Tip sheet no. 5

Floods

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
EEA	European environment agency
AMI	Call for expressions of interest
APCA	Permanent assembly of chambers of agriculture
BRE	Rural lease with environmental clauses
CEN	Conservatory of natural areas
CEPRI	European centre for flood risk prevention
CEREMA	Centre for studies and expertise on risks, the environment, mobility and planning
CIPAN	Intermediate crops that trap nitrates
CNPF	National centre for forest ownership
CRPF	Regional centre for forest ownership
CRTE	Contract for a successful ecological transition
CTF	Controlled traffic farming
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
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
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
PAPI	Flood risk management plan
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
SMIVAL	Interdepartmental joint association of the Lèze valley
IUCN	International union for conservation of nature

Fighting floods through natural water retention

How can flood risk be defined?

Flooding is the temporary submersion of an area that is usually above water. Flood risk is the combination, in a given geographical location, of a hazard (e.g. the possibility of a river overflowing) and specific conditions (whether human, economic or environmental) that could cause damage or harm.

Floods can be categorised as follows:

- flooding caused by river overflow, which can be slow (plain flooding) or rapid (torrential flooding);
- flooding due to runoff, wether urban or agricultural;
- flooding due to rising groundwater levels.

Marine submersion can also be considered a type of flood.

Floods are the leading natural hazard in France in terms of damage caused, mainly to property and, more exceptionally, to people[1] .

For more information on floods: Floods and marine submersion – Eaufrance, the public information service on water.

Current trends

Although floods have always affected France, since the 2000s the damages have been particularly severe, exacerbated by certain land-use practices such as building in flood-prone areas, soil sealing and some river engineering works.

Significant floods have affected the country in recent years, for example in the Aude department in October 2018, in the Île-de-France region in May and June 2016, and in the Alpes-Maritimes and Pas-de-Calais departments in October 2015 and 2020 (winter 2023/2024).

It is well established that climate change is causing, and will cause, an increase in the frequency of extreme weather events[2] , which will amplify the risk of flooding.

How can we prevent the risk of flooding and reduce its impact by relying on natural water retention in the catchment basin?

The first step is to increase the proportion of precipitation that infiltrates the soil and slow down surface runoffs. Measures to achieve this can be implemented in all sectors. When deployed over a sufficient area of the catchment, they reduce the volume of water that will concentrate in aquatic and urban environments, while spreading out the flood peak.

Certain natural water retention measures also help to control river overflow by spreading floodwaters across low-risk areas, often referred to as "flood expansion areas".

Finally, a few measures specific to urban areas aim at temporarily storing runoffs from impervious surfaces to reduce the volume of water entering the river system.

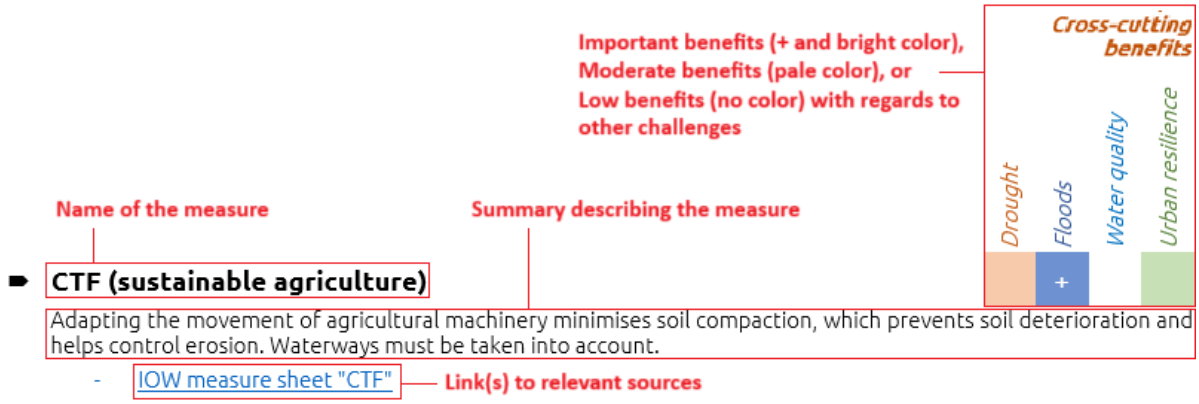
[1] OFB, 2023. Questions and answers on flooding.
[2] EEA, 2021. How are Europe's cities adapting to climate change and moving to a sustainable future?
OFB, 2024. Explore2 – the future of water.

The thirteen most relevant natural water retention measures to reduce flood risk

The measures proposed in this document are direct modifications to ecosystems or changes and adaptations to practices that increase water retention in a catchment area by improving and restoring the water retention capacities of soils, aquatic ecosystems and aquifers.

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

At least thirteen natural measures are of great interest for reducing flood risks. They are listed in the following fact sheets, according to the following template:



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

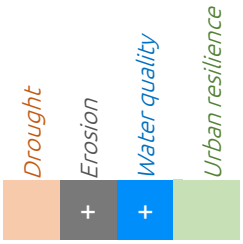
Who are the tip sheets intended for?

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 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 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 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



Permanent grasslands

Maintaining or establishing grasslands stabilises the soil, limits surface runoff and promotes infiltration, thanks to dense herbaceous vegetation.

- Patur'ajuste, technical data sheet Restoring grassland cover "naturally"
- OFB technical portal "Grasslands, a question of balance"

Buffer zones and hedges

The establishment of vegetated areas (herbaceous plants, bushes or trees) along watercourses, plot boundaries or across drainage channels slows down runoff and promotes infiltration.

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

Crop association

Adding one or more additional species to a crop to cover soil that would otherwise be bare (e.g. between rows) reduces surface runoff and increases infiltration.

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

Cover crops

These cover crops, which are either intercropped (planted simultaneously or during the development of the main crop) or intermediate (sown between the harvest of one main crop and the planting of the next), reduce runoff and nitrogen leaching outside the plots.

- Gerbeaud fact sheet "Intermediate, intercropping and cover crops"

Fascines

Fascines are linear structures made of bundles of wood positioned perpendicular to a runoff axis, which slow down runoff and promote sedimentation.

- AREA fact sheet "Fascines"

CTF (controlled traffic farming)

Adapting the traffic of agricultural machinery minimises soil compaction, which prevents soil deterioration and preserves its infiltration capacity.

- IOW measure sheet "CTF"

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 project): In 2024, a new impetus was given to the PATs in terms of coordination, support and ambition, notably through the creation of the France PAT portal and a support mechanism for the PATs' transition to the operational phase, with the aim of strengthening the PATs' impact on the regions regarding the transition to sustainable food systems.
  France PAT portal
  MASA - Support mechanism for the transition of PATs to the operational phase
- **[FR] 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** are primarily aiming at protecting water quality, but the actions they include can also help reduce runoff.
  Water catchment resource centre - OFB
- **[FR] Programmes or operations run by chambers of agriculture** to combat agricultural runoff and mudslides exist in some regions. Programmes may also be run by trade unions or inter-municipal bodies.
- **[FR] Contracts (basin, territorial, thematic)** financed by water agencies enable actions aiming at reducing flood risk (technical actions, awareness-raising, coordination, etc.).

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.
- **[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.
  The 2015-2022 MAECs - MASA guide
- **[FR] PSEs** enable public or private syakeholders to compensate agricultural operators who implement environmentally friendly measures.
  PSE guides - MASA
- **Regional aid**: some regions can help with the implementation of certain practices that reduce runoff and therefore the risk of flooding, such as the transition to soil conservation agriculture.
- **[FR] The France Relance plan** offers aid for planting hedges and converting agricultural equipment.
- Some associations also support **agroforestry practices** (hedge planting, etc.), such as the French association Agroforesterie. Some practices can also be a source of economic value, such as hedges (wood chips, fodder supplement, etc.).

Land contractualisation

- **[FR]** The **BRE** allows a restrictive 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 form of 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 private legal entity acting on behalf of the environment. Water agencies can assist buyers and compensate for practices.
  Discover OREs - Cerema's methodological file

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 can be made available depending on the case.
  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.

Potential technical partners

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

An example: planting of a flood-control hedge in Béarn (64)

Since 2009, SMIVAL has been involved in replanting flood-control hedges in the floodplain of the Lèze river to reduce the risks of flooding. In 2013, the intervention programme was extended to the slopes of the entire river basin and its tributaries. Thanks to the combined effect of these plantings, an overall reduction in flood flows has been observed throughout the valley.

Measure implemented: Buffer zones and hedges

Find out more: project details

Most effective measures in aquatic environments

Reminder: "aquatic environment" 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. Functional wetlands can store large amounts of water.

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

Restoration and management of floodplains

Reconnecting the watercourse with its floodplain to allow floodwaters to overflow and spread across the floodplain, thereby reducing downstream floods. The connection between oxbow lakes and the floodplain facilitates the filling of the watercourse during floods.

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

Hydromorphological restoration of watercourses (riverbed)

Recreating the natural morphology of the riverbed, in particular by restoring its sinuous character (re-meandering), improves the storage capacity of runoff and slows down flows, thereby spreading the flood peak and reducing the risk of flooding.

- OFB fact sheet "Modification of the geometry of the riverbed within the current layout"
- OFB fact sheet "Re-meandering"
- OFB fact sheet "The return of 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 flow, reduces the period of dry weather and promotes water infiltration.

- 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 promotes overflow in low-risk areas.

- OFB fact sheet "Removal of lateral constraints"

Depolderisation

Reconnecting polders reduces the risk of damage, particularly in the event of coastal flooding.

- 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 areas such as flood expansion zones and wetlands.
  Wetlands and urban planning
- **[FR] The SAGE and its regulations** may impose conditions relating to the preservation of aquatic or wetland environments and their restoration within the framework of projects.
  Wetlands in the SAGE

Financial aid and action programmes

- **[FR] PAPIs** are calls for projects aiming at promoting comprehensive flood risk management. They can enable the implementation of measures to slow down runoff in the catchment area.
- **[FR] Contracts (territorial, basin, thematic)** financed by water agencies enable the planning of actions to restore the hydrosystem with a 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 and 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
- **[FR] Compensation protocols in the event of floods** enable landowners affected by floods (loss of crops, loss of land value, damage to equipment, etc.) to receive financial support from water agencies.

Local authorities' responsibilities

- **[FR]** The **GEMAPI**[3] competence enables the relevant authorities to take action to restore the hydrosystem.

[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

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

An example: removal of two weirs on the Gland (02)

A tributary of the Oise, the Gland has been heavily modified in the past and caused significant damage during the floods of 1993 and 2011 in Hirson in particular.

In order to reduce the risk of floods in the municipality, the river has been restored and two weirs have been removed to slow down the flow upstream of Hirson, increasing the storage capacity of the river bed during floods.

Measures implemented:

- Hydromorphological restoration of watercourses (riverbed)
- Removal of transverse structures

Find out more: Le Gland, a river that has resumed its course

Most effective measures in an urban context

Cross-cutting benefits

Integrated rainwater management

Integrated rainwater management involves promoting stormwater management as close as possible to the point of precipitation (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, which are therefore dry) and retention troughs (wet), and, on the other hand, structures that promote the infiltration of rainwater as close as possible to the point of precipitation, such as permeable pavements, green roofs, and several other types of vegetated depressions (infiltration basins, infiltration trenches, rain gardens, filter strips, infiltration wells, or soak pits). Of an intermediate nature between these two types of structures, vegetated swales are also relevant structures.

! *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"

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 delimit flood risk areas, wetlands and natural heritage features.
- **[FR] The SAGE and its regulations** may impose requirements relating to rainwater management and impermeable surfaces.
- **[FR] Rainwater zoning** is a rainwater management tool for local authorities, which may include the implementation of natural water retention measures. It helps prevent the degradation of aquatic environments during rainy weather and identifies "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).

Action programmes

- **[FR] PAPIs** are calls for projects aiming at promoting comprehensive flood risk management. They can enable the implementation of measures to slow down runoff in the catchment area.

Financial aid 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.
  Aides-territoires platform
- **[FR] Water agencies** offer **assistance** for rainwater management that promotes natural infiltration into the soil.
- **[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]** The **GEMAPI**[4] competence enables the implementation of measures, some of which contribute effectively to flood risk reduction.
- Other local authorities' **responsibilities** may enable the implementation of natural water retention measures that are useful for reducing flood risk: urban planning, housing and accommodation, water and sanitation, environment and heritage, roads, urban development, land use, territorial strategy, water and waste.

Potential technical partners

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

An example: Better rainwater management in Crépy-en-Valois (60)

The town of Crépy-en-Valois is constantly seeking to reduce the amount of rainwater sent into the municipal sewer system in order to reduce the risk of flooding downstream.

To this end, every development project in the municipality is an opportunity to implement measures that promote rainwater infiltration and retention, including measures designed on a case-by-case basis.

Measures implemented:

- Integrated Rainwater Management: swales, permeable surfaces, retention basins in green spaces
- Other measures.

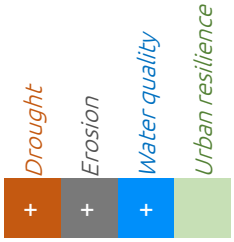
Find out more: ADOPTA case study "Beautifying the city with rainwater"

[4] 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 a forest context

Cross-cutting benefits



Afforestation

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

! *The gain varies depending on many parameters, including the previous land use in the areas to be afforested, the tree species planted, etc.*

- IOW "Afforestation" measure 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 landowners to implement measures. However, in this case, the consistency of measures across the catchment area is not guaranteed.

Action programmes

- **[FR] PAPIs** are calls for projects aiming at promoting comprehensive flood risk management. They can enable the implementation of measures to slow down runoff in the catchment area.
- **[FR]** The **Low Carbon label**, established by the CNPF, and more broadly **carbon offset** projects, can serve as a lever for afforestation or forest restoration.
  Low Carbon Label – MTEBFMP
- **[FR] Natura 2000**: if a site belongs to the Natura 2000 network, certain management requirements may apply, some of which may concern the maintenance of forest cover.

Financial assistance

- **Calls for projects** from departments, regions and public institutions (e.g. regional nature parks, water agencies) provide opportunities to implement forestry 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.
  CNPF website: forests protect your water
- **[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 government aid.
  PSG procedures - MASA

Local authority responsibilities

- **[FR] Management of public forests**, in partnership with the ONF, which implements the provisions of the forest regime.
- **[FR]** The **ENS** competence of departments enables them to take action in forest areas.

Potential technical partners

Local authority departments that have already worked on this issue, ONF, CNPF and CRPF, FNCOFOR, forestry experts, associations, universities, decentralised departments of the Ministry of Agriculture (DRAAF) and river basin unions.

Available resources

- IUCN, 2019. Nature-based solutions for water-related risks.

  Contextual 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
- 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?

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