# Morphological restoration of temporary watercourses in the National Forest of Chaux

### Year of issue

2025

### Summary

Chaux Forest is a timber production area threaded by many small, originally sinuous headwater streams. A 2006–2008 LIFE pilot restored two intermittent tributaries; building on those results, the National Forest Office (ONF) scaled up to ~45 km of temporary tributaries from 2015, redirecting flows to former meanders, adding coarse woody material and sediment to counter decades of straightening/drainage that had widened and incised channels, sped floods and lowered near-surface water tables. Since 2021, ONF and the Doubs-Loue river syndicate have restored ~13 km of the Clauge mainstem inside the forest (2021–2023): narrowing/raising the bed with vegetated berms, gravel recharge, selective infilling of over-wide sections and engineered log structures. Monitoring reports a strong hydrological response: depending on context, the hydropériode of the Clauge headwaters and intermittent tributaries now increases by ~2–6 months per year (including +3–12 weeks in spring), alongside recovery of aquatic bio-indicators. In June 2025 the project received the national “Rivière en bon état” distinction and the Nature-based Solutions award from the Rhône-Méditerranée-Corse Water Agency. Next step: design for restoring the Tanche tributary, with works targeted for 2026.

### Photo Gallery



### Location

47.0813, 5.6601

### Project

NWRM

### National ID

France_13

### Sector

Hydromorphology

### Installation Date

2009-2025

### Implementation status

Completed

## Overview

### Location of the project

The Chaux forest is covered by a large number of small streams, originally winding and of small size (more than 400 km). They are located at the head of the catchment area and are tributaries of the Clauge.

### Country

France

### NUTS2 Code

Franche-Comté

### Sponge measures implemented in the case study

Restoration and reconnection of seasonal streams

Coarse woody debris

Re-meandering

Wetland restoration and management

Water sensitive forest management

### Objectives

• Restore hydrologic function of the Chaux headwaters and mainstem (≈45 km tributaries; ≈12 km mainstem).
• Reconnect wet valley fringes and floodplain (reported several hundred hectares reconnected).
• Raise water table / lengthen hydroperiod; reduce incision/erosion; recover biodiversity (fish, macroinvertebrates, amphibians).

### Involved partners

| Authority type | Authority name | Authority role | Comments | Authority responsibility |
|---|---|---|---|---|
| Other | National office of forest (ONF) | Initiation of the measure | Project owner, the forest manager for both the french state and the local authorities owning the land. | Responsible |
| Research institute / University | Marie and Louis Pasteur University - Sciences and technologies department | Monitoring | — | Supporting |
| Local water authority | SMIX Doubs Loue | Implementation | Local authority responsible for aquatic environment management and flood prevention | Responsible |
| Architects / Engineers | Teleos | Determination of design details of the measure | Modeling of the project | Supporting |

### Documents

mnre_rex08_foret_de_chaux.pdf (1.38 Mo)

## Site Information

### Climate Zone

Cool temperate moist

### Temperature (°C)

11.60 °C

### Elevation range

260 m

### Slope range

0-1%

### Groundwater level

An impermeable clay layer is only 7 meters deep. The maximal water storage volume in the soil is easily reached after rain.

### Vegetation class

Oak–beech high forest (with hornbeam), large lowland deciduous massif.

### WFD Ecological status

Good

### WFD Chemical status

Good

### Water quality status

No major water quality issues observed. Roads, forestry and hunting activities could cause some pollution events though.

## Design and Implementation

### Project scale

Meso

### Project scale specifications

Work carried out on approximately 60 km of temporary tributaries of the Clauge River (until 2018), and more for the Tanche river (2025).

### Project area

2 700 ha

### Project area specifications

Restored watercourse represents about 60 km, out of the estimated 450km of watercourses in the whole forest.

### Size

60.00

### Size unit

km

### Principles

Community involvement, with pedagogic explainations.
Integrating a relfexion on waterways crossing and creation of bypass paths where possible.
Use of LIDAR technology when possible to identify the former river beds.

### Factor constraints

Low-gradient, alluvial/lacustrine valley floors (ancient Rhine deposits, “lac Bressan” context) with hydromorphic, fine soils; shallow water table; dense legacy drainage/straightening; extensive forest road network. Constraints: Natura 2000 and Water Law permitting windows; soil bearing capacity and machinery impacts. Favourable: public ownership/ONF stewardship, local wood/sediment availability, clear LiDAR-visible paleo-meanders.

### Favourable preconditions

Almost all the temporary tributaries of the Clauge being originally meandriformes, a remeandering operation is justified following their transformation in the 1960s into deep rectilinear ditches, so that they can regain a hydrological functioning that allows them to support an associated biodiversity.

## Financing

### Total cost

1429000.00 €

### Total cost information

• 2015–2019 (headwater tributaries, ~45 km): €581,500 total. Funding: €465,200 Agence de l’eau RMC; €116,300 ONF self-financing. Tranche costs: T1 €263,500; T2 €198,000; T3 €120,000.
OIEau
• 2021–2023 (mainstem Clauge, ~12–13 km): €848,000 (excl. VAT). Funding: €594,000 (70%) Agence de l’eau RMC; remaining 30% by project owners/partners.

### Financing authorities

| Authority name | Type of funding | Financing share |
|---|---|---|
| Water Agency Rhône Méditerranée Corse | Sub-national funds | 70% |
| National Forest Office (ONF) | National funds | 30 % |

### Compensations

Non

## Policy and Governance

### Policy description

The Chaux forest is covered by a large number of small streams, originally winding and of small size (more than 400 km). All the temporary tributaries of the Clauge were transformed in the 1960s into deep straight ditches via canalization works. ONF led early phases (post-LIFE 2008 pilots) with Univ. of Franche-Comté; since 2018 the Syndicat Mixte Doubs-Loue (SMIX) shares/co-leads under GEMAPI for mainstem works; Agence de l’eau RMC is principal funder. The measure targets WFD ecological status via hydromorphological recovery, mitigating historical drainage/channelization and climate-driven drought stress in a Natura 2000 forest.

### Land ownership

State-owned: the Forêt domaniale de Chaux belongs to the French State; land is managed by ONF (project owner).

### Target remarks

Significantly restoring the hydraulic functioning of the Clauge and improving the conservation status of the species covered by the Habitats Directive.

### Requirement directive

| Requirement directive | Specification |
|---|---|
| Other EU | Habitats Directive |

### Requirement directive remarks

Emblematic species to be preserved in a Natura 2000 zone.

### Part of a wider plan

Non

### Public consultation

Oui

### Consultation activities

| Activity stage | Activity type | Key issues | Comments |
|---|---|---|---|
| Design phase | Consultation meetings | Preconcieved ideas from local residents, representatives, hunters, etc. : "The project will flood the forest", "The Clauge floods will be worsen". | The goal was to explain how the various preconcieved ideas were wrong. |

| Activity stage | Activity type | Key issues | Comments |
|---|---|---|---|
| Implementation phase | Conference with officials and local representatives (2018) | The budget allowed to the project was considered by some as too expensive, especially in comparison with the smaller budget allowed for forest roads or other infrastructures. | Explaining the project and how it works. |
| Implementation phase | Press articles | — | A significant effort was made to communicate informations to the local press. |
| Other | Information panels on a new wooden footbridge over the river downstream (2025). | — | The goal is to communicate with people directly on the field. |

#### Has contractual arrangements

Non

## Impacts and Monitoring

### Monitoring System

#### Monitoring parameters

A monitoring protocol was set up in 2017 with the University of Franche-Comté (technical assistant) and the ONF (National Office of Forest), with the help of 2 master trainees.
Entomological monitoring is carried out in the spring, at the net and in the watercourses and is led by the University. It is carried out before and after, at a control site, and at restored sites, with a time grid every two and three years. The control shows that the observed changes are not due to climatic variations.
Piezometric monitoring (individual or online). : About twenty piezometers have been installed with weekly automatic readings.
Dendrometric monitoring : At the level of the piezometers, vegetation monitoring plots are placed by the ONF (height, diameter, health status, dominance) on control plots of 1000m². The population evolution will be monitored over the long term.
2 weather stations will be installed in 2025 to study pluviometry and nebulosity.

### Maintenance

### Maintenance requirements

Almost no maintenance operations, the idea is to let ecosystems repair themselves. Some small operations can be carried out shortly after installation (removing unwanted debris for example).

## Impact Assessment Methodology

### Biophysical impact assessment method

Comparison with a control site.

## Socio-economic Impacts

### Direct benefits

Social benefits are limited, as the forest is not a huge tourism area.
Economic benefits mainly come from the provided peak-flow reduction downstream.

## Biophysical impacts: Hydrology

### Hydrological effects

The increase in low-flow rates and the extension of the hydroperiod of the temporary streams, as well as the peak-flow reduction downstream..

### Information on retained water

Hydroperiod increase +2–6 months/year (incl. +3–12 spring weeks) in restored reaches; water table residence time increased.
Restored channel complexity (sinuosity, benches, large wood), floodplain reconnection (hundreds of ha), and attenuation of downstream flood effects during high water.

### Information on increased groundwater level

Piezometric monitoring shows an increase in the hydroperiod (+20 days) because the time of presence of water in the watercourse is longer, as these are surface aquifers that are in silts and dry in summer, water is more available for trees in spring. When the time of presence of water in the stream is extended, it is also extended in the groundwater table.

### Information on Restoring hydraulic connection

The hydrosystems improved as wanted. Waterways are balancing themselves on the way to complete restoration.

## Biophysical impacts: Biodiversity

### Improved biodiversity

Oui

### Information on improved biodiversity

Biodiversity monitoring reveals a better attractiveness of the spawning sites for amphibians (frogs, salamander, newt, reproduction multiplied by 10) and amphibians because the river was not initially biogenic;
It also reveals an improvement in habitat for entomofauna, with the number of taxa multiplied by 2, a recovery by ephemeropterans, perlids and trichopterans protected at the European level (e. g. Hagenella clathrata classified as endangered (EN) on the IUCN Red List). There is also an improvement in quality (i.e. more demanding species that are dependent on wetlands).

### Biophysical impacts: Others

### Information on ecosystem impact climate regulation

Climatic impacts will be assessed using data from the weather station installed in 2025. Positive impacts (heat reduction) due to nebulosity improvements are expected.

## Lessons Learned

### Key lessons

As of 2025, the morphological restoration is considered a success. The restoration was awarded a "Nature Based Solution Price" in 2025 by the French ministry of environment.
Anticipation is needed to carry out a similar project. It allows to prevent future problems, human or technical.
It is better to use the available technologies (LIDAR, modeling) for design and communication.
The sponge effect is working, but is not perfect : the massive october 6 2024 flash flood showed how even with fucntioning sponge measures flood can cause catastrophes.

### Barriers

| Barrier type | Barrier role | Comments |
|---|---|---|
| Legal obligations / restrictions | Main barrier | The main constraint was the completion of the public inquiry, since it represents a significant cost, and also a duration of 6 to 8 months. |
| Attitude of relevant stakeholders | Secondary barrier | There was a need to negotiate with people, to explain to them the necessity of the chosen measures in relation to the local hydrology and geology. |

### Drivers

| Driver type | Driver role | Comments |
|---|---|---|
| Other | Main driver | The fact the habitat was seriously degraded and other experience of successful restoration of habitat on a similar area was a key driver, as positive results were already forecasted from the beginning. |

### Success factors

| Success factor type | Success factor role | Comments |
|---|---|---|
| Other | Main factor | The presence of only one forest manager over a large area. Many differetn land woners and managers would have slowed down and/or prevented a similar project to be implemented. |
| Available support tools | Main factor | The access to LIDAR technology to identify the various former river beds helped to restore them. |
| Available support tools | Main factor | The modelisation work carried out by TELEOS allowed to show the local community how this project worked. |

### Cost effectiveness

The project was a compromise between the most effective (filling of all straightened river beds) and least expensive (leaving ecosystem heal by themselves), choosen to be the most cost effective.

### Transferability

Highly transferable to low-gradient forested headwaters where legacy drainage/straightening dominates. Critical enablers: public land control; integrate works with forest operations to minimize new crossings; use local materials; LiDAR-guided design; secure Water Law/Natura 2000 permits and work within seasonal windows; plan multi-year adaptive monitoring.

## Sources

### Sources


Reconstitution des écoulements de surface de deux affluents temporaires de la Clauge amont

Dossier de demande d’autorisation au titre de la Loi sur l’Eau et les Milieux Aquatique et de Natura 2000

En forêt de Chaux, la restauration des cours d’eau porte ses fruits

Reviviscence des affluents de la Clauge