Water erosion of soil

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
APCA	Permanent assembly of chambers of agriculture
AREAS	Association for research on runoff, erosion and land management
ASP	Services and payment agency
BRE	Rural lease with environmental clauses
CEN	Conservatory of natural areas
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
GIEE	Economic and environmental interest group
GTSMA	Working group on forestry and aquatic environments
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
RTM	Restoration of mountain land
SAGE	Water development and management plan
SCIC	Cooperative society of collective interest
IUCN	International union for the conservation of nature
WSL	Swiss federal institute for forest, snow and landscape research

Combating water erosion of soil through natural water retention

What is water erosion of soil?

There are several types of erosion. Soil erosion caused by water occurs when part of the rainfall runs off and carries soil or rock particles with it. Excessive soil erosion causes soil losses and degrades water quality by introducing fine particles into aquatic environments.

Many factors influence water erosion, such as the infiltration capacity of soils, their structure, the slope (length and gradient), and the presence or absence of vegetation cover. Human activities can contribute to accelerating or intensifying this phenomenon. This can have adverse effects on the balance of natural environments and can manifest itself violently, for example in the form of mudslides or landslides.

The seasonality of erosion risk varies from place to place, with some regions being more susceptible to winter erosion and others to spring erosion linked to storms.

For more information: Erosion, pressure on the environment and risks - Eaufrance, public information service on water.

Current trends

In mainland France, the risk of soil erosion (probability for erosion of a given intensity to occur) is moderate to very high in around one fifth of the country. Soil losses due to water erosion are estimated at an average of 1.5 t/ha/year, with significant variability (more than 15% of the territory loses more than 5 t/ha/year).

More details: Soils in France – Data and statistical studies, 2022.

How can water erosion of soil be prevented and its impact reduced by relying on natural water retention in watersheds?

Measures that limit rapid water runoff on soil or promote soil structure maintenance reduce the risk of erosion by increasing the infiltration and storage capacity of the soil surface. Measures that prevent the concentration of runoff are also relevant, thanks to soft hydraulic engineering and coordinated crop rotation measures (see box on p. 7).

Maintaining soil cover is a key measure for limiting water erosion. Improving soil structure and rooting helps reduce the risk of runoff and improve the soil's ability to infiltrate and retain water. Measures to limit ploughing (as well as any measures aiming at limiting soil compaction in general) will also help reduce the risk of erosion by limiting the risk of runoff.

In forest areas, maintaining permanent vegetation cover is also an essential lever for limiting erosion. Phenomena that expose the soil (fires, clear-cutting) are the cause of high erosion risks.

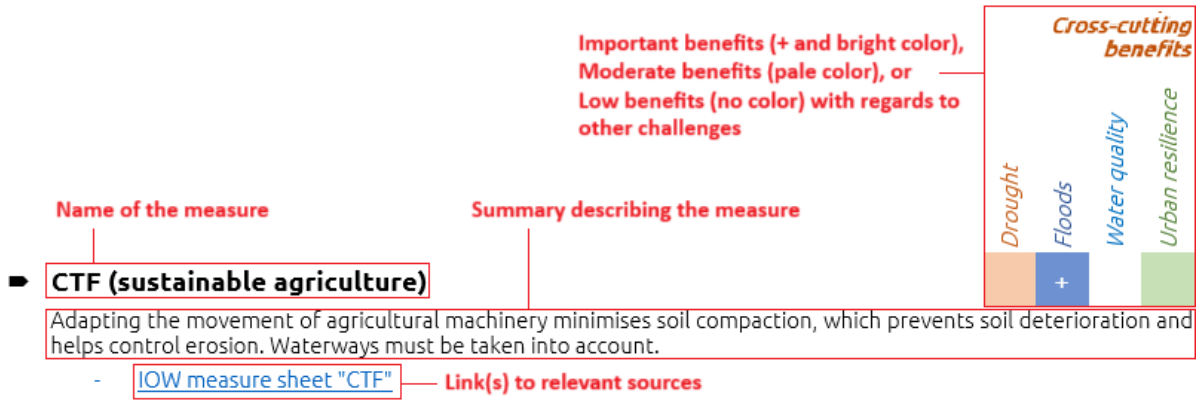
These measures mainly concern agricultural and forest soils.

The fifteen most relevant natural water retention measures to prevent water erosion of soil

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 capacity of soils, aquatic ecosystems and aquifers.

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 fifteen natural measures are of great interest for reducing the risk of water erosion of soils and mitigating its impacts, mainly in the agricultural and forestry sectors. 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 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 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

Permanent grasslands

Maintaining or establishing permanent grasslands improves soil structure, limits surface runoff and promotes infiltration, particularly 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 creation of vegetated areas (herbaceous plants, bushes or trees) along the edges of plots or across drainage channels promotes water infiltration. When well positioned, these elements can also interrupt muddy water flows and retain suspended matter.

- 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 runoff and increases infiltration, allowing for better erosion and sediment control.

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

Simplified cultivation techniques

These alternative cultivation techniques to ploughing and/or with minimal soil tillage limit erosion by preserving soil porosity.

- Osaé fact sheet on simplified cultivation techniques
- Osaé fact sheet on "Direct sowing under plant cover"

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), prevent the soil from being left bare, thereby reducing water and wind erosion and improving soil fertility.

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

Fascines

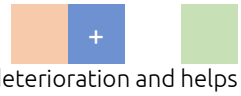
Fascines are linear structures made of bundles of wood positioned perpendicular to a runoff axis, which slow down runoff and promote sedimentation.

- AREAS fact sheet "Fascines"
- Grand Est Chamber of Agriculture fact sheet on fascines

Terraced cultivation

This is a system of terraces that follow the contour lines of the slope of the land, thereby artificially reducing the slope of cultivated areas. This limits the speed of rainwater and, as a result, erosion.

- IOW measure sheet "Terraced cultivation"



CTF (controlled traffic farming)

Adapting the traffic of agricultural machinery minimises soil compaction, which prevents soil deterioration and helps control erosion. Waterways must be taken into account.

- IOW measure sheet "CTF"

Extensive grazing

Reducing livestock loads helps minimise soil compaction. Improved soil structure and increased vegetation cover can thus reduce the risk of erosion and sediment transfer.

- OFB, Technical Handbook "Extensive Grazing"

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):** In 2024, a new impetus was given to the PATs in terms of coordination, support and ambition, in particular 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] 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** are primarily aiming at combating diffuse pollution from agriculture, but the actions they include can also help protect soils from erosion.
  Water catchment resource centre
- **[FR] Chambers of Agriculture programmes** to combat erosion exist in some regions (e.g. in the Hauts de France region). Programmes may also be run by trade unions or communities of municipalities.

Financial assistance

- Several **European programmes** provide funding for projects that include natural water retention measures: EAFRD fund, 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** (notably Seine-Normandie and Artois-Picardie) target aid at measures to combat soil erosion involving soft hydraulic engineering, runoff retention areas, hedges and fascines.
- **[FR] MAECs** enable farmers 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 stakeholders to compensate agricultural operators who implement environmentally friendly measures.
  PSE guides - MASA
- **Regional aid**: some regions can help with the implementation of certain practices, such as the transition to soil conservation agriculture.
- **[FR] Hedge Pact:** Part of the ecological planning programme and with a budget of €110 million from 2024, this pact provides support for planting, planting assistance and sustainable hedge management.
  ASP - Pact for Hedges

- 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 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 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 be available depending on the case.
  The agroecological collectives website
- **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** can also lead to the implementation of measures due to their agronomic benefits. The use of soil conservation agriculture can thus be one of the measures contributing to the fight against erosion.
  Example of an individual initiative: OSAE

Potential technical partners

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

An example: combating erosion through agricultural techniques and soft hydraulics in the Bas-Rhin (67)

In order to reduce the risk of mudslides affecting villages during spring and early summer storms, **concerted crop rotation** measures (preventive measures) and **soft hydraulic engineering** measures (curative measures) have been implemented in agricultural catchment areas in the Bas-Rhin.

With regard to soft hydraulic engineering measures, hedges, fascines and grass strips have been installed by various project leaders depending on the area (municipalities or inter-municipal communities). Concerted crop rotation, which involves alternating spring and winter crops within the watershed in a thoughtful and strategic manner, is coordinated by the Chamber of Agriculture and also allows for the gradual transition of some crops to no-till farming, while local authorities manage the implementation of soft hydraulic engineering works. These measures have reduced the risk of mudslides.

Measures implemented:

- Buffer zones and hedges
- Crop rotation
- Simplified cultivation techniques

Find out more: project details and video presentation

Most effective measures in a forest context

Afforestation

Afforestation can target different areas:

- Areas upstream of watersheds to reduce runoff, which has a stabilising effect on soils.
- Areas that were previously bare or heavily eroded, particularly to limit soil erosion.
- Previously unwooded areas to reduce runoff, improve infiltration and stabilise soils.

! *The benefits vary depending on many factors, including the previous land use in the areas to be afforested, the tree species planted, climate change, etc.*

- IOW "Afforestation" measure sheet

Continuous cover forestry

Reducing the number or size of clearcuts ensures the presence of cover and limits sediment production and mobilisation.

- Forest MOOC for change "Mixed forestry with continuous cover"

Appropriate log removal

Adopting forest machine operating methods that limit their impact helps reduce soil susceptibility to erosion.

- WSL fact sheet "Soil protection when using forestry machinery"
- Syndicat mixte de la Loue fact sheet "Logging techniques in wetlands"

Forest road design

Adapting forest road layouts to the topography, managing drainage effectively, stabilising the soil with suitable materials and vegetation, and ensuring regular maintenance helps to limit soil erosion in forests.

- GTSMA guide "Forestry and watercourses – guide to good practice"
- ONF fact sheet "Crossing a watercourse"

Riparian forests

Riparian forests stabilise the soil and limit bank erosion thanks to the roots of the trees that form them. They slow down water and protect the soil from bad weather. It should be noted that due to their relatively narrow width (approximately twice the height of the trees), they have a fringe effect rather than a true forest effect.

- OFB website "Preservation and management of riparian forests and semi-aquatic fauna"

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.
- **[FR]** The **classification** of certain forests as **protected forests**, whose conservation is recognised as necessary "[...] for defence against avalanches and erosion".
  Protected forest for public utility - Cerema

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, there is no guarantee that measures will be consistent across the entire catchment area.
- **[FR] RTM services**, implemented by the ONF, to prevent erosion in mountain departments.
  Mountain land restoration (RTM) - ONF

Action programmes

- Action programmes in **certain regions** for the forestry and timber industry, including reforestation measures.
- **[FR]** The **Low Carbon label**, established by the CNPF, and more generally **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 measures, including the maintenance of forest cover, may be required.

Financial assistance

- **Calls for projects** from departments, regions and public institutions (e.g. regional nature parks, water agencies) provide opportunities to implement certain natural forest water retention measures.
  All aid 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] Some PSE programmes** allow public or private stakeholders to compensate agricultural operators who implement environmentally friendly measures. They may apply to natural forest water retention measures.
  CNPF website: forests protect your water
- **Aid for afforestation** in catchment areas by water agencies and departments, local forest funds.
- **[FR]** Aid under the **France Relance plan** and climate change issues, particularly aiming at improving poor wildlife populations or restoring populations of scolytes.
  MASA - France Relance: the renewal of French forests
- **[FR]** For private forest owners, the approved PSG (forest management plan) - subject to the effective implementation of their felling and work programmes - provides the guarantee of sustainable management required by the Forest Code, enabling them to benefit from tax exemptions and state aid.
  PSG procedures - MASA

Local authorities' 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 departmental share 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.

Depending on the context: local agricultural partners.

An example: the Aigoual forest, a major reforestation programme

Located in the Occitanie region, the Aigoual massif stretches between the Cévennes and the Causses.
The massif underwent massive deforestation with the intensification of pastoral practices in Gallo-Roman times, then in the 8th century with the development of chestnut and cereal cultivation, and later in the 13th century with the cultivation of olive trees.

From the18thcentury onwards, the forests were overexploited to meet the demand for heating, charcoal and the growth of the glass, iron and silk industries, as well as for grazing. In 1850, only 2,200 hectares of woodland remained in what would become the Aigoual national forest (now covering 16,124 hectares). This deforestation led to major soil **erosion** and catastrophic flooding.

Reforestation work in the late 19thand early 20thcenturies, made possible in particular by the implementation of the **RTE** laws (1860, 1864 and 1882), transformed the landscape. In 150 years, the forest cover of the Aigoual massif increased from 25% to 75%.

Measures implemented:

- Afforestation
- Continuous cover forestry

Find out more: Aigoual, an exceptional forest: the rediscovered forest - ONF

Water erosion mainly affects agricultural and forest environments.

While certain measures implemented in urban areas or on the hydrosystem can help reduce erosion in the catchment area, they have a curative effect (sedimentation of suspended matter) rather than a preventive effect (less soil erosion). They have therefore not been listed above.

Available resources

- OFB. Page on natural water retention measures from the watercourses resource centre
- 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 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
- AREAS. Their resource centre page and toolbox.
- Chambre d'Agriculture des Hauts de France, 2018. Erosion guide.

Title: Tip sheet no. 2 - Water erosion of soils - Reducing risks through natural water retention measures.

Year of publication: 2024-2025

Date of publication: June 2025

Publisher: International Office for Water (IOW)

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Keywords: water, erosion, natural water retention measures, agroecology, forest, urbanisation, aquatic environments

Language: English

Geographical coverage: France

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