal procedures over wastewater treatment failures, highlighting the persistent gap between policy ambition and on-the-ground implementation. This means that even when rivers and reservoirs continue to flow, the water they carry is often no longer healthy.

Water health isn't a side issue; it's the main challenge in safeguarding Europe's water future.

Addressing this challenge requires more than incremental change. It demands a system-level approach: one that strengthens governance, improves production practices, enhances water, wastewater and waste treatments, and accelerates innovation. It calls for collaboration across sectors and borders, and for investment in solutions that deliver measurable impact, environmentally, socially, and economically.

In 2022, the EU abstracted
197 billion m³ freshwater



35%	30%	20%	15%
Electricity cooling	Agriculture *70% of Europe's net freshwater use	Public water supply	Manufacturing

11.(Reuters, 2025) 12.(Water News Europe, 2021) 13.(European Environment Agency, 2022) 14.(European Environment Agency, 2022) 15.(Rossi, 2019) 16.(European Commission, 2025)

SPOTLIGHT

Water under pressure: *a planetary boundaries perspective*

The water pollution challenges in Europe reflect a global state of environmental stress explained by the planetary boundaries framework. The framework identifies nine critical Earth systems and thresholds that define the environmental conditions necessary for a stable and habitable planet for people.

These boundaries include climate change, biosphere integrity, land-system change, freshwater change, biogeochemical flows, novel entities, ocean acidification, atmospheric aerosol loading, and stratospheric ozone depletion. The most recent assessment shows that seven of these nine boundaries have already been transgressed, with ocean acidification recently added, leaving only atmospheric aerosol loading and stratospheric ozone depletion within safe limits.[17] Together, these illustrate humanity's safe operating zone, a measure of the conditions that sustain our health and well-being.

These boundaries are not breached in isolation but through cascading interactions. Together, they illustrate how human pressures on land and water systems reinforce one another. Their impacts also extend offshore: nutrient and chemical runoff entering warming seas contributes to ocean acidification and the loss of the ocean's natural carbon storage capacity, showing how land, freshwater, and marine systems are tightly connected.

The freshwater change boundary represents one of the fundamental limits to Earth system stability, as water regulates energy flows, biogeochemical cycling, and the functioning of all living systems. This boundary is divided into two dimensions: "green water," which reflects soil moisture and vegetation water availability, and "blue water," which covers liquid water in rivers, lakes, and aquifers. Both are assessed to be beyond the safe operating space globally.

Human alteration of freshwater systems through damming, groundwater extraction, land conversion, and pollution has disrupted natural hydrological patterns. Reduced green-water availability due to deforestation and land degradation alters moisture release from soil and vegetation, disrupting regional rainfall, while overuse and contamination of blue-water resources threaten drinking water and aquatic ecosystems. These interlinked processes amplify drought/flood cycles, compromise carbon storage in soils and wetlands, and intensify feedback loops across climate, land, and biosphere boundaries.

Across freshwater systems, diffusing pollution from agriculture and industry compounds the stress on water quality. Agricultural expansion releases excess nitrogen and phosphorus into waterways, intensifying eutrophication, algal blooms, and oxygen loss. Industrial and synthetic chemicals – such as PFAS, persistent pesticides, and other long-lived compounds – add further stress, remaining in the environment for decades and accumulating in soils and food webs. Together, these contaminants disrupt nutrient cycles, threaten human health, and push the planetary boundaries for both biogeochemical flows and novel entities further beyond their safe limits.

The degradation of soils, wetlands, and freshwater ecosystems does more than compromise water quality and flood management; it also erodes the habitats that sustain biodiversity. As natural filters fail, pollutants and novel chemical compounds increasingly accumulate in rivers, lakes, and aquifers. These pressures directly stress species and ecosystems, pushing the planetary boundary for biosphere integrity and setting the stage for the biodiversity declines observed across the globe.

Restoring the integrity of freshwater systems is therefore not only an environmental imperative but a foundation for planetary resilience. Addressing water quality and quantity together – through sustainable land use, reduced chemical inputs, and ecosystem restoration – is essential to bring humanity back within a safe operating space for both people and nature.

At Summa, we view planetary boundaries as a guiding framework for sustainable growth. In our latest planetary boundaries report, we showcase how a systemic approach to targeted investments and portfolio management can contribute to pushing the boundaries back into safe operating spaces.

Read the report here

17.(PBScience, 2025)

From exposure to persistence: pollutants putting people's health at risk

Understanding the health risks of water pollution requires nuance. It's not just about what a substance is, but how it behaves, how people are exposed over time to combinations of these substances, and how this exposure interacts with other pathways such as food intake, skin and inhalation.

Toxicity varies widely. Some pollutants cause acute harm, immediate mortality, or organ failure, while others trigger chronic effects, disrupting metabolism, reproduction, or behavior over time.

Exposure is constant and often invisible. Pollutants enter daily life through drinking water, food, bathing, and air. Lead from aging pipes, pesticides in groundwater, pharmaceuticals in rivers, and PFAS in food chains are just a few examples. Chronic low-level exposure is rarely captured by current monitoring systems.

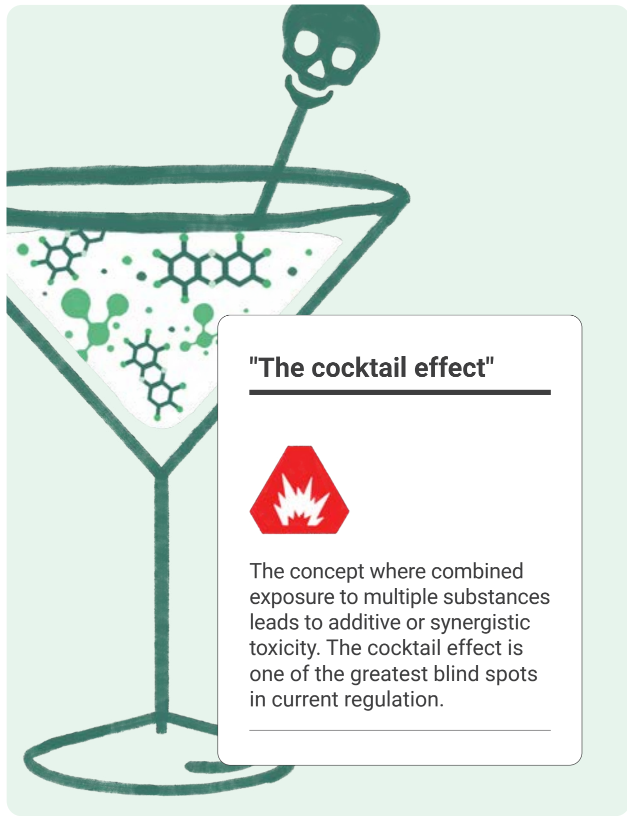
Transformation matters. Pollutants don't always degrade safely. Some break down into even more toxic by-products that are poorly understood and largely unregulated.

Bioaccumulation amplifies risk. Substances such as mercury, PFAS, and pesticides build up in fish and livestock, concentrating as they move up the food chain. Humans, at the top, carry the heaviest load, in blood, fatty tissues, and even breast milk.

Mixtures multiply harm. The "cocktail effect", where combined exposure to multiple substances leads to additive or synergistic toxicity, is one of the greatest blind spots in current regulation. Most frameworks assess pollutants in isolation, underestimating real-world risks. Together, the cocktail and accumulation effects define today's public health impasse: constant, compounding exposure that existing standards were never designed to address.

Growing research around the exposome concept highlights this complexity. It reframes health not as the result of single agents, but as the outcome of a lifetime of chemical, biological, and social exposures.[18] This perspective shows that water pollution is inseparable from public health, inequality, urban design, and everyday consumption.

Despite this understanding, mixture toxicity remains largely unaddressed in policy. Closing that gap requires integrated monitoring that links chemical data with biomonitoring and health outcomes. An exposome-informed approach that prioritizes prevention over remediation.



"The cocktail effect"

The concept where combined exposure to multiple substances leads to additive or synergistic toxicity. The cocktail effect is one of the greatest blind spots in current regulation.

18.(Wild, 2005)

Six pollutant families at the heart of the water health challenge.

Six pollutant families are driving systemic water risk across Europe. Of the twelve major chemical groups identified in European waters, these six stand out for their persistence, bioaccumulation, and direct links to serious health and ecosystem impacts. Their relevance is immediate and well-documented.

PFAS: and other Persistent Organic Pollutants (POPs) including PCBs, and dioxins, are found in everyday products like non-stick cookware, waterproof textiles, and industrial insulators. They are linked to cancer, endocrine disruption, liver and thyroid disease, immune system damage, and developmental toxicity. There is growing evidence of reduced vaccine response and metabolic disorders from chronic exposure.[19]

Pesticides: including herbicides, such as glyphosate, atrazine, and chlorpyrifos, widely used in agriculture, are associated with neurological disorders, reproductive harm, endocrine disruption, and increased cancer risk through both acute and chronic exposure. Their persistence in groundwater, even decades after being banned, and the cocktail effect of multiple residues acting synergistically, significantly magnify their toxicity.[20]

Nutrients: such as nitrogen and phosphorus from fertilizers and manure are essential for plant growth yet harmful in excess. They fuel algal blooms that choke waterways and release potent toxins, damaging aquatic life and posing direct health risks to people. In humans, these toxins can impair liver and nervous system function, while excessive nitrates in drinking water are known to cause methemoglobinemia (blue baby syndrome) in infants. Over time, sustained exposure to elevated nitrate levels has also been linked to higher rates of gastric, bladder, and thyroid cancers, as these compounds can transform into carcinogenic by-products within the body.[21]

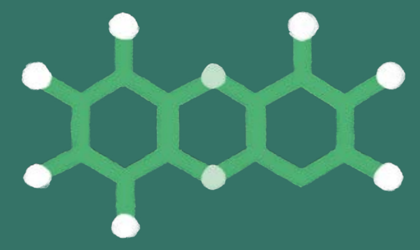
PPCPs: antibiotics, hormones, cosmetics, and disinfectants, disrupt endocrine and reproductive systems, and promote antimicrobial resistance, a major global health threat. They induce chronic stress responses and organ damage in aquatic life even at nanogram-per-liter levels. Persistent compounds such as diclofenac and carbamazepine are linked to kidney and liver toxicity and may contribute to metabolic and cardiovascular stress in humans over time.[22]

Microplastics: generated from tire wear, synthetic clothing, paints, and degraded packaging, act as physical irritants and as vectors for other pollutants, carrying toxic chemicals such as PFAS, pesticides, and heavy metals through air, water, and food chains. They have been detected in human blood, lungs, liver, kidneys, and brain, where they trigger inflammation, oxidative stress, and immune system disruption. As they fragment into nano plastics, they may cross cell membranes and interfere with genetic and hormonal regulation.[23]

Heavy metals: such as lead, mercury, and arsenic, originate from industrial emissions, mining, and legacy pollution. Toxic even at trace levels, they cause irreversible neurological impairment in children, kidney and cardiovascular damage, immune and developmental disorders, and multiple forms of cancer, with no safe level of exposure for some elements such as lead. Bioaccumulation in crops and fish makes food ingestion the dominant exposure pathway for many Europeans. Contaminated groundwater continues to threaten communities near legacy industrial and mining sites.[24]

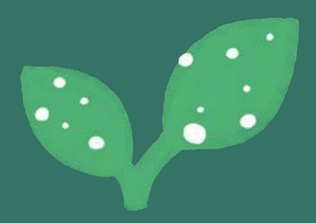
These pollutants are among the most resistant to conventional water treatment. Their persistence and toxicity make early detection and upstream prevention essential. Addressing them is not just a regulatory challenge; it's a public health and environmental imperative.

19.(World Health Organization, 2012) 20.(IARC Monographs, 2017) 21.(World Health Organization, 2017) 22.(World Health Organization, 2021) 23.(World Health Organization, 2019) 24.(World Health Organization, 2017)



PFAS
14% of European adolescents have blood concentration above safety line of 6ng/ml for PFOS and PFAS values[25]

Pesticide
Less than 1% of any pesticide spray actually reaches the target pest[26]



Nitrates
Europe has lost around half of its wetlands since 1970 – natural filters that can remove up to 55% of nitrates, 60% of phosphates, and over 90% of some pesticides[27]

PPCP
About 12,000 tons of pharmaceuticals enter Europe's waters and soils each year – two-thirds from human medicines in wastewater and one-third from veterinary antibiotics in livestock farming spread on fields[28]

Microplastics
Tires represent ~30% of microplastics released everyday into the environment[29]

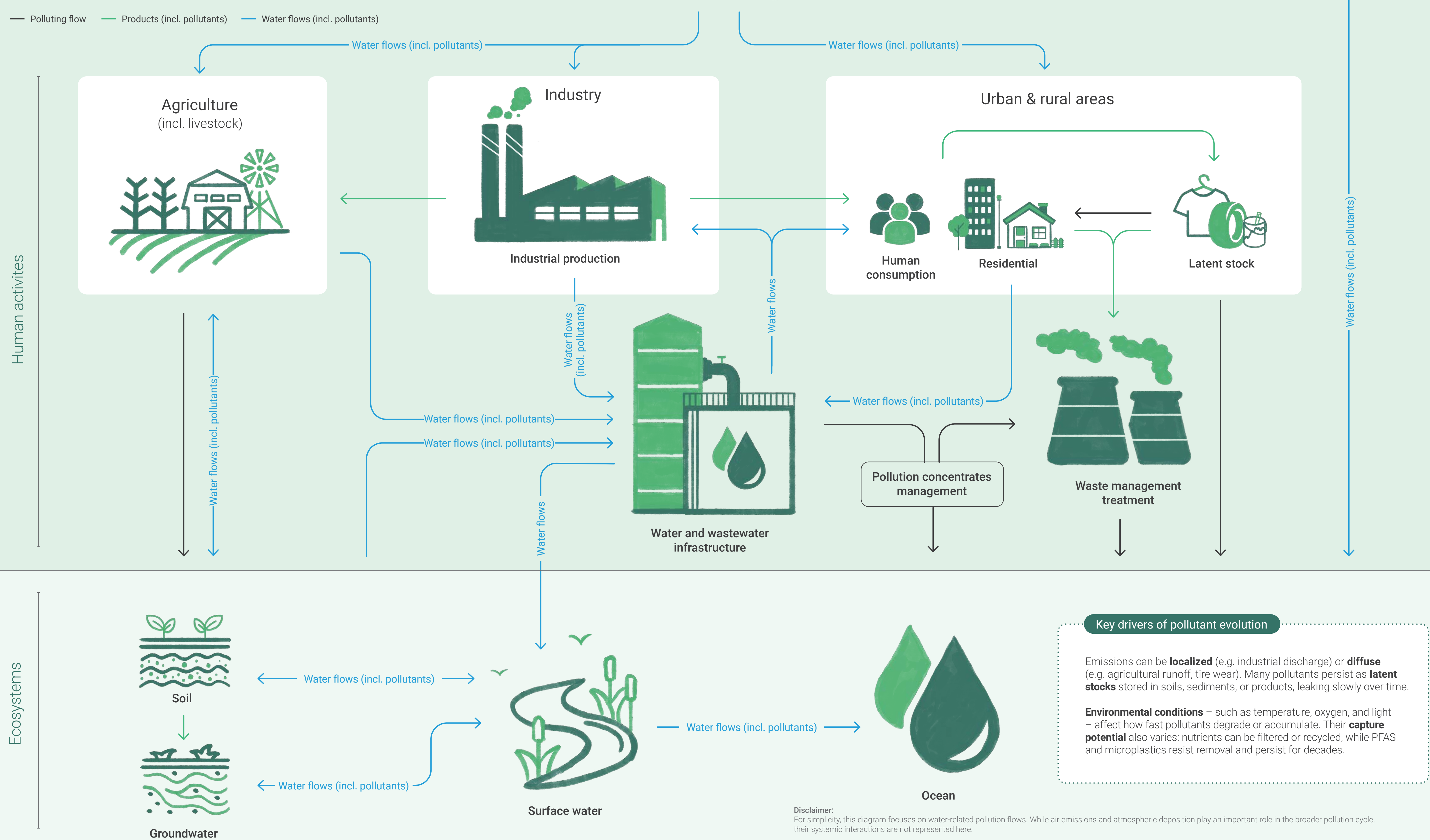
Heavy metals
Lead from ammunition is one of the key sources of heavy metal contamination in European soils[30]

25.(European Environment Agency 2025) 26.(Carvalho, 2017) 27. (Vymazal, 2007) 28.(Berger, 2025) 29.(European Commission, Joint Research Centre, 2024) 30.(BirdLife, 2025)

Investing in Europe's water health: from toxic to thriving

Figure 02
Dynamic map of the main flows of water pollution

Water pollution is a systemic challenge driven by human production and consumption, with pollutants circulating endlessly through the water cycle, transferring between soil, groundwater, surface water, and the atmosphere, and accumulating across ecosystems.



Key drivers of pollutant evolution

Emissions can be **localized** (e.g. industrial discharge) or **diffuse** (e.g. agricultural runoff, tire wear). Many pollutants persist as **latent stocks** stored in soils, sediments, or products, leaking slowly over time.

Environmental conditions – such as temperature, oxygen, and light – affect how fast pollutants degrade or accumulate. Their **capture potential** also varies: nutrients can be filtered or recycled, while PFAS and microplastics resist removal and persist for decades.

Disclaimer:
For simplicity, this diagram focuses on water-related pollution flows. While air emissions and atmospheric deposition play an important role in the broader pollution cycle, their systemic interactions are not represented here.

How key pollutants spread through waters

PFAS: persistent and rising
PFAS contamination is escalating across Europe, fueled by the continued use of so-called "next-generation" replacements (short-chain and emerging variants). Today, the PFAS family is including approximately 10,000 different chemicals and leak into the environment at every stage of their lifecycle, from production and everyday use to firefighting foams, textiles, landfills, and even sewage sludge. Europe is already carrying a massive hidden stock of PFAS in products consumed by its population, estimated at 1.4 to 2.3 million tons. Much of this legacy stock will inevitably leak into the environment, with release rates as high as 90% for fire-fighting foams[31] and up to 50% for textiles.[32]

Until recently, the Water Framework Directive only monitored PFOS (perfluorooctane sulfonate, one of the most widespread PFAS chemicals), and more than half of Europe's rivers, up to a third of its lakes, and almost all coastal waters exceeded its safety thresholds.[33] This gap is now partly addressed: in September 2025, EU institutions agreed on a major update expanding the scope from one substance to group limits covering the sum of 25 PFAS in surface waters and four PFAS in groundwater.[34] These additions represent meaningful progress, yet implementation will take time. Member States must prepare action plans by 2030 and reach compliance by 2039, with possible extensions until 2045.[35] This long lead time creates a clear lag between regulatory recognition and real-world impact, leaving PFAS pollution likely to worsen before it begins to decline.

> – The U.S. EPA has set a PFAS limit of 4 ng/L, reflecting both scientific evidence and legal obligations under the Safe Drinkiang Water Act. Studies by the National Academy of Sciences confirmed that PFOA and PFOS are carcinogenic, leading the EPA to establish a health goal of zero. The enforceable standard was then set as close to zero as technologically and economically feasible, marking one of the world's most stringent drinking water protections.
>
> **Bruno Pigott**
> Executive Director WateReuse Association (ex. US EPA)

Meanwhile, drinking-water standards for PFAS have remained unchanged. Under the EU Drinking Water Directive, the sum of 20 priority PFAS must not exceed 100 ng/L, while a broader safeguard limit of 500 ng/L applies to all PFAS combined. The US has adopted a limit of just 4 ng/L for PFOA and PFOS individually. In France, around half of tap water samples would exceed Denmark's unilateral 2 ng/L limit for the sum of four PFAS – the strictest in Europe – while remaining compliant with EU thresholds.[36] This shows how widely safety standards differ within the EU, leaving millions exposed to levels considered unsafe elsewhere.

Pesticides: widespread but partially controlled
In 2022, the EU sold around 320,000 tons of pesticide active substances.[37] Yet, less than 1% reaches its intended target, while the remainder disperses into soils, waterways and the wider environment.[38] While many modern products degrade relatively quickly, the EU still allows the use of pesticides classified as hazardous to health and the environment. At the same time, legacy chemicals such as atrazine continue to persist in groundwater decades after being banned.[39] The result is widespread contamination: 10–25% of river sites and 5–10% of groundwater sites exceed safety thresholds.[40]

This pollution is not only chemical, but also ecological. Pesticide contamination drives biodiversity loss, with concentrations on around half of EU cropland already high enough to cause harm. The EEA reports that freshwater biodiversity has been deteriorating for decades in polluted areas.[41] Human exposure is low overall, but some local contamination above safety limits still occurs. Despite a 10% drop in sales over the last decade and regulatory bans that have cut overall pesticide risk by nearly half since 2015,[42] Europe remains locked into a system where hazardous pesticides continue to enter water and food chains.

Nutrients: essential but leaching
In 2023, European farmers used about 9 million tons of nitrogen and 1 million tons of phosphorus fertilizers,[43] while other sectors added another 2 million tons of each.[44] Much of these valuable nutrients end up in wastewater and soils. Once released into the environment, nitrogen and phosphorus trigger eutrophication in rivers, lakes, and coastal waters, fueling algal blooms, depleting oxygen, and causing severe biodiversity loss.

Nitrates move easily through the environment: about 30% run off into rivers and lakes,[45] and another 15% seep into groundwater.[46] As a result, nitrate levels in Europe's freshwaters have stayed at around 24 mg/L since 2000, showing how these nutrient stocks persist year after year.[47] Phosphates are less mobile, with little leaching to water, but they build up in soils as "inherited phosphorus".[48]

Recovering and reusing lost nutrients could transform a costly pollutant into an economic resource. The nutrient load in European manure alone carries an estimated value of EUR 10.7 billion per year if recovered and used as fertilizers.[49] Extending similar recovery approaches to wastewater and other nutrient-rich streams would further reduce dependence on imported fertilizers and phosphorus abstraction abroad, lower energy use, and accelerate the transition toward a circular nutrient economy.

PPCPs: rising and resistant
Europe uses around 29,000 tons of active pharmaceutical and Personal Care Products (PPCPs) ingredients each year, with ~24,000 tons for human use and ~4,000 tons for veterinary use.[56] Roughly 17,000 tons are excreted or discarded in active form, while the rest are degraded, treated, or safely disposed of. Most residues from human medicines enter sewers and flow to wastewater treatment plants. Veterinary drugs add further pressure: antibiotics in manure often bypass treatment entirely and are spread directly on fields, contaminating soils and nearby water bodies. In total, around 12,000 tons of active pharmaceutical substances enter Europe's waters and soils each year.[57]

Microplastics: diffuse and exploding
Europe releases large quantities of microplastics each year, mostly from everyday sources such as tire wear, paints, and textiles.[50] Packaging adds additional pressure as it breaks down into fragments. Much of this pollution reaches the environment through diffuse pathways such as road runoff and the spreading of sludge on fields.[51]

According to estimates by the European Environment Agency, up to 1.8 million tonnes of microplastics are unintentionally released into the European environment every year.[52] This represents roughly three times the quantities of microplastics observed floating at the ocean surface, which account for only a small fraction of total releases, as most particles sink but remain accessible to marine life.[53]

Microplastics break down into smaller pieces, but they do not biodegrade. Once released, they accumulate everywhere: roughly half end up in soils, 40% in water, and 10% in the air.[54] Overall, the EU is already carrying a stock of around 16 million tons of microplastics across soils, waters, and the atmosphere. The monitoring is patchy, but evidence shows they carry toxins and pathogens.[55]

Beyond their physical persistence, microplastics act as vectors for other pollutants, binding and transporting toxic chemicals such as PFAS, pesticides, heavy metals, and pathogens through ecosystems and into the food chain. Yet monitoring remains patchy, and the full extent of their impacts on human and ecosystem health is still emerging.

Heavy metals: declining but legacy-driven
Emissions of toxic metals have declined sharply since the mid-20th century, driven by regulatory measures. Lead is down 44%, mercury 53%, and cadmium 39% between 2005–2022.[58] Cleaner fuels and tighter emissions control have reduced releases from industrial and energy sources. Yet, legacy contamination remains a major challenge. Lead from hunting ammunition is still widely used because it is dense, inexpensive, and easy to mold. It accounts for around 44,000 tons of releases each year,[59] while mercury from coal and cadmium from smelting continue to add pressure on ecosystems.

Historic pollution adds to the burden: lead in roadside soils, cadmium in fertilizers, and mercury hotspots near mines and landfills continue to seep into water. Europe's soils alone hold some 44,800 tons of mercury,[60] and mercury is still detected in nearly half of surface waters.[61] Remediation has been slow: by 2016, only 8.3% of contaminated sites had been cleaned up, with heavy metals found in about 60% of cases.[62] The challenge has shifted from cutting new emissions to managing the vast stocks that persist in soils and sediments.

Ecosystems, more broadly, are not just habitats; **they are vital infrastructure.** They provide water purification, flood protection, food provision, pollination, carbon storage, and recreation.

The European Commission estimates that these services together are worth more than **EUR 230 billion annually**, comparable to the economic output of agriculture and forestry.

31.(European Chemical Agency, 2023) 32.(CEC, 2017) 33.(European Environment Agency, 2024) 34.(European Parliament, 2025) 35.(European Parliament, European Council, 2025) 36.(Gervais, 2025) 37.(Eurostat, 2024) 38.(Carvalho, 2017) 39.(Le Monde, 2025) 40.(European Environment Agency, 2024) 41.(European Environment Agency, 2024) 42.(Global 2000, 2022) 43.(Eurostat, 2025) 44.(European Sustainable Phosphorus Platform, 2019) 45.(IPCC, 2006) 46.(Environmental Pollution, 2021)

47.(Our World in Data, 2023) 48.(Luo, et al., 2024) 49.(European Commission, 2024) 50.(European Environment Agency, 2025) 51.(TNO, 2022) 52.(European Environment Agency, 2025) 53.(National Geographic Society, 2015) 54.(European Environment Agency, 2022) 55.(Kandasubramanian & Issac, 2021) 56.(EEB, 2025) 57.(Berger, 2025) 58.(European Environment Agency, 2024) 59.(BirdLife, 2025) 60.(European Commission, 2025) 61.(European Environment Agency, 2018) 62.(European Environment Agency, 2024)

Compounding pressures: ecosystems, biodiversity and human health

Water pollution in Europe is compounded by climate extremes, ecosystem degradation, and persistent legacy contamination.

These pressures undermine the capacity of natural systems to degrade pollutants, amplifying risks to biodiversity, and illustrating that when ecosystems falter, so does planetary and human health.

Climate strikes twice: how droughts and floods amplify pollution

Climate change is no longer a distant risk; it's actively reshaping Europe's water systems. As temperatures rise and precipitation patterns shift, droughts linger, shrinking rivers into slow-moving channels where pollutants concentrate. Nutrients, pesticides, metals, and emerging contaminants spike to levels 20–60% above normal, suffocating aquatic life and triggering toxic algal blooms.[63] Floods bring the opposite challenge. Intense rainfall overwhelms wastewater infrastructure, pushing untreated or partially treated water into rivers. Under future scenarios, overflow volumes could rise by up to 256%, forcing stormwater and sewage into the same overburdened pipes.[64] The sudden rush dilutes the waste and pushes it through treatment stages too quickly to be properly cleaned. The sheer force strains aging sewer networks, causing leaks and breakages.

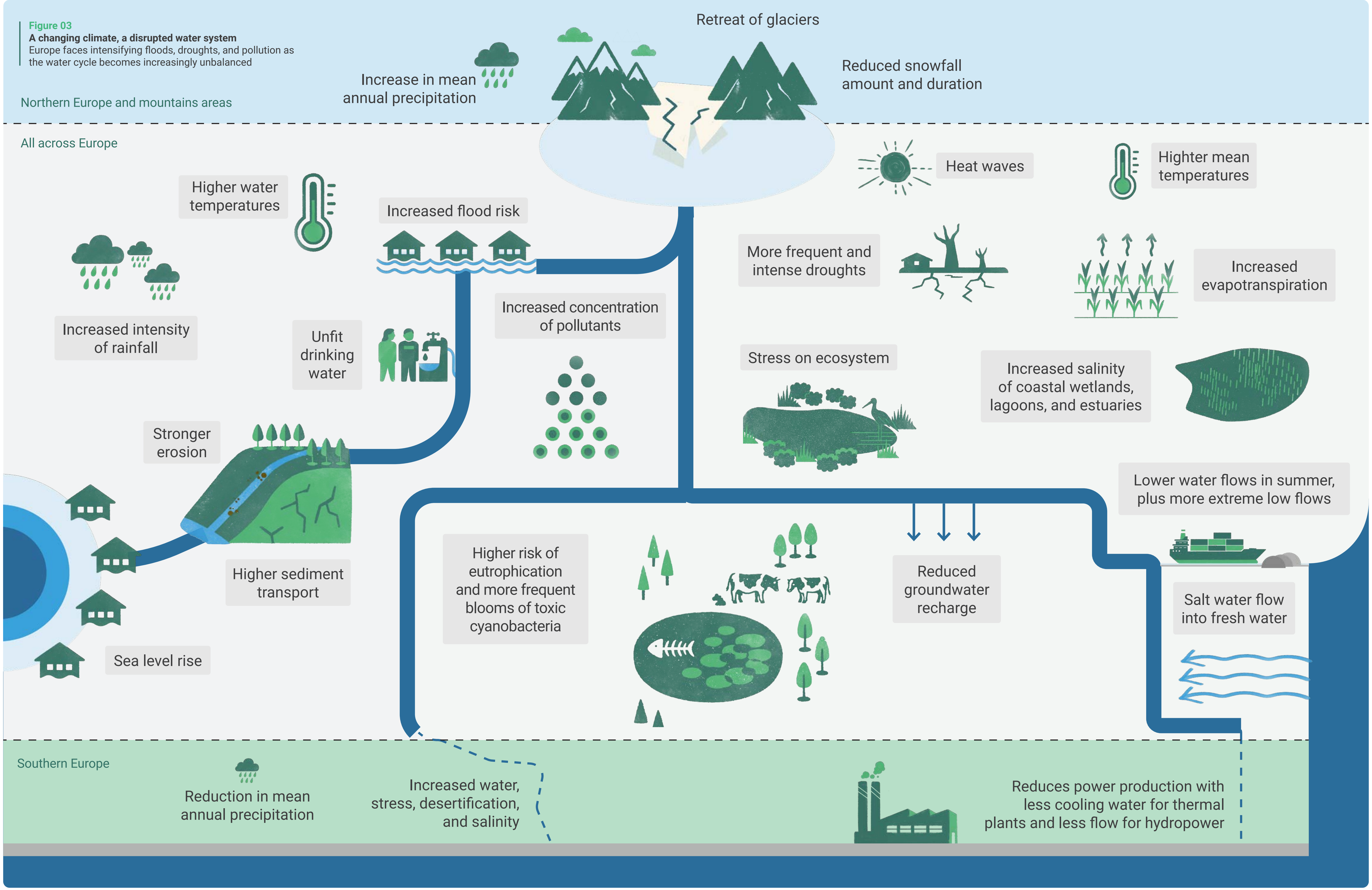
Meanwhile, water temperatures are rising steadily. Since 1900, rivers and lakes have warmed up by 1–3°C, reducing oxygen levels and accelerating harmful algal blooms.[65] Projections from the Intergovernmental Panel on Climate Change (IPCC) under its Representative Concentration Pathway (RCP) scenarios 4.5 and 8.5 show a up to 70% probability of declining groundwater levels in Sweden and Finland by mid-century. By 2040, one third of European rivers may become too warm for sensitive species during summer. Warmer seas create "dead zones" while shifting plankton populations threaten biodiversity and fisheries.

Even winter is changing. Warmer seasons lead to rapid snowmelt, flushing road salts, heavy metals, and persistent organic pollutants (polycyclic aromatic hydrocarbons, or PAHs) into waterways in a single, concentrated pulse.

63. (Blunke, Moritz, & Brack, 2019) 64.(Rodriguez, Fu, Butler, Yuan, & Cook, 2024) 65.(European Environment Agency, 2008)

Investing in Europe's water health: from toxic to thriving

Figure 03
A changing climate, a disrupted water system
Europe faces intensifying floods, droughts, and pollution as the water cycle becomes increasingly unbalanced



The cost of losing nature's water filters

Europe's natural ability to clean its waters is being steadily dismantled. Artificial surfaces now cover parts of the continent's land, sealing off soils and stifling the microbial life that would otherwise help break down pollutants, while also accelerating runoff.[66] At the same time, wetlands are critical ecosystems that have shrunk by around 50% across Western, Central, and Eastern Europe since 1970, driven by urban expansion, agricultural drainage, and infrastructure.[67]

This loss has real consequences. Wetlands can remove 40–55% of nitrates, 40–60% of phosphates, and over 90% of certain pesticides.[68] They also store floodwaters, recharge aquifers, and support up to 40% of global species. When these natural systems are damaged, pollutants flow freely into rivers and lakes, while floodwaters that would once have been absorbed and slowed now overflow into towns and farmland, amplifying environmental and economic damage.

Ecosystems, more broadly, are not just habitats; they are vital infrastructure. They provide water purification, flood protection, food provision, pollination, carbon storage, and recreation. The European Commission estimates that these services together are worth more than EUR 230 billion annually, comparable to the economic output of agriculture and forestry. Water purification alone delivers nearly EUR 60 billion in avoided treatment costs each year, while flood protection contributes another EUR 18 billion in prevented damages.[69] By naturally filtering and slowing water flows, Europe's wetlands and floodplains save governments and citizens billions in avoided infrastructure and insurance costs every year.

These systems are deeply interconnected. When ecosystems are overloaded with nitrogen, they may still filter water, but at the cost of biodiversity loss and reduced recreational quality. In other words, forcing ecosystems to overperform in one area reduces their capacity to deliver in others. By restoring ecosystems, we unlock co-benefits. Wetlands that retain nitrogen also recharge aquifers, buffer floods, store carbon, and sustain habitats.

The loss of wetlands and healthy soils is not just ecological. It is an erosion of natural capital that safeguards water quality, biodiversity, climate resilience, and Europe's long-term prosperity. The loss of these natural systems is also a signal that we are operating beyond safe environmental limits, with cascading consequences for planetary health.

Biodiversity in decline

The first signal of this erosion is in Europe's biodiversity. Diffuse pollution is placing chronic pressure on rivers, lakes, and aquifers, steadily weakening the ecosystems they sustain. Unlike the point-source discharges of the past, today's pollution is constant, widespread, and chemically complex. Pollutants often co-exist in the same rivers, lakes, and aquifers. This creates a persistent background haze of contamination that wildlife is exposed to year-round.

The effects are subtle but cumulative. Chronic exposure impairs metabolism, disrupts reproduction, and alters behavior, weakening populations, and destabilizing food systems. Native species lose ground to more pollution-tolerant ones, shifting entire ecosystems. The toll is stark: migratory freshwater fish populations have collapsed by 93% since 1970,[70] only 15% of EU habitats are in good condition.[71] Widespread pesticide use has driven steep declines in insects, including bees and wasps that are crucial for pollination, undermining the food base for birds, amphibians, and other species.[72]

Invisible threats to human health

The impacts extend beyond nature. Water pollution affects people both directly, through bioaccumulation, and indirectly, by degrading the ecosystems we rely on. Often called an invisible killer, it rarely causes immediate harm. Instead, it causes long-term damage that builds silently. Across Europe, most people carry contaminants in their bodies. A biomonitoring study conducted in five countries found that 84% of participants had at least two pesticides in their system, with children showing the highest levels.[73] In Sweden, communities exposed to PFAS-contaminated drinking water have reported measurable thyroid disruptions.[74] In the US, exposure to the pesticide atrazine, banned in the EU, has been linked to reduced fertility and developmental challenges.[75]

According to the Global Burden of Disease 2021 study by the Institute for Health Metrics and Evaluation, pollution across air, water, and soils remains one of the world's most significant health threats. Exposure to environmental and occupational pollutants was responsible for more than 12 million premature deaths globally in 2021, making pollution the second leading risk factor for mortality after high blood pressure. Air pollution alone accounted for about 8.1 million deaths, while unsafe water and sanitation caused around 1.4 million deaths, lead exposure about 1.5 million, and occupational pollutants – including hazardous waste, carcinogens, and contaminated soils – nearly 1 million more. These deaths are driven by chronic diseases linked to polluted environments, ranging from heart and respiratory conditions to cancers and neurological disorders. It underlines that human health itself is intertwined with planetary health. When environmental limits are breached, so too are the biological thresholds that sustain us.[76]

The message is clear: pollution isn't just "out there" in rivers and lakes. It's in our blood, and in the water and soils that will shape the health of future generations.

Figure 04
Main exposure route for the six pollutant families

	Water (% of exposure)	Food (% of exposure)	Dermal (% of exposure)
PFAS	15%	85%	0%
Pesticides & nutrients	10%	90%	0%
PPCPs	5%	15%	80%
Microplastics	80%	19%	1%
Heavy metals	20%	80%	0%

Pollution on the plate: how food became the main exposure pathway

For most pollutants, food is now the primary route to the human body. Over 90% of pesticide exposure in Europe comes from what we eat.[77] 85% of PFAS intake is linked to crops, fish, and livestock.[78] Heavy metals follow the same pattern: 80–90% of cadmium and mercury exposure comes through food, even when the contamination starts in water.[79] Nitrates, while present in some drinking water, are more commonly consumed via vegetables and processed meats.

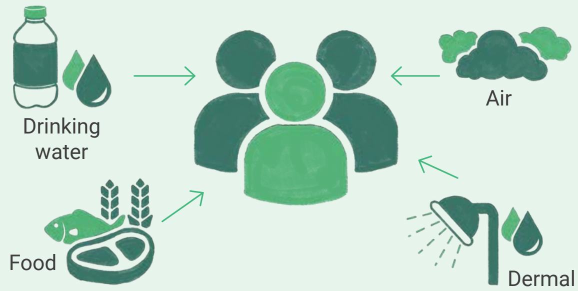
There are exceptions. Microplastics are primarily ingested through water, especially bottled water, with seafood as a secondary source. For personal care chemicals such as phthalates and parabens, skin contact is the main pathway. But these are outliers. For most pollutants, food is the dominant and invisible pathway, weaving environmental contamination into daily routines. Yet the common denominator is water.

Figure 05
Routes of human exposure to water pollution

What starts as an environmental burden becomes a public health crisis – as scientists now estimate that up to

80%

of health determinants are environmental, **not hereditary**



It may not be the original source of pollution, but it is the recipient and carrier – the medium that transports pesticides, fertilizers, and industrial chemicals into soils, crops, and aquatic life. When water becomes contaminated, the entire food system absorbs that contamination, turning what should nourish us into a secondary exposure route. Food, in that sense, becomes a reflection of polluted water.

Not all communities are equally exposed. In pollution hotspots, such as areas near PFAS production sites or nitrate-contaminated aquifers, drinking water alone can account for over half of total exposure.[80] These disparities are shaped not just by geography, but by regulatory gaps and historical legacies. Once inside the body, pollutants behave differently. Some, including nitrates and many pharmaceuticals, are water-soluble and eventually excreted. Others, such as PFAS, dioxins, and certain pesticides, are fat-soluble, persistent, and can accumulate in organs for decades. Some even cross the placenta or enter breast milk.

The body's detox systems were never designed to handle this scale or complexity of synthetic chemicals. For many substances, prevention at the source is the only real protection. Addressing water pollution is therefore not just an environmental issue; it's a public health imperative. It is a matter of equity, and a step toward breaking the cycle of toxic legacy that some communities carry without choice.

66.(European Environment Agency, 2024) 67.(European Commission, 2022) 68.(Vymazal, 2007) 69.(European Commission, 2021)70.(World Wildlife Fund, 2020) 71.(European Environment Agency, 2023) 72.(European Environment Agency, 2020)

73.(European Environment Agency, 2023) 74.(Li, Xu, Fletcher, Scott, & Nielsen, 2021) 75.(Rinsky, Hopenhayn, Golla, Browning, & Bush, 2012) 76.(Institute for Health Metrics and Evaluation, 2021) 77.(European Environment Agency, Pesticides in food, 2025) 78.(European Food Safety Authority, 2020) 79.(United Nations Environment Programme, 2010) 80.(DeLuca, Minucci, Mullikin, Slover, & Cohen Hubal, 2022)

Pollution waves mirroring human activity

Economic expansion has driven successive waves of pollution.

Europe's water quality is deeply intertwined with its economic trajectory. Each wave of industrial, agricultural, and urban expansion has left a lasting chemical impact on rivers, lakes, and aquifers.

The 19th-century Industrial Revolution introduced coal-fired factories, dense urban settlements, and uncontrolled discharges of sewage and industrial waste. Rivers became carriers of industrial waste and urban sewage spreading contaminants from tanneries, textile mills, and metalworks, triggering routine outbreaks of cholera and typhoid.

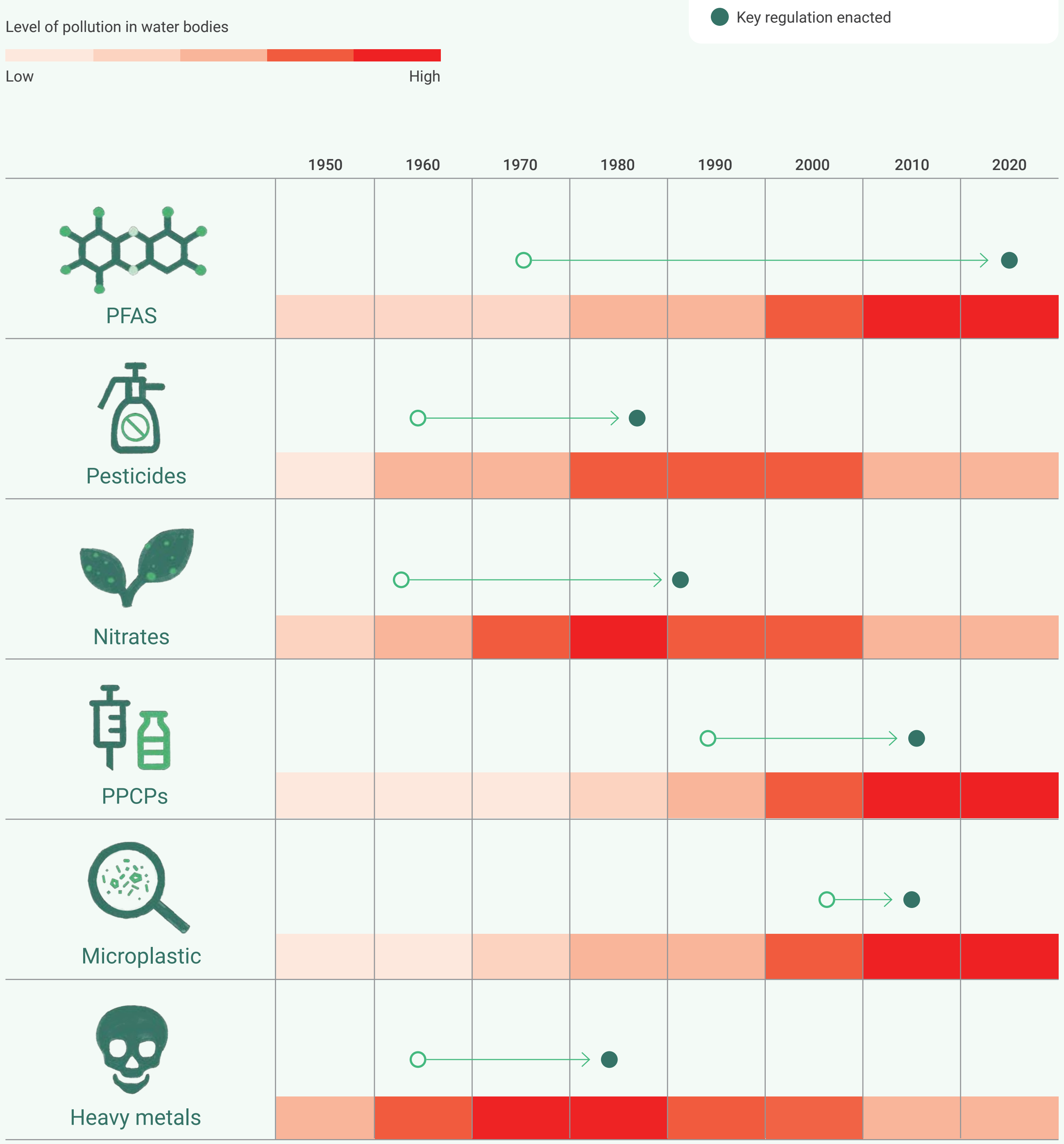
By the mid-20th century, post-war economic growth brought mass mechanization, chemical-intensive agriculture, and widespread use of synthetic compounds. As GDP surged, so did discharge heavy metals, nutrient runoff, and unregulated chemicals, from solvents to plastics.

Even as environmental awareness grew in the 1970s and landmark policies emerged, the legacy of decades of unchecked emissions was already embedded in soils, sediments, and aquifers. Many pollutants including lead, mercury, and PFAS remain chemically intact for decades or longer, slowly leaching into water supplies and food chains.

This has created a persistent "pollution time lag," where the full impact of past emissions continues to unfold. Europe's economic progress has come with a long tail of environmental cost, one that demands forward-looking investment, regulation, and innovation to reverse.

A persistent policy delay: regulation trails pollution by at least two decades – allowing contamination to deepen before action begins

Figure 06
The pollution policy gap: decades from risk recognition to regulation



A crisis where regulation chases pollution instead of preventing it

Europe's water systems are under increasing strain, driven by a combination of legacy pollution, emerging contaminants, and regulatory delays. Historically, water regulation has been reactive, introduced only after ecological damage was already done. For example, heavy metal concentrations in European rivers peaked between the 1960s and 1980s, long before the EU's Dangerous Substances Directive began reversing the trend. By then, contaminated sediments had already accumulated, continuing to release pollutants during floods and disturbance, a legacy burden that persists today.[81]

PFAS contamination follows a similar trajectory. Their production and emissions have surged over recent decades, prompting regulatory action such as the 2023 REACH proposal to restrict certain PFAS chemicals.[82] Yet, their extreme persistence and widespread use mean they remain a long-term challenge. Contamination has already been confirmed at over 23,000 sites across Europe.[83]

Microplastics are also on the rise. In 2019 alone, up to 1.8 million tons of microplastics were unintentionally released into Europe's environment, with annual growth projected at 7–9%.[84] Pharmaceuticals and personal care products are contributing to a growing chemical cocktail in waterways, with chronic low-dose exposure becoming a public health concern, especially as antimicrobial resistance spreads.

This "late recognition, delayed action, slow phase-out" cycle means Europe is constantly managing a backlog of legacy contamination while new pollutants enter the market faster than monitoring and regulation can adapt. For emerging contaminants like pharmaceuticals and microplastics, there is still no binding EU-wide monitoring, leaving potential threats to accumulate largely unchecked.

The net result is a regulatory treadmill: each pollutant wave is addressed only after it has already entrenched itself in the environment, forcing long-term, resource-intensive remediation. In many cases, it leads to permanent loss of ecological quality.

Regulation is evolving, but still too slow and siloed

The EU's water laws are built on a layered framework of directives, with the Water Framework Directive (WFD) at the core. Since 2000, it has required Member States to manage river basins holistically and restore all waters to "good chemical and ecological status" by 2027. Supporting directives target groundwater, drinking water, wastewater, nitrates, and bathing water. Implementation, however, varies widely. France uses basin agencies funded by pollution fees, the Netherlands relies on elected Water Boards, and Norway and Switzerland apply EEA-aligned laws. Despite these structures, there are significant compliance gaps. The 2025 Environmental Implementation Review warns that full compliance with the WFD's objectives by 2027 will not be achieved with the current measures, and that delays in tackling nutrient and pesticide pollution continue to undermine progress.[85]

Recent updates have been promising but overdue. The 2020 Drinking Water Directive introduced the world's first group limit for 20 key PFAS compounds and a dynamic watch list mechanism for emerging contaminants ensuring regular updates as scientific evidence evolves. The 2024 Urban Wastewater Treatment Directive (UWWTD) expanded coverage to all settlements over 1,000 people, tightened nutrient removal. It introduced extended producer responsibility: from 2028, pharmaceutical and cosmetic companies must fund advanced treatment technologies such as ozonation and activated carbon.

In 2025, the revision of the Water Framework and Groundwater Directives updated environmental quality standards (EQS), adding the sum of 25 PFAS, selected pharmaceuticals, and a group target for the sum of selected pesticides. This expands the number of regulated contaminants under the WFD from 45 to around 70, the largest update since its adoption. The revision also introduces systemic coverage to detect the combined effects of all chemicals in water through effect-based monitoring. It tasks the Commission with developing a Joint Monitoring Facility and examining an extended-producer-responsibility scheme to help fund national and EU-level monitoring programs.[86]

Other measures include:

- A ban on intentionally added microplastics is being phased in, alongside product-specific rules such as France's requirement for fiber traps in all new washing machines from 2025[87]
- Five Member States and Norway are pushing for a REACH restriction – the EU's Regulation on the Registration, Evaluation, Authorization and Restriction of Chemicals, which governs the production and use of chemical substances – to phase out most non-essential PFAS by 2035[88]
- The Green Deal targets a 50% reduction in pesticide use and risk by 2030, and a 50% cut in nutrient losses. This is backed by tighter fertilizer accounting and livestock buyouts in countries like the Netherlands[89]

81.(Royal Society of Chemistry, 2020) 82.(REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) is the EU's main chemical safety legislation, designed to control hazardous substances by limiting their manufacture, sale, and use) 83.(The Forever Pollution Project, 2025) 84.(European Environment Agency, 2025) 85.(European Commission, 2025) 86.(European Parliament, European Council, 2025) 87.(Susnjara, 2021) 88.(HEJ, 2025) 89.(NL Times, 2023)

- Pharmaceuticals are being added to the EU priority list, with Swiss pilots showing 80–90% removal through upgraded effluent treatment[90]
- Heavy metal emissions have dropped by over 40% since 2005, but mercury still exceeds biota standards, prompting sediment remediation[91]

The EU has achieved one of the world's most comprehensive frameworks for water protection, expanding pollutant coverage and introducing advanced monitoring tools. These reforms mark real regulatory progress and growing political recognition of water's role in health and resilience. Yet, deadlines continue to stretch far into the future, and the practical enforcement of these measures differ widely between Member States. Negotiations have also reflected the influence of economic and industrial interests. Debates over cost-sharing and feasibility have shaped key provisions, including PFAS carve-outs and disputes over who should finance the advanced treatment upgrades required under the UWWTD. In several cases, new laws have strengthened objectives on paper while postponing concrete results in practice.

The 2025 revision of the Water Framework and Groundwater Directives highlights the tension between ambition and feasibility. Member States secured longer transition periods and greater discretion over implementation.

Existing standards will be tightened only by 2033 and new substances, such as the expanded PFAS group, selected pharmaceuticals, and pesticides, will take effect from 2039, with possible extension to 2045.

The deal also weakens the WFD's non-deterioration rule by permitting temporary declines in status and the transfer of polluted sediment or water between bodies, provided that total pollution does not increase. Defenders call this pragmatic for sediment and infrastructure management, while critics warn it opens loopholes that undermine the Directive's core safeguard. The long timelines and new exemptions show how political compromise continues to delay measurable gains in water quality despite rising legal ambition.

The Commission emphasizes that stronger enforcement is needed, as the implementation gap is costing the EU at least EUR 180 billion annually in health, clean-up, and ecosystem losses.[92]

Looking ahead, regulation is set to evolve along four lines:

1. The Water Resilience Strategy (2025) will integrate scarcity, quality, and restoration, linking subsidies and permits to water goals
2. Economic instruments such as extended producer responsibility could expand to tire wear and fertilizer producers, with refined basin-level pollution taxes
3. Digital monitoring will shift to real-time, open data using biosensors
4. The Nature Restoration Law will remove 25,000 km of river barriers (man-made obstructions preventing the natural movement of species, sediments and nutrients) by 2030, supporting biodiversity and pollutant dilution[93]

By

2030

European Green Deal's Zero Pollution Action Plan

Member States must deliver real reductions: –50% nutrient loss, –50% pesticide use and risk, –30% microplastic release

By

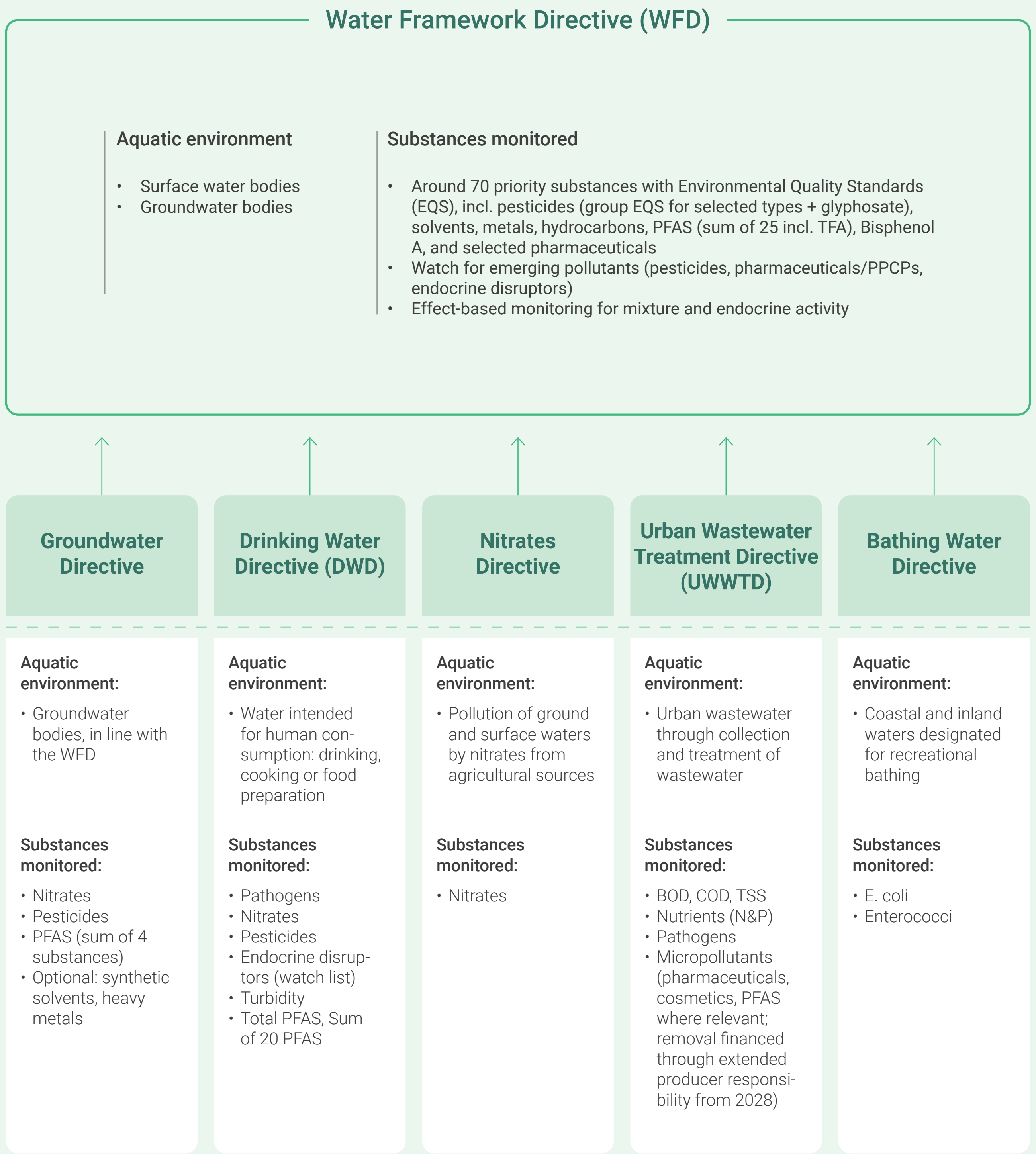
2050

European Green Deal's Zero Pollution Action Plan

The vision is zero-pollution waters that support biodiversity, climate resilience, and a toxin-free economy[94]

90.(FOEN, 2012) 91.(European Environment Agency, 2024) 92.(European Commission, 2025) 93.(Directorate-General for Environment, 2024) 94.(European Environment Agency, 2024)

Figure 07
Main EU water legislation and substances monitored



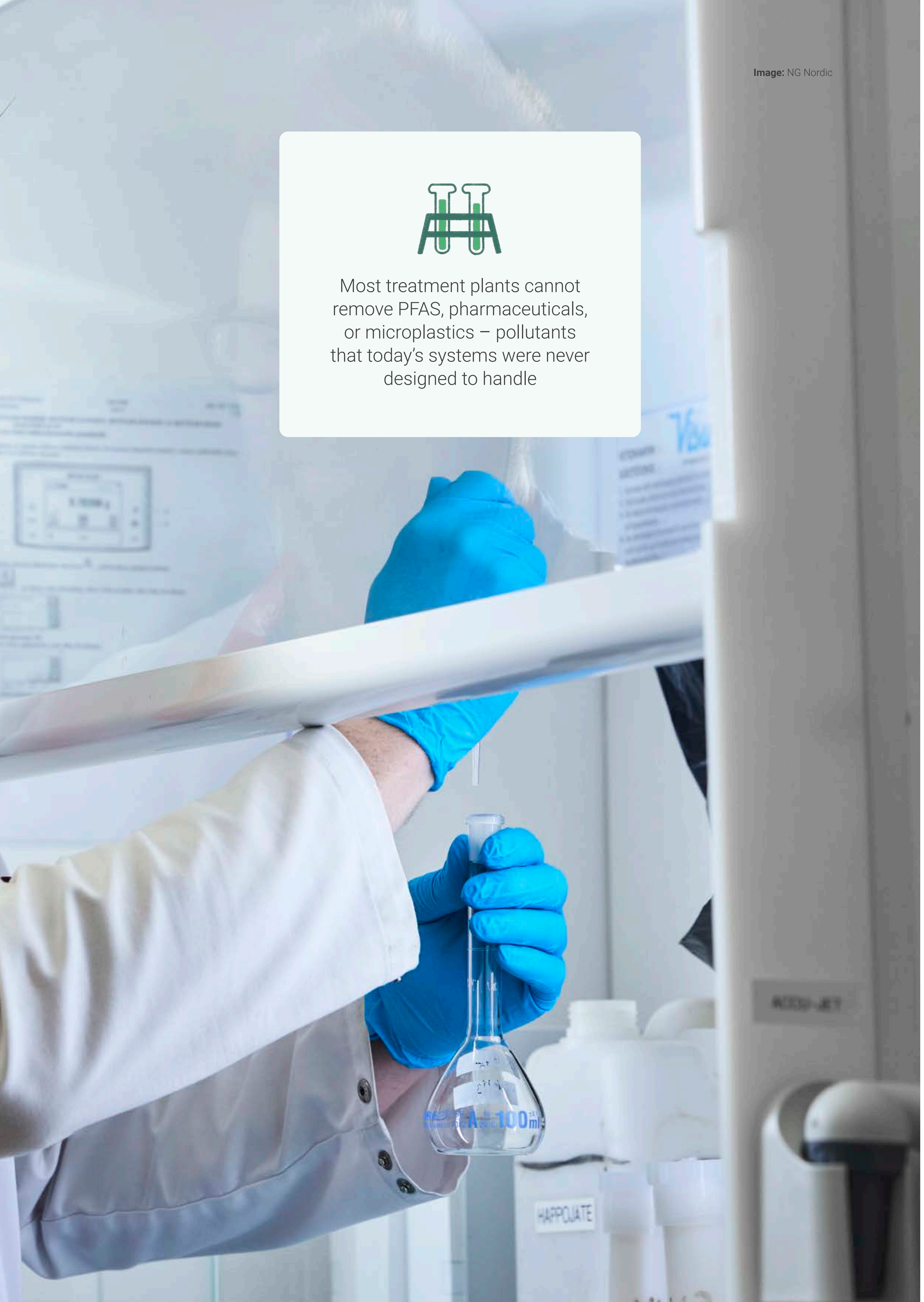


Image: NG Nordic

Most treatment plants cannot remove PFAS, pharmaceuticals, or microplastics – pollutants that today's systems were never designed to handle

A system unfit for today's pollution reality

Europe's water systems lag behind modern pollution challenges. Most treatment plants cannot remove PFAS, pharmaceuticals, or microplastics, while funding and enforcement gaps hinder upgrades.

Public awareness and trust in tap water remain low, and the polluter pays principle is inconsistently applied. This leaves Europe's water sector under-financed, technologically outdated, and unprepared for climate and chemical pressures.

Monitoring falling short for emerging pollutants

Europe's water monitoring still lags far behind the scale and diversity of pollution. While thousands of chemicals are in use, EU law routinely tracks only a fraction. Many emerging contaminants such as PFAS, microplastics, pharmaceuticals, and newer pesticides are still rarely monitored, and the combined cocktail effect of multiple pollutants is unassessed.

Monitoring is skewed toward large rivers, under-representing small streams where concentrations, especially of pesticides, can be far higher. Chronic effects are also harder to detect than acute toxicity, adding uncertainty to risk assessments.

The EU's watch list mechanism was designed to close these gaps, but progress is slow. Substances can take years to be added, and enforcement of monitoring requirements is patchy.

Despite advances in detection technology, coverage, timeliness, and mixture risk assessment remain weak, leaving Europe without a complete picture of the pollution burden in its waters. Today's systems can measure pollutants at the nano-molecule level, but they rarely capture how these substances – alone or in mixtures – translate into real-world toxicity or health effects. This gap between exposure measurement and health understanding lies at the heart of the exposome challenge: the difficulty of tracing cumulative, low-dose exposures and cocktail effects through to disease outcomes.

Treatment technologies are not keeping up with modern pollutants

Most of Europe's water and wastewater treatment systems were designed for a different era; one focused on organic waste, not today's complex chemical mix. PFAS, pharmaceuticals, pesticides, and microplastics are toxic at extremely low concentrations and often pass through conventional treatment untouched.[95]

Advanced technologies such as activated carbon, membrane filtration, ion exchange, and advanced oxidation processes (AOP) can remove more of these substances. No single method can address all pollutants, meaning multiple systems must be combined, raising both costs and complexity.

95.(Treating micropollutants in wastewater, 2024)

Water pollution is a public health issue, but public awareness remains low

Nearly half of Europeans feel uninformed about water issues, even though 70% express concern about scarcity.[96] The disconnect is dangerous. Water contamination is often invisible and slow to show. PFAS and other persistent chemicals raise cancer and hormone risks, but symptoms may take years to appear. Banned pesticides such as atrazine can linger in groundwater for decades, with concentrations rising as aquifers shrink.[97]

Unlike air and climate, water has long been sidelined in public campaigns; only in 2024 did the EU launch its first continent-wide effort #WaterWiseEU, with limited reach.[98] The result: water pollution remains a silent killer, eroding health and ecosystems long before the damage becomes visible.

Bottled water can be up to

3,500

times more damaging to ecosystems than tap water due to plastic waste, carbon emissions from transport, and high energy demands for bottling

Although the public tends to prioritize water scarcity over water quality, the two are inseparable. Pollution shrinks the share of water that is safe and usable, effectively deepening scarcity. By improving water health, Europe not only protects ecosystems and public health but also expands the availability of clean, reliable freshwater, strengthening resilience against shortages.

Trust gap: tap versus bottled water

Despite 98% of EU tap water meeting safety standards – and being tested far more frequently than bottled water - public perception lags. Europeans consume an average of 120 liters of bottled water per person annually (250 L in Italy). In France, bottled water costs about 35 euro cents per liter, compared to just 0.43 euro cents per liter for tap water, a nearly 80-fold price gap.[99,100] This is largely driven by marketing that positions bottled water as "purer" or "better tasting," while public utilities rarely invest in branding or proactive communication.

Yet these safety standards do not capture the full picture. Many emerging contaminants such as PFAS, pharmaceuticals, and microplastics are still under-monitored or regulated at thresholds well above the most protective national or international limits. Up to 50% of Europeans remain exposed above levels considered safe by leading health authorities. This does not argue against tap water itself, but rather for accelerating investment to modernize drinking-water treatment and monitoring so that safety keeps pace with science.

The case for confidence in tap water remains compelling. Large-scale treatment upgrades are far more efficient than reliance on bottled alternatives, but also more inclusive – ensuring safe, affordable water for everyone, regardless of income or location. It delivers cleaner water to all citizens at a fraction of the price and environmental footprint. Bottled water is not only up to 80 times more expensive, but also up to 3,500 times more damaging to ecosystems through plastic waste, transport emissions, and energy use.[101] Rebuilding trust in tap water while upgrading systems to meet tomorrow's standards offers one of the most efficient and sustainable paths to protect both people and the planet.

Funding water system protection needs profound reshaping

Europe's water infrastructure is mainly funded through tariffs (user charges), taxes (public budgets), and transfers (international aid) with tariffs providing the largest share - supplemented indirectly by innovation and cost reductions that help stretch limited budgets further. User charges give utilities a stable revenue stream but also raise equity concerns: lower income households may struggle to pay, and because most infrastructure costs are fixed, declining consumption reduces income without lowering expenses, often forcing price hikes.

Tariffs are both the backbone and the bottleneck of Europe's water financing model. Because water services are capital-intensive and largely fixed-cost, tariffs must recover not just daily operations but also long-term depreciation and renewal of assets. When water use declines due to conservation, industrial efficiency, or drought restrictions, revenues fall even though costs don't, often forcing utilities to raise prices. This self-reinforcing cycle can undermine affordability and public trust, particularly in low-income or rural regions where household water bills already represent a higher share of income.

Funding models vary widely across Europe: Denmark relies heavily on tariffs, leading to high prices (~EUR 9/m^3),[102] while Ireland uses subsidies to keep prices below EUR 2/m^3.[103] France and Germany fall in between, with typical charges of EUR 4–5/m^3.

Despite these differences, tariffs remain the dominant revenue source, covering roughly 70–90% of utility costs and averaging EUR 94 per inhabitant per year across the EU.[104] Transfers are marginal; the European Investment Bank has invested EUR 90 billion over six decades (~EUR 1.5 billion/year, <1% of costs).[105] EU cohesion funds make similar contributions, however they remain marginal compared to the annual financing needed for maintenance, modernization, and compliance with new directives.

Tariff-based pricing can also serve a broader purpose: charging water by volume encourages efficiency and reduces consumption, easing pressure on resources and, over time, limiting the scale of future infrastructure needs. However, heavy dependence on tariffs alone now constrains investment capacity. Political caps on price increases restrict utilities' ability to fund advanced treatment upgrades, leakage reduction, or digital monitoring systems. As a result, Europe risks underinvesting precisely when infrastructure renewal and pollutant control demand historic spending.

The next phase of Europe's water transition will therefore hinge on rebalancing who pays, and how. Strengthening the polluter-pays and beneficiary-pays principles can better align costs with responsibility and value. Industrial emitters and high-impact sectors should help fund advanced treatment (as required under the 2024 Urban Wastewater Directive), while vulnerable households are shielded through targeted social support rather than blanket subsidies. Only by reshaping this cost-sharing model can Europe secure both the financial sustainability of its water systems and the human right of universal access.

Polluter or producer pays in principle, not yet in practice

Recent EU directives are sharpening application of the polluter pays principle. The 2024 Industrial Emissions Directive requires stricter Best Available Techniques and chemical inventories, while the revised Urban Wastewater Treatment Directive requires pharmaceutical and cosmetics firms – responsible for 92 % of effluent toxicity – to cover at least 80 % of the EUR 1.2 billion annual cost of removing micropollutants.[106]

Yet enforcement is uneven, as diffuse pollution from farming and atmospheric deposition is hard to trace. Only 70% of Member States apply pollution taxes.[107] Agriculture remains a blind spot and runoff is rarely charged. Only France, Denmark, and Sweden tax pesticide and nitrate sales. The traditional polluter pays principle is hard to enforce when pollution cannot be directly attributed to individual actors.

In these cases, a beneficiary pays approach can be more effective. It recognizes that sectors benefiting from agricultural productivity, clean water, or healthy ecosystems should help finance their protection. This could take the form of levies on agri-food and input industries, water-use charges that fund catchment restoration, or producer-responsibility schemes where companies co-finance nutrient reduction and wetland restoration. Yet these mechanisms remain the exceptions and not the rule. Despite being central to EU environmental law, the polluter and producer pays principles are still applied inconsistently across sectors, leaving large gaps in cost recovery and accountability.

Barriers to private capital in Europe's water sector

Private capital remains largely untapped. The sector is fragmented across Europe; for example, Italy's water sector is divided among many small utilities, making projects too small-scale for institutional investors. Water infrastructure is capital-intensive with long payback periods, while tariffs are sometimes set below cost-recovery. Regulatory complexity adds further risk.

Unlocking private finance will require aggregating projects for scale, standardizing regulations, improving risk-sharing instruments, and blending public–private funding. Stronger polluter-pays enforcement would also create more predictable revenue streams, making investment more attractive.

96.(Directorate-General for Communication, 2024) 97.(Li, et al., 2025) 98.(Bolitho, 2024) 99.(Confort & Eau, 2024) 100.(EauFrance, 2018) 101.(ISGlobal, 2021)

102.(State of Green, 2022) 103.(Ireland, Citizens Information, 2025) 104.(EurEau, 2023) 105.(Chaaban, 2025) 106.(European Commission, 2022) 107.(Trancon & Leflaive, 2024)

Turning the tide: forces driving water resilience in Europe

Despite escalating pollution and structural inefficiencies, Europe's water future remains open – and the path to recovery is within reach.

A growing set of forces, regulatory reform, corporate leadership, citizen action, and technological innovation, is shifting the system toward resilience. The path forward is uneven, but the foundations for a more secure, sustainable water future are taking shape.

Changing regulatory frameworks

A decade ago, EU water policy was largely reactive, focused on compliance, not prevention. That's changing. The 2025 European Water Resilience Strategy marks a structural shift: for the first time, the EU is building a coordinated framework to restore the water cycle, improve efficiency, and prepare infrastructure for climate shocks.

This shift is reinforced by sharper national action plans and stronger EU directives. The revised Urban Wastewater Treatment Directive and updated Drinking Water Directive introduce stricter thresholds, extended producer responsibility, and integrate climate adaptation into water governance. PFAS, once a low-priority risk, is now under intense scrutiny. The EU has proposed a sweeping REACH restriction, while Denmark has already banned PFAS in food packaging and are pushing for stricter water quality thresholds. In August 2025, the European Chemicals Agency published its updated proposal to ban PFAS manufacturing in Europe.[108]

Together, these measures mark a transition from piecemeal compliance to systemic reform designed to secure the long-term health of Europe's waters.

Corporates moving from compliance to water positivity

For industry, water is no longer just a cost; it's a strategic asset. Companies in food, beverages, pharmaceuticals, and technology are investing in closed-loop recycling, precision agriculture, and advanced treatment to secure supplies and meet tightening discharge standards. Water quality is central to this transformation, not only as a compliance issue, but as a driver of operational stability, brand reputation, and license to operate.

Failures now carry both financial and reputational penalties. Together, these shifts position the corporate sector as both a risk-holder and a driver of innovation in building water resilience.

Citizens are becoming water stewards

Public participation is also gaining traction. From the EU-supported #WaterWiseEU campaign to citizen-science initiatives such as FreshWater Watch, communities are generating data, exposing pollution, and pressing for reform.

In 2016, Spain's Mar Menor lagoon suffered catastrophic algal blooms and mass fish die-offs. In response, more than 640,000 citizens signed a petition that led to Law 19/2022, granting the lagoon legal personhood.[109] The case shows how a health crisis can drive grassroots mobilization and legislative change.

108.(European Chemical Agency, 2025) 109.(Jones, 2022)

This momentum is not only collective but personal. Alongside citizen-science networks, 20,000 people across Europe have already contributed 50,000 datasets on nutrient pollution and aims to involve 100,000 people in safeguarding 10,000 water bodies.[110] In parallel, there are signs that some citizens are becoming more aware of their personal water footprint, with increasing attention to product choices, chemical content, and water-saving habits in daily life. The uptake of home filtration systems is rising where PFAS, microplastics, and other contaminants are in the public eye. As with climate activism two decades ago, most still underestimate the scale of the threat. However, awareness campaigns, citizen data, and visible ecological losses are shifting perceptions. The trajectory is uneven, but points towards more informed and empowered citizens.

Europe invests in advanced technologies to remove and destroy complex pollutants

Technological innovation is beginning to reshape how Europe addresses complex pollutants, with developments coming from both research laboratories and pilot projects. Next-generation systems combine advanced oxidation, catalytic reactors, high-selectivity membranes, and activated carbon into flexible treatment trains that can remove or break down highly persistent molecules. Many of these systems are modular, allowing utilities to adapt to shifting pollutant profiles without overhauling entire plants.

To close the loop, new destruction technologies are tackling one of the toughest challenges: how to safely eliminate the concentrated waste streams that older systems send to landfills or incinerators. Promising solutions range from supercritical water oxidation and plasma treatments to hydrothermal processes and advanced high-temperature incineration, many of which can achieve near-total breakdown of persistent pollutants like PFAS.

Filtration methods are also evolving. Biodegradable silk-cellulose hybrid membranes combine high adsorption capacity with resistance to biofouling, reducing both waste and maintenance. Magnetic nano-coatings and gel-based flocculants can capture the smallest and most mobile microplastic particles, otherwise typically missed by conventional systems.

Pilot and demonstration projects are accelerating across Europe, supported by EU Horizon funding and national innovation programs. Yet full-scale adoption is uneven, often limited by capital costs, operational complexity, and the need for skilled operators. Success will depend on parallel investments across three areas. First, clear regulatory frameworks are needed to phase out production of the most harmful substances. Second, scalable solutions must be developed to concentrate and destroy pollutants. Third, fair cost-sharing models are required between utilities, industries, and consumers.

Nature-based solutions scaling as low-energy water infrastructure

Nature-based solutions (NBS) are proving their value. Constructed wetlands, biofiltration beds, and sponge city designs can remove 30–70% of micropollutants[111] and up to 100% of nitrates and heavy metals.[112] They also store floodwater, recharge aquifers, and support biodiversity.

Projects such as RHE-MEDiation show that decentralized systems can halve pollutant loads with minimal emissions. Urban NBS, rain gardens, water plazas and green roofs, boost both livability and resilience. The European Commission is preparing dedicated incentives to scale NBS as climate-resilient infrastructure across rural and urban areas.

Digital technologies transforming water management

Digital technologies are shifting water management from reactive repair to predictive, system-wide optimization. AI-driven analytics, IoT sensors and cloud platforms now enable real-time tracking of feedwater quality, groundwater levels, and network performance. Leak detection tools combining acoustic sensors, satellite imagery, and pressure monitoring are reducing losses. Predictive consumption analysis and adaptive pressure management help utilities optimize distribution.

In sewer systems, level sensors, probes, drones, and robotic cameras are coupled with real-time stormwater control to limit overflows. At treatment plants, digitally assisted processes and adaptive dosing improve efficiency and extend removal capacity to complex contaminants such as nitrogen, phosphorus and PFAS. Projects such as Horizon IBAIA are pioneering modular micro-sensors that feed directly into dosing systems, cutting both chemical use and operational costs.[113]

Across the value chain, predictive maintenance, geo-localized information systems, and digital twin models support asset management, workforce coordination and long-term resilience. A new wave of innovation in water quality testing is also transforming how pollution is detected and managed. Rapid field-sensing technologies for emerging pollutants such as PFAS are now capable of delivering results in minutes at parts-per-trillion precision, allowing operators to identify contamination directly on site rather than relying solely on centralized laboratory analyses.[114] This real-time capability turns monitoring from a periodic exercise into a continuous early-warning system, enabling faster responses, smarter treatment adjustments and stronger public trust. Together, these advances form the digital backbone of the EU Water Resilience Strategy, creating the transparency, responsiveness, and integration needed to meet Europe's pollution reduction and restoration goals.

From waste to resources: circular solutions recover value and neutralize harm

Europe is rethinking what it means to treat waste. Residuals including sewage sludge, industrial brine, and membrane rejects, once destined for disposal, are now being mined for value. Nutrients such as nitrogen and phosphorus, along with renewable energy, are recovered from these concentrated pollution streams, marking a shift from end-of-pipe management to circular resource recovery.

Biosolids are emerging as a strategic resource, supplying fertilizer-grade nutrients, producing biogas, and improving soils. Yet regulatory pressure on PFAS and heavy metals is making land spreading less viable, driving utilities toward advanced recovery methods.

The result is a new generation of treatment plants, no longer just disposal sites, but circular platforms that recover resources, lower carbon intensity, and support Europe's resilience and circularity goals.

Still, the system must evolve. Not all residuals should be reused: some, especially those containing persistent pollutants, must be safely destroyed. This raises two critical dilemmas. First, conventional recycling and disposal methods are often ineffective at containing or destroying PFAS, leading to contamination of soil, water, and even new products made from recycled materials. Second, Europe must decide how to manage the millions of tons of legacy products that already contain PFAS and will enter the recycling stream for decades to come. Stopping circularity is not an option – but preventing the recirculation of "forever chemicals" will require clear criteria, open communication, and innovative treatment solutions.

Financing water resilience: fairer and smarter cost-sharing

Europe's water transition will not succeed without a financing model that matches its ambition. Historically, water infrastructure has been underfunded and overly reliant on household tariffs. That's beginning to change.

New instruments are emerging to spread costs more fairly and attract investment. The European Investment Bank has committed over EUR 15 billion between 2025 and 2027 through its new Water Program and Sustainable Water Advisory Facility.[115] The European Water Resilience Strategy promotes public–private investment in detection and monitoring technologies. Biodiversity and nature credits are being developed to incentivize restoration.

National reforms are also unlocking new markets. Denmark's 2025 Act on the Supply of Technical Water removes tariff caps and enables private-sector supply of non-potable industrial water through market-based contracts, reviving a stagnant reuse sector.[116] Together, these developments are making the financing landscape broader, more dynamic, and better aligned with the long-term needs of Europe's water systems.

110.(EarthWatch, 2025) 111.(Ilyas, Ilyas, & Hullebusch, 2020) 112.(Knox, Paller, Seaman, Mayer, & Nicholson, 2021) 113.(Horizon Europe, 2022)

114.(Global Water Intelligence, 2025) 115.(Smart Water Magazine, 2025) 116.(Antonov, 2025)

Image: NG Nordic

NG Nordic

Summa's portfolio company, NG Nordic, has developed, piloted, and patented a circular process for treating sulfate-rich wastewater, enabling the recovery of high-value products, while achieving **>80%** sulfate removal

Systems change: envisioning a water healthy future

A resilient Europe built on clean water, fertile soils, and thriving ecosystems.

At Summa, we believe that healthy waters are not just possible; they are foundational to Europe's future. A resilient water system underpins everything from public health and food security to digital infrastructure and economic stability.

Summa believes that curbing pollution and protecting people requires a systemic approach built on four complementary levers: →

Only by activating all four levers together can Europe tackle pollution across its full life cycle – from source to exposure – and turn today's contamination challenge into tomorrow's resilience opportunity.

Synthesis of our Water Health Scenario for 2040

Developed by Summa Equity, the Water Health Scenario delivers a decisive turnaround for Europe's water systems. Fewer than 5% of Europeans remain exposed to drinking water above the advocated safety line (vs. 50% today), while pollutant emissions across all major contaminant groups fall by more than half. Bringing most European water bodies – around three-quarters – within compliance with the new EU Environmental Quality Standards by 2040, nitrate exceedances are eliminated, and pesticide and PFAS exposure drop by over 80%. Aquatic biodiversity begins to recover as eutrophication and chemical toxicity retreat below effect levels, with fish, invertebrates, and pollinators returning to healthier populations. At the same time, cleaner sludge management, heavy-metal removal, and the expansion of organic farming to a quarter of EU cropland rebuild soil fertility and microbial diversity, reducing contamination risks for crops and grazing animals. Together, these measures safeguard human health, regenerate ecosystems, and restore the natural resilience of Europe's waters, soils, and wildlife.

Reduce
Eliminate harmful substances through bans, phase-outs and substitution

Capture
Intercept pollutants at their source or along their pathways

Shield
Protect populations from pollutants exposure in drinking water

Remediate & Regenerate
Restore soils, waters and natural ecosystems

1. Reduce: stop it at the source: The most effective protection comes from preventing pollutants from entering water systems. By 2040, the scenario foresees a near-total phase-out of the most persistent and toxic substances. A REACH restriction would progressively eliminate most non-essential PFAS, but this will require scaling safer alternatives such as fluorine-free foams and barrier coatings. High-risk pesticide groups (3–4) could be phased out alongside biocontrol, precision spraying, and resistant crop varieties, backed by strong farmer support. Lead ammunition can be replaced with steel, copper or tin-based alternatives – with steel often the cheaper option - though uptake will depend on cost, performance, and acceptance among hunters. The phase-out of intentionally added microplastics is already underway, but sectors such as cosmetics, detergents, and fertilizers each require tailored substitutions. Together, these measures could prevent more than 3 million tons of emissions, provided the transition is carefully managed, and alternatives are viable at scale.

2. Capture: intercept it in the pathways: Where pollution cannot be fully avoided, it must be stopped before it spreads. By 2040, 80% of municipal wastewater is expected to undergo quaternary treatment using ozonation, activated carbon, or membrane filtration to remove pharmaceuticals and PFAS. While effective, these upgrades are costly, and smaller municipalities will need EU and national support. Road runoff can be captured through ponds and curbside traps, but this requires new infrastructure and ongoing maintenance. Stricter sludge standards will block contaminated biosolids, while treating 80% of sludge solids with high-temperature incineration or advanced oxidation will reduce recirculation of pollutants, though with higher energy demands. Agricultural buffer zones can cut nutrient and pesticide runoff significantly but require land-use changes and long-term financial incentives for farmers.

Wastewater treatment chain:

Pre-treatment: physical removal
Removes large solids

1 **Primary treatment: physico-chemical**
Removes settleable matter

2 **Secondary treatment: biological treatment**
Biogrades organic matter, suspended solids & nutrients

3 **Tertiary treatment: polishing stage**
Removes remaining fine particles, nutrients and trace contaminants

4 **Quaternary treatment: suitable for reuse**
Removes pathogens, micropollutants, viruses and salts

3. Shield: protect people at the tap: Drinking water systems are being upgraded to provide a final barrier where contamination persists. By 2040, PFAS concentrations should fall below 2 ng/L for the sum of four PFAS; a level far more ambitious than current EU standards of 100 ng/L for the sum of 20 PFAS and 500 ng/L for total PFAS, nitrate concentrations will be cut by half so that no communities remain above the 50 mg/L safety limit, and exposure to lead and cadmium will be reduced to below 5 micrograms per liter. Trace pharmaceuticals will also be closely tracked and steadily reduced. Achieving this will require widespread upgrades to treatment plants and the replacement of lead pipes, but the result will be safer water for millions. By 2036, half of Europe's water utilities could already meet these higher standards, if financing is secured and consumers accept the changes.

Drinking water treatment chain:

Pre-treatment: physical removal
Removes large solids

1 **Physico-chemical**
Removes settleable matter

2 **Filtration**
Removes remaining fine particles

3 **Advanced filtration (Quaternary reatment)**
Removes nutrients, viruses, salts and micro-pollutants

4 **Disinfection**
Removes pathogens, bacteria and viruses

4. Remediate and regenerate: clean up the past and restore ecosystems: By 2040, around 2,300 PFAS hotspots could be remediated, and 200–400 kilotons of contaminated soils treated each year. Unsafe sludge and sediments will be destroyed through high-temperature or advanced oxidation methods, though these are both expensive and energy-intensive. Complementing technological solutions, nature-based approaches such as wetlands, riparian buffers, and organic farming on 25% of cropland can halve nutrient runoff while restoring biodiversity and soil health. These solutions not only help reduce pollution but also deliver co-benefits for climate adaptation and rural resilience, though they require land use changes, long-term financing, and strong stakeholder buy-in.

The combined effect of these measures would be a reduction of more than 50% in emissions across all major pollutant classes, significant declines in human exposure, and a slowing of environmental stock accumulation. This scenario is not about quick fixes. It acknowledges the trade-offs: bans require affordable substitutes, advanced treatment is costly; restoration takes time and political will. Crucially, it is also financially feasible. By combining polluter-pays schemes (covering treatment and remediation), beneficiary-pays models (rewarding farmers and land managers for water stewardship), targeted EU and national funds (as seen in Switzerland's multi-billion-franc wastewater-treatment and river-restoration program), and phased tariff adjustments to close the remaining gap, Europe can build a financing model that is effective and sustainable. By facing these challenges head-on and ensuring that costs are shared equitably, Europe can move from reactive crisis management to proactive protection, securing long-term water health for people and nature.

What follows is a closer look at each pollutant family, focusing on the risks of inaction with the transformative potential of a Water Health future. The stakes could not be higher, but so too is the opportunity. A Europe with cleaner water, healthier ecosystems, and protection for generations to come.

Achieving this transformation will not only demand bold regulatory action and technological innovation. It will require mobilizing equitable and sustainable financing. As we show later in the report, polluter- and beneficiary-pays mechanisms, complemented by EU funds and targeted tariff adjustments, can provide a credible path to finance the investments needed by 2040. In other words, this scenario is not just aspirational; it is financially feasible.

Investing in Europe's water health: from toxic to thriving

Figure 8

Our Water Health Scenario by investment lever and pollutant type (2025-2040)

- Investment assessed as part of the Water Health Scenario
- Investment not assessed or non material

EUR 22 6bn to be invested to enable the Water Health Scenario

<table>
<tr><th></th><th></th><th>PFAS</th><th>Pesticides</th><th>Nutrients</th><th>Microplastics</th><th>PPCPs</th><th>Heavy metals</th></tr>
<tr><td rowspan="2">Reduce
EUR 28 bn</td><td>Ban or substitute hazardous substances</td><td>Ban all PFAS substances by 2030 (with targeted exceptions)</td><td>Ban & enforce all group 3 and 4 substances</td><td></td><td></td><td>Optimize formulas using biodegradable ingredient</td><td>Ban lead used for hunting and fishing</td></tr>
<tr><td>Reduce emissions</td><td></td><td>Reduce pesticides with precision farming</td><td>Reduce nutrients with precision farming</td><td>Reduce emission from packaging, tires, paints etc.</td><td>Reduce live-stock's antibiotics consumption</td><td>Speed up replacement of lead-made water pipes</td></tr>
<tr><td rowspan="3">Capture
EUR 155 bn</td><td>Runoff management (capture pollutants over their flows)</td><td></td><td>Buffer zones and constructed wetlands</td><td>Buffer zones and constructed wetlands</td><td>Decentralized capture from roads (e.g. tires...)</td><td></td><td></td></tr>
<tr><td>Upgrade wastewater treatment</td><td colspan="6">• Europe's large urban treatment plants – covering around 80% of urban effluents – would be upgraded to full tertiary and quaternary treatment, eliminating nutrients, pharmaceuticals, and microplastics, and cutting long-chain PFAS by about 90%
• Around 45% of effluents would receive next-generation treatment with nanofiltration, removing over 90% of all PFAS (both long- and short-chain) and enabling safe water reuse</td></tr>
<tr><td>Achieve safe destruction of pollutant concentrates</td><td colspan="6">• For 80% of EU total dry solid tonnage of wastewater & drinking water sludge, achieve destruction of all pollutants either with high temperature incineration or other methods such as oxidation
• Resource recovery from sludge e.g. nitrates and phosphates, as well as biogas energy, can be achieved before or after destruction phase</td></tr>
<tr><td rowspan="2">Shield
EUR 31 bn</td><td>Upgrade drinking water treatment</td><td colspan="6">• Europe's drinking water systems would ensure full removal of pesticides and advanced treatment of PFAS – achieving around 90% removal for long-chain compounds and lower rates for short-chain PFAS – using activated carbon or ion-exchange technologies. This would enable compliance with a ≤ 2 ng/L limit for the sum of four PFAS, far stricter than current EU standards
• Around 68% of capacity would add ultrafiltration to capture microplastics, while 39% would use nanofiltration for the most stringent PFAS removal and highest water purity
• Heavy metals would be treated where tap water exceeds EU Drinking Water Directive threshold</td></tr>
<tr><td>POE/POU treatment</td><td colspan="6">In areas that are most intensively polluted and cannot shield with public infrastructure.</td></tr>
<tr><td>Remediate & Regenerate
EUR 12 bn</td><td>Depollute sites</td><td>Depollute 2.3k hotspots (out of 23k identified)</td><td></td><td></td><td></td><td></td><td>Decontaminate 200-400k tons of soils</td></tr>
</table>

Environment   Human

Today

PFAS

Stock in the environment **1.6Mt**

~200m inhabitants exposed over the safety line (≤2 ng/L sum of 4 PFAS)

Pesticides

45m inhabitants exposed over the safety line

Nitrates

Average concentration in the aquifer **24 mg/L**

3% of population exposed over the safety line

PPCPs

12kt reach the environment each year (out of 29kt consumed)

Microplastics

Stock in the environment **16Mt**

Average annual intake per person of **c. 20,000 particles**

Heavy metals

44 kt/year of lead ammunition

120m people exposed to lead pipes (indirectly affecting drinking water)

2040 Current trajectory

PFAS

- Massive increase with stock in the environment of **4Mt**
- More than **300m** inhabitants exposed over the safety line

Pesticides

- Stable situation

Nitrates

- Stable situation

PPCPs

- **11 kt** reach the environment each year (out of 34kt consumed)

Microplastics

- Huge increase to **+30Mt by 2024**
- Doubling of annual intake

Heavy metals

- **660 kt** accumulated by 2040
- Population above safety threshold up to **15m**

2040 Water Health Scenario

PFAS

- Stock in the environment **2.2Mt**
- **<5m** inhabitants exposed over the safety line (≤ 2 ng/L sum of four PFAS)

Pesticides

- **<8m** inhabitants exposed over the safety line

Nitrates

- Average concentration in the aquifer 12 mg/L
- **0** population exposed over the safety line

PPCPs

- **6kt** reach the enviroment each year (out of 33kt consumed)

Microplastics

- Stock in the environment **20Mt**
- Average annual intake per person **< 3,000 particles**

Heavy metals

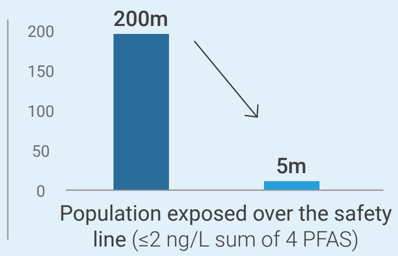
- No more lead in the ground added (~ 100 to 150kt by the time regulations pass)
- **Up to 12m** people exposed to lead leaching from pipes after eliminating heavy metals at the drinking water treatment plant

What we aim to reach by 2040

Today   Water Health Scenario

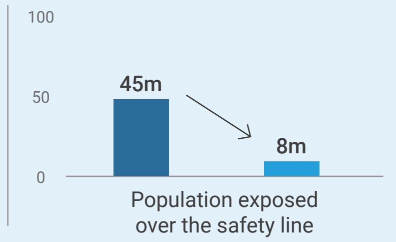
PFAS

The sharpest decline. A near-total REACH ban, large-scale quaternary treatment, hotspot clean-up, and advanced drinking-water polishing reduce the population above the 2 ng/L safety line from around 200 million to fewer than 5 million. In affected areas, blood concentrations drop by over 90%.



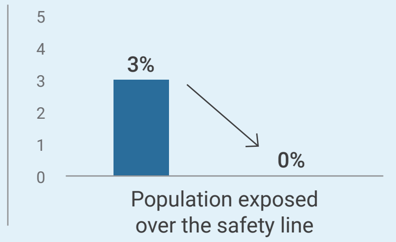
Pesticides

The second-largest gain. Phasing out the most hazardous substances, scaling precision agriculture, and expanding organic farming lower tap-water exceedances from 45 million to under 8 million people, with most remaining risk tied to legacy contamination.



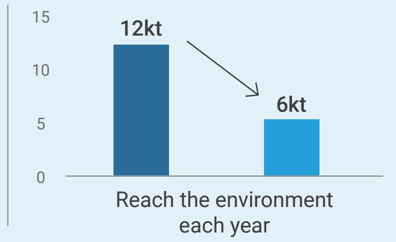
Nitrates

Aquifer concentrations halve, from 24 mg/L to 12 mg/L, and no one remains above the 50 mg/L threshold, thanks to nutrient-loss reductions and large-scale deployment of wetlands and buffer strips.



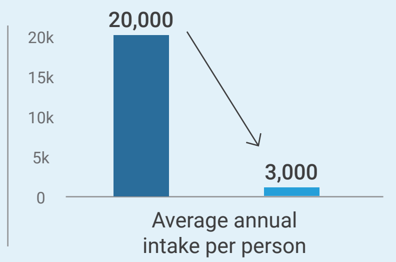
PPCPs

Advanced treatment in wastewater plants, combined with reduced livestock antibiotic use, brings priority drug residues below watch-list thresholds for over 90% of consumers, cutting exposure by 70%. By 2040, less than 20% of consumed pharmaceuticals reach ecosystems, mostly from livestock and untreated areas.



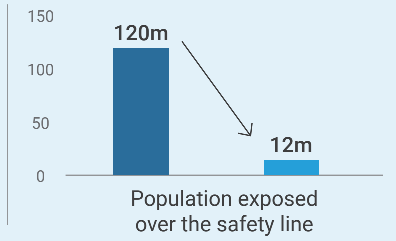
Microplastics

Tire-particle capture, road-runoff ponds, and ultrafiltration cut annual ingestion from about 20,000 to fewer than 3,000 particles per person, even as environmental contamination levels rise.



Heavy metals

EU-wide programs replace every lead service line by 2030 (ahead of the current 2036 target) and tighten cadmium and lead caps in sludge and fertilizers. As a result, more than 90% of today's population exposure above 5 µg/L disappears.



PFAS

Stop PFAS spread.
Protect people.

Current trajectory

PFAS contamination is one of the most persistent and complex water health challenges facing Europe. Without decisive intervention, environmental stocks are projected to rise sharply, from ~1.6 million tons today to around 4 million tons by 2040. The projected increase of 2.7 million tons includes both new PFAS-containing products and about 0.6 million tons mobilized from existing hidden stocks, with natural decay reducing the total by only 0.3 million tons.[117]

Even with partial upgrades under the revised Urban Wastewater Treatment Directive, covering ~30% of municipal flows, residual emissions and uncontrolled sludge recirculation will keep exposure levels high. At current EU drinking water thresholds (100 ng/L per compound; 500 ng/L total), tens of millions of Europeans will remain above serum levels linked to immune suppression, cancer, and other health effects.[118]

Water Health Scenario

A more resilient path is possible. In the Water Health Scenario, non-essential PFAS are phased out within five years under REACH, with exemptions managed in closed-loop recycling systems. Environmental stocks stabilize, peaking at ~2.2 Mt by 2040 before declining. About 0.5 Mt of residual emissions still enter the environment from the final years of use and from PFAS already embedded in soils, sediments and products. Expanded wastewater treatment covering 80% of municipal flows by 2040 and stricter sludge standards will remove ~0.4 Mt, thanks to the expansion of the scope of the revised Urban Wastewater Treatment Directive. Hotspot clean-ups will remove an additional ~0.1 Mt near drinking water sources, reducing direct risks to local populations.[119]

Yet even in this improved scenario, delayed effects mean pollutant stocks continue to rise for some time. Advanced treatment at the drinking water stage becomes essential. Half of Europe's population will require quaternary treatment to meet <2 ng/L thresholds. Over time, reduced intake and natural elimination (3–9 years depending on the compound) lower average PFAS blood levels to <0.2 ng/mL. Short-chain PFAS clear faster from the body but remain environmentally persistent.[120]

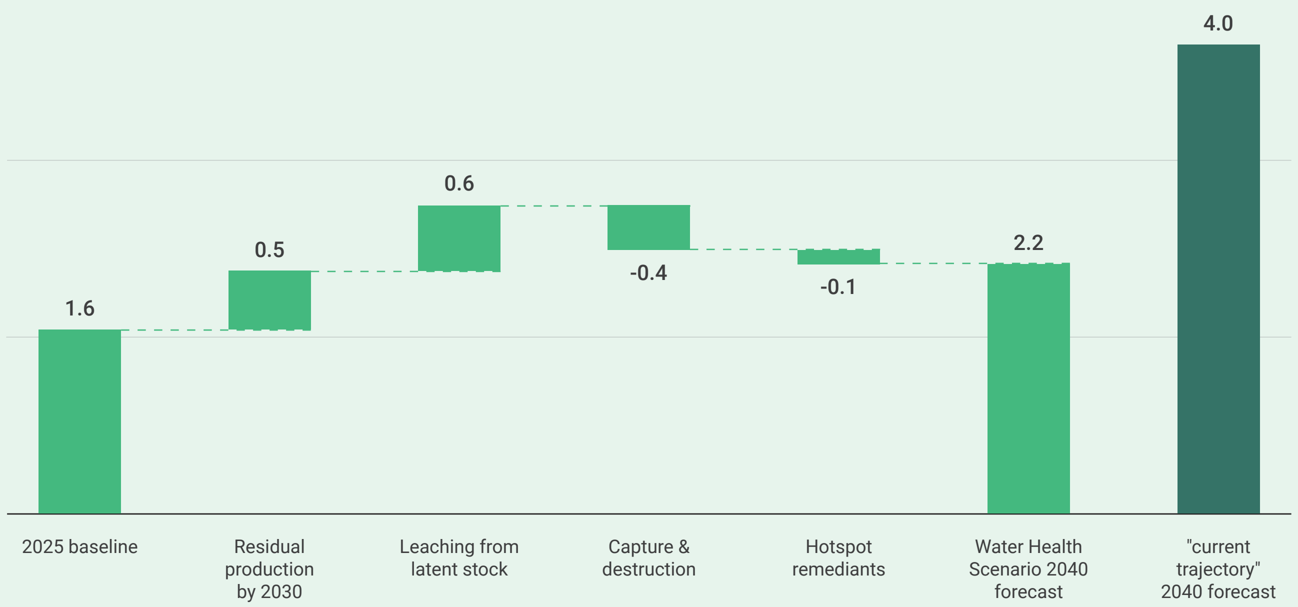
This is a systemic challenge. It demands upstream prevention, circular design, and targeted remediation. It's also a strong investment opportunity: solutions that reduce exposure, restore water health, and protect populations are not only urgent, but they're also commercially viable.

 117.(Berger, 2025) 118.(Berger, 2025) 119.(Berger, 2025) 120.(Berger, 2025)

Reduce: ban all PFAS except for non-replaceable for which a closed loop is implemented
- PFAS ban within 2030, with limited exemptions for essential uses in closed-loop systems, financed through polluter-pays and extended producer responsibility schemes. Transition is enabled by rapidly advancing PFAS-free substitutes, such as fluorine-free firefighting foams, non-fluorinated coatings, and new medical and electronic materials, alongside strict containment and monitoring of exempted uses to prevent environmental releases
- Immediate prohibition in high-risk applications such as firefighting foams with transition costs covered by producers

Capture: scale up wastewater treatment infrastructure and improve concentrate management
- Quaternary treatment at all plants >10k p.e. (population equivalent) by 2040 (80% of EU urban effluents), in addition to most stringent PFAS removal for 45% of EU urban effluents through nanofiltration targeting >90% removal *(EU law: quaternary treatment is mandated by 2045, but PFAS are only subject to monitoring, with no binding removal requirement)*
- Tighten sludge-use standards and invest in permanent PFAS destruction via hydrothermal alkaline treatment, gasification, or plasma oxidation

Figure 09
Evolution of PFAS stock in the environment (est. in Mt)



Summa portfolio example

NG Nordic

NG Nordic has built and piloted its patented LoopCarb systems for PFAS treatment in wastewater – demonstrating >80% removal efficiency, including ultrashort chains – and operates high-temperature incineration facilities for the complete destruction of PFAS concentrate, closing the loop between capture and elimination.

Shield: scale up drinking water treatment infrastructure and deployment of last miles barriers in hotspot areas
- Install advanced treatment (GAC, ion exchange, RO, and combined processes for short-chain PFAS) at 50% of EU drinking water plants covering 39% of EU population (focusing on high-exposure zones)
- Introduce a ≤2 ng/L regulatory limit for the sum of four PFAS (PFOA, PFOS, PFNA and PFHxS) in drinking water, following Danish best practice. This target, central to Summa's Shield proposal, represents one of the most ambitious PFAS policies globally and would reinforce the EU's leadership on chemical safety
- Deploy point-of-use filtration in households where concentrations are too high until centralized systems are operational

Remediate: high PFAS contaminated areas, close to water catchments
- Decontaminate 2,300 priority sites near water catchments, primarily production and firefighting training areas, using soil excavation, hazardous landfill disposal, or soil washing. Costs to be covered by the polluter and by public funds where polluters cannot be identified

Nitrates

Cut nutrient losses to safeguard biodiversity.

Current trajectory

Without stronger EU targets, nutrient surpluses, particularly nitrates, remain high at ~50 kg/ha, and the Green Deal goal of halving nutrient losses is missed. Aquifer nitrate concentrations stagnate around 24 mg/L, leaving ~3% of Europeans exposed to tap water above the 50 mg/L legal limit, especially in intensive farming regions. Excess nutrient pollution continues to burden rivers, lakes, and coastal waters, degrading biodiversity and increasing treatment costs.[121]

Water Health Scenario

In a positive trajectory, upstream agricultural nutrient losses are cut by 50% to ~25 kg/ha. Average aquifer nitrate concentrations fall to 12 mg/L, eliminating all drinking-water exceedances. Advanced treatment to remove nitrates and phosphate is widespread in regions vulnerable to nutrient pollution. In hotspots, drinking water plants use advanced nitrate-removal systems, ensuring 100% of Europeans are protected from harmful levels.[122]

 121.(Berger, 2025) 122.(Berger, 2025)

Reduce: upstream entrants and agricultural nutrient loss

- Halve nutrient surpluses by 2040 via nitrification inhibitors (cutting total losses by 15%) and controlled-release fertilizers (synchronizing nitrogen supply with crop demand, can lower fertilizer use by ~20% and reduce total losses to the environment by about 15%), transition costs supported through EU CAP subsidies and beneficiary-pays schemes
- Optimize application with variable-rate technologies (drones, satellites, sensors) to cut fertilizer volumes and reduce nitrogen surplus by 10% without yield loss
- Enhance soil quality with winter cover crops, legumes, and reduced tillage, helping soils retain nitrogen and reducing nutrient losses by around 10%

Nutris

Summa portfolio example

Nutris demonstrates how regenerative agriculture can be scaled profitably, reducing reliance on synthetic inputs and cutting nutrient runoff. A concrete model of how beneficiary pays schemes can reward farmers for water protection while driving systemic change.

- For phosphorus: avoid overload on soils, match applications to crop needs, prevent risky spreading near water, and replace mined phosphate with recycled sources like manure or recovered nutrients, with polluter-pays levies on fertilizer producers helping finance the shift

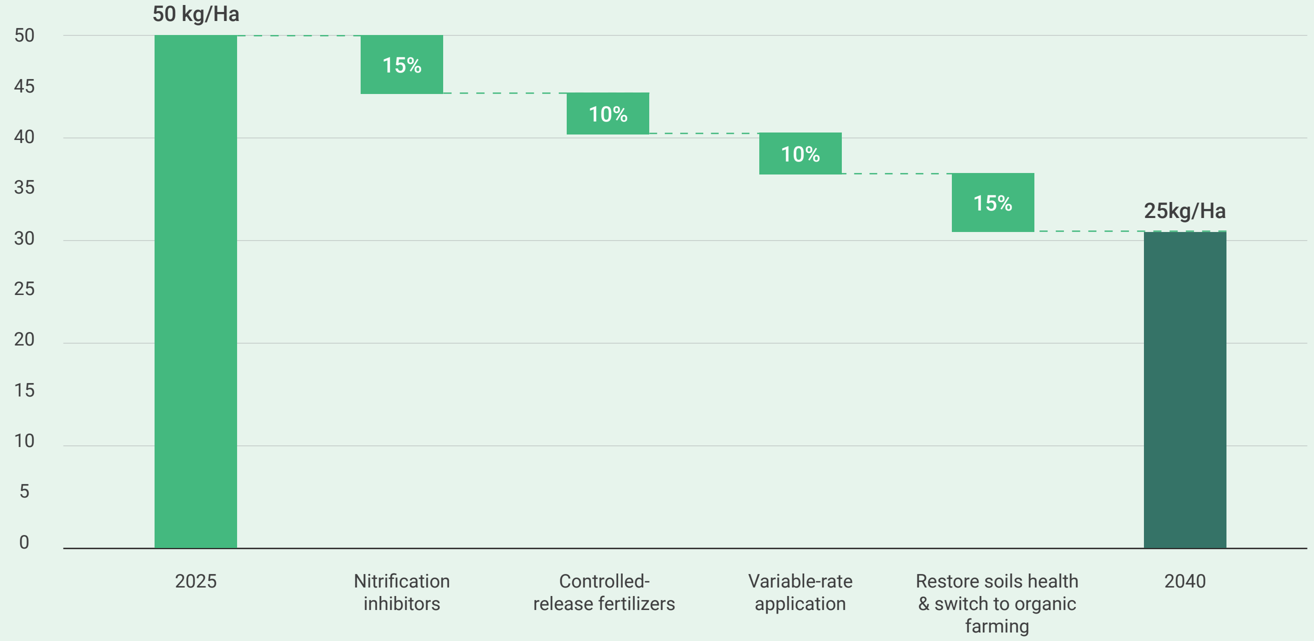
Capture: develop nature-based solutions to close nutrient cycles before run-offs / infiltration

- Use vegetated buffer strips, retention ponds, and constructed wetlands to trap and degrade nitrates and phosphates before they reach water bodies
- Extend tertiary treatment for nitrates and phosphates to all plants >10,000 p.e. covering 80% of EU urban effluents *(EU law requires it for large plants (≥150,000 p.e.) by 2039 and for plants >10,000 p.e. when they discharge into eutrophication-sensitive areas, with deadlines stretching to 2045)*
- Recover nitrogen from sludge before incineration (such as ammonia stripping and struvite) and phosphorus from ash after incineration)

Shield: upgrade drinking water treatment infrastructure

- In agricultural regions with high nitrate infiltration, install advanced drinking-water treatment to reduce all exceedance in drinking water (currently 3% of EU population)

Figure 10
Scenario for cutting nutrient inputs in agriculture by 50% by 2040



PPCPs

Strengthen treatment and source control of pharmaceuticals discharge.

Current trajectory

By 2040, PPCP consumption is expected to rise by 5–20%, driven by Europe's aging population and growing healthcare demand. The revised Urban Wastewater Treatment Directive will require large plants (≥150,000 p.e.) to remove 80% of priority micropollutants. However, under the current rollout pace, only ~30% of urban effluents will receive such treatment by 2040. Livestock-related emissions, untreated in municipal systems, are likely to remain a significant source of PPCPs. Combined, this leads to only a 10% reduction in overall PPCP emissions, down from 12 kt to 11 kt/year. This leaves persistent residues in rivers and lakes and maintains chronic exposure for aquatic species and humans.[123]

Water Health Scenario

Accelerating the directive's implementation to equip 80% of urban effluents with quaternary treatment by 2040 transforms the outcome. Improved animal health and husbandry, including better housing and hygiene, vaccination, optimized feeding, and stricter veterinary oversight, reduce livestock discharges by 20%. Together, these measures cut total PPCP emissions by ~50% (6kt / year), with the largest declines in the most harmful and persistent compounds.[124]

Reduce: decrease upstream PPCP used in livestock

- Design drugs that biodegrade ~80% faster in natural waters, financed through producer R&D obligations and regulatory incentives
- Healthier livestock practices, including investing in better ventilation systems, reducing over-crowding, and setting up isolation facilities for sick animals, aim to cut routine antibiotic use. These measures are supported by EU agricultural funds and beneficiary-pays schemes

Capture: upscale wastewater treatment infrastructure and sludge management

- Quaternary treatment at all plants >10,000 p.e. by 2040, enabling 80% cover of urban effluent and cutting human caused PPCP emissions by >60% *(EU law requires quaternary treatment for ≥150,000 p.e. plants and >10,000 p.e. in sensitive areas by 2045)*
- Require pharma and cosmetics producers to finance ≥80% of quaternary treatment costs, incentivizing more efficient drug design and medicine recovery schemes, aligning with the polluter-pays principle and incentivizing improved drug design
- Prevent PPCP recirculation by setting residue thresholds, using advanced oxidation to degrade pollutants, or diverting sludge to incineration (>95% PPCP destruction)

123.(Berger, 2025) 124.(Berger, 2025)

Investing in Europe's water health: from toxic to thriving

Pesticides

Ban harmful pesticides. Restore water through better farming.

Current trajectory

If current trends persist, Europe's pesticide use will remain high at 300–350 kt/year, with the most hazardous substances (Group 3) still accounting for 10–15% of volume even after the Green Deal's 50% hazard-reduction target. Under this scenario, 10–25% of surface water sites and 4–11% of groundwater sites would continue to exceed the "no-effect" thresholds for biodiversity. Persistent stocks from past use would remain in groundwater for years, sustaining chronic exposure risks for ecosystems and, in some cases, people.[125]

Water Health Scenario

A comprehensive hazard- and exposure-reduction strategy would deliver sharp improvements. All Group 3–4 pesticides, those with high toxicity and long half-lives, including PFAS-based pesticides, are banned. Smart farming practices and organic agriculture expand to cover 25% of cropland, reducing tonnage on an "equivalent substance" basis by ~20% without yield loss. The result is a large drop in total toxicity, with only short-decay pesticides in use. Exceedance rates for biodiversity-safe thresholds in surface and groundwater decline accordingly, with residual contamination limited mainly to deep-lying legacy plumes.[126]

Summa is committed to driving systems change in food and agriculture. By investing in regenerative and plant-based food systems, we can restore ecosystems, improve human health and reduce emissions.

Read the report here

Reduce: ban most hazardous or un-assessed pesticides

- Ban all Group 3–4 pesticides, not just halve usage as per Green Deal targets, financed partly through pesticide levies that support farmer's transition
- Achieve the EU's 25% organic farming target by 2040 to reduce chemical reliance and capture price premiums for lower-yield, pesticide-free production, with subsidies and beneficiary models covering conversion cost
- Deploy preventive measures such as crop rotation, pest-resistant varieties, traps, and nets to reduce chemical need
- Use precision application technologies (GPS-guided sprayers, variable-rate nozzles) to cut usage by ~20% without yield loss
- Support adoption through EU-level banded pesticide taxes based on toxicity, harmonizing disparate national schemes

Capture: develop nature-based solutions to degrade pesticides after release in the environment and ensure full tertiary treatment

- Expand nature-based solutions such as buffer strips, vegetated drainage ditches, and constructed wetlands to intercept and break down pesticides in run-off with EU CAP funds and beneficiary-pays schemes rewarding farmers for water quality gains
- For drinking water sludge, the pesticides need to be destroyed via incineration or alternative methods

Shield: scale up drinking water treatment infrastructure to shield population

- Target 100% population shield from pesticides in drinking water by upgrading drinking water treatment plants, typically with granular activated carbon filtration

125.(Berger, 2025) 126.(Berger, 2025)

Microplatics

Tackle microplastics from source to exposure.

Current trajectory

Current environmental stocks of microplastics are estimated at ~16 Mt, rising rapidly as diffuse emissions from tire wear, packaging breakdown, and paint degradation push annual releases to >1.3 Mt/year by 2040. This is a 40–80% increase from today. Without changes to sludge management, large volumes of microplastics captured by wastewater plants will continue to re-enter soils and waters via land-spread biosolids. By 2040, the total environmental stock would exceed 30 Mt, increasing human ingestion and ecological impacts.[127]

Water Health Scenario

Targeted interventions cut annual emissions by >50% through upstream material changes, capture devices, and waste-stream controls. Stocks still rise given environmental persistence but slow to ~20 Mt by 2040.[128]

Reduce: upstream microplastics emissions (Up to 250 kt/year fewer microplastic emissions)
- Tires: low-wear compounds, electrostatic capture, regenerative air sweepers and eco-driving, cutting 50–100 kt/year
- Packaging: deposit-return schemes, bag bans/taxes, 30% reuse targets and material substitution. ~30 % reduction supported by extended producer responsibility fees
- Paints/coatings: abrasion-resistant formulations and controlled application, a ~30 % reduction
- Phase out microbeads, curb textile shedding, retrofit washing machines with microfiber filters, financed through product standards and producer obligations

Capture: improve road run-off & stormwater, wastewater and sludge management
- Install bioretention systems and sump retrofits on 15% of EU roads, diverting 70–110 kt/year from waterways
- Equip all wastewater treatment plants >10k p.e. with ultrafiltration (quaternary treatment) to remove up to 95% of particles *(EU law requires quaternary treatment for ≥150,000 p.e. plants and >10,000 p.e. in sensitive areas by 2045)*
- Upgrade sludge treatment via pyrolysis, gasification, or hydrothermal processes to destroy or sequester microplastics, avoiding re-release via land application

Shield: protect drinking water supply
- Install advanced filtration at surface-water drinking plants (covering ~35% of EU supply) and 50% of groundwater drinking plants (65% of EU supply) to remove remaining particles before human consumption

waterise

Summa portfolio example

Waterise is pioneering deep-sea desalination at ~400-600m depth, where natural hydrostatic pressure drives the reverse osmosis process. Seawater is filtered through semi-permeable membranes to remove salts and contaminants with far lower energy use. The system produces pristine microplastic- and PFAS-free permeate water, which is pumped back to shore for final treatment. It also discharges a chemical free brine only 20% more concentrated than the surrounding deep-sea waters, released at the same depth where limited permanent marine life exists. This approach reduces the impact of desalination while providing a scalable, low-impact source of high-purity freshwater for water-scarce regions.

 127. (Berger, 2025) 128.(Berger, 2025)

Heavy metals

Eliminate remaining sources of heavy metal and remediate yesterday's mistake.

Current trajectory

Even without major new measures, heavy metal emissions in Europe are expected to decline gradually thanks to structural shifts, such as the phase-out of coal-fired power plants. However, persistent sources will remain: 44 kt/year of lead from ammunition, 100–120 t/year of mercury from charcoal burning and residual industrial uses, and 300–400 t/year of cadmium from agriculture and industry. Across the EU, 2.8 million contaminated sites exist, around 60% of which contain lead, cadmium, or arsenic. At the current pace, only ~10% will be fully remediated by 2030, leaving large stocks in soils and sediments. In addition, 25% of Europeans, around 120 million people, are still supplied by lead pipes, with replacement only mandated by 2036. Without faster action, exposure will persist in hotspots for decades.[129]

Water Health Scenario

By combining stricter regulation, infrastructure replacement, targeted remediation, and treatment upgrades, Europe can achieve a 90% cut in lead emissions, 70% in mercury, and 30–40% in cadmium by 2040. Lead pipe replacement is accelerated to 2030, reducing drinking water exposure by up to 90%. Soil and sediment remediation is scaled up to 200–400 kt/year, tackling high-risk sites first, especially those near water intakes and agricultural zones.[130]

Reduce: ban lead ammunition and eliminate lead in water infrastructure
- Ban lead in ammunition and fishing gear across the EU, replacing it with safer alternatives such as steel (low-cost, widely available), bismuth (closer to lead performance, moderately higher cost), or tungsten (high performance, but premium cost), financed by producer levies and product standards
- Bring forward the EU deadline for lead pipe replacement from 2036 to 2030 (up to 90% reduction in lead exposure for up to 120 million people), co-financed by utilities, national budgets, and EU funds

Capture: improve sludge management to avoid further contamination
- Lower cadmium, mercury, and lead thresholds in fertilizers and sludge (from today's 20 mg/kg Cd, 16 mg/kg Hg, 750 mg/kg Pb) to align with stricter national standards. When limits are exceeded, apply alternatives such as sludge incineration for energy recovery or advanced pretreatment (ion exchange, activated carbon) co-financed through polluter-pays mechanisms

Shield: implement advanced treatment for drinking water treatment plants in polluted areas
- Deploy advanced treatment at drinking water plants in heavy metal hotspots to consistently meet <5 µg/L thresholds, ensuring clean drinking water at the plant even though lead exposure may still occur through ageing distribution pipes

Remediate: clean-up legacy contamination
- Remediate 200–400 kt/year of contaminated soils and sediments using excavation, stabilization, or secure disposal by 2030, costs borne by polluters where identifiable, and public funds covering diffuse or historical sources

129.(Berger, 2025) 130.(Berger, 2025)

EUR
226bn

investment opportunity over the next 15 years beyond current regulatory requirements

Investing in solutions for safer, more resilient waters in Europe

> – The thing is that we humans have protective barriers around us. We have technical solutions to clean and improve water quality before we drink it. Nature doesn't have that. That means we have the responsibility to protect nature – but we don't.
>
> **Ingo Fetzer, PhD**
> Researcher at Stockholm Resilience Center

Summa is committed to investing in solutions that address and eliminate pollution, protecting both human life and the natural world. While humans can safeguard our own health through knowledge, innovation, and financial means. Nature depends on our stewardship. It is our shared responsibility to ensure that progress does not come at the expense of planetary health.

Consequently, Summa recognizes the critical importance of mobilizing stakeholders across society to actively reduce human impact on the environment and to protect and restore ecosystems damaged by past harm.

According to GWI data, the total planned investments in treatment over the 2025-2040 period is EUR 420 billion (drinking water, wastewater and sludge management, including meeting the UWWTD and DWD requirements). The Water Health Scenario would require roughly 30% more than the GWI baselines in water treatment only.

In addition, the Water Health Scenario calls for EUR 106 billion across agriculture, site remediation, and microplastic capture. In total, this amounts to a EUR 226 billion investment opportunity over the next 15 years beyond current regulatory requirements.

We estimate that water-health markets can generate around EUR 370 billion in annual revenues by 2040, driven by growing demand for advanced treatment, resource recovery, and ecosystem restoration. These investments can also deliver attractive returns, with the valuation of Europe's water-health economy expected to exceed EUR 1 trillion by 2040, reflecting the full growth potential enabled by both the baseline and incremental investments identified in Summa's Water Health Scenario.

EU Directives sets a path to advanced pollution control in water by 2040

The EU's revised water directives (2024) mark a decisive shift from basic provision to advanced pollution control, setting out a EUR 21 billion investment path to safer water by 2040.

- Around EUR 15 billion will go into wastewater upgrades, mainly advanced nutrient and micropollutant treatment. The EU standards include PFAS limits of 100 ng/L (sum of 20) and 500 ng/L (total), but these remain well above the ≤ 2 ng/L benchmark for the sum of four PFAS applied in Denmark and advocated under the Water Health Scenario
- EUR 6 billion will strengthen drinking water systems, including meeting the first-ever binding PFAS limits

Alongside these headline measures, the directives also call for tighter monitoring, stormwater management, and coverage expansion to smaller towns. While the final legislation is less ambitious than the 2022 proposal, national estimates suggest that actual costs, particularly for PFAS removal, could exceed EU projections. Even so, these investments represent a decisive step toward safer, more resilient water systems across Europe.

EUR 226 billion additional investment to deliver the Water Health Scenario by 2040

Achieving the objectives of the Water Health Scenario by 2040 will require an estimated EUR 226 billion in capital expenditure over the next 15 years (2025-2040), or roughly EUR 15 billion annually, on top of existing estimated CAPEX spend and regulatory requirements.

The Water Health Scenario goes beyond minimum EU compliance. It accelerates and broadens the rollout of advanced treatment for wastewater, drinking water, and biosolids, bringing full pollutant removal and regulatory alignment by 2040, five years ahead of current EU timelines. This ambition ensures earlier health and environmental gains while positioning Europe as a global leader in integrated water management.

Beyond treatment, the scenario also includes complementary initiatives that strengthen water resilience across the entire system – from pollution prevention and infrastructure renewal to nature-based and circular solutions, and digital monitoring for smarter water management. Together, these measures deliver a holistic approach that not only meets regulatory goals faster but also tackles the root causes of pollution and water loss.

Reduce – Tackling agricultural pollution at its source

The Water Health Scenario commits EUR 28 billion to cutting nutrient and pesticide use through precision farming and better land management. It promotes precision farming on 25 % of EU farmland, improving input efficiency and reducing diffuse pollution at its origin. These measures address contamination before it enters the water cycle, strengthening the sustainability and competitiveness of European agriculture.

Capture – Building Europe's first line of defense against pollution

In the Water Health Scenario, wastewater treatment becomes the backbone of Europe's clean-water strategy. By 2040, all plants will achieve full nutrient removal, compared with around 65% coverage today. This step is critical to halting eutrophication and protecting freshwater biodiversity, requiring about EUR 24 billion in additional investment. Both chemical and advanced biological methods – such as Biological Nutrient Removal (BNR) and Membrane Bioreactor (MBR) systems – are scaled up to achieve this goal.

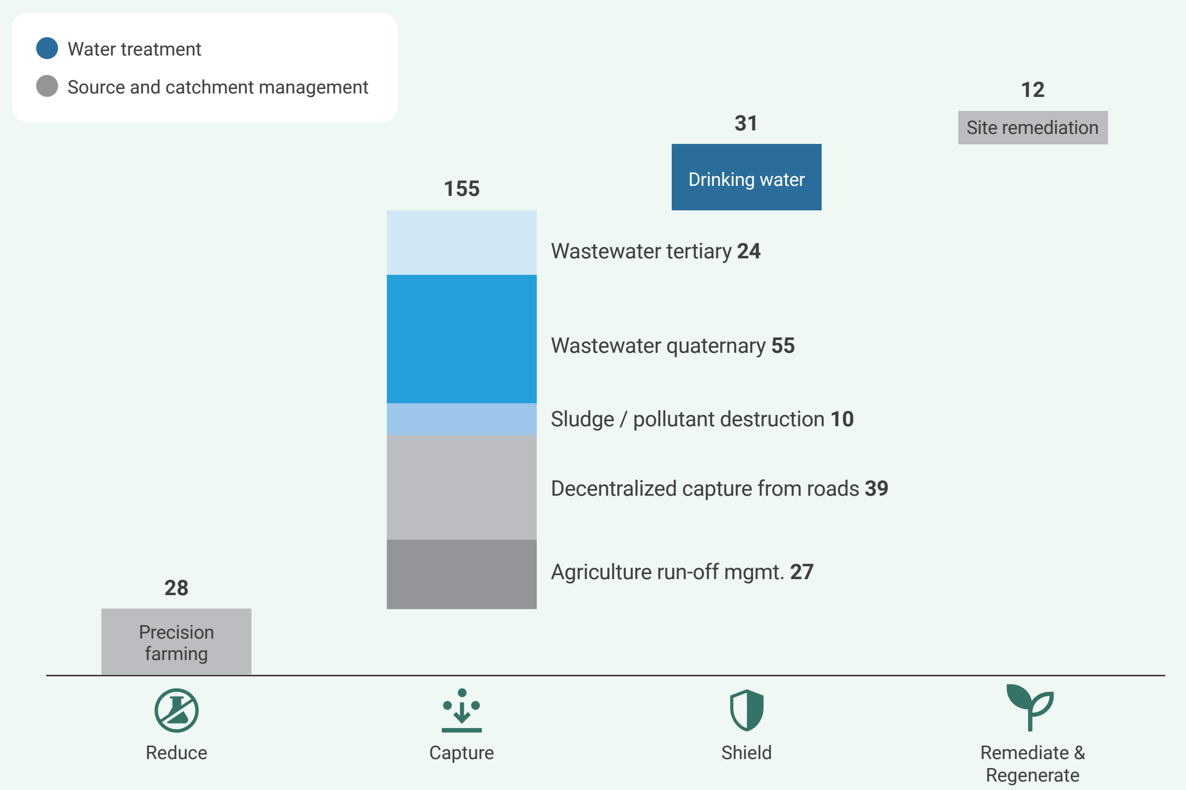
The scenario also accelerates removal of emerging pollutants. By 2040, all large and medium wastewater plants will apply advanced treatment for pharmaceuticals and microplastics, covering 80% of the EU population – five years ahead of directive timelines. Nanofiltration for PFAS is added in one-quarter of plants (45% coverage), while drinking-water treatment is reinforced with pre-filtration. Quaternary treatment adds EUR 55 billion in investments.

As advanced water treatment expands, sludge volumes are expected to rise by 20% by 2040. To prevent harmful substances from re-entering the environment, the scenario phases out land spreading and shifts to final destruction pathways. By 2040, 80% of all sludge produced will have a final destruction solution through incineration, thermal treatment, or advanced technologies such as Supercritical Water Oxidation. Achieving this transformation will require around EUR 10 billion in investment, ensuring that residual pollution from the water cycle is permanently eliminated rather than recycled back into soils or food chains.

Agricultural runoff management contributes a further EUR 27 billion, funding landscape-scale buffer zones, retention ponds, and drainage filtration that intercept pollutants before they reach water bodies.

Finally, EUR 39 billion supports decentralized storm-water capture, targeting 30% of Europe's Road network (~1.5 million km). Two filtration units per km, supported by retention ponds and biofilters, intercept tire-derived microplastics before they reach water bodies.

Figure 11
Breakdown of EUR 226 billion Water Health investments by intervention lever. → EUR bn



Shield – Protecting Europe's taps from emerging pollutants

The Water Health Scenario goes beyond current EU policy by expanding treatment coverage across Europe's drinking water systems. Instead of limiting advanced treatment to pesticides in surface water (~35% of supply), it introduces advanced treatment for both surface water and half of all groundwater sources, ultimately protecting 68% of the EU population.

This includes nanofiltration via low-pressure reverse osmosis (RO), combined with microfiltration/ultrafiltration pre-treatment, achieving over 90% PFAS removal, including short-chain compounds that conventional GAC systems cannot capture. The total investment required is estimated at EUR 31 billion between 2025 and 2040, positioning Europe to effectively safeguard its drinking water against PFAS, microplastics, and other emerging pollutants.

Lead pipe replacement is already mandated under the Drinking Water Directive. The Water Health Scenario does not expand this obligation but accelerates the timeline from 2036 to 2030, ensuring earlier health benefits.

Remediate & Regenerate – Restoring what's left

The Water Health Scenario advances large-scale remediation of Europe's most contaminated industrial and mining sites. It combines soil washing, excavation, hydraulic containment, and in-situ stabilization to halt pollutant migration and eliminate residual PFAS and heavy-metal contamination near water catchments. This final clean-up phase will require around EUR 12 billion by 2040, restoring the natural filtration capacity of soils and aquifers and removing some of the continent's most persistent sources of human and ecological risk.

Financial feasibility and scale of Water Health investments compared to current spending

Polluter pays mechanism

To realize the Water Health Scenario, polluters must bear a greater share of costs while consumers recognize the true value of water. The polluter/producer pays principle is gaining traction, especially for PFAS: France has introduced a levy of EUR 100 per 100 g of new PFAS emissions,[131] while in Sweden, courts have held the Defense Force liable for PFAS clean-up in Uppsala.[132]

For the additional Water Health investments, a lower recovery rate is assumed: polluters would cover 40% of the incremental effort for quaternary treatment and sludge destruction. This equates to EUR 38 billion, or about one-third of the EUR 120 billion needed for drinking, wastewater and sludge investments. In addition, polluters are projected to finance 80% of site remediation costs.

Reaching the Water Health Scenario by 2040 will demand about

30%

higher yearly investment in water treatment

131.(Mandard, 2025) 132.(Sweden Herald, 2025)

> – According to major French agricultural cooperatives, the cost of motivating farmers to commit to these agro-ecological transitions is estimated at EUR 150 to 200 per hectare per year.
>
> **Philippe Mauguin,**
> CEO and PDG, INRAE

Beneficiary pays mechanism
Beneficiary pays schemes reward environmental services and promote less polluting production, offering the greatest potential in agriculture. Organic food is the most established model: it already represents over 10% of EU farmland,[133] with an EU target of 25% by 2030.[134] These mechanisms complement public and private finance by linking consumer or beneficiary contributions directly to water-quality outcomes. In particular, precision farming, constructed wetlands, and regenerative soil management central to the Water Health Scenario.

A recent interview with Soil Capital, a leading regenerative agriculture platform, highlights how the beneficiary pays models are already taking shape in practice. Operating across 500,000 hectares with 1800 Farmers in Europe, Soil Capital has paid close to EUR 16 million to farmers for regenerative practices. Their performance-based approach starts with a baseline carbon assessment and then rewards annual improvements, not only in carbon, but increasingly in water quality and biodiversity outcomes.

Under this approach, farmers are recognized as land and water stewards rather than polluters to be penalized. Companies contract directly with farmers through insetting schemes, typically paying EUR 30–50 per hectare for regenerative practices. While this is still below the full transition cost of ca. EUR 150–200 / ha, the model demonstrates how corporates can begin to align their Scope 3 climate strategies with wider ecosystem services.

Crucially, when considering the positive externalities of regenerative farming, the societal return is even greater. For instance, the avoided water treatment costs alone can amount to EUR 200–400 per hectare. This illustrates how beneficiary-payer mechanisms, if scaled, could channel value not just to farmers but to society at large, reinforcing both the Water Health Scenario and other vital systemic transitions.

EU funds needed for the agricultural transition and affordability
Tackling agricultural pollution requires shared financing models rather than placing the burden solely on farmers. In 2023, Nature-Based Solutions (NBS) investment in Europe reached EUR 10.8 billion, with 79% funded by EU-level instruments. Among these, the EAFRD, contributed USD 5.7 billion to sustainable agriculture and forestry.[135] Transition costs should be supported by time-bound EU financing, phased out once farms achieve profitability gains from lower input use, greater resilience, and possible price premiums. To ensure fairness, the EU should also introduce mirror clauses and targeted tariffs on imports produced with pollutants banned in the EU. The Water Health Scenario builds on these blended mechanisms – EU funds, national budgets, and private capital – to scale up NBS and curb agricultural runoff.

Beneficiary pays mechanism can also be further promoted through water tariffs and development of water reuse
The Water Health Scenario leaves EUR 82 billion in costs not covered by polluter pays, or about EUR 5.5 billion annually. This would require water bills to rise by 7–13%, depending on operating cost increases.

The impact will vary across Europe: high-income countries with established cost recovery can absorb the rise, while lower-income Member States will need phased implementation and protections for vulnerable households. Over time, innovation and large-scale investment are also likely to reduce costs, as seen in the case of desalination and other advanced water technologies. Strong public communication and visible benefits such as expanded wastewater reuse and advanced treatment will be essential to build acceptance and create a sustainable financial base.

Cost of action vs inaction
Investing in water health is a "no-regret" choice when compared to the costs of inaction. The European Commission estimates that delayed implementation of environmental directives creates an annual investment gap of EUR 122 billion and costs the EU economy EUR 180 billion per year, nearly half linked to pollution.[136] EU impact assessments also confirm strong benefit–cost ratios, with nutrient removal investments more than doubling their value in health and ecosystem gains.

133.(IFOAM Organics Europe, 2025) 134.(European Commission, 2020) 135.(Smith, et al., 2025) 136.(European Commission, 2025)

Theory of change: connecting systems change to investment opportunities and impact

Impact
Indirect impact

Impact represents the long-term, systemic change that results from sustained outcomes. It moves beyond immediate results to deliver broad societal and environmental benefits that align with Summa's mission. For Summa's Water sub-theme, this means realizing a future where everyone can trust in the safety, availability, and quality of water as a foundation for resilient communities, healthy ecosystems, and sustainable growth.

Achieving this vision requires collaboration across industry, academia, regulators, and communities, as no single actor can drive this transformation alone. Regulatory changes, as outlined earlier, are essential to accelerate progress. This theory of change guides all our activities, ensuring we remain focused on creating positive, lasting impact for Europe's water systems and the people who depend on them.

Input
Direct impact

Summa's core input is our investments in resilient, high-performing companies that solve global challenges. Through direct investments in sectors such as water, we contribute to shaping a more secure and sustainable water future.

Summa also invests significantly in partnerships and industry knowledge. Our team works alongside leading water specialists, including Bertrand Camus and Aurélia Carrère. Their knowledge and experience in the field are instrumental in guiding our strategies and ensuring we stay at the forefront of industry developments and have a clear guide for our sourcing work. To ensure that our theory of change considers the latest scientific findings, we partnered with Roland Berger, who has consulted leading research institutions and the European Commission on flagship water regulations.

The Summa community of portfolio companies is a vibrant network of knowledge sharing, collaboration, and continuous improvement. We regularly host events that bring together industry leaders, researchers, and stakeholders to inspire innovation and share best practices, including in water and circularity. These forums help our companies stay ahead of emerging risks, align with regulatory expectations, and build secure-by-design systems that support both operational excellence and trust.

Activity
Direct impact

Summa's Water Health investment strategy spans the full value chain. It includes early-stage advisors designing nature-based solutions; suppliers and innovators upgrading drinking water safety and biosolids valorization; asset owners and service providers deploying advanced treatment and destruction of forever chemicals; and companies safeguarding human health at the tap, restoring polluted soils, and enabling real-time water quality monitoring. Together, these companies address critical leverage points for building resilient, circular, and future-ready water systems. These sectors are more than just avenues for water resilience. They represent the next frontier of high-impact, high-growth investment opportunities. We believe that by investing in these areas, we can unlock both significant financial returns and systemic change.

Summa solutions
Navigate to the next page to learn more about the water activities that we invest or seek to invest in, and their alignment with our theory of change.

Investing in Europe's water health: from toxic to thriving

Output
Direct impact

The Water sub-theme sits within Summa's Circularity investment theme, where portfolio companies are expected to deliver tangible operational improvements in water quality and pollution control. These outputs demonstrate direct, measurable contributions towards restoring Europe's water health.

At a company level, key metrics include:
- Freshwater withdrawal (m^3/year)
- Water consumption and efficiency ratio (m^3/unit of output)
- Volume of water reclaimed or recycled (%)
- Compliance rate of discharged wastewater with local or EU standards (%)
- Concentrate and brine management performance (share of safely treated or valorized concentrate)
- Pollutant load removed (kg COD/N/P per year)
- Energy intensity of water treatment (kWh/m^3)

Beyond the water sector itself, our Water Health theory of change highlights the critical role of agricultural and industrial practices in preserving human and ecosystem health. Companies operating upstream are therefore expected to report on:

- Pesticide consumption (kg active ingredient/ha)
- Nutrient run-off and leaching (kg N or P/ha/year)
- Soil restored or remediated (hectares or tons treated)

Sectors contributing to microplastic pollution, such as tire manufacturers, textile, and packaging producers, should also track microplastics emissions (grams released per tons of product or percentage reductions year-on-year).

Outcome
Indirect impact

Building on these company-level outputs, the expected outcomes reflect broader improvements in human health and ecosystem integrity, as outlined in the Water Health Scenario. These outcomes capture the system-level progress achieved when multiple interventions align across sectors.

Improvement of people's health
- Reduction in the population exposed above health safety limits in drinking water for PFAS, pesticides, and heavy metals – from >200 million to <25 million inhabitants by 2040
- Sevenfold reduction in the average annual microplastics ingestion per person (from 20,000 particles per year to 3,000 particles per year)

Restoring ecosystem quality
- Stabilization by 2040 of PFAS and microplastics stocks in the environment, following a temporary rise due to legacy pollution release
- 50% reduction in average nitrate concentration in aquifers (e.g., from >50 mg/L to <25 mg/L)
- 50% reduction in pharmaceutical residues reaching surface waters
- Reduction in annual heavy metal inputs to soils by >40%, especially in agricultural and industrial areas

Rebuilding ecological integrity
- Achieving ~75% of EU water bodies in compliance with Environmental Quality Standards by 2040, compared to ~40% today (EEA baseline)

While more complex to quantify than outputs, these outcomes represent the true indicators of progress – showing how the collective performance of Summa's portfolio contributes to healthier people, cleaner ecosystems, and more resilient water systems across Europe.

Activities we seek to invest in:

Achieving the Water Health Scenario demands targeted investments across the entire water cycle, from source protection and pollution removal to the destruction of pollution concentrates and continuous water quality monitoring. With growing regulatory pressure and urgent environmental needs, there are clear opportunities for private capital to accelerate the shift toward safer, cleaner, and more circular water systems.

Summa focuses on companies that operate across the water cycle, turning pollution prevention and remediation into measurable impact.

Assist: advisor for water health
Weak protection at source allows pollutants to enter water systems long before treatment. We invest in firms that design and engineer nature-based solutions (NBS) to intercept contaminants where they arise, from agricultural nutrients to microplastics in stormwater.

These companies deliver end-to-end design and turnkey runoff capture systems, such as vegetated buffer strips, retention ponds, and constructed wetlands. Their work strengthens catchment resilience, prevents diffuse pollution, and forms the foundation of water-system protection.

Shield: potector of drinking water safety
Meeting Europe's tightening PFAS and micro-contaminant standards requires quaternary-level treatment. We invest in equipment suppliers and solution integrators that provide advanced membrane, ion-exchange, and adsorption technologies to ensure safe, potable water.

Our focus is on scaling proven solutions while advancing next-generation, low-energy membranes that cut operating costs and environmental impact. These innovations make high-grade treatment economically viable and sustainable across diverse geographies.

Recover: generator of value from biosolids
As land application of sewage sludge is phased out, utilities must adopt circular waste strategies. We invest in companies that build and operate digestion, gasification, and energy-recovery assets, transforming sludge into renewable energy and valuable materials.

Emerging hydrothermal gasification technology destroy contaminants while recovering energy and phosphorus. By closing resource loops and minimizing landfill dependency, these solutions align circularity with environmental protection.

Remove: remover of emerging pollutants
Persistent pollutants such as PFAS, pharmaceuticals, and microplastics demand advanced water and wastewater treatment. We invest in turnkey suppliers, EPC contractors, and modular treatment providers delivering tertiary and quaternary systems. This includes ion-exchange, granular activated carbon, ultrafiltration, and reverse osmosis.

Mobile and rental units allow utilities to manage compliance risks before committing to permanent infrastructure. These models expand access to cutting-edge treatment and offer utilities both flexibility and resilience as regulation tightens.

Destroy: destructor of pollutant concentrates
Concentrates and sludge containing PFAS and similar compounds must be completely destroyed to prevent recontamination. We invest in firms deploying supercritical water oxidation, electrochemical, hydrothermal, and plasma-based destruction systems.

These providers convert hazardous residuals into inert end-products, ensuring full regulatory compliance. Their onsite and offsite service models enable utilities of all sizes to achieve permanent pollutant elimination at scale.

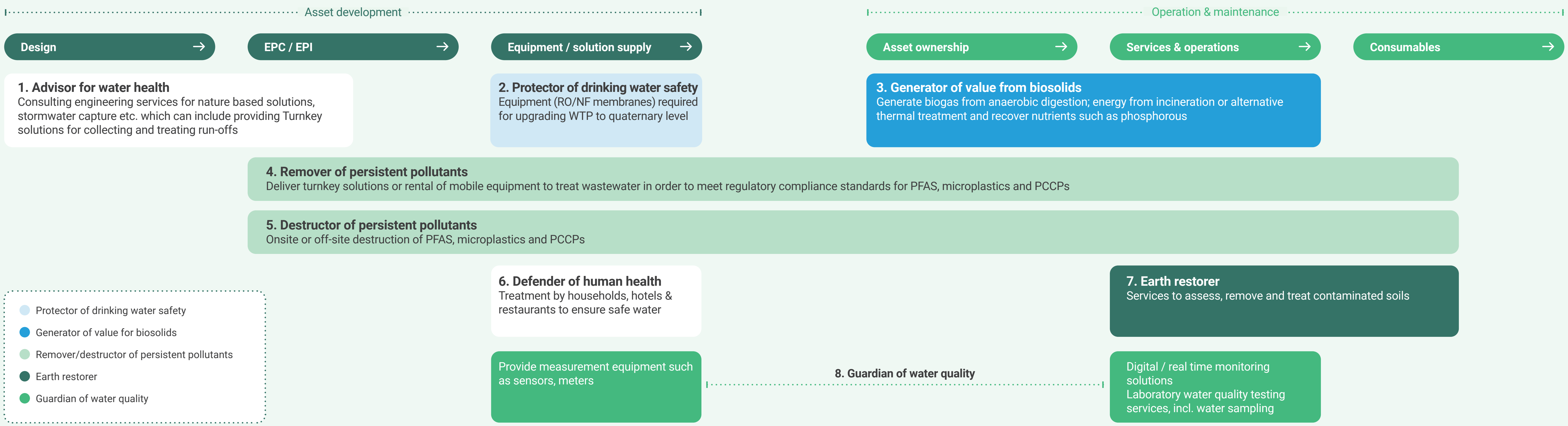
Restore: restorer of the earth
Soil contamination undermines groundwater safety and ecosystem recovery. We invest in specialist remediation and restoration firms using bioremediation, chemical stabilization, and soil washing to remove or neutralize pollutants such as PFAS and heavy metals.

These services prevent leaching, restore ecological function, and unlock the environmental and economic value of degraded land, making soil restoration an essential link in circular land and water management.

Monitor: guardian of water quality
Reliable data underpins effective water management. We invest in digital monitoring platforms, laboratory testing services, and sensor technologies that enable real-time tracking of water quality and system performance.

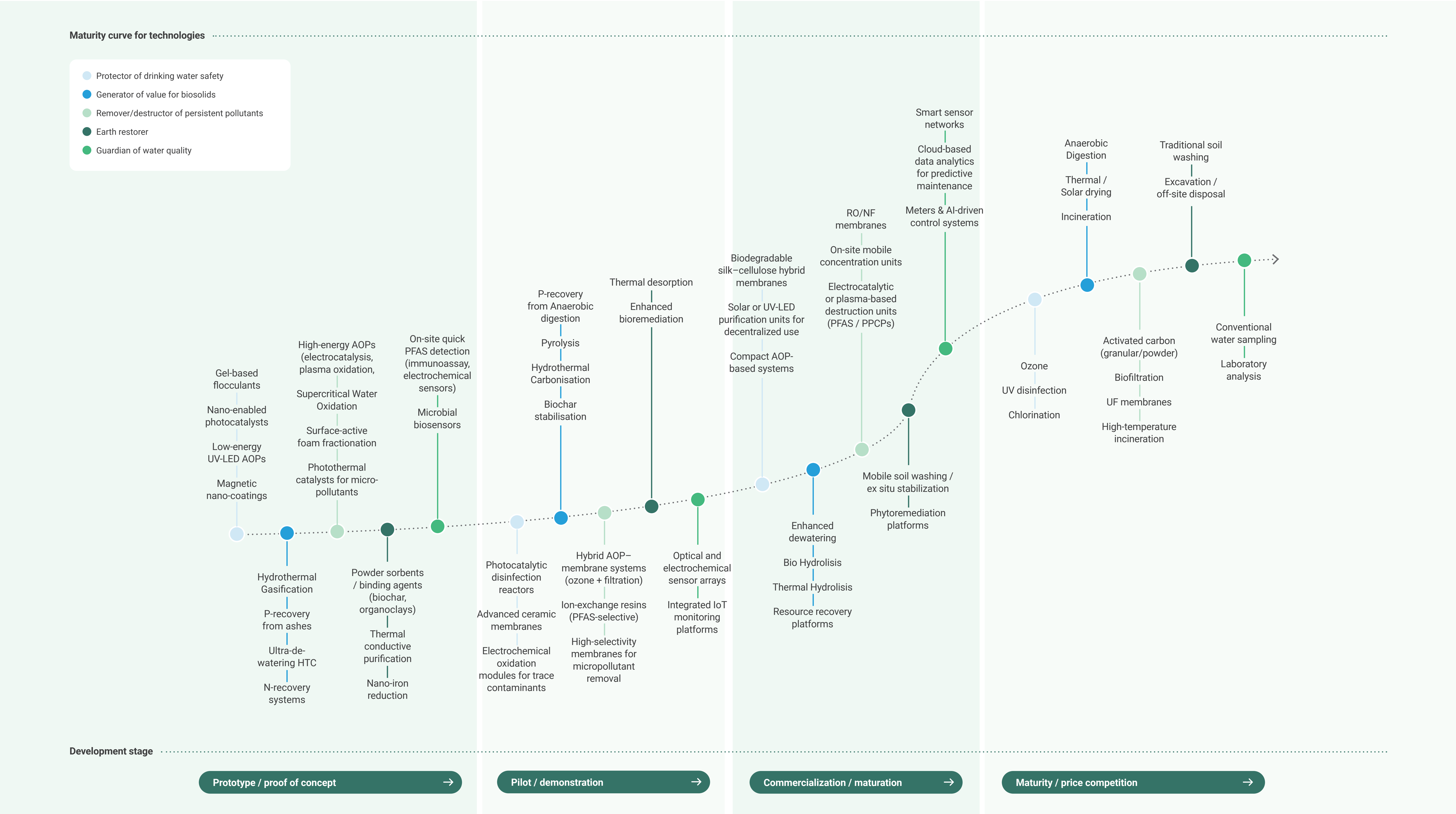
By combining analytics, smart meters, and predictive tools, these companies detect emerging pollutants early, optimize treatment, and verify compliance. Their integrated equipment-and-data model provides recurring revenue and anchors the digital transformation of the water sector.

Figure 12
Investment opportunities in the water value chain



Note: This section focuses specifically on investment opportunities across the full water-sector value chain — from design and equipment supply to operations and asset ownership. It reflects a different analytical lens from the Water Health Scenario, outlining activities within the water sector only rather than the four systemic levers (Reduce, Capture, Shield, Remediate) and thereby excluding agricultural and cross-sector interventions

Figure 13
A wide range of water technologies are ready to scale



A call to action: turning ambition into collective action for water health

Water health is not only a risk – it is one of the most compelling investment opportunities of the decade.

The current trajectory of water pollution presents growing systemic risks. Without coordinated action, Europe will remain in a cycle of costly, reactive responses that fail to address root causes.

The transformation ahead requires a system that prevents pollution before it occurs and restores what has been lost. This means rethinking how capital, policy, and industry work together to move from fragmented responsibility toward shared accountability.

Investors can accelerate this shift by directing long-term capital toward solutions that transform the way water is valued, managed, and restored. Policymakers must create stable, coherent frameworks that link incentives to measurable environmental outcomes. Industry should go beyond compliance to redesign processes and products around circular and zero-pollution models. It also means adopting a stance of anticipation, ensuring that innovation never outpaces our ability to manage its consequences. From advanced polymers to nanomaterials, new developments must be approached with hyper vigilance, assessing their persistence and long-term ecological risks before they become tomorrow's pollutants. Citizens, as voters and consumers, play a role in demanding transparency, accountability, and healthier products that safeguard water, health, and ecosystems.

Real progress will come from collaboration, bringing innovation, financing, and governance together behind a single objective: restoring water as the foundation of Europe's resilience and prosperity.

Those who lead this transition today will shape a future where safeguarding ecosystems and generating sustainable growth are one and the same. Now is the time to turn ambition into action: to invest in Europe's water health and secure the foundations of its sustainable future.

Summa's Water Health Scenario:

75%

of water bodies will achieve compliance with the EU quality standards in 2040

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