‘Improving water quality is still the major concern of the Seine-Normandy basin, despite real progress made over the last thirty-five years. Storm runoff during periods of heavy rainfall continues to create problems, causing wastewater to be discharged directly into rivers or overloading wastewater treatment plants, thereby decreasing their efficiency. Non-point source pollution from farming and urban areas is still a major problem as nitrate, pesticide and heavy metal concentrations continue to increase.’

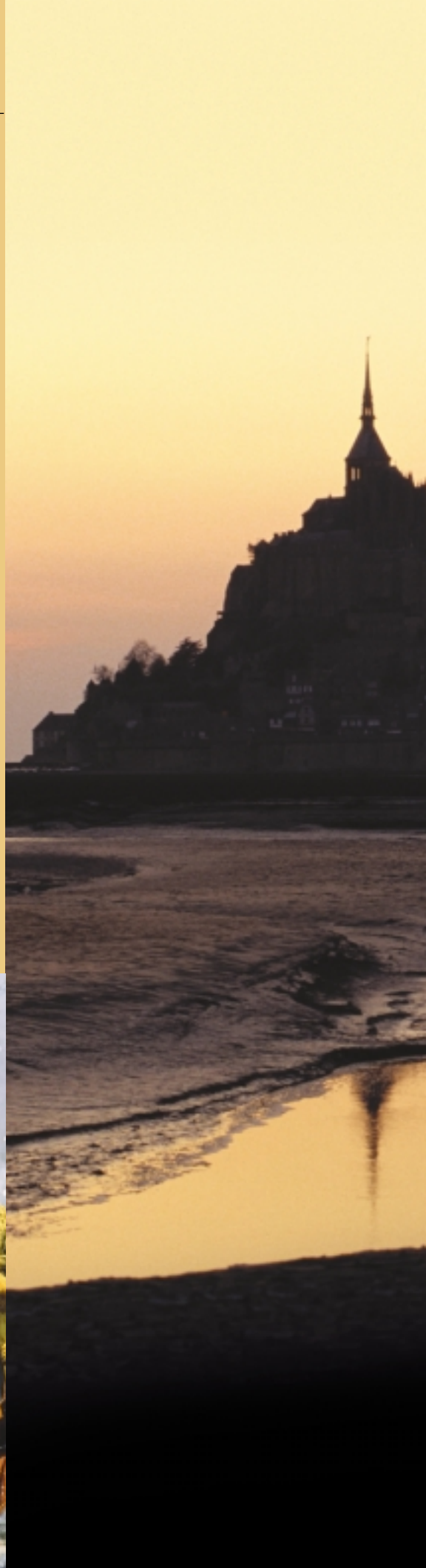
19

Seine-Normandy Basin, France

By: The Seine-Normandy Water Agency (AESN, Agence de l'eau Seine-Normandie)

Table of contents

Seine-Normandy Basin, France



Under the Pont Mirabeau the Seine
Flows with our loves
Must I recall again?
Joy always used to follow after pain.

Guillaume Apollinaire

IT WAS ONLY FORTY YEARS AGO that the Seine River was declared 'dead'. Levels of pollution from industry and agriculture were dangerously high. Native fish had disappeared, plant life was dying, and the water was unsafe for swimming. Today, however, the river and its surroundings have been rehabilitated. The city of Paris even organizes fishing contests on summer afternoons. This dramatic change began with the recognition in 1964 of six river basins as the natural hydrographic units in France and the creation of six water agencies to manage them accordingly. Problems remain, especially nitrate pollution from fertilizers and the continuing disappearance of wetlands, but the case study presented here shows that the application of modern technology, a sound tax base and political will on several levels can go a long way towards reversing some of the neglect of the past.

THE SEINE-NORMANDY BASIN district in the north-west of France covers an area of about 97,000 square kilometres (km²), nearly 18 percent of the country's total surface area. It is made up of the drainage basins of the Seine River and its tributaries, the Oise, Marne and Yonne, and those of Normandy's coastal rivers.

General Context

The land is relatively flat with altitudes generally under 500 metres. The climate is oceanic and temperate with an average annual rainfall of 750 millimetres (mm) and an average annual potential evapotranspiration of 500 mm. Annual rainfall varies between 300 and 1,600 mm, depending on the area. In Paris, it varies from 400 to more than 800 mm from year to year. The average monthly temperature in Paris is between 2.5°C (in January) and 24.6°C (in August). Periods of freezing temperatures are short along the coast in the west, but lengthen as we move towards the eastern edge of the basin.

Map 19.1: Locator map

Source: Prepared for the World Water Assessment Programme (WWAP) by AFDEC, 2002.

Geology

The Seine-Normandy basin includes a large portion of the sedimentary Paris basin. The geological structure of the Paris basin resembles a stack of 'saucers' with the most recent layers (Tertiary) outcropping in the centre and the oldest layers (Mesozoic) outcropping on the outer edges of the basin. These layers overlie the Hercynian bedrock (Palaeozoic) that outcrops in the western part of the basin. This type of geological structure contains numerous aquifers of extremely varying size and structure (alluvial, sedimentary and fractured aquifers). In the Paris basin, about ten of these aquifer formations are very important in terms of usage.

Leached brown soil covers the western part of the basin. There is a thinner layer of acid brown soil, eutrophic brown soil and calcareous soil on the eastern edge of the Paris basin and in Lower Normandy. The rendzina soil found in many places at the base of hills is used for vine growing in the Champagne region.

Population density

The Seine-Normandy basin has an estimated population of 17.5 million people, 80 percent of whom live in urban areas, most of which are located along the basin's rivers and in the Paris region (located approximately in the centre of the basin). Population density in the basin varies greatly. The Paris suburbs are now spreading into Upper Normandy. The Ile-de-France region around Paris is the most popular tourist destination in France and has, for example, 35 million foreign-tourist-nights per year. The populations of some of the departments along the Normandy coast are also subject to very high seasonal variations.

Table 19.1: Hydrological characteristics of the Seine-Normandy basin

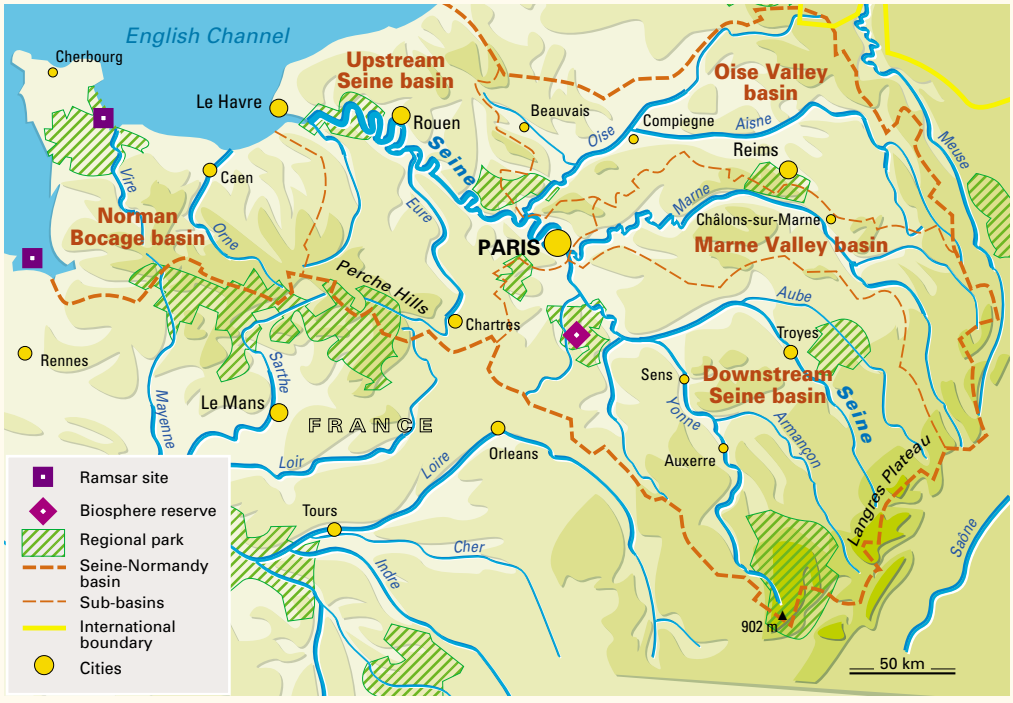
Surface area of the basin	97,000	km^2
Annual precipitation	750	mm/year
Annual potential evapotranspiration	500	mm/year
Average discharge in the coastal rivers of Normandy	125.8	m^3/s
Average discharge in the Seine River	460	m^3/s

Economics

Economic activity in the Seine-Normandy basin is dynamic. Industrial production in the basin alone accounts for 40 percent of domestic production, and includes 60 percent of France's automobile industry and 37 percent of its oil refining industry. There are agro-food industries located throughout the basin, whereas heavy industry (chemical, oil, paper, metallurgy) is concentrated in the Lower Seine Valley and the Oise Valley. There is a wide range of economic activity, in terms of both size and diversity, in the Paris region alone. The trades, service and commercial sectors, an integral part of the urban fabric, also flourish due to the high population density.

The basin also has a prosperous farming industry, with extensive farming on vast plains and the renowned wine-producing regions of Champagne and Burgundy. Sixty percent of the surface area of the basin is used for agriculture, and 80 percent of France's sugar, 75 percent of its oil and protein seed crops and 27 percent of its bread grain comes from this region. Since 1970, farming practices in the basin have followed the global trend towards large industrial crops with high added value (sugar beets, rapeseed, potatoes) with a concentration of cereal crops in the south-west and livestock production on the edges of the basin.

Map 19.2: Basin map



Source: Prepared for the World Water Assessment Programme (WWAP) by AFDEC, 2002.

Water Resources

Increasing anthropogenic pressure on hydromorphology

The Seine-Normandy basin has 55,000 km of water courses. The Seine, fed by the Oise, Marne and Yonne Rivers, is the basin's central artery. The rivers have gentle slopes due to the flat terrain. During flood periods, river water overflows into floodplains that are, in places, more than 10 km wide.

Flooding is indeed a major concern in the basin. Runoff has increased as more of the basin has been rendered impermeable (1,600 km^2 of impermeable ground out of a total surface area of 100,000 km^2, though these areas are concentrated).[1] Flow is often disrupted by the overdeepening of riverbeds, dredging and gravel pits. Dams in the Seine-Normandy basin, partly meant for levelling off of peak flow, often have a minimal effect on floods due to their distance from the large urban areas and their limited capacity compared to the volumes of the exceptional floods.[2] However, these large dams do regulate low flow and without them the rivers upstream from Paris would be dry during the summer due to the large amount of water withdrawn by the Paris region.

Human development also harms the biology of the rivers: migratory fish cannot get past 60 percent of the hydroelectric power plants and less than 20 percent of the dams are equipped with fish-passes. Modifications to the basin's major rivers, particularly for navigation purposes (1,427 km of navigable waterways, 550 of which have large or medium clearance), are the principal cause of decline in the population of migratory fish species.

The quantitative effects of other anthropogenic pressures on the basin are not major issues. Out of about forty aquifer formations, only three have temporarily dropped below their water stress thresholds. In rivers, withdrawal mainly affects quality. The water in some rivers is now simply outflow from wastewater treatment plants.

Water quality: a mixed balance sheet

Despite greater human activity, which produces oxidizable waste, the dissolved oxygen concentration in the basin's rivers has increased over the last thirty years, after becoming seriously depleted in the 1960s.[3] The nitrate situation is, however, worsening. Since 1965, the nitrate concentration in the lower Seine has

1. Additional runoff due to the waterproofing of surfaces is estimated to be 760 million cubic metres per year, based on a runoff coefficient of 100 percent on impermeable surfaces and 20 percent on permeable surfaces, and an average annual rainfall of 600 mm.
2. While the large dams on the Seine, upstream from Paris, can hold 800 million m^3 of water, almost 4 billion m^3 flowed through Paris during the 1910 flood.
3. The average oxygen content at the Poses measuring station (lower Seine), has increased, on average, by 0.9 percent/year over the last twenty-five years, which therefore reflects the efforts made throughout the Seine basin.

increased significantly, even if the rate of progression has slowed since 1989. The same concentrations are also occurring in groundwater.[4] Today, some 25 percent of the basin's groundwater measurement points show more than 40 milligrams (mg) of nitrate per litre; 12 percent show more than 50 mg/litre. But these nitrate rates still are under the groundwater threshold for producing drinking water (which is 100 mg/litre, while it is 50 mg/litre for surface water). Nitrate is also the third biggest cause of coastal and seawater pollution. When combined with phosphate, it can cause eutrophication and the proliferation of toxic microalgae. Phosphate input from continental sources, which is the main cause of eutrophication in freshwater, has decreased considerably but is still too high.[5]

Metal concentrations are also decreasing.[6] While naturally present in small quantities in the aquatic environment, metals also come from insufficiently treated wastewater and from surface runoff in urban areas. While the accidental discharge of highly toxic contaminants that kill fish is now rare, high concentrations are still measured near contaminated sites.

On the other hand, polychlorinated biphenyl (PCB) concentrations are still alarming, even though they are decreasing.[7] Although PCBs have not been manufactured since 1987, they are still produced by the incineration of domestic waste and the manufacture of paints and lubricants. Along with metals and hydrocarbons, PCBs are the second biggest cause of coastal and seawater contamination (after microbiological pollution). Groundwater is, however, little affected by organic micropollutants other than pesticides.

Pesticides, used not only in agriculture but also along railways and roads and in gardens, are a serious problem in the Seine-Normandy basin. Triazines – highly soluble, mobile and persistent organo-nitrogenous compounds – are the most prominent. They are present in surface water (with peaks in spring), coastal waters and, above all, in groundwater.[8]

In general, organic micropollutants are a major water management problem because the concentrations that must be measured are extremely low and new synthetic molecules, which must also be detected, are constantly appearing. Map 19.3 shows the basin's physico-chemical fitness between 1997 and 1999.

4. In 2000, out of 407 wells, 37 percent had nitrate contents between 20 and 40 milligrams per litre and 14 percent had very poor quality water (>50 mg/litre).
5. The flux entering the Seine estuary decreased from 60 to 39 t/day between 1974 and 1999.
6. Since 1976, there has been a decrease at Poses (lower Seine) in the dissolved metal loads of cadmium (a tenfold decrease over the last thirty years), cobalt, chromium, mercury, nickel, lead and zinc. Those of other metals, such as copper, titanium, vanadium, iron and manganese are also decreasing, but less markedly.
7. Their concentration has been decreasing since 1978, but is still five to six times greater than the national average.
8. Half of the 371 wells in the monitoring network were contaminated in 1999. Forty percent had triazine concentrations of over 0.1 micrograms per litre.

Biodiversity on the upturn

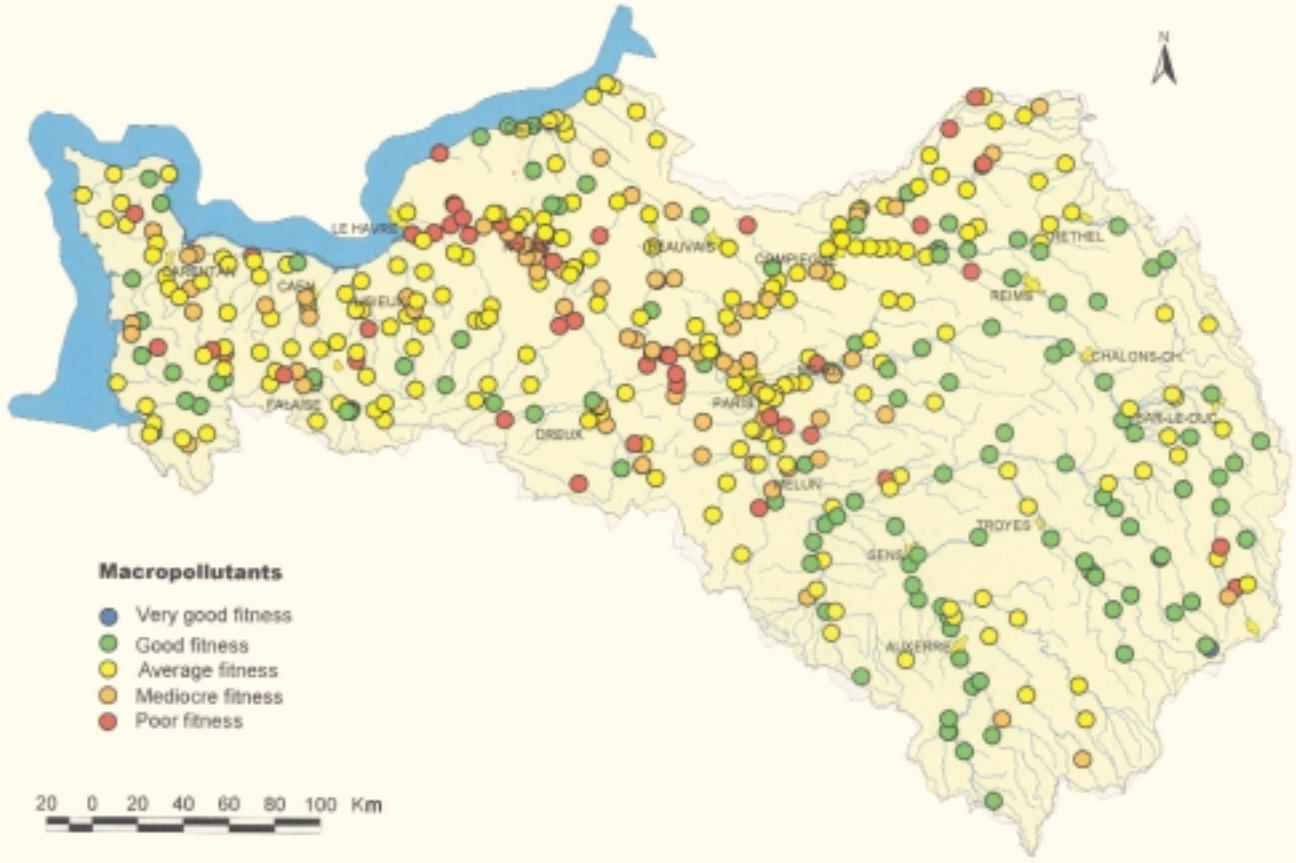
Out of a total of thirty-three fish species that have been identified as belonging to the local ecosystem, twenty-six are still commonly found today, a considerable improvement over the 1960s when the diversity and number of fish had declined due to heavy water pollution (Belliard, 2001). The Seine-Normandy basin's Hydrobiological and Piscicultural Network for monitoring fish populations now has 143 stations. Three or four times a year, electrical fishing techniques are used to study fish populations. The live fish are then returned to the river. While conditions near the edges of the basin are generally favourable to fish life, this is not the case in its centre (in the Seine River, in particular). In small rivers, non-point source pollution and the silting up of riverbeds are the main causes of the decrease in fish populations. In large rivers, the causes are mainly physical barriers and discharge from urban areas. Along with the negative impact of anthropogenic pressure (seven species are no longer present), about twenty new species have been introduced by humans,[9] who have also brought in invasive plant species, such as Japanese knotweed.[10]

Readily available water data

The Seine-Normandy Water Agency (AESN, Agence de l'Eau Seine-Normandie) and French government services, together with other public institutions, manage several measurement networks that gather quantitative and qualitative data on surface water and groundwater. For example, common surface water quality parameters were measured at 441 points in the basin in 2000. Of these, 171 were also analysed for metals and 120 for micropollutants. These points are sampled six to forty-eight times a year, for determination of more than 150 parameters (for a total of nearly 2 million data items/year), which vary in time and space with field conditions. The groundwater quality network uses 402 wells and piezometers to monitor the basin's ten major aquifers. Samples are taken twelve to forty-eight times a year for determination of more than 250 parameters (nearly 3 million data items/year). Networks have also been set up to monitor coastal waters. In 2000, water samples from 130 sites were analysed for swimming quality, twenty-two sites for shellfish and eleven sites for marine sediments. In estuaries, coastal rivers, swimming areas and at discharge points, the principal tests carried out are bacteriological analyses (*Escherichia coli*, Enterococci), backed up by chemical analyses

9. Examples of species that have been introduced are ruff and hotu (*Chondrostoma nasus*), and those that have disappeared include sturgeon, sea trout (or squeteague), salmon and sea lamprey.
10. The *phytophora fungus*, part of whose life cycle is in rivers, severely damages alders, which are of major ecological and silvicultural importance. The Dreissene is an invasive mollusc in rivers. *Cladophora* and *Vaucheria* are green algae that thrive in eutrophic environments and have been introduced by humans from aquariums. *Cyanophyta* are also disturbing in freshwater environments for health reasons.

Map 19.3: Water quality in the Seine-Normandy basin



Quantitative and qualitative data on surface water and groundwater are processed using a Quality Evaluation System (SEQ-Eau) based on indicator sets and use requirements.

Sources: AESN, 2001b. IGN-BD Cartho 94.

(suspended particulate matter, oxidizability, nitrate, chloride). Shellfish are analysed for bacteria (total coliform count, Streptococci, Salmonella), metals and radioactivity. Marine sediments are analysed for radioactivity.

The resulting data are processed using a Quality Evaluation System (SEQ-Eau) based on both the notion of indicators (groups of similar parameters, such as 'metal' or 'nitrate') and the requirements of the various uses (drinking water supply, irrigation, swimming). This system is very flexible and enables water quality to be evaluated according to the most relevant criteria for a given use.

Quantitative data are measured at 174 rain gauges, 214 piezometers and 418 hydrometric stations. These enable monitoring of flood risk and the possible effect of flooding on water quality. Water level records are stored in a database and are available to the public via web site.[11] Most of this data is also available to the public on the AESN web site,[12] which uses dedicated software to produce summaries by measuring point and parameter, upon request.

In France, the public is very aware of the seriousness of environmental problems, especially where human health may be affected. People living in the Seine-Normandy basin are much more concerned about water quality than they are about water shortages. They know that pesticides and chemical fertilizers are a major problem and understand that water has to be 'cleaned up' before it is discharged. They therefore consider it normal to pay for this service although they object when they think the price is too high for the service provided or that the costs are not being equitably shared among stakeholders. Interestingly, water consumption has dropped recently, but studies show that price is not directly responsible for this trend.

11. http://infoterre.brgm.fr/
12. www.eau-seine-normandie.fr

Challenges to Life and Well-Being

Stringent health control

The quality of drinking water is much better now than it was thirty-five years ago. Standards are higher and treatment techniques are much more efficient. Drinking water must satisfy criteria based on Maximum Permissible Doses (MPD). The European Water Framework Directive (WFD) requires that forty-eight parameters be taken into account, including microbiology, toxic substances and 'undesirables'. The drinking water of more than half of the basin's population is supplied by groundwater. With groundwater, biological standards can be met simply by protecting wells and slightly disinfecting the pumped water (except when the water is turbid, which can occur during periods of heavy rainfall in karst regions, thus depriving about 500,000 people of water for several days each year). In and around Paris, where drinking water comes mainly from rivers, the treatment required depends on the quality of the raw water. Surface water is ranked in three categories according to quality, each category requiring increasingly stringent treatment. The most polluted water may not be used as a drinking water resource. However, there are few instances of below-grade classification in the Seine-Normandy basin. On the other hand, the MPDs for atrazine (a chemical weed killer) pose a problem, especially since the limits set by the European Union (EU) are even more stringent than those of the World Health Organization (WHO) at 0.5 micrograms (µg) per litre for total organic micropollutants and 0.1 µg/litre for each individual substance. For nitrates, the EU recommends 25 mg/litre, but the current standard for both Europe and WHO is 50 mg/litre. Trends in the basin indicate that the MPDs for nitrate will also soon pose a problem. High lead content in drinking water is frequently a problem in old houses, due mainly to the state of privately owned pipes.

Bathing in rivers is still often restricted due to poor bacteriological quality. The basin's coastline is the site of flourishing tourist activity and a dynamic shellfish farming industry specialized in mussels and oysters, both of which require very high-quality seawater. Microbiological pollution from sewage systems, surface runoff and coastal rivers is the main threat, and has very harmful effects on economic activities. The situation has improved considerably since 1990, but isolated incidents still occur during periods of heavy rainfall. Areas used for shellfish culture are ranked in four quality categories, each of which requires increasingly stringent treatment in order to ensure that the commercialized products meet standards.

Drinking water supply and wastewater treatment

In 1999, 1,564 million cubic metres (Mm^3) of water were pumped in the Seine-Normandy basin for the drinking water supply. This corresponds to a distributed volume of about 1,240 Mm^3, given network losses (estimated to be about 20 percent), providing an average daily consumption of about 190 litres per inhabitant per day or 70 m^3/year.

Concerning wastewater treatment, reduced nitrogen discharge is considered to be the determining factor for river water quality. This depends on the capacity of the receiving environment and the efficiency of wastewater treatment plants.[13] Each city in the basin with a population of more than 10,000 inhabitants has a treatment plant. In 1999, 88 percent of the basin's population was hooked up to municipal wastewater collection networks (the rest of the population lives in isolated dwellings with private sewage disposal systems), and the basin's wastewater treatment plants had a total capacity equivalent to waste from 20.7 million inhabitants. They are usually very effective in removing suspended particulate matter (85 percent) and oxidizable matter (78 percent), but not as good for nitrogenous matter and compounds containing phosphorous (Seine-Normandy Basin Committee, 2000. While these results are adequate, they must be interpreted with caution because they do not include the 60 Mm^3 that flow directly into rivers each year during periods of heavy rainfall when storm runoff exceeds the capacity of the drainage network and/or the treatment plant. Figure 19.1 shows the improvement in water quality following the commissioning of the Saint Dizier treatment plant.

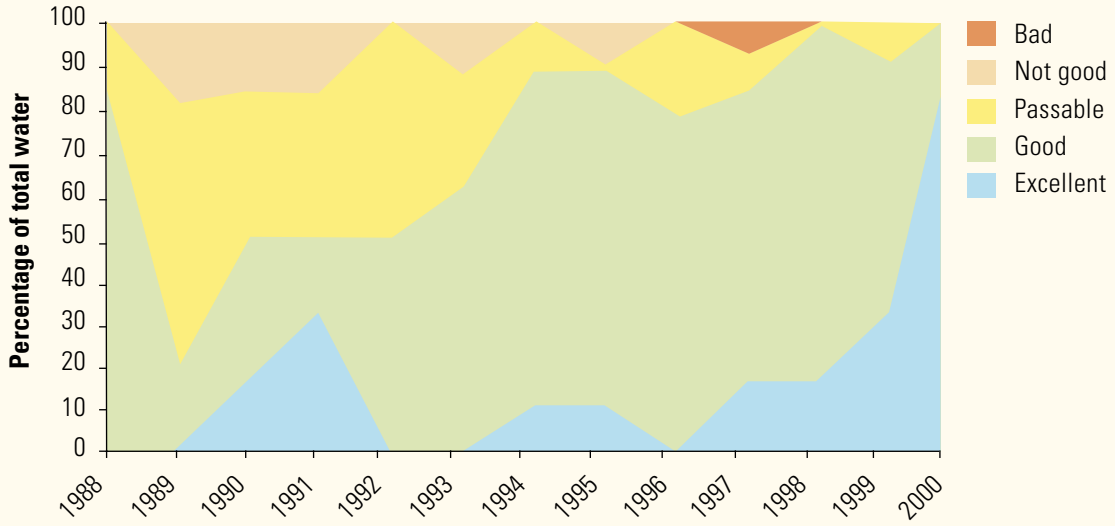
During storms, urban runoff is sometimes passed through wastewater treatment plants, depending on the storage capacity and treatment available, and on the storm's intensity. At present there is inadequate provision for treating contaminated and high-risk runoff. However, the city of Paris is planning to build new stormwater storage with a capacity of 1,6 Mm^3. Hazardous wastes, both solid and liquid, are deposited in seventy-seven private landfills within the basin. Five of these are used for dangerous materials; their impact on water is low and they are well monitored. The remaining seventy-two landfills are for normal waste. Taxes are paid on each ton of waste brought to the landfill.

Domestic users are also a source of non-point source pollution. Contaminants are carried off by surface runoff, which is rarely treated and flows directly into rivers. Waste from public areas and animal droppings in towns and cities are also major sources of contamination.

The disposal of treatment plant sludge (190,000 tons of dry matter/year) is also problematic. Most of it is recycled by farmers, which in turn poses the problem of heavy metals spreading on agricultural land.

13. The effects of an urban area on its drainage river can be expressed by an indicator calculated by relating the discharge capacity of the treatment plant, A, to the five-year minimum flow of the receiving river. Thus, the ratio A/Q_{mna5} enables us to calculate the maximum ammonium concentration in the river at the point of discharge.

Figure 19.1: Improvement of water quality of the Marne River



Thanks to the implementation of a wastewater treatment plant in Saint Dizier in 1995, the water quality of the Marne River has considerably improved: more than 80 percent of the water was considered of excellent quality in 2000, compared to 10 percent in 1995.

Source: AESN, 2002.

Agriculture

In the Seine-Normandy basin, irrigation is used to increase crop yield, to improve the quality of the produce, to regulate production and to grow crops that are very sensitive to water shortages (for example, potatoes for the industrial production of chips). At present, 394,000 hectares (7 percent of the usable farm area) can be irrigated: this has nearly doubled since 1988. The quality of the water withdrawn, 90 percent of which is groundwater, is generally very good. In spite of this sharp increase, irrigation still has little quantitative impact on the resource, except for occasional cases of overpumping that have been resolved by regulating demand.[14] Irrigation does, however, have an indirect impact on quality because it favours intensive farming techniques and spring crops, which leave the soil bare for long periods of the year and increase the chemical load in the rivers by leaching and draining.

Non-degradable substances from, or excessive use of, fertilizers, pesticides, liquid manure and other substances spread on crops or coming from livestock activities end up in rivers and groundwater. This has a harmful effect on both the environment and other water uses. Pollution is increasing as meadows are ploughed up (the total surface area of grassland decreased 22 percent between 1988 and 2000) and off-soil production becomes increasingly widespread, leading to problems of effluent management. Soil erosion, which causes water turbidity, is also closely linked to farming practices.

Industry

Industry in the Seine-Normandy basin consumed 1,612 Mm^3 of water in 1999, most of which was pumped directly from rivers, and most of which was used by power plants. The chemical and oil-refining industries also use large amounts of surface water. One third of the water withdrawn from the resource during low water periods comes from rivers. The volume of water withdrawn for industrial purposes, with the exception of power plants, has decreased by about 3 percent a year over the last ten years. The chemical and agro-food industries prefer to use groundwater, and often treat it before use.

Despite the high production of oxidizable matter (20 to 30 tons/day produced by the largest industrial units), treatment reduces average unit fluxes to 300 kilograms (kg) per day. Average purification rates are lower for nitrogenous matter, of which industry produces several hundred kg/day. Some industries are hooked up to municipal wastewater sewage systems, thus increasing the burden on wastewater treatment plants and the heavy metal load in the sludge, thereby limiting its use in agriculture.

Despite the large amounts of hazardous waste generated by industry (ten times more than domestic waste in terms of volume),[15]

14. For example, the water level in the Beauce aquifer dropped sharply in 1992 and 1997, causing water use conflicts.

15. The list of polluted industrial sites is available on the Internet at http://basol.environnement.gouv.fr.

industrial pressure on aquatic environments has been considerably reduced because the basin is very well equipped with waste treatment and disposal facilities.[16] Reducing pollution at the source by using clean processes and recycling polluted materials further reduces the industrial pressure on the resource. Remedial measures include improving the yield of wastewater treatment plants using denitrification processes. AESN is promoting this effort.

Another major issue concerns discharge from wine-producing activities and from the numerous small services and trades businesses that are an integral part of the urban fabric.

About thirty accidental pollution incidents from industrial sources occur each year. In more than half the cases reported, fish died and the contamination spread over more than 3 km.

Aquatic environments for biodiversity and tourism

In the Seine-Normandy basin, two major challenges must be met – protecting wetlands and combating eutrophication – if water is to act as a reservoir of biodiversity and an attractive and healthy environment for outdoor recreation.

The basin's wetlands (about 580,970 hectares) are capable of decreasing the levels of nitrogen and phosphorous in wastewater by 60 to 95 percent. They also help to reduce severe flooding by absorbing groundwater and providing room for rivers to expand. They are also of strategic interest for many water birds: 74 percent of the water birds that nest on a regular basis in France and 81 percent of the overwintering species find shelter in the basin. Six of the ten major migration routes that cross France pass over the basin. Unfortunately, twelve of the seventy-eight nesting species and fifteen of the ninety-four overwintering species are now in decline due to the deterioration of the environment. Indeed, half of the wetlands have disappeared over the last thirty years due to anthropogenic pressures, in particular, drainage for agriculture (1,400 hectares in 1999) and major navigation works, hydroelectricity schemes, and roads/railway lines.

Water is also a major tourist attraction and both rivers and beaches are threatened by eutrophication. In the summer, some beaches are invaded by 'green tides' that can result from a high phosphate and nitrate content in the water.

16. Twelve hazardous waste wastewater treatment plants that can generally destroy or trap more than 95 percent of the pollutants, five centres for burial of ultimate waste using efficient confinement techniques, and seventy-two centres for burial of common industrial waste.

Management Challenges: Stewardship and Governance

The 1964 and 1992 Water Laws and the European Union Water Framework Directive (WFD)

The first French Water Law laid the foundations for the French water management system. This law resulted from the growing need to coordinate the numerous local water uses and responsibilities when, in the early 1960s, the country was faced with both an increase in pollution as a result of urban and industrial growth and a sharp increase in the demand for water. The 1964 Water Law created the novel concept of Water Agencies,[17] each with its own 'water parliament', or Basin Committee. The decentralization of water management was reinforced by the second Water Law, which, in 1992, increased the role of the Water Agencies and created a Master Plan for Water Management (SDAGE, Schéma directeur d'aménagement et de gestion des eaux), guidelines for balanced water management on a river basin scale, to be drawn up by a Basin Committee.[18] The SDAGE reports on the state of the basin (see indicators in box 19.1 at the end of the chapter), with the approval of the various stakeholders, and determines long-term strategic objectives (ten to fifteen years). In 2000, the EU issued its WFD, which outlines the principles for Integrated Water Resources Management (IWRM) at the river basin level and requires that member states achieve 'good status' for all of its water bodies by 2015, using any methods they should choose. From an institutional point of view, the WFD follows the French system. The new French Water Law, which will come into force in 2003, transposes the WFD into French law.

Delineated water management roles

Distinctive aspects of the French water management system are the high degree of local responsibility, public-private sector partnerships, coordination on a river basin level and a taking into account of all water uses.

Municipalities (from small villages to big cities) have been responsible for all services associated with water since the nineteenth century. Today, they are not only responsible for initiating water works and operating facilities, but are also legally responsible for the quality of services and rates charged to users in their community. Towns, therefore, often set up intercommunity

17. The water agencies are public bodies administered jointly by the Ministries of the Environment and Finance. There are six in France, one for each of the country's major catchment basins: Seine-Normandy, Artois-Picardy, Loire-Britanny, Rhône-Mediterranean-Corsica, Adour-Garonne and Rhine-Meuse.
18. The Seine-Normandy SDAGE was approved in 1996; thematic data sheets concerning the SDAGE are available on the Internet at www.environnement.gouv.fr/ile-de-france.

associations to operate drinking water supply (an approach that concerns 67 percent of the basin's population) and wastewater treatment (16 percent of the basin's population) networks. They also create joint public-private partnerships by subcontracting water supply and treatment services to private companies under various types of contracts (85 percent of the basin's population for water supply, 36 percent for wastewater treatment). They are still, however, responsible for the system and the private service provider must return the network in proper working order at the end of the contract period.

In addition to water supply and treatment services, water management involves many responsibilities that are sometimes rather vague. An example of this is the management of privately owned rivers. Their maintenance is, theoretically, the responsibility of riparian owners but, in practice, is often undertaken by intercommunity volunteer groups.

All water users must comply with standards set by the water laws, and compliance is monitored by local representatives of state agencies. The state, therefore, remains the 'guardian' of the resource. It is also responsible for maintaining public rivers, a task largely delegated to the French Navigable Waterways Authority (Voies Navigables de France).

Faced with this complex allocation of responsibility, the role of the Water Agency at the river basin level is to promote measures undertaken to ensure a balance between water resources and needs. Its role is mainly financial. It allocates funds – in the form of loans or subsidies – for projects that correspond to the objectives of the Water Agency programme. Thus, by evaluating proposals and monitoring funded projects, it also plays an advisory and consultant role that is widely recognized by its partners. The money that it distributes comes from users in the form of taxes or fees based on the quantities of water consumed and the amount of pollution discharged. It collects all the water taxes from its river basin. The acknowledged neutrality of the Water Agency also enables it to act as a mediator.

Undeniable but limited public participation

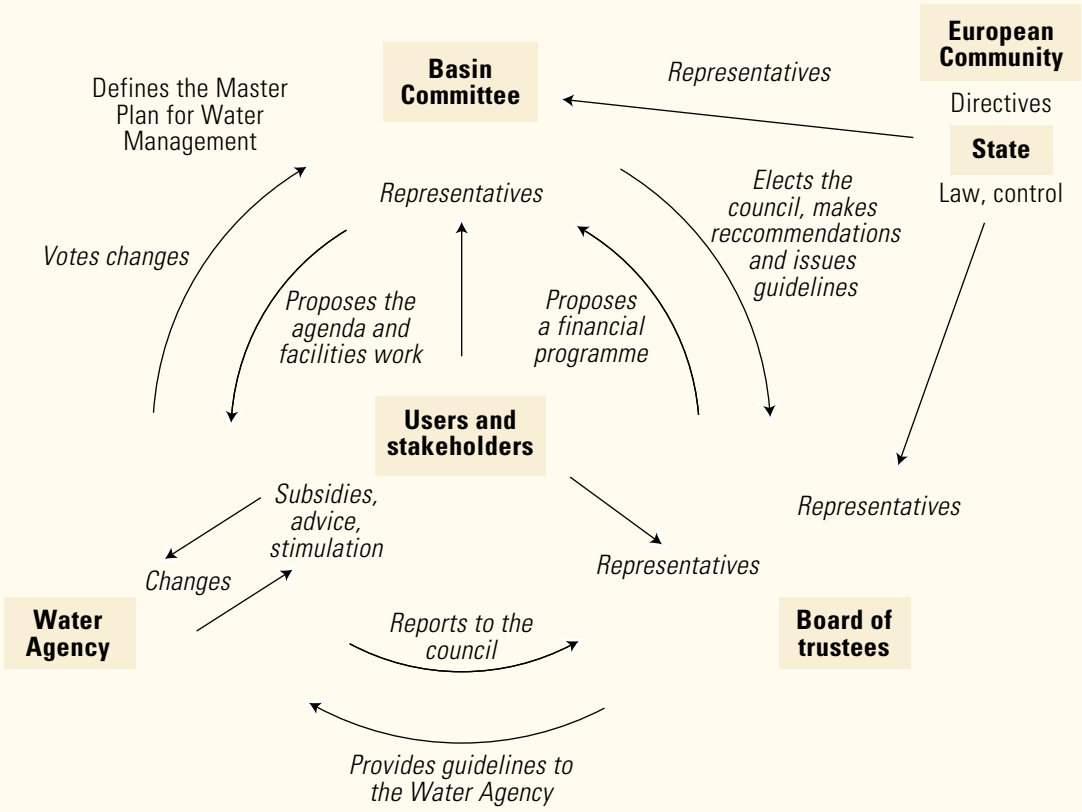
The Basin Committee is an advisory and decision-making body made up of three representative groups – elected officials, water users and people appointed by the state. After studying the situation within the basin, the Committee recommends water tax bases and rates, based on the five-year plans drawn up by the Water Agency and its Board of Trustees (which is made up in the same way as the Basin Committee). Water Agency programmes must follow the SDAGE guidelines, which, in accordance with Water Law requirements, are also the result of extensive collaboration. The state is, therefore, but one of many participants involved in the planning stages (see figure 19.2). It participates in discussions concerning policies that are made and financed by those directly involved. It has, however, administrative control over all of the actions carried out. At a local level (water course, groundwater), very decentralized mechanisms enable the allocation of local responsibilities. Cooperation is achieved through interdepartmental agreements, intercommunity associations and, in particular, local participatory initiatives such as local water management plans (SAGEs, Schémas d'aménagement de gestion des eaux), which are drawn up for sub-river basin catchment areas along the lines of the river basin level SDAGE, and 'rural contracts' created by the AESN.

The composition of the Basin Committee and the steering committees of the local participatory initiatives guarantee, in principle, that water management is, to a certain extent, open to the public. In practice, however, this attempt to be open is sometimes ineffective. User participation in debates is often minimal, local input often being limited to financial-level rather than project-level planning. Faced with this situation, which is closely related to the general timidity of civil society in France, it is clear that the Water Agency needs to encourage more public participation, in particular when the WFD goes into effect.

Payment of water services, financial aid and resource management

The water bill paid by domestic and industrial users hooked up to the municipal water supply network covers the cost of drinking water distribution and wastewater collection and treatment. The price of water varies according to its treatment, management, supply conditions, and wastewater discharge. The bill also includes a pollution tax and a resource withdrawal tax levied by the Water Agency. These taxes represent only a small proportion of the total water bill. Their revenues are redistributed by the Water Agency in the form of interest-free loans or subsidies, in accordance with a five-year programme drawn up jointly by representatives of water users within the framework of the basin's SDAGE. This financial aid is meant to incite users to reduce the impact they have on the resource through investments or improved techniques. The amount of financial aid allocated to the various categories of users is roughly equivalent to the taxes they pay. Funds are, however, shifted somewhat between the basin's various categories of users and geographic areas according to a principle of 'basin solidarity'. For example, domestic users in Paris pay, on average, more in pollution and withdrawal taxes than they get back in aid. This is understandable since their water is pumped upstream and they contribute significantly to pollution downstream. The WFD recommends that the actual cost of water be fully paid by users, that an 'actual cost' indicator be measured, and that appropriate rates be charged to improve quality. In the Seine-Normandy basin, and elsewhere in France, consumers are billed for the cost of

Figure 19.2: Water legislation in France



Many stakeholders are involved in the planning stages; the Basin Committee, the advisory and decision-making body, guarantees – to a certain extent – user participation.

distribution and treatment. But users do not pay for environmental damages due, for example, to non-point source pollution, in particular from agriculture. The basin must be more transparent about how it shifts funds between the various categories of users, the state and public institutions, and must take into account costs engendered by the environmental impact of uses.

The calculation of the Water Agency pollution tax is based on the actual quantity of polluted water. For instance, a water treatment allocation has been set up for industries, which is based on water treatment efficiency and the wastewater destination, so that they are taxed only for the actual amount of pollution that they release into the environment and into the local sewage systems. Water management in the Seine-Normandy basin is, therefore, in accordance with the polluter pays principle.

All Water Agency revenues are spent on supporting pollution reduction and clean-up actions. The nuisances caused by one specific water use over another (negative externalities) still have to be measured and accounted for in the rate setting. This WFD recommendation should be met by 2010.

In 1999, the average price of water in the Seine-Normandy basin was 2.74 €/m^3 (about US$2.8/$m^3$). The annual bill for domestic users was 126 €/inhabitant (about US$129/inhabitant), around 20 percent of which were taxes. The average amount spent on water per household was 1.03 percent of total income, and 4 percent of housing costs. In light of these figures, the socio-economic weight of the water sector, which employs 18,700 people in the basin (for water supply and treatment), can be estimated: it represents an annual investment of about 60 €/inhabitant/year (around US$61/inhabitant/year). Existing supply and treatment facilities were assessed, in 1999, at 9.360 €/household (around US$9.6/household). The annual expenditure per household in the water sector is therefore 0.5 per thousand of the Gross Domestic Product (GDP).

Achievements of this water management system

Decontamination projects

The Water Agency's first financial aid measures in the 1960s incited many municipalities that had been hesitant until then to launch costly water treatment programmes. During the Water Agency's first five-year programme, the number of wastewater treatment plants in the basin increased threefold. Between 1972 and 1976, financial incentives were created to increase the efficiency of wastewater treatment plants (which has since increased from 40 to 70 percent). Since 1971, SATESE units (technical support for wastewater treatment plants) employ people to monitor the proper operation of wastewater treatment plants. In 1976, inhabitants were made responsible for the pollution they generated and they now pay a unit price for pollution. As a result, wastewater collection and treatment networks have been renovated. At the same time, the Water Agency also began funding private sewage disposal systems. Between 1977 and 1981, Water Agency efforts focused on restoring river water quality by launching numerous joint actions at a local level that were to evolve into river development plans. Diagnostic studies of wastewater collection systems were funded, and the training of SATESE personnel was intensified. Between 1982 and 1986, priority was still given to improving wastewater collection systems. The Water Agency then created 'Reinforced Action Zones' where a higher pollution tax was levied (plus 70 percent) in exchange for an increase in financial aid. Between 1987 and 1991, the fifth Water Agency programme focused on 'black spots', highly polluted areas requiring remediation, and made wide use of pluri-annual contractual agreements to incite urban areas to undertake long-term waste treatment works. Today, the Seine-Normandy basin has 2,100 wastewater treatment plants, which collect wastewater from 3,200 municipalities or intercommunity associations. Current efforts focus on developing more efficient wastewater treatment methods, particularly in terms of nitrogen pollution that take into account surface runoff, and treatment methods that are better suited to rural areas (lagooning, spreading, sand filters, garden filters). The Water Agency is now encouraging small polluters to reduce the spread of pollution.

The Water Agency also participates in the construction of drinking water plants. At the present time, it is financing new filtration techniques.

Preventive measures

The pollution tax has incited industries to make decontamination practices both systematic and highly efficient. An increasing number of companies, supported by the Water Agency, are now using clean processes in order to reduce pollution at the source.

The recent implementation of rural contracts enables local actors to work together on local issues, particularly with respect to combating non-point source pollution. For the moment, these contracts play an important role in terms of raising awareness and inciting action. An encouraging sign in the Seine-Normandy basin is that policies are being developed jointly at the local and regional level to prevent pollution, particularly non-point source agricultural pollution.

In order to reduce this, the Water Agency is financing a pilot project to develop non-polluting farming techniques (soil cover in winter, better use of pesticides, more efficient matching of soils and crops) and to help stockbreeders bring their facilities into compliance with water protection regulations (by means of a new animal-farming tax). There are rules governing the storage of agricultural discharge and most stockbreeders pay an animal-raising tax that corresponds to the impact of discharges into the environment. Farmers using water for irrigation pay a fixed water tax based on their declared area of irrigation. If they own a meter, they pay lower taxes. The installations of meters is subsidized by the Water Agency. The Agency also provides financial assistance to stockbreeders in order to improve their farming practice. They are encouraged to bring manure pits into compliance with nitrate controls and to put down protective groundcover to avoid leaching. The Ministry of Agriculture prohibited the sale of atrazine after September 2002, and will forbid its use after June 2003.

Regulation of and changes in certain chemical products have also had beneficial effects. The increased use of phosphate-free washing powders, combined with particular efforts made by industry, have resulted in a significant decrease in phosphate levels. Cadmium concentrations in Seine estuary sediments have decreased during the last five years since by-products from the manufacture of phosphate fertilizers are no longer discharged into the environment.

Environmental protection and remediation

Other preventive measures specifically concern the environment. One of these is the protection of wetlands. While only 11 percent of the basin's wetlands are protected by regulatory measures, 55 percent are classified under international labels (Ramsar sites, United Nations Educational, Scientific and Cultural Organization [UNESCO] biosphere reserves). The Water Agency also buys wetlands outright (643 hectares were acquired in 2001, almost ten times more than in 1999, and 1,262 hectares have been acquired over the last five years). In addition, it participates in studies and the employment of local wardens and technical personnel. Moreover, for seven years now, the Water Agency has encouraged efforts to restore wetlands by awarding prizes at an annual competition. The Water Agency invested million US$1.53 (1.6 million €) in wetlands in 2000, more than twice the amount allocated in 1998.

The Water Agency has set up technical support units for river maintenance jointly with local authorities and fishermen's federations, and encourages the drawing up of river contracts. Some

of these measures are already bearing fruit. Trout have been reintroduced in the Touques River in Normandy, for example, and its river banks have been improved for walkers and anglers. By 2002, some 200 dams were to be equipped with fish passes.

Risk management focused on water shortage, flood and health

The principal risks in the Seine-Normandy basin are those of flooding, severe low water levels and contamination of the drinking water resource. Twenty-two percent of the flood-prone communities have flood risk prevention plans. The local population is informed of the risk of flooding and has Internet access to relevant information.[19] A detailed flood risk map of the region is near completion. Permeable road surfaces are now being used to limit the adverse effects of impermeability on flooding. Since dams do little to control flooding, civil engineering works focus mainly on creating spreading basins. The Water Agency has been able to do little in this area up until now since it has never collected taxes for flood risk management. While the probability of losing life in a flood is extremely low in the basin, property damage is another matter. It is estimated that another flood like the one in 1910 would cost more than 4 billion € (US$4.1 billion).

The large dams on the Seine, the construction of which was subsidized by the Water Agency, ensure that the Marne, the Yonne and the Seine do not dry up in the summer as a result of withdrawals for the Paris region. Using hydrodynamic models, specialists can now study the principal aquifers, particularly as regards the risk of their drying up. Risk thresholds have been set, and specific measures stipulated in management plans are taken if these are exceeded (spreading basins that reduce the flow rate have been defined). Aquifer contracts between groundwater users ensure that, in the event of a crisis, the shortage is shared by all of the users according to a priority scheme (for example, irrigation quotas in the Beauce aquifer, see box 12.4 in chapter 12 for more details).

In order to decrease the risk of contamination of the Paris basin drinking water supply, a project to drill very deep wells to tap the Albien aquifer, 700 metres deep and extensive under the basin, is currently being studied.

Conclusions

Improving water quality is still the major concern of the basin, despite real progress made over the last thirty-five years. Storm runoff during periods of heavy rainfall continues to create problems, causing wastewater to be discharged directly into rivers or overloading wastewater treatment plants, thereby decreasing their efficiency. Non-point source pollution from farming and urban areas is still a major problem as nitrate, pesticide and heavy metal concentrations continue to increase. There are rules for farm waste, just as there are for industries, but only concerning stockbreeding.

Municipal and industrial wastewater treatment still needs to be improved by increasing the efficiency of wastewater treatment plants, particularly with respect to nitrate and phosphate. The wastewater collection system must be improved, and pollution discharged by small businesses and artisans must be controlled. Erosion is another source of non-point source pollution, especially in karst regions where domestic users are still occasionally deprived of drinking water due to turbidity. Combating floods and eutrophication, protecting wetlands, and the spread of treatment plant sludge are also major issues in the Seine-Normandy basin.

All of these problems are on the Water Agency's agenda. Taxes will be levied to more efficiently combat nitrate pollution (a nitrate tax, proportional to the agricultural wastewater discharge) and flooding (a water regime modification tax, based on the impermeable surface area, structures that impede river flow and barriers to flood expansion). An ecology tax has been levied on certain chemical products in order to reduce their use (pesticides, phosphate washing powders).

The European WFD not only confirms French water management principles (management at the scale of major hydrographic basins, direct involvement by those concerned), but also marks a major turning point by setting an ambitious goal to improve the quality of water resources and to achieve 'good status' over the coming fifteen years. Thus, specific prescriptive policies (such as determining discharge standards) will need to be broadened to cover all uses and assess overall environment impact. For those involved in water management, this will mean passing from an obligation of means (doing what is required by law, regardless of results) to an obligation of results (doing whatever is necessary to meet quality objectives required by law). WFD requirements will force the French water management system to increase its public participation and transparency, a task already undertaken by the creation of Basin Committees.

19. www.environnement.gouv.fr/ile-de-france

Box 19.1: Development of indicators

Since the Seine-Normandy SDAGE was implemented, an operating report has been published each year. Progress towards reaching the objectives set by the Basin Committee can thus be monitored. Monitoring is done with indicators that are well suited to the specific context of the basin and focus on Water Agency activities.

Theme	Indicators
MANAGEMENT OF AQUATIC ENVIRONMENTS	• Six indicators of river functionality (fish passes, financial aid for river maintenance) • Three indicators of wetlands preservation (surface areas drained, regulatory protective measures) • Two indicators of decreased dredging of gravel • One indicator of runoff and erosion control
WATER QUALITY MANAGEMENT	• Four indicators of general quality (polluted sites, Seine river water quality) • Five indicators of municipal and industrial discharge • Four indicators of decreased agricultural pollution (demarcation of vulnerable zones, controlling effluents from stockbreeding) • Two indicators of coastal pollution control • Two indicators of drinking water supply (water quality and well protection) • One indicator of pipes and major works
CRISIS MANAGEMENT	• Four indicators of extreme low water level management (expansion zones, warning zones, etc.) • Three indicators of flood control (risk prevention plans, improved forecasting)
INTEGRATED MANAGEMENT	• One indicator of SDAGE progress (local water development and management plans) • Two indicators of contracts
KNOW-HOW AND COMMUNICATION	• Three indicators of knowledge development (research programmes, inventories) • Three indicators of aquatic environment monitoring (measurement network, databases)
STATE OF THE ENVIRONMENT	• Six maps that indicate the state of the aquatic environment: groundwater levels, physico-chemical quality of surface water, pesticide content in surface water, quality of fish populations, quality of coastal waters, maximum nitrate and pesticide concentrations in groundwater

These indicators have been sufficient for monitoring changes in the environment and the management system under the current SDAGE. The EU WFD objectives for achieving 'good status' and covering actual costs will undoubtedly require additional monitoring indicators.

Within the framework of the World Water Assessment Programme (WWAP), the AESN recommends that the following indicators of the environment, governance and financial aspects also be taken into consideration.

Theme	Indicators
ENVIRONMENT: QUALITY (ADAPTABLE TO GROUNDWATER, WATER BODIES AND COASTAL WATERS)	• Maps made using a Quality Evaluation System, based, at least, on the following indicators: BOD5, NH4+, NO3-, P total, suspended particulate matter, pH, conductivity, colour, thermotolerant/ faecal coliform organisms, total chromium, mercury, lead, DDT op', DDT pp', lindane, endrine, dieldrine, aldrine
ENVIRONMENT: WETLANDS	• Surface area and evolution: protected wetlands and RAMSAR sites, basin wetlands, especially those in flood plains, drained areas. • Maps of urban areas and density of industrial fabric. • Changes in the pressures from intensive farming, industry and urban development in the basin.
ECONOMY	• Average price of drinking water/m^3, annual amount paid by inhabitants for drinking water, proportion of the price of water used to protect the resource, the value of distribution and treatment facility assets/household, funds earmarked for water/GDP, volume consumed annually/ inhabitant, annual water bill per household/ annual income. Cost recovery index. Pricing of services and financial autonomy of water works budgets.
GOVERNANCE	• Decentralization, involvement of public in water policy decisions, transparency, allocation of roles, openness to civil society, mobilization of know-how, sharing of knowledge, management system evaluation, public-private partnership (equity and efficiency).

Box 19.1: *continued*

If we attempt to assign global scores for sustainable resource management we run the risk of ending up with meaningless figures. The details on which the ratings are based must be preserved and accompanied by the individual scores for each indicator. The methods used to obtain and calculate indicators must also be described in detail. It might be difficult to assign a precise score to some indicators. The state of the environment, for example, is generally shown with a map. Weighting, which favours certain themes or indicators to the detriment of others, should also be carefully considered. For example, different weighting methods would result in different scores, each of which could be used to more accurately reflect a specific area of water management (shortages, governance, environment).

Data for some of the indicators proposed by WWAP are now being gathered at the Seine-Normandy basin level. Data gathering methods for others are still being developed, while for still others data cannot be gathered at present, or the indicators are too vague.

Challenge area	Seine-Normandy basin indicator
SURFACE WATER	• Withdrawals: 2,044 bm^3/year • Precipitation: 750 mm • Evapotranspiration: 500 mm
WATER QUALITY	• Yearly maps for monitoring the quality of water courses using indicators • SEQ tool (Quality Evaluation System) is used, which covers groups of similar parameters • French Environmental Institute (IFEN) quality indicators
GROUNDWATER	• 10 major water tables • Withdrawals: 1,213 bm^3/year • Volume of underground resources has not yet been accurately assessed • Piezometric monitoring of groundwater tables; three tables have overrun the hydric stress threshold over the last ten years, but have been filled up again due to recent heavy rainfall
PROTECTING HEALTH	• Incidence of water borne diseases is low • Virtually all households have access to good quality potable water (conformity level of potable water analyses › 99% for the sixty-two parameters) • 0.03% of the population is deprived of potable water several days per year due to turbidity in periods of heavy rainfall in certain zones • 88% of the population has access to collective sanitation and 10% use individual sanitation measures (in rural areas) • Right to water is legally recognized • Public drinking fountains, washing places or baths in each town or village • Temporary social aid for the poor in paying their water bills; water cuts very rare and theoretically forbidden for poor people
PROTECTING ECOSYSTEMS	• Present estimation of the surface area of wetlands: 580,969 hectares, 6% of the basin area), of which 2% is protected by national regulations and 9% by international regulations • In 2004, 31% of wetlands will be classified as sites of European importance. • Three Ramsar sites • 1.6% of the surface area in the basin has been rendered impermeable • Around 600,000 ha drained between 1974 and 1999 (in other words 6.2% of the basin area) • 33 fish species listed in the Seine
WATER AND CITIES	• Withdrawals of potable water: 1.6 bm^3 • 20% leaks and is used for cleaning the network; the inhabitants consume 70 m^3/year. • 100% have access to potable water • Access to sanitation in towns currently being evaluated • 100% of communities with more than 10,000 inhabitant equivalents have a wastewater treatment plant • The responsibility (penal) for water and sanitation services is incumbent on the local authority
SECURING THE FOOD	• Indicator that is not very relevant in the Seine-Normandy basin (no problems of securing food)
SUPPLY WATER AND INDUSTRY	• Annual use of water by industry: 95 m^3/inhabitant (of which 2/3 is used for cooling thermal power plants) for 188 m^3/inhabitant of the water withdrawn annually • Pollution from industries not connected to the sewage system: 147 t/day of oxidizable matter; 19 t/day of nitrogenous matter: 3.2 milliequivalents (Meq)/day of inhibiting matter; 2.9 t/day of toxic metals.

Box 19.1: *continued*

Challenge area	Seine-Normandy basin indicator
WATER AND ENERGY	• Annual use of water for cooling of thermal power plants 831 Mm^3/year
MANAGING RISKS	• 2,239 communities are at risk to flooding; 22% of them have a Risk Prevention Plan. Flooding map for the whole basin
SHARING WATER	• Welfare measures have been put into place to ensure that the poor have access to water (cutting off the water supply is prohibited) • 49% of withdrawals are for domestic water requirements, 27% for industry, 3% for farming, 23% for electricity and 5% for other uses (cleaning of roads, etc.) • If there is any conflict between sectors in the use of the resource, domestic supply water is treated as a priority • Water counters exist
VALUING WATER	• Price of potable water is on average 2.74€/m^3 (US$2.80/ m^3), which is 126€/inhabitant/year (US$120/inhabitant/year) • Tariff varies from 0.15 to 5.35€ (US$0.14 to 5.11), depending on the size of the community, the complexity of treatment required, and the specific management set-up • All consumers are billed for water and sanitation services • On average, households spend 1.03% of their income per year on water and sanitation • Pricing system is controlled by the state • On average, the fees represent 20% of the price of potable water • Annual water expenditure (potable water and sanitation) is 0.5% per thousand GDP
ENSURING KNOWLEDGE	• For surface water 150 parameters are measured 6 to 48 times per year, on 441 observation points, relating to 15,000 km of principal drains and 17 million inhabitants • For groundwater: 402 boreholes, measured 12 to 48 times per year, on 250 parameters; relating to 10 or so main aquifers, a total surface area of 97,000 km^2 and 17 million inhabitants

Challenge area	Seine-Normandy basin indicator
ENSURING KNOWLEDGE	• For quality of coastal waters: 130 'swimming' sites (ten or so parameters), 22 'shellfish' sites (around 5 parameters), 11 'sediment' sites (at least radioactivity, heavy metals) relating to 600 km of coast • In quantitative terms there are: 174 rain gauges, 214 piezometers and 418 hydrometric stations • In total around 5 million sets of data per year, a large proportion of which is available to the general public on the Internet • The quality data is analyzed using the SEQ (Quality Evaluation System), which allows maps to be produced by type of indicator (grouping together of similar parameters)
GOVERNING WATER	• Local authorities responsible for water and sanitation; programming, coordination on a catchment area level • Management interventions adapted to the scale of the problem (river contracts, management schemes on the small catchment area scale) • Effective delineation of roles and balanced public / private partnerships (delegation of water and sanitation services) • Insufficient participation by civil partnerships and vagueness for the responsibility for the upkeep of rivers • Transparency in the price of water and water budget autonomy, fees monitored and well discussed • Problems of imbalance in expertise and insufficient evaluation of management actions • Solidarity funds for rural zones to promote equity, basin solidarity between zones and end users • Delegating water and sanitation services to the private sector (46% of cases) • Close correlation between the public and water policy in small communities, representatives of associations in the Basin Committee, but these openings are not sufficient

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