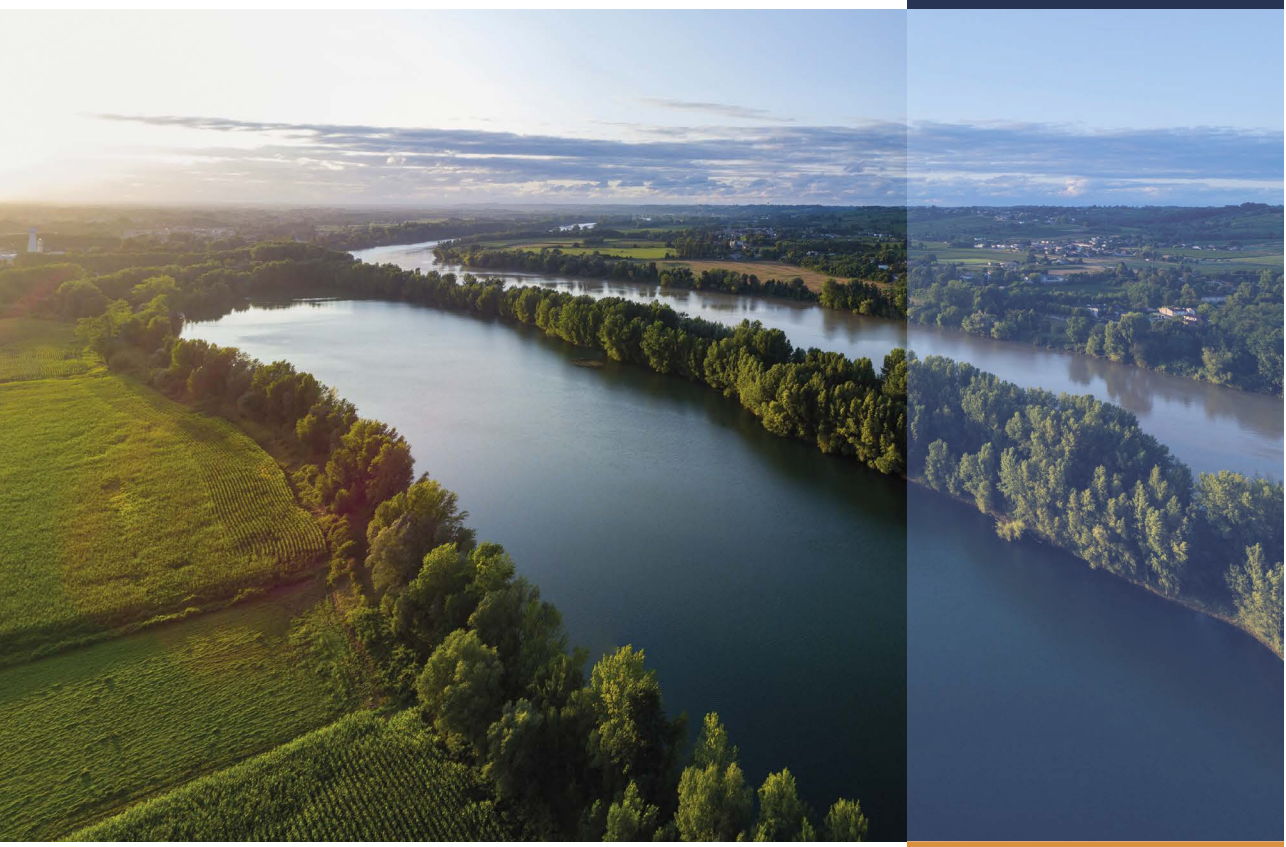
INITIATIVES POUR L'AVENIR
DES GRANDS FLEUVES
INITIATIVES FOR THE FUTURE
OF GREAT RIVERS

Toulouse/ Bordeaux
France



Resilience of territories to climate change:
the example of the Adour-Garonne basin

7th SESSION

APPEALS AND RECOMMENDATIONS

15/19 October 2018

Bringing together actors committed to the development and protection of the world's rivers, Initiatives for the Future of Great Rivers (IFGR) offers an original, international and multidisciplinary forum open to stakeholders and oriented towards action. It acts to conceive the river of tomorrow and contributes to enriching national and international debates on water and climate change. Indeed, rivers are situated at the heart of current climatic and environmental issues (energy, production, food security, public health, mobility, etc.) and could also provide solutions for building a sustainable world.

Founded by CNR, the multipurpose concessionary of the River Rhone and France's leading producer of 100% renewable electricity, IFGR is an association in the general interest chaired by Erik Orsenna, an economist and writer, member of the prestigious Académie Française.

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Introduction

IFGR held its 7th international session at Toulouse and Bordeaux (France), from 15 to 19 October 2018, hosted by the Prefecture of the Region and Greater Bordeaux. Why focus on the River Garonne and its basin? Because the Adour-Garonne basin lacks water. It is becoming scarcer, more variable and there is increasing pressure on the river due to the dual impact of climate change and rapid urbanisation. By taking the example of this basin – which will that most affected by climate change in France – and by providing the testimonies of our international experts to local stakeholders, IFGR is continuing its mission as whistle blower and facilitator of solutions regarding these key issues of hydric stress and the necessary adaptation of water management in the territories.

Furthermore, the Ministry of Ecological Transition awarded our session the National Water Conference label in the framework of its second theme titled: "*Climate change and water resources: how will the territories, ecosystems and all the actors adapt?*".

At the same time as we began our works, dramatic floods struck southwestern France, following long weeks of drought. These two apparently contradictory situations in fact form two dimensions of the same reality: climate deregulation. The political decision-makers of the Southwest* have the courage to face the difficult reality of the present. They came to declare water as a major regional cause and set out the priorities for preserving the resource and ecosystems. Faced with the shortage of water, emergency measures such as restrictions on the distribution of water for agriculture and domestic uses, and support to maintain low water levels, are no longer sufficient. It is necessary to rethink the management of water and its uses, by taking an integrated and long-term approach, by conducting collective reflection and ensuring the capacity of innovation. The role of our association is to assist these initiatives in order to protect and enhance our rivers and ensure that the territories become more resilient to climate change.

How can the needs for water be reconciled with its availability? This question was the guiding thread of our exchanges, which we structured according to four themes: **water for fields** or how agriculture is obliged to undergo transition to manage natural resources more sustainably; **water for towns and cities**, which brings together the challenges of urbanisation, artificialisation of soils and pollution; **environmental water** in order to maintain good environmental status and, finally, ensure the continuity of the services it renders; lastly, **the renewal of water governance** necessary for adaptive resource management on the scale of the territory.

* On 18 October, the Prefecture, the regions of Occitanie and Nouvelle-Aquitaine and the Adour-Garonne Basin Committee reached an agreement to coordinate the combat against the effects of climate change in the basin.

Rarefaction of water resources: key data at the global level

According to the United Nations' estimates, two thirds of the world's population could be living in conditions of hydric stress by 2025. This rarefaction of water resources already affects every continent: 1.2 billion people live in areas affected by drought and another 500 million are close to this situation – that is to say a quarter of the world's population. Water consumption has risen twice as quickly as the population during the last century. What is more, from now to 2050, demand could increase by another 55% due to demographic growth and the increased needs of industry and agriculture. According to the scientific journal Nature, half the world's cities could be faced with interruptions of their water supplies by 2050.

The rarefaction of water is therefore both a natural phenomenon and a human one. There is enough freshwater on the planet for 7 billion people but it is unequally distributed and too often wasted, polluted or poorly managed.

It's a daunting challenge for food security, health, biodiversity and peace in the world. The UN Security Council recently acknowledged the causal link between climate change and the multiplication and aggravation of conflicts.

The IFGR's panel of experts was working on the Garonne river: public meeting on 15 October, in Toulouse

The Adour-Garonne basin,
an illustration of the impacts of climate change on water resources

1

Normally, there is no lack of water in the Adour-Garonne basin, with 90 billion m^3 of rainwater received every year, two natural water towers, the Pyrenees and the Massif Central, 120,000 km of rivers, a temperate climate and a river, the Garonne, France's third largest in terms of discharge. For all that, tensions are already being felt.

1.1.

Tensions over water resources exist already

A **surface area** of
117,000 km²

3
regions covered
(Nouvelle-Aquitaine, Occitanie and part of Auvergne-Rhône-Alpes)

8 million
inhabitants

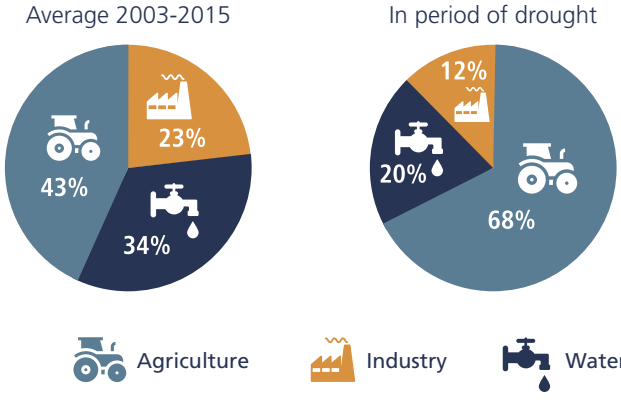
Tensions exist in particular during periods of low flow from July to October.

Maintaining a sense of community in this huge territory requires reconciling the different uses of water, including:

IRRIGATION

The basin has 800,000 ha dedicated to agriculture. About 20% of farmland is irrigated, leading to the **consumption of 900 million m³ a year** on average, withdrawn from rivers and streams (and their associated water tables) and farm reservoirs. Requirements for water increase during low flow periods and represent from 70 to 80% of withdrawals, leading to restrictions on drinking water.

VOLUMES ABSTRACTED BY WATER USES



The Adour-Garonne basin benefits from 90 billion m³ of water every year including 35 billion m³ of "useful rain" (not immediately lost through runoff). Human withdrawals of water amount on average to 2 billion m³/year, but can reach as much as 2.4 billion in a dry year.

Source: Adour-Garonne Water Agency

DRINKING WATER

Withdrawals for drinking water amount to about **700 million m³/year**. They are made from rivers, groundwater and captive aquifers.

INDUSTRY

More than 90% of withdrawals of water destined for industry (paper, automobile, aeronautical, nuclear power, etc.) are made from rivers. This represents about **400 million m³/year**. Nearly 90% of the water is returned to the natural environment.

90%
of the water destined for industry is returned to the natural environment

Account must be taken of other uses such as hydroelectricity, the protection of natural habitats, navigation, and leisure activities in natural sites.

The management of low flow periods: ensuring the best possible quantitative distribution of the resource

Systems for supporting low flows, intended to offset the volumes withdrawn by irrigation and drinking water in summer, are managed by the SMEAG (Syndicat Mixte d'Études et d'Aménagement de la Garonne). The Garonne is not equipped with reservoirs dedicated to support low flows. Therefore, it is necessary to recharge the rivers from hydropower structures (releases from dams). Specific reserves have been excavated over the last forty years. At present, 8% of electricity reserves are devoted to supporting low flows, i.e. a usable volume of 52 million m³ withdrawn from 7 dams.

Nonetheless, the level of supply no longer satisfies the demand for withdrawals: there is a shortage of about 200 million m³ during low flow periods. How to deal with this deficit? The answers given remain marked by a binary vision split between saving water – which can lead to financial losses for the farmers and the deterioration of water quality, notably in the estuary – and the formation of reserves to guarantee available supply.

With its Garonne-Ariège Low Flow Management Plan 2018-2027, the SMEAG wants to provide a technical management and forecasting tool shared at interregional level to permit the co-existence of all the uses of water and the smooth functioning of wetlands during low flow periods.

1.2.

The dual pressure of demography on water and soil

Toulouse and Bordeaux are the two most dynamic cities in France, with a demographic growth rate of more 7% between 2010 and 2015. This dynamism demands more water and more space: between 1996 and 2010, 4,000 ha of land (+ 11%) were artificialized to the detriment of natural spaces and farmland. In a context of strong economic and demographic development, the challenges have to be met on two scales:

- **The territorial development** to maintain a reasonable balance between natural spaces, farmland, forests and urban areas;
- **The resource sharing** between the different uses while maintaining the quality of wetlands.

“Without water, we couldn’t justifiably aim to receive an additional 50,000 inhabitants per year. (…). Efforts have to be made regarding the major components of our life on Earth. I’ve mentioned water but I could also talk about soil. In our region, the artificialization of soils has started to reach unacceptable levels. Each new inhabitant of Occitanie leads to the artificialization of about 600 m² for their residence, school, hypermarket, sports ground, etc. We can no longer continue with figures of this magnitude.”

PASCAL MAILHOS,
PREFECT OF THE OCCITANIE REGION, PREFECT OF THE BASIN (UNTIL 6/11/2018)

1.3.

And tomorrow…

The increase in temperature, already begun, should reach +2°C by 2050 and will have many impacts on the environment, the landscape and water resources. Whereas water resources will be less plentiful and more variable, demographic pressure will be stronger, with an additional 1.5 million inhabitants in 2050.

Three major impacts have been identified:

RESOURCE AVAILABILITY

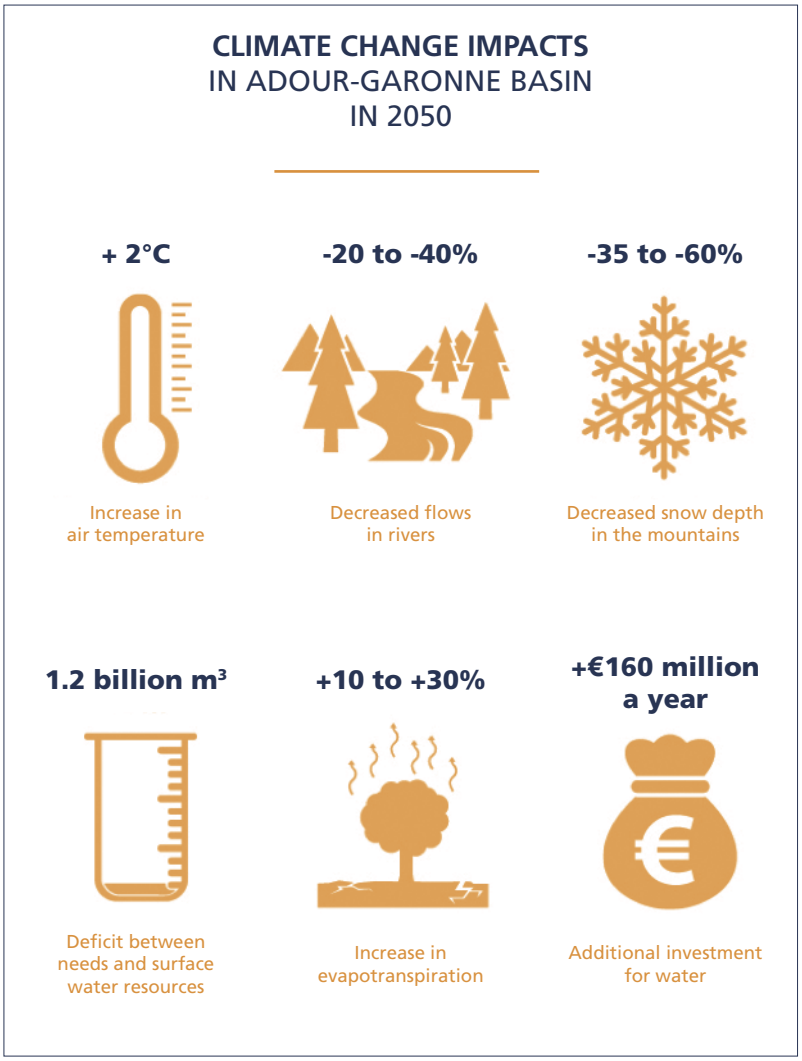
The discharges of the river will plummet by around -20 to -40% over the year, with low flow periods with half as much water as the discharges at present in summer and autumn. Soils will suffer more regularly and more intensely from droughts and aquifers will no longer have the same recharging capacities.
The deficit between needs and water resources is estimated at 1.2 billion m^3 in 2050!

WATER QUALITY AND WETLANDS

The reduction of discharges will reduce the river's capacity to treat discharges of effluents generated by human activities naturally, due to its reduced capacity to dilute them.
Furthermore, the temperature of these waters will increase, leading to a lower rate of dissolved oxygen, increased eutrophication and the proliferation of algae, greater ecotoxicity, etc.

THE INCREASED VULNERABILITY OF TERRITORIES TO EXTREME EVENTS

Extreme climatic events (droughts, heatwaves, floods) will occur more frequently and be more intense, with other associated risks on the coastline such as coastal erosion and marine submersion. Those territories with the most artificialized land will be the most exposed.



Source: Adour-Garonne Water Agency

> *The territories must be trusted to find the best possible combinations and stop disputes with each other about ideal solutions.*

ALINE COMEAU,
DEPUTY GENERAL MANAGER, ADOUR-GARONNE WATER AGENCY

In order to go beyond the diagnostic, in July 2018 the Adour-Garonne Basin Committee* adopted **a Climatic Change Adaptation Plan**, positioned as a reference document on the scale of the basin and a repository of solutions to be appropriated by public and private actors. **Its implementation requires a constant and regular investment of about €160 million a year from now to 2050.**

It has four main objectives:

- **Find a new balance between needs and resources** through the adaptation of individual behaviours, lifestyles and production, and by building new material infrastructures for storing water when it is plentiful and supplying it as close as possible to needs, recycling it and protecting populations.

- **Reduce pollutions at source and treat them better:** water quality is under threat due to the reduction of hydrology and the increase of water temperature.

- **Strengthen the capacity of natural wetlands to resist** a warmer and drier climate and play their role in regulating the hydrological cycle. This also concerns soils which must be moist and alive, capable of retaining water on the scale of watersheds.

- **Protect against natural risks:** floods, coastal erosion and marine submersions.

This plan shows that the whole challenge of resilience to climate change consists in determining a panel of solutions with the different levers of nature, scale and time. There is no single or ideal solution. It does entail however **getting users to acknowledge their interdependence and set up a community of interests** whether in the same sector (for example, the distribution of water between irrigators) and between sectors.

The other condition is political: it is important to leave behind the technical and sectorial management of water (agricultural, industrial, urban, natural heritage, etc.) and progress to **making water the backbone of different territorial policies**.

* Also called the "Water Parliament", the Basin Committee organises consultation and solidarity between all the actors in water on its territory, by defining a wetland management and development policy. It orients the actions of the Water Agency by drawing up, monitoring and updating the water management and development master plan (SDAGE) every six years.

How can the resource be better shared?

2

Water is not only a technical subject. It raises all the issues involved in living as a community. Sharing it well and better is a collective challenge, concerning the general interest, henceforth necessary in the face of climate change, in order to prevent the spread of individual, short-term solutions.

2.1.

Acknowledging the value of water in all its dimensions

70%
of the water managed by the CACG is intended for the environment.

The missions entrusted to the CACG (Compagnie d'Aménagement des Coteaux de Gascogne) lead to considering all the uses made of water and acknowledging its environmental value in particular. This subject is moreover increasingly present in international meetings on the Sustainable Development Goals, regarding **solutions based on nature and the notion of ecosystem service, which evaluate the importance of environmental protection for maintaining economic activity and the well-being of populations**.

The CACG manages a number of structures that connect the Pyrenees with the 17 rivers of Gascony (2,000 km of rivers) via the Canal de la Neste, and stores water for different uses. The main uses are drinking water supplies, irrigation (this system irrigates 50,000 hectares of farmland) and maintaining biodiversity and low flows, given that these rivers run dry naturally for part of the year.

70% of the water managed by the CACG in this "Neste system" is intended for the environment. Climate change demands taking greater account of the environmental dimension in the system's management. In 2017, the CACG was obliged to support low flows until the end of December.

Recognising and defining an environmental value for water has become vital. The question of the economic value of the services rendered by water, as yet ignored, should be raised.

"Nobody pays for environmental use today. The financial balance is provided by drinking water, industry and 90% by irrigation. Besides the economic aspect, there is a legal question: in the absence of a contract, who will define uses and remunerations. There is only one regulatory obligation in the framework of the SDAGE (Water Management and Development Master Plan) to supply water to support low flows."

ALAIN PONCET,
GENERAL MANAGER OF THE CACG

2.2.

Being collectively responsible for a common good

Sharing water resources raises the question of their governance: who distributes it? At what level, local, regional or national? And how? Several examples that orient the policies of infrastructure managers and basin administrations were presented to us.

IN AUSTRALIA: AN ORIGINAL METHOD FOR MANAGING WATER IN RESPONSE TO A HUGE CHALLENGE

Katherine Daniell, PhD and researcher at the Australian National University, sketched a portrait of a country that is certainly one of the first to feel the effects of climate change. Australia's climate has always been variable, with periods of drought and heavy rains that its indigenous populations learnt to live with for over 40000 years. As far back as the late 1700s and 1800s, European colonists and other migrants settled the country in a manner to ensure their access to water and even at Federation, at the turn of the 20th century, negotiations were held between the States and New Federal Government to determine the roles of each entity in managing the Murray-Darling Basin, the country's largest hydrographic network*.

Australian culture is marked by this reality of climate variability. However, it was necessary to carry out novel structural reforms in the late 1900s and early 2000s, due to the effects of climate change and impacts on the environment of lifestyles and economies that consume large quantities of water. The water diverted from the basin inflows for agriculture represented less than 50% of resources in the 1980s but rose to 76% in the 2000s at the peak of the millennium drought. Due to these significant withdrawals, the mouth of the river has often completely closed and many sensitive riverine ecosystems have struggled to survive.

Following several waves of reforms that had not achieved the reductions in river withdrawals required to support the health and functioning of the river and its dependent communities, the Federal government decided in 2007 to centralise the management of the basin, with States having to refer their power over water to them. The Murray Darling Basin Authority thus was set up at the end of 2008 and, after much argument, controversy and debate, the Basin plan -that set new sustainable diversion limits (i.e. the total amount of water that can be extracted from the basin)- was adopted in 2012.

* The Murray-Darling Basin covers an area of 1,072,000 km² (14% of the territory) and encompasses 70% of irrigated land and 40% of farm production. It is also home to over 2 million people.

New limits on water extraction from the basin were set.

The new Government policy included:

- Setting **new limits on the amount of water that can be extracted** across the basin;
- **Setting up a market where water access entitlements (rights) could be bought or sold** in addition to the existing water allocation markets. This new market was made possible by a regulatory change that disassociated water access rights* from land ownership deeds.
- **Setting up a Government managed 'Environmental Water Holder'** to purchase and manage water for the environment.

Through these reforms, the government invested Aus$10 billion to purchase these water entitlement and restore water to natural habitats, renovate irrigation structures and introduce innovative management systems, in particular for urban water (desalinisation; reutilisation of water taken for irrigation; recharging of aquifers; a system for measuring and predicting underground water resources, etc.).

With these new governance arrangements and water markets basin, it has been possible in periods of drought to reduce water extractions significantly from the basin, without having a large impact on the volume of production in economic terms. This is since water is transferred to crops of higher economic value and other farmers survive on the sales of their water, rather than producing crops. About 10,000 water allocation and 5000 water entitlement transactions are made a year representing a total volume of over 4 million m^3 of water, depending on the year. These water markets are now commonly used by farmers with irrigated land but also increasingly used by investors and drinking water suppliers.

Introducing these reforms was difficult but the water crisis situation strengthened political will and helped to convince water users and voters of the need for change. However, these reforms required concrete prerequisites such as effective water metering, accounting and compliance systems– meaning they cannot be easily transposed to another country without such systems. Despite some improvements in the Basin's management systems, there are still parts of it requiring further reforms. Today, it is still necessary to adapt the governance system to ensure better compliance and protection of ecosystems while balancing the water needs of urban and rural areas. We also need to think about how the Basin will function in the near future, when temperatures will more regularly reach 50°C! At the end of November 2018, after catastrophic winter harvests, the government has proposed the creation of a new Aus$5 billion fund to prepare the country for the impact of future droughts.

* A system of water allocation quotas and associated markets have existed since the 1980s as a means of allowing redistribution of the resource between water users.

OTHER EXAMPLES FROM ELSEWHERE

Sun Feng, Deputy Director of International Cooperation at the Yellow River Conservation Commission, **in China**, presented the system set up for this river basin. This commission was founded in 1998 to manage water resources on the scale of the basin, which is subject to serious problems, including sedimentation, pollution and drought. Since then, it has distributed water quotas between the 9 provinces crossed by the river and it is the provinces that are responsible for controlling the withdrawals so as not to overshoot the annual quota allocated.

Another member, Corinne Castel, an archaeologist and Director of Research with the CNRS, described the situation in **Oman, in the Middle East**. Water there is a rare commodity, more valuable than oil. The Sultanate of Oman uses an irrigation technique called "falaj", consisting of underground galleries that avoid evapotranspiration. All the water produced by the falaj is allocated according to distribution based on a unit of time called "water round". Since the discharge of the falaj varies during the year, the volume of available water varies too, in rhythm with the seasons. Each farmer is the owner of a given irrigation timeslot rather than of a quantity of water. The water round is divided into smaller units of time, down to a half hour of irrigation. The management of the water is entrusted to a village institution that monitors the cycle and the distribution between the beneficiaries. Water is a tradeable commodity, with properties of permanent right or the weekly purchase of an irrigation timeslot, based on the principle of mutual dependence.

Will it be sufficient to regulate demand in the future? Nothing is less certain. To return to the Adour-Garonne basin, in 2014 the SMEAG introduced a fee for the service rendered of low flow, paid by large industrial companies, municipalities and irrigators and which participates in the funding the operations (between €2 and 4 million/year). This system functions well but might prove inadequate, with forecasts of even lower flows in summer and autumn. **A more shared, community-oriented and environmental approach between the upstream and downstream reaches is required to guarantee that the policies implemented are accepted.**

2.3.

Developing consultation to build a common project

Water is becoming scarcer; it is necessary that everyone feels more involved in its management and that claims by various sectors are avoided.

“Through water, we touch on key issues of democracy and its link with the Republic in the true meaning of the term, that’s to say a common project. Without a common project, democracy is merely a means.”

ERIK ORSENNA, CHAIRMAN OF IFGR

Not just in Toulouse but everywhere in France, the drama of Sivens*still sours the debate on the creation of new reservoirs. To avoid all forms of radicalisation, water must not remain a subject for specialists, and the sharing of responsibility must take precedence to avoid conflicts. For example, the CACG has set up the Neste Commission that gathers all the actors together in an operational manner. In a situation of crisis, shared solutions to reduce consumption are sought to avoid the prohibition of withdrawals.

“We have to make a great effort to assist the stakeholders to become more aware, and make them understand that they are jointly responsible for aiding projects. This joint responsibility implies consensus and therefore the rejection of radicalisation.”

HERVÉ GILLÉ, CHAIRMAN OF THE SMEAG

* The project to build a dam at Sivens (in the Tescou valley near Toulouse) in the 2000s stirred fierce opposition, the occupation of the work site and confrontations with the police. A young demonstrator died in 2014 during these clashes, leading to the interruption of the project and the abandon of any new project to develop a reservoir in France.

The territorial project as a tool of mediation relating to saving water and sharing its management

In France, a new approach to "territorial water management projects" incorporates a global view that takes into account all the uses of water and associates all the actors of the territory. Jean-Michel Fabre, Vice President of the Departmental Council of Haute-Garonne, came to present the Garonne Upstream project for better quantitative management, with three main orientations:

- **The creation of new reservoirs and the optimisation of existing ones** (i.e. 20 million additional m^3 of water);
- **Assistance for farmers** to control irrigation and manage soils capable of retaining water;
- **Improving the yield of irrigation networks.**

Dialogue with the community is the keystone of the approach.

How can we adapt to climate change?

3

The territories must show more resilience by combining different solutions, innovating and regularly questioning the choices made. Climate change underlines the need for collective intelligence.

3.1.

Finding not one but several solutions adapted to the territory: the example of agriculture

Our session dealt extensively with the necessary transition for agriculture, which has already begun in Adour-Garonne. Agriculture is indeed in the frontline: first, because it uses 70% of the world's freshwater and is sensitive to meteorological conditions; second, because it supplies food to the planet's ever larger population.

Viticulture is a major activity in the basin and wine is an important component in the economy and heritage of the Bordeaux region. Adapted to high temperatures, grapevine resists hydric stress well as its root system is capable of delving deep into the soil to find the water the plant requires. Traditionally, the vineyards of Bordeaux are not irrigated. However, the quantity of water potentially available can affect yields and quality. **Finding the right level of hydric stress that grapevines are capable of withstanding is therefore a challenge to adapt to climate change**, as emphasised by Nathalie Ollat, a research engineer with the INRA.

What solutions? Irrigation is seen as an obvious and efficient way of mitigating drought and it can, in the short term, secure yields without affecting quality. Many vineyards in France and elsewhere in the world are irrigated or becoming so. For example, the Société du Canal de Provence (which transports about 200 million m^3 of water a year to the rural territories of southern France for agriculture, industries and local authorities) has just formed a partnership with the wine cooperatives of Côtes de Provence, and Coteaux Varois and the IGP du Var to develop its irrigation networks over 20,000 ha of vineyard, which will be greatly affected by the phenomenon of evapotranspiration. The project will cost €250 million, paid in part by the profession.

But in the long-term, this approach alone comes with several risks: it is subject to legal constraints (particularly in France where irrigation is strictly regulated for harvests labelled PGI – Protected Geographical Indication – i.e. 96% of French vineyards), it is expensive to install, it can lead to problems of soil salinization in certain regions where the soil already contains salt, such as areas close to the coast and, lastly, and it can make the plant dependent. Irrigation without prior careful consideration is not sustainable and tension over water resources is increasing.

It will therefore be necessary to **mobilise and combine several modes of adaptation relating to plantation and production, besides possible irrigation**: selecting new varieties and rootstocks, modifying cultivation practices (staggering harvests, upgrading wine-making methods, etc.), giving attention to soil quality and spatial distribution to allow the grapes to withstand more higher temperatures.

TESTIMONY FROM MICHEL DELAERE & ISABELLE DUPOUY, OWNERS OF «LES ACACIAS» VINEYARD, SPECIALISED IN PRODUCING THE PGI WINE CÔTE DE GASCOGNE AND AOC ARMAGNAC AT BEZOLLES, IN GERS (FRANCE)

The major drought periods that struck from 2011 to 2013 had an impact on the quality of our productions, leading to a loss of income. This triggered our search for "smart" irrigation, which resulted in 2015 in the installation of 88 km of piping to supply water drop-by-drop. The water is pumped from the river across the valleys to the feet of the vines.

This installation, which is controlled regularly and capable of predicting the needs of the plants for water and nutrients, has allowed us to renew 7 ha of "new" and organic vines on our 28 ha to replace the part damaged by drought and diseases.

We also changed to mechanical pruning to give the grapes more space and give them denser foliage to provide shade and protection against the sun's rays and to prevent water from stagnating. We planted almond trees and organic mustard to protect the vines against strong heat and provide them with the nutrient elements they need to thrive.

Agri-forestry promotes the well-being of the vines and the development of biodiversity (birds, insects, etc.) and natural protection against strong winds and the rain: a virtuous circle of sorts.

Agriculture as a whole has to change its production systems in order to use resources sustainably – soil, water, energy – and reduce the use of fertilisers, water and phytosanitary products. **It's obviously a question of water, how to use it better and save it**.

This requires, for example, staggering production through the season, drop-by-drop irrigation and smart control systems that collect data from the soil, the atmosphere and the plants in real time to distribute water at the right time.

Changing cropping practices is another path. Mozammel Haque, President of the Bangladesh Inland Water Transport Authority, shared the experience of agriculture in Bangladesh, as the country suffered food shortages in 1971, although it now finds itself with a food surplus. Farming innovations have been introduced with varieties which require no artificial fertilisers when the water recedes from the fields (every year, 40% of farmland is flooded) and, in the case of rice, varieties that tolerate sea salt and which no longer need freshwater. They now make up 30% of the country's total food production.

Lastly, there is the issue of economising soils. Reintroducing soil biodiversity, by combining several crops, could also nourish soils and favour the infiltration of water rather than its runoff.

"We're now in a period of profound transition, in which the issues of water, fertilisers and phytosanitary products have to be treated as a whole."

MADINA QUERRE,
GENERAL SECRETARY OF BIOTOPE FESTIVAL

3.2.

Becoming aware of the risk and changing it into an opportunity

The Bordeaux region is subject to the dual risk of the sea and the river. The confluence of the Garonne and one of its tributaries, the Dordogne, and the largest estuary in Western Europe (635 km^2), mostly open to the sea, exposes the Bordeaux metropolitan area to the risk of flooding. The tidal range in the estuary can reach 7 metres between the low and high tides and the discharge of the Garonne can vary from 100 m^3/s to 5,000 m^3/s. Climate change will make the hazard of submersion more frequent, with an additional water height of 20 to 60 cm taken into account by the city.

The Garonne Eiffel project will accommodate **19,000 inhabitants** and **10,700 jobs.**

However, nearly 13,500 hectares, i.e. almost a quarter of the city's total surface area are located below the sea level at high tide and so are potentially vulnerable to flooding.

A Flood Risk Protection Plan has been drawn up to ensure the city's development while taking this risk into account. Protection structures (80 km) have been brought under direct management by the city to ensure their durability; dikes without heightening have been restored and the rivers protected to ensure flows.

The city's major urban development projects also take this risk into consideration, and even go so far as to make it a structural component of their responses. This is the case of the Garonne Eiffel project, sited on 128 hectares on the right bank of the Garonne, of which 100 ha are floodable. It will accommodate 19,000 inhabitants and 10,700 jobs in the long term. For this vulnerable site, the design and construction supervisor, Bordeaux Euratlantique and the Ingérop engineering office, reversed the usual design approach: the flood risk was transformed into an opportunity rather than one hemmed in by the constraint of conforming to the non-floodable zones and water level thresholds. The development therefore includes a resilient global hydraulic design that incorporates 17 hectares of green space in the floodable perimeter, which functions like a network thanks to wide, shallow ditches called *noues**, and discrete channels that allow the water to pass and control flooding. In the case of flooding, culverts distribute and spread the water over the largest surface area possible to reduce water heights in the residential zones. It will then be channelled into the hollows and the lowest points before being directed to the drainage networks. In addition to their key role in reducing the exposure of the inhabitants to risk, these green spaces enhance the landscaping of the site. The buildings also participate in retaining and distributing the water, for example, by avoiding the creation of corridors into to which the water can surge between two buildings.

* A wide, shallow and planted ditch, that temporally holds water.

3.3.

Experimenting and foreseeing

More than
80%
of wastewater in the world is discharged into the environment without treatment.

Worldwide, **only**
2%
of wastewater is used.

Climate change and the numerous associated hazards it causes **call for flexible and reversible solutions, and foresight**.
This is the case of farmers who are now testing tomorrow's solutions. Likewise, for the managers of hydroelectricity plants. At CNR (the Compagnie Nationale du Rhône, manager of the River Rhone), the impacts of climate deregulation are perceivable: in one century, the spring peak due to snow melt has advanced by 22 days. In Switzerland, the Furka glacier, the source of the Rhone, is receding every year and will have vanished before the 22nd century. Today, melting glaciers provide additional water that globally offsets the fall in volume linked to climate change. However, it is necessary to prepare for the following phase to mitigate the fall in hydroelectricity production and to continue balancing uses. The actions to be carried out are multiple: increase flexibility in operational maintenance programs, store energy, strengthen coordination between users in the Rhone Valley as well as on the border, preserve natural habitats, especially the Camargue which is sensitive to salt water intrusion.

It is also necessary to think of new resources, such as wastewater. In 2017, the United Nations published a report with the title "*Wastewater: an unexploited resource*". It demonstrated that improved management of wastewater could have definite economic and environmental benefits, since the global demand for freshwater is increasing and more than 80% of wastewater in the world is discharged into the environment without treatment. Worldwide, only 2% of wastewater is used although an increasing number of countries are turning to it, such as **Israel** which lifted regulatory barriers and now uses 80% of its wastewater, and **Singapore**, where NEWater has become the symbol of the nation's success story. Wastewater there is purified and demineralised for industrial purposes and partially for consumption.

An incentive policy to reuse wastewater could serve agriculture in particular. For example, an experiment on grapevine was performed at Gruissan, in Languedoc-Roussillon, to test the impact of micro-irrigation using treated water (the Irri-Alt'Eau project carried out by the INRA).

Health regulations currently prevent greater recourse to wastewater; the challenge of gaining social acceptance is also considerable.

3.4.

Knowledge to understand and orient action

Managing water requires collecting data for supervision, control and anticipation.

This makes research essential. An example was provided by a study called REGARD (Reduction and Management of Micropollutants In the City of Bordeaux), carried out by the City of Bordeaux on the effects of micropollutants generated by human activity (heavy metals, pesticides, fuels, drug and domestic cleaning product residues, etc.) on wetlands.

Carried out over 4 years and endowed with a budget of €3.3 M, this project is interesting for several reasons:

- **The diversity of the partners** brought together from public and private research, alongside the municipality;
- **The implication of citizens**: public information and awareness are dimensions that has been an integral part of the project since the beginning and "Water challenge" families have been associated with the diagnostic and actions;
- **A global approach on the scale of the city** to take into account sources of pollution and hazardous substances in a context of strong economic and demographic development: 258 micropollutants have been diagnosed from source to the natural environment by conducting an array of measurements (73 sampling points) and analysing their impacts to select actions to be implemented in priority;
- **Experimentation** by seeking solutions for reduction and their application to evaluate their efficiency, cost and social acceptability. Lastly, the aim is to help the city orient its choices to combat these pollutions;
- **Its capacity of transferability and reproducibility** in other territories.

The collection and supervision of data therefore permits guiding public and private actions. For instance, it is vital to improve the performance of irrigation systems (knowing the volumes withdrawn using connected meters and the surface areas irrigated permits optimising network design, improving the yields of irrigation channels and precise invoicing of consumptions). Likewise, for drinking water, as we were able to see during our visit to the Remote Control Centre of Ausone which continuously monitors the drinking water network. Also, in Bordeaux, the RAMSES system installed by the City and SUEZ, is another strategic component of water management policy devoted to rainwater: rain episode forecasting, flood protection, storage and removal.

Recommendations for assisting change

This week provided the opportunity to reflect on the future of a basin of activity crossed by the Garonne, and its governance. What priorities for what uses? What practices have to change? What choice of urban planning options? What facilities should be decided? With what investments? What knowledge should be taught in schools and elsewhere, to make the users of water aware of their interdependence?

Several major recommendations regarding the future of the basin were outlined to Alain Juppé, the Mayor of Bordeaux and President of Bordeaux Métropole.

1. PLACE RESEARCH AT THE FOREFRONT:

In the era of metamorphosis in which we live, it is important to understand what is happening, by looking towards the long-term in order to ensure the continuity of data, interdisciplinarity and the communication of the results.

We know that the discharges of rivers will tend to decline. Finding sustainable solutions to ensure the continuation of every use is no simple matter, for two main reasons:

- It is no longer possible to use only current data as references and build models based on historic data. The criteria for building new facilities, whether for a wastewater treatment plant or water reservoir, have to take into account the fact that water will be less available and that climatic phenomena will be more extreme.

- We cannot focus on a single dimension, since climate deregulation triggers an array of risks that will accumulate*. As emphasised by Bernd Gundermann, architect, one mustn't project oneself into the future by looking at only one parameter while considering the others will remain stable. We have to combine the potential of disturbance and effects in cascade, not only in the natural environment but also in the economic and political environment.

* A study published in Nature Climate Change on 19/11/2018 shows that climatic hazards can generate 467 different risks for life on Earth, whether for health, food, water, infrastructures, the economy and security

The IFGR Rivers Committee was welcomed at City Hall by Alain Juppé, the Mayor of Bordeaux and President of Bordeaux Métropole.

The long-term and the variability have to be taken into account in decisions. Interdisciplinary research programs – like the PIREN programs for the environment in France – are capable of responding to this level of complexity. This means that students are trained to follow this approach in universities.

2. SIMPLIFY

Today, water remains a nexus of sectorial policies - agricultural, industrial, urban, etc. – and is subject to a complex administrative system. Good territorial water management requires flexibility, a simplified administration and a long-term collective vision.

> *“Having a collective vision requires creating trust between urban and rural territories, between upstream and downstream, between different economic activities, and between technical knowhow and political will.”*
>
> **ALINE COMEAU,** DEPUTY GENERAL MANAGER, ADOUR-GARONNE WATER AGENCY

3. UNIFY

The river should not be segmented, either regarding its course or its uses. Each river is unique, living entity. This is one of the keys of the respect with which it must be treated. This unity must be geographic, achieved by ensuring that all the territories crossed by the river participate in its life, but it is also functional, associating the public and the private.

> *"A river cannot be segmented between several regions or cities. Why not found a national company of the Garonne, like the Compagnie Nationale du Rhône, to ensure this unity?"*
>
> **ELISABETH AYRAULT,** CHAIRWOMAN AND CEO OF CNR

Managing a river therefore supposes control of the general interest.

4. DYNAMIZE

Confronted by climate change, three transitions have to be achieved at the same time: energy, agricultural and urban. They are closely linked and water lies at the heart of these transitions. The new situation of less water has to be incorporated in the formulation of agricultural, tourism, urban planning and territorial development strategies.
Incubators and start-ups working on water could breathe life into this new economy. They will be positioned at strategic locations outside the two cities to encourage the territories to adopt their projects.

5. SHARE

Sharing data and practices, especially in agriculture which is now undergoing radical transformation, to create a new economic model is the only means of avoiding confrontations between positions of principle, bypassing individual solutions that result from laisser-faire approaches, and defining the rules needed for the general good.

6. SEQUENCING SPATIAL, GEOGRAPHIC, SOCIOECONOMIC AND TEMPORAL SCALES

Sequencing projects in space and time, whether for irrigation, water supplies to cities or urban development, allows better linking of different interdependent natural resources like water, soil and biodiversity in the long term.
Doing it on the scale of the basin is the right scale of action, rather than aiming to act globally, which is too difficult. Doing it quickly is important, too, without waiting for possible new ideal solutions. The result of our present actions will only be apparent in fifty years' time. We are forced to become increasingly intelligent, work more and more collectively and learn how to progress by moving forward.

"The Garonne is both a risk and a great opportunity. The transformation of Bordeaux relied to a great extent on winning back the two banks and this urban development was accepted unanimously. We still have a large margin of progression to make the Garonne a more hospital place for navigation. We have to keep on developing our river."

ALAIN JUPPÉ,
MAYOR OF BORDEAUX, PRESIDENT OF BORDEAUX MÉTROPOLE

7. APPROPRIATING RIVERS IN ORDER TO SHARE THEM

The fact that cities all over the world are making efforts to win back their river banks is glaringly obvious. Rivers have long been artificialized, because feared, and hidden from people's gazes, further fuelling these fears. The challenge is now to reverse this situation, by allowing people to rediscover their rivers, by telling their histories and imagining the solutions they can provide. This entails understanding and its transmission to create trust and act for the community!

The case of Bordeaux is exemplary in this respect. Water is part of the city's identity: its location and development have relied on the wealth provided by the river. However, the city turned its back on the river for many years. The reversal occurred about twenty years ago with urban projects that placed the river at centre stage.

Composition of the Rivers Committee

On the occasion of this 7th session, two new members joined IFGR: Anne-Claire Vial, President of the Institut du Végétal – ARVALIS and Thierry Guimbaud, Managing Director of VNF.
The Yellow River Conservation Commission was represented by Sun Feng, Deputy Managing Director of international cooperation.

Ricardo Javier Álvarez
Vice-President of the Argentinian subsidiary of the Ibero-American Institute of Maritime Law (IIDM) and coordinator of Hidrovias Latin America.

Pascal Bourdeaux
Historian, Associate Professor of the École Pratique des Hautes Études (Religions of Southeast Asia).

Corinne Castel
Archaeologist, Director of Research at the CNRS, Director of the French-Syrian Archaeological Mission of Al- Rawda, seconded to the laboratory "Archéorient. Environnement et sociétés de l'Orient ancient" of the Maison de l'Orient et de la Méditerranée (MOM).

Julien Clément
Doctor of anthropology.

Daniel Dagenais
Vice-President of Operations of the Montreal Port Administration.

Katherine Daniell
PhD and researcher at the Australian National University; member of the Australian National Committee of Water Engineering; specialist on water governance and participatory processes.

Thierry Guimbaud
Managing Director of Voies Navigables de France (VNF).

Bernd Gundermann
Architect, founder of and Director of Urbia-Group – Think Beyond.

Mohammad Mozammel Haque
President of the Bangladesh Inland Water Transport Authority (BIWTA).

Mirdad Kazanji
Director of the Pasteur Institute of French Guyana.

Kabiné Komara
International consultant, member of the International Action Council.

Sergio Makrakis
Associate Professor and researcher at the State University of Western Parana - Unioeste (Brazil); specialist on the evaluation of the impacts of fish passes on populations of migrating fish.

Ghislain de Marsily
Emeritus Professor at Sorbonne University (Paris VI-Pierre-et-Marie-Curie) and at the École des Mines de Paris, member of the Academy of Sciences.

Gilles Mulhauser
Managing Director of water for the State of Geneva, Switzerland.

Tamsir Ndiaye
Managing Director of the Société de Gestion de l'Énergie de Manantali - SOGEM (Mali).

Erik Orsenna
Economist, author, member of the French Academy, and specialist on sustainable development, the environment, agriculture and emerging economies.

Irina Ribarova
Professor at the UACEG (University of Architecture, Civil Engineering and Geodesics, Sofia, Bulgaria), expert on the integrated management of water resources and the circular economy relating to water.

Papa Abdoulaye Seck
Minister of Agriculture and Rural Facilities of Senegal.

Hamed Diane Semega
High Commissioner of the Senegal River Development Organisation – OMVS.

Alfredo Sese
Technical Secretary of Transport Infrastructure at the Rosario Stock Exchange – BCR (Argentina).

James Spalding Hellmers
Former Managing Director of Itaipu Binacional (Paraguay).

Yangbo Sun
Director of International Cooperation of the Yellow River Conservation Commission, Ministry of Water Resources, China.

Marie-Laure Vercambre
Director of the Water for Life and Peace program, Green Cross International.

Anne-Claire Vial
President of the Institut du Végétal – ARVALIS.

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