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

Synopsis sheets

Rivers of the World

THE RHONE

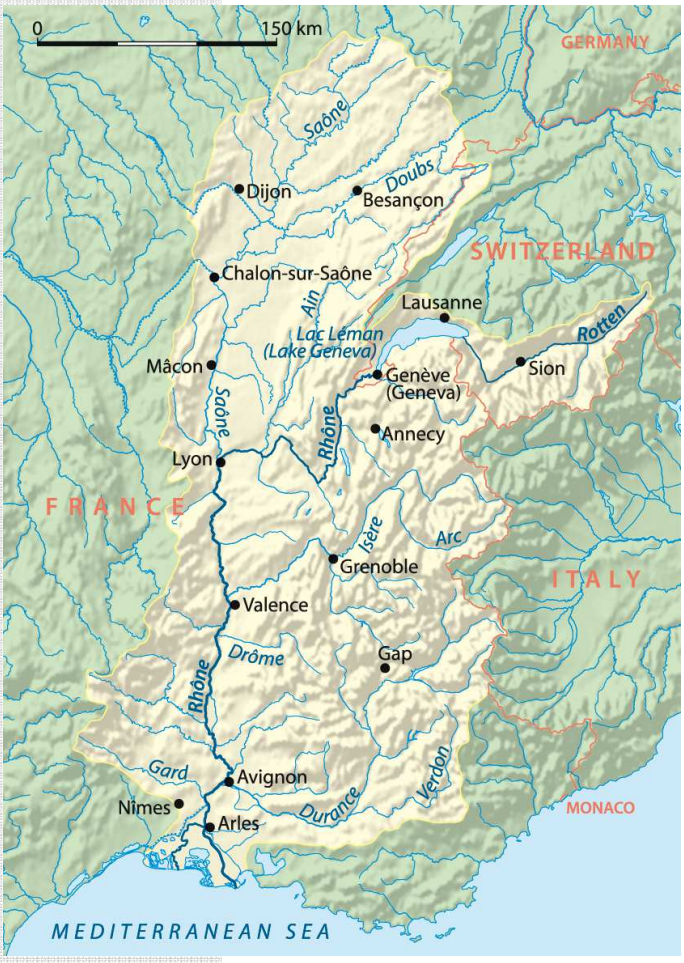
Initiatives pour l'Avenir des Grands Fleuves

The Rhone

The source of the Rhone is the Furka glacier located on the Saint-Gothard massif in Switzerland, in the canton of Valais, from where it flows 810 kilometres before reaching the Mediterranean Sea. This length includes the 72 km of Lake Geneva and 522 km in France. It is the most powerful French river with a discharge of 1,800 m^3/s at its mouth. Developed from the 19th century onwards, it is a natural and vital corridor for fauna, flora and man.

The current situation presents a large number of challenges for the Rhone: economic, political, environmental and legislative: the deregulation of the European electricity market and the expiry of the structural concession contract, transformations of the European energy mix, water pollution and changes to environmental standards, etc.

Genesis of an economic and societal corridor



The origins

The Rhone springs from the formation of the Rhone Valley, a huge gouge caused by the separation of the Earth's crust about 55 million years ago. After marine, river and lagoon episodes, the Mediterranean Sea retreated 6 million years ago leaving the river to sculpt its bed. This was then followed by a large number of geological and climatic episodes until the final metamorphosis occurred, from the end of the 19th century: climate change – the end of the Little Ice Age - coincided with a change in the socioeconomic context (rural exodus and voluntary reforestation of mountain areas), and technological breakthroughs: henceforth the technological resources needed to control the river with hydraulic structures became available.

Initially intended to protect against flooding following the record floods of 1840 and 1856, the works then focused on making the Rhone navigable.

Starting in 1884, the senior engineers of the Rhone, Messrs Jacquet and Girardon, developed flow control strategies using groynes, dikes, wing dikes, etc. CNR's hydroelectric development schemes were added to these structures, starting in the 1950s.

A new chapter began twenty years ago, with great attention being given to the hydrological functioning of the river and its surrounding habitats that had suffered from the construction of the installations.

Technical sheet

Discharge	1,800 m^3/s	Countries crossed	Switzerland, France
Length	810 km	Tributaries	Arve, Saone, Isère, Drôme, Gard, etc.
Watershed	97,800 km^2		

Caractéristiques	
Upper Rhone (Lake Geneva - confluence with the Saone)	The Rhone flows for more than 200km crossing the Jura mountains and the foothills of the Alps before reaching the plain of the Ain and then Lyon. There is a succession of narrow gorges (canyons of Bellegarde, Yenne, Creys-Mépieu) and wide flood plains (the marshes of Chautagne and Lavours, the plain of north Isère). The waters of Lake Bourget (France's largest natural lake) flow into the Rhone via the canal of Savières (whose flow reverses when the Rhone is in flood.
Middle Rhone (Lyon-Valence)	Narrow alluvial plain, intense pressure from industry and agriculture. Three natural sites: the natural habitats of the river's oxbows and islets; the nature observation centre of Ile du Beurre, the nature reserve of Ile de la Platière and the meander of Oves.
Lower Rhone (downstream of Montélimar-Delta)	Three specific characteristics: its regime is modified by the flows of tributaries from the Cevennes and the southern Alps; the geomorphology of the alluvial plain and delta of Camargue increase the risk of flooding. The flow of water end sediment influence the stability and equilibrium of marine ecosystems.

The Rhone

Multiple uses

Hydroelectricity production

The hydroelectric energy produced on the French section of the river reaches **an annual average of 14,900 GWh generated by nineteen hydropower plants**. When taking into account the production of the other plants, particularly those in the Alps, this activity represents more than 93% of the country's renewable electricity and makes France the European leader in hydroelectricity production.

The production on the river varies as a function of daily and seasonal flowrates. The energy produced can be slightly adjusted, mainly thanks to the contribution of the head at Génissiat, with a small reservoir holding 50 million m^3. The storage of part of the flowrates in the forebays upstream of each plant makes it possible to satisfy peak period demand every day.

The strong position of the Rhone basin is further reinforced by the installation of high voltage power lines in the valley that link the different production sites with each other.

Navigation

A major corridor linking Northern Europe to the Mediterranean**, the Saone-Rhone river network** has been a thriving trade route throughout the ages. In Gallo-Roman times, the Rhone, prolonged by the Saone, was one of the busiest rivers in the Roman Empire after the Nile. In the Middle Ages, it transported salt, metals, wood and cereals. In the 19th century, it went through a period of decline due to competition by rail. Although activity on the river continued, it was not until CNR developed its infrastructures and opened it up to wide gauge traffic along more than 300 km, that navigation along the Rhone Valley underwent a new lease of life.

The current multimodal network is composed of 18 industrial and port sites, including the Port of Lyon, and it is connected to the Mediterranean sea thanks to a direct access to the ports of Marseille-Fos and Sète. There are 230 companies that moved along the river, and an average of 6.4 million tons of goods are transported every year. The growth potential is still very important, yet the activity intensity is uneven.

Rhone

Multiple uses

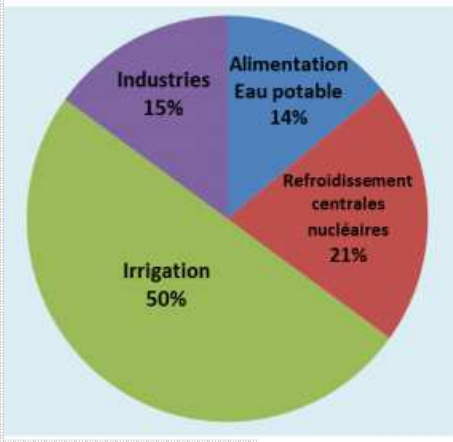
Irrigation

Thanks to **40 water supply points**, the surfaces areas effectively irrigated by the Rhone amount to a total of just about **120,000 hectares** for an irrigable surface area of about 190,000 hectares.
In the Drôme department (1st agricultural department in the region), 80% of the agricultural irrigation volumes come from the Rhone and the Isere.

Productions and exploitation structures are varied, with specific development paces: rice growing demands large quantities of water, around 30,000 to 50 000 m^3/ha depending on the type of soils, but it is in decline. The surface areas cultivated in Comtat and the lower plain of the Rhone are shrinking due to the expansion of urban and industrial areas. Lastly, the progression of drop-by-drop techniques reduces water consumption by fragile crops (orchards and vegetables). These different factors could lead to a decrease in consumption. On the contrary, large surface areas dedicated to arboriculture are being transformed into plots for rapeseed/maize type crop rotation, following Italian and Spanish competition, and due to the aid provided by the CAP. The subsequent increase in water consumption could be accentuated as the biofuels sector develops.

Agriculture in the Rhone Valley is facing multiple challenges, including strong variations in prices, increasing regulations in favour of the environment, food safety and products quality, adaptation to climate change, exploding urbanisation… New models need to be found to ensure a better water management.

Withdrawals of water for energy production and industrial activities



On the **scale of the watershed of the Rhone**, most of the withdrawals are made from the tributaries and surface water. Irrigation and hydroelectricity production are the uses that require the most withdrawals.

The withdrawals **from the Rhone Valley and its alluvial groundwater** make up 22% of the net withdrawals on the scale of the entire basin. The major share of withdrawals are taken from the lower Rhone and are used mainly for agricultural purposes, especially rice-growing in the Rhone delta.

Annual withdrawals linked to energy production amount to about 12,800 million m^3. The river water is used as a cold source for cooling the coal-fired power plant of Aramon and the nuclear power plants of Bugey, Saint-Alban, Cruas and Tricastin. The energy produced annually by this sector amounts to 90,000 GWh.

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Multiple uses

Tourism and leisure

The Rhone attracts a large number of activities along the Valley, with the redevelopment of its banks, the development of tourism, and the restoration of navigability to the Upper Rhone. Growing numbers of canoeists, swimmers, jousters and pleasure boaters demonstrate renewed interest from the public in these activities. The most visited sites include the Miribel-Jonage Park and the leisure centres of Roches-de-Condrieu, Épervière at Valence and Barthelasse at Avignon.

The ViaRhôna is a biking track linking the Leman lake to the Mediterranean sea along the river. It represents a great development potential for the regions' touristy activities.

There is also an increase of tourism on the river itself: a boom in the river cruisers caused the number of passengers to rise from 12 500 in 1998 to 203318 in 2015.

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Governance and international cooperation

1/ Management on the Swiss Rhone

Ownership

Upstream of Lake Geneva, the Rhone belongs to the Federal Office of the Environment, while downstream of the lake it belongs to the Canton of Geneva and is managed by the *Services Industriels de Genève*.

Structure of governance

The structure of governance of the river in Switzerland is mainly organised around legal measures of public law and counts a great number of actors involved in the governance system. Cantons are very powerful, they are responsible for the creation and the implementation of the intercantonal Act with reference to the correction and the regulation of the Léman's waters, and for the concession contract delegating position for the management of installations.

The canton of Geneva is the lynchpin. It is the majority shareholder of the endowment capital of an operator dedicated to producing hydroelectricity, the authority that sets out the terms of the contracts for the concession of the dams of Seujet and Verbois, and the authority that determines the different missions assigned to the SIG (notably those relating to preserving the environment). The canton has to share its responsibility between the preoccupations of the actors located upstream of Geneva.

Main actors

SIGs: semi-private operators with the legal status of autonomous public institutions in charge of the operational management of the river works. The SIGs are electricity producers, heat, gas and water suppliers, waste and telecommunications managers. The company itself is exclusively owned by public actors (55% of the stocks belong to the state of Geneva, 30% to the city of Geneva and 15% to the towns of the Geneva canton), however it operates like a classic industrial actor on a market slightly open to competition. The SIGs can decide for their own industrial and commercial strategy.

The ICPLW: International Commission for the protection of the Leman Waters (ICPLW)

MPCPC: Motive Power of Chancy-Pougny Company is an incorporated company following Swiss legislation. The hydroelectric work of Chancy-Pougny is located on the hydroelectric network upstream of the SIGs works and downstream of CNR's works.

The Rhone

Governance and international cooperation

2/ Management on the French Rhone

Ownership: Water "*belongs to the common heritage of the nation*" (the Environment Code). The bed of the Rhone and its banks belong to the Public Fluvial Property of the State.

Management

In France, for the most part, the State entrusted its public fluvial property to Voies Navigables de France (VNF) on 20 August 1991. However, regarding the Rhone, VNF's competences are subordinated by the missions also entrusted by the State to Electricité de France (EDF), and above all CNR.

Each part of the river is managed by one specific actor. Here are these actors, starting from the upstream part of the Rhone, where it crosses the french border:

- From the Swiss border to the downstream part of the Sault-Brenaz derivation: CNR
- From the downstream part of the Sault-Brenaz derivation until the joining with the Ain department: VNF
- From the joining with the Ain department until the meeting of the Jonage canal and the Miribel canal: EDF, except for the Miribel canal, which is the responsibility of VNF
- All the way through Lyon until the confluence of the Saone and the Rhone: CNR for the Rhone river itself, and VNF for the banks
- From this confluence until the separation of the small Rhone from the Great Rhone in Arles/Fourques: CNR
- For the small Rhone between Fourques and the sea: VNF

These actors are in charge of the unique public river domain. In the "natural" and non built sectors, dikes that belong to local communities are not considered part of the domain, and they are managed by mixed unions or by union associations.

Governance

The governance structure of the French Rhone is very different than the one of is Swiss part, as it depends mainly on the coordination between private or semi-private actors. Contractual measures and the actors' slight auto-organisation for the management and share of water make the situation highly complex. Numerous agreements were made between the two main actors who have an industrial use of the Rhone: CNR (hydroelectricity production) and EDF (nuclear plants cooling).

Public actors are part of the actors' configuration but they do not directly interfere in the operational management of the river.

The Rhone

Governance and international cooperation

2/ Management on the French Rhone

Legal system

The OMWLP

The Organisation and Management of Waters Leading Plan (OMWLP) is a planning document that allows a consistency between the various uses of the Rhone in the Rhone-Mediterranean river basin. The OMWLP gives the lead on the fundamental orientations allowing a balanced management of the water resource and the necessary dispositions to get to it. It is produced by the Basin Committee and approved by the basin coordinating prefect.

The Basin Committee

The Basin Committee is a place for debate and for defining the main parts of the water management and the preservation of water environments policy in the basin, with the respect of the national policy plan. The Committee is a real "water parliament" and it gathers representatives of the State, of local elected members and of private users.

The Rhone Plan

The Rhone Plan was conceived in 2006 as a global project for sustainable development. Although the initial objective was to define a flood prevention strategy, it soon became logical to extend its scope to cover other areas of action. A second Rhone Plan was drawn up for the period 2015-2020.

The Rhone Plan has three main aims:
- reconcile flood prevention and the pressure to build in floodable areas;
- preserve and improve the living environment of the inhabitants;
- ensure the long-term economic development of this strategic territory.

It is organised around six thematic sections: heritage and culture; the prevention of flood risks; the quality of water, resources and biodiversity; energy; river transport and tourism.

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Actors

CNR: It's the Rhone operator, in charge of the management of 19 hydroelectricity production constructions, of the guarantee of good navigation conditions on the river and of the supply of water for agricultural uses (irrigation). CNR is the first world producer of 100% renewable energy (water, wind and sunlight); it's a incorporated company with a non-profit legal status, which means that the revenues made from hydroelectricity production must be used for the two other missions, and the capital is distributed between public and private stockholders.

The concession comes with a bill of specifications and a leading plan. By signing these two documents, CNR commits itself to operate constructions and actions on the river. The current leading plan goes from 2003 to 2023. It contains actions directly linked to CNR's main responsibilities but also guidelines about the environment protection. In 2004 CNR created **General Interest Missions** which are programs made for and in cooperation with local territories. These actions can be in favour of economic and touristic development thanks to the river; or in favour of the protection of the river wildlife, electric mobility…

Key-number: 446 million euros of investment are expected by 2018 for general interest missions:

- 1st and 2nd GIM plans (2004-2008/2009-2013): 286 M €
- 3rd GIM plan (2014-2018): 160 M €

Key dates

May 27th 1921: Rhone construction law
1933: Creation of CNR
1934: CNR is granted the exclusive concession of the Rhone for the next 90 years
1935: beginning of the construction of the port of Lyon called Edouard Herriot
1937: Beginning of the construction of Genissiat, first hydroelectric plant (Ain department)
1946: Nationalisation of electricity (creation of EDF)
1948-2000: Creation of a convention between CNR and EDF: EDF operates the plants, sells the production and keeps the revenues, while CNR builds all the Rhone works (19 plants from 1948 to 1986) and is paid for its missions thanks to a negotiated contract with EDF.
2000: liberalisation of the electricity market
2001: CNR changes status and is an independent electricity producer again
2003: Modifications of the stockholding system: a decree gives CNR a new status, and Electrolabel, a subsidiary of the Suez group, becomes a stockholder
2003: Creation of CN'Air, a subsidiary dedicated to wind power and photovoltaic development
2004: Start of the General Interest Missions
Since 2004: CNR diversified into wind and solar power and worked to develop new renewable energies (hydrogen, marine currents) and electric mobility, while offering its knowhow in managing intermittent energies and engineering services to third parties. It has fulfilled 2 plans of the Missions in the General Interest and launched a third in 2014.

The Rhone

Governance and international cooperation

Other actors on the Rhône

VNF: Voies Navigables de France (VNF) is a public administration in charge of the management of the majority of the navigable routes in France; its administrative supervision is done by the State through the General Board of infrastructures, transportation and sea water of the Sustainable Development Ministry.

EDF manages nuclear plants located on the sides of the Rhône. EDF needs a continuous supply of 130m^3/s in order to be able to cool down the temperature in the Bugey plant. For that matter EDF can use the waters of Arve for which it has a consecutive priority (granted by the State) of its uses for nuclear production and navigation.

The Basin coordinating Prefect: The Rhone-Mediterranean basin coordinating Prefect is the prefect of the Rhone-Alpes region, where the rhone-Mediterranean Basin Committee is located.

The DREAL: The authority in charge of CNR's surveillance

ZABR: The ZABR gathers 21 research institutions which, thanks to a multidisciplinary approach, study the interactions between the river environment of the Rhone and the societies that develop on its basin. It is a support for research programs that work on bringing elements that will help public decision regarding a sustainable management of waterways and their watersheds.

BRL: The National Planning Company of the Bas-Rhone and Languedoc Regions (NPCBRLR, turned into BRL in 1993) was created by an order in 1955. Its mission is to ensure the irrigation of the Oriental Languedoc and to diversify productions that are generally way too specialized in viticulture.

The Rhone

Governance and international cooperation

3/ International cooperation

1 – The management of water quality: the ICPLW

The surveillance of the lac Leman's waters quality is done by the CIPEL. Created in 1962 by a convention between France and Switzerland, the International Commission for the Protection of the Leman Waters (ICPLW) insures the surveillance of the lake's water quality of the one of its upstream basin. With the results obtained, the ICPLW makes recommendations every year in order to encourage the French and Swiss governments to take measures against the potential sources of pollution in the lake.

2 – Water volumes management

The Inter-canton Act
The regulation of the Leman lake is the sole responsibility of the Valais, Vaud and Geneva cantons thanks to an inter-canton Act (signed in 1884 and renewed in 1984). Its purpose is to guarantee the populations and the infrastructures safety. For historical reasons , French public and regional entities were not (and are still not) included in this regulation system.

The Emosson's international convention
The Inter-canton Act has an exemption called the Emosson's international convention (August 23rd 1963). It states that the water flow coming from the French watershed of Arve that was redirected during the Swiss construction of Emosson towards the Leman lake must be given back to France by a volume of 87 million m^3 .

The "Emosson waters" that are available for France are stored in the Leman lake; they are supplied by the Seujet in order to allow navigation, and more importantly to allow the cooling of the nuclear plants temperatures during very low water level periods.

In concrete terms, the lake's water level regulation is managed in Geneva thanks to the Seujet dam. This dam is under the responsibility of the SIG.

3 – The sediment management

The Arve meets the Rhone between the spillway of the Seujet and the Verbois dam. This torrent is concentrated with suspended matters (SM) that get stuck in the Verbois and Chancy-Pougny's installations, up to about 500 000 tons a year. To avoid this siltation phenomenon and a dangerous increase of the water level in the Verbois installation that could threaten some areas of Geneva, sediments evacuation operations take place every 3 or 4 years. They used to be called "hunts", but a more eco-friendly and better coordinated management was created and named "mixed sedimentary management".

4 – The Chancy-Pougny dam management

The Chancy-Pougny installation was first conceded in 1915. It is a franco-swiss dam, so the concession is attributed to both countries. The operator is called The Chancy-Pougny Motive Power Company (CPMPC Inc.)

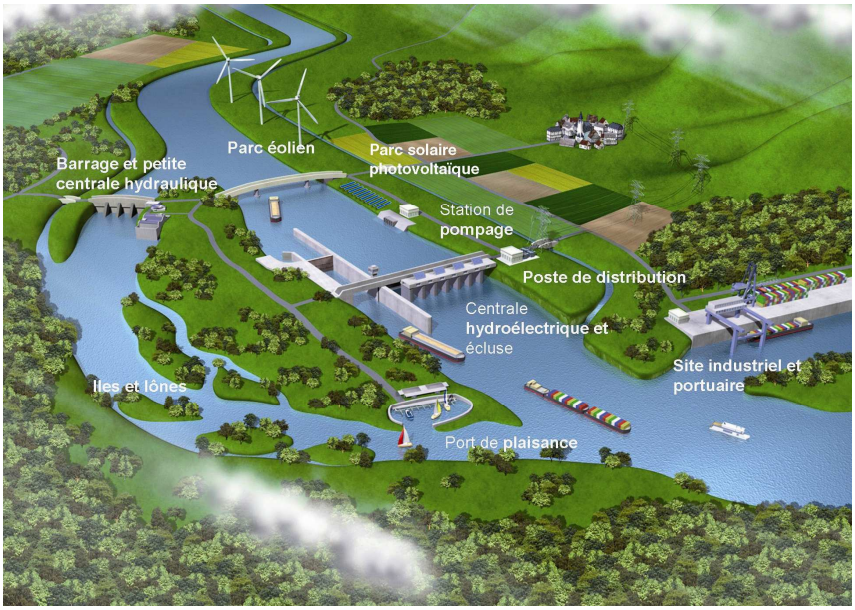
Rhone

Structures

Hydroelectric production

CNR has built and operates **19 hydropower plants and 27 small hydropower plants** (that have a total installed capacity of 3,103 MW). With 42 wind farms and 20 solar power plants, CNR has a global installed capacity of 3,696 MW in France in 2017.

General scheme of the Rhone's development by CNR



Navigation

Locks

CNR manages:
- 14 large locks
- 5 pleasure locks

Industrial installations and ports

CNR manages 18 multimodal platforms, including the port of Lyon:

- 184 ha on the left bank, south of the Lyon agglomeration, where the Saone and Rhone rivers meet. It gathers 70 industrials.
- The port of Lyon is a multimodal platform connected to 550 km of large leak. It is equipped to serve by several modes: river and maritime modes, rail, road and pipelines.

And 8 activity sites

In 2017, 4,42 million tons of goods were transported on the Rhone and 79, 649 containers.

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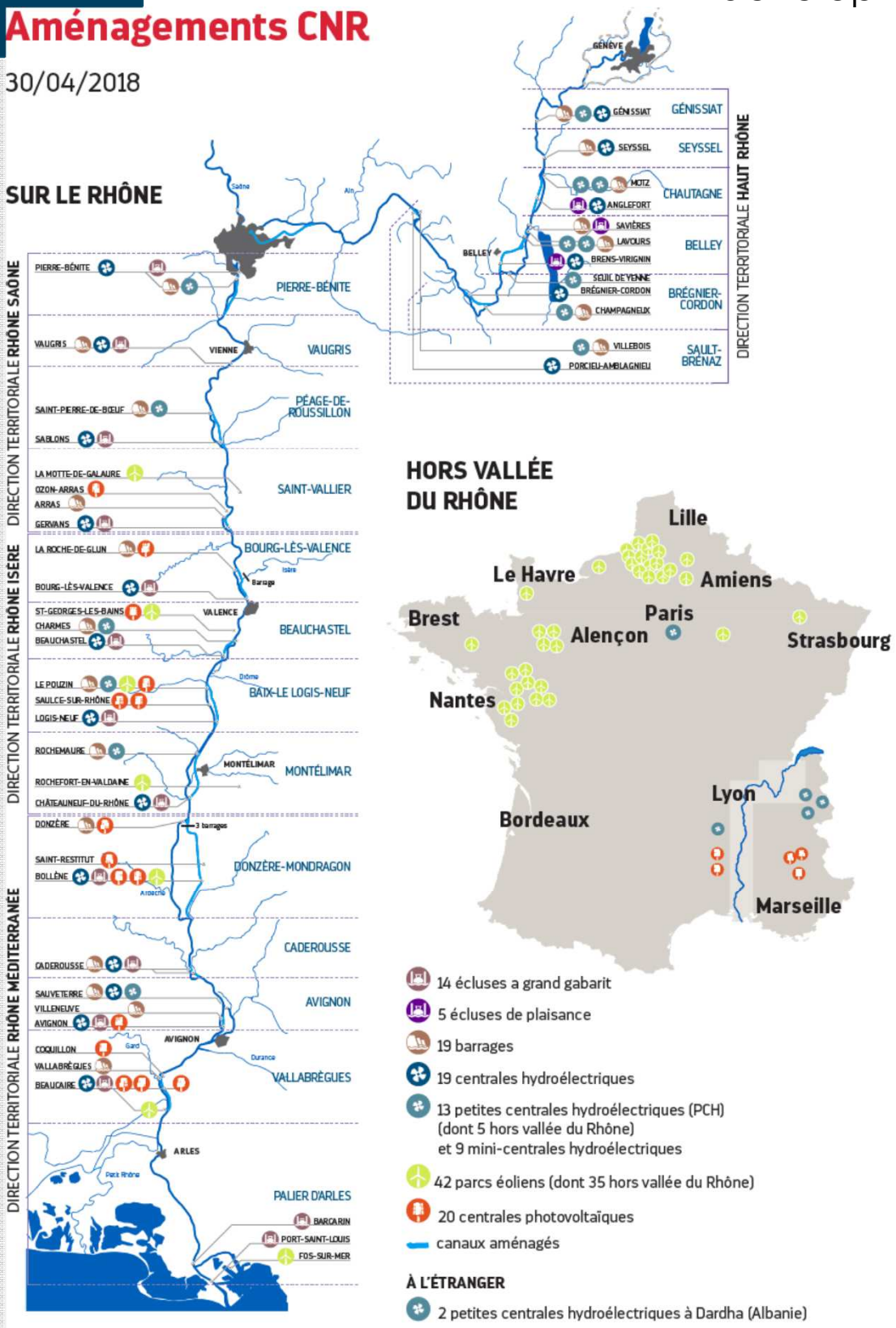
CNR's developments



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Rhone

Envisaging tomorrow's river

The river is characterised by diverse hydrographic conditions, a wide range of uses and the fact that it crosses a border, which involves coordination mechanisms and mediation between two different regulatory frameworks. This complexity has now been increased by the new challenges confronting the river.

The impact of climate change in the Rhone basin

According to river forecasting models, climate change will have impacts on discharges, temperatures and on the severity of extreme events (low water and heavy floods).

The RMC Water Agency estimates that an increase of 30% in withdrawals from the Rhone by 2060, combined with an equivalent fall in the Rhone's discharge linked to climate change, will exceed the capacity of the river.

Is the structure of the Rhone's governance robust enough to resist a change in the river's hydrographic regimes?

How will the configuration of actors and the different agreements evolve if the discharges of the Rhone are affected by recurrent extreme situations (from the standpoint of floods and periods of low water)?

Evolution of the hydrological regime

In winter, the snow will remain only at higher mountain altitudes; falls in volumes and more premature thaws will lead to more irregular flows in Alpine rivers. Increased evaporation rates throughout the year will reduce annual discharges and result in low summer flows in many rivers, inevitably causing conflicts between water users. However, how floods will evolve is less clear.

Result: a change in the relations of each economic actor with the river, especially during the low flows of the Rhone.

The delta

The Rhone delta is one of the most fragile French coastal areas with respect to climatic hazards.

Building dikes on the river does not allow the deltaic plain to defend itself against the rising sea level. The reduction of sediment deposits and consolidation of the mouth reduce the supply of sand to replenish the beaches. The unequal though fast retreat of the coastline is due to the exhaustion of sand supplies and increasingly aggressive sea dynamics.

Water pollution

The River Rhone is exposed to micro-pollutants due to the characteristics of the territory it crosses: industrial activities, large towns and cities, intensive agriculture and very busy highways close by, etc.

Different substances have been identified in the river, especially downstream of Lyon. Thanks to the Rhone's capacity to dilute them, the contamination is mostly found in the sediments and very little in the water. However, their effects on organisms have been observed.

Actions have been carried out to reduce discharges of micro-pollutants, with operations such as SPIRAL-Eau in the city of Lyon. Nonetheless, this task requires active engagement.

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Envisaging tomorrow's river

The weaknesses of the governance system

Cross border governance

The Rhone is by no means unaffected by cross border tensions, aggravated by climate change about which most of the actors ignored the impacts.

The strong interdependence between France and Switzerland regarding the water of the Rhone still requires a legal framework. Failing the implementation of adapted legislation, management of the water is usually limited to occasional collaborations to deal with specific problems, though there is no common or global vision of the stakes.

Creating a common vision of the Rhone's management

A common vision of the river started to emerge as early as the 1960s among specialists on fluvial topics, with initiatives that brought together experts from different disciplines (the natural sciences and the social and human sciences, etc.) to deal with the challenges of the Rhone. The *Zone Atelier Bassin* of the Rhone (ZABR) still drives this interdisciplinary approach. The notion of "hydrosystem"*, a term now employed all over the world, first came into use for the Rhone.

* A system composed of interconnected water and wetlands in a specific geographic sector, notably a watershed.

Increasing river transport

The landlocked nature of the Saone-Rhone basin to the north of Lyon for wide gauge boats, impedes the flexible management of hulls (the place where the goods carried by boats are stored). The adaptation of equipment to changes in traffic is difficult and requires costly transfers from boats. Certain port infrastructures and naval repair sites are saturated. Landlocked to the north, the traffic on the navigable waterway of the Rhone Valley is oriented southwards to the ports of Marseille-Fos and Sète. It suffers from the lack of competitiveness of Marseille-Fos in comparison to Genoa and Barcelona.

With the Rhone Plan, the actors involved have launched projects to overcome these handicaps.

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Envisaging tomorrow's river

The choice of energy policies

Energy transition

From a policy above all focused on nuclear and fossil fuels, European governments are tending to take the path of supporting the development of renewable energy sources, especially hydroelectricity. Consequently, the policies adopted by the Rhone's management are being reshaped by the presence of the hydroelectric sector and stronger environmental policies with, among other, the influence of European regulations. The management of the Rhone will be influenced by changes in energy policies and by the place of hydroelectricity in the energy mix at European scale, and by fluctuations of electricity prices.