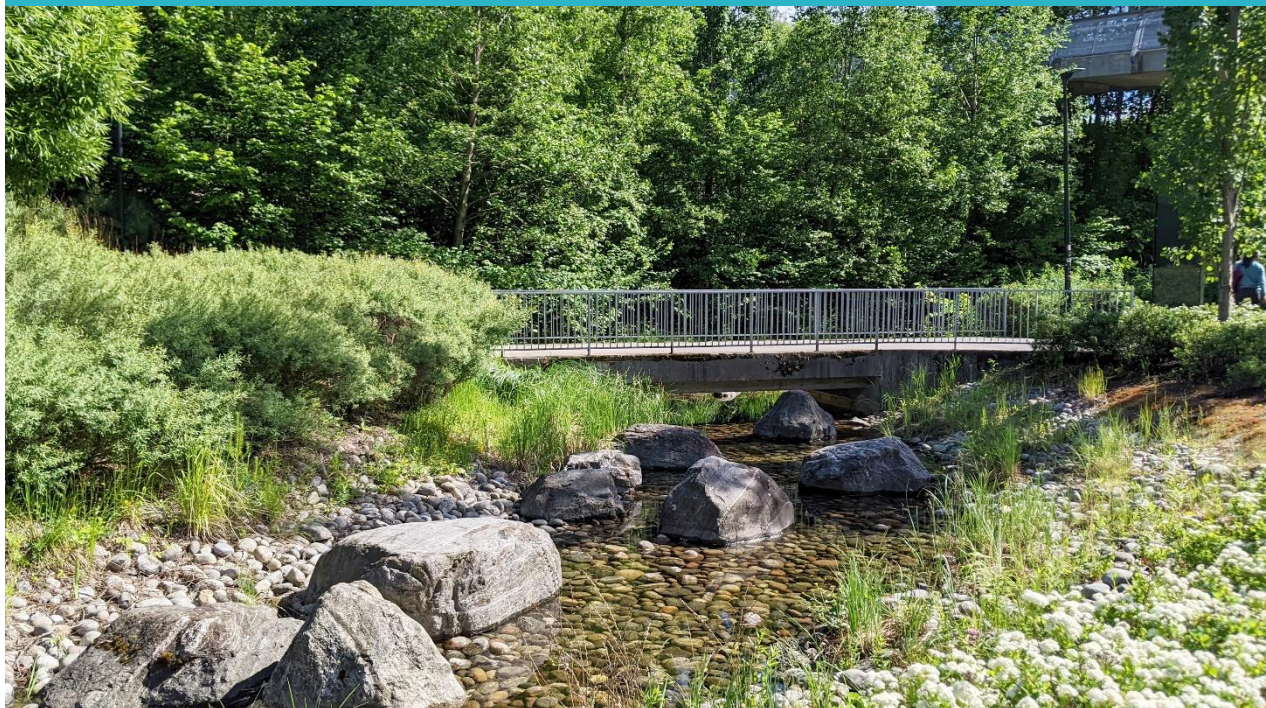


POLICY BRIEF

OneAquaHealth | Protecting Urban Aquatic Ecosystems to Promote One Health



Urban stream ecosystem health as a One Health priority

Urban freshwater ecosystem restoration should be prioritized as a **preventive One Health measure** that simultaneously protects biodiversity and reduces public health risks. **Immediate investment** is needed to rehabilitate riparian zones, renaturalize channels, and upgrade sewage systems and wastewater treatments to address pollution and emerging contaminants. **Systematic monitoring of urban streams** should be integrated into public health surveillance frameworks. European water policy, including the Water Framework Directive, should be **expanded to incorporate One Health indicators** linking ecosystem and human health.

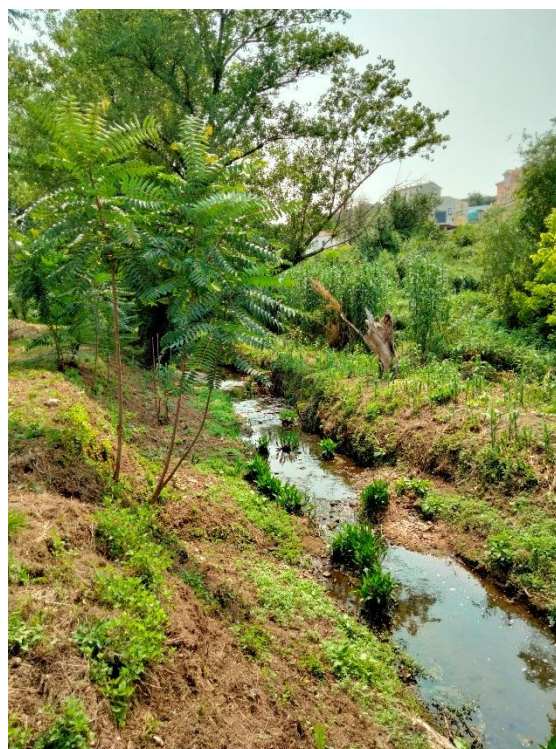
The OneAquaHealth initiative investigated 100 urban stream sites across five European cities to assess how urbanization impacts freshwater ecosystems and how this degradation may increase health risks for people. The findings confirm that ecosystem degradation and human health are deeply interconnected, while urban stream restoration delivers mutual benefits for environmental and public health.

KEY RESULTS

- Urbanization consistently degrades freshwater ecosystem health and decreases biodiversity across European cities, with nutrient pollution, contamination by pharmaceuticals, alterations of the stream channel, soil sealing, artificial light at night, and loss of the natural riparian vegetation as the main drivers.
- Pharmaceuticals were detected in 91% of monitored sites, confirming widespread contamination with risks for aquatic organisms and humans.
- Diatom (microalgae) morphological deformities were identified as early warning indicators of pharmaceutical contamination that would go undetected by standard monitoring.
- Degraded urban streams are associated with higher cause-specific mortality and reduced life expectancy, likely reflecting the loss of freshwater ecosystem services including water quality, climate regulation, and mental health benefits.
- Urban streams host insect communities (Diptera) of public health importance, including mosquito species that are vectors of West Nile virus, dengue, and chikungunya, whose composition is shaped by climate and local habitat conditions, including urbanization pressures.
- Insectivorous birds, amphibians, and fish are natural control agents of insect disease vector populations. Poorer habitat conditions lead to the decline of these insect predators, weakening biological control of insects in cities.
- Invasive alien plants increase significantly with urbanization and pose direct human health risks through skin irritation, allergies, poisoning, and the creation of favorable habitats for disease vectors
- Stream biofilms in more urbanized areas carry higher loads of clinically relevant pathogens and antibiotic resistance genes, posing human health risks.

POLICY RECOMMENDATIONS

- Integrate urban freshwater ecosystem restoration into municipal and regional strategic health planning as a preventive public health intervention.
- Invest in the rehabilitation of riparian galleries, renaturalization of channels and banks, and improvement in water quality treatment and sewage systems as urgent measures in urban stream restoration strategies.
- Incorporate Diptera monitoring from urban streams into national public health surveillance systems, using city-specific environmental baselines to assess and mitigate vector-borne disease risks.
- Expand European water policy beyond the Water Framework Directive to incorporate One Health indicators that explicitly link freshwater ecosystem health and human health.



CONTEXT

More than half of the world's population currently lives in cities, and urban areas continue to expand. Aquatic ecosystems in urbanized landscapes constitute ecological corridors between fragmented natural areas that support a wide diversity of ecosystem services and biodiversity, improving the sustainability of cities. When in good condition, urban streams contribute to regulating water temperature and flooding, filtering pollutants, improving air, soil and water quality, supporting valuable biodiversity, and offering spaces for recreation and well-being. As such, **the health of freshwater ecosystems and human health and wellbeing in urban contexts are intrinsically interconnected**: improving one directly improves the other, reestablishing the balance between nature and humans. In this context, the One Health approach is based on the principle that human health, animal health, and environmental health are inseparable pillars of a healthy and thriving planet.

Global urbanization poses a challenge to nature preservation, specifically to stream and river ecosystems, through cuts of riparian vegetation, artificialization of the channels, impervious areas in the margins, water pollution, noise, excessive lights, among others. This widespread deterioration can ripple through human health. Degraded freshwater ecosystems reduce the availability of clean water, loose biodiversity, promote the spread of invasive species, create conditions that amplify waterborne pathogens, foster disease vectors, and erode the nature-based buffers that protect communities from heat, flooding, and contamination, while also weakening the natural defenses of both wildlife and people.

The OneAquaHealth project focused on 100 urban stream sites across five European cities, Benevento (Italy), Coimbra (Portugal), Ghent (Belgium), Oslo (Norway), and Toulouse (France), to investigate how urbanization drives the degradation of aquatic ecosystems and, with it, increases physical and mental health risks for people. The findings, summarized here, underscore the dual imperative of protecting and restoring urban streams, as critical priorities for both environmental conservation and public health, to build more sustainable, healthier cities.

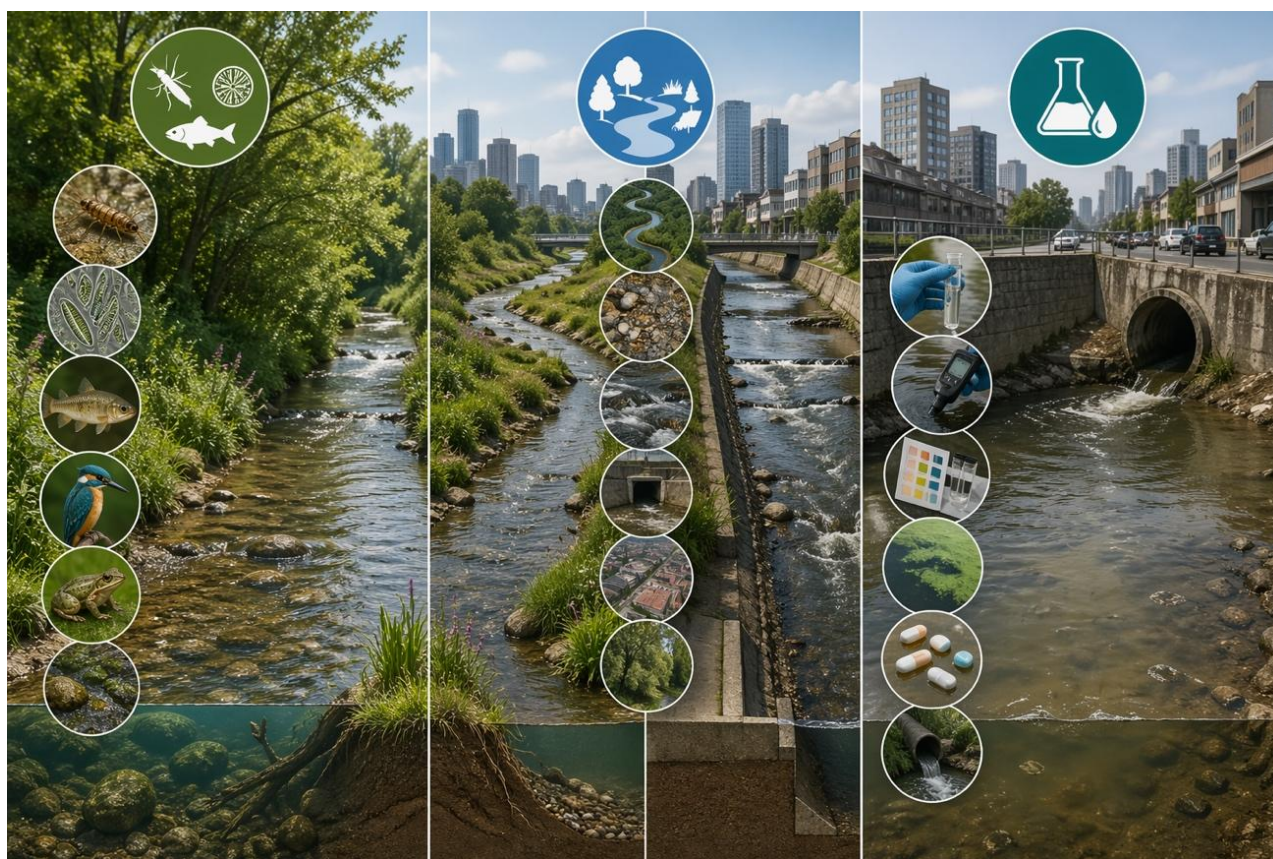


MAIN FINDINGS

Ecosystem and biological health indicators

OneAquaHealth examined a range of **indicators** to evaluate **urban stream health** and how effectively these indicators can signal a **risk to human populations**. Selected key indicators can be **biological**, **hydromorphological**, and **physico-chemical** and were chosen according to their sensitivity to urbanization and environmental change, the relevance to human health risks, and feasibility of routine monitoring.

Biological indicators include elements of aquatic communities, such as **fish**, **macroinvertebrates**, and **diatoms** (microscopic algae), which are already used as ecological quality indicators of rivers following the European Water Framework Directive. In addition, OneAquaHealth studied **biofilm** communities, **amphibians**, **birds**, and **flying insects** in the margins and **riparian vegetation** as **indicators of One Health**. These communities change as conditions deteriorate, translating the cumulative effects of multiple stressors over time, which provides a continuous record of changes in the streams. They can also display physical alterations (deformities, alterations in body size) as a result of certain stressors.



Hydromorphological quality describes the **physical structure** of the **stream** and its **banks**, including the type and diversity of aquatic habitats, substrate of the bottom and margins, flow type, river size, existence of barriers, or other artificial structures, and land use in the margins. Those characteristics influence the river continuum, the habitats available for the aquatic biota, the species migration, and the sediments, water flow, and energy transferences over the river basin.

Urban land use intensity, measurable through imperviousness density, reflects population density and is particularly relevant in cities. It is often accompanied by the removal or degradation of riparian corridors (trees, shrubs, and herbaceous plants along the stream margins). However, intact riparian vegetation provide shade, regulating water and air temperature, filter pollutants from runoff, stabilize banks against erosion, and provide habitat for both aquatic and terrestrial biodiversity; thus, their degradation has cascading effects for all other indicators and ecosystem services (i.e., benefits provided by the ecosystem to human populations).

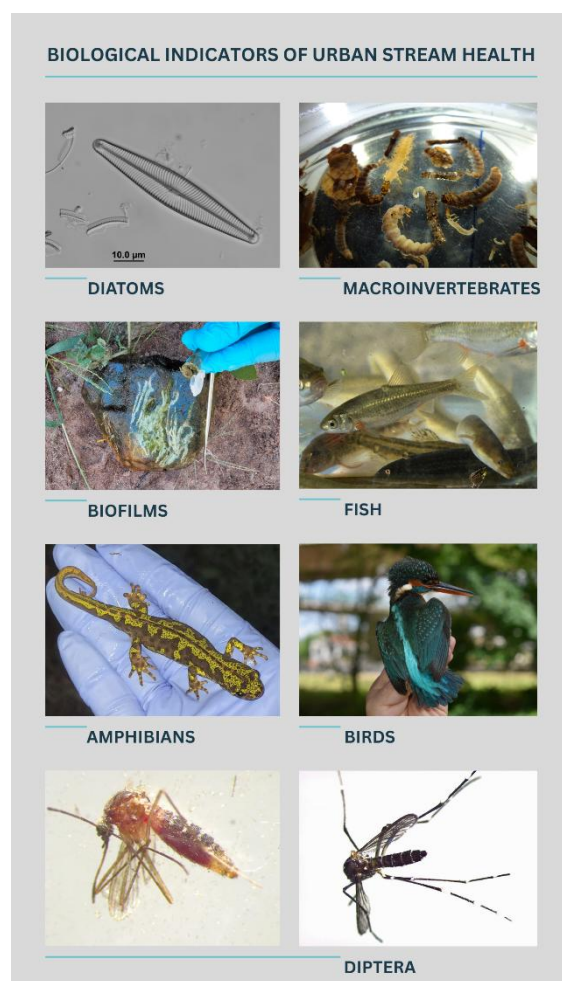
Water physical and chemical properties include **pH**, **dissolved oxygen**, **nutrient concentrations** (e.g., nitrates, nitrites, ammonia, phosphates), or of other **pollutants** such as **emergent contaminants** (e.g., pharmaceuticals). The value of these variables can be altered by many anthropogenic factors, which include sewage discharges, runoff from impervious surfaces and agricultural fields, the presence of artificial barriers, water abstraction, and the removal of riparian vegetation, among others. They directly influence ecosystem integrity and may bring risks for human health.

Urbanization impacts freshwater ecosystem health

Ecosystem health represents the capacity of aquatic ecosystems to **maintain their structure, function, and resilience** under environmental stressors. Urban streams are under rising pressure from a combination of physical, chemical, biological, and climatic stressors. Evidence gathered by OneAquaHealth consistently shows that **urbanization degrades freshwater ecosystems** along a clear gradient, with severe consequences for ecosystem health. The degradation of freshwater ecosystems leads to a decrease of the diversity of aquatic organisms (e.g., invertebrates, microalgae - diatoms, fish), with a lower abundance or absence of sensitive species, and an increase in the proportions of species that are tolerant to stress.

The underlying urbanization pressures driving ecosystem degradation and the decrease of biodiversity were, among others: excess of nutrients (e.g., total phosphorus and nitrates), contamination by pharmaceuticals, alteration of the stream channel (e.g., straightening, concreting, reinforcement), transversal barriers (such as dams and weirs), artificial light at night, the sealing of soils in the margins and surroundings with pavement and buildings, alteration of riparian vegetation structure, as well as aquatic and terrestrial invasive species. These stressors are directly linked to urbanization processes and human activities and often act in synergy, hindering the capacity of urban streams to support diverse and healthy biological communities.

Macroinvertebrate and diatom communities changed their community structure and composition, **lost** sensitive taxa and altered the abundance of certain species as a result of urbanization pressures. In addition, invasive invertebrate species were recorded in many urban streams. **Diatom** physical deformities in their



cell walls were associated with the presence of pharmaceuticals. These deformities can therefore be used as **early-warnings of contaminations** that would go undetected by standard monitoring.

The diversity of **fish** declined in more urbanized streams, while non-native species increased. As top predators and prey, fish are important to regulate the populations of other organisms, such as insects, supporting ecosystem and human health. Similarly, **bird** diversity decreased with urbanization level, particularly where riparian vegetation was altered, with a notable decline in insectivorous species in the most degraded streams. Non-native species were also present in the most urbanized sites. Endemic **amphibian** species of conservation concern were restricted to less degraded and more oxygenated streams, while tolerant species occupied a broader gradient of urban degradation. In addition, degraded sites showed individuals contaminated with pathogens (fungi and virus) known to cause mass mortality in amphibians worldwide, which suggests that urban stress facilitates the spread of diseases. Individual physical condition also reflected this pressure, with some specimens showing abnormal body sizes compared to reference populations.

Pharmaceuticals are Contaminants of Emerging Concern, with known effects on aquatic organisms such as increased mortality and reproduction inhibition. Sixteen pharmaceuticals were observed in 91% of the sites, often as complex mixtures. Several compounds flagged on the European Watch List 2025 were detected across multiple cities, confirming the widespread pharmaceutical pollution of urban streams, which could lead to risks for the health of aquatic organisms and humans. This contamination was mitigated in sites in good ecological condition.

Degraded streams have the potential to increase human health risks

OneAquaHealth established a link between freshwater ecological quality and human health across Europe. The decline of urban stream ecosystem services was associated with a potential **increased risk of several diseases** related to air and water quality and climate regulation, as well as reduced educational and cognitive development and therapeutic services, with effects on human physical and mental health.



Poorer ecological conditions of urban streams were associated with **higher cause-specific mortality and reduced life expectancy**. These relationships likely reflect the combined consequences of the **loss of freshwater ecosystem quality and services** on human health and longevity.

Non-native plants were found in the margins of urban streams with the potential to affect human health directly and indirectly. They are a threat to native species and disrupt ecosystem services and functioning, with severe economic and human health impacts. They can cause skin irritation, allergies, or poisoning, but also provide suitable habitats for disease vectors, promoting pathogen transmission. The incidence of non-native plant species, including **harmful species**, was associated with **urbanization intensity**.

Several **Diptera species** known to carry diseases were found in the vegetation of the urban stream margins. Diptera are insects (e.g., mosquitoes, flies) that spend their early life stages in the water, and some are vectors of pathogens (viruses, bacteria, parasites) that cause diseases like West Nile virus, dengue, and

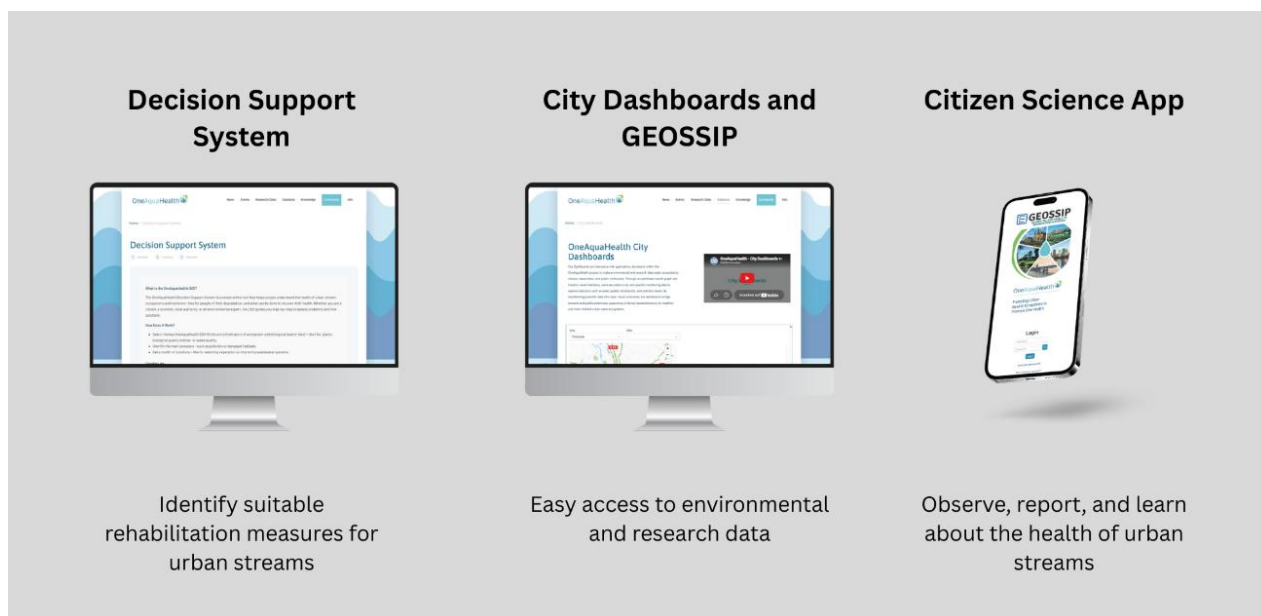
chikungunya. The Diptera communities are associated with habitat conditions, water quality, hydrology, riparian vegetation, and climate, and also include species that can affect human and animal health. This is significant because Diptera can be useful indicators of both ecosystem integrity and human exposure pathways, supporting the One Health approach.

Degraded habitat conditions lead to the decline of **insect predators**, which include **amphibians, fish, and birds** using the riparian galleries, weakening their important role as **natural control agents**, with potential consequences for public health. The maintenance of insectivorous birds within cities, for example through the preservation of the riparian vegetation and less light at night, may help to regulate the populations of disease vectors, limiting the spread of pathogens.

The analyses of **biofilms**, communities of microorganisms that cover stream substrates, in urban streams confirmed the occurrence of **bacteria of health concern**, including those responsible for anthrax, pneumonia, and meningitis. In addition, these biofilms carry a high load, richness and diversity of **antibiotic resistance genes**, which could make infections more difficult to treat. More urbanized areas were associated with greater risks from microbial and antibiotic resistance genes.

SUPPORTING DECISION MAKING ON URBAN STREAM MANAGEMENT: SOLUTIONS AND TOOLS

Understanding the health of urban streams is the first step towards effective interventions to restore these ecosystems and reduce human health risks. OneAquaHealth has developed a set of solutions and tools designed to support decision-makers in translating scientific evidence into concrete actions to promote more sustainable cities available through the Hub/Solutions (oneaquahealth.eu).



Decision Support System

The **OneAquaHealth Decision Support System (DSS)** is a digital tool designed to guide users step-by-step from the identification of the main problems of urban streams towards specific solutions. The DSS is structured around three connected components. The first is an assessment of the selected key ecosystem and biological health indicators, each supported by dedicated factsheets accessible to non-specialists. The

second component identifies the main stressors affecting a given urban stream as a result of urbanisation pressures. The third and final component is the **Toolkit of Solutions**, a package of rehabilitation measures matched to the problems identified. Users are guided from the results of the assessment of key ecosystem and biological health indicators to diagnose the potential stressors, and receive tailored, evidence-based recommendations. The DSS operates through a guided workflow accessible via the OneAquaHealth Open Information Hub.

The Toolkit of Solutions implemented in the DSS is grounded in **the OneAquaHealth Catalogue of Measures for the Rehabilitation of Urban Streams** (www.cordis.europa.eu/project/id/101086521/results), a comprehensive, evidence-based document covering a wide range of interventions available to restore degraded urban watercourses. The catalogue offers technical solutions to address the biological, morphological, hydrological, chemical, and social dimensions of stream degradation, including priority actions such as pollution control and the restoration of riparian vegetation, but also structural interventions. Special emphasis is placed on nature-based solutions, including stream renaturalization, riparian corridor restoration, floodplain reconnection, and near-natural water retention, all of which contribute simultaneously to ecological recovery, climate resilience, flood regulation, and urban quality of life. For each measure, the catalogue details the objectives, application scenarios, ecological and health benefits, implementation constraints, links to ecosystem services, and demonstrates feasibility with successful applications.

City Dashboards and GEOSSIP

The **City Dashboards**, accessible directly through GEOSSIP and the OneAquaHealth Open Information Hub (www.oneaquahealth.eu/city_dashboards), are an important feature for local authorities and the public. These interactive, map-based tools visualise key ecological and water quality indicators for urban streams across the five research cities. Users can select a city and a specific monitoring site and view indicators including biological quality, nitrate status and species richness. This makes it straightforward for managers and policymakers to assess the health of urban streams and identify problem areas.

GEOSSIP (Geospatial and Satellite Information Platform, www.oneaquahealth.eu/geossip) integrates Earth Observation satellite data with in-situ field measurements collected at OneAquaHealth research sites, providing this information in a web-accessible platform. GEOSSIP ensures efficient handling, processing, and retrieval of data, aggregating in-situ measurements, Earth Observation analytics, user content, and health indicators into a secure, scalable repository.

The OneAquaHealth Citizen Science App

OneAquaHealth recognises that monitoring urban streams at the scale and frequency needed to inform good management decisions cannot rely on expert field surveys alone. The **OneAquaHealth Citizen Science App** (<https://apps.oneaquahealth.eu/login>) engages the broader public as active contributors to environmental monitoring. It extends the reach and continuity of urban stream health data collection, generating scientifically valuable data which may contribute to inform management, while also strengthening citizen awareness of and connection to the urban freshwater ecosystems around them.

The app enables citizens to submit georeferenced observations from urban stream sites, including information on water flow types, colour, vegetation, channel characteristics, and surrounding land use, complemented by photo and video uploads. Additionally, it includes questions focused on human well-being, reflecting the project's One Health perspective by capturing citizen perceptions of wellness and their connection to urban streams.

POLICY RECOMMENDATIONS

Prioritize ecosystem restoration as a preventive public health investment

As cities continue to expand at unprecedented rates, urban planning must prioritise not only adequate healthcare infrastructure and sanitary conditions, but also active disease prevention and the reduction of population exposure to pollutants and contaminants. Restoring degraded urban streams can help reduce health risks associated with poor water quality, flooding, heat waves, biodiversity loss, and limited access to blue-green spaces. Therefore, the **restoration of urban freshwater ecosystems** should be acknowledged as a form of **preventive public health intervention**. Investing in ecosystem restoration has the potential to significantly reduce healthcare expenditure over time.

Health plans should include objectives, indicators, and funding mechanisms that support the protection and restoration of urban freshwater ecosystems, in coordination with urban planning, water management, and public health authorities. Ecosystem restoration and rehabilitation should therefore be recognized as a joint effort to protect both nature and human health and well-being.

OneAquaHealth findings confirm the **critical role of riparian zones** with well-vegetated margins to buffer water temperature and humidity, filter pollutants, support biological communities, and ultimately **protect the ecosystem services** that urban populations depend on. Urban landscape planning should actively promote and protect the riparian vegetation, integrating it into municipal strategies and biodiversity plans. The rehabilitation of the riparian vegetation should prioritize a diverse corridor with native species typical of riparian zones of that region, extending along both stream margins, allowing a natural successional process to maintain the connection between terrestrial and aquatic ecosystems and ensuring that it is free from invasive alien species and from artificialization or unnecessary clearing of the vegetation.

URBAN STREAM RESTORATION

- Removal of artificial materials (e.g. concrete)
- Renaturalization and reinforcement of channels and margins with natural materials and autochthonous substrates
- Recovery of the riparian galleries
- Creation of space for natural flooding (e.g., removal of grey infrastructure from the margins and floodplains)
- Removal of barriers to the longitudinal connectivity that prevent the circulation of water, sediments and organisms (e.g., dams, weirs, grids)
- Adaptation or reduction of the artificial light in the margins of streams
- Improvement of sewage systems and water treatments, among others.

Bridge ecosystem health and human health through integrated indicators

Current European water policy, centered on the Water Framework Directive (WFD), focuses primarily on ecological status and does not systematically address the human health dimensions of freshwater ecosystem degradation. Ecosystem health assessments of urban streams should move beyond the biological quality elements from the WFD and incorporate a **broader, integrated set of indicators** that explicitly **bridge ecosystem and human health**, including adult Diptera in the margins, birds, amphibians, deformities in diatoms, pathogens in aquatic biofilms, and pharmaceuticals in the water.

Including these indicators in existing monitoring frameworks would represent a concrete step towards aligning European water policy with a One Health framework, but requires coordination between different stakeholders (e.g., municipalities, environmental agencies, public health authorities). The OneAquaHealth Decision Support System, which enables the identification of priority intervention areas and select evidence-based restoration measures, provides the necessary, evidence-based insights to support this challenge.

Strengthen multilevel governance and integrated data systems for One Health implementation

Moving from evidence to practice requires intersectoral collaboration, multidisciplinary expertise, and interinstitutional coordination across national, regional, and local levels. Authorities should work together across the environment, water management, urban planning, and healthcare sectors to ensure coordinated implementation. Integrated data systems are essential to align ecological, environmental, and health information, enabling joint monitoring, shared accountability, and evidence-informed decisions.



About this Policy Brief

This Policy Brief is a deliverable of the OneAquaHealth project, funded by the European Union's Horizon Europe research programme under Grant Agreement No 101086521.

It shares key results of research on urban aquatic ecosystems and provides evidence-based policy recommendations to support healthier and more sustainable cities.

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