



INITIATIVES POUR L'AVENIR  
DES GRANDS FLEUVES  
INITIATIVES FOR THE FUTURE  
OF GREAT RIVERS

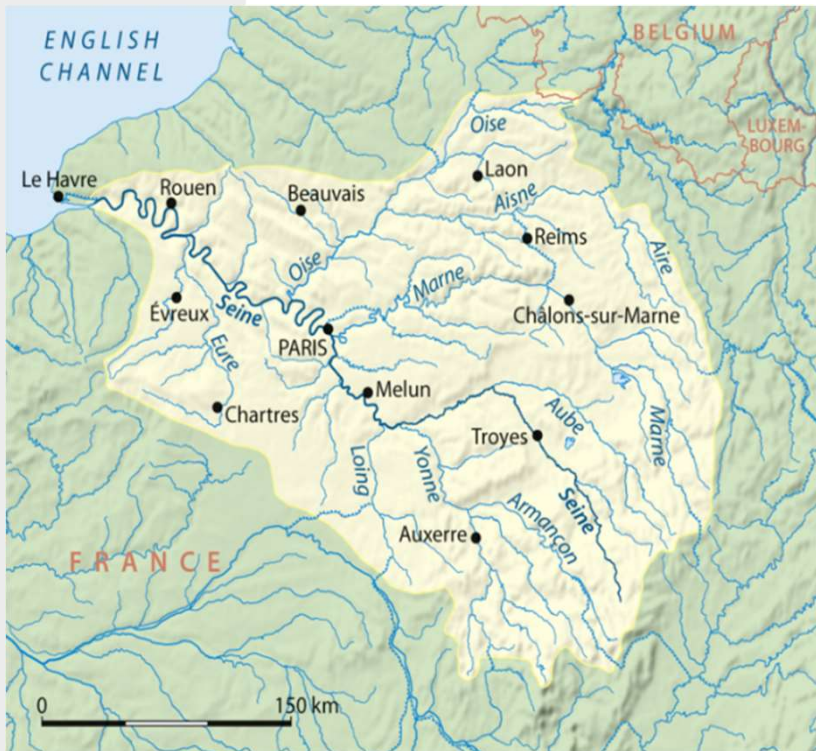
# Synopsis sheets

Rivers of the World

# THE SEINE

# The Seine

The Seine is a French river 777 km long whose source lies in Côte-d'Or, at an altitude of 452 m. It crosses 400 municipalities in 13 departments, including the city of Paris which it divides into two parts. A source of life in a basin in which 17 million people live, and a trade route, the Seine is a powerful and sometimes uncontrollable river. It flows through Normandy and then into the English Channel at Le Havre, a city sprung from the creation of its port in 1517. In a context of ever busier trade, adaptation to climate change and the need to satisfy the pressing demands of Paris, water management and protecting the balance of the river are major challenges for the basin's actors, especially with the constant requirement to improve the quality of the river's water and wetlands.



## Technical data

Length : 777 km

Watershed: 76,238 km<sup>2</sup> (14% of French metropolitan territory with a density of 225 inhabitants/km<sup>2</sup>),

Hydrological regime: pluvial oceanic, characterised by high water in winter and low water in summer.

Average rainfall: 800 mm of water a year over the entire basin.

Average discharge: 310 m<sup>3</sup>/s in Paris and 563 m<sup>3</sup>/s at Le Havre, with large seasonal variations (from 100 in summer to 600 m<sup>3</sup>/s in winter); on average 50% of the surface discharge of the Seine at the entry of the estuary (at Poses) stems from the basin's aquifers.

Regions crossed: Bourgogne-Franche-Comté, Grand Est, Ile-de-France, Normandy

Main tributaries: on the right bank: the Aube, Marne, Oise / on the left bank: the Yonne, Loire, Eure. In all, 47 tributaries flow into the Seine.

## History

### **Adapting to the Seine: the first trading channels**

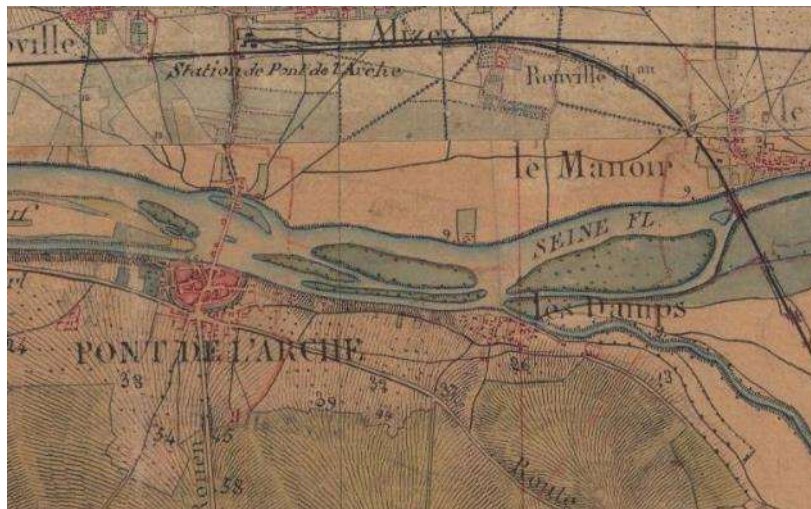
Various cartographic and geomorphological data from the 19<sup>th</sup> century show **the Seine as being an impetuous river with a shallower bed than today**. The river was composed of branches separated by several islands. The main branch lay in the middle of the valley and can still be clearly distinguished today.

**Archaeological studies have shown that channels already existed between the pre- and protohistoric periods.** Most of the islands were used for agriculture, grazing, and the plantation of willows to stabilise the banks. These discoveries also revealed human presence as early as the middle Palaeolithic (-18,000 years ago), at the confluence of the Seine and Marne. In the Mesolithic period, 6,000 years ago, evidence has been found of wooden pontoons and stone landing stages to facilitate access to the river.

In the Middle Ages, aristocratic manors were built near the river at Bercy, Conflans and Choisy. Dwellings were built at a distance from the Seine, vineyards appeared and submerged agricultural land was drained. Two communication routes linked Paris – on the right bank – and Sens – a town located in the department of Yonne in Burgundy Franche-Comté, on the left bank. **During the Middle Ages, Paris became a trading city and the centre of royal administration. Supplying the city was crucial.**

# The Seine

Navigation became important and developed strongly in the 18<sup>th</sup> century despite the lack of resources: the boats were propelled by poles or towed by animals. **The first port was that of Meules de Charenton, where grindstones were unloaded for milling.** There were 5 fords that facilitated crossing from one bank of the Seine to the other, between Villeneuve-Saint-Georges and Vitry-sur-Seine, and 3 ferries at Choisy-le-Roi, Ablon-sur-Seine and Charenton-le-Pont.



Map drawn by the military staff committee in 1850. It shows the Seine with its many branches and islands.

Nonetheless, river navigation remained arduous and sometimes dangerous due to the fragility of the banks. Riggers, hauliers and sailors guided and aided boats to sail up and downstream in return for payment. Between 576 and 1982, the Seine overflowed its banks sixty times and flooded a large number of towns. **Projects to develop the river basin began to emerge following the French Revolution** and it wasn't until the beginning of the 19<sup>th</sup> century that river infrastructures were built.



The Seine has flooded many times. The most severe were those of 1658 and 1910, the latter being qualified as a hundred year flood. It was not lethal but caused a great amount of damage in the surrounding towns.



# The Seine

## ***The development of river navigation on the Seine in the 19<sup>th</sup> century***

With the development of railways and the expansion of Paris in 1860 – to the northeast of Ivry and areas of Bercy – the rural landscape gradually gave way to the capital of industries, warehouses for storing goods, and wharves built all along the banks. One of the aims of these many developments was also to make the river navigable: the bed of the Seine was deepened, the fords were replaced by the first dams-locks built between Paris and Rouen between 1840 and 1866, and the ferries were progressively replaced by bridges.

However, these new structures were not enough to bring the river under control. **After 1866, new works were carried out to build a network of dams. The construction of the dam-lock of Poses-Amfreville, the last dam before the estuary of the Seine, was the largest of these works**, supervised by the engineer in chief Edouard Caméré between 1879 and 1885. These works opened the way for the transport of relatively large volumes of goods. Nonetheless, faced with the growth of trade, new development projects were engaged during the 1930s. The first was the **channelling of the Seine**. The aim was to “tame” the river by deepening its bed upstream of the Martot dam, by erecting dikes and consolidating its banks at several points, and finally by excavating a channel in the main branch of the river. The second was **the extension of the Eure – a tributary of the Seine**. To maintain a sufficiently high level of water close to the surrounding dwellings, a spillway was built before the Pont-de-l'Arche in 1935 and a canal was excavated to facilitate the passage between the Eure and the Seine for small boats.



*Photograph dating from 1935 showing the works carried out to widen the arches of Pont-de-l'Arche to improve navigation on the Seine*



*The spillway before Pont-de-l'Arche built in 1935.*

Source: Armand Launay. (2019). *The Seine, from a wild river to a commercial channel: overall view of the Pont-de-l'Arche area from the Revolution to today*. Available on: <http://pontdelarche.over-blog.com/article-grands-travaux-de-la-seine-dans-la-region-de-pont-de-l-arche-annees-1930-78659526.html>

All these works permitted navigation while bringing the Seine under control. **However, road transport tended to supplant river navigation after 1970**. Over the last few years it has returned in a context where efforts are made to transport large volumes of goods more safely, economically and ecologically.

# The Seine

## Its uses

The Seine is shared by numerous activities: goods transport, tourism, drinking water supply, industrial ports and marinas.

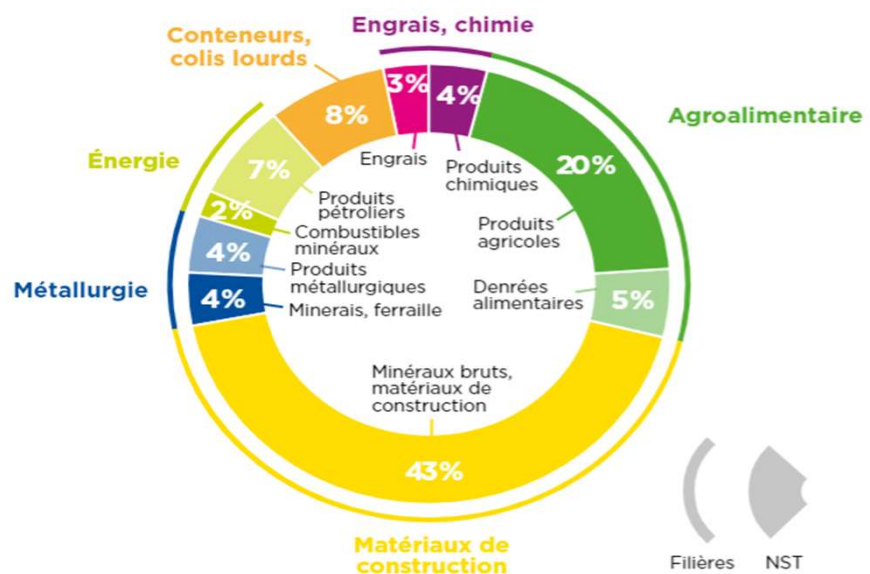
### Goods transport

**Nearly 50% of river freight in France, i.e. 6,700 million tonnes-km (t.km), is transported in the Seine basin.** In 2019, 23,7 million tonnes of goods were transported on the Seine, that is to say a 10.4% increase in traffic in comparison to 2018 – resulting in the reduction of about one million trucks on the roads in the Ile-de-France region. This increase can be explained by the recovery of the construction sector, with notably the Grand Paris project, and emerging sectors such as wood, heavy loads, wastes and products produced in the circular economy. In the longer term, the European North Seine Canal will represent further potential for river transport.

**The agri-food sector also takes up a large share of river transport.** Growth in 2019 reached 15.5% in t.km in comparison to the previous year, i.e. 2.3 billion t.km, thanks to the recovery of cereal transport and to an increase in the production of soft wheat. The Seine's tributaries are also used, for example, the Seine-Oise basin for cereals and oleaginous products.

Besides agri-foods and construction materials, **river transport serves many other sectors that have shown satisfactory growth since 2018.**

RÉPARTITION DES TRAFICS FLUVIAUX  
PAR TYPE DE MARCHANDISE (EN TONNES)



Source: Voies navigables de France, VNF. (2018). The figures for river transport for 2018. Available on : <https://www.vnf.fr/vnf/brochure-et-lettres/les-chiffres-du-transport-fluvial-en-2018/>

# The Seine

## \*The Seine-North Europe Canal



The purpose of this European project is to link the Seine basin to the river Escaut. It crosses three countries, namely France, Belgium and the Netherlands, before ending its journey in the North Sea. The aims or the project are multiple. Firstly, this canal will provide an alternative to transporting goods by road on the north-south corridor. Indeed, in an

era in which energy efficiency and the environment are becoming increasingly important, river transport is now seen as more modern and more ecological than the other modes of transport, and economically competitive. This project will expand and complete the wide gauge network at the European scale. Thus, it will facilitate trade between Northern Europe with the ports of Rouen, Le Havre and Dunkirk. Lastly, the Seine-North Europe Canal will be a genuine lever for economic development in France, notably for the agricultural, agroindustry, circular economy and construction sectors.

## *Tourism activities*

River tourism is a dynamic sector of great importance to the economy of Ile-de-France. **In 2018, 10 million passengers took advantage of the different tourism offers in the Seine basin.** For example, excursion cruises. There are 128 excursion cruise boats on the river, 125 of which are in Ile-de-France and 3 in Normandy. These boats are operated by nearly 50 companies in the Parisian reach of the Seine. The Seine is Paris's 4<sup>th</sup> most popular tourist site, generating a turnover of around €130 million in 2018.



River cruise ships,  
Photo credit : VNF

# The Seine

## Its uses

### *Exploration of hydroelectricity potential*

River transport remains the main activity on the Seine but its hydroelectricity potential has barely been harnessed. Projects for small hydropower plants were launched in 2016 by VNF with the industrial company Quadran to exploit the heads of dams and locks on the Seine, Marne and Oise.

In 2018, VNF signed a cooperation agreement with VALOREM to develop and operate 10 hydropower plants from now to 2022, of which half are in the Seine basin with an annual output of 58,000 MWh, corresponding to the consumption of 22,000 households.



### *Drinking water supply*

The Ile-de-France region is supplied with drinking water:

- of which 60% is extracted from groundwater outside the city of Paris.
- the remaining water is extracted from surface water in the main rivers: the Oise, the Seine and the Marne.

A total of **1,515 million m<sup>3</sup> of drinking water** is produced every year by 5,200 pumping stations in the basin. Furthermore, the 156 km long Aqueduc de la Vanne, in the Burgundy region, contributes to supplying Paris with drinking water.



# The Seine

## The actors of the river and its governance

### Voies Navigables de France



A public administrative entity founded in 1991, it is responsible for the protection and maintenance of the majority of the French navigable waterway network. **VNF fulfils three main missions: the development of river logistics, tourism, territorial development, and the global management of water resources.** Responsible for the river's navigability, VNF modernises its navigation infrastructures and manages hydraulic aspects (cooling nuclear power plants, discharge, fish life, supplying drinking water to the population, irrigating agricultural land, hydropower production, etc.).

VNF has 7 territorial managements ensuring decentralised actions in the regions in which they are active. **In the regional management of the Seine Basin**, which covers 5 regions, **VNF manages a network of 1,400 km of navigable waterways**, i.e. 800 km of rivers (the Seine, the Marne, the Oise and the Loire) and 600 km of canals (the canal of the North, Picardy and Champagne-Ardenne) and 450 km of wide gauge waterway.

### HAROPA



HAROPA is a network that groups the maritime ports of Le Havre (France's largest maritime port for container traffic), Rouen (Western Europe's leading port for cereal exports), and the autonomous port of Paris (France's largest river port). It was **founded in 2012 in view to creating a European-scale port system active in the sectors of logistics, industry and tourism.**

In 2019, HAROPA recorded nearly 90 Mt of maritime traffic and 25 million tonnes of river traffic, i.e. the 5<sup>th</sup> largest port system in Northern Europe, meeting the needs of 25 million consumers. **The activities carried out around the banks of the Seine make up a third of France's GDP.**

### The City of Paris Interdepartmental Drainage Syndicate (SIAAP)



**A public entity responsible for wastewater, rainwater and industrial water treatment, in the Ile-de-France**, the SIAAP was set up in 1970 by the departments of the outer belt to pool, distribute and treat their wastewater. It gradually extended its activities to the entire region surrounding Paris and is administered by the elected representatives of the departments composing it. It is equipped with:

- A 440 km long underground network of conduits also called outfall sewers that are used to convey and then treat about 2.5 million m<sup>3</sup> of wastewater a day for a territory of 1,800 km<sup>2</sup>, thereby serving 9 million users.



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- 6 wastewater treatment plants in the Ile-de-France region.
- 2 pre-treatment plants linked to Seine centre: the plant of Clichy-la-Garenne which is the pre-treatment centre for the sewers of Paris; and the plant of Briche in Epinay-sur-Seine which receives most of the wastewater of the department of Seine-Saint-Denis and the north of Paris.
- 4 tunnel-reservoirs and 8 storage basins to manage the accidental pollution of the Seine and the Marne, as well as flood risks.

**The challenges represented by wastewater treatment in Ile-de-France are many: Paris is the densest city in Europe and the resulting urbanisation leads to severe pressure for the environment and agriculture**, making the natural absorption of rainwater through the soil difficult. The work of SIAAP is crucial for the conservation of the Seine, due to the many types of pollution discharged into it every day. The industrial activities installed in the Paris region increase the urgency of treating wastewater, so SIAAP has set up specific actions to protect the river: **26 floating dams have been installed to trap drifting solid wastes, and clean-up teams empty them once a week.** Human activities are not the only threat to the river's equilibrium: heatwaves and storms, which can be very intense during summer, deplete the oxygen levels in the water, thereby creating a risk for fish. **SIAAP has developed "survival islands" equipped with oxygen reservoirs that are triggered when the oxygen levels in the water fall too low.** SIAAP's action, coordinated with those of other public actors and in line with the recommendations of the Water Management and Development Master Plan (SDAGE), has borne fruit: since 1970, the number of fish species identified in the Seine has risen from 3 to 32. Furthermore, since 1990, SIAAP has monitored the fish populations of the Seine and the Marne in the Paris region.

SIAAP also plays a **role in controlling the quality of the Seine's water**, and in this capacity has created the **MeSeine**, a program aimed at analysing surface waters, the rate of micro-contamination, and other elements linked to the quality of the river. The quality the Seine is currently assessed as "fragile" although it is improving year by year.

## The EPTB Seine Grands Lacs

The purpose of this syndicate is to manage the upstream basin of the Seine, by coordinating the public actions of the territorial authorities. **This mainly entails managing flood risks for the Seine and ensuring low flows to maintain the discharges of the river and its tributaries (Yonne, Aube and Marne).** The aim is to make the spaces less vulnerable to extreme fluvial phenomena. Seine Grands Lacs is also responsible for **preserving, restoring and managing wetlands and the biodiversity of aquatic ecosystems.** It supports the territorial authorities and is called on in particular for institutional advice and information on new regulations: changes in policies relating to water, the statuses and competences of different local actors.



# The Seine

**Seine Grands Lacs maintains, develops and operates 4 reservoir lakes** – Pannecière-Chaumard, Seine-Lac d'Orient, Marne-Lac du Der-Chantecoq, Aube-Lacs Amance and Temple – to sustain low water levels during dry periods and mitigate floods during winter. They can store up to **830 million m<sup>3</sup> of water**. This permits regulating the annual discharge, protecting the economy and the local population.

Recent years have shown the importance of such structures, with the flood of 2016 and that at the beginning of 2018, which paralysed activity and transport in the Paris region. In January 2018 the Marne reservoir-lake allowed absorbing large quantities of water, lowering the level of the river by from 60 to 75 cm during the peak flood. The lake was not saturated and proved its usefulness for managing this type of phenomenon.

## *Eau de Paris*

**A public water company responsible for distributing drinking water to 3 million users.** It is responsible for the management of 3 aqueducts, 5 reservoirs and 1,200 fountains giving access to drinking water in the streets of Paris. What is more, it treats the groundwater in 4 plants built in 2004 and 2009, and 2 older plants that treat the water of the rivers in the Paris region.

## **Agence de l'eau Seine-Normandie**

The Agence de l'eau Seine-Normandie is a public establishment founded in 1992 under the aegis of the Ministry of Ecological and Social Transition and the Ministry of Finances. It has two main missions. **The first is to fund all the actions and structures intended to reserve water resources and combat pollution. The second is to give technical support to different users to carry out certain activities.** For example, the treatment and distribution of drinking water, the elimination of industrial wastes, and good farming practices.

It draws up the Water Management and Development Master Plan (SDAGE) and action programs, and sets out the procedures for obtaining aid. It receives fees from water users (consumers and extractors) which are then redistributed in the form of subsidies or advances in the framework of carrying out actions in favour of preserving water resources and wetlands.

## *PIREN-Seine*

The PIREN (Interdisciplinary Environmental Research Programs) were launched by the National Centre for Scientific Research (CNRS) in the middle of the 1980s. They were initiated by the ambition to encourage dialogue between river managers and scientists to build a common vision of the qualitative and quantitative management of water resources.

There are many institutional and industrial actors in the Seine basin, making the river's management complex. The PIREN-Seine was founded in 1989, at the instigation of Ghislain de Marsily, now emeritus professor at the University Pierre and Marie Curie and the Ecole des Mines de Paris, and a member of the Academy of Sciences.



# The Seine

## The Seine of tomorrow

### Preserving the river's health

The water of the Seine basin has suffered from a fall in quality due to the impact of urbanisation, industrialisation and the transformation of agricultural practices during the 20<sup>th</sup> century. **Only 28% of the groundwater is considered to be of good quality.** Although the quality of the water and wetlands has improved over the last few decades, pollution from human activities persists.

**One of the main causes of this deterioration is the result of changes in agricultural practices starting in the 1950s** in the basin towards intensive cereal crops highly dependent on chemical fertilisers. Cereal crops and colza now occupy more than 60% of the basin's surface area (5.7 million hectares). Groundwater pollution is therefore not recent and, in addition, leads to risks with different effects: nitrates – fertilisers – and pesticides of agricultural origin, some of which are no longer used, are still present in the groundwater. This is due to the time taken for infiltration at depth, meaning that actions taken as of now to improve water quality are not immediately visible. **Of 53 aquifers, 39 present high pesticide concentrations.** In addition, the pollution of the aquifers and rivers is mostly due to the discharge of partially treated wastewater that still contains solvents found in drugs used in human beings and animals, and to industry which also uses heavy metals like lead and mercury. Improving the operation of the drainage system, prohibitions relating to the use of pollutants such as PCBs and phosphate residues, and new manure spreading techniques have made major contributions to improving the quality of water and wetlands,

**Monitoring coastal and aquatic habitats remains essential and is carried out by a network of nearly 1,000 monitoring stations.**

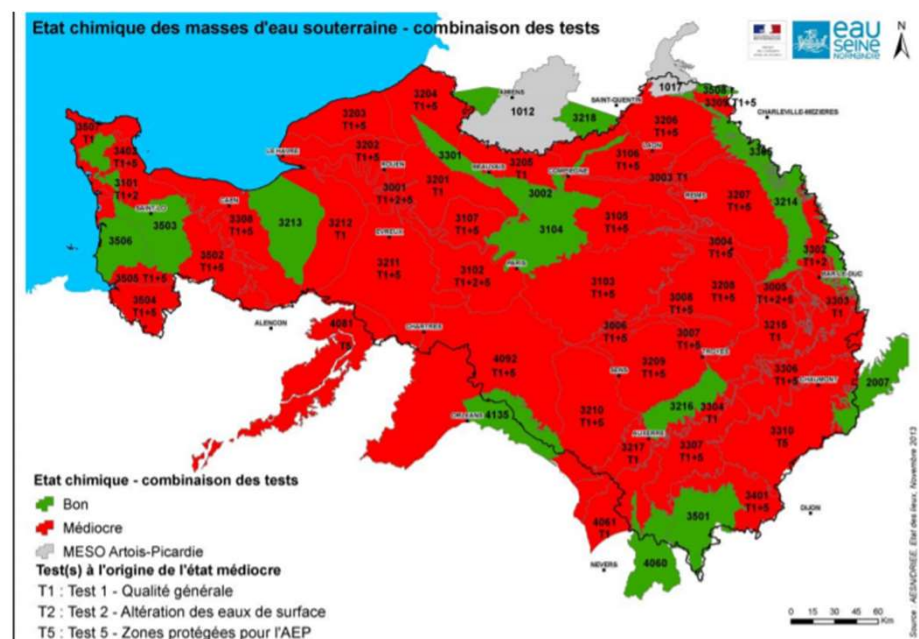


Figure 6. État chimique des eaux souterraines du bassin Seine-Normandie

# The Seine

## **Impermeable surfaces in towns and cities also leads to the problem of rainwater runoff.**

By infiltrating through soil, rainwater bestows the latter with its natural function as a sponge. The challenge of yesterday was the collection of rainwater to prevent floods. Now, the risk is to health with increased volumes of rainwater in sewage systems, leading to possible saturation and dysfunction.

Lastly, **the problems mentioned above have a direct impact on biodiversity, especially on interactions between living habitats:** poor microbial life, falls in insect and bird populations.

## ***Restoring natural habitats***

### **The law of 9 August 2016 concerning the reconquest of biodiversity, nature and landscapes, has repositioned the challenges linked to preserving water resources and the protection of natural habitats at the centre of priorities.**

A large number of structures – dikes, dams, sluices, artificial banks, the elimination of meanders – have led to the modifications of flows and the natural orientation of the waters of the Seine-Normandy basin. The hydromorphological deterioration of rivers has had impacts on wetlands through the displacement of sediments and species, and the degradation of biological habitats important during spawning periods, and as places where fauna can rest and feed. Preserving and restoring rivers benefits biodiversity through better oxygenation of water and the presence of vegetation that is capable of storing carbon and acting as a source of food for many aquatic species. What is more, it cools the temperature.



**The drainage of agricultural land leads to another problem, that of the disappearance of wetlands, including streams and brooks,** which are essential links in the water cycle. They serve to filter water, mitigate small floods, and feed small watercourses before flowing into larger and deeper rivers, and finally the sea.

In sum, they are “sponges”, reservoirs that encompass a biodiversity that enriches ecosystems in rhythm with the flow. This disappearance of wetlands is aggravated by climate change which decreases the discharge of rivers.

**Restoring natural habitats also means giving greater importance to meadows. Livestock breeding on meadowland has declined continuously:** during a period of thirty years, 37% of meadowland in the Seine basin has disappeared, mainly due to urbanisation. However, meadows participate in preserving biodiversity and natural landscapes.



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To cope with these persistent problems, solutions have been implemented such as **the demolition of 500 dams in the Seine-Normandy basin between 2013 and 2018, in order to facilitate the passage of fish and sediments.** In addition, the restoration of nearly 4,500 km of rivers and streams has led to their recolonisation by species known to favour good quality water, like trout, salmon and the European bullhead.



*In the Seine-Normandy basin and in the western part of Côte-d'Or, structures have been installed to allow the unhindered passage of fish and sediments. / Source: Hydrauxois*

## **Reconciling development, the protection of coastal habitats and economic activities**

Coastal tourism and port and maritime activities can be sources of economic development at the regional scale. They generate around 46,500 jobs in the Normandy region. **The eco-existence of coastal wetlands and economic activities that produce wastewater, solid wastes and fuels illustrates the need for taking a consensual and global approach to environmental, economic and social problems.** Indeed, the eutrophication\* of the coast and aquatic habitats leads to the development of toxic bacteria, algae and phytoplankton, rendering certain activities such as fishing, bathing and shellfish farming unfeasible. These problems are further compounded by the inadequacy of protection against rising sea levels and coastal erosion. It is estimated that the sea level may rise by 80 cm in 2100; the damage caused by submersion by seawater, the infiltration of salt in groundwater and the rise of aquifers could cost €12 billion for the departments of Calvados and Manche alone. It is therefore more than necessary to devise other policies for developing the coast.

*\*Eutrophication is the term given to the accumulation of nutritive substances such as nitrates and phosphates originating from wastewater, automobile pollution and agricultural products. It is worsened by rising water temperatures due to climate change,*

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However, some progress has been made. Besides the decrease of certain pollutants due to improvements made to national and European regulations, microbiological pollution is monitored constantly for shellfish farming and bathing. **Today, more than 80% of coastal waters are considered as being good and even excellent for bathing.** Moreover, the Seine Estuary-Coastal Conservatory works to maintain and restore the 14% of the coastal land it owns.

## ***Anticipating the effects of climate change***

The effects of climate change are becoming more intense with longer durations of extreme drought and rainfall episodes, with the risk of floods. **Between 1988 and 2013, these climatic disasters cost insurance companies in France roughly €48 billion.** According to the French Federation of Insurance Companies, this cost could double by 2040. First, the construction of buildings in floodable areas and developments that hinder the circulation of rivers are all factors that expose the surrounding populations to risk. Second, droughts are aggravated by poor land management, dams, disturbed sediment transport, the drying of the watershed downstream and annual falls in discharge.

Different measures have been taken to reduce extractions of water from rivers and groundwater; for example, the improvement of performance of household appliances and the distribution network. The objective is also to ensure better discharge regulation thanks to the reservoir lakes. In 2017 and 2018, the Public Seine Grands Lacs Establishment stored about 500 million m<sup>3</sup> of water, thereby maintaining the level of the Seine during summer and reducing flood risks during winter and spring. On 23 December 2015 the **Flood Risk Management Plan (PRGI) came into force in the Seine-Normandy basin, in view to reducing the effects of floods on human health, the environment, the economy and cultural heritage.**



*On 8 December 2016, the Seine-Normandie Basin Committee adopted the strategy of adapting to climate change.*