Tip sheet no. 4

Urban challenges

Addressing these challenges through natural water retention measures

Produced by the International Office for Water, with financial support from the French Office for Biodiversity

GLOSSARY

ADASEA	Departmental association for the development of farms' structures
ADOPTA	Association for the operational development and promotion of alternative techniques
APCA	Permanent assembly of chambers of agriculture
ARB	Regional agency for biodiversity
AREAS	Association for research on runoff, erosion and land management
BAEC	Good agricultural and environmental condition
BRE	Rural lease with environmental clauses
BRGM	Geological and mining research bureau
CEN	Conservatory of natural areas
CEREMA	Centre for Studies and Expertise on Risks, the Environment, Mobility and Planning
CNPF	National centre for forest ownership
CRPF	Regional centre for forest ownership
CRTE	Ecological transition and recovery contract
DDT(M)	Departmental directorate for territories (and the sea)
DRAAF	Regional directorate for food, agriculture and forestry
DREAL	Regional directorate for the environment, planning and housing
EPAGE	Public water management and development agency
EPTB	Public territorial basin establishment
EAFRD	European agricultural fund for rural development
FNCOFOR	National federation of forest municipalities
GEMAPI	Management of aquatic environments and flood prevention
GEPU	Urban rainwater management
GIEE	Economic and environmental interest group
GRAIE	Rhône-Alpes research group on infrastructure and water
IWA	International water association
LIFE	European funding for action on the environment and climate
MAEC	Agri-environmental and climate measure
MASA	Ministry of agriculture and food sovereignty
MESR	Ministry of higher education and research
MTEBFMP	Ministry of ecological transition, biodiversity, forestry, sea and fisheries
OFB	French office for biodiversity
IOW	International office for water
ONF	National forestry office
ORE	Environmental real obligation
CAP	Common agricultural policy
PAEC	Agro-environmental and climate project
PAT	Territorial food project
PLU(i)	Local urban development plan (inter-municipal)
PNR	Regional natural park
PPRI	Flood risk prevention plan
PSE	Payment for environmental services
PSG	Simple management plan
SAGE	Water development and management plan
SCIC	Cooperative society of collective interest
SCOT	Territorial coherence plan
IUCN	International union for the conservation of nature

Meeting urban challenges through natural water retention

What are today's urban challenges?

In the current context of climate change, cities are particularly vulnerable to environmental and climatic hazards due to their characteristics: concentration of human activities, soil sealing, etc. This can manifest itself in various ways: extreme rainfall events, significant local temperature rises (also known as urban heat islands), pollution, etc. The consequences can range from increased energy consumption in summer to the destruction of equipment and homes, and even loss of lives.

Faced with these many challenges, cities have several levers at their disposal to mitigate the effects of climate change. The solutions they adopt must take into account environmental, economic and social issues, with a long-term vision, in order to be relevant. When these solutions are natural, they also help to improve the living environment of residents and preserve biodiversity.

Current trends

Most of Europe's population now lives in cities. These cities are already facing extreme events such as severe flooding and drought. Climate change is leading to an increase in extreme weather events: increased risk of flooding, more frequent droughts, water stress on drinking water supplies[1] , etc.

The impacts of climate change are felt across all parts of the territory, but urban areas are particularly vulnerable to certain impacts such as heatwaves (presence of urban heat islands).

How can we better respond to urban challenges by relying on natural water retention in the watershed?

Measures that reduce or even eliminate the soil sealing in cities help to make them more resilient. There are many such measures: preserving open spaces in urban areas, soil renaturation, de-waterproofing of surfaces, use of permeable pavements, installation of green roofs and facades, swales, etc. They enable rainwater to be managed directly or close to where it falls, reducing its contribution to runoff/flooding and slowing down the drying out of soil and vegetation.

In areas where surface runoff occurs, several measures can be taken to intercept this runoff for infiltration or storage at the surface, including retention and infiltration basins, or urban parks, if properly located.

A good example is sponge cities, whose aim is to absorb rainwater through infiltration into the ground in order to regulate urban flooding and reduce the vulnerability of cities during periods of drought. Unlike conventional urban engineering, which tends to induce a high risk of runoff and regulate this risk through "grey" measures, sponge cities use surfaces and their porosity or permeability, as well as the greening of walls and soils, to promote rainwater infiltration.

On a larger scale, maintaining or developing flood expansion areas can reduce the vulnerability of urban areas to flooding.

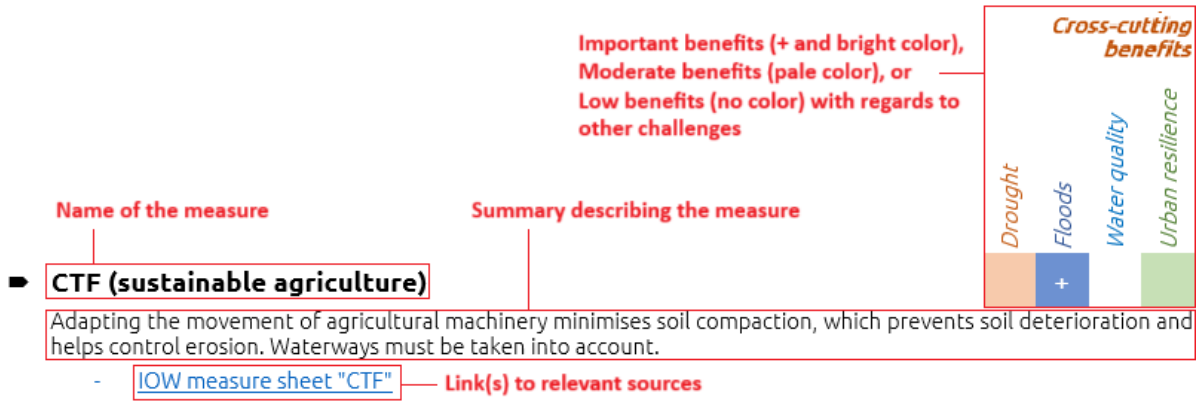
[1] European Environment Agency, 2020. Urban adaptation in Europe: how cities are responding to climate change

The twelve most relevant natural water retention measures for urban challenges

The measures proposed in this document are changes and adaptations to practices that increase water retention in urban environments.

These natural measures are known as multifunctional, as they simultaneously address several societal challenges (flooding, biodiversity preservation, living environment, etc.) while preserving or restoring the ecological functions of the environment.

At least twelve natural measures are of particular interest in addressing the current challenges facing cities. They are listed in the fact sheets below, according to the following template:



The measures are classified by type for ease of reading, but they can be implemented in any context.

Who are the tip sheets intended for?

The tip sheets are documents aiming at improving the understanding of the concepts of "natural water retention measures" and "nature-based solutions" by those involved in promoting, implementing and managing them in France. They aim to facilitate the implementation of these natural measures by helping potential project owners identify which ones are best suited to their needs and learn about the possible implementation and financing options. They also contain examples of concrete cases that illustrate the benefits of these measures.

These tip sheets will be useful primarily to project owners (both decision-makers and technical agents) and more broadly to all stakeholders promoting natural water retention measures.

This document will not address the most effective measures in an agricultural or forestry context, as the decision was made to focus on measures that can be implemented directly in urban areas. Nevertheless, urban areas can be highly dependent on land use planning throughout the entire watershed, and in particular upstream of their localisation. Put simply, flooding in towns and cities can result from a failure to implement natural retention measures at the head of the catchment area. We therefore encourage an integrated approach across the entire catchment area. For more information on the most relevant agricultural and forestry measures, please refer to the tip sheets on drought, flooding and pollution. The relationship between cities and river basins is essential for adapting to climate change and must be taken into account when implementing natural water retention measures.

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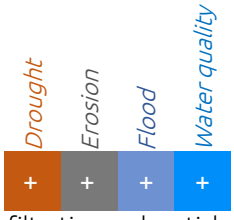
Most effective measures in aquatic environments

Reminder: "aquatic environments" measures can be implemented in urban, forest and agricultural contexts.

Cross-cutting benefits



Restoration and management of wetlands

Preserving or restoring the hydrological functions of wetlands helps slow runoff and promotes infiltration and particle filtration. They also act as carbon sinks and play an important role in the living environment and identity of the region.

- Patrinat reference framework for "ecological actions that can be implemented in wetlands"

Restoration and management of floodplains

Reconnecting the watercourse with its floodplain allows it to overflow in the event of flooding and spread out into the flood expansion zone. The connection between the oxbow lakes and the floodplain of the watercourse facilitates its filling during floods and creates natural habitats.
These areas also contribute to climate change adaptation by fixing CO_2 and burying carbon. They also offer recreational opportunities.

- OFB fact sheet "Removing lateral constraints"
- OFB fact sheet "Reconnecting hydraulic annexes"

Hydromorphological restoration of watercourses (riverbed)

Recreating the natural morphology of a watercourse, in particular by restoring its sinuous character (re-meandering), improves its capacity to store runoff and slows down the flow, thereby reducing the risk of flooding. The habitats created improve the resilience of biological communities. The development of vegetation provides shade and reduces water temperature.

In urban areas, the space available for the free flow of watercourses is often limited, making the objective of re-meandering more difficult to achieve.

- OFB fact sheet "Modifying the geometry of the riverbed within the current right-of-way"
- OFB fact sheet "Re-meandering"
- OFB fact sheet "Returning watercourses to their thalweg"
- OFB fact sheet "Re-exposing watercourses to the open air"
- OFB fact sheet "Reconstitution of the alluvial mattress"

Restoration and reconnection of intermittent watercourses

Restoring and reconnecting temporary watercourses slows down the flow, reduces the period of dry weather and promotes water infiltration. This helps reduce the risk of flooding and also preserves biodiversity by reducing fragmentation.

- OFB guide "Hydromorphological restoration of intermittent and/or low-flow watercourses"

Removal of bank protections

Removing all or part of bank protections improves lateral connections, diversifies flows and habitats, and limits flooding.

- OFB fact sheet "Removal of lateral constraints"

Restoration of water bodies

Restoring a water body allows water to be stored and supplied for various uses. This can contribute to carbon storage, provide habitats for animals and plants, and have recreational and cultural benefits.

- OFB website "Restoration of water bodies"

Controlled aquifer recharge

This involves increasing the volume of groundwater available by promoting its infiltration into the aquifer by artificial means. Restoring natural infiltration contributes to climate change adaptation.

! *This practice carries health risks if poorly controlled: microbiological contamination (bacteria, viruses), chemical pollution (nitrates, heavy metals, drug residues), alteration of natural water quality, and spread of existing pollutants. Strict monitoring, prior water treatment, and careful site selection are essential to limit these risks.*

- Note from the Rhône-Mediterranean Basin Committee, "Controlled aquifer recharge techniques"
- BRGM press kit "Sustainable groundwater management: from natural recharge to controlled recharge"

Depolderisation

Polders with natural characteristics can be optimised to create floodplains, for example. The watercourses in these areas can provide habitats for aquatic fauna.

- Bibliographic bulletin of the Wetlands Relay Centre "Depolderisation"

How can these measures be implemented?

Regulatory measures

- **[FR] Urban planning documents and flood risk prevention plans (PPRI)** help to preserve natural spaces such as wetlands.
  Wetlands and urban planning
- **[FR] The SAGE (Water management and development plan) and its regulations** may impose conditions relating to the management of aquatic or wetland environments.
  Wetlands in the SAGE

Financial aid and action programmes

- **[FR] Contracts (territorial, basin, thematic)** financed by water agencies enable actions to restore the hydrosystem with financial participation from the agency.
- **[FR]** The **Green Fund, launched in 2023,** contains a focus on "Renaturation of towns and villages", including the restoration of the hydrographic network, wetlands and flood expansion areas.
  Support documents for the implementation of the Green Fund
- Several **European programmes** provide funding for projects that include natural water retention measures, in particular the EAFRD fund and the Interreg programme for agriculture, as well as the LIFE programme and the Horizon Europe programme.
  Europe in France website: European Structural Investment Funds
  Financing ecological actions in wetlands - IOW
  The LIFE programme (MTEBFMP)
  European Interreg website
  Horizon Europe (MESR)
- **[FR] Water agencies** offer **grants** or **calls for projects** aiming at preserving or restoring aquatic or wetland environments.
- **[FR] Calls for projects** from departments, regions and public institutions (e.g. OFB) provide opportunities to implement certain natural water retention measures.
  Aides-territoires platform
- **[FR]** In 2022, the government launched a €500 million programme to **renature cities**, including measures to manage aquatic environments. The aid is provided by various organisations.
  Urban renaturation: aid programme

Local authorities' responsibilities

- **[FR]** The **GEMAPI**[2] competence enables the relevant local authorities to take action to restore the hydrosystem.

Potential technical partners [FR]

Public basin establishments (EPTB, EPAGE, basin or river syndicates), OFB, water agencies, nature conservation associations (e.g. CEN), fishing federations and associations, universities and research centres, decentralised departments of the Ministry of Ecology (DDT(M), DREAL), water syndicates.

An example: restoration of the Estagnol marsh (83)

Located in the immediate vicinity of the Toulon conurbation, the Estagnol site has lost its wetland character. Drained for agriculture, it was filled in from the 1990s onwards by nearby industries.
The high level of soil sealing in this attractive coastal area exacerbates the phenomenon of intense runoff, exposing the inhabitants of its catchment area to frequent hazards.

The restoration project will increase the potential for runoff retention and, ultimately, the resilience of the watershed by reducing flood peaks. Restoring the site's functionality will also create a refuge for species dependent on low-lying wetlands. The restoration covers 27 hectares.

Monitoring and evaluation mechanisms will eventually confirm the co-benefits of such practices compared to conventional engineering works, such as the cooling island effect for local residents and, more broadly, the improvement of the living environment.

Measures implemented: restoration and management of wetlands

Find out more:
Restoration of the Estagnol marsh - OFB

[2] The actions undertaken by inter-municipal authorities within the framework of GEMAPI are defined as follows by Article L.211-7 of the Environment Code:

- The development of river basins
- Maintenance and development of watercourses, canals, lakes and water bodies
- Flood and sea defence
- Protection and restoration of wetlands

Most effective measures in an urban context

Integrated rainwater management

Integrated rainwater management involves managing stormwater as close as possible to where it falls (temporary storage, evapotranspiration or infiltration), thereby limiting the risk of flooding in urban areas. In this environment in particular, two types of structures are used: on the one hand, structures that collect rainwater and allow it to flow more gradually downstream, such as retention basins (storm basins) and retention troughs, and, on the other hand, structures that promote the infiltration of rainwater as close as possible to the precipitation site, such as permeable pavements, green roofs, and several other types of vegetated depressions. A hybrid between these two types of structures, swales are also useful, as they both slow down and infiltrate runoff.

! *There is a risk of groundwater contamination if infiltration basins and wells are not properly installed. The underlying water table must be at least 1 m below these structures. In the case of infiltration wells, the collected water must be pre-treated before infiltration.*

Infiltration trenches are unsuitable in contexts with high sediment loads (risk of rapid clogging).

- Astee guide "Sustainable rainwater management solutions"

Trees in towns and wooded parks

Maintaining or planting trees and wooded parks in urban areas can help store runoff and promote infiltration. They also sequester carbon, provide habitats for wildlife and limit heat peaks through shading and evapotranspiration, which create cool islands.

- ARB Centre Val de Loire toolbox "Let's get green!"
- OFB guide "Rain trees"
- Plante&Cité website resource centre

The role of soil in urban areas

The implementation of natural retention measures in urban areas must take into account the physical and chemical properties of soils and their quality, which can influence the lifespan of trees in cities (soil analysis is recommended before planting).

There are urban planning tools for preserving open ground in urban areas, as well as publications on the benefits of taking action to improve urban soils.

Resources:

- Cerema-OFB "Study on the coefficients of unsealed or eco-developable areas: first deliverables available"
- Plante&Cité "Taking action for urban soils"

How can these measures be implemented?

Regulatory measures

- **[FR] Urban planning documents and sanitation plans:** inclusion of provisions in the PLU(i) (local urban planning plan), SCOT (territorial coherence scheme) and sanitation regulations. Certain provisions may be

included in these **planning documents** to ensure sustainable rainwater management, including its retention and infiltration, but also to delimit flood risk areas, wetlands and natural heritage features.

- **[FR] The SAGE and its regulations** may impose provisions relating to rainwater management and soil sealing in urban areas.
- **[FR] Rainwater zoning** helps prevent the degradation of aquatic environments during rainy weather and identify "areas where measures must be taken to limit soil sealing and ensure control of the onset and flow of rainwater and runoff ". It is integrated into the PLU(i).

Financial assistance and action programmes

- **[FR]** The **national action plan for rainwater management** aims in particular to promote rainwater infiltration in towns.
- **[FR] Calls for projects** from departments, regions and public institutions (e.g. OFB, water agencies) provide opportunities to implement certain natural water retention measures aiming at making cities more sustainable.
  Aides-territoires platform
- **[FR] Water agencies** offer **assistance** for rainwater management that promotes natural infiltration into the soil and the return of nature to cities.
- **[FR]** In 2022, the government launched a €500 million programme to **renature cities**, including measures to promote rainwater retention and infiltration in urban areas. The aid is provided by various organisations.
  Urban renaturation: aid programme
- **[FR]** The **Green Fund, launched in 2023,** contains a focus on "Renaturation of towns and villages", including the greening of public spaces and soil de-sealing.
  Support documents for the implementation of the Green Fund

Local authorities' responsibilities

- **[FR]** The **GEPU** competence leads to action on slowing down, retaining and infiltrating rainwater in towns and cities.
- **[FR] GEMAPI**[3] expertise enables measures to be implemented, provided that they contribute effectively to reducing flood risk.
- Other local authorities' **responsibilities** may enable them to implement natural water retention measures that also contribute to a more resilient city: urban planning, housing and accommodation, water and sanitation, environment and heritage, roads, urban development, land use, territorial strategy, water and waste.

Approaches and initiatives

- **[FR]** Some approaches can support local authorities in sustainable city management: IWA Water-Responsible Cities, the EcoQuartiers approach, and the France Ville Durable association.

[3] The actions undertaken by inter-municipal authorities within the framework of GEMAPI are defined as follows by Article L.211-7 of the Environment Code:

- The development of river basins
- Maintenance and development of watercourses, canals, lakes and water bodies
- Flood and sea defence
- Protection and restoration of wetlands

Potential technical partners [FR]

Urban planning agencies, specialised associations (e.g. ADOPTA, GRAIE, Plante & Cité), decentralised departments of the Ministry of Ecology (DDT(M), DREAL), Cerema.

An example: rain gardens in Saint Martin d'Hères (Isère)

With the arrival of the tramway in the city centre, Square Lucie Aubrac was redeveloped with the aim of managing rainwater in pedestrian areas.

©GRAIE

The construction of a single basin was abandoned because it took up too much space, in favour of several islands of vegetation allowing rainwater to infiltrate, while also providing shade and coolness.

Measures implemented: integrated rainwater management (with rain gardens and infiltration wells).

Find out more:
- A busy square redesigned to allow rainwater infiltration - Cerema
- Square Lucie Aubrac in Saint Martin d'Hères: managing rainwater in a busy area - GRAIE

See also: A new ambition to make Lyon a nature city

Available

- IUCN, 2019. Nature-based solutions for water-related risks in France
  Background information and feedback from France on the implementation of nature-based solutions to reduce water-related risks.

- IUCN, 2016. Nature-based solutions to fight against climate changes
  Background information and brief examples of nature-based solutions implemented to combat climate change in France and around the world.

- IOW, 2020. Natural water retention measures: 10 case studies in mainland France

- IOW, 2020. Web conference "Rethinking water in cities: using nature to develop my region sustainably"

- CEREMA, 2019. SESAME study – Which trees for our cities tomorrow?

- Towards a permeable city – How can we make our soils less impermeable? – Rhône-Méditerranée-Corse Water Agency, Auvergne-Rhône-Alpes Regional Directorate for the Environment, Cerema

- Renaturing cities: methods, examples and recommendations

- Podcast "Small streams – Better water management through nature" – IOW

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Authors: FOUILLET M. (IOW), MAGNIER J. (IOW), BARREAU S. (IOW), HASSE M. (IOW).

Contributors: PERESS J. (OFB), MOUSSOURS M. (OFB), GARNAUD-CORBEL S. (OFB), MONOD K. (OFB).

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Contact

If you have any questions or would like to share your feedback, please contact:

- Maxime Fouillet, International Office for Water: m.fouillet@oieau.fr
- Marion Hasse, International Office for Water: m.hasse@oieau.fr

15 rue Edouard Chamberland
87065 Limoges Cedex
Tel.
www.oieau.org

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