Tip sheet no. 1

Drought and quantitative deficit

Reducing risks through natural water retention measures




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

GLOSSARY

AAC	Water catchment area
ADASEA	Departmental association for the development of farms' structures
ADOPTA	Association for the operational development and promotion of alternative techniques
PDO	Protected designation of origin
APCA	Permanent assembly of chambers of agriculture
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
CLIMSEC	Climate and climatic services
CNPF	National centre for forest ownership
CNPR	Regional centre for forest ownership
CRTE	Contract for a successful ecological transition
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
DRIAS	Providing access to regionalised climate scenarios in France for the impact and adaptation of our societies and environment
ENS	Sensitive natural area
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
IPCC	Intergovernmental panel on climate change
GIEE	Economic and environmental interest group
GRAIE	Rhône-Alpes research group on infrastructure and water
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
PTGE	Territorial projects for water management
SAGE	Water development and management plan
SCIC	Cooperative society of collective interest
SCOT	Territorial coherence plan
IUCN	International union for conservation of nature

Combating drought through natural water retention

What is drought?

Drought is an exceptional climatic event characterised by a water deficit over a period of time that varies in length and depends heavily on local conditions (climate, vegetation type, etc.). It is a slow and gradual phenomenon that can take several months or even years to develop.

The phenomenon of drought covers several realities. **Meteorological drought** is a prolonged deficit of precipitation. It can lead to **edaphic drought**, i.e. it can impact the soil and vegetation: the amount of residual water in the root zone is too low to be used by plants. Finally, the absence of precipitation leads to **hydrological drought,** which results in low water levels in rivers and groundwater.

Human activities can exacerbate this phenomenon through water abstraction and changes in land cover.

For more information: Drought - Eaufrance, public information service on water.

Current trends

This is a natural phenomenon, but its frequency and severity are set to increase with climate change. Repeated meteorological droughts over long periods and increased evapotranspiration linked to rising temperatures are likely to lead to more severe edaphic and hydrological droughts. Their multi-year nature increases their severity. Several examples of this situation have been observed in mainland France and in some overseas departments and regions.

Several sources of information can be used to understand current trends and possible futures:

- The 6th IPCC Synthesis Report,
- The Global Drought Atlas (in English),
- The ClimSec project (2011), which focuses on edaphic drought,
- The Explore 2 project (2024), which focuses in particular on hydrological drought and has a results visualisation interface (Méandre).

How can we prevent droughts and reduce their impacts by relying on natural water retention in the catchment area ?

It is difficult to influence **meteorological drought**, although under certain conditions it is possible to influence atmospheric water circulation to promote precipitation through forest cover (see forestry measures).

Increasing the amount of water retained in the soil and reducing evapotranspiration can slow the onset of **edaphic drought**. The measures to be implemented focus on improving soil quality (organic matter content and structure) and optimising vegetation cover. Promoting rainwater infiltration also contributes to this.

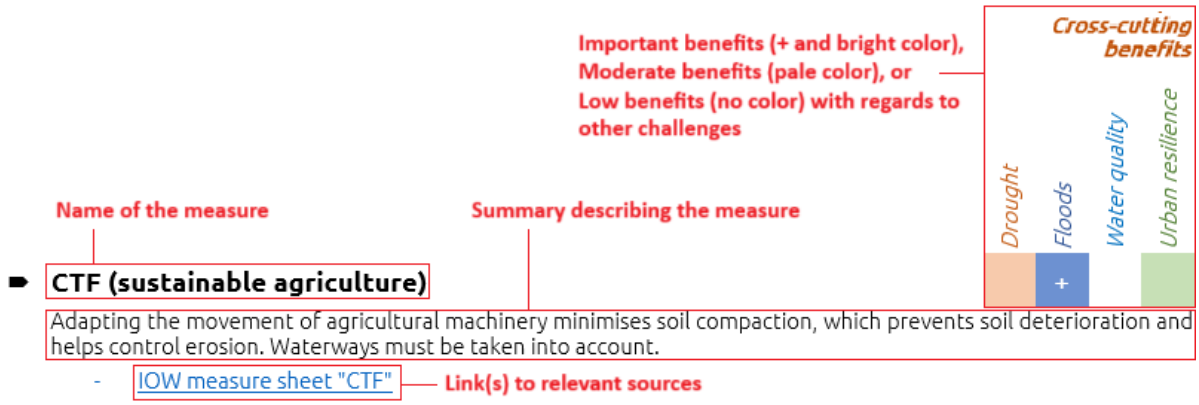
Finally, reducing **hydrological drought** requires promoting winter recharge of groundwater for better low-flow support. Measures that promote infiltration at the expense of runoff should therefore be implemented, and natural infrastructure that stores water during rainy periods and helps support low flows during low-water periods should be used.

The ten natural water retention measures most relevant for preventing drought

The measures proposed in this document are direct modifications to ecosystems or changes and adaptations to practices that increase water retention in a watershed by improving and restoring the water retention capacities of soils, aquatic ecosystems and aquifers. They can also be described as nature-based solutions (NbS) or nature-based adaptation solutions (NbAS).

These natural measures are said to be multifunctional, in that they simultaneously address several societal challenges (floods, biodiversity preservation, living environment, etc.), while preserving or restoring the ecological functions of aquatic environments.

At least ten natural measures are of particular interest for reducing drought risk and mitigating its impacts. They are listed below, according to the following template:



The measures are classified by type for ease of reading but they can be implemented in different contexts.

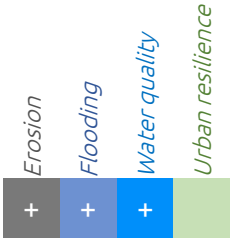
Who are the tip sheets intended for?

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 and implementing 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 to find out 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 potential project owners (both decision-makers and technical agents) and, more broadly, to all stakeholders promoting natural water retention measures.

Most effective measures in an agricultural context

Cross-cutting benefits



Buffer zones and hedges

The creation of vegetated areas (herbaceous plants, bushes or trees) along the edges of plots or across drainage channels promotes water infiltration. The shade and wind protection provided by hedges have a local protective effect against evapotranspiration and soil drying.

- OFB website "Buffer zones: definition and typology"
- Hedges Network France "Guide to sustainable hedge management recommendations"

Crop associations

Adding one or more additional species to a crop to cover soil that would otherwise be bare (e.g. between rows) increases infiltration and reduces surface runoff. Crop combinations improve water retention at the plot level during heavy rainfall.

- Osaé fact sheet "Crop associations"
- Osaé fact sheet "Grassing of vineyards"

Agroforestry

Agroforestry, which covers all agricultural practices that combine trees (in all their forms: hedges, rows, copses, etc.) with agricultural and/or livestock farming on the same plot, provides shade and protection from the wind and can therefore help to mitigate soil drying.

- Osaé fact sheet: "Reintroducing grazing into perennial grassland crops"
- Documentation from the French Agroforestry Association

How can these measures be implemented?

Regulatory measures

- **[FR] The SAGE (water management and development plan) and its regulations** may impose conditions relating to agricultural environments or practices.
  Gest'eau Resource Centre

Action programmes

- **[FR] The PATs (territorial food projects)** enable the implementation of actions of this type as part of a transition towards sustainable food systems.
  France PAT portal
  MASA - Support mechanism for the transition of PATs to the operational phase
- **[FR]** The **CRTE** (formerly meaning "ecological transition and recovery contracts") are designed to support the creation and/or strengthening of regional projects that are compatible with regional cohesion and ecological transition needs, including the development of agroecological practices. A new dynamic (and a name change) was introduced in 2024 to encourage these contracts.
  The CRTE - National Agency for Territorial Cohesion
- **[FR] The AAC action programmes** aim primarily to protect water quality, but the actions they include may be of interest for quantitative water management.
  Water catchment resource centre - OFB
- **[FR] PTGEs** may include in their memoranda of understanding the implementation of natural water retention measures in agricultural areas with the aim of reducing quantitative deficits.
  PTGE Resource Centre

Financial assistance

- Several **European programmes** provide funding for projects that include natural water retention measures: EAFRD funds, the Interreg programme for agriculture, the LIFE programme and the Horizon Europe programme.
  Europe in France website: European Structural Investment Funds
  The LIFE programme - MTEBFMP
  European Interreg website
  Horizon Europe - MESR
- **[FR] Water agencies offer grants or calls for projects** targeting agricultural practices that promote sustainable water resource management.
- The **conditionality of CAP aid** relating to good agricultural and environmental conditions (GAEC) may require the implementation of certain natural water retention measures.
- **[FR] MAECs** enable agricultural stakeholders who implement environmentally friendly measures to be remunerated. Funding comes from the CAP. This requires the presence of a PAEC led by a local operator.
  MAECs 2023-2027 - guide MASA
- **[FR] PSEs** enable public or private stakeholders to compensate agricultural operators who implement environmentally friendly measures.
  PSE guides - MASA

Land contractualisation

- **[FR] The BRE** allows a limited list of practices likely to protect the environment to be included in the management of a site. The lessor or funding provider is a legal entity governed by public law or an association.
  The BRE – 10 questions, 10 answers? - Cerema guide (2016)
- **[FR] The ORE** is a protection attached to real estate, established for up to 99 years. The contract can be signed with a public authority, a public institution or a legal entity governed by private law acting on behalf of the environment. Water agencies can assist buyers and compensate for practices.
  Discover OREs - Cerema's methodological dossier

Agricultural initiatives

- **[FR] GIEEs** are groups of farmers recognised by the State who are committed to a multi-year project to implement agroecological practices. Funding may be available depending on the case.
  The dedicated website - APCA
- **Local stakeholders** can build local momentum to support agricultural producers in a given area to adopt natural water retention measures.
  Example of SCIC Terre de sources
- **Individual initiatives** may also lead to the implementation of measures due to their agronomic benefits.
  Example of an individual initiative: OSAE

Potential technical partners

Chambers of Agriculture, government departments responsible for agriculture (DRAAF) and ecology (DDT(M) and DREAL), agricultural advisory associations (e.g. ADASEA), AREAS, agricultural cooperatives, river basin unions, regional natural parks, CEN, drinking water unions and their delegates, hunting associations, etc.

OiEau
Office International de l'Eau

June 2025

Most effective measures in aquatic environments

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

Cross-cutting benefits

Erosion | *Flood* | *Water* | *Urban resilience*

Ponds

The restoration or creation of ponds can help combat drought in the long term: ponds act as a buffer zone, promoting rainwater storage. They can also be fed by a spring or groundwater flow, providing water for livestock.

- Agricultural ponds in Hauts-de-France, Hauts-de-France Chamber of Agriculture (2020)
- CNPF guide to "preserving ponds in forest management"

Restoration and management of wetlands

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Preserving or restoring the hydrological functions of wetlands slows runoff and promotes infiltration. Functional wetlands can store large amounts of water.

- Patrinat reference document on "ecological actions that can be implemented in wetlands"

Restoration and management of floodplains

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Reconnecting the watercourse with its floodplain to allow floodwaters to overflow and spread across the floodplain, slowing down water flow and promoting groundwater recharge through infiltration.

- OFB fact sheet "Reconnection of hydraulic annexes"
- OFB fact sheet: "Removing lateral constraints"

Hydromorphological restoration of watercourses (riverbed)

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Removal of concrete and inert structures from the riverbed, slowing down the flow, raising the roof of the alluvial aquifer and promoting water infiltration. Reconnection of meanders or creation of new meanders. The length of the watercourse is extended and the speed of the water decreases.

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

Restoration and reconnection of intermittent watercourses

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Restoring and reconnecting temporary watercourses slows down flow, reduces the period of dry weather and promotes water infiltration.

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

Controlled aquifer recharge

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This involves increasing the volume of groundwater available by promoting its infiltration into the aquifer by artificial means

! *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"

How can these measures be implemented?

Regulatory measures

- **[FR] Urban planning documents and PPRIs** (flood risk prevention plans) help to preserve natural areas such as wetlands and floodplains.
  Wetlands and urban planning
  Technical guide for the integration and protection of wetlands in urban planning documents
- **[FR] The SAGE 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] PTGEs** may include in their memoranda of understanding the implementation of natural water retention measures with the aim of reducing quantitative deficits, particularly those related to the maintenance and agricultural management of wetlands.
  2019 circular (MTEBFMP)
  PTGE resource centre
- **[FR]** Other **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, 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

Local authorities' responsibilities

- **[FR] The GEMAPI**[1] competence enables competent local authorities to take action to restore the hydrosystem.

Potential technical partners

Public basin establishments (EPTB, EPAGE, basin or river syndicates), OFB, nature conservation associations (e.g. CEN), fishing federations and associations, universities, research centres, regional natural parks, decentralised departments of the Ministry of Ecology (DDT(M), DREAL), water syndicates, local authorities' urban planning departments.

Depending on the context: local forestry or agricultural partners.

[1] 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

An example: restoration of temporary watercourses in the upper Clauge basin

The recalibration of the headwaters of the Clauge in the last century accelerated their drying up in spring and delayed their refilling in autumn.

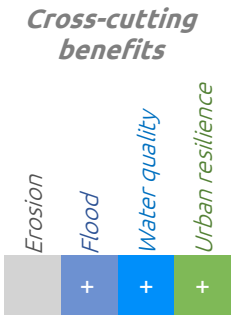
Restoration work on the hydrographic network has reduced the intermittent flow period of streams by one month and increased the presence of surface water by two months.

Measures implemented:

- Hydromorphological restoration of watercourses (riverbed)
- Restoration and reconnection of intermittent watercourses
- Adapted log removal
- Development of forest paths
- Dead wood in rivers

Find out more: Case study (2020)

Most effective measures in an urban context



Integrated rainwater management

Integrated rainwater management involves manging stormwater as close as possible to the point of precipitation (temporary storage, evapotranspiration or infiltration), thereby enabling better recharge of groundwater in urban areas. There are many tools available: permeable pavements, vegetated swales, infiltration basins, infiltration wells (soakaways), infiltration trenches, rain gardens, green roofs, canals and gutters, retention basins (wet), retention or storm basins (dry).

Urban rainwater can be loaded with pollutants and sediments. This must be taken into account in the design of integrated rainwater management tools in order to avoid polluting the underlying groundwater and prevent the rapid clogging of the installed systems.

- Astee guide "Sustainable rainwater management solutions"

Trees in towns and wooded parks

Maintain or create wooded parks in urban areas can help urban rainwater infiltration and benefit from the cooling effect produced by vegetation.

- ARB CVL toolbox "Let's get green!"
- OFB guide "Rain trees"

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 plan) and sanitation regulations. Certain provisions may be included in these **planning documents** to ensure sustainable rainwater management, particularly retention and infiltration, but also to define flood risk areas, wetlands and natural heritage features.
- **[FR] The SAGE and its regulations** may impose conditions relating to rainwater management.
- **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 the control of rainwater and runoff flow". It is integrated into the PLU(i).

Financial assistance and action programmes

- **[FR] Calls for projects** from departments, regions and public institutions (e.g. OFB, water agencies) provide opportunities to implement certain natural water retention measures.
  Aides-territoires platform
- **[FR] Water agencies** offer **assistance** for rainwater management that promotes infiltration.
- **[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** involves taking action to slow down, retain and infiltrate rainwater in towns and cities.

- **[FR]** Other local authority responsibilities can also be used to implement natural water retention measures that are also beneficial for drought prevention: urban planning, housing and accommodation, water and sanitation, environment and heritage, roads, urban development, land and property, regional strategy, water and waste.

Potential technical partners

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

An example: de-sealing in Lyon

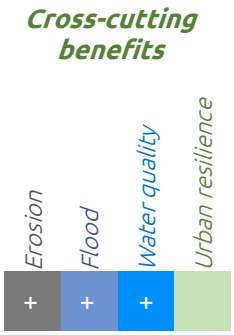
Project to use tree pits for infiltration to recharge groundwater and reduce the impact of drought on trees, enabling them to develop optimally.

Measures implemented:

- Integrated rainwater management
- Trees in cities and wooded parks

Find out more: Article by the Lyon Metropolitan Area - GRAIE webinar presentation

Most effective measures in a forest context



Afforestation

Planting trees in an area that was previously unwooded can improve water infiltration and storage in the soil. Preserving existing woodlands, particularly at the heads of watersheds, also contributes to this, starting upstream. Afforestation is achieved either through planting or spontaneous regeneration.
The ability of woodlands to infiltrate water varies depending on the species and context.

! *The gain varies depending on numerous parameters, including previous land use in areas subject to afforestation, the species planted, climate change, etc.*[2] .

- IOW "Afforestation" measurement sheet

How can these measures be implemented?

Regulatory measures

- **[FR] The SAGE and its regulations** may impose conditions relating to forest management.
- **[FR]** Certain provisions may be included in **planning documents such as the PLU(i)** to ensure the preservation of natural heritage features such as woodlands.
- **[FR]** Private forest operators who own an area of 25 hectares or more must draw up and have approved **a PSG,** which guarantees sustainable forest management and logging. Private forest owners who own between 10 and 25 hectares may voluntarily have a PSG approved.

Forest management

- The implementation of natural water retention measures in forest environments can be integrated into the forest management of **public forests**.
- **Individual initiatives** may also lead private owners to implement measures. However, in this case, the consistency of measures across the catchment area is not guaranteed.

Action programmes

- **[FR] PTGEs** may include in their memoranda of understanding the implementation of natural water retention measures in forest environments with the aim of improving soil resistance to drought.
  2019 circular - MTEBFMP
  PTGE resource centre
- **[FR]** The **Low Carbon label**, established by the CNPF, and more generally **carbon offset** projects, can serve as a lever for afforestation or reforestation.
  Low Carbon Label – MTEBFMP
- **[FR] Natura 2000**: if a site belongs to the Natura 2000 network, certain management measures may be required, some of which may concern the maintenance of forest cover.

[2] According to some studies, under certain conditions, afforestation of part of a watershed can lead to reduced flow at the outlet: Intervention by P. Lachassagne (2023); A. Hurand and V. Andréassian (2003), Forest cover and watershed hydrology.
Other references with contrary results are mentioned by INRAE (2025): Slowing down and conserving water in headwaters: challenges, solutions and assessment of hydrological effects, p. 29.

Financial assistance

- **[FR] Calls for projects** from departments, regions and public institutions (e.g. regional natural parks, water agencies) provide opportunities to implement certain natural forest water retention measures.
  All aid available on Aides-territoires
- Several **European programmes** provide funding for projects that include natural water retention measures in forest environments, in particular the EAFRD, LIFE, Interreg and Horizon Europe programmes.
  Europe in France website: European Structural Investment Funds
  The LIFE programme (MTEBFMP)
  European Interreg website
  Horizon Europe (MESR)
- **[FR] PSEs** enable public or private actors to compensate actors who implement environmentally friendly measures. PSEs can apply to natural forest water retention measures.
  CNPF website: forests protect your water
- **[FR]** Aid under the **France Relance plan** and climate change issues, particularly aimed at improving poor wildlife populations or restoring populations of scolytes.
  MASF website: France Relance: renewing French forests
- **Aid for afforestation** in catchment areas by water agencies, departments and local forestry funds.
- **[FR]** For private forest owners, the approved PSG provides the guarantee of sustainable management required by the Forest Code, enabling them to benefit from tax exemptions and state aid.
  PSG procedures - MASF

Local authority responsibilities

- **[FR] Management of public forests**, in partnership with the ONF, which implements the provisions of the forest regime.
- **[FR]** The departments' **ENS** competence enables them to take action in forest areas. A portion of the development tax is used to finance these ENS.

Potential technical partners

ONF, CNPF and CRPF, forestry cooperatives, FNCOFOR, forestry experts, PNR, associations, universities, decentralised departments of the Ministry of Agriculture (DRAAF), hunting associations, river basin unions.

An example: the preservation of the forest of Double

The forest massif of Double covers several hundred square kilometres at the headwaters of the Saye, Galostre and Lary river basins. In this area, which is considered a prime rainwater infiltration zone, the river basin authority's interventions on the hydrographic network are minimal in order to allow the alluvial woodlands to evolve freely.

Measures implemented:

- Afforestation
- Dead wood in rivers

Find out more: article on p. 5 of the Gazette river.

Available resources

- OFB. Page on natural water retention measures from the watercourses resource centre
- IUCN, 2019. Nature-based solutions for water-related risks

  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 change

  Background information and brief examples of the implementation of nature-based solutions to combat climate change in France and around the world.
- IOW, 2020. Natural water retention measures: 10 case studies in mainland France
- GRAIE, 2018. Comparison of the costs of rainwater management scenarios - Case study
- Rhin-Meuse Water Agency. Frequently asked questions on sustainable and integrated stormwater management

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