

Removing a weir and renaturalising the Iton River on the Plis industrial site in Hondouville

The operation

Category	Restoration
Type of operation	Partial or total weir/dam removal
Type of environment	Lowland rivers
Issues at stake (water, biodiversity, climate)	Good habitat status, reduction of flood risks

Start of operation	2014
End of operation	2014
Length of river affected by the works	200 m

River in the restored sector

Name	Iton River
Distance to source	126 km
Mean width (bankfull width)	17 m before works 17 m after works
Mean gradient	0.2 ‰
Mean discharge	Appr. 3.7 m ³ /s

Environment and pressures

- Restore river continuity in the Iton.
- Renaturalise the Courtieux stream.
- Reduce the risks of accidental water pollution and of flooding.

Environment and pressures

The Iton River springs from the Perche hills and is a 132-kilometre left-bank tributary to the Eure River. The river basin, approximately 1 200 km² in size, is predominantly rural with cereal farming on the plateaus and the head of the basin devoted to livestock farming. The river is heavily impacted by human activities with numerous modified reaches and over 220 hydraulic installations, including numerous mills. Most of the installations block sediment transport and the passage of fish. The Iton is a salmonid river, home to brown trout, grayling, bullheads, stone loach, eels and brook lamprey.

The industrial site in Hondouville was constructed in the beginning of the 1900s as a textile factory. A weir was built across the Iton with a bypass leat leading to a mill, called the Plis mill. In 1977, the paddle-wheel disappeared, but the hydraulic installations remained, even

The localisation

Country	France
River basin	Seine-Normandie
Region(s)	Normandie
Departement(s)	Eure
Commune(s)	Hondouville, Amfreville-sur-Iton



Regulatory context	Not applicable
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European directive references

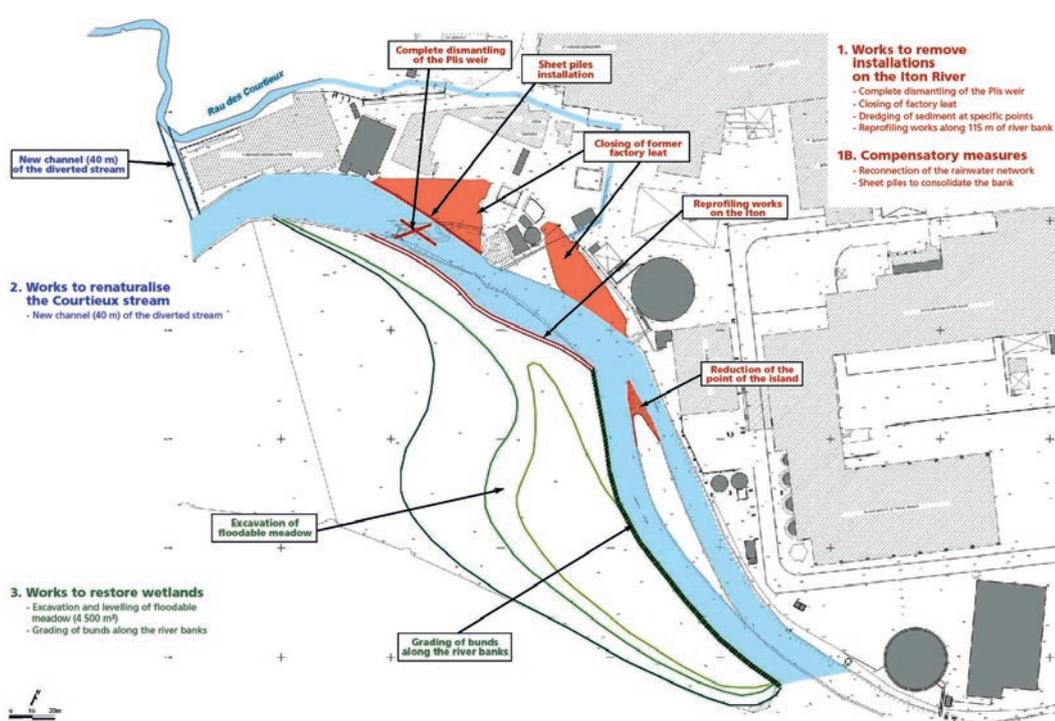
Water-body ref.:	FRHR259
Natura 2000 site ref.:	Not applicable
ROE code of the obstacle	70747 and 3872

The Plis factory around 1910.



The Plis weir in 2014.

SCA Tissue France



Overview of the selected project. [Egis Eau, 2013]

though they no longer served any purpose. The factory, owned by SCA Tissue France, now produces paper and sanitary cotton products.

The outdated Plis weir measured 1.1 metres high with the gates closed and 0.8 metre with the gates open. It caused numerous malfunctions in the river, including a break in sediment transport, an obstacle to the passage of trout and eels, degraded water quality, a more uniform flow pattern and siltation of habitats (an impounded reach extending 600 metres).

In addition, the Courteux stream flowed through the industrial site, itself located in a floodable zone, before reaching the Iton. In the lower section, the stream runs through a culvert, but due to its poor positioning, the stream is clogged with sediment over more than 350 metres, with as a result a break in continuity between the stream and the river.

Finally, there was a risk of accidental pollution due to the position of the Courteux stream and the factory leat in the middle of the industrial installations and no means to control the water entering or exiting them. The position of the factory wastewater-treatment plant, on an island in a floodable zone, was also a problem.

Opportunities to act

The river board for the lower Iton (Saviton) is in charge of protecting and managing the lower stretch of the Iton River and its tributaries. The board wishes to undertake restoration work to improve river continuity. In the framework of preparing the multi-year restoration and maintenance plan, an assessment of the river basin was carried out in 2003-2004. Among other surveyed hydraulic installations, the assessment concluded that the Plis weir was outdated and an obstacle to sediment and biological continuity.

Saviton informed SCA Tissue France on the problems caused by the Plis weir, on the possibility of a public subsidy to remove the structure and proposed providing assistance to the industrial company during the operation. SCA Tissue France had no further use for the weir and wanted to avoid incurring costs for its maintenance, consequently, it accepted the idea of removing it.

The fact that the company owned the meadow opposite the site was a chance to restore the flood storage zone and to reduce the flood risk for the factory. In addition to removing the Plis weir, the final project included filling in the factory leat to improve access to the wastewater-treatment plant, bypassing



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The meadow after restoration of the wetland (2014).

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the Courtieux stream to avoid the industrial site and the creation of a wetland in the meadow opposite the site. SCA Tissue France decided in favour of the project given that it was economically beneficial for site operation and corresponded to its environmental values.

■ Works and developments

The works took place in three phases.

The gates, concrete glacis and spillway were removed. The factory leat and part of the low-water channel upstream of the weir were dredged. The island downstream of the factory channel was eliminated to enable a distribution of flows similar to that prior to the works.

The future riverbed was dug out, the banks were graded to a slight slope and replanted. The former bed was filled in with landfill from the new bed. The bunds along the banks were removed to create a wetland and the section of the lot along the Iton was cleared.

The factory channel was filled in with the landfill from the meadow. The banks along the industrial site were reinforced with sheet piles to protect the buildings. The outlet of the wastewater-treatment plant, originally in the factory channel, was extended to the Iton.

■ Regulatory approach

- The works were authorised in accordance with the Water law.

■ Post-restoration management

The meadow is used for extensive grazing. Mobile, electric fences are used to protect the newly created banks of the Iton.

■ Monitoring

The pre works monitoring done in 2012 dealt with the biological (benthic macroinvertebrates) and morphological (topographic surveys of the long and cross profiles, sedimentation levels) compartments.

The first survey after the works in 2015 (n+1) dealt with the morphological compartment (topographic surveys of the long and cross profiles, water depths, substrates and current velocities) at four points along the riverbed and the flood plain, in a zone stretching 400 metres upstream and downstream of the former weir. The monitoring programme is scheduled to continue for two more years (n+2 and n+3).

■ Outcome of the project and outlook

This project opened and restored 800 metres of the Iton (though there remain five structures downstream and 200 upstream) and restored 600 metres of favourable habitats for category-1 species thanks to the elimination of the impounded reach. Sediment transport was previously blocked by the weir, but has now been restored. The restoration of the meadow provides the river with a flood expansion zone and would appear to be a potential habitat for the yellow-bellied toad, whose presence has been observed near the site.

One year after the works, the hydromorphological studies on the Iton at the site of the former weir revealed a modification in the long profile with a drop of 25 centimetres in the water level upstream and an increase of 25 to 30 cm downstream. In economic and flood-security terms, the project is beneficial for SCA Tissue France in that the firm succeeded in protecting its installations from the river and avoided maintenance costs. The risk of accidental pollution was reduced by returning the Courtieux stream to the talweg and by filling in the factory channel.

However, due to the small amount of available land, the new bed of the Courtieux stream is straight and the banks could not be planted as planned.

The drop in the water level indirectly damaged the foundations of the industrial installations along the river by exposing them to freezing temperatures.

That being said, SCA Tissue France and its partners consider the project a success because it met both the economic and ecological objectives, thanks to the technical support from Saviton and the implication of the industrial company.



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Filling in the factory leat following the removal of the Plis weir (2014).

Costs

In euros ex. VAT

Preliminary study	35,000 €
Purchase of land	Not applicable
Works and developments	314,000 €
Monitoring studies	10,000 €
Promotion	Not applicable
Total cost of project (not including monitoring)	359,000 €

Financial partners and funding:

Seine-Normandie water agency (80%), SCA Tissue France (20%)

Technical partners:

Saviton, Seine-Normandie water agency, Eure departmental territorial and maritime agency, Onema, Haute-Normandie regional environmental directorate, Egis Eau consulting firm, SETHY company



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Filling in the factory leat following the removal of the Plis weir (2014).

Promotion of the project



Following the works, in 2014 SCA and the Seine-Normandie water agency produced a film on the project. A visit to the site was also organised for local residents, elected officials as well as the technical and financial partners.



The Hondouville site was awarded the SCA Europe Excellence prize 2014, the "Caring for people and nature award".



In the beginning of 2015, SCA published a press release that generated articles in the local, national and professional press, as well as an interview for an economic show on television.



- Film on the project at SCA France:
<http://www.sca.com/fr/france/Medias/Actualites/2014/Renaturation-Iton/>
- SAGE de l'Iton - PAGD et règlement. 2012, 112 p.
- Saviton. Article on the project to renaturalise the Iton River. 4 February 2015.
<http://saviton.net/2015/02/04/etude-de-renaturation-site-industriel-hondouville/>
- Étude d'effacement d'ouvrage et de renaturation de cours d'eau sur le site industriel de Georgia Pacific, Phase 3, Programme de travaux. Egis Eau, R. Fourier, août 2013, 38 p.

Project owner



SCA Tissue France

Assisting the project owner:
Saviton

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Reopening side channels along the Saône in Jassans-Riottier

The operation

Project owner	Voies navigables de France (VNF - French waterways authority)
Category	Improvement of waterways
Type of operation	Creation or reopening of alluvial wetlands
Type of environment	Lowland rivers
Issues at stake (water, biodiversity, climate)	Good status of habitats, river continuity
Start of operation	September 2007
End of operation	April 2008
Length of river affected by the works	500 m

River in the restored sector

Name	Saône River
Distance to source	408 km
Mean width	215 m
Mean discharge	400 m ³ /s

Aims of the project owner

- Restore links between the main channel and the side channels.
- Recreate diverse habitats for various species.
- Improve site landscaping for tourism.

Environment and pressures

The Saône originates in the town of Vioménil, in the Vosges mountains. The river is 480 km long and flows into the Rhône River in the city of Lyon. Its basin covers a surface area of 29 950 km².

Over the centuries, first the floodplain of the Saône was modified, primarily in order to gain land for agriculture and other purposes. Then the riverbed itself was adapted and channelised in the 1800s to facilitate and develop trade between the Mediterranean and Northern Europe. Approximately 15 locks were created along this tributary to the Rhône.

Shipping is possible on the Saône from the town of Corre in the north of the Haute-Saône department to the point where it joins the Rhône in Lyon, 365 km downstream.

The location

Country	France
River basin	Rhône-Méditerranée-Corse
Region(s)	Rhône-Alpes
Departement(s)	Ain
Commune(s)	Jassans-Riottier



There are numerous natural zones with high ecological value (ZNIEFF) all along the Saône valley. The town of Jassans-Riottier lies in the "Saône floodplain" Type-1 ZNIEFF. A number of regionally protected species have been observed, such as pike, beavers and several species of birds.

In this sector, the Saône has been channelised to enable the passage of large ships. The ships on this section of the river include pleasure boats and cruise ships (floating hotels 140 metres long), as well as large merchant ships.

Regulatory context	Not applicable
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European directive references

Water-body ref.:	FRDR1807b
Natura 2000 site ref.:	Not applicable

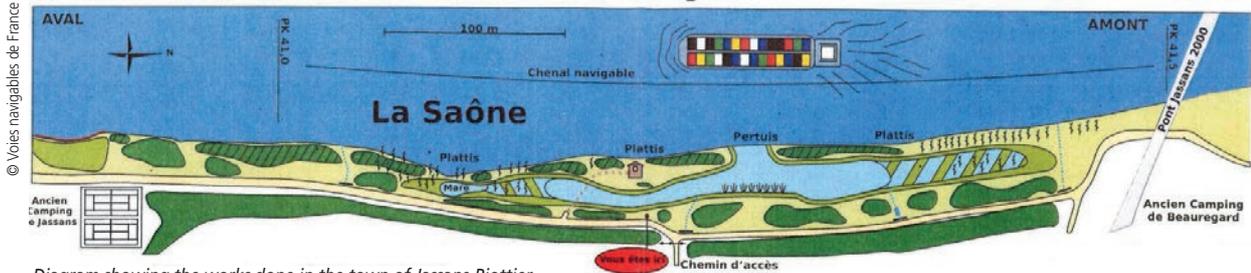


Diagram showing the works done in the town of Jassans-Riottier.

With these development works of the Saône river bed, certain alluvial side channels were cut off from the main channel and had started to fill in.

Filling in and cutting off of wetlands is a natural phenomenon, however it was significantly accelerated in this case due to the disconnection with the main channel. The lateral areas along the Saône in Jassans-Riottier were covered with nettles, brambles, and the next stage of shrub growth (ash, maple, alder) was already present on the site. It was no longer possible to walk along the tow-path.

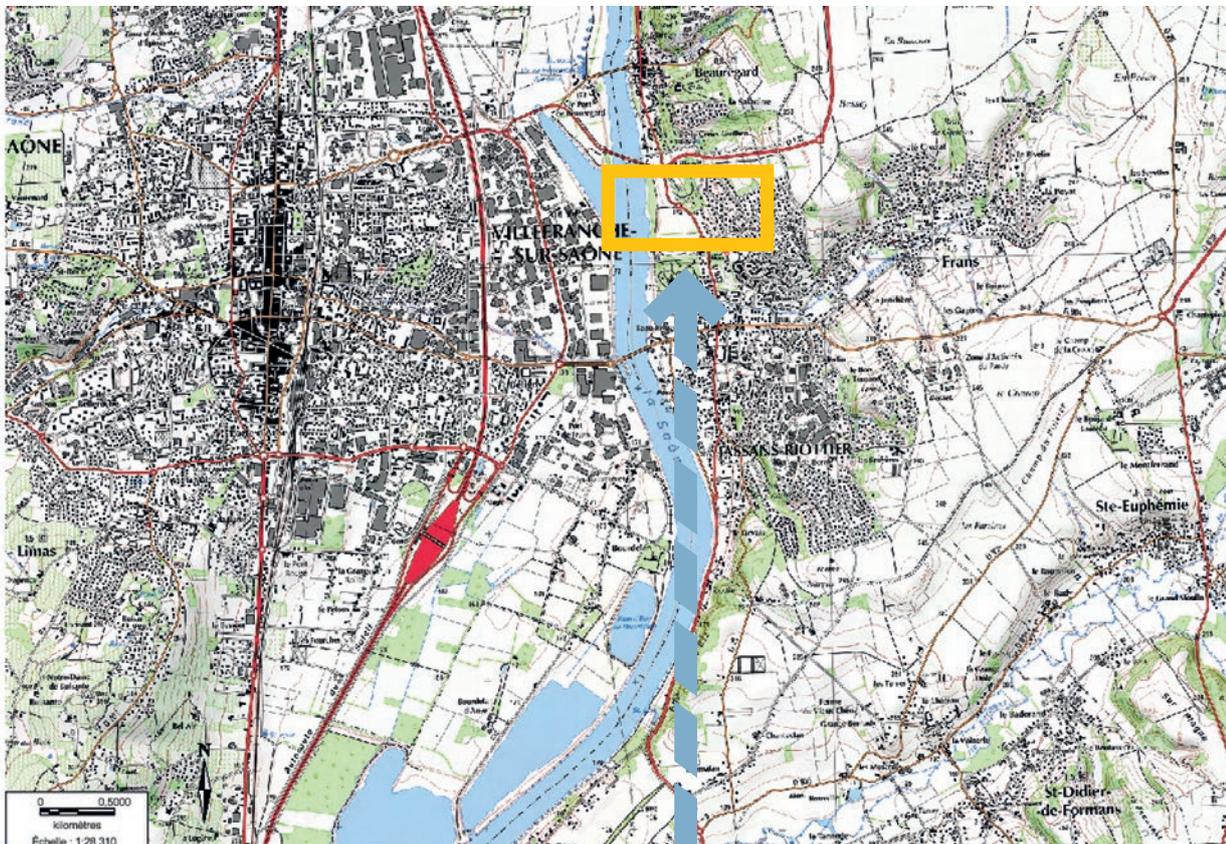
■ Opportunities to act

The 2003-2008 contract for the floodable Saône valley was an action programme managed by the Saône and Doubs public river-basin territorial agency (EPTB) to establish collective, sustainable and balanced management of water and the corresponding environments in the Saône valley.

As part of the programme, an assessment was run in 2003 to identify problems along the river and propose solutions adapted to the local issues.

The assessment pinpointed the areas suitable for ecological development work, with a low topographic level, without any major projects or issues nearby, and having worthwhile ecological potential (alluvial areas, etc.). It also identified areas of interest for tourism infrastructure along the river (boating sites, etc.).

Subsequently, VNF, the managing authority for the waterway, decided to work on the wetlands that were filling in along the Saône in the town of Jassans-Riottier. This project was part of the contract for the floodable Saône valley and met one of its objectives, namely to restore and protect natural environments.





© Voies navigables de France (VNF)

Earthwork to restore a side channel and ponds. October 2007.



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Flooding of the restored side channel. December 2009.



© Voies navigables de France (VNF)

The vegetation in the restored side channel had developed well 4.5 years after the works. September 2012.

■ Works and developments

Works were done on the remains of wetlands that still existed along the Saône. In 2007, secondary channels and ponds that were continuously or intermittently linked to the Saône were restored by moving 12,000 m³ of earth.

Then the worked and graded sites and banks were planted with 8 000 clumps of helophytes comprising a total of ten species.

The foot of the bank at the connection point with the Saône was bio-engineered over a distance of 40 metres to limit erosion and the effects of ships' wakes on the restored alluvial zone.

A sluice ensures continuous connection between the river bed and the side channel.

In 2008, all the worked surfaces, not including the low areas, were planted with grass and the service road was restored with a stone surface.

■ Regulatory approach

The works were authorised in accordance with the Water law.

■ Post-restoration management

The vegetation is maintained by the town of Jassans-Riottier in a partnership with VNF. Each year, the town mows and clears the high banks and the area around the observation platform. The shrub vegetation is also monitored and any willows and others species are cut down if they are in poor health or represent a danger for site visitors.

■ Monitoring

A brief pre-works report was drafted in the framework of the preliminary study. It contained topographical measurements and an analysis of the terrestrial vegetation in the side channels that were slowly filling in.

Following the works, ecological monitoring by a consulting firm was carried out over four years from 2009 to 2012.

Monitoring addressed the physical compartment, e.g. with topographic, temperature and physical-chemical surveys, and the biological compartment with an analysis on phytoplankton, zooplankton, fish and the aquatic and riparian vegetation. An analysis on visits to the site and on site maintenance (number of visits, damage done to installations, etc.) was also carried out.

■ Outcome of the project and outlook

The topographic profiles prepared in 2009 revealed a high level of local sedimentation causing a narrowing of the side channel. On the basis of the results from 2010 to 2012, this sedimentation is apparently caused by readjustments on the worked site where successive floods and the wakes of ships even out the profile of the side channels.

The modifications made at the foot of the embankment limited erosion as planned.

However, the analysis also revealed that the wakes of ships produced effects in the side channel and represented a significant pressure on the environment by limiting biological development. Fine sediment in the side channel was regularly resuspended in the water by the wakes, which may reduce the environmental value of the area.

VNF planned for 2013 to set up an experimental technique involving a planted, submerged levee positioned

Cost

In euros ex. VAT

Initial assessment and monitoring study <i>* of which the monitoring study: 80 365 €</i>	95 365 €*
Purchase of land	-
Works and developments	145 000 €
Promotion	6 500 €
Total cost of project	245 865 €

Financial partners and funding:

Rhône-Méditerranée-Corse water agency (60%), Rhône-Alpes region (20%), Voies navigables de France (20%)

Technical partners:

Rhône-Méditerranée-Corse water agency, Ain departmental territorial directorate (DDT 01). Saône and Doubs public river-basin territorial agency, "Porte Ouest de la Dombes" intermunicipal association



© Voies navigables de France (VNF)

Observation hut for wildlife that burned in November 2008 and was replaced by an elevated boardwalk. July 2008.

at the connection point with the Saône in order to limit the effects of wakes and to avoid the resuspension of the fine particles (suspended matter).

On growing, the plants will be visible and should break the wakes and stop them from entering the side channel via the opening.

Monitoring of the fish populations revealed an increase in the number of species caught in the side channel, from 17 species in 2010 to 21 in 2012. In the spring, the time of rising water levels, the side channel remains a calm environment that is favourable for small species. At the beginning of the fall of 2012, the side channel was home to a diversified

and more abundant community than in the spring, due to the hydrology of the Saône and to the development of the grass beds that enhanced site attractiveness. In addition, a number of fish-eating species were noted, including perch, pikeperch and pike, re-observed for the first time in 2012.

The aquatic vegetation in the continuously filled pond underwent considerable change with respect to the observations made from 2009 to 2011. The dominant Nuttall's pondweed, an invasive alien species, gave way to significant development of rigid hornwort, a native species. The number of inventoried plant species remained virtually identical. A stabilisation process would seem to be under way in some of the side channels.

The VNF technical department and the town are satisfied with the operation. However, the large number of visits to the site have resulted in vandalism creating pressure on the vegetation and incurring additional costs for maintenance and the installation of systems to limit access.

Promotion of the project

In order to enhance the value of the wetlands in the eyes of the general public, the "Porte Ouest de la Dombes" intermunicipal association invested in facilities to welcome the public in the framework of a development programme for the Saône banks. An elevated boardwalk provides access deep into the wetlands and to an observation platform in the middle of the reed bed.

VNF set up informative signs explaining the works done on the site.

Project owner	Voies navigables de France (VNF)
	
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GREBE, 2012. *Etude de suivi des aménagements écologiques réalisés sur les frans-bords de la Saône à Jassans-Riottier – année 2012.* VNF

Bio-engineering and creation of side channels along the rectified section of the Scarpe River in Arras

The operation

Project owner	Arras urban area (CUA)
Category	Improvement of waterways
Type of operation	Bio-engineering techniques for river-bank protection
Type of environment	Intermediate river zone
Issues at stake (water, biodiversity, climate)	Good status of habitats, river continuity
Start of operation	2009
End of operation	2012
Length of river affected by the works	1 760 m

River in the restored sector

Name	Upper channelised Scarpe
Distance to source	35 km
Mean width	23 m
Mean discharge	3.2 m ³ /s (in Brebières)

Aims of the project owner

- Improve the biological and chemical quality of the Scarpe River.
- Recreate reproduction habitats for various species.

Environment and pressures

The Scarpe is a river in the Escaut basin and has its source in the town of Berles-Monchel in the Pas-de-Calais department. The river is 102 kilometres long and its basin spans 1 120 km². It flows under natural conditions (marshes, peat bogs), but also through agricultural areas and urban zones (in the cities of Arras and Douai).

The river was initially diverted to the north to supply the city of Douai and subsequently converted into a waterway shortly before the year 1000. Repeated dredging and widening followed. Its bed was rectified and diked, its discharge regulated. The development of river transportation continued in northern France in the 1800s with works on the banks and the creation of locks. In addition, human activities produced effluents that altered the physical-chemical quality of the water.

The location

Country	France
River basin	Artois-Picardie
Region	Nord – Pas-de-Calais
Departement(s)	Pas-de-Calais
Commune(s)	Arras, Saint-Nicolas-lez-Arras, Saint-Laurent-Blangy



Banks protected by sheet piles prior to the restoration works. Autumn 2010.

Regulatory context	Regulated river (List 1)
Water-body ref.:	AR48
Natura 2000 site ref.:	Not applicable

European directive references

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Creation of stagnant and semi-stagnant lagoons along the Scarpe. Summer 2010.

The Scarpe is currently channelised over two-thirds of its overall length, making it possible to travel from Arras to Mortagne-du-Nord, where it flows into the Escaut, via 19 locks dropping the level approximately 40 metres. This rectified section is made up of three reaches, the upper, mid and lower Scarpes.

The upper channelised Scarpe is 23 kilometres long and links Arras to Corbehem via nine locks. The valley, between Arras and Vitry-en-Artois, has been designated as a Type-2 ZNIEFF (high-value ecological zone) that includes the Fampoux marshes. The river is home notably to eels and pike, two fish species that are listed as vulnerable on the Red list of fresh-water fish in France.

To meet the needs of commercial shipping and recreational boating, the banks along the river were adapted to the "Freycinet gauge" (350-ton capacity) involving major civil works. Metal sheet piles line sections of the Scarpe from Arras to Douai. They limit diversification of habitats and exchanges between the aquatic and terrestrial environments, which in turn leads to a progressive disconnection of the side channels and a loss of transitional environments. Along the banks, great quantities

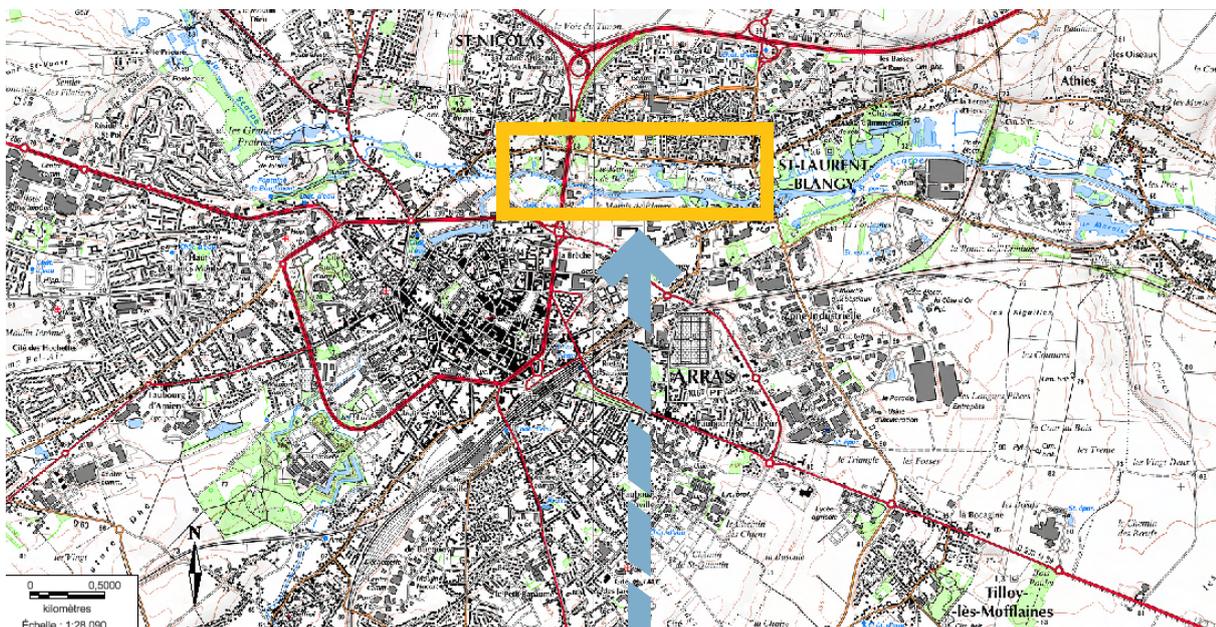
of rocks and landfill also limit the development of aquatic and helophyte vegetation. The fairly uniform plant cover is dominated by hydrophilic plants and is limited to the non-protected sections of the banks.

The environment is also exposed to other pressures, notably recreational activities (people walking along the tow-paths, hunting, fishing, boating) and a large geese population in Saint-Laurent-Blangy.

■ Opportunities to act

Since 2003, the Arras urban area (CUA) has pressed for effective projects to improve ecological continuity, efforts that were subsequently folded into implementation of the French ecological network "Trame Verte et Bleue". It also wished to take action on the Scarpe in order to meet the good ecological-potential objective set for 2021.

In a partnership with the Artois-Picardie water agency, CUA launched ecological-restoration works on a section of the Scarpe. The reaches most affected by anthropogenic pressures were seen as the priority, namely the entire section between Arras and Saint-Laurent-Blangy.



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Banks regraded and planted. Autumn 2012.

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Erosion and damage near the turn-around point on the Scarpe. Autumn 2010.

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Regrading and creation of a reed bed by closing the turn-around point. Autumn 2012.

In 2010, a preliminary study on the section was carried out by a specialised consulting firm. The study listed how the site is used, the constraints weighing on it and analysed its ecological value. The ecological assessment revealed the presence of emblematic plant and animal species such as woolly burdock and flowering rush. Three invasive species, including Japanese knotweed, were also observed and mapped on the banks.

The study recommended restoring natural banks with a slight slope and improving the riparian vegetation.

■ Works and developments

One land-based and two floating workshops were created to work simultaneously on different reaches and accelerate the works. The river was first dredged to enable the transport of the material required for the works.

The metal sheet piles, initially installed for bank protection, were deemed unsuitable and removed.

The banks were graded to a slight slope and stabilised using techniques suited to the hydraulic constraints weighing on each sector:

- helophyte rolls or calcareous landfill with geotextile fabric in areas where the constraints are not severe;
- mixed techniques (gabion bed and vegetated geomats) in areas subjected to greater constraints.

A total of 1 750 metres of bio-engineering bank-protection techniques were installed.

A number of measures were taken for the riparian vegetation, including planting of helophytes at the foot of banks, seeding of work areas with a mix of herbaceous plants, restoration of wooded areas by planting white willows and elimination of the invasive species found on site.

The top of the white willows was cut to encourage the growth of buds and of the tree trunks. This pruning technique will produce cavities that birds, small mammals and insects can use.

A lagoon was also created as an alluvial "annex" with two reed beds measuring 1 000 and 1 450 m² on the site of the former turn-around point for péniche barges in an effort to restore habitats for different species, notably pike.

■ Regulatory approach

The works were authorised in accordance with the Water law.

■ Post-restoration management

Over the three years following the works, maintenance and management adapted to the different areas was carried out by the contractor. After the three years, the management was taken over by the Arras urban area. In this sector, management of the waterway, normally assumed by Voies navigables de France (VNF), was delegated to the Arras urban area.

An agreement concerning the experimental management, development and operation of the upper channelised Scarpe from Arras to Fampoux has been in force since 1 January 2012 between VNF and the Arras urban area.

Management of the two restored redds is ensured by the Pas-de-Calais departmental federation of certified associations for fishing and protection of aquatic environments (FDAAPPMA 62).

■ Monitoring

An pre work survey was carried out in 2010, on the plant and animal compartments. Currently, no particular ecological monitoring has been set up. However, a check on the renewed growth of the vegetation was run in September 2012, during the works.

An assessment on the changes in the environment is also planned at some point at least five years after the works.

Cost

In euros ex. VAT

Preliminary studies	132 277 €
Purchase of land	-
Works and developments	1 189 032 €
Promotion	-
Total cost of project	1 321 310 €

Financial partners and funding:

Artois-Picardie water agency (51%), ERDF (48%) and the Arras urban area (1%)

Technical partners:

Artois-Picardie water agency; Pas-de-Calais departmental federation of certified associations for fishing and protection of aquatic environments (FDAAPPMA 62)

Outcome of the project and outlook

The works to renaturalise the banks of the upper channelised Scarpe will be pursued until reaching Fampoux and has already improved the quality of aquatic and terrestrial habitats as well as their diversity. The potential of the banks to serve as habitats for plant and animal species that depend on the nearby wetlands was optimised.

This project contributes to reaching the objectives for 2021, namely preserving fragile, natural areas and achieving good ecological status. It also fulfils a growing social demand and was very well received by visitors and local residents.

Unfortunately, the works had to be done from the water, which made it difficult. In addition, a large geese population, present on the river since before the works, has damaged and slowed the regrowth of the helophyte vegetation, particularly in the reed beds.

In 2010, the pre works assessment revealed a relictual population of woolly burdock that still existed on the site, but was threatened. The assessment was also an occasion to run surveys on two fish species, two emblematic bird species and one emblematic insect species. No amphibian species were noted.

An assessment of the impact of the works on the restored habitats and on biodiversity is planned at some point at least five years after the works in

order to give enough time to the environment to adapt and to the various species to go through their life cycle. The assessment, carried out by a specialised consulting firm, will be based on the changes in the population numbers of the species listed in the initially in order to determine the degree to which the objectives set by the project owner were met, namely:

- maintain the woolly burdock, pike and eel populations;
- install at least one amphibian species;
- double the number of bird and insect species (two and one respectively) observed prior to the works.

This project strove to achieve a balance between the ecological value of the site and its use as a waterway, i.e. a channel for commercial shipping, pleasure boating and the corresponding recreational activities. For example, the landscape of the site was improved with beneficial effects on tourism and pleasure boating, as well as on recreational activities (walking, etc.).

Promotion of the project

Several press conferences were organised during and at the end of the works to inform on the project for the ecological restoration of the upper channelised Scarpe. Informational signs will also be installed upstream and downstream of the project site.

Project owner	Arras urban area (CUA) 
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Widening and sediment reloading of the Drac riverbed in Saint-Bonnet-en-Champsaur

The operation

Catégorie	Restoration
Type of operation	River gravel input
Type of environment	Intermediate river (braided channel)
Issues at stake (water, biodiversity, climate)	Hydromorphology
Start of operation	November 2013
End of operation	June 2014
Length of river affected by the works	3,600 m

River in the restored sector

Name	Drac River
Distance to source	36 km
Mean width (bankfull width)	30 to 40 m before works 80 to 120 m après travaux
Mean gradient	10 ‰
Mean discharge	Appr. 9 m ³ /s

Aims of the project owner

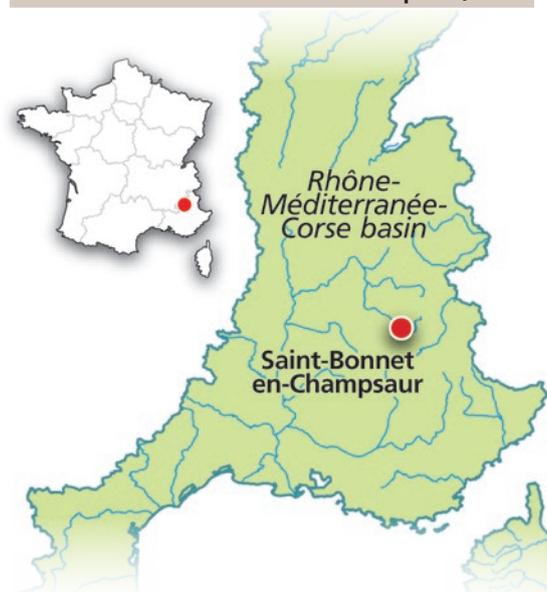
- Restore the braided channel dynamics of the the Drac.
- Restore sediment continuity and halt river bed scouring.
- Restore lateral connections with tributaries, side channels and wetlands.
- Maintain tourism and economic activities at the lake and along the Drac.
- Make the area safer in terms of flooding and landslides.

Environment and pressures

The Drac Blanc and the Drac Noir torrents both originate at an altitude of over 2,500 metres in the Écrins mountains in the Alps and join to form the Drac River at the town of Orcières. The Drac transports considerable amounts of sediment and has a number of braided sections in its upper reaches. The river flows in a valley where rock bars and basins alternate in an Alpine and rural setting. The river basin is the site of major tourism activity, in both the summer and winter, with numerous aquatic activities (fishing, white-water sports, swimming) taking place in the Drac and in the lake.

The localisation

Country	France
River basin	Rhône-Méditerranée-Corse
Region(s)	Provence-Alpes-Côte d'Azur
Departement(s)	Hautes-Alpes
Commune(s)	St-Bonnet-en-Champsaur, St-Julien-en-Champsaur, St-Laurent-du-Cros, Laye, La Fare-en-Champsaur,



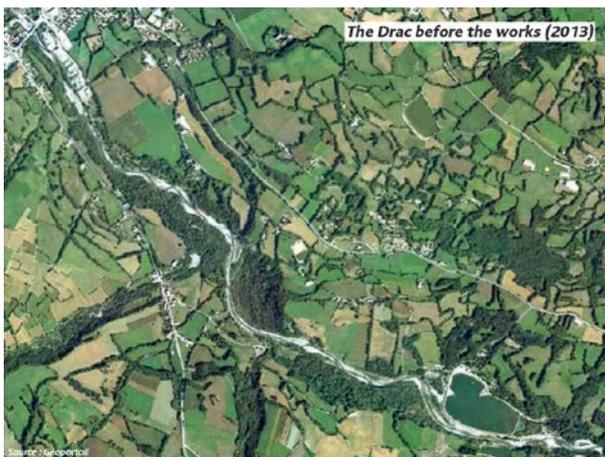
Regulatory context	Peripheral zone of the Écrins national park
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European directive references

Water-body ref.:	FRDR353b
Natura 2000 site ref.:	Not applicable
ROE code	49613 weir near the recycling center of the obstacle
	49609 weir at the Baraques bridge



Bed scouring of the Drac into the clay, loss of riparian vegetation and a landslide, in November 2011.



GéoPortail

A study carried out in 2000 signalled a problem of incision in the bed of the Drac (clay substratum) upstream of the town of Saint-Bonnet-en-Champsaur, caused by massive extractions of gravel since the 1960s and that ended only in 2012.

The major floods in 2006 and 2008 worsened the phenomenon. The results were perfectly clear, i.e. severe bed scouring over a distance of 3.5 km starting at the old weir at the Champsaur Lake and running downstream to the weir near the civic amenity site in the town of Saint-Bonnet. The bed and the alluvial groundwater level had dropped three metres. riverbed incision threatened the stability of nearby infrastructure, notably the dike for the Champsaur lake, affected economic activities (dewatering of abstractions) and nearby ecosystems (drying of parallel streams and disconnection of tributaries), and had clear consequences for recreational activities and for public safety.

■ Opportunities to act

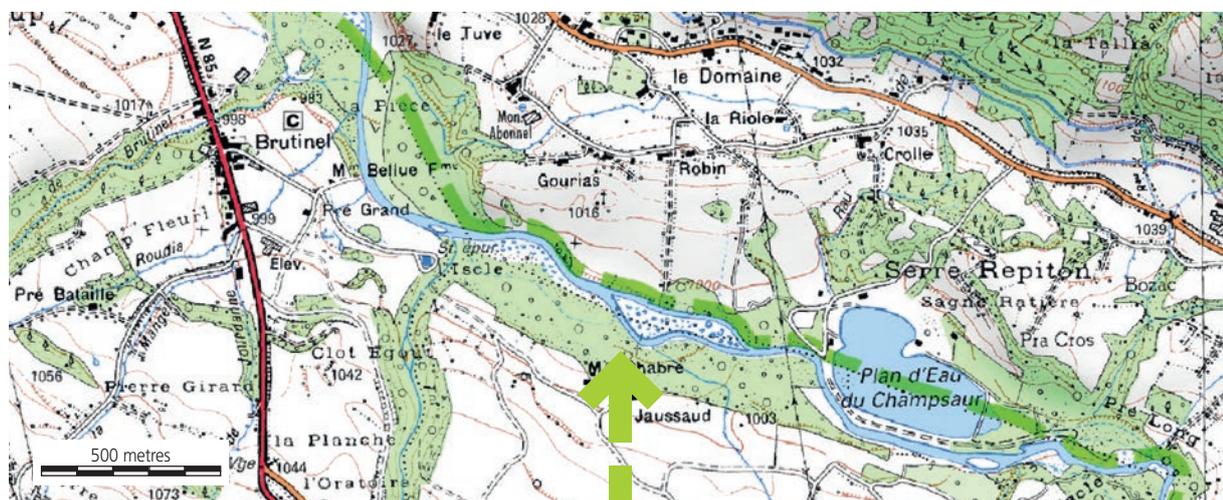
The Upper Drac management plan ("SAGE Drac amont") was established in 1999. The follow-on plan with a river contract and the corresponding action programme started in 2011-2012. Both the plan and the river contract are managed by CLEDA (managing entity

for the upper Drac), which represents the intermunicipal associations in the river basin. The physical restoration of the riverbed upstream of Saint-Bonnet was a priority in the river contract for the upper Drac signed in 2011. The plan was for a major operation to physically restore the riverbed by widening the bed (lowering the banks) and reloading the river using the coarse sediment taken from the banks.

CLEDA succeeded in convincing the funding entities and in 2012 it was possible to launch the calls for tenders, the studies for the works and to prepare the authorisation requests.

■ Works and developments

The works were done over the winter of 2013-2014, during the low-flow period. It involved over 80 people and 60 earthmoving machines for a period of six months. During the first phase, 3.6 kilometres of alluvial terraces along the Drac were cleared of trees and trunks, representing a total surface area of 27 hectares. The active channel of the Drac was thus considerably widened and the alluvial bars were once again exposed to the river currents. Some small islands with vegetation were maintained to enable the formation of side channels, secondary channels and nesting sites.



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The second phase consisted of a vast operation to reload the bed with 450,000 m³ of alluvium removed from the former terraces of the Drac and from zones of sediment accumulation along other rivers in the river basin.

During the third phase, following the return of the water to the bed, the new banks were stabilised using geogrids and bundled wood (fascines), then seeded and planted with over 6,400 willow cuttings and 500 helophytes, notably along the track for maintenance access and walkers on the right bank. In addition, 13 hectares of wetlands and parallel streams were created, primarily in the lower section of the reach.

In order to make the transverse obstacles compatible with the river continuity requirements stipulated in article L. 214-17 of the Environmental code, works was done on the weirs at the Baraques bridge and the recycling center site, located downstream of the reloading zone, during the year prior to the reloading. It consisted amongst others of building a stud-type fish pass designed specifically for trout and a passageway for canoes.

Reloading required that the weir at the recycling center site, downstream of the reloading zone, be raised 1.65 metres in order to stabilise the new steady slope and the upstream reload level. Finally, the weir for the lake in Saint-Bonnet was maintained, but buried under the reloaded sediment in order to conserve a solid anchoring point, yet removing a difficult obstacle for fish.

■ Regulatory approach

- Declaration of works in the public interest, with purchase of land on the basis of mutual agreements with the land owners.
- Water-law formalities with an impact study and a public enquiry.
- CNPN authorisation to move a protected species (miniature cattail).
- Authorisation to clear 27 hectares (Forest code).

■ Post-restoration management

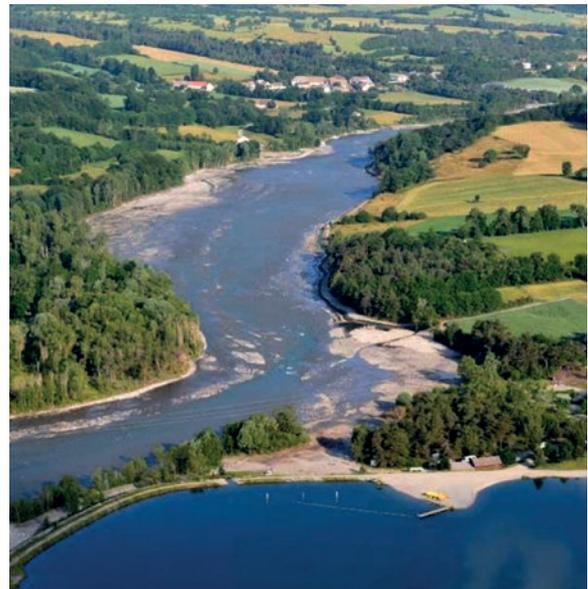
It was initially decided to let the dynamics of the river and the riparian vegetation proceed naturally. If clay formations are uncovered, CLEDA may, as necessary, reload specific spots.

■ Monitoring

In the framework of the network of demonstration sites, the Water agency established a monitoring programme before and for five years (n+5) after the works, addressing biological aspects (fish, macroinvertebrates, diatoms) and the hydromorphology. This programme was filled out with a complete survey of active and potential redds for trout, in the main channel and in the reconnected secondary



The Drac with the scoured bed next to the Champsaur Lake in August 2009.



The restored Drac next to the Champsaur Lake in June 2014.

channels. This survey was carried out by the Onema local office*.

A multi-partner monitoring plan (CLEDA, Water agency, Onema, Hautes-Alpes department, IRSTEA, Écrins national park, consulting firms) has been set up to complement the EU ALPeril programme that made possible Lidar topographical surveys in 2009 and 2015.

In addition, a thesis organised by Onema/CNRS/ University of Paris 7 is now under way to assess the effectiveness of restoration works on rivers characterised by high levels of sediment transport and to study the dynamics of sediment transport.

■ Outcome of the project and outlook

Even in the absence of a significant flood, the entire widened section of the active channel has since become a braided riverbed. The current monitoring programme will provide information on the subsequent changes in the reloaded zone.

* For more information, see the "Monitoring" section in the fact sheet on the Wetlands portal.

Costs

In euros ex. VAT

Preliminary study	174,850 €
Purchase of land	210,000 € (59 ha)
General-contractor fees	224,240 €
Works and developments	4,142,920 € <i>including 420,000 € to raise and equip the weir near the civic amenity site</i>
Monitoring	Not calculated
Promotion	50,000 € <i>(share paid by CLEDA, not including funds from IFORE and the Water agency)</i>
Total cost of project	4,802,010 €

Financial partners and funding: Rhône-Méditerranée-Corse water agency: 47.25%; Champsaur intermunicipal association: 20%; Provence-Alpes-Côte d'Azur region: 14.25%; Hautes-Alpes departmental council: 10%; EU (ERDF): 8.5%

Technical partners:

Onema; assistant to project owner: ETRM; general contractor: Burgeap and Geolithe

The works produced a long-lasting solution for the problems arising from riverbed scouring and resolved the difficulties threatening the attractiveness of the valley for tourists (safeguarding the Champ-saur Lake, creation of a walking trail along the Drac, passage for white-water craft, enhanced fishing conditions, etc.).

From the ecological standpoint, sediment reloading of the Drac and the rise in groundwater reconnected six tributaries and resupplied with water side channels of high biological value. The return to the Drac of emblematic species, such as the common kingfisher, was observed shortly after the works. The living and reproductive zones of aquatic species that had abandoned the most heavily down-cut areas were recreated and clogging of the riverbed was reduced. During the 2015-2016 winter, Onema noted approximately 30 salmonid redds over the four-kilometre work area where only five had been observed prior to the works.

The physical restoration of the Drac required enormous resources and means at a very high cost. The project would have been much smaller and less expensive if measures had been taken when riverbed incision was first observed.



- *La restauration écologique du Drac : un projet de territoire*, Films IFORE, septembre 2015, 14'37.
<https://www.youtube.com/watch?v=HHLnsfWbF5Q>
- *Les travaux de restauration du lit du Drac pour éviter une catastrophe écologique et humaine*, Film CLEDA, oct 2013, 4'38.
<https://www.youtube.com/watch?v=VsanyriLOC4>

Promotion of the project



CLEDA launched a major communication effort before and after the works. Several films were produced, before the works in 2013 by CLEDA and in September 2015 by IFORE, with 3D animation showing the risks of erosion if the Drac continued to drop.

Signs explaining the project were set up prior to the works at each end of the restored sector. In addition, the walking trail created along the right bank of the Drac offers local residents and tourists a close view of the riverbed and its ecological environment.

This project was a candidate for the National ecological-engineering grand prize in the category "Ecological engineering for the preservation of continental aquatic ecosystems".

Project owner



CLEDA
(managing entity for the upper Drac)

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Restoring the natural dynamics of the upper Adour

The operation

Category	Restoration
Type of operation	Removal of riverbank protection or river embankments
Type of environment	Intermediate river zone
Issues at stake (water, biodiversity, climate)	Good habitat status, control of invasive species
Start of operation	1997
End of operation	2004
Length of river affected by the works	12,100 m

River in the restored sector

Name	Adour river
Distance from the source (at upstream end of works section)	25 km
Mean width	Single channel: 9 to 15 m Braided channel: 15 to 50 m
Mean gradient	Single channel: 17‰ Braided channel: 10‰
Mean discharge	9.57 m ³ /s

Aims of the project owner

- Restore the physical quality of the river.
- Improve its ecological functions.
- Dissipate flood flows.

Environment and pressures

The Adour River in Southwest France spans a basin covering 17 000 km². It flows a total of 309 kilometres before it enters the Atlantic Ocean (Bay of Biscay). The river is a passageway for migratory fish and the river stretch around Bagnères-de-Bigorre is of importance for salmonid reproduction. Over the first 6.2 kilometres, the river bed naturally forms a single channel, then a braided channel over the remaining 5.6 kilometres of the section affected by the works. In this sector are a number of alluvial bars and more or less connected secondary channels. The substrate consists essentially of stones and pebbles. The area is covered by a biotope-protection decree for brown trout and the Pyrenean desman. Very little land along the river is cultivated and the alluvial forest still exists.

The location

Country	France
River basin	Adour - Garonne
Region(s)	Midi-Pyrénées
Department(s)	Hautes-Pyrénées
Commune(s)	Bagnères-de-Bigorre, Pouzac, Ordizan, Montgaillard, Hiis



Regulatory context	Prefectoral decree for biotope protection
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European directive references

Water-body ref.:	FRFR236 and FRFR237B
Natura 2000 site ref.:	Not applicable



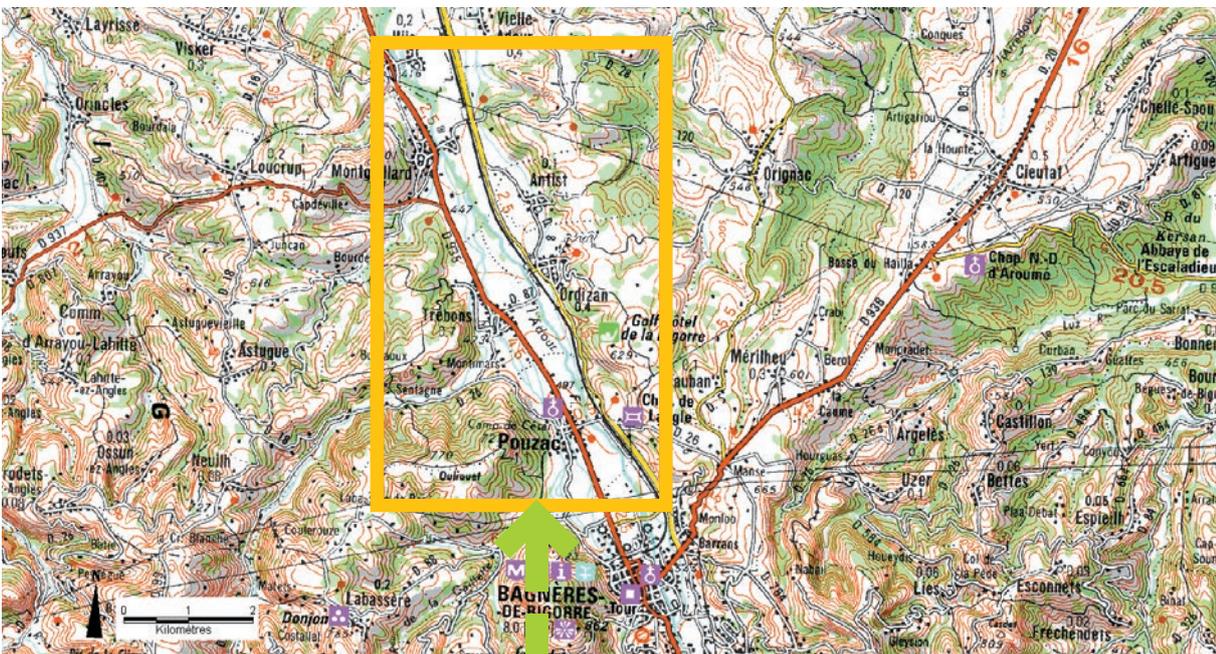
Veronique de Billy – Onema



Veronique de Billy – Onema

An alluvial bar on the upper Adour before (above) and after (opposite) the works.

The upper Adour has not been confronted with a major flood for the past 50 years. The flood representing the highest level recorded in this section of the river took place in June 1879. But in order to protect nearby land and homes from flooding, work was regularly done on the river with the main objective being to narrow the river bed and to create a single channel. In the process, alluvial bars along the entire upstream section were systematically removed and the resulting sediment was spread along the banks



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to form bunds. This contributed to incision of the river bed and disconnection of side channels from the main channel. It also resulted in significantly destabilising the river banks.

■ **Opportunities to act**

Confronted with these problems, the elected officials of the "Haute Bigorre" intermunicipal association decided as early as 1997 to modify the river-management policy and to adopt an ecological approach. The restoration works were conducted in the framework of the river contract for the upper Adour.

■ **Works and developments**

The works consisted of removing the bunds by re-grading the banks and modifying the management techniques for accumulated debris and dead wood. The side channels that had been cut off were restored and a network of secondary channels was created to manage flooding. Bank-protection systems were installed only as needed and exclusively using bio-engineering or mixed techniques. Sectors with sparse vegetation were planted. Finally, efforts were made to counter the development of Japanese knotweed, an invasive species.

■ **Regulatory approach**

The work was authorised in accordance with the Water law.

3.1.2.0: Modification of the riverbed long profile or cross profile, or creating a bypass

■ **Post-restoration management**

A track parallel to the banks, at least ten metres from the river in the riparian vegetation and open only to maintenance personnel and local land owners, was created to facilitate maintenance and provide access to the river in the event urgent action is required during a flood. Vegetation is cut on a very selective basis in order to preserve the habitats of the animals that depend on the aquatic environments. Management of accumulated debris and jams is kept to a minimum. An assessment now determines whether debris and jams constitute an effective obstacle to the flow of water and only the "risky" situations are managed by removing any vegetation and raking the sediment to a depth of 80 cm.

The upper Adour with a treated left bank



Veronique de Billy - Onema

Restoring the river continuity of the Bresle River by returning it to its original bed in Sénarpont

The operation

Category	Restoration
Type of operation	Returning a watercourse to its original bed
Type of environment	Lowland rivers
Issues at stake (water, biodiversity, climate)	River continuity, good status of habitats
Start of operation	November 2013
End of operation	May 2015
Length of river affected by the works	660 m

The River in the restored sector

Name	La Bresle
Distance to source	30 km
Mean width (bankfull width)	7 m before works After the works, several channels of different widths
Mean gradient	2,2 ‰
Mean discharge	1.07 m ³ /s

Aims of the project owner

- Restore the free passage of migratory fish.
- Restore the hydromorphological characteristics.
- Consolidate and revitalise the EU-listed alluvial wetlands.

Environment and pressures

The Bresle is a coastal river, 70 kilometres long, that flows into the English Channel at the town of Tréport. Agriculture is the primary economic activity in the river basin (748 km²). In spite of significant runoff from fields with no permanent cover, the physical-chemical quality of the water is generally good. The river is a category-1 river for fish and is mentioned in Lists 1 and 2 of Article L. 214-17 of the Environmental code.

Numerous migratory species, both diadromous (sea trout, Atlantic salmon, sea and river lampreys, European eels) and holobiotic (brown trout, brook lamprey), may be found in the Bresle. Given their ecological value, the valley and several tributaries constitute a Natura 2000 site.

The location

Country	France
River basin	Seine-Normandie
Region(s)	Hauts-de-France
Department(s)	Somme
Commune(s)	Sénarpont



Regulatory context Lists 1 and 2 L. 214-17

European directive references

Water-body ref.:	FRHRSV07
Natura 2000 site ref.:	FR2200 363
ROE code of the obstacle	38669

Numerous weirs make passage difficult or impossible for fish, thus inhibiting the biological cycle of migratory species and blocking sediment transport as well. Over 230 obstacles have been listed throughout the river basin, many of them the historic relics of former grain mills and installations used to flood meadows, dating back in some cases to the 1100s.

As of the year 2000, the weir of the mill in Sénarpont [ROE 38669], 1.9 metres high with an impounded reach extending approximately 800 metres, represented the historic limit to colonisation of the Bresle by long-distance, migratory salmonids. The mill dates back to the Middle Ages and is made up of a leat, a bypass located in the middle of the leat, an outlet used to flood the underlying meadows and the main system component, a weir equipped with a large gate at the end of the leat.



Stéphane Forgeois, Onema

The Sénarpont weir, a total barrier for fish, in 2012 prior to the works.

When the mill and the leat were created, the Bresle was moved from its bed to a new channel, to become the leat. The structures of the Sénarpont mill blocked access to an 8 km section of river upstream, a reach without any major obstacles and conducive to the growth and reproduction of migratory species. The mill, abandoned since the 1970s, was in poor condition and the lack of upkeep had enabled the development of ecologically valuable environments, e.g. the wet woodlands of alder and ash between the two arms of the bypass channel.

■ Opportunities to act

The Noriap agricultural co-op, the owner of the mill that it had not been used for 40 years, delegated its rights over the project to the Bresle public river-basin territorial agency (EPTB). Given the high ecological importance of the project and following several impact studies, in 2003 EPTB contacted the local land owners in view of returning the river back to its original bed. This first approach failed due in part, during the preliminary study, to communication efforts poorly suited to the local context and to the desire of the residents not to change the landscape. Numerous discussions subsequently took place to inform and to take into account the opinions of each person

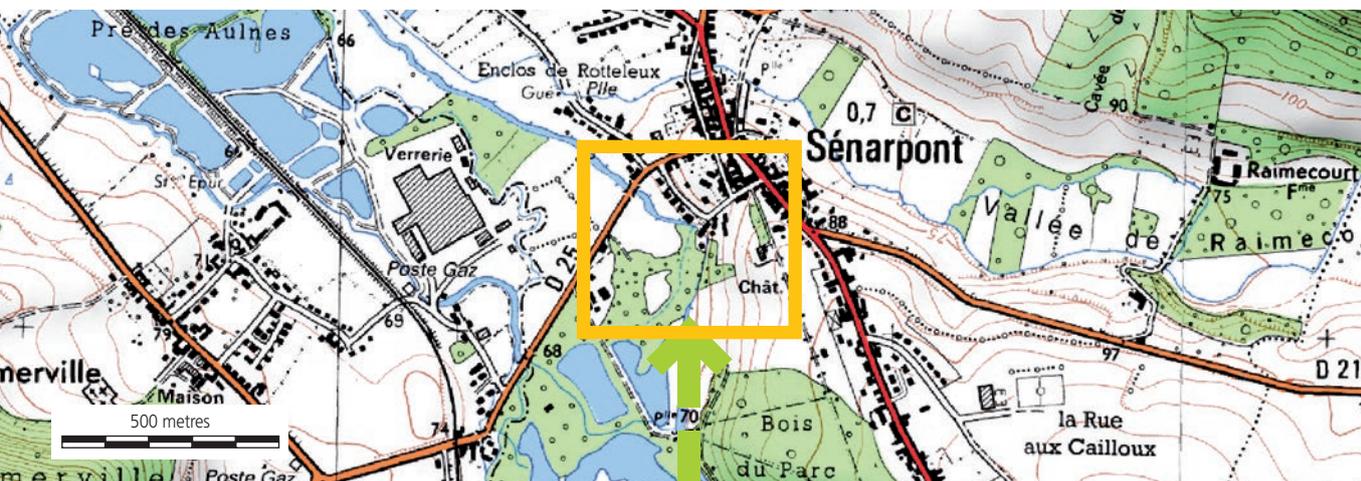
concerning the project. In 2011, one land owner still disagreed because he did not perceive the ecological value of the project and criticised a waste of public money. In 2013, the discussions with the land owners, in a partnership with the Downstream Seine territorial and maritime division of the Seine-Normandie water agency, continued. The project was modified toward more ambitious technical solutions, including two scenarios to restore river continuity, namely the creation of a fish pass or the return of the river to the original bed via the former bypass channels. Success was finally achieved in the discussions with a consensus on the project. The idea of a fish pass was abandoned because it offered insufficient ecological results given the issues at hand and the high cost. For an equivalent cost, the return of the river to its original bed would contribute more to improving habitats and avoid the maintenance costs of a fish pass.

■ Works and developments

The works, done at the end of 2013, consisted of creating multiple channels along the original bed, using some of the former bypass channels of the abandoned mill.

Some of the earthwork was done in the standard manner with machines designed for wetlands. The rest was done by the river itself which carved out its bed in the former bypass channels. This hydraulic earthwork was facilitated by the presence of gates to adjust discharges and to create a bankfull, morphogenetic discharge. Left to its own devices for over a month, but watched over by the earthworks company, the river redrew a perfectly natural bed. This method, thanks to the natural erosion, redistributed the coarse sediment of the banks and thus avoided the high cost of trucking in material. This method also avoided any compaction or damage to the alder and ash stand, which maintained its functions.

For the works, it was decided to adapt the project to the actual terrain rather than follow the theoretical course calculated during the preliminary phase.



The result was a more natural river bed. The leat, was filled in with a soil and gravel mix brought in from outside the area to stabilise the terrain, in compliance with the commitment made by the project manager to the land owners.

Additional works, such as putting up fences and creating drinking points for livestock, was done in 2015 to maintain the farming activities while protecting water quality.

■ **Regulatory approach**

The works were authorised in accordance with the Water law.

■ **Post-restoration management**

A pasture for horses was created on the left bank.

■ **Monitoring**

Biological monitoring of this project is based on fish populations. The pre-works situation was assessed in 2013 on the basis of an electrofishing campaign in the leat. The assessment was carried out with redd countst on the project site in 2013 and 2014, and in 2015 with a count in the upstream 8 kilometres of river made accessible for fish by the works (the count was carried out in a partnership with the Onema salmonid centre). Post-works monitoring was done from 2013 to 2015. Two inventories were carried out in 2015 by the Seinormigr association, using the IAT (trout abundance index) protocol. The initial and post-works assessments did not implement identical methods, i.e. the first was a fish rescue in the former leat and the second implemented the IAT protocol. The results are nonetheless useful on the basis of individual density calculations.

■ **Outcome of the project and outlook**

The bypass of the Sénarpont hydraulic structure made possible to restore the continuity of the Bresle River a further eight kilometres upstream. The works also improved the functioning of the alder and ash wet woodland by enhancing the supply of water. The operation also restored 650 metres of river by reducing the impounded reach to 400 metres and reinjecting water into a number of side channels (250 metres). The connection between the riverbed and the side channels in the project sector created new expansion zones (in non-critical areas) for flooding. These lateral connections improve water quality through enhanced self-cleansing and the creation of greater habitat diversity, a positive factor for biodiversity.

The former impounded reach was replaced by a series of diversified flows in multiple channels in the valley bottom. Fine sediment was removed to reveal the coarse substrate that is now renewed naturally thanks to the restoration of the morphodynamic process.



The new channel in the talweg in 2014.



The diverse, intermediate zone in 2014, following the works.

Monitoring of fish revealed that prior to the works in 2013, trout density was 0.5 fish per 100 m². In July 2015, after the works, the measured density was 5.6 trout per 100 m². The trout population gained in numbers by a factor of 11 with a significant increase in the percentage of the juvenile population (30% of the total in 2013, 85% in 2015). The site has thus become highly favourable for spawners and the growth of juveniles.

At the end of 2013, just after the diversion of the river to its original bed, several sea trout were observed spawning in the restored channel. Five redds for migratory salmonids were observed on the site. One year later, a dozen redds were noted. During the inventory, bullheads and eels were also caught.

The strong point of this project is the restoration of the overall functioning of the river and of its side channels for a relatively small amount of money. The Bresle EPTB succeeded in defending its restoration objective and in negotiating over a long period to convince all the land owners and the town council.

Today, the results are positive. Local residents have easier access to the nature and take pleasure in observing a dynamic river with a diversified ecology.

This project was all the more beneficial that a number of mill owners who were previously hesitant to work on their installations are now ready to launch operations to restore river continuity.

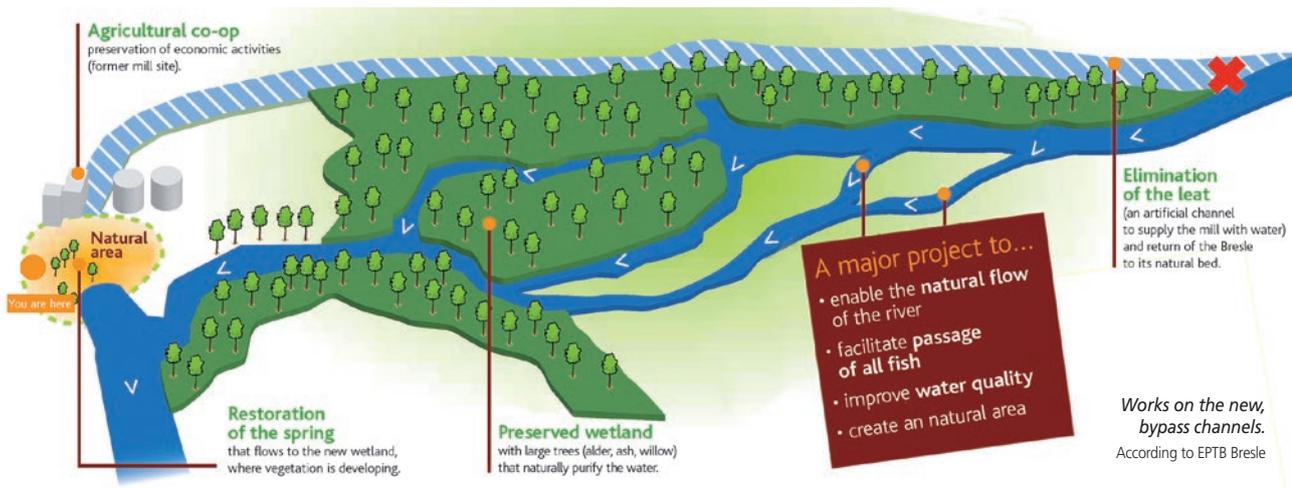
Costs

In euros ex. VAT

Preliminary study	38,880 €
Purchase of land	Not applicable
Works and developments	108,390 €
Monitoring	Costs assumed by various organisations
Promotion (printing of a brochure)	2,980 €
Total cost of project	150,250 €

Financial partners and funding: *Preliminary study: AESN 80%, NORIAP 20%. Works: AESN 100%.*

Technical partners: *AESN, Onema, Somme departmental territorial and maritime agency.*



Promotion of the project



A large number of field trips have been organised by the Bresle Institution to present the project and its results to the owners of hydraulic installations, elected officials and other organisations. This particular approach has served as a showcase, notably to convince the owners of hydraulic installations to undertake work on their weirs. An informative sign is set up on-site to explain the project to visitors.



In 2015, the Bresle Institution received the "Environmental preservation" prize awarded by the Picardie

regional council for an outstanding regional initiative for the environment. Numerous press articles on the project have been published and France 3 television also produced a sequence on this remarkable project.

Viewpoint

"It is interesting to note that the Bresle has returned to its natural bed. Today, visitors find a calm and relaxing environment. Walkers take pleasure in a charming site, offering a rich array of sights and sounds with the return of the natural sound of flowing water. The most striking change concerns the spot where the old waterfall existed. Work was recently done there to limit the strong vegetation growth."

Patrick Bèle, mayor of Sénarpont.



- *Rétablissement de la continuité écologique et revitalisation de milieux humides d'intérêt communautaire à Sénarpont – Grand prix du génie écologique.* 4 pages.
- *Évaluation des effets des travaux de renaturation de la Bresle à Sénarpont sur la faune piscicole.* Institution de la Bresle. 2015, 2 pages.
- France 3 Normandie. Televised report (16 March 2014) on the restoration of continuity in the Bresle River. <http://france3-regions.francetvinfo.fr/haute-normandie/2014/03/16/senarpont-76-le-vieux-barrage-detruit-la-voie-est-libre-pour-les-poissons-433825.html>

Project owner

Bresle interdepartmental institution



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