Water services and climate change:

Winning innovations delivering greater resilience

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Climate change places our water resources under enormous pressure. Depending on the particular region, it leads to increasing shortages, severe droughts and ever-growing pressure on essential infrastructure. Water services have to evolve if they are to deal with these urgent challenges. Innovation plays a crucial role in this transformation: advanced leak detection techniques, proactive management of corrosion, and reuse of treated wastewater are all key solutions for optimizing how this precious resource is managed and guaranteeing a reliable supply.

And the challenges don't end there. To stave off water stress and preserve this vital resource, there is an urgent need to adopt alternative strategies such as groundwater recharging, forward planning to anticipate vulnerabilities in drinking water production systems triggered by climate change, and rolling out frugal solutions that use less water. It is equally vital that sewer systems are reinforced so they can better deal with heavy rainfall and pollution.

Read on to discover how these solutions are transforming water management and tackling climate challenges while also working to protect public health.

INTRODUCTION

WATER: A MARKER OF CLIMATE CHANGE

Climate change is disrupting water cycles, leading to extreme weather events such as droughts, flooding, storms and coastal flooding. These disruptions also have a direct impact on public health, particularly by degrading water quality, which in turn favors the propagation of water-borne diseases. Around 36% of the global population already lives in a region where water is rare, and according to the IPCC this could climb to 40% by 2040.[1] The impacts of these events are amplified by urbanization and migration, which increase the need for water

1 Intergovernmental Panel on Climate Change (IPCC, 2021). IPCC Sixth Assessment Report: Climate Change 2021 – The Physical Science Basis. Cambridge University Press.

and overload existing infrastructure. An instructive figure to bear in mind is that 90% of natural disasters are linked to water[2], due to resource scarcity or extreme events.

ADAPTATION AND MITIGATION STRATEGIES: BOOSTING THE RESILIENCE OF WATER SERVICES

Operators of water services[3] face a major challenge that centers on managing chronic water shortages and very heavy rainfall while maintaining water quality to protect public health. They have to anticipate crises, ensure continuity of services, and adapt their infrastructure while simultaneously making plans for long-term solutions. This critical challenge facing operators and regional authorities requires them to constantly re-evaluate systems and adapt investment plans. This article explores the strategies used to boost the resilience of water services, with a special focus on challenges relating to water stress and flooding.

Without water no organism, be it human, animal or plant, can survive. However, its availability and quality are threatened around the world by climate change, a reality that has major repercussions on public health. Rising incidences of drought and flooding, persistent obstacles to rolling out WASH (water, sanitation and health) infrastructure to all corners of the planet, and the growing vulnerability of infrastructure to climate disasters are forcing water operators to revise how they manage their water resources so they can maximize its availability. Close to one in eight Europeans lives in an area potentially at risk of flooding, while 30% of people living in southern Europe have to deal with permanent water stress.[4] These phenomena demand immediate solutions: reduction of leaks, sustainable infrastructure management, adoption of less resource-intensive water management solutions, and interconnection between networks and wastewater reuse. As of right now, operators need to prepare for the future by adapting their drinking water production systems, for example, by planning solutions based on groundwater recharging to guarantee a resilient supply source.

NEW TECHNOLOGIES FOR TRACKING AND REPAIRING WATER LEAKS

Fighting water wastage is a priority and the first step is detecting and repairing leaks. Globally, on average leaks account for 30% of the volume of drinking water produced, rising to as much as 50% in certain aging networks. This massive wastage compromises our water resources and leads to much higher costs.

To reduce leaks, water operators use a mix of conventional and innovative technologies, such as acoustic correlation, which uses analysis of the speed of sound to locate leaks, and tracer gas to find faults in pipes. Acoustic sensors detect noise generated by leaks, making it possible to locate them with a high degree of accuracy, even in complex environments. In 2023, sensors resulted in a 15% cut in water losses in the Barcelona network, as well as a 20% fall in leaks over five years in the network used for Bordeaux, France. However, major leaks sometimes go undetected.

Innovative new techniques are being tested: in France a project called Echoleaks uses acoustic sensors and artificial intelligence to create a “digital ear” to assess the severity of leaks, quantify the volumes of water lost, and prioritize the order of repairs. Other solutions are already in operation, such as LeakTracker from Alcom Technologies, which uses a smartphone to detect leaks in less than 60 seconds, and sniffer dogs trained to spot the presence of traces of chlorine that provide an effective alternative in several regions.

REDUCING CORROSION TO MAKE WATER NETWORKS MORE SUSTAINABLE AND MORE RESILIENT

Aging infrastructure, particularly pipes, is very vulnerable to climate change impacts such as flooding and drought.[5] The main cause of failure is not age but corrosion, which weakens networks and can lead to breakages and leaks.

Corroded water pipe

If corrosion is not proactively managed, metal pipes will degrade at an accelerating rate, increasing maintenance costs and leading to interruptions in drinking water distribution. Even when water meets applicable standards, if it is corrosive – or the surrounding soil is corrosive – it can weaken networks, making them more vulnerable to extreme climate events.

2 The human cost of weather-related disasters 1995-2015. (November 24, 2015). UNDRR. https://www.undrr.org/publication/human-cost-weather-related-disasters-1995-2015.

3 **Water and sanitation services** are responsible for distributing drinking water to water service customers as well as collecting and treating the wastewater these customers produce.

4 European Environment Agency. (2024). Climate health risks posed by floods, droughts and water quality call for urgent action.

5 OECD. (2024). Infrastructure for a Climate-Resilient Future. OECD Publications. https://doi.org/10.1787/a74a45b0-en.

A research program called CROWN (Corrosion & Reliability Optimization of Water Networks) provides a proactive approach to tackling this issue. By using **corrosion coupons** to measure the speed of pipe deterioration, the critical zones that are corroding the fastest can be identified. This then allows **adjustments to the water's physicochemical profile**, via remineralization treatments or optimizing chemical dosages at the treatment works.

This approach reduces the corrosiveness of the water, extends the service life of infrastructure, and guarantees a reliable water supply while also increasing the resilience of water services in the face of climate events.

The research project has been successfully rolled out in several areas in France where Veolia is contracted to provide water services. In Sablé-sur-Sarthe it slowed the speed of corrosion by up to 50% in certain areas.

WATER SUFFICIENCY: EVERYBODY IS INVOLVED!

Adopting sustainable water-use habits is crucial to relieving pressure on resources used to produce drinking water. There are an array of solutions, from technical to price-based, including remote meter readings.[6]

FLOODING: URBAN FLOOD SOLUTIONS

As well as shortages of water and increasingly frequent droughts, we are also witnessing periods where there is **too much water. Flooding**, more frequent and severe as a consequence of climate change, poses a major challenge to water services. The increase in very heavy rainfall, rising sea levels and ever-growing urban spread combine to accelerate water run-off and multiply the risks of flooding. And flooding adversely impacts water quality by transporting pollutants and sediments and placing enormous strains on sewage infrastructure. To strengthen the resilience of water systems in the face of flood risks, it is essential to implement solutions that combine risk management with sustainable infrastructure.

These include **hydro-meteorological management** to monitor and predict weather conditions in real time, making it easier to react quickly in the face of extreme events. For example, the town of Dinard in France uses hydrodynamic valves to limit spillage during heavy rain, leveraging the storage capacity of its collection basins. In the city of Nimes, a plan known as AR3ENE combines early warnings, obtained by analyzing past events and looking at hydrometeorological parameters, with constant surveillance to organize preventive measures and targeted emergency interventions. The town of Tønder in Denmark, which has experienced severe flooding during the past decade caused by rising sea levels, has set up a dynamic system to manage its rain water collection and storage installations in real time. The system uses artificial intelligence and can provide authorities with as much as six hours' notice of imminent flooding.

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Equally, **dynamic management of wastewater networks** also helps prevent spillages during heavy rain. For example, Kolding in Denmark uses a real-time surveillance system (Hubgrade Performance Sewer) to optimize wastewater flows, avoid spillages and reduce energy costs.

In some cases a more comprehensive approach is needed, including **flood forecasting and systems to warn local people directly**. In the Bièvre valley, near Paris, an early-warning system warns residents in the event of a flood risk based on forecasts that are updated every five minutes, a three-hour lead-time and a 2D hydraulic model that displays at-risk zones in real time. Since it was set up the system has been used to manage floods comparable to those experienced in the 1980s, but with far less damage incurred.

Other solutions, based on **collecting and storing rainwater** in temporary accumulation zones, provide innovative approaches to attenuating the risk of flooding. In Alicante, in Spain, El Marjal city park is a 3.6-hectare site that includes green spaces and two ponds that can hold up to 45,000 cubic meters of rainwater. This artificial wetland supports local biodiversity as well as offering local people a recreational area.

Finally, in cases where preventive measures prove insufficient,**crisis management solutions** become crucial for maintaining drinking water supplies and restoring wastewater infrastructure in the aftermath of an extreme climate event. In 2019, storm Alex

6 For more details, please see Sufficiency: challenges for Veolia Water France, an article in the 2024 issue of FACTS on the social and economic challenges of sufficiency: Source : Veolia Institut. (2024). Sufficiency: Challenges for Veolia Water France. In FACTS: Social and economic challenges of sufficiency (Edition 26). https://www.institut.veolia.org/sites/g/files/dvc2551/files/document/2024/10/Veolia_FACTS_26_2024_GB_Web_Interactif_0.pdf.

caused widespread destruction in the Alpes-Maritimes region of France, with exceptional volumes of rainfall, flooding, partial destruction of several villages and considerable loss of life. An operational center was set up in Breil-sur-Roya to coordinate repair work, including laying pipes for drinking water supplies and connecting to water sources, as well as the use of mobile sewage treatment units to restore essential services as rapidly as possible.

These crises illustrate the importance of having a rapid response capability as well as underlining the need to adapt drinking water production to anticipate future needs in the light of new climate challenges.

ADAPTING DRINKING WATER PRODUCTION IN THE FACE OF CLIMATE CHALLENGES

Climate change leads to greater scarcity of water resources, rising temperatures, flooding, and lower water quality, which is a threat to drinking water production. There is now a vital need to adapt water systems, particularly in regions afflicted by water stress, as required by France's **2021 Resilience and Climate Act**.[7]

If they fail to adapt, regions risk experiencing **water shortages, high operating costs**, and **weak infrastructure**, threatening continuity of service. This is precisely the problem facing the **Toulouse metropolitan authority**, which has entrusted management of its drinking water to SETOM, a Veolia company, tasking it to forecast impacts likely to affect the city in the period 2035-2050.

To meet these challenges, teams from Veolia carried out a study to identify the **system's vulnerabilities according to different climate scenarios**, evaluate risks facing drinking water production, and improve the scaling of future infrastructure. The diagnosis of Toulouse's vulnerability centered on three areas: analysis of previous climate events, examination of the vulnerability of its infrastructure, and an assessment of the financial impacts (operating costs versus capital investment costs). This approach will be rolled out at other sites to increase the robustness of climate risk assessment and provide adaptation recommendations that are more detailed.

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WATER IS FAR TOO PRECIOUS TO BE USED JUST ONCE!

Faced with droughts, water shortages and water stress, **reuse of treated wastewater** offers an important alternative solution for preserving **freshwater resources**. Yet in France less than **1%** of wastewater is reused, compared to countries such as Israel where the reuse rate is as high as **90%**. While the technologies for treating wastewater to make it suitable for reuse are well known to water operators, uptake in France continues to be hampered by **regulatory restrictions**.

Bearing in mind what is at stake, research and innovation have played a key role over the past decade, demonstrating the absence of health risks posed by wastewater reuse solutions as well as optimizing their implementation. Standout projects include **Irri-Alt'Eau**, which tested the benefits of micro-irrigation for vines using treated wastewater, and **SmartFertiReuse**, combining wastewater recovery with optimized management of fertilizers in agriculture.

These advances have resulted in the development of a safe and reliable solution: **ReutBox**, which makes reused wastewater accessible for the uses permitted by France's public health rules.

Reutbox is a **plug & reuse** system capable of reusing anywhere from **5 to 20 cubic meters** of wastewater every hour. Already in use at over **30 treatment plants** in France, the technology has resulted in annual drinking water savings of **15,000 cubic meters in Narbonne** and **18,000 in Rodez**. The recycled water covers the plants' **internal water needs**, for tasks such as preparing polymers, cleaning equipment and, more infrequently, cleaning premises or watering green spaces without having to apply for official authorization. In configurations where it meets type-A quality criteria and with the appropriate authorizations, it can also be used to cover **external needs** locally, such as high-pressure water jetting or street cleaning.

7 Légifrance. (2021). Act no. 2021-1104, dated August 22, 2021, on fighting the climate crisis and strengthening resilience to combat its effects. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000043956924.

GROUNDWATER RECHARGING: AN EFFECTIVE SOLUTION FOR COMBATTING WATER SHORTAGES

Around 95% of freshwater comes from groundwater reserves, as does a large part of the water we consume (25% to 40%).[8] However, disruptions to the natural water cycle caused by climate change compromise the **natural process of groundwater recharge from rainfall**. According to the IPCC, there may be a 10% to 30% reduction in groundwater recharging around the world by 2070,[9] leading to problems such as finding a balance between the availability and need for water and water-related conflicts.

Southern Europe is badly impacted, **Spain** in particular, with **60%** of the country suffering from a water deficit and water reserves in 2022 at their lowest levels in **25 years**. One interesting response to this critical situation is an initiative to **infiltrate reclaimed wastewater to groundwater** so they can be recharged. This is the goal of **LIFE Matrix**, a **36-month project** co-financed by the European Union that aims to demonstrate the technical, environmental and health feasibility of **managed groundwater recharge** using reclaimed water in the **Costa del Sol**.

The planned treatment techniques combine **physicochemical and biological processes** with **nature-based solutions**[10] such as artificial wetlands. Thanks to these advanced treatments, wastewater will be transformed into **very high quality water,** suitable for reinfiltration into groundwater. Concretely, **50,000 cubic meters** of recycled wastewater will be used to recharge groundwater in the **Costa del Sol**, delivering a **15%** increase in available underground water reserves.

Another initiative, **artificial groundwater recharging**, consists of compensating for falling groundwater levels by infiltrating water from alternative sources, such as rivers, into groundwater. During high-water periods, excess water is re-routed and infiltrated to boost groundwater levels. This technique offers an effective alternative to dams by limiting the evaporation and eutrophication of surface waters. Widely used in Australia and California, but far less in France, the technique regenerates groundwater, limits evaporation, and prevents salt contamination of coastal groundwater.

A trial run by the Mining and Geological Research Bureau uses excess water drawn from the River Garonne in springtime to refill alluvial groundwater. The water temperature of 14-15°C helps combat warming of the river. This project forecasts a deficit in excess of a billion cubic meters of water by 2050, highlighting the importance of this solution for managing water stress. In addition to regenerating groundwater reserves, the technique mimics the natural infiltration cycle, limits evaporation and eutrophication, and contributes to biodiversity. However, it can alter hydrological balances and presents pollution risks if the quality of the infiltrated water is not properly controlled.

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NATURE-BASED SOLUTIONS AS KEY COMPONENTS IN WATER SERVICE RESILIENCE IN THE FACE OF CLIMATE CHANGE

Nature-based solutions provide an approach that uses natural processes to tackle environmental and climate problems. For example, restoring wetlands makes it possible to recharge groundwater, prevents flooding and promotes biodiversity. Similarly, making cities greener and more permeable helps them absorb rainwater, which in turn reduces the risk of flooding in the city.

8 *Les nappes phréatiques [Groundwater], Agence de l'Eau Artois-Picardie* (n.d.). https://www.eau-artois-picardie.fr/education-leau-dossiers-thematiques/les-nappes-phreatiques#:~:text=Environ%2095%20%25%20de%20l'eau,infiltrations%20of water%20de%20pluie.

9 IPCC. (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-4/.

10 **Nature-based solutions** are actions designed to protect, sustainably manage, and restore ecosystems to address issues such as climate change, water management and biodiversity while also providing benefits to society.

These solutions offer many advantages. They help mitigate the effects of flooding, improve water quality and boost the resilience of ecosystems in the face of extreme climate events. Nature-based solutions are often also cheaper than traditional infrastructure in the long term. This focus on resilience drives Veolia in its commitment to deliver actionable solutions for saving water, illustrated by a key indicator: volume of freshwater saved.

POWERFUL COMMITMENTS FOR SAVING WATER, TRANSLATED BY A KEY INDICATOR: VOLUME OF FRESHWATER SAVED

With climate change making it critical to save freshwater resources, Veolia is actively committed to protecting this vital resource. Veolia has set up a key indicator, **annual volume of freshwater saved**, aiming to save 1.5 billion cubic meters of water by 2027. The indicator is based on three components: volume of water reused post-treatment, volume of water desalinated, and volume saved thanks to improvements in yields in drinking water networks. Veolia is implementing a range of concrete solutions to help it meet its target: reducing the amount abstracted and increasing recycling at its drinking water plants and industrial sites; a 40% cut in pipe leaks in France to reach a rate of under 10% in most parts of the country; encouraging water sufficiency, and supporting farmers to switch to less water-intensive practices.

WASTEWATER: A VALUABLE HEALTH INDICATOR FOR THE CLIMATE EMERGENCY

Water services are boosting their resilience in the face of climate change thanks to solutions that are ecological, such as nature-based solutions, and innovative, all while protecting human health. Wastewater can also be an invaluable source of public health indicators. The climate emergency leads to variations in temperature and rainfall that **encourage the propagation of vector-borne diseases**. With these growing risks, wastewater can act as an advanced early-warning tool to identify the propagation of emerging pathogens.

During the Covid-19 pandemic, wastewater was an essential tool for monitoring and anticipating changes in how the virus was circulating. This approach, known as wastewater-based epidemiology, was successfully applied by Veolia's research teams in 2020. Veolia's researchers demonstrated the validity of this surveillance approach by developing an innovative services model based on the use of digital PCR[11] and an online dashboard using operational data (rainfall, sewage plant loading, etc.) to provide the analysis with context. The solution was used to **forecast peaks in hospitalizations as much as two weeks in advance**, giving local authorities an important head start so that they could react efficiently to the evolving epidemic and take the necessary measures.

CONCLUSION

ADOPTING RESILIENT STRATEGIES TO PROTECT THE HEALTH OF HUMANS AND THE ENVIRONMENT

Climate change demands in-depth changes in how water services are managed. Faced with growing problems centering on water shortages and surpluses, innovations and infrastructure adaptability are vital to maintaining continuity and security of supply. By rolling out advanced technologies for detecting leaks and anticipating the effects of corrosion, promoting the reuse of wastewater and shifting to greener infrastructure and nature-based solutions, water network managers are providing real-world responses to the challenges of water shortage.

At the same time, tackling issues raised by excess water requires a variety of flood management strategies that look beyond the question of crisis management. Setting in place hydrometeorological systems, water retention mechanisms and forecasting and alert solutions allows local authorities to plan ahead for extreme events and limit the risks to local people.

Lastly, to preserve this precious resource and ensure equitable access to it, sustainable and adaptable economic models must be put in place while involving all actors in society in the task of managing water together. This represents a significant challenge, entailing as it does a real transformation in how we use and manage water so that we can protect a resource that is vital to life and essential to the development of our societies.

11 PCR = polymerase chain reaction. An analytical technique used to amplify the DNA or RNA of a microorganism. It allows direct detection of the presence or absence of the microorganism in a sample of water.