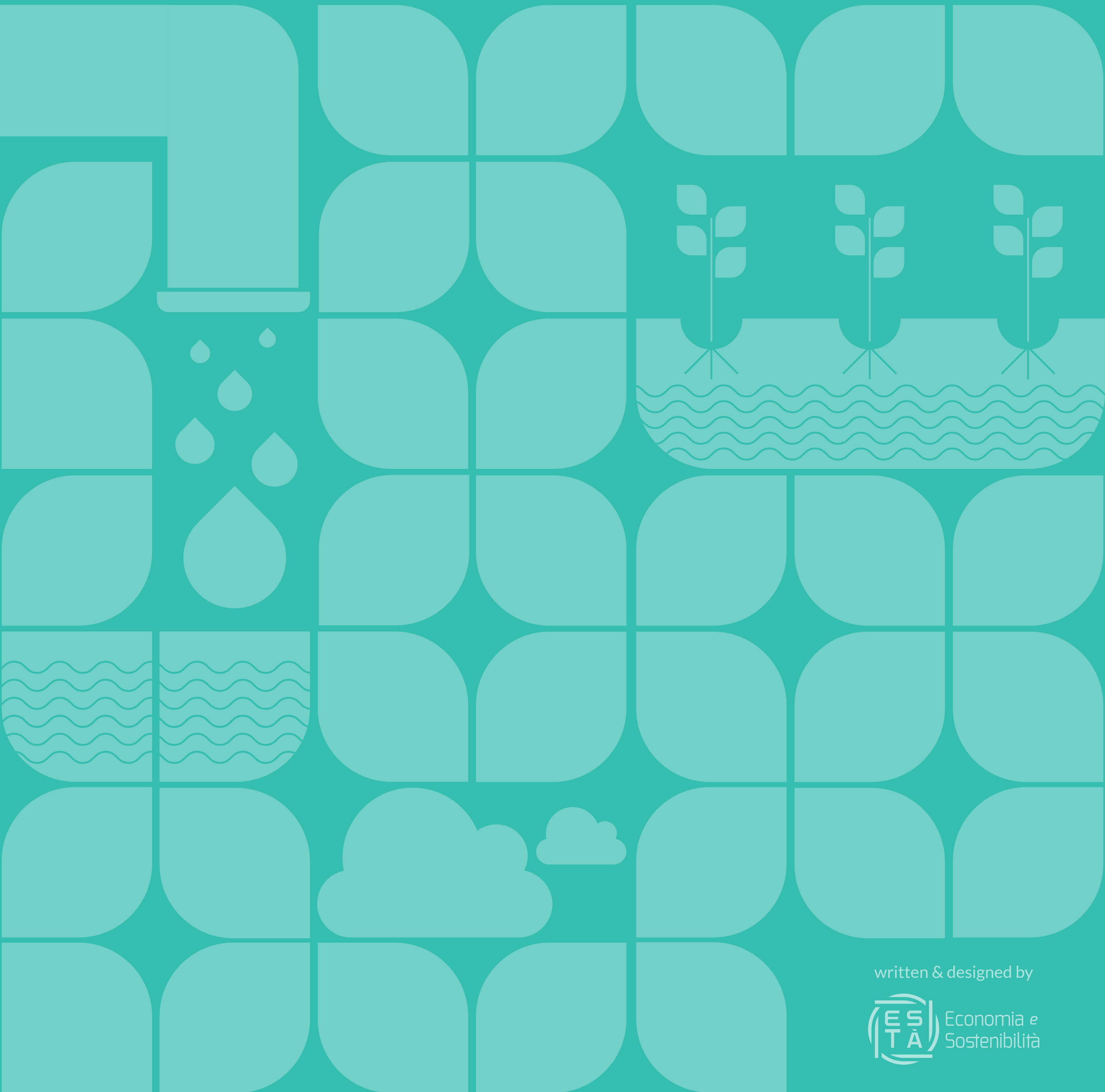
WATER AND FOOD SYSTEMS

a key nexus for urban food policies



written & designed by

Economia e Sostenibilità

WATER AND FOOD SYSTEMS

a key nexus for urban food policies

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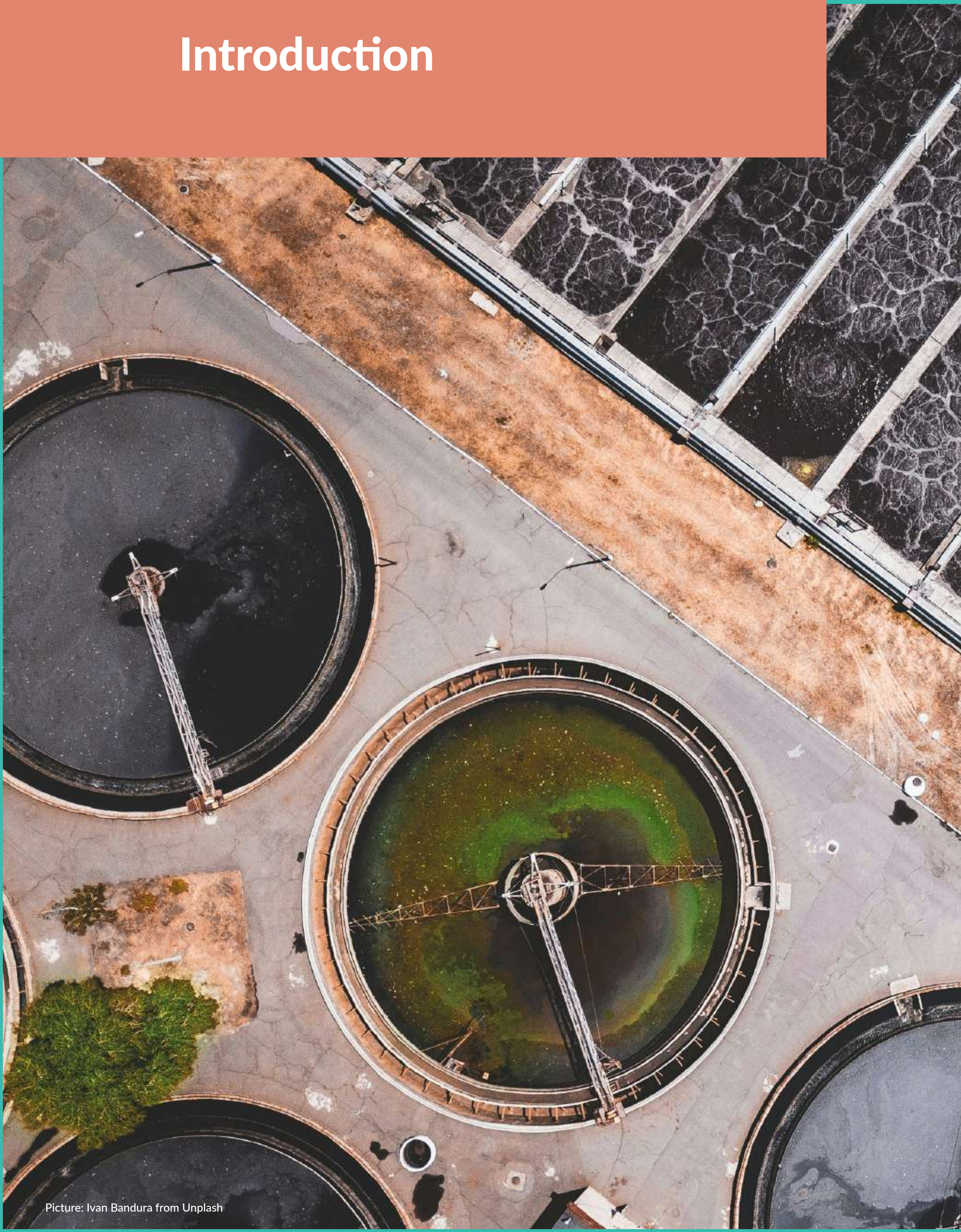
Introduction



Picture: Ivan Bandura from Unplash

What is the MUFPP

Milan Urban Food Policy Pact

The Milan Urban Food Policy Pact is **one of the main legacies** of the Universal Exhibition "Expo Milan 2015" Feeding the Planet, Energy for Life. The Milan Pact is a global commitment of mayors from around the world that considers food as an entry point for the sustainable development of growing cities. It represents the **main framework** for cities and international stakeholders active in the definition of innovative urban food policies.

Milan Pact Framework for Action

The Milan Pact is the result of a **participatory process** among 46 cities that worked together in 2014, under the guidance of a technical team of international experts, on the definition of 37 recommended actions structured into **6 integrated categories:**

The Milan Pact's Framework for Action presents a holistic approach towards the food system. A dedicated Monitoring Framework supports cities in better structuring and assessing the impact of their food policies.

Governance and membership

To date, **the Milan Pact gathers more than 310 cities,** representing a total of 500 million inhabitants over the **6 MUFPP regions.** The governance of the Pact is ensured by a Steering Committee, which is elected every two years and has the responsibility of representing signatory cities at global level. It is composed of 13 members, 2 per each MUFPP region together with the Mayor of Milan which is the permanent Chair.

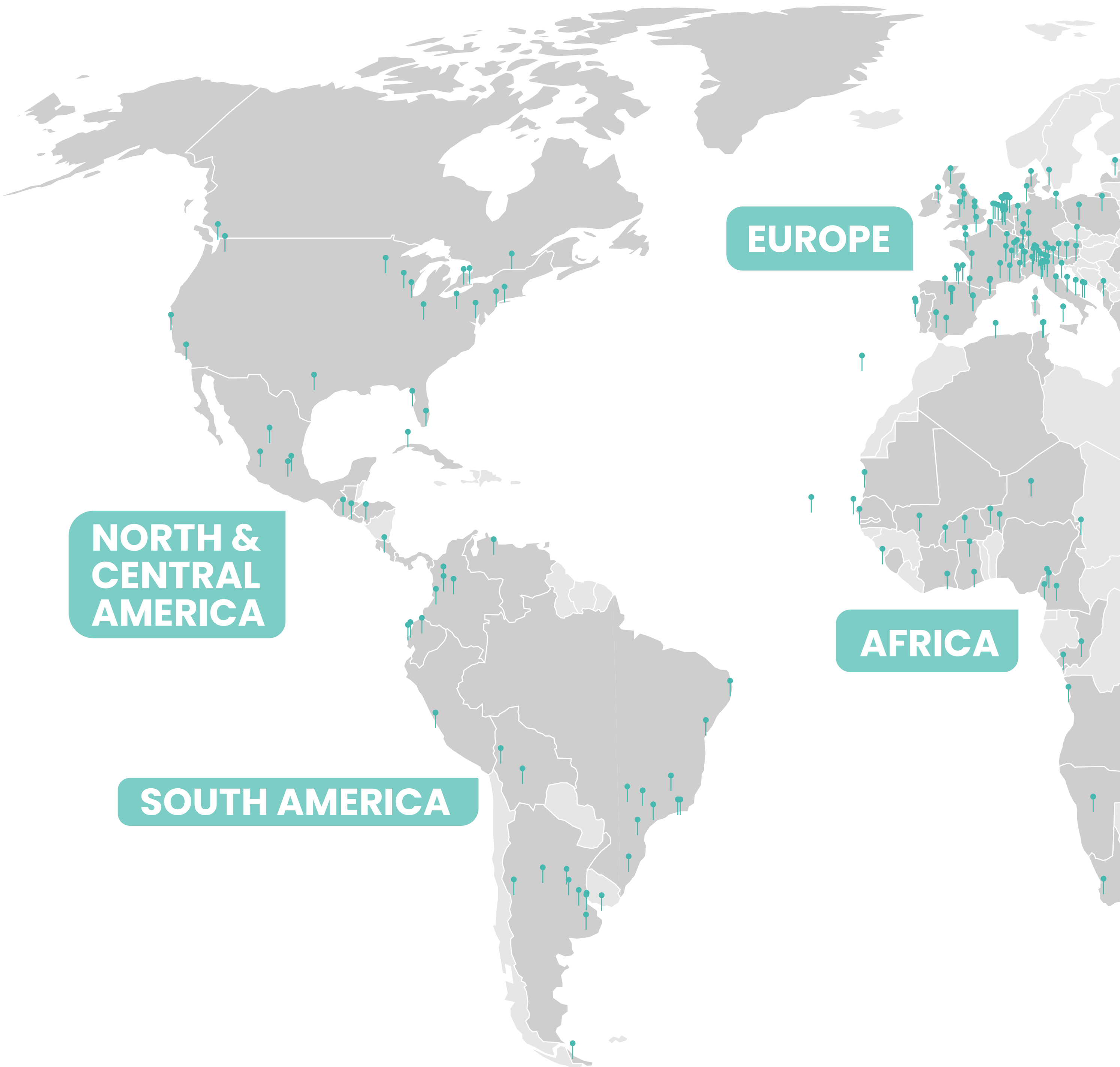
What is AICS and its focus on water

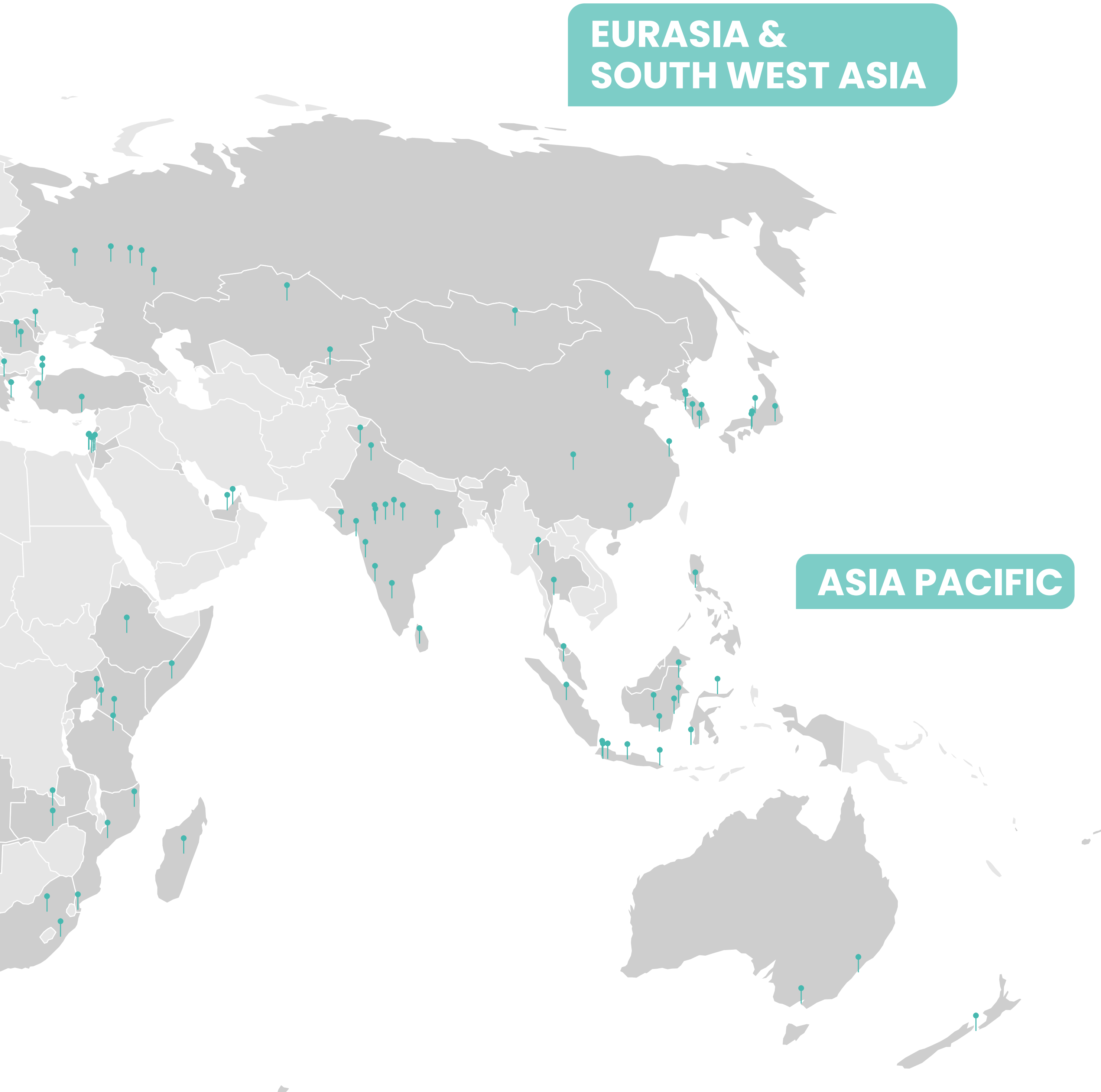
The **Italian Agency for Development Cooperation (AICS),** is the Italian government's main agency for international development aid. Founded in 2016, AICS operates under Italy's **Ministry of Foreign Affairs and International Cooperation** to address global challenges and support sustainable development in third countries. AICS prioritizes projects focused on **reducing poverty, advancing human rights, and promoting sustainable economic growth.** AICS' work aligns with the United Nations' Sustainable Development Goals (SDGs), focusing particularly on sectors like health, education, job creation, rural development and food security, environmental sustainability, and humanitarian aid. It collaborates with international partners, non-governmental organizations (NGOs), and local communities to deliver aid, build infrastructure, and empower vulnerable populations. Through 20 field offices, AICS manages operations and initiatives in partner countries worldwide by adopting a cooperative approach to ensure the alignment of development efforts with the specific needs of the communities.

The Agency is aware that **water-related issues naturally play a central role in food system transformation and sustainable development.** Therefore, they are integrated, where necessary and appropriate, into all initiatives funded by Italian cooperation in both agricultural and non-agricultural sectors. These initiatives aim to promote the conservation and rational use of water resources at **local, national, and regional levels,** respecting the principles of economic, social, and environmental sustainability. Therefore, they aim to increase the availability of water resources for current and future generations, promoting and integrating both **innovative and traditional practices** available, and improving governance through increased active participation of all actors in the integrated management of water resources at all levels.

MUFFP Signatory Cities

312 CITIES in
90 COUNTRIES





MILAN URBAN FOOD POLICY PACT

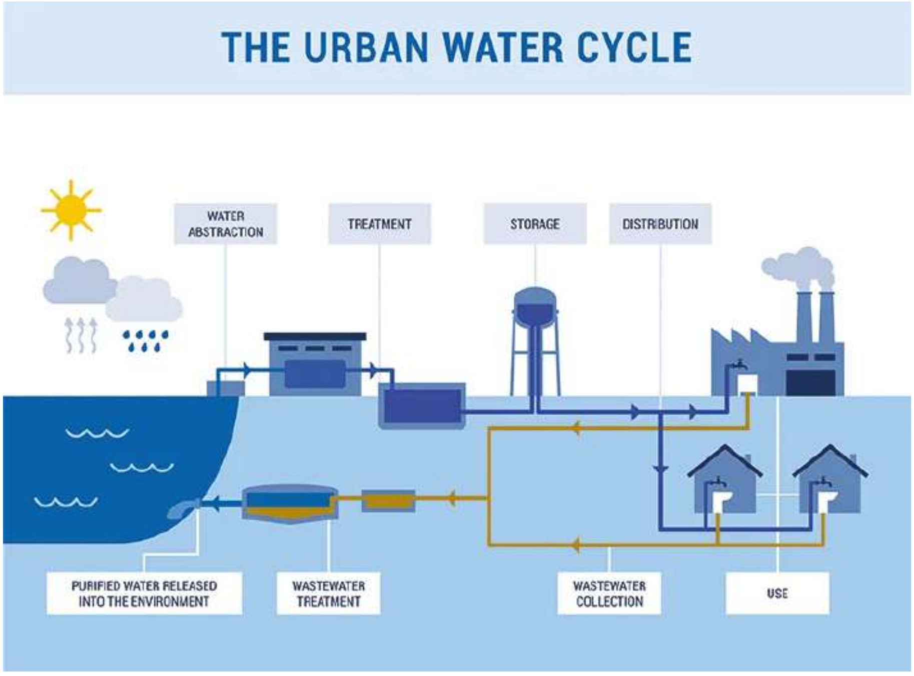
Why water and food systems

Water plays a **vital role** in urban environments, shaping how cities function and influencing public health, economic development, and social equity. The **efficient management of water resources** is essential for addressing the many challenges that urban areas face, including population growth, climate change, and environmental degradation. Effective water policies are critical for **ensuring sustainable water access and addressing the interconnected** issues of water scarcity, pollution, and hygiene.

Despite in many cities, the overexploitation, waste, degradation, and pollution of water resources pose significant challenges, **water is often seen as a topic to be managed outside of urban environments.** However, cities play a crucial role in the management of water resources by overseeing a range of **essential infrastructure systems.** These systems include aqueducts, which collect water from underground sources or other natural resources and through water treatment processes or plants, ensure that the **water is purified and safe for consumption.** In addition to that cities need to clean water after use (domestic, industrial) before giving it back to the ecosystem. This entails the development of effective and efficient water sewage systems and wastewater system plants, to ensure the correct water management of the entire system. Furthermore, cities manage irrigation canals, which are vital for **supporting agricultural activities** and maintaining green spaces. Through the effective operation and maintenance of these infrastructures, cities ensure **a sustainable and reliable water supply for their growing populations,** while also addressing challenges such as water conservation, pollution control, and efficient distribution.

Today, **the impact of climate change** on urban water systems is increasingly evident, with droughts and floods becoming more frequent and severe. These climate-induced events create significant risks for urban populations, including water shortages and contamination from flooding. The rise in extreme weather events necessitates **resilient urban water policies** that incorporate climate adaptation strategies, ensuring that cities can recover from such shocks. Access to **quality drinking water** is fundamental for achieving adequate hygiene and sanitation standards, as well as food security. Urban water policies must prioritize ensuring that **all residents have equitable access to safe drinking water,** particularly to vulnerable groups and marginalized communities who often face barriers to access. This commitment aligns with the recognition of the **right to water** as a fundamental human right, which obligates governments - at all levels - to guarantee access to safe and sufficient water for all.

The efficient use of **water in agriculture** also plays a crucial role in urban water management. As cities expand, their reliance on surrounding agricultural areas for food increases, highlighting the need for **integrated**



Source: Aquamain UK, Available at: https://aquamain.com/why-is-water-infrastructure-so-important/

policies that ensure the correct use of water at local level ensuring that there is adequate access to water resources for each use (i.e, households, agriculture, industry, energy production). Agriculture is the largest consumer of freshwater, utilizing approximately 70% of the world's accessible water supply. The shift towards sustainable agricultural practices is crucial for enhancing food production while minimizing water usage. Techniques such as irrigation efficiency, rainwater harvesting, and the use of drought-resistant crops can mitigate water waste and enhance agricultural output.

It is why **multilevel governance is essential** for managing water resources in both rural and urban areas, as it ensures **coordinated decision-making** across different levels of government and stakeholders. At the local level, municipalities manage water distribution, treatment, sewage system and infrastructure, ensuring that **urban populations have access to clean and reliable water.** In rural areas, governance focuses on agricultural water use, irrigation systems, and groundwater management, where local communities could have a direct role in **resource management.** The multilevel approach allows for more integrated water management, where **policies are aligned across sectors and scales,** addressing both urban demands and rural sustainability. It also promotes the participation of various actors, local municipalities or river basins authorities, including farmers, water utilities, environmental groups, and citizens, fostering a shared responsibility for the long-term preservation and equitable distribution of water resources. **Effective multilevel governance in water management helps balance the needs of urban growth, agricultural productivity, environmental protection, and climate resilience.**

Hence, urban areas have a unique opportunity to implement food policies that address water management sustainably. By promoting sustainable food systems, cities can reduce water consumption and improve water quality: on one hand, initiatives that support water use education to reduce waste and to preserve the resource at individual and collective level, additionally activities such as urban farming, community gardens, and local food sourcing can better contribute to food security through an efficient water use. The formulation and implementation of effective water policies are crucial for addressing the challenges posed by climate change, resource scarcity, and urbanization.

Availability and quality of water resources

The availability and quality of water resources are fundamental to human health, economic development, and environmental sustainability. **Fresh water,** which comprises only about 2.5% of the Earth's total water supply, is essential for various uses, including **drinking, agriculture, sanitation, and industrial processes**. As global populations grow and climate change intensifies, ensuring adequate access to quality water resources has become increasingly challenging.

Water availability refers to the **quantity of fresh water** accessible for various uses. This includes surface water, such as rivers and lakes, and groundwater, stored in aquifers[1]. Although there are substantial freshwater reserves, **their distribution is uneven globally,** leading to regions with abundant water resources and others facing severe scarcity. **Climate change has significant implications for water availability,** contributing to extreme weather events such as droughts and floods. These events can disrupt the natural water cycle, affecting both the quantity and reliability of water resources. As temperatures rise, glaciers and snowpack—which act as natural reservoirs—are diminishing, further impacting water supplies in regions dependent on meltwater.

The **quality of water** resources is equally important. Water quality determines its **safety for consumption and its suitability for agricultural and industrial use.** Contaminated water can lead to serious health issues, including waterborne diseases, and can adversely affect ecosystems.

Water quality **is often compromised by pollutants** from agricultural runoff, industrial discharges, sewage, and urban runoff. Nutrient pollution, particularly from fertilizers, can lead to harmful algal blooms and dead zones in aquatic ecosystems. Additionally, heavy metals and other hazardous substances from industrial processes can contaminate water supplies, posing health risks to communities. Ensuring the quality of drinking water

1. **Surface Water:** Rivers, lakes, and reservoirs serve as critical sources of fresh water. However, the sustainability of these resources is often threatened by pollution, over-extraction, and climate-related changes, such as altered precipitation patterns and increased evaporation rates.

Groundwater: Groundwater is a crucial resource for drinking water and irrigation, particularly in areas where surface water is scarce. Yet, overexploitation of aquifers can lead to depletion and land subsidence, reducing the availability of this vital resource. In some regions, groundwater is being extracted faster than it can be replenished, raising concerns about long-term sustainability.

involves **extensive treatment processes that remove contaminants and pathogens.** However, inadequate infrastructure and funding can hinder access to safe drinking water, especially in low-income communities. Addressing these gaps is essential for promoting public health and environmental sustainability. **Regular monitoring** of water quality is crucial for detecting contamination and ensuring compliance with health standards. This includes assessing parameters such as **pH, turbidity, microbial content, and concentrations of harmful substances.** Effective monitoring programs can help identify pollution sources and guide remediation efforts.

The interplay between water availability and quality is significant. When water resources are scarce, the demand for available water increases, which can lead to the **over-extraction of both surface and groundwater.** This over-extraction often results in the deterioration of water quality, as lower water levels can concentrate pollutants.

The relationship between food and water at the international level

The relationship between food and water at the international level is complex and multifaceted, **requiring collaborative efforts** to address the challenges posed by scarcity, climate change, and inequitable access. **Water has increasingly become a central focus in the geopolitics of the 21st century,** impacting international relations, national security, and economic development. As fresh water becomes scarcer due to population growth, climate change, pollution, and over-extraction, the potential for conflict over water resources is rising. It is today well known that **water resources are unevenly distributed across the globe,** creating disparities between water-rich and water-scarce regions. This geographical imbalance contributes to tensions, especially in regions where rivers and aquifers cross national boundaries. Nations sharing these water bodies often have competing needs for water for agriculture, drinking, energy production, and industry, leading to disputes that can escalate into geopolitical tensions. **Climate change further complicates the geopolitics of water.** Altered precipitation patterns, increased frequency of droughts and floods, and rising temperatures can exacerbate water scarcity, particularly in already vulnerable regions.

Despite the potential for conflict, **water also serves as a catalyst for international cooperation.** Many countries have recognized the **necessity of collaborative water governance** to address shared challenges. The **international community** recognizes the importance of addressing the nexus between food and water through **various agreements and treaties.** Key among these is the **United Nations Watercourses Convention** (1997) which provides guidelines for fair use, non-harm, and cooperation on shared water resources. Similarly, the **Ramsar Convention** (1971) focuses on the conservation of wetlands, recognizing their role in water regulation and biodiversity. The **UNECE Water Convention**, initially a European agreement, was extended globally in 2016 to foster collaboration among countries sharing transboundary waters, emphasizing pollution prevention and sustainable practices. In 2015, the **Sustainable Development Goals introduced Goal 6,** aiming to ensure universal access to water and sanitation by 2030, underscoring the international commitment to water security. This commitment aligns with the **UN's 2010 declaration of access to clean water and sanitation** as a fundamental human right. Complementing these frameworks, the **WHO's Drinking-water Quality Guidelines** serve as an international standard, setting safe water criteria that influence national policies. Additionally, the **UN's International Decade for Action on Water for Sustainable Development** (2018–2028) prioritizes sustainable water practices and disaster resilience. Finally, the **Paris Agreement**, though focused on climate change, indirectly addresses water security by encouraging adaptive water management in response to climate-induced challenges like droughts and flooding.

Many are the frameworks useful to understand the intricate relationship between food and water as critical to sustainable development, particularly on an international scale. One of the most common is the concept of the **Water-Energy-Food-Ecosystems (WEFE)**, which underscores the interconnectedness of these essential resources. As the global population continues to grow, the demand for food is escalating, placing unprecedented pressure on water resources. This dynamic highlights the need for **integrated management strategies that address the complexities of water access, food security, energy sustainability and ecosystem services.**

Source: UNEP-DHI and the UNEP Copenhagen Climate Centre, available at: https://unepdhi.org/working-with-the-water-energy-food-ecosystems-wefe-nexus/

WEFE NEXUS

The water-food-energy-ecosystems nexus is a concept describing the interconnected nature of water, food, energy systems and ecosystems and how changes or pressures on one system impact the others. This approach emphasizes that sustainable management requires an integrated understanding of these three critical resources, as they are mutually dependent in numerous ways. It is widely used by institutions at all levels, from the UN to the European Commission. The WEF Nexus Index[2] serves as a repository of data regarding this interconnectedness.

- **Water for Food Production:** Agriculture is highly water-intensive, using around 70% of the world's freshwater. Water is essential for irrigating crops, raising livestock, and processing food. Water shortages or changes in water availability directly affect food security and crop yields.
- **Water for Energy Production:** Water is also vital in producing energy, particularly for hydropower, thermal power plants, and biofuel production. Large volumes of water are used for cooling in thermal power plants (coal, nuclear, natural gas) and for growing biomass crops for biofuels. Thus, water scarcity or increased demand for water in other sectors can limit energy production.
- **Energy for Water Supply and Treatment:** Energy is required to extract, treat, and distribute water. This includes pumping water for agriculture, desalinating seawater, and treating wastewater. In many regions, the water sector is one of the largest consumers of electricity, particularly for irrigation and urban water supply. Energy shortages or high energy costs can reduce access to safe, reliable water.
- **Energy for Food Production:** Modern agriculture and food processing depend heavily on energy for running machinery, producing fertilizers, processing food, and transporting products to markets. Energy prices and availability impact food costs and production sustainability.

2. More at https://wefnexusindex.org/

At the core of the WEFE relationship is the access to **physical and economic water resources.** While physical access refers to the availability of water bodies such as rivers and aquifers, economic access pertains to the affordability and infrastructure necessary to utilize these resources effectively. **Many countries face significant challenges in both dimensions.** In regions where water is scarce, agricultural productivity is severely impacted, leading to food insecurity and economic instability. Moreover, the inequitable distribution of water resources exacerbates social disparities, often leaving vulnerable communities without adequate access to clean water and food. The **WEFE Nexus** framework highlights the interconnectedness of water, energy, food, and ecosystems in urban settings.

The concept of the **water footprint**—quantifying the total water used to produce goods and services— also provides valuable insights into the relationship between food and water. The Water Footprint Network[3] provides insights into the topic along with a repository of data, useful for future policy development. Understanding the water footprint of different foods can **guide consumer choices and agricultural policies,** promoting water-efficient crops and practices. Related to the water footprint concept, countries can also benefit from incorporating the **principles of blue, green, and gray water management** into their agricultural frameworks. This includes recognizing the contributions of rainwater (green water) to crop production, managing surface and groundwater (blue water), and addressing wastewater (gray water) treatment for potential reuse in agriculture.

Understanding **water footprints helps policymakers and consumers make informed decisions** regarding water use, encouraging more sustainable practices in agriculture and industry.

3. More at https://www.waterfootprint.org/

BLUE, GREEN, GREY WATER

The definitions of **blue water, green water,** and **gray water** were developed by **Arjen Hoekstra**, a Dutch professor of water management that was working at the UNESCO-IHE Institute for Water Education in the Netherlands and who introduced the water footprint concept in 2002. These terms were created to help **categorize the different types of water resources involved in the production and consumption of goods and services.**

- **Blue Water:** Refers to the freshwater resources that are taken from surface and groundwater sources, such as rivers, lakes, and aquifers. This type of water is often used for irrigation, industrial processes, and urban water supplies.
- **Green Water:** Represents the rainwater stored in the soil and used by plants. It's essential for crop growth and natural vegetation and is often considered "invisible" in traditional water accounting because it does not flow through rivers or aquifers.
- **Grey Water:** This refers to the water required to dilute pollutants and maintain water quality standards, specifically the amount needed to assimilate wastewater and pollution generated by production activities, agriculture, or industry.

Despite the international recognition and the many tools and framework available, **challenges persist.** Climate change exacerbates water scarcity, affecting agricultural productivity and food security globally. Increased frequency of extreme weather events—droughts, floods, and heatwaves—threatens both water availability and agricultural output. Moreover, population growth and urbanization intensify competition for limited water resources, necessitating **innovative solutions and robust policy frameworks** that integrate water, food, and energy considerations. Addressing the geopolitical dimensions of water requires a **multifaceted approach that combines governance, technology, and cooperation, which can be found through the lens of local food policies.**

Role of cities in water management through food policies

The relationship between water and local food policies is critical, as both **resources are interconnected and play essential roles in community health, sustainability, and economic development.** Here are the current and potential relationships between water and local food policies:

1. Water Access and Quality Standards:

Access to clean water is essential for public health and disease prevention. Quality standards ensure that drinking water is safe, free from contaminants, and suitable for human consumption. Effective water management reduces the risk of outbreaks and improves sanitation conditions. Investing in water infrastructure is crucial for community well-being and sustainable development.

2. Water Availability for Agriculture:

Local food policies often emphasize the importance of locally grown produce, which relies heavily on adequate water supply for irrigation. Policies that support sustainable water management practices directly impact agricultural productivity and food security.

3. Irrigation Management:

Local food policies may include provisions for efficient irrigation systems and technologies, such as drip irrigation and rainwater harvesting, which optimize water use in agriculture. This not only conserves water but also enhances crop yields and reduces costs for farmers.

4. Urban Agriculture Initiatives:

Many cities are promoting urban agriculture as a means to improve food security and access to fresh produce. Water policies that support rainwater harvesting and greywater reuse can enhance the viability of urban farms by providing alternative water sources.

5. Community Engagement and Education:

Local food policies often involve community engagement initiatives that educate residents about the importance of water conservation and sustainable agricultural practices. These programs can raise awareness about the interdependencies between water management and food production.

Water is therefore an opportunity for cities to connect with their surroundings and with key stakeholders that are working on the topic. There is an opportunity for local policies to create synergies between food security, water management, and economic development. Future local food policies could adopt **a more integrated approach** that simultaneously addresses water and food system challenges. This could involve **cross-sector collaboration to develop strategies that optimize both water use and food production,** particularly in regions facing water scarcity. As climate change impacts water availability and food production, local policies could focus on **enhancing the resilience of food systems to climate-related challenges.** This might include investing in water-efficient crops, promoting agroecological practices, and developing infrastructure that can adapt to changing climate conditions.

Local food policies can also promote practices that **enhance ecosystem services,** such as watershed management and conservation agriculture. These practices not only improve water quality and availability but also **support biodiversity and soil health,** benefiting food systems. Local policies could consider **water pricing mechanisms** that encourage water conservation and efficient use. By pricing water in a way that reflects its true value, communities can support local food systems while promoting sustainable water management practices. Also, increased investment in research and innovation can lead to the **development of new technologies and practices** that enhance the relationship between water and local food policies. This includes advancements in irrigation technology, soil moisture monitoring, and climate-smart agriculture practices. Finally, local food policies that address **food waste can also impact water use.** Reducing food waste not only conserves the water used in food production but also **minimizes the environmental impact of discarded food in landfills,** which can contribute to water pollution.

Water in the Milan Urban Food Policy Framework for Action

The Milan Urban Food Policy Pact Framework for Action address the issue of water management in cities through the following actions and targets:

Sustainable Diets and Nutrition

SUSTAINABLE DIETS & NUTRITION

10

Action 10 Adapt standards and regulations to make sustainable diets and safe drinking water accessible in public sector facilities such as hospitals, health and childcare facilities, workplaces, universities, schools, food and catering services, municipal offices and prisons, and to the extent possible, in private sector retail and wholesale food distribution and markets.

> **Indicator 17** Percentage of population with access to safe drinking water and adequate sanitation

13

Action 13 Invest in and commit to achieving universal access to safe drinking water and adequate sanitation with the participation of civil society and various partnerships, as appropriate.

> **Indicator 17** Percentage of population with access to safe drinking water and adequate sanitation.

Food Production

FOOD PRODUCTION

24

Action 24 Help provide services to food producers in and around cities, including technical training and financial assistance (credit, technology, food safety, market access, etc.) to build a multigenerational and economically viable food system with inputs such as compost from food waste, gray water from post-consumer use, and energy from waste etc. while ensuring that these do not compete with human consumption

> **Indicator 30** Number of urban and peri-urban food producers that benefited from technical training and assistance in the past 12 months

26

Action 26 Improve (waste) water management and reuse in agriculture and food production through policies and programmes using participatory approaches

> **Indicator 33** Annual proportion of urban organic waste collected that is re-used in agricultural production taking place within municipal boundaries.


Picture: Archivio MM Spa

Food policies and water

Picture: Lumin Osity from Unplash

Right to water

Water is essential not only as a basic human need but as a cornerstone of food production, health, and sustainable urban living. Recognized under human rights frameworks, **water as a resource links directly to the right to food and health,** especially in the urban context where reliable, **safe water access is crucial for public health and food security.** The right to water and food provides a foundation for tackling urban water challenges and ensuring that both individual and community needs are met effectively.

Water is often conceptualized primarily as **a means of hydration,** but it plays **a multifaceted role in food systems.** This water-food relationship underscores why access to **water is also a prerequisite for the right to food,** as recognized in international frameworks like the United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas[4], which emphasizes **access to water for small farmers, fishers, and agricultural communities.**

The right to water **was declared a human right by the United Nations General Assembly in 2010**[5], recognizing that access to sufficient, safe, acceptable, and affordable water is **essential to human dignity and health.** Similarly, the right to food acknowledges that everyone has the right to adequate, nutritious food for a healthy life. When these rights intersect, they underscore the **need to protect water resources to secure food production and, by extension, human health.** Legal frameworks addressing these rights aim to hold **governments accountable** for providing safe water and food for all citizens, particularly marginalized communities who often lack reliable access. Ensuring these rights requires **strong policies to prevent water scarcity and pollution,** as both of these issues undermine food systems.

In **urban areas, securing the right to water and food is a particular challenge** due to high population density, pollution, and competition for limited water supplies. Programs that prioritize clean, accessible drinking water and safeguard water sources for agricultural use **help protect both urban and rural populations' rights to water and food.** In cities, where over half the world's population now lives, ensuring a steady supply of **clean drinking water is both a public health necessity and a significant logistical challenge.** Urban drinking water safety impacts not only individual health but the broader public health system, as waterborne diseases can spread quickly in densely populated areas. Cities are tasked with maintaining **complex infrastructures** to source, treat, and distribute drinking water, which often

4. More at https://digitallibrary.un.org/record/1650694?v=pdf
5. See Resolution 64/292 from United Nations

requires significant financial investment, technological upgrades, and strict regulation to prevent contamination.

Safe drinking water access in cities also intersects with **social equity.** Marginalized communities, including low-income neighborhoods, are often the most vulnerable to issues like polluted water, unreliable supplies, or higher costs for water access. **Ensuring safe water access within cities is vital to achieving health equity,** as these populations disproportionately suffer from water insecurity. On the other hand, in **rural and remote areas,** providing safe drinking water can be challenging as well. Small-scale solutions include **rainwater harvesting:** collecting and storing rainwater is effective for areas with intermittent rainfall, providing an alternative water source for drinking and irrigation. Or another solution might be **solar-powered desalination and filtration:** small, portable desalination units can be powered by solar energy, making them feasible for individual use in water-scarce areas.


Picture: Thisisengeneering from Unplash

Sustainable management of water resources in agriculture (urban and peri-urban)

Soil degradation, due to erosion, salinization, and nutrient depletion, poses significant **risks to agriculture.** Fragile soils, particularly in arid and semi-arid regions, require special management techniques such as crop rotation, cover cropping, and minimal tillage to maintain structure and fertility. In high-risk areas, soil stabilization efforts, like adding organic matter and practicing contour farming, help prevent erosion and promote long-term soil health. **Resilient food systems and sustainable agricultural practices are critical to managing resources efficiently, especially in the face of climate change.**

For decades farmers have used water-saving techniques such as **aridoculture**, which are techniques designed for arid and semi-arid regions such as using drought-resistant crops and reduced tillage to conserve moisture and reduce soil disturbance. Another water-saving technique is **mulching**, namely covering soil with organic or inorganic materials reduces evaporation, helps retain soil moisture, and controls weeds, which otherwise compete for water. Or, again, **drip irrigation systems** that provide precise amounts of water directly to plant roots, reducing water wastage compared to traditional flood irrigation. These systems are ideal for regions with limited water supply and high evaporation rates.

Each of these techniques, tools, and strategies contributes to sustainable water and resource management, which is essential for **building resilient food systems and ensuring water security in agriculture.** Together, they enable communities to adapt to diverse environmental conditions and resource limitations, promoting sustainable agricultural practices that protect both water and soil resources for future generations.

The Köppen climate classification[6] system categorizes climates based on temperature and precipitation, which significantly influence crop water needs. Different climate types include:

1. **Tropical (A):** High temperatures and abundant rainfall characterize these regions, with water-intensive crops like rice and sugarcane often grown here. While the warm, humid climate supports diverse agriculture, it also raises challenges for water conservation.

6. More at https://www.britannica.com/science/Koppen-climate-classification/World-distribution-of-major-climatic-types

2. **Arid and Semi-Arid (B):** Water scarcity is prevalent here, with crops like millet and sorghum adapted to minimal moisture. Water-saving techniques such as drip irrigation and mulching are crucial in these regions to ensure crop survival.
3. **Temperate (C):** Moderate rainfall and temperature make these regions suitable for a wide variety of crops. However, irrigation might still be necessary during dry spells, especially in areas with seasonal rainfall patterns.
4. **Continental (D) and Polar (E):** Short growing seasons and extreme temperatures limit agricultural activities. Here, greenhouses or soilless cultivation may be used to extend growing seasons and ensure stable production.

Different soils vary in their structure, nutrient content, and ability to retain water, impacting crop growth across climate zones. Key soil types include:

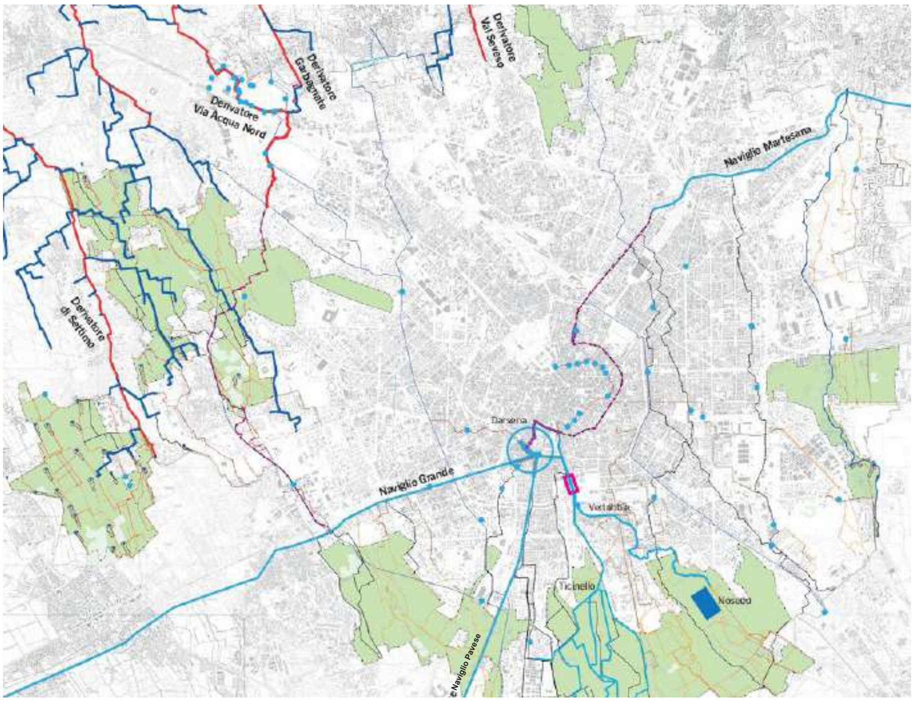
1. **Sandy Soils:** These soils drain quickly and retain little water, making them more suited for arid climates with low rainfall. However, due to their quick-draining nature, frequent irrigation is often required.
2. **Clay Soils:** High water retention makes these soils suitable for regions with sporadic rainfall. However, they can become compacted and poorly drained, especially in wetter climates, necessitating careful management.
3. **Loamy Soils:** Balanced in sand, silt, and clay, loamy soils retain moisture well and drain sufficiently, making them ideal for agriculture in most climates.
4. **Peaty Soils:** With high organic matter, peaty soils hold substantial water but may become waterlogged in humid climates. They require careful drainage management, especially in regions with heavy rainfall.

Innovative approaches are increasingly necessary to optimize water and energy use. Some of these approaches include unconventional use of water resources such as, for instance, the use of **wastewater**. Treated wastewater can be safely **reused for irrigation,** providing a sustainable alternative to freshwater. Proper treatment reduces the risk of contamination, making it suitable for agriculture and reducing strain on natural water sources. Another example is the use of **saline and drainage water:** salt-tolerant crops and halophytes allow the use of saline water in agriculture, reducing freshwater dependence. Advanced drainage systems also enable the reuse of runoff water, which can be redirected to crops after treatment. Finally, **desalination technologies** can provide fresh water in regions facing extreme water scarcity. While costly, advances in desalination technology, especially when coupled with renewable energy, make it a viable option for some coastal agricultural regions.

Using **information technology to monitor and control irrigation** allows farmers to use water more efficiently is also extremely important. With sensors and IoT-based systems for **precision irrigation,** farmers can adjust water application based on soil moisture, crop type, and weather conditions, reducing water waste. Also, combining **drip systems with smart controllers** maximizes water efficiency by delivering water directly to plant roots based on real-time data.

Another innovative solution is the **use of soilless cultivation:** hydroponics, aeroponics, and aquaponics are alternatives to traditional soil-based farming, particularly useful in urban agriculture and areas with poor soil quality. These systems allow crops to be grown with minimal water, as they recirculate nutrient solutions rather than relying on soil moisture.

Picture: Nadine Primeau from Unplash



Map summarising waterflows in the green areas of Milan →

DROUGHT IN THE NORTH OF ITALY CASE STUDY

In early 2022, Northern Italy experienced one of the most severe droughts in European recent history, profoundly impacting agriculture, hydropower generation, and water management. This drought, particularly pronounced in the Po River basin, was marked by a severe precipitation deficit that began in December 2021 and persisted through March 2022.

Background and Key Drivers The region typically relies on two main wet seasons, in late spring and autumn. However, from December 2021 to February 2022, precipitation in key areas such as Piedmont was only 40 mm—far below the expected 160 mm. This resulted in a rapidly increasing cumulative precipitation deficit. Additionally, warmer-than-usual winter temperatures contributed to reduced snow accumulation in the Alps, with the Snow Water Equivalent Indicator reporting levels at only 40% of the 2009–2021 median. These factors collectively heightened concerns over spring and summer water availability, particularly for river discharges heavily dependent on snowmelt.

Agriculture Impacts The drought significantly affected soil moisture and water availability for irrigation. As early as March 2022, competition for water resources among farmers began, months ahead of the usual irrigation season. This competition was particularly acute for crops like rice, which depend on reliable water supplies. Marginal rice-growing areas were left unsown, and water stress threatened winter crop yields, reducing the overall productivity of the region.

The sharp decline in hydropower reservoir levels and river discharges, coupled with severe seawater intrusion in the Po River Delta, not only intensified immediate challenges in energy and water management but also underscored the broader vulnerability of critical infrastructure and ecosystems to prolonged drought conditions. Future Implications. Seasonal forecasts for the following months (April–June 2022) predicted below-average precipitation, raising concerns about prolonged and intensifying drought impacts. This event highlighted the vulnerability of Northern Italy's agricultural and hydrological systems to climate variability and underscored the need for adaptive water management strategies, such as efficient irrigation technologies, cooperative water-sharing agreements, and improved reservoir management.

The 2022 Northern Italy drought serves as a stark reminder of the intricate links between climate change, water resources, and agriculture. Collaborative frameworks among stakeholders, investments in resilient infrastructure, and sustainable practices are crucial to mitigating the adverse impacts of future droughts in the region.

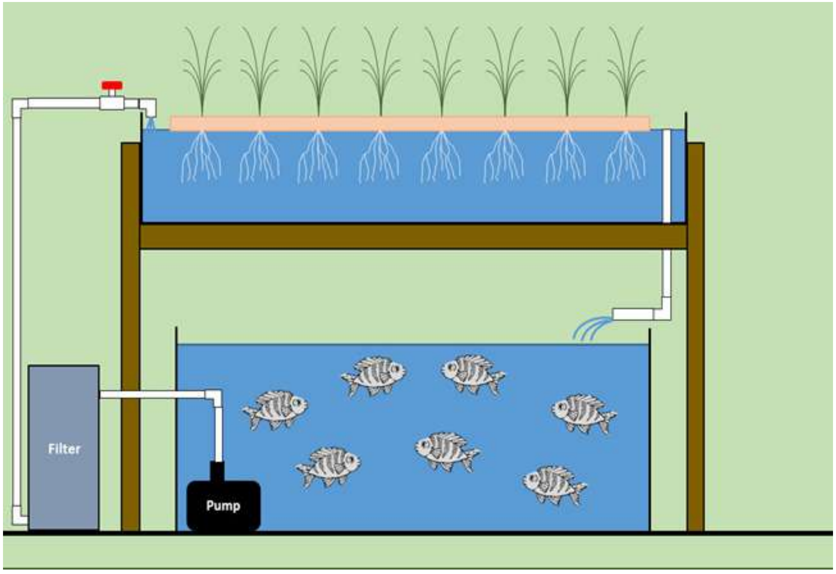
Source: European Commission Joint Research Centre. (2022). Drought in northern Italy - March 2022. EUR 31037 EN. Publications Office of the European Union. https://doi.org/10.2760/781876

HYDROPONICS, AEROPONICS, AQUAPONICS

Hydroponics is a method of growing plants without soil, using nutrient-rich water to deliver essential minerals and nutrients directly to the plant roots. The water is typically contained in a reservoir, and plants are supported by an inert medium such as perlite, coconut coir, or rock wool. This method allows for efficient control of the growing environment, leading to faster plant growth, higher yields, and the ability to grow crops in areas with poor soil quality.

Aeroponics is a soil-free cultivation technique where plants grow in air or mist environments. The plant roots are suspended in the air and receive nutrients through a fine mist of water and nutrients. This method uses less water than hydroponics and can provide faster plant growth due to the increased oxygenation of the roots. Aeroponics is often used in vertical farming systems, maximizing space for plant production in urban environments or areas with limited arable land.

Aquaponics combines aquaculture (the cultivation of aquatic animals like fish) with hydroponics to create a sustainable ecosystem. In this system, fish produce waste that is rich in nutrients, which is then filtered into the hydroponic plant beds. The plants absorb these nutrients, cleaning the water in the process, which is then recirculated back to the fish tanks. This symbiotic relationship creates a self-sustaining cycle, reducing the need for external fertilizers and water, making it an environmentally friendly and resource-efficient method of food production.



Source: Lance Beecher, Clemson University, available at: https://lgpress.clemson.edu/publication/aquaponics-system-layout-and-components/

Water Infrastructure

In cities, **water infrastructure is complex and highly interconnected.** Urban areas rely on extensive systems for sourcing, treating, and distributing water for drinking, sanitation, industrial uses, and green spaces. Given the density of urban populations, the infrastructure must be **robust and capable of delivering consistent, safe water to millions of people daily.** Key components include **water treatment facilities,** which remove contaminants and pathogens to make water potable; **pipelines and reservoirs,** which ensure that water is readily available; and **wastewater treatment plants,** which handle the collection and processing of wastewater to protect public health and local ecosystems.

Effective water infrastructure in urban areas is **essential for public health and safety.** Without reliable access to clean water, cities face increased risks of waterborne diseases and sanitation challenges, which can lead to public health crises. Additionally, by supporting industries and enabling efficient water usage, well-maintained infrastructure contributes to urban economic growth and resilience. Modern urban water systems often **integrate advanced technologies for monitoring and managing water quality,** leak detection, and energy-efficient treatment processes, which enhance operational efficiency and conserve resources. However, urban water infrastructure **also faces significant challenges.** Rapid urbanization, aging infrastructure, and climate change are putting pressure on water systems worldwide. Cities are increasingly investing in **innovative solutions like smart metering, automated leak detection, and rainwater harvesting** to ensure that infrastructure keeps pace with growing demands. **Green infrastructure**—such as urban wetlands, permeable pavements, and green roofs—also helps cities manage stormwater, reduce flooding, and enhance water quality by mimicking natural processes.

In rural areas, water infrastructure serves smaller, often dispersed populations, and focuses heavily on **agricultural needs in addition to drinking water.** Agriculture is the largest consumer of water globally, and in rural areas, irrigation systems are crucial for sustaining crop yields and livestock. Infrastructure like **irrigation canals, groundwater wells, and storage tanks** are central to rural water management, allowing farmers to access and use water efficiently, even during dry seasons.

Access to clean **water for drinking and sanitation** in rural communities is essential for health, economic development, and education. In many rural areas, especially in developing regions, people rely on local rivers, lakes, or groundwater sources, which may be contaminated. In these cases, infrastructure such as **boreholes, rainwater harvesting systems, and small-scale filtration units are critical.** These decentralized solutions can be highly effective in rural areas where installing large-scale infrastructure is not economically feasible. One of the challenges in rural water infrastructure is **maintaining water quality and access in remote or underserved areas**. Often, these regions are more **vulnerable to climate change impacts,** such as droughts and flooding, which can damage infrastructure and limit water availability. Investment in **resilient and adaptable infrastructure,** like solar-powered pumps and drought-resistant water storage, can help rural communities better manage water resources in the face of environmental variability.

The **interconnectedness of urban and rural water demands calls for a holistic approach,** often referred to as **integrated water resources management (IWRM)**. Urban areas frequently depend on rural watersheds, rivers, and aquifers for their water supply, while rural regions rely on urban markets and industries for economic stability. Thus, water infrastructure that supports both urban and rural needs can enhance resilience across regions. For instance, **large reservoirs and dams** built to supply water to cities can also support rural irrigation, energy generation, and flood control. **Efficient rural-to-urban water transfers and water trading systems,** coupled with improved rural water conservation practices, help balance demand across regions. Investing in **water reuse,** where treated wastewater from urban areas is repurposed for agricultural irrigation, is another emerging solution. This **circular approach reduces the pressure on freshwater sources and ensures that both urban and rural areas can access the water they need without over-extracting from natural ecosystems.**

Picture: Archivio MM Spa

MM Spa Case Study

MM was founded in 1955 with the aim of designing the Milan Metro lines. Thanks to the acquisition of more and more expertise in the field of engineering, over the years the company has been entrusted with numerous areas of intervention, including roads, water, buildings, schools and green areas.

Since 2003 MM has been managing the Integrated Water Service of the City of Milan, ensuring the constant supply of essential public services of aqueduct, sewerage and purification, including emergency services, customer service and maintenance of infrastructures, networks and plants.

Milan's water is drawn entirely from the second water table, at a depth of between 80 and 100 metres, using a double-lift system consisting of more than 500 wells for hydropotable use and 32 pumping stations, which feeds the adduction and distribution network to the territory.

The water in the Milan aqueduct is constantly monitored by MM's laboratory according to a programme shared with the health authorities, which involves over 3,600 samplings a year for a total of over 170,000 parameters analysed.

After being checked and treated, the water is distributed to the city through approximately 2,209 km of pipes. Through the distribution network, the water reaches more than 50,000 users (condominiums and individuals), serving a population of approximately 2 million people, including residents and city users.

The water used then ends up in the sewage network, which extends underground for about 1,639 km. The sewage contains various types of pollutants whose elimination, before being returned to the environment, the final step of the integrated water service, is only possible in a specialised plant through an industrial process in several stages.

The water therefore flows from the sewers to the city's two large purification plants: Milano San Rocco and Milano Nosedo. Here the wastewater is treated and purified, and then returned to the environment to feed the canals and marcite that irrigate the peri-urban agricultural fields.

More than 256 million cubic metres of water are purified each year by MM's plants.

The two purification plants are real garrisons of the circular economy at a European level, aiming at the efficiency of water resources and returning purified water to the City of Milan to be used for irrigation.

The Nosedo purifier is the largest of the plants managed by MM to serve the city of Milan, with a treated water flow rate ranging from 5,000 litres/second in dry weather to 15,000 litres/second in rainy weather. Located to the south-east of the city, in an area between the Corvetto-Porto di Mare area and the vast agricultural strip extending near the Chiaravalle Abbey, the Milan Nosedo wastewater treatment plant has a treatment capacity of more than one million two hundred thousand population equivalents and serves the central-eastern districts of the city, accounting for about 50% of the total wastewater collected by the city's sewer system. Much of the water purified at Nosedo is returned mainly to the Roggia Vettabbia, where it is recovered for irrigation purposes by farms covering an area of approximately 4,000 hectares.

The San Rocco purification plant is located within the Parco Agricolo Sud di Milano, between the municipalities of Rozzano and Opera. The plant has a treatment capacity of over one million population equivalent and serves an area of 101 square kilometres in the western part of the city. In particular, about 40% of the sewage discharged into the sewerage system of the Municipality of Milan and part of the sewage of the Municipality of Settimo Milanese flows into the treatment plant. The purified and disinfected water is ready to be returned to the environment, going to feed the rivers and canals of the peri-urban water network and the irrigation ditches that feed the agricultural fields of the metropolitan area.

The biological sludge resulting from the wastewater treatment process represents the main waste produced by MM.

Confirming MM's responsible approach to the environment, no sludge is disposed of in landfills, but is 100% sent for material and/or energy recovery; it is therefore all reused in, for example, the cement industry and agriculture.


Picture: Archivio MM Spa

Wastewater Collection and Management

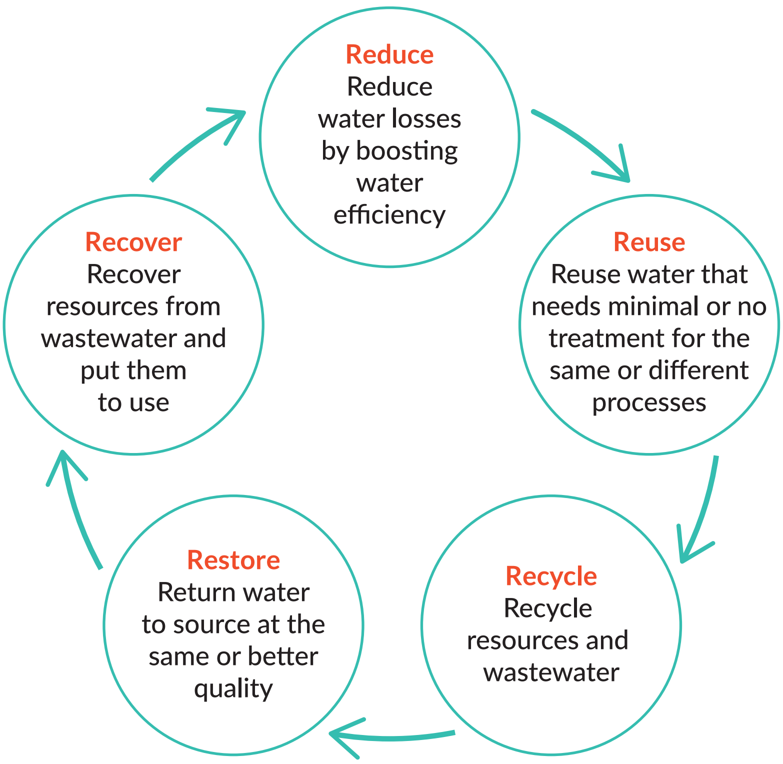
Wastewater collection and management involve the **systematic gathering, treatment, and disposal or reuse of wastewater** from residential, industrial, and commercial sources. In urban areas, wastewater is typically collected through a **network of sewage pipes that transport it to treatment facilities.** At these facilities, wastewater undergoes various treatment stages to remove contaminants, pathogens, and pollutants, making it safer for disposal or reuse. Effective wastewater management is vital for **reducing pollution in water bodies, protecting ecosystems, and ensuring public health.** Inadequate wastewater management can lead to untreated waste entering rivers, lakes, and oceans, which negatively affects aquatic life and can spread waterborne diseases among humans. Improved wastewater management can reduce pollution, safeguard health, and support sustainable water cycles. **Water reuse refers to the process of treating and using wastewater for various applications,** including agricultural irrigation, industrial processes, and even indirect potable reuse (where treated water recharges aquifers or supplies reservoirs for future drinking water).

Process	Description	Benefits
DIRECT REUSE	Treated wastewater is used immediately after purification for applications like irrigation or industrial cooling.	Reduces freshwater demand, supports sustainable agriculture and industrial efficiency, and lowers water supply costs. In agriculture, it provides both water and nutrients, reducing the need for synthetic fertilizers.
INDIRECT REUSE	Treated wastewater is discharged into natural water systems (rivers, groundwater) before being extracted and treated again for further use.	Enhances natural water replenishment, provides additional filtration, supports ecosystem stability, and decreases pollution load on ecosystems. Helps sustain potable water supplies for urban and rural use.
WATER RECOVERY	Capturing and reusing water within closed systems, especially in industries like manufacturing, power generation, and mining.	Lowers freshwater consumption, reduces wastewater discharge, cuts operational costs, and allows facilities to recycle water multiple times using technologies like membrane filtration. Helps industries maintain efficiency while minimizing environmental impact.

Another important step in the water waste management is the **wastewater desalination,** a process of **removing salts and other impurities** from wastewater to make it suitable for reuse. This process is particularly relevant in regions with **limited freshwater resources,** where saline or brackish water is often the only water source available. **Desalination technologies,** like reverse osmosis and distillation, make it possible to reclaim and reuse water from various sources, including agricultural runoff, industrial processes, and even municipal wastewater. While desalination is effective in producing high-quality water, **it is energy-intensive and can have environmental impacts,** such as brine disposal, which needs careful management to prevent harm to marine ecosystems. To reduce these impacts, desalination plants are increasingly **integrating renewable energy sources,** such as solar or wind power, which can decrease the carbon footprint of the process.

The **circular water economy,** which promotes water reuse and resource recovery from wastewater, **is increasingly recognized as essential for sustainability.** Innovative wastewater management and water reuse can **mitigate water scarcity, support food and energy production, and reduce environmental impacts,** making it a foundational element of resilient water systems worldwide.

Circular economy water management



Water management system in urban and rural area

Water collection

Surface water collection
Reservoirs, rivers, lakes, dams

Groundwater collection
Wells, boreholes, aquifers

Rainwater harvesting
Roof catchments, collection tanks (for decentralized systems)

Water treatment

Urban area

Drinking Water Treatment Plants (DWT)
Filtration, disinfection, purification

Advanced Treatment
(e.g., reverse osmosis, UV treatment)

Rural area

Small-Scale Filtration Units
For decentralized drinking water solutions

Basic Disinfection
Chlorination or UV systems for smaller populations

Water distribution

Urban area

Pipelines, pressure control, metering systems

Water towers and storage tanks to regulate flow

Rural area

Irrigation Channels and Canals
Direct delivery to agricultural fields

Rural Piping Systems
Decentralized pipes to small communities and farms

Wastewater collection and treatment

Urban area

collection
Sewer Networks

treatment
Urban Wastewater Treatment Plants
Removal of contaminants and pollutants

Rural area

collection
Septic Tanks and Localized Systems

treatment
Rural On-Site Treatment
Smaller, decentralized systems (e.g., septic systems, natural filtration)

Recycled/Reused water systems

Urban area

Treated wastewater for industrial cooling, landscape irrigation

Dual piping systems for non-potable use
(e.g., gray water reuse)

Rural area

Treated wastewater for agricultural irrigation

Water recovery and recycling in farming operations
(e.g., gray water reuse)

Stormwater management

Urban area

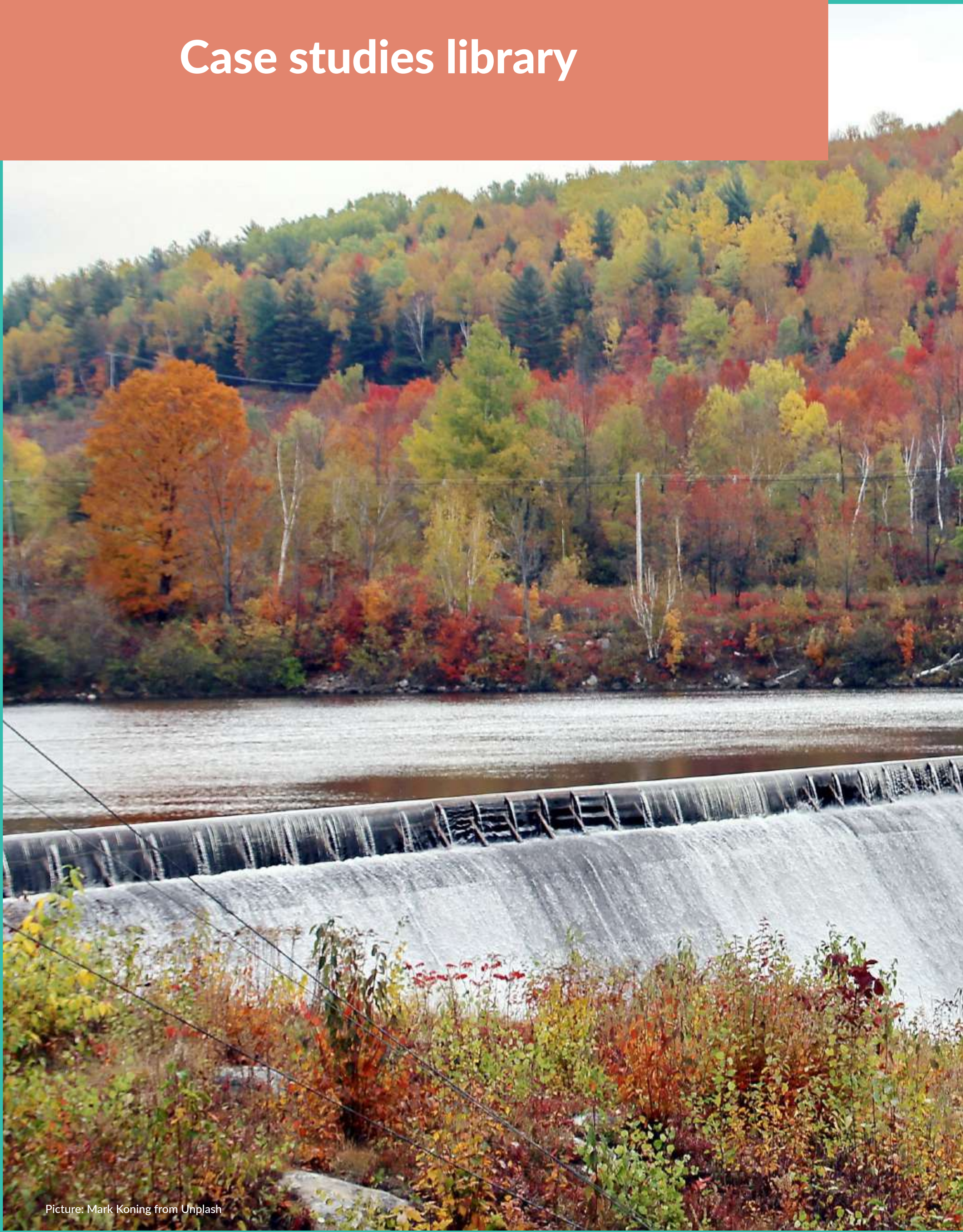
green infrastructure
Rain gardens, permeable pavements, bioswales

Rural area

green infrastructure
Floodplain restoration, natural wetlands

grey infrastructure
Drainage systems, retention basins, dams for flood control

Case studies library



Picture: Mark Koning from Unplash

Barcelona, Spain, Europe

Six projects aimed at tackling the drought

Barcelona has allocated funding to six innovative projects aimed at addressing the ongoing drought. **These initiatives focus on optimizing water use, improving sustainability, and promoting efficient management of water resources.** The selected projects include technological advancements, infrastructure improvements, and nature-based solutions designed to enhance water conservation. **By investing in these projects, the city aims to mitigate the effects of water scarcity, ensure long-term sustainability, and strengthen resilience against future droughts.** This effort is part of Barcelona's broader commitment to environmental sustainability and climate adaptation, reinforcing its leadership in urban water management.

Among the winning projects, one aims to **recover and reuse greywater in urban areas,** reducing dependency on potable water. Another initiative focuses on **improving rainwater collection and storage systems** to maximize water availability during dry periods. A third project involves the **installation of smart irrigation systems** that adjust water use based on real-time environmental conditions. Additionally, there is a plan to enhance the **regeneration of aquifers by increasing their infiltration capacity.** Some projects emphasize nature-based solutions, such as restoring green spaces to improve water retention and biodiversity. These efforts align with Barcelona's broader **strategy for climate resilience and sustainable water management.**

Source: https://www.barcelona.cat/barcelonasostenible/en/la-xarxa/actualitat-de-barcelona-sostenible/barcelona-grants-six-projects-aimed-at-tackling-the-drought-1461636

Dire Dawa, Ethiopia, Africa

Development Actions to Improve Food Security in the City of Dire Dawa

The project titled "*Development Actions to Improve Food Security in the City of Dire Dawa*" (DAISC) is an initiative aimed at **enhancing food security** in Dire Dawa, Ethiopia. Implemented by the Comunità Volontari per il Mondo (CVM) and funded by the Italian Agency for Development Cooperation, the project focuses on the **critical interplay between water resources, food production, and urban development.** Dire Dawa faces challenges such as water scarcity and rapid urbanization, which strain its food supply systems. To address these issues, DAISC promotes sustainable agricultural practices, efficient water management, and the strengthening of local food markets. By **improving irrigation infrastructure and supporting urban agriculture,** the project aims to increase food availability and resilience within the city. Additionally, DAISC emphasizes **community engagement and capacity building** to ensure the sustainability of its interventions. Through these integrated efforts, the project seeks to create a **harmonious balance** between water usage, food production, and urban growth, contributing to the overall well-being of Dire Dawa's residents.

Source: Italian Agency for Development Cooperation

Ouagadougou, Burkina Faso, Africa

Fighting Malnutrition in Informal Settlements in Peri-urban Areas

The "*sLuM*" project in Zagtouli, on the outskirts of Ouagadougou, Burkina Faso, addresses the **pressing challenges of malnutrition in informal settlements** through a multisectoral approach. This densely populated area, home to nearly 60,000 residents, faces severe poverty, inadequate sanitation, and food insecurity, exacerbated by the COVID-19 pandemic. **Improving water access and hygiene practices** directly impacts food security by reducing disease prevalence and ensuring better nutrient absorption among children. The initiative **strengthens healthcare services,** enabling better identification and treatment of acute malnutrition through improved anthropometric screening and community-based nutritional education. **Local women and families receive training** on breastfeeding, complementary feeding, and urban gardening techniques, fostering self-sufficiency and dietary diversity. Furthermore, **income-generating activities** empower families to afford nutritious food, bridging economic gaps that contribute to food scarcity. The **integration of sustainable water management with urban agriculture** ensures long-term resilience, while public awareness campaigns promote hygiene and nutrition best practices. Through these efforts, **the project establishes a framework where water, food, and urban development are interconnected,** fostering healthier communities in vulnerable peri-urban settings.

Source: Italian Agency for Development Cooperation

Milan, Italy, Europe

Milan and Its Surface Water System

Milan, the second-most populous city in Italy, is located in Lombardy, a highly urbanized region spanning 1,300 km^2. The city's **complex hydraulic system** includes rivers like Ticino and Adda, smaller rivers such as Seveso, Olona, and Lambro, and artificial canals like the Naviglio Grande and Naviglio Pavese, used for irrigation, navigation, and flood control. This system is managed by **a network of regional, municipal, and consortial entities.**

Milan's water management also relies on: Artificial irrigation canals distributing water to agriculture, The Darsena, a hub connecting canals, Wastewater treatment plants, redirecting processed water, Groundwater pumps and geothermal systems contributing to irrigation.

Mapping these infrastructures and weekly monitoring of reserves, including snow cover and reservoirs, are essential to anticipating issues during irrigation periods. The Food Policy Department uses ARPA Lombardia's weekly bulletins to guide interventions.

The 2022 Drought Emergency. From December 2021 to February 2022, **precipitation in Northern Italy fell to 25% of normal levels,** triggering competition for scarce water resources. Hydroelectric plants retained water, while farmers struggled to irrigate crops like maize and rice. **Over 30 peri-urban farmers faced severe risks to their harvests.**

The Food Policy Department **mobilized a stakeholder roundtable** with municipal officials, the ETV Villoresi Reclamation Consortium, and farmers' unions. Using Galli's Law, which frames water as a public good, they **prioritized small farmers' irrigation needs.** Water was released from the Darsena into the Ticinello Canal, saving 80% of crops compared to 40% in other areas.

The **collaborative actions led to several significant outcomes:** crop losses were reduced to 20%, understanding of Milan's water systems was enhanced, and stronger networks were established between farmers, associations, and authorities. **Daily water level monitoring** was improved via ARPA bulletins, new water infrastructure projects were funded under NRRP, and critical infrastructure was strategically mapped for future resilience. Additionally, **the importance of winter and irrigation monitoring** was emphasized to better anticipate and address seasonal challenges.

Milan's response illustrates the **power of collaboration in water management.** This case was part of the Water Resilience Experiment (WRE), a JRC and Politecnico di Milano initiative. The WRE developed **strategies for climate-resilient governance through local collaboration and adaptive planning.**

Source: the municipality of Milan

Mexico City, Mexico, North & Central America

Urban adaptation through rainwater harvesting and recovery of traditional agricultural techniques

Mexico City, one of the world's largest and most densely populated metropolises, faces an **escalating water crisis** driven by uncontrolled urban expansion, aging infrastructure, and climate change. The city grapples with **chronic water scarcity** affecting millions, while also enduring frequent flooding during the rainy season. The depletion of lakes and overexploited aquifers has intensified the urgency of sustainable water management, **prompting authorities to implement innovative solutions**. Among them, the *Isla Urbana* project has introduced **rainwater harvesting systems** to thousands of vulnerable households, reducing dependence on groundwater and mitigating flood risks. This initiative is complemented by the Cosecha Lluvia program, which seeks to **expand rainwater collection on a broader urban scale.**

In parallel, the city is reviving the ancient chinampa agricultural system, a network of floating islands dating back to the Aztec era, to improve **water retention, restore wetlands, and strengthen local food production.** The *Escuela Chinampera* project, launched in 2015, is central to this effort, aiming to **recover abandoned chinampas**, promote agroecological practices, and provide technical education for new farmers. Recognized by FAO and UNESCO, the system functions as a **natural water reservoir, supports biodiversity, and enhances urban resilience.** By integrating chinampa-grown produce into local markets and diets, the initiative also strengthens food security while preserving Mexico City's cultural heritage.

Institutionally, the *Climate Action Program* incorporates **water governance into urban policies,** promoting soil conservation and real-time monitoring of resources. **A dedicated government cabinet coordinates efforts between local and federal agencies to improve water supply management.** These strategies highlight how innovative water conservation, combined with the **restoration of traditional agricultural practices,** is key to addressing Mexico City's environmental and social challenges. Through a model of urban resilience, the city is redefining its relationship with water, ensuring sustainability for future generations.

Source: Milan Pact Awards and C40 https://www.c40.org/case-studies/rainwater-harvesting-in-mexico-city-as-a-measure-to-reduce-the-impacts-of-floods-increase-water-security-and-guarantee-rights-to-water-and-health

Johannesburg, South Africa, Africa

Urban Aquaponic Farm, A combination of vegetable and cat fish farming

Johannesburg's Urban Aquaponic Farm initiative is a sustainable agriculture project launched in 2018 that combines aquaculture and hydroponics for food production in an urban environment. The city partnered with INMED and **used unused land to build an aquaponic system with five fish tanks** (350 fish per tank) **and ten hydroponic units.** The project not only provides fresh food to the local community, but generates income for small farmers and supports schools and underprivileged patients.

The main innovation is the ability to produce ten times more vegetables than traditional agriculture while simultaneously reducing energy consumption by 75 percent and water consumption by up to 95 percent. Aquaponics uses no chemical fertilizers or pesticides, lowering costs and environmental impact. The project promotes training and inclusion, involving various local and international organizations.

The impacts are many: from supporting the children of Soweto with donations of vegetables, to reducing emissions through more efficient farming. The economic aspect is based on the sale of vegetables and fish, ensuring financial self-sufficiency in the long term.

The main challenges include financing, equipment theft, and the need to expand the project. For the future, Johannesburg aims to develop automated aquaponics systems, vertical farming and rooftop cultivation to strengthen food security and reduce environmental impact.

Source: Milan Pact Awards

Sahel Region, Africa

Water Security in the Sahel: Harnessing the Power of Neglected Crops

Water scarcity is a growing crisis in the Sahel, where communities struggle with access to clean drinking water. In Burkina Faso and Niger, the **SUSTLIVES project,** funded by the European Union, is addressing this issue by **promoting neglected and underutilized species** (NUS)—drought-resilient crops with overlooked potential. Among these, **moringa** stands out not only for its nutritional value but also for its water purification properties.

In Ouagadougou and Niamey, as well as surrounding rural areas, **communities face severe water shortages, exacerbated by climate change.** The SUSTLIVES project, coordinated by AICS and CIHEAM Bari, works alongside Joseph Ki-Zerbo University (Burkina Faso) and Abdou Moumouni University (Niger) to integrate NUS into **local food and water systems. Moringa seeds,** when crushed and used in filtration, **can remove impurities and bacteria from water,** providing an accessible and sustainable purification method for remote areas.

Beyond water purification, the project promotes **drought-resistant crops** such as cassava, sweet potato, and Bambara groundnut, which thrive in arid soils with minimal water.

By combining **traditional agricultural knowledge with modern innovation,** the project helps communities adapt to climate change while securing their most essential resource: water.

Source: CIHEAM Bari, Mediterranean Agronomic Institute of Bari

Yambio, Ibba, Maridi, Ikotos, Torit, Sud Sudan, Africa

Food Security, Nutrition and Hygiene for Communities in the Equatorial Belt of South Sudan

The project identified *"S.A.N.I. - Food Security, Nutrition and Hygiene for Communities in the Equatorial Belt of South Sudan"* is an initiative funded by the Italian Agency for Development Cooperation (AICS) in South Sudan. Its primary objective is to **enhance access to clean water and improve food security in urban areas.** By constructing and rehabilitating water infrastructure, the project aims to provide **reliable sources of potable water to city residents,** thereby reducing waterborne diseases and promoting better health. Additionally, the initiative supports **urban agriculture** by offering training and resources to local communities, enabling them to **produce their own food and reduce dependence on external supplies.** This dual focus on water and food within the urban context seeks to foster **sustainable development and resilience** among South Sudan's urban populations.

Source: Italian Agency for Development and Cooperation

Porto Alegre, Brazil, South America

Agroforestry Systems and Collaborative Governance: Sustainable Production and Citizen Participation

Porto Alegre has a significant rural area, being the third largest among Brazilian capitals. This territory plays a **fundamental role in food security and economic development.** Currently, 184 registered local producers, including 90 family farmers, directly supply markets, fairs, and municipal schools, promoting **proximity between production and consumption** and strengthening the quality and diversity of local products.

In recent years, Porto Alegre has faced **significant hydrological fluctuations.** In the first week of February 2024, Lake Guaíba reached only 37 centimeters, compromising the city's water supply. Three months later, **one of the largest floods ever recorded raised the water level to 5.37 meters,** a historic mark that affected 30% of the municipal territory and impacted more than 160,000 people.

Agricultural production was severely affected, with over 60% of activities compromised, especially in horticulture and fruit farming. Fish farming was also impacted. Despite these challenges, **the commercial distribution system remained operational,** ensuring the supply of markets and fairs, except during the peak of the floods.

In light of this situation, since 2023, Porto Alegre **has intensified the use of Agroforestry Systems (AFS) in both urban and rural areas,** aiming to promote more sustainable agricultural practices. Experience has shown that agroforestry productive areas **allow for a faster recovery of agricultural activities,** enabling the swift restoration of food production, even after extreme weather events.

AFS stands out for four main characteristics: diversity, density, succession, and stratification. Thus, they contribute significantly to: a) **Water infiltration** into the soil, improving groundwater recharge b) **Pollutant filtration,** reducing contamination risks c) **Erosion control,** preventing soil degradation and surface runoff d) **Reduction of greenhouse gas emissions** in the atmosphere e) **Water retention,** ensuring greater production stability, even during drought periods.

As part of this strategy, agroforestry community gardens have expanded food production in urban areas, contributing to the creation of **more humid microclimates and reducing water evaporation.**

By February 2025, the City Hall, with the participation of community leaders, **has implemented 22 agroforestry gardens,** with the goal of reaching 68 by June 2025. These spaces allow the population not only to consume the food but also to actively participate in its production, monitoring, and maintenance. This **participatory approach,** which includes workshops on AFS, s**trengthens community integration in urban territories,** in addition to encouraging the responsible and efficient use of natural resources. By **expanding the social ownership of sustainability,** these actions empower citizens as protagonists in building solutions.

Both in urban community gardens and rural agroforestry initiatives, **collaborative governance plays an essential role in coordinating between the public sector, producers, and the community.** This approach of coordinated and networked collaboration encourages the creation of sustainable and scalable solutions to promote food security, social and economic development, climate adaptation, and participatory territorial management. This **integrated network approach** generates multiple benefits: a) **for producers:** improvement in production quality and diversity b) **for the community:** ownership of the concept and good sustainable practices and effective use of water resources c) **for management:** organizational learning and connection between public policies in different areas d) **for the environment:** sustainability.

The project is conceived and managed by the **Governance Secretariat,** with close monitoring by Secretary Cassio Trogildo, technical support from agronomist specialists, and assistance from the Social Communication team, which helps in disseminating the project to the public. Starting in 2025, the **Networks Coordination** will also track the project from the perspective of collaborative governance and the benefits generated for different audiences.

Source: Olivia Bertolini, Coordinator of Networks at the City Hall of Porto Alegre

Picture: Marília Jung/ PMPA

MILAN URBAN FOOD POLICY PACT

Rennes, France, Europe

Protection of water resources through local food chains

Rennes is a **pioneer in linking the protection of water resources to the promotion of local food systems** through the **"***Terres de Sources*" initiative. A project that unites farmers, local authorities, and consumers in a collaboration aimed at **protecting the quality of drinking water while promoting sustainable and local agriculture.**

"*Terres de Sources*" **incentivizes farmers** located in the watersheds that supply the city of Rennes to practice **environmentally friendly agriculture.** In return, they receive technical and economic support to adopt more sustainable practices, such as reducing the use of pesticides and chemical fertilizers. **Products** from participating farms are then **distributed through short supply chains,** such as local markets and school canteens-opportunities for nutrition education and awareness raising. **The model integrates water conservation with the creation of a resilient food system,** ensuring that water remains drinkable and consumers have access to local, healthy and sustainably produced food.

Source: the municipality of Rennes

Source pictures: https://terresdesources.fr/

Kolkata, India, Eurasia & South West Asia

Wetlands and sustainable waste management for food production

Kolkata is globally famous for its **East Kolkata Wetlands**, a complex system of wetlands used for urban waste treatment and sustainable food production. These wetlands are an outstanding example of how **natural resources can be integrated into urban planning** to improve environmental sustainability and food security.

The East Kolkata Wetlands use a **traditional system** that combines natural wastewater treatment with fish farming and agriculture. The **city's wastewater is channeled to the wetlands,** where it undergoes a natural purification process thanks to the plants and microorganisms present. **The purified water is then used to feed one of the largest urban fish industries in the world.** In addition, these wetlands support the cultivation of rice and vegetables. Agricultural and fishing practices **are managed by local communities** that depend on these ecosystems for their economic and food survival. This model **integrates tradition and innovation,** showing how urban waste management can be turned into a resource.

The East Kolkata Wetlands were declared a **Ramsar site in 2002,** because **they are a unique ecosystem that combines natural wastewater purification with sustainable agriculture and aquaculture.** It means that it is an area of international importance according to the namesake Convention - signed in 1971 in Iran, city of Ramsar - for the conservation and sustainable use of wetlands, for which UNESCO is the depository organization.

Source: https://ekwma.in/ek/

Picture: Biswarup Ganguly, CC BY 3.0

Valencia, Spain, Europe

Water tribunal

The Tribunal de las Aguas de la Vega de Valencia, known in English as the Water Tribunal of Valencia, is a historic institution responsible for resolving irrigation-related disputes among farmers in the Horta de València region.

Comprising representatives from eight irrigation communities—Quart, Benàger i Faitanar, Tormos, Mislata, Mestalla, Favara, Rascanya, and Rovella—the tribunal convenes every Thursday at noon. Meetings are held publicly at the Apostles Gate of Valencia Cathedral, where disputes are addressed orally and in the Valencian language. The tribunal's procedures are characterized by their speed, efficiency, and adherence to traditional customs.

The Tribunal de las Aguas primarily deals with conflicts related to irrigation, focusing on various issues that arise among farmers. One of the most common disputes involves unauthorized water use, where individuals may be accused of diverting more water than permitted or taking it without authorization. Another frequent issue is the obstruction of irrigation channels, whether due to debris, poor maintenance, or intentional blockages that disrupt the flow of water.

The tribunal also handles cases of damage to irrigation infrastructure, such as ditches, sluices, or other communal water systems that are essential for fair distribution. Scheduling conflicts are another point of contention, as irrigation follows a strict timetable, and disagreements occur when a farmer uses water outside their assigned time slot. Additionally, the tribunal ensures that traditional water rights are respected, preventing misuse or unfair distribution among the farming communities.

What makes the tribunal unique is its direct approach to resolving these disputes. Operating outside the standard judicial system, its rulings are final and cannot be appealed. This long-standing tradition has contributed to the tribunal's enduring role in Valencia's agricultural system and its continued relevance in modern times.

In 2009, UNESCO recognized the significance of the Water Tribunal by inscribing it on the Representative List of the Intangible Cultural Heritage of Humanity, highlighting its enduring role in community-based water management. In 2023, our partner CEMAS organised a congress about this governance practice to celebrate and spread its legacy.

The tribunal's enduring presence underscores its importance in Valencia's agricultural practices and cultural heritage, serving as a testament to effective self-governance and the preservation of historical traditions.

Source: https://tribunaldelasaguas.org/es/el-tribunal/historia

Windhoek, Namibia, Africa

Pioneering Wastewater Recycling for Drinking Water

Windhoek, the capital of Namibia, has been facing water scarcity for decades due to the country's arid climate. To ensure a sustainable water supply, the city adopted an innovative solution: since 1968, it has been **producing drinking water by recycling its wastewater, becoming the first in the world to implement this process.** Since 2001, the plant has been operated by WINGOC (Windhoek Goreangab Operating Company), a consortium formed by Veolia, Berlinwasser International, and WABAG.

The plant uses an advanced **"multi-barrier" process** that includes treatments such as ozonation, ultrafiltration membrane filtration, and residual chlorination. These steps **eliminate all contaminants,** ensuring that the produced water is safe and of high quality. Currently, **the plant supplies drinking water to approximately 400,000 residents,** covering about 35% of the urban area's water needs.

This approach not only increases the availability of drinking water but also **provides significant environmental benefits:** it prevents excessive use of natural resources and significantly reduces pollutant discharges. Windhoek's experience has become an **international benchmark for sustainable water management,** attracting experts from around the world.

In summary, Windhoek represents a **pioneering example of how wastewater recycling can be an effective solution** to address water scarcity in arid regions while ensuring environmental sustainability.

Source:https://www.veolia.com/en/newsroom/news/drinking-water-recycling-wastewater-windhoek-namibia

Conclusions

Water and food are deeply interconnected in urban environments, shaping not only the sustainability of cities but also public health, economic development, and social equity. **Effective governance**—both vertical, across different levels of government, and horizontal, across sectors—**plays a pivotal role in managing this nexus.** Cities are not isolated from broader water management challenges; instead, they are central actors in ensuring sustainable water use, reducing pollution, and maintaining crucial infrastructure such as aqueducts, treatment plants, and irrigation canals. However, despite their importance, water resources are often overexploited, degraded, or polluted, with urban policies sometimes treating water as a separate issue from food systems. To address these challenges, **cities must develop integrated governance approaches** that align urban water management with food production, distribution, and consumption.

Access to safe drinking water is not just an infrastructure issue but a **fundamental public health necessity.** Clean water is essential for drinking, food preparation, cooking, and sanitation. The consequences of inadequate water access are severe, particularly for marginalized communities, leading to heightened risks of waterborne diseases, malnutrition, and food insecurity. **Urban policies must prioritize equitable water distribution,** ensuring that all residents—regardless of socioeconomic status—can benefit from reliable and affordable access. This commitment aligns with the recognition of **water as a basic human right,** obligating governments at all levels to take proactive measures to guarantee safe and sufficient water for all. Climate change is further exacerbating these challenges, with more frequent and intense droughts and floods disrupting water supplies and food production. **Resilient urban water policies must therefore integrate climate adaptation strategies,** such as flood management and drought-resistant planning, to safeguard future generations.

Beyond governance and health, **innovation is increasingly vital in addressing water scarcity and ensuring circular water management.** The agricultural sector, which consumes nearly 70% of the world's accessible freshwater, must shift towards more sustainable practices to reduce its environmental impact. **Cities can play a key role in promoting water-efficient food production,** supporting urban farming, rainwater harvesting, and the use of irrigation technologies that optimize water use. At the same time, modern technological advancements—such as wastewater recycling, desalination, and digital monitoring systems—must be integrated with traditional, nature-based solutions, like wetland restoration and soil moisture conservation, to create more sustainable water-food systems. **A circular approach to water use,** where wastewater is treated and reused, rainwater is harvested, and food production minimizes water waste, is essential for long-term urban sustainability.

Urban areas have a unique opportunity to lead the way in **integrating food and water policies into a holistic framework.** By fostering multi-stakeholder collaboration, investing in resilient infrastructure, and adopting innovative water-saving techniques, **cities can reduce their water footprint while enhancing food security and public health.** The path forward requires a commitment to coordinated governance, recognition of water's role in health and nutrition, and a strong push for sustainable technological solutions. **Only through these combined efforts can urban food systems become more resilient, equitable, and sustainable in the face of growing global challenges.**

This report serves as a **first step in fostering a dialogue among cities** on the critical link between water and food systems. Through the lens of the **Milan Urban Food Policy Pact and AICS,** it highlights the importance of **collaborative governance** in managing water resources sustainably. By exploring key issues such as **water availability and quality, urban and peri-urban agriculture, infrastructure, and wastewater management,** the report provides a foundation for cities to share experiences and best practices. Through case studies and policy analysis, it sets the stage for an ongoing exchange, encouraging cities to develop **integrated strategies** that enhance resilience, ensure equitable access to water, and promote sustainable food systems.

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